MINING HISTORY AND MINERAL RESOURCES OF THE MIMBRES RESOURCE AREA, DOÑA ANA, LUNA, HIDALGO, AND GRANT COUNTIES, NEW MEXICO

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ABSTRACT

The Federal Land Policy and Management Act of 1976 (FLPMA) charges the U. S. Bureau of Land Management (BLM) with the responsibility for preparing a mineral-resource inventory and assessment for mineral resources for all of the public lands they manage. The Mimbres Resource Area of the BLM, includes all of Doña Ana, Luna, Hidalgo, and Grant Counties, the most mineralized area in New Mexico. Mining has been an integral part of the economy of the Mimbres Resource Area since pre-historic times. Twentyfive types of deposits are found throughout the Mimbres Resource Area, including several world-class ore deposits.

The Mimbres Resource Area accounts for most of the copper and zinc production from New Mexico as well as significant amounts of gold, lead, and silver. Total production from the Mimbres Resource Area is estimated to amount to 15.7 billion pounds of copper, 100 million ounces of silver, 1.2 million ounces of gold, 651 million pounds of lead, and 2.8 billion pounds of zinc. This accounts for over 90% of the total copper, zinc, and silver production from New Mexico (1848-1993), 89% of the lead, and 46% of the gold production. Other commodities have been produced as well. Most mining since 1950 has occurred in the Silver City area.

Many districts in the Mimbres Resource Area account for most of the metals production in New Mexico. In Grant County, the Chino (Santa Rita district) and Tyrone (Burro Mountains district) mines are the largest porphyry-copper deposits in New Mexico. The Chino mine is also the state's largest gold producer. The Burro Mountains district is the 2nd largest silver producing district in New Mexico, whereas the Bayard district ranks 3rd. The Bayard district is the 2nd largest silver producing district in the state. The Fierro-Hanover district ranks 3rd in copper production behind Santa Rita and Burro Mountains districts, and ranks 4th in lead and 1st in zinc production. Other districts also are significant base- and precious-metals producers: Piños Altos (5th zinc, 6th copper, 10th gold), Copper Flat (6th in zinc), Carpenter (7th in zinc), and Steeple Rock (9th gold, 13th silver). In Luna County, the Cooke's Peak district ranks 5th in lead production in the state and 9th in zinc production and the Victorio district ranks 7th in lead production in the state. In Hidalgo County, the McGhee Peak mining district is the 8th largest zinc and lead producing district in New Mexico and Lordsburg is the 10th largest lead and zinc producing district in the state. The Lordsburg district is also 4th in copper production, 6th in gold, and 4th in silver production.

Today metal mining is occurring in the Silver City area (Chino, Tyrone, Continental mines) and in the Lordsburg and Steeple Rock districts. Manganese is sporadically produced from government stockpiles in Luna County. Industrial minerals, especially scoria (Aden district), clay (Brickland and Pratt districts), silica (Brockman district), travertine (Rincon, Doña Ana County), agate, and sand and gravel are important commodities. Many of these mining districts have excellant potential for additional mineral discoveries.

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INTRODUCTION

The Federal Land Policy and Management Act of 1976 (FLPMA) charges the U. S. Bureau of Land Management (BLM) with the responsibility for preparing a mineral-resource inventory and assessment for mineral resources for all of the public lands they manage. In order to meet this requirement, the BLM requested the U. S. Geological Survey (USGS) to prepare a comprehensive report on the mineral resources in the BLM's Mimbres Resource Area, which includes Doña Ana, Luna, Hidalgo, and Grant Counties in southwestern New Mexico (Fig. 1). The USGS, in turn, requested the assistance of the staff at the New Mexico Bureau of Mines and Mineral Resources (NMBMMR). This report includes sections describing the mining history and geology of the mining districts in the Mimbres Resource Area, which will be included in the final USGS report. This report is open-filed by NMBMMR in order to make this information available quickly to the public. This report also contains some information not included in the final USGS report. This study is based upon integration of limited field reconnaissance with published and unpublished reports and geochemical data. More detailed reports are underway and will be available as NMBMMR county bulletins.

ACKNOWLEDGEMENTS

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MINING HISTORY AND PRODUCTION IN THE MIMBRES RESOURCE AREA

Introduction

Mining has been an integral part of the economy of the Mimbres Resource Area since pre-historic times. Mining districts are found throughout in the Mimbres Resource Area (Table 1, Fig. 1) and several world-class ore deposits are found in the region. Unfortunately, financial scams and frauds along with exaggerations of vast mineral wealth have also plagued southwestern New Mexico. Despite this, the Mimbres Resource Area accounts for most of the copper and zinc production from New Mexico as well as significant amounts of gold, lead, and silver. Total production from the Mimbres Resource Area is estimated to amount to 15.7 billion pounds of copper, 100 million ounces of silver, 1.2 million ounces of gold, 651 million pounds of lead, and 2.8 billion pounds of zinc (Table 2). This accounts for over 90% of the total copper, zinc, and silver production from New Mexico (1848-1993), 89% of the lead, and 46% of the gold production (NMBMMR file data, compiled by V.T. McLemore). Other commodities have been produced as well.

TABLE 1—Mining districts of the Mimbres Resource Area. District names modified from File and Northrop (1966), Northrop, 1959), and North and McLemore (1986). Type of deposit after North and McLemore (1986, 1988) and includes USGS classification in parenthesis (Cox and Singer, 1986).

DISTRICT (ALIASES)	YEAR OF DISCOVERY	YEARS OF PRODUCTION	COMMODITIES PRODUCED (PRESENT)	TYPE OF DEPOSIT
Doña Ana County				
Aden (Potrillo, Black Mountain)	1900s	1950s-present	scoria	volcanic
Bear Canyon (Stevens, San Agustin)	1900	early 1900s, 1932, 1950s	Cu, Ag, Pb, Ba (F, V, Mo)	Rio Grande Rift
Black Mountain[1] (Kent, Organ)	1883	1883-1900s	Cu, Au, Ag, Pb, F (Ba)	Rio Grande Rift
Brickland (Eagle)	1900s	present	brick clay, silica, limestone	sedimentary
Doña Ana Mountains	1900	early 1900s	Cu, Au, Ag, marble (Mn, Pb, Zn)	volcanic-epithermal (25b,c,d,e)
Iron Hill (Robledo Mts.)	1930s	none	Fe, travertine	sedimentary iron deposits (34f)
Northern Franklin Mountains	1914	1914	Ag, Pb, Fe, jarosite, gypsum, limestone, shale (F, Ba)	Rio Grande Rift, volcanic-epithermal (?)

DISTRICT (ALIASES)	YEAR OF DISCOVERY	YEARS OF PRODUCTION	COMMODITIES PRODUCED (PRESENT)	TYPE OF DEPOSIT
Doña Ana County(cont.)				
Organ Mountains (Mineral Hill, Bishops Cap, Organ, Gold Camp, Modoc, South Canyon, Texas)	1830s (perhaps as early as 1797)	1849-1961, 1969-1972	Cu, Au, Ag, Pb, Zn, U, F, Ba, Bi, brick clay (Mo, Te, W, Sn, Mn, Fe, marble, magnesite, beryl, feldspar, topaz, Sb,)	carbonate-hosted Pb-Zn replacement (19a, 18a), skarn (18a,19a), pegmatites, epithermal/mesothermal veins (22c), porphyry Cu-Mo (?) (21a), copper breccia, Rio Grande Rift
Potrillo Mountains	1883	?	Cu, Au, Ag, Pb, travertine (Ba, F, Zn, Fe)	Rio Grande Rift
Rincon (Hatch, Woolfer Canyon)	early 1900s	1918	Mn, Ba (F, W, Cu, Pb, Zn, Ag, U, travertine)	epithermal manganese (25g), Rio Grande Rift
San Andrecito-Hembrillo (Membrillo, Capital Peak)	1890s	1890s-1945	Cu, Ag, Pb, talc (Ba, F, W?)	Rio Grande Rift, Precambrian vein and replacements(?) (22c)
San Andres Canyon (Capital Peak)	1900	1900-1904	Cu, Pb (Ag, Ba, F)	Rio Grande Rift
Tonuco Mountain (San Diego Mountain)	1900	1919-1935	Ba, F, Mn, travertine (U, Fe)	Rio Grande Rift (26b)
Tortugas Mountain	1900	1919-1943	F, Mn, Ba (travertine)	Rio Grande Rift
Grant County[2]				
Alum Mountain (Gila River, Alunogen, Copperas Creek))	1893	1885, 1945	Au, Ag, alum, meerschaum (Cu, Pb, Zn, Ga, clay)	volcanic-epithermal (25b,c,d,e)
Bayard (Central, Groundhog, San Jose)	1858	pre 1869, 1902-1969	Cu, Pb, Au, Ag, Zn, V (W, Mo, Te, Ba)	Laramide vein (22c), placer gold (39a)
Black Hawk (Bullard Peak)	1881	1881-1960	Au, Ag, Cu, Pb, F, W, Mn. Fe (Co, Ni, U, Bi, Mo, Ba, Zn)	Laramide vein (22c), tungsten placers
Bound Ranch (Langford Hills, Separ)	?	1900s-1940s	W, F (Au, U, Ba, Cu, Ni, Ag)	Laramide vein (22c), fluorite veins
Burro Mountains (Tyrone)	1871	1871-present	Au, Ag, Cu, Mo, Pb, Zn, F, W, Mn, Bi, U, turquoise (Te, Be)	placer gold (39a), porphyry Cu (21a), Laramide vein (22c)
Caprock Mountain	1917	1917-1959	Mn,F	epithermal manganese (25g)
Carpenter (Swartz, Schwartz)	1891	1891-1969	Au, Ag, Cu, Pb, Zn (F, W, Be, Ba)	carbonate-hosted Pb-Zn replacement (19a, 18a)
Chloride Flat (Silver City, Boston Hill)	1871	1873-1946	Au, Ag, Cu, Pb, Mn, Fe	carbonate-hosted Ag-Mn replacement (19a,b)
Copper Flat	late 1800s	1927-1947	Cu, Au, Ag, Pb, Zn, Fe	Laramide Pb-Zn, Cu skarn (18a,19a)
Cora Miller	1880	1940-1941	Cu, Au, Ag, Pb (Mn)	volcanic-epithermal (25b,c,d,e)
Eureka (Hachita)	1871	1880-1957	Au, Ag, Cu, Pb, W, Zn, As, turquoise (Be, Te, Bi, Mo, Ba, F, Fe, V)	Laramide vein (22c), Laramide Pb-Zn, Cu skarn (18a,b, 19a), placer gold (39a)
Fierro-Hanover	1850	1889-1980, present	Au, Ag, Cu, Pb, Zn, Fe, F, Mn (Ge, Be, Bi, Cd, Mo, W)	Laramide Pb-Zn, Cu skarn (18a,19a), carbonate-hosted Mn replacement
Fleming (Bear Mountain)	1882	1882-1959	Cu, Au, Ag, Pb,Z n, F (Mn)	Laramide vein (22c)
Georgetown (Mimbres)	1866	1866-1985	Ag, Pb, Au, Cu, Zn (Bi, F, Ba, Mn, V)	carbonate-hosted Ag-Mn replacement (19a,b)
Gila Fluorspar (Brock Canyon)	1880	1880s-1959	F (Ba, Au, Ag, Cu, U, Pb, Zn, Mo)	volcanic-epithermal (25b,c,d,e)
Gold Hill (Camp Bobcat)	1884	1886-1941	Au, Ag, Cu, Pb, W, F, Be, REE, beryl (U, Ta, Ba, Mn, Bi, Zn, mica)	Laramide vein (22c), placer gold (39a), epithermal manganese (25g), pegmatite
Lone Mountain (Mineral Mountain)	1871	1871-1955	Au, Ag, Pb, Mn, Cu, Fe	carbonate-hosted Ag-Mn replacement (19a,b)
Malone	1884	1884-1961	Cu, Au, Ag, Pb, Zn, F (U, Bi)	Laramide vein (22c), placer gold (39a)
Northern Cooke's Range	?	?	Ag, Pb, F (Zn)	carbonate-hosted Pb-Zn replacement (19a, 18a), Rio Grande Rift(?)
Piños Altos (Juniper Hill)	1860	1867-1957 1980s-present	Cu, Au, Ag, Pb, Zn, Fe (W, In, Be, Ba)	Laraamide Pb-Zn, Cu skarns (18a,19a), Laramide vein (22c), placer gold (39a)
Ricolite (Ash Creek)	?	?	Mn, F, ricolite	epithermal manganese? (25g)
San Francisco prospects (Potholes, Mule Creek)	1960s	none	(Au, Ag, Cu, Mo, Sb, Mn)	volcanic-epithermal (25b,c,d,e)

DISTRICT (ALIASES)	YEAR OF DISCOVERY	YEARS OF PRODUCTION	COMMODITIES PRODUCED (PRESENT)	TYPE OF DEPOSIT
Grant County(cont.)				
Santa Rita	1800	1801-present	Cu, Au, Ag, Mo, Fe (Zn, Pb, Sb, Be)	porphyry Cu (21a), Laramide Cu skarns (18a)
Steeple Rock (Twin Peaks, Duncan, Goat Camp Springs, Bitter Creek)	1860	1880-1993	Au, Ag, Cu, Pb, Zn, F, Mn (Mo, clay, alunite, U, Be, Ba)	volcanic-epithermal (25b,c,d,e)
Telegraph (Red Rock, Anderson, Ash Creek, Wildhorse Mesa, Clarks Peak)	1881	1885-1951	Cu, Au, Ag, Pb, Zn, Mn, F (U, Th, Ba)	volcanic-epithermal (25b,c,d,e), fluorite veins (26b)
White Signal (Cow Spring)	1880	1880-1968	Cu, U, Au, Ag, Pb, Bi, F, garnet (Th, Zn, Ta, turquoise, Zn, REE, Ba)	Laramide vein (22c), placer gold (39a), pegmatites, porphyry Cu-Mo (21a)
Wilcox (Catron County) (Seventy-four)	1879	1941	Cu, F, Te, Au, Ag (Pb, Zn, Mo, Cd, Mn)	volcanic-epithermal (25b,c,d,e)
Hidalgo County				
Antelope Wells-Dog Mountains (Alamo Hueco)	?	1954	Mn, U (travertine, guano)	epithermal manganese (25g)
Apache No. 2 (Anderson, Hachita)	late 1870s	1880-1956	Au, Ag, Cu, Pb, Zn, Bi (W, Ge, Be, F, Mo)	carbonate-hosted Pb-Zn replacement (19a, 18a)
Big Hatchet Mountains	1917	1917-1960	Ag, Pb, Zn (Cu, U, Cd, gypsum)	carbonate-hosted Pb-Zn replacement (19a, 18a)
Brockman	1900s	early 1900s-present	silica	sedimentary
Fremont	1860	1880-1959	Cu, Pb, Zn, Au, Ag, U, V (Bi)	volcanic-epithermal (25b,c,d,e), carbonate-hosted Pb-Zn replacement (19a, 18a)
Gillespie (Red Hill)	1880	1905-1970	Au, Ag, Cu, Pb, F, Mn (W, Zn, Mo)	volcanic-epithermal (25b,c,d,e)
Granite Gap (San Simon)	1887	1897-1955	Cu, Pb, Zn, Au, Ag, W, Sb (Bi, Be, F, U, REE, As, Ba)	carbonate-hosted Pb-Zn replacement (19a, 18a)
Kimball (Steins Pass)	1875	1875-1953	Cu, Au, Ag, Pb, Zn, Mn	volcanic-epithermal (25b,c,d,e)
Lordsburg (Virginia, Pyramid, Ralston, Shakespeare)	1870	1885-1978, 1990-present	Cu, Pb, Zn, Au, Ag, F, perlite (Ge, Be, Mo, Ba, U, pumice)	Laramide vein (22c), placer gold (39a)
McGhee Peak	1894	1894-1956	Cu, Pb, Zn, Au, Ag (Sb)	carbonate-hosted Pb-Zn replacement (19a, 18a), porphyry Cu (21a)
Muir	?	1940s, 1952	F, Ag, clay (Pb, Cu, Au, Sb, Mn)	epithermal Mn (25g), fluorite veins (26b), volcanic-epithermal (25b,c,d,e)
Pratt	1900s	1912-present	fire clay	sedimentary
Rincon (Animas)	1880	1940-1949	Cu, Au, Ag, Pb (F, Mn, Ba)	carbonate-hosted Pb-Zn replacement (19a, 18a), epithermal manganese (25g), volcanic-epithhermal (25b,c,d,e)
Silver Tip (Bunk Robinson, Whitmore, Cottonwood Basin)	1930	none	(Au, Ag, Pb, Mo, Zn, Bi, Ba, F)	volcanic-epithermal (25b,c,d,e)
Sylvanite	1871	1902-1957	Cu, Pb, Au, Ag, W, As (Sb, Te, Zn, Ge, Be, Mo, Bi, Ba, F)	Laramide Pb-Zn, Cu skarns (18a,19a), Laramide vein (22c), placer gold (39a)
Luna County				
Camel Mountain-Eagle Nest	?	none	(Au, Ag, Pb, Zn, F, Mn)	volcanic-epithermal (25b,c,d,e), carbonate-hosted Ag-Mn replacement (19a,b)
Carrizalillo (Cedar Mountains, Stonewall)	late 1800s	late 1800s, 1930-1956	Cu, Pb, Ag, Au, agate, geodes (U, Mn,W, Zn, Mo)	volcanic-epithermal (25b,c,d,e), Rio Grande Rift
Cooke's Peak (Jose)	1876	1876-1965	Cu, Au, Ag, Pb, Zn, F, Mn (U, Ba, Fe)	carbonate-hosted Pb-Zn replacement (19a, 18a), carbonate-hosted Mn replacement (19a), polymetallic veins (22c), fluorite veins (26b)
Florida Mountains	1876	1880-1956	Cu, Pb, Zn, Au, Ag, Mn, F (Ba, Ge, Fe, travertine)	fluorite veins (26b), epithermal manganese (25g), carbonate-hosted Pb-Zn replacement (19a, 18a), polymetallic veins (22c)
Fluorite Ridge	1907	1909-1954	F, Mn (Ba, Zn, travertine)	Rio Grande Rift, epithermal manganese (25g), fluorite vein (26b)

DISTRICT (ALIASES)	YEAR OF DISCOVERY	YEARS OF PRODUCTION	COMMODITIES PRODUCED (PRESENT)	TYPE OF DEPOSIT
Luna County (cont.)				
Little Florida Mountains (Black Rock)	1915	1918-1951	F, Mn (Ba, Co, clay)	Rio Grande Rift (?), epithermal manganese (25g), fluorite veins (26b)
Old Hadley (Graphic)	1880	1880-1929	Cu, Pb, Zn, Au, Ag (Ba, U, alunite)	volcanic-epithermal (25b,c,d,e)
Tres Hermanas	1881	1885-1957	Cu, Pb, Zn, Au, Ag, Mn (U, W, Ge, Be, F, Fe, travertine)	Laramide skarn (19a, 18a), Laramide vein (22c)
Victorio (Gage)	1870s	1880-1957	Cu, Pb, Zn, Au, Ag, W, limestone (Be, U, Fe, F, Mo)	carbonate-hosted Pb-Zn replacement (19a, 18a), tungsten-beryllium contact-metasomatic deposits (14a), porphyry Mo-W (?) (16?)

[1]Black Mountain is now restricted in this report to include only Rio Grande Rift deposits in the Black Mountain area. North and McLemore (1986) and McLemore (1994b) included the description for Mineral Hill (Precambrian veins and replacement deposits) as part of the Black Mountain district. However, the gold production from Mineral Hill was credited to the Organ Mountains district. The veins at Mineral Hill are now classified as epithermal/mesothermal veins and are included as part of the Organ Mountains district.
[2]The Central mining district is not used in this report. Historically, it referrs to all or part of the Bayard, Chloride Flat, Fierro-Hanover, Fleming, Georgetown, Lone Mountain, Piños Altos, Santa Rita, and Silver City mining districts.

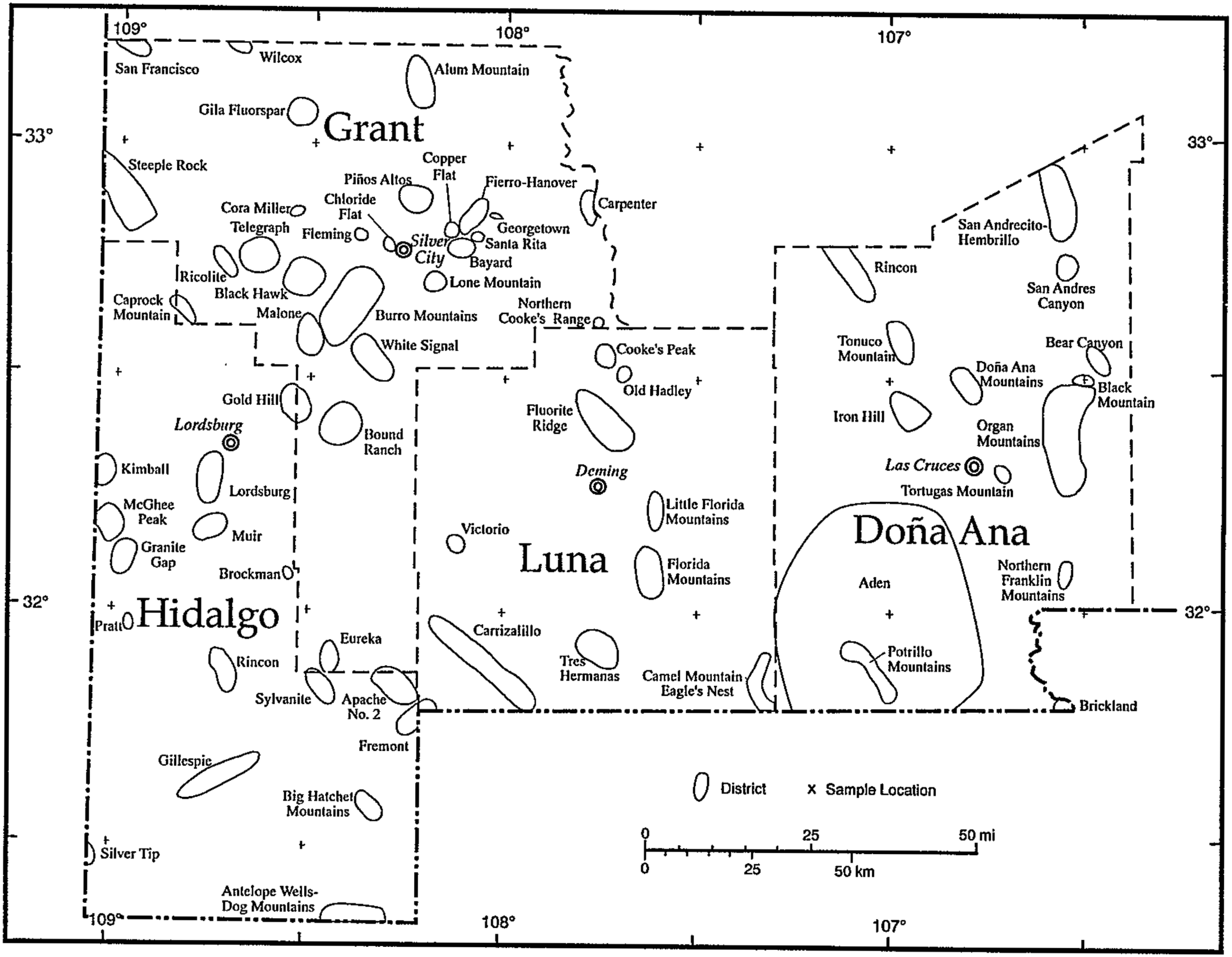

Figure 1—Mining districts in the Mimbres Resource Area, Doña Ana, Luna, Hidalgo, and Grant Counties, New Mexico.

TABLE 2—Base- and precious-metal production in the Mimbres Resource Area. ( )—estimated data. Small, some, W—production not available. — No data. Production statistics in part from U. S. Geological Survey (1902-1927) and U. S. Bureau of Mines (1927-1990).

DISTRICT	PERIOD OF PRODUCTION	ORE (SHORT TONS)	COPPER (POUNDS)	GOLD (TROY OUNCES)	SILVER (TROY OUNCES)	LEAD (POUNDS)	ZINC (POUNDS)	REFERENCES	COMMENTS
Dona Ana County									
Bear Canyon	early 1900s-1950s	—	(<10,000)	—	(<100)	some	—	Dunham, 1935; McLemore, 1994b	—
Black Mountain	1883-1900s	—	(<10,000)	(600)	(<1,000)	some	—	Dunham, 1935; North and McLemore, 1986; McLemore, 1994b	$12,000 of gold production from Mountain Chief mine
Doña Ana Mountains	early 1900s	—	small	(100)	(5,000)	—	—	North and McLemore, 1986	—
Northern Franklin Mountains	1914	—	—	—	small	small	—	North and McLemore, 1986	—
Organ Mountains	1849-1961, 1969-1972	—	(4,636,000)	(11,500)	(820,000)	(25,000,000)	(1,700,000)	USBM file data; Jones, 1965; North and McLemore, 1986; Seager, 1981; Dunham, 1935; Eveleth, 1983	produced about $2.7 million 1849-1961
Portrillo Mountains	?	—	some	some	some	some	—	Dunham, 1935	minor production
San Andrecito-Hembrillo	1914, 1915, 1918, 1920-1930	—	(<10,000)	—	(<100)	some	—	Anderson, 1957; McLemore, 1994b; Dunham, 1935	<$10,000 produced
San Andres Canyon	1900-1904	—	(<10,000)	—	—	some	—	Dunham, 1935	—
Grant County									
Alum Mountain (Gila River, Alunogen)	1945	3	—	1	21	—	—	North and McLemore, 1986	—
Bayard	1902-1969 1902-1969	4,462,414	102,880,241 (110,000,000)	23,340 (24,000)	7,365,992 (7,500,000)	224,786,835 (225,000,000)	808,877,092 (809,000,000)	USBM file data; Johnson, 1972; Anderson, 1957; Richter and Lawrence, 1983	more than $7 million produced 1906-1932
Black Hawk (Bullard Peak)	1881-1960 1940, 1946	— 359	(3,000) 2,100	(1,000) 14	(1,286,000) 4,637	(4,000) 3,800	—	North and McLemore, 1986; Richter and Lawrence, 1983; USBM file data	1885-1910 production about $1 million (Lindgren et al., 1910)
Burro Mountains (Tyrone)	1871-1992	318,000,000	(5,240,000,000)	(>50,000)	(>10,000,000)	(>200,000)	(>300,000)	North and McLemore, 1986; Kolessar, 1982	over $20 million produced 1904-1956

DISTRICT	PERIOD OF PRODUCTION	ORE (SHORT TONS)	COPPER (POUNDS)	GOLD (TROY OUNCES)	SILVER (TROY OUNCES)	LEAD (POUNDS)	ZINC (POUNDS)	REFERENCES	COMMENTS
Grant County (cont.)									
Carpenter (Swartz)	1891-1969	(75,000)	(310,000)	300	(60,000-180,000)	(6,000,000)	(12,500,000)	Hedlund, 1985b; USBM file data	$1.35 million produced 1938-1957
Chloride Flat (Silver City)	1873-1946	149,000	(20,000)	(200)	(4,000,000)	(500,000)	—	USBM file data; Richter and Lawrence 1983; Thompson 1965a,b; Anderson, 1957	$5 million Ag produced 1870-1946 (Northrop, 1959)
Copper Flat	1927-1947	(200,000)	W	W	W	W	W	North and McLemore, 1986	—
Cora Miller	1940-1941	(300)	W	W	W	W	—	North and McLemore, 1986	—
Eureka (Hachita)	1880 -1961	—	(500,000)	(5,000)	(450,000)	(2,900,000)	(1,700,000)	USBM file data; North and McLemore, 1986; NMBMMR file data	over $600,000 produced 1934-1957, $1.59 million 1878-1952
Fierro-Hanover	1890-1980s	—	(1,250,000,000)	(>50,000)	(>5,000,000)	(>52,000,000)	(1,210,000,000)	USBM file data; North and McLemore, 1986; Anderson, 1957; Richter and Lawrence, 1983	1858-1861 1 million pounds copper produced (Jones, 1904)
Fleming	1882-1893 1936-1948	— 1,436	(100) 450	(<1,000) 54	(300,000) 11,192	(1,000) 465	(11,000) 10,013	North and McLemore, 1986; Thompson, 1965a,b; USBM Mineral Yearbooks	$300,000 total produced 1934-1957 (Anderson, 1957)
Georgetown	1866-1975	—	some	some	(3,858,000)	some	some	North and McLemore, 1986; Thompson, 1965a,b; Richter and Lawrence, 1983	$3.5 million total produced (Anderson, 1957)
Gold Hill	1911-1941	5,686	6,845	1,620	(3,000)	(16,100)	—	USBM files; North and McLemore, 1986	more than $100,000 in Ag (Richter and Lawrence, 1983)
Lone Mountain	1871-1950 1936-1950	— 5,342	(5,000) 2,800	(<1,000) 18	(>100,000) 28,578	(5,000) 1,000	—	North and McLemore, 1986; USBM file data	—
Malone	1884-1961	—	some	(12,000)	(>10,000)	some	some	North and McLemore, 1986; Richter and Lawrence, 1983	about $300,000 produced
North. Cooke's Range	?	—	—	—	some	some	—	North and McLemore, 1986	—

DISTRICT	PERIOD OF PRODUCTION	ORE (SHORT TONS)	COPPER (POUNDS)	GOLD (TROY OUNCES)	SILVER (TROY OUNCES)	LEAD (POUNDS)	ZINC (POUNDS)	REFERENCES	COMMENTS
Grant County (cont.)									
Piños Altos	1890-1994	—	(59,500,000)	(169,000)	(2,600,000)	(6,000,000) — —	(64,000,000)	Johnson, 1972; USBM file data; North and McLemore, 1986; Richter and Lawrence, 1983; Osterberg and Muller, 1994	over $10.3 million produced; $4.7 million produced prior to 1904 (Jones, 1904)
Santa Rita	1801-1994	482,900,000	(9,080,000,000)	(>500,000)	(>5,360,000)	—	—	Wunder and Trujillo, 1987; North and McLemore, 1986; Long, 1995	—
Steeple Rock	1880-1991	(365,000)	(1,200,000)	(151,000)	(3,400,000)	(5,000,000)	(4,000,000)	Richter and Lawrence, 1983; Griggs and Wagner, 1966; USBM file data; North and McLemore, 1986; Tooker and Vercoutere, 1986; McLemore, 1993	Carlisle mine, total production about $5 million; additional production in 1970s; total district produced about $10 million
Telegraph (Red Rock)	1938-1951	98	1,700	1	1,350	37,800	some	Ratté et al., 1979	—
White Signal	1880-1968	(2,000)	(26,000)	(1,700)	(2,500)	(2,200)	—	North and McLemore, 1986; Johnson, 1972; Richter and Lawrence, 1983	total production $80,000 (Anderson, 1957)
Wilcox	1941	2	some	some	17	—	—	—	—
Hidalgo County									
Apache No. 2	1927-1956 1880-1956	5,607 —	176,400 (1,300,000)	41 (300)	14,282 (125,000)	111,600 (300,000)	14,300 (20,000)	North and McLemore, 1986	$107,000 produced (Elston, 1965)
Big Hatchet Mountains	1917, 1919	—	—	—	small	small	small	North and McLemore, 1986; Elston, 1965	$2,000 produced (Elston, 1965)
Fremont	1880-1951 1947-1951	— 279	(2,000) 400	(10) 3	(10,000) 377	(190,000) 20,500	(4,000) —	North and McLemore, 1986	—
Gillespie (Red Hill)	1908-1950 1880-1950, 1970s	3,746 —	3,400 (15,000)	6 (20)	14,249 (20,000)	1,019,500 (1,800,000)	— (2,000)	Elston, 1965; North and McLemore, 1986; USBM file data	about $100,000 produced

DISTRICT	PERIOD OF PRODUCTION	ORE (SHORT TONS)	COPPER (POUNDS)	GOLD (TROY OUNCES)	SILVER (TROY OUNCES)	LEAD (POUNDS)	ZINC (POUNDS)	REFERENCES	COMMENTS
Hidalgo County (cont.)									
Granite Gap (San Simon)	1934-1955	16,906	20,400	303	91,052	1,606,750	652,200	Richter and Lawrence, 1983	about $1.95 million produced
Kimball (Steins Pass)	1875-1953	—	(12,000)	(1,500)	(400,000)	(125,000)	some	North and McLemore, 1986; USBM file data	about $500,000 produced
Lordsburg	1885-1992	—	(229,577,000)	(266,600)	(7,371,697)	(11,000,000)	(4,200,000)	Richter and Lawrence, 1983	more than $60 million produced
McGhee Peak	1894-1956	100,000	(85,000)	(100)	(200,000)	(12,000,000)	(10,000,000)	Gillerman, 1958; Richter and Lawrence, 1983	Carbonate Hill mine produced over $1.5 million
Muir	1943-1948	(<100)	—	—	(<100)	—	—	Elston, 1960	$100
Rincon (Animas)	1940-1949	—	(<10,000)	some	(>10,000)	some	—	North and McLemore, 1986	$20,000 worth of silver produced (Elston, 1965), about $320,000
Sylvanite	1902-1957	(6,100)	(130,000)	(2,500)	(35,000)	(80,000)	—	North and McLemore, 1986; Johnson, 1972	about $315,000 produced
Luna County									
Camel Mountain-Eagle Nest	none	—	—	—	—	—	—	—	—
Carrizalillo (Cedar, Stonewall)	late 1800s, 1945-1956	—	(<1,000)	(<100)	(<1,000)	(<1,000)	—	North and McLemore, 1986; Griswold, 1961	—
Cooke's Peak	1876-1965 1902-1956	— 29,159	(23,000) 22,607	(<1,000) 672	(71,000) 70,862	(50,000,000) 8,483,509	(7,000,000) 6,469,702	Jica, 1954; Thompson, 1965a	estimated $3 million produced 1880-1908 (Lindgren et al., 1910); $4.2 million 1876-1952 (Northrop, 1959)
Florida Mountains	1880-1956 1934-1956	— 116	(5,000) 4,150	(<10) <1	(8,000) 6,391	(>30,000) 25,980	some	Griswold, 1961	$102,000 produced 1880-1957
Old Hadley	1880-1929	—	some	150	(550)	some	some	Jicha, 1954; North and McLemore, 1986	—
Tres Hermanas	1885-1957	—	550	7	(4,000)	(200,000)	(1,000,000)	Griswold, 1961	Mahoney mine produced estimated $500,000
Victorio	1880-1959	70,000-130,000	(41,000)	(12,200)	(581,500)	(17,500,000)	(>60,000)	Tooker and Vercoutere, 1986; Richter and Lawrence, 1983	$2.3 million 1880-1940

Mining records and, especially, production records are generally poor, particularly for the earliest times; because they have not been preserved through the generations. Miners do not always keep adequate records or advertise their activities. Many of the early records are conflicting and scams were and still are common. Metals production from the area since the late 1800s is listed by district in Table 2. Tables 3-8 list production of other commodities from the Mimbres Resource Area. These production figures are the best data available and were obtained from a variety of published and unpublished sources, most of which are on file at the NMBMMR. However, some of these production figures are subject to change, as new data are obtained.

TABLE 3—Placer gold deposits in the Mimbres Resource Area (modified from Johnson, 1972; McLemore, 1994a). Production is in troy ounces.

DISTRICT	YEAR OF DISCOVERY	ESTIMATED GOLD PRODUCTION PRIOR TO 1902	RECORDED GOLD PRODUCTION 1902-1991	TOTAL ESTIMATED GOLD PRODUCTION	LOCATION	REFERENCES
Piños Altos	1860	38,842	5,995	50,000	T16-17S R13-14W — Bear Creek, Rich Gulch, Whiskey Gulch, Santo Domingo Gulch, near Mountain Key mine	Lasky and Wootton (1933), Paige (1911, 1912), Wells and Wootton (1940)
White Signal and Malone	1884	some	366	1,700	T20S R14, 16W —Gold Gulch, Gold Lake	Richter and Lawrence (1983)
Bayard	1900	some	128	<1,000	T17-18S R12-13W — drainages near Bayard	Lasky (1936a)
Sylvanite	1908	none	109	<200	T28S R16W —drainages from west side of Little Hatchet Mountains	Lasky (1947), Wells and Wootton (1940)
Gold Hill	?	?	?	?	T21S R16W —Gold Hill Canyon (Foster)	Richter and Lawrence (1983)
Burro Mountains	?	?	?	?	unspecified streams and dry washes	—
Lordsburg	?	?	none	?	arroyos draining known mines	Northrop (1959)

TABLE 4—Known barite and fluorite production from mines in the Mimbres Resource Area. * Includes production from Catron County portion of the district.

DISTRICT	BARITE PRODUCTION (SHORT TONS)	FLUORITE PRODUCTION (SHORT TONS)	PERIOD OF PRODUCTION	REFERENCES
Doña Ana County				
Bear Canyon (Stevens)	50	—	1932	Dunham (1935), Williams et al. (1964), McLemore (1994b)
Bishops Cap (Organ Mountains district)	—	150	1944, 1969-1972	Williams (1966), McAnulty (1978), Seager (1981)
Black Mountain	—	1,100	?	Dunham (1935), Williams (1966), McAnulty (1978), Smith (1981), McLemore (1994b)
Organ Mountains (White Spar, Tennessee, Golden Lily, Ruby)	600	1,500	1933, mid 1900s	Talmage and Wootton (1937), Rothrock et al. (1946), Williams (1966), Williams et al. (1964), McAnulty (1978), McLemore (1994b)
Rincon (Palm Park, Horseshoe)	10,250	—	?	Williams et al. (1964), Filsinger (1988)
Tonuco Mountain	200	7,720	1919-1935	Rothrock et al. (1946), Clippinger (1949), Williams et al. (1966), McAnulty (1978)
Tortugas Mountain	100	20,751	1919-1943	Ladoo (1923), Rothrock et al. (1946), McAnulty (1978)
Grant County				
Black Hawk	—	615	?	Richter and Lawerence (1983)
Bound Ranch	—	3,230	?	Gillerman (1964), Williams (1966), Richter and Lawrence (1983)
Burro Mountains	—	172,539	1880-1954	Richter and Lawrence (1983)
Fierro-Hanover	—	110	—	McAnulty (1978)
Fleming	—	232	—	Williams (1966)
Gila Fluorspar	—	47,586	1885, 1935-1953	McAnulty (1978)
Gold Hill	—	3,240	1952-1953	McAnulty (1978)
Malone	—	408	?	Gillerman (1964), Williams (1966)
Northern Cookes Range	—	63,531	1948-1953	McAnulty (1978)
Ricolite	—	15,289	?	McAnulty (1978)
Steeple Rock	—	11,000	?	McLemore (1993)
Telegraph	—	16,603	1911-1945	Williams (1966)
*Wilcox	—	10,603	1880s, 1926-1953	Williams (1966), McAnulty (1978)
White Signal	—	3,644	1932-1952	Williams (1966), McAnulty (1978)
Hidalgo County				
Muir	—	9,175	1940s, 1952-1953	Rothrock et al. (1946), McAnulty (1978)
Lordsburg	—	3,527	?	Lasky (1938a), Rothrock et al. (1946); Richter and Lawrence (1985)
Gillespie (Red Hill)	—	1,500	?	Zeller and Alper (1965), Williams (1966), McAnulty (1978)
Luna County				
Cooke's Peak	—	452	1918-1954	Soulé (1946), Rothrock et al. (1946), Griswold (1961), Williams (1966)
Florida Mountains	—	200	?	Griswold (1961), McAnulty (1978)
Fluorite Ridge	—	93,827	1909-1954	Rothrock et al. (1946), Griswold (1961)
Little Florida Mountains	—	13,428	?	Lasky (1940), Griswold (1961), Williams et al. (1964)

TABLE 5—Uranium production from mines in the Mimbres Resource Area (McLemore, 1983). This includes total ore that was received at the buying stations and mills.

MINE NAME	SHORT TONS ORE	POUNDS U_3O_8	% U_3O_8	POUNDS V_2O_5	% V_2O_5	PERIODS OF PRODUCTION
Doña Ana County						
Blue Star (Bishops Cap in Organ Mountains)	12	14	0.06	9	0.04	1955
Grant County						
Floyd Collins (White Signal district)	165	489	0.15	94	0.05	1953, 1959, 1964
Inez (White Signal district)	262	848	0.16	268	0.05	1955
Section 21 (Burro Mountains)	38	30	0.04	23	0.03	1956
Hidalgo County						
Napane (Fremont district)	9	35	0.19	4	0.02	1955

TABLE 6—Other production from mines in the Mimbres Resource Area. Location includes section, township, and range.

MINE	DISTRICT	LOCATION	PERIOD OF PRODUCTION	PRODUCTION	REFERENCES
Doña Ana County					
Hembrillo, Redrock	San Andrecito-Hembrillo	sec. 1, 12 T22S R4E	1917-1930, 1942-1945	10,000 short tons of talc 2,602 short tons of talc	Chidester et al. (1964), Fitzsimmons and Kelly (1980), McLemore (1994b)
Texas Canyon	Organ Mountains	sec. 34 T22S R4E	1908-1921	small amount of ore containing 1% Bi	Dasch (1965)
Scoria pits	Potrillo Mountains	—	1975-1988	estimated 582,000 short tons worth $10 million.	New Mexico State Mines Inspector (1950-1982)
various	Iron Hill	—	1930-1950	unknown amount of 50-55% Fe	Harrer and Kelly (1963)
Copiapo jarosite mine	Northern Franklin	sec. 8 T26S R4E	1925-1928	several hundred short tons of jarosite	Dunham (1935)
Grant County					
Boston Hill, Chloride Flat	Chloride Flat	—	—	2.7 million short tons Mn-Fe ore (30-40% Fe)	Harrer and Kelly (1963)
Copper Flat	Copper Flat	—	1931-1937	10,000 short tons of 55-58% Fe ore	Harrer and Kelly (1963)
Gold Lake	White Signal	sec. 20 T20S R14W	1931-1932	10 pounds of garnet	Richter and Lawrence (1983), Gillerman (1964)
Bear Creek- Juniper Hill	—	sec. 14 T16S R15W	prior to 1915	1,000 short tons of sepiolite	Richter and Lawrence (1983)
various	Fierro-Hanover	—	1889-1962	5.5 mill long tons Fe ore	Harrer (1965)
Chino	Santa Rita	—	1943-1944	unknown amount of 54.6% Fe	Harrer and Kelly (1963)
various	Pinos Altos	—	—	unknown amount of Fe ore	Harrer and Kelly (1963)
Grandview	Gold Hill	—	—	>500 short tons beryl	Griffitts (1965)
Hidalgo County			—		
Sunrise, Baker-Standard, Scheelite	Granite Gap	—	1948	5 short tons 6% Sb	Hobbs (1965), Dasch (1965)
variou	Sylvanite	—	1924	carload of As	Dasch (1965)
Pratt (Phelps Dodge)	Pratt	33 T27S R20W	1908-present	$150,000-200,000 refractory clay, shale	Hatton et al. (1994)
Brockman	Brockman	1 T26S R17W	1900s-present	$1 million in silica	—

TABLE 7—Tungsten production from the Mimbres Resource Area. Location includes section, township, and range.

MINE	DISTRICT	LOCATION	PERIOD OF PRODUCTION	PRODUCTION (SHORT TONS)	%WO_3	REFERENCES
Grant County						
Morning Star	Black Hawk	sec. 28 T18S R16W	1953	1,400	71	Richter and Lawrence (1983); Dale and McKinney (1959)
Zelma	Black Hawk	sec. 33 T18S R16W	1953-1955	7,920	62	Richter and Lawrence (1983); Dale and McKinney (1959)
Green Rock	Black Hawk	sec. 29,32 T18S R16W	—	267	2.7	Richter and Lawrence (1983)
Pacemaker	Black Hawk	sec. 35 T18S R16W	1954	955	62	Richter and Lawrence (1983)
Hillside	Bound Ranch	sec. 26 T22S R16W	1941	650	—	Richter and Lawrence (1983); Dale and McKinney (1959)
Alpha, Hillside, Bluebird	Bound Ranch	sec. 27 T22S R15W	1939, 1941, 1952	3,500	1	Richter and Lawrence (1983); Dale and McKinney (1959)
Hidalgo County						
Eagle Point	Sylvanite	sec. 22 T29S R16W	1943	5,632	0.44	Dale and McKinney (1959)
Cactus	Sylvanite	sec. 10 T29S R16W	1943	small	0.10-0.14	Dale and McKinney (1959)
Sunrise	Granite Gap	sec. 35 T25S R21W	1943	3,000	0.5	Dale and McKinney (1959)
Baker-Standard	Granite Gap	sec. 23,26,27 T25S R21W	1954-1957	unk.	unk.	Dale and McKinney (1959)
Luna County						
Irish Rose (Tedford)	Victorio	sec. 30,31 T24S R12W	1942	20,000 19.6	1 60	Dale and McKinney (1959), Hobbs (1965)

TABLE 8—Manganese production from the Mimbres Resource Area, 1883-1958 (from Farnham, 1961; Dorr, 1965).

MINE	DISTRICT	ORE PRODUCTION (LONG TONS)	GRADE %Mn	CONCENTRATE PRODUCTION (LONG TONS)	GRADE %Mn
Dona Ana County					
Rincon	Rincon	1,529	27-40	—	—
Grant County					
Boston Hill	Chloride Flat	1,632,000	10-13	—	—
Chloride Flat	Chloride Flat	3,132	11.7-16	—	—
Bear Mountain	Chloride Flat	1,830	30	20	45.8
Cliff Roy	Caprock Mountain	1,148	21-36	789	33-35
Consolation	Caprock Mountain	—	—	2,550	35
Hidalgo County					
Rusty Ruthlee	Antelope Wells- Dog Mountains	5.6	37.9	—	—
Luna County					
Manganese Valley	Little Florida Mountains	12,933	21.4	19,871	45
Luna	Little Florida Mountains	6,593	19.1	1,522	30-45
Birchfield	Florida Mountains	1,421	22-30	—	—
Starkey (Ruth)	Cooke's Range	—	—	450	33-46

Early mining activities

Native Americans were the first miners in the area and used local sources of hematite and clay for pigments and obsidian for arrow heads. Their houses were made of stone, adobe, and clay (Fig. 2). Clay was also used in making pottery. Stone tools were shaped from local deposits of pebbles, jasper, chert, and obsidian. The first commercial mining by Native Americans was to obtain turquoise for trading and making ornaments. The frequent occurrence of charcoal at old mines suggests that simple heating of the rock was used to free the valued blue-green turquoise. Charcoal is also a necessary ingredient in both smelting and working iron and steel (ie. blacksmithing). Native copper was mined at Santa Rita and traded for weapons and impliments. Stone tools were undoubtedly used. But the Native Americans never mined great quantities of minerals; vast deposits were left for future generations of Spanish, European, and American miners.

FIGURE 2—Rock house at the Gila Cliff Dwellings National Monument (V. T. McLemore photo, 1994).

The Spanish first entered New Mexico in 1534 with the expedition led by Alvar Nunez Cabeza de Vaca and followed in 1539 by Fray Marcos de Niza. Francisco Vasques de Coronado led an expedition in 1540 looking for gold (Jones, 1904; Christiansen, 1974). Coronado did not find any gold or silver, but he did find turquoise and led the way to future colonization. Early Spanish mining in New Mexico was centered around the Cerrillos and Old Placers districts in Santa Fe County, but some activity occurred in the Mimbres Resource Area, near Silver City. The Pueblo Revolt in 1692 was in part attributed to Spanish enslaving the Native Americans into mining; but there is little documentation to support such accounts (Jones, 1904; Northrop, 1959). Probably the earliest mining by the Spanish in the Mimbres Resource Area was for turquoise in the Burro Mountains and at Santa Rita (Paige, 1922; Gillerman, 1964). However, mining by the Spanish in the Mimbres Resource Area did not amount to much until ca. 1798, when an Apache Indian told Col. Manuel Carrasco about the copper deposits at what is now known as Santa Rita. Carrasco interested Francisco Manuel Elguea to form a partnership and they were issued a land grant, the Santa Rita del Cobre Grant. By 1804 Elguea bought out Carrasco and began mining the copper at Santa Rita in earnest. Elguea found a ready market for copper in Mexico City for coinage. Actual production records are lacking, but Christiansen (1974) estimates he shipped 200 mule trains annually, amounting to about 6,000,000 pounds of copper per year. The expedition of Lieutenant Pike in 1807 encountered mining at Santa Rita (Jones, 1904). The ore was shipped with little or no processing and what processing that was required involved smelting in simple adobe furnaces. Elguea died in 1809 and mining at Santa Rita diminished as a result of increasing costs, difficult transportation, Native Americans uprisings, declining copper demands in Mexico, and finally the Mexican Revolution in 1810. The records are conflicting as to who owned and operated the mines after 1809 and the mines finally closed in 1834. They were still inactive when Kearney's army visited the area in 1846 (Jones, 1904; Milbauer, 1983).

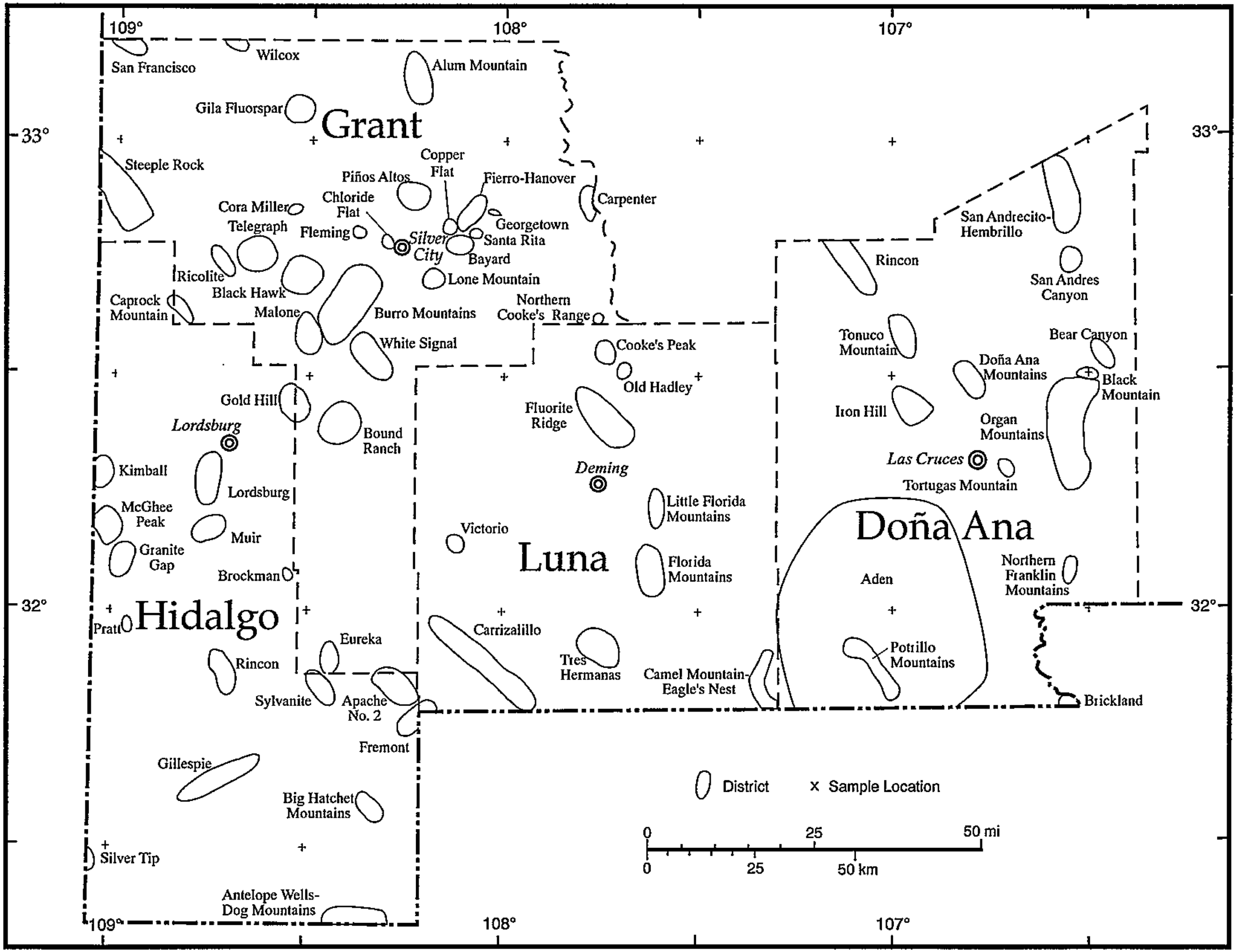

Figure 1—Mining districts in the Mimbres Resource Area, Doña Ana, Luna, Hidalgo, and Grant Counties, New Mexico.

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In 1848, New Mexico became part of the United States as a territory and the mining industry became a dominant force in the state. Written records of mining activity and production were still rarely preserved and conflicting stories exaggerating mineral wealth in New Mexico are abundant in early accounts. At first, mining was by small groups of individuals; large mining companies were not formed until the late 1880s. Gold was discovered in the Ortiz Mountains in north-central New Mexico in 1828 (Jones, 1904; McLemore, 1994a) and drew an estimated 2,000-3,000 miners to that region. When the gold played out at Ortiz, many of these miners began prospecting throughout New Mexico, especially in the Mimbres Resource Area. Additional prospectors traveling through the state heading for the gold fields in California in the 1850s, found New Mexico to their liking and stayed. Prospectors had already discovered the mineral deposits in the Organ Mountains in the 1830s; the Stephenson-Bennett mine was discovered in 1849 (Dunham, 1935; Eveleth, 1983). Placer gold was discovered in the Piños Altos district in 1860 (Table 3), when more than 700 miners were working in the district (Milbauer, 1983). Mining began in the Fierro-Hanover district in 1850, Bayard district in 1858, and Piños Altos, Fremont, and Steeple Rock districts in 1860 (Table 1). Mining had resumed at Santa Rita by the late 1850s. But then the Civil War erupted in the east and the soldiers were needed there. All mining in the Mimbres Resource Area ceased in 1862 with the invasion of New Mexico by the Confederate forces (Milbauer, 1983). The Civil War depleted the number of soldiers in the state and the mining camps were no longer safe from Indian raids; thus many districts remained inactive until after the war.

Mining after the Civil War

The end of the Civil War brought tremendous change to mining in New Mexico. Better records were kept in the late 1800s and preserved for the future. Settlers and prospectors fled the war torn east to start new lives in the west. Soldiers were sent to New Mexico and Arizona to eliminate interference by Native Americans. The Mimbres Resource Area was one of the last areas in the United States to be rid of the threat of Indian attacks and many mining districts were not discovered until 1890-1900 (Table 1). The Federal Mining Act of 1866 established rules and regulations governing prospecting and mining with provisions to obtain private ownership of federal land containing valuable mineral resources. The act was subsequently amended in 1870 and 1872 and in the years since. The mining act further encouraged mining and prospecting in the Mimbres Resource Area and the mining boom of 1870-1890 began. Many districts began to open up and production began as the Indian threat was subdued (Table 1). The telegraph and then the railroad improved conditions in the area as mining continued to flourish. New metallurgical techniques were developed. The cyanide process was perfected in 1891 and revolutionized gold recovery. Times were exciting for the miner in the late 1800s as metal prices soared. Large mining companies were formed to develop the larger deposits.

The 1870s and 1880s saw growth in mining in many districts. In 1873, M. B. Hayes obtained the Santa Rita mine and commenced mining. The mine changed owners several times from 1881 to 1904 (Sully, 1908). The railroad was completed to Lordsburg in 1881, to Hanover in 1891 and to Santa Rita in 1899 (Sully, 1908; Christiansen, 1974) and made ore production more profitable. Silver was discovered in the Black Hawk district in 1881 and gold was found in the Malone and Gold Hill districts in 1884 (Gillerman, 1964). Fluorite was mined for smelter flux in the 1880s at the Burro Chief mine in the Burro Mountains district and at the Foster mine in the Gila Fluorspar district (Gillerman, 1964; Williams, 1966). Iron ore was also mined in the area and used for smelter flux (Harrer, 1965).

Silver became important in 1870-1880s in many districts. Silver was discovered in the Chloride Flat district in 1871, which produced approximately $4 million worth of silver prior to 1893. The lead-zinc-silver deposits in the Cooke's Peak district yielded approximately $3 million by 1900. Horn silver was found in the Telegraph district in 1882 with assays as high as $300-$500/ton (Northrop, 1959). Georgetown produced $3.5 million worth of silver prior to 1893 (Anderson, 1957). In 1890 the Sherman Silver Act was passed which increased the price and demand for silver. It was short lived. The Sherman Silver Act was repealed in 1893 and most silver mines in the Southwest closed, never to reopen. A depression resulted and, in some districts, only gold ore was important. The Hanover mines were idle during most of the 1880s; but in 1891 markets developed for iron and zinc and once again the Hanover mines began production. Manganese was produced from the Chloride Flat district in 1883-1907 and was used in smelters in the Silver City area (Farnham, 1961; Dorr, 1965). However, by 1900, little activity occurred in the much of the Mimbres Resource Area.

Mining in the Twentieth Century

New mining and milling technologies were developed throughout the twentieth century that encouraged exploration and development of many deposits in the Mimbres Resource Area that were ignored in the 1800s. But booms and busts were the norm for most mining towns in New Mexico as world wars and financial slumps controlled the metals markets. Demands for new commodities such as manganese, uranium, and barite were seen.

In 1904, Daniel C. Jackling opened the first large, open-pit mine to produce low-grade copper ore (less than 2% Cu) at Bingham Canyon, Utah. At the same time, John M. Sully arrived at Santa Rita and recognized the similarity of ore at Santa Rita to that mined at Bingham Canyon. Sully thoroughly explored the area and attempted to obtain backers (Sully, 1908). Finally, in 1909 he obtained financial backing and in 1910 production began. The first concentrator mill was erected at Hurley in 1911; flotation concentration was added in 1914 (Hodges, 1931).

Other commodities were developed (Tables 4, 6, 8). Fluorite was discovered and mined at Fluorite Ridge in 1909 and manganese was produced from the Little Florida Mountains in 1918 (Griswold, 1961). Manganese production resumed throughout the Mimbres Resource Area in 1916 for use as smelter flux at Pueblo, Colorado (Dorr, 1965).

New Mexico became a state in 1912 and in 1914 World War I began. Metal prices and production increased as metals were needed for the war effort. The annual production of minerals in New Mexico was an all time high of over $43 million and much of that production came from the Mimbres Resource Area (Table 2). In 1918, World War I ended and was followed by a depression which closed many mines (Northrop, 1959). Fluorite was produced from the Cooke's Peak district in 1918 and from the Tonuco and Tortugas Mountains districts in 1919 (Table 4). The Ground Hog mine in the Fierro-Hanover district began production in 1928. In 1930, the price of copper dropped from 18 to less than 10 cents per pound, but production continued at the big mines in the area. Copper was only 5 cents per pound in 1932, forcing most of the copper mines to close (Northrop, 1959). Recovery did not occur until 1938.

World War II began in 1940 and once again a war increased demand for metals. On October 6, 1942, the U. S. War Department closed all gold mines in the U. S. Only base metals and other strategic minerals such as tin, tungsten (Table 7), manganese (Table 8), beryllium, fluorite (Table 4), and iron were mined. Exploration for these commodities increased and many mines went into production. The war ended in 1945 as did the Federal ban on gold mining.

Mining in the Mimbres Resource Area continued after the war; booms and busts in exploration and production continued to be the trend. Drilling in the Piños Altos area by the U.S. Mining, Smelting, and Refining Co. in 1948 encountered lead-zinc ore bodies that were recently mined by Cyprus Metals Co. (Osterberg and Muller, 1994). The Federal government initiated incentive buying programs for domestic production of manganese (Agey et al., 1959), tungsten, and uranium in 1951. Tungsten and uranium mines in the area began production (Tables 5, 7) and exploration intensified. Termination of these programs in 1956 (tungsten), 1959 (manganese) and 1965 (uranium) effectively closed these mines for good. Most districts in the area have seen some exploration since the 1960s as company after company examined the area, looking for the missed deposit. But most districts have seen insignificant production since the 1950s (Table 1, 2). Most mining since 1950 has occurred in the Silver City area. Industrial minerals have become more important in the 1970s (Tables 4, 6).

Today metal mining is occurring in the Silver City area (Chino, Tyrone, Continental mines) and in the Lordsburg and Steeple Rock districts. Manganese is sporadically produced from government stockpiles in Luna County. Industrial minerals, especially scoria and sand and gravel are important commodities.

Mining Methods

The earliest mining methods were crude and simple. The ore was simply dug out using simple tools. Locally, the rock was broken up by heating using fire and quenching with water. Mechanized methods of production were not common until the 1880s.

Although most mineralization found in the early years occurred at the surface, shafts were the common method of production which connected underground to working level drifts, raises, and haulage drifts. The Eighty-Five and Bonney mines in the Lordsburg district are the deepest shafts in the Mimbres Resource Area with workings to 1,650 and 2,200 ft deep (Youtz, 1931). Most underground mining utilized shrinkage and cut-n-fill techniques. Square-set techniques were used only on rare occasions, because of high cost of lumber in southwestern New Mexico; only four stopes utilized square-set timbering in 11 years of mining at the Eighty-Five mine (Youtz, 1931).

The Silver City area is well known for the large open pits: Santa Rita (Chino), Tyrone, Continental, etc. But most of the early production at these and other mines was by underground methods. Open-pit mining began at Santa Rita in 1910 (Thorne, 1931) and mining methods, although more refined and safer, are basically the same today as in the past (Hardwick, 1958).

Ore Processing

The first ore processing techniques were simple, requiring only crude adobe smelters (Christiansen, 1974). Gold was processed using stamp mills or arrastra (Fig. 3) mills. In the late 1800s, mills and smelters were built in most major mining districts.

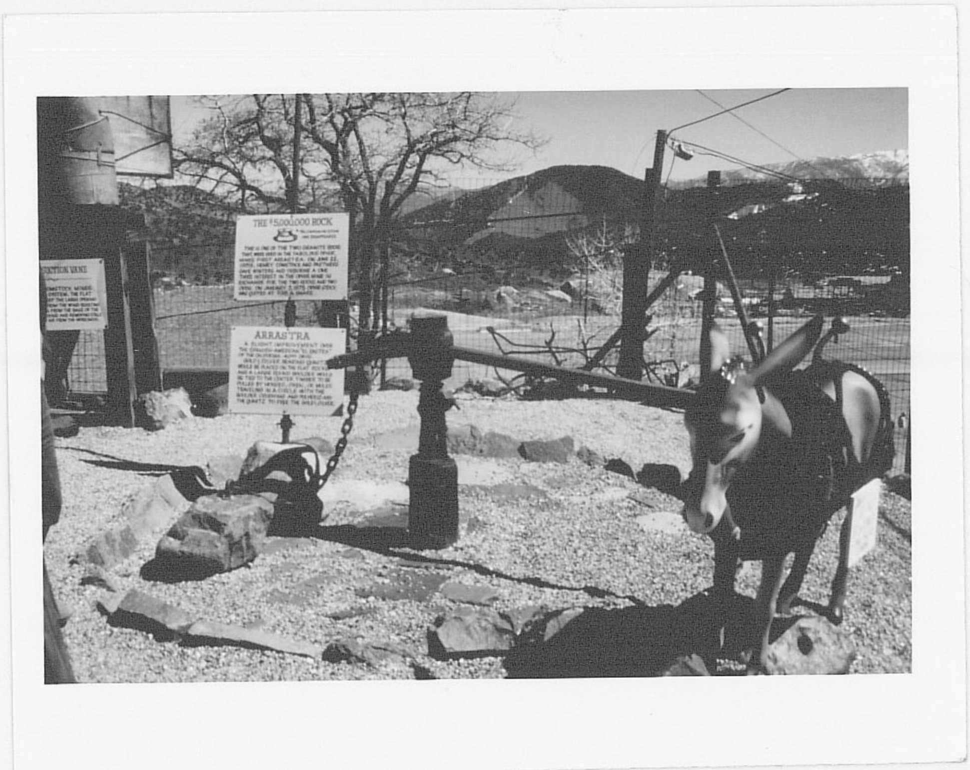

FIGURE 3—Arrastra mill on display at the Way It Was Museum in Virginia City, Nevada. These mills, pulled by mules were common in southern New Mexico and throughout western United States (V. T. McLemore photo).

The Federal Mining Act of 1872 established procedures for patenting a millsite. Many millsites were patented, but the records are not always clear as to what kind of mill, if any, was established or if the mill operated. It is difficult to trace the history of a given mill, because owners changed and mills were typically dismantled at one site and rebuilt at another site. The early mills were typically associated with a specific mine; in the late 1800s, mills were established in or near a large district and would custom mill ore from throughout the Southwest. Selected mills are listed in Table 9.

The Deming area has been the site of numerous mills since 1928 when the Peru mill was first built (Table 9). ASARCO built a mill in Deming in 1949. Both processed lead-zinc ores from the Silver City area. Manganese was concentrated and shipped from a purchasing depot in Deming 1953-1955 (Agey et al., 1959); much of the remaining material has been reprocessed and sold. Deming has abundant groundwater, adequate area for disposal of tailings, and is accessibile to the railroad (Griswold, 1961). Today, both mills in Deming are closed (Fig. 4, Table 9). However, the Hurley and the Playas smelters are active (Fig. 5). In addition, two processing plants are in El Paso: ASARCO's El Paso smelter (copper) and Phelps Dodge's El Paso Works (430,000 tpy copper by SX-EW).

FIGURE 4—Cyprus mill at Deming in 1995, before closure (V. T. McLemore photo).

FIGURE 5—Hurley smelter in Grant County, New Mexico in 1995 (V. T. McLemore photo).

TABLE 9—Selected active, inactive, and dismantled mills in the Mimbres Resource Area. Some mills were rebuilt or changed owners at the same site, but are included as separate mills. Location includes section, township, and range. Active mills denoted by *. FN—unpublished field notes, V. T. McLemore.

DISTRICT	NAME OF MILL	LOCATION	LATITUDE	LONGITUDE	TYPE OF MILL	COMMODITIES	YEARS OPERATED	COMMENTS	REFERENCES
Doña Ana County									
El Paso	*Eagle mill (Hortense)	15 29S 4E	31° 47' 27"	106° 32' 39"	mill	brick clay	prior to 1979-present	—	Hatton et al. (1994)
Hatch	Standard Oil Co.	9 19S 3W	32° 40' 31"	107° 9' 33"	mill	clay	1937-1940	—	NMBMMR file data
Organ	Dona Dora	26 21S 4E	32° 27' 10"	107° 30' 14"	concentrator	Au,Ag,Cu,Pb	1906-1911	—	NMBMMR file data
Organ	Filmore	6 23S 4E	32° 20' 25"	106° 34' 35"	adobe furnance	Pb, Zn	1849-1857	smelted ore from Stephenson-Bennett mine	Dunham (1935)
Organ	Memphis	36 21S 3E	32° 25' 52"	106° 35' 30"	water-jacket smelter	Cu,Ag,Zn	1884	—	Dunham (1935)
Organ	Modoc	31 22S 4E	32° 20' 38"	106° 34' 46"	mill	Pb	1879-1906, 1908	3 types of milling processes attempted	Dunham (1935), Lindgren et al. (1910), NMBMMR file data
Organ	Morman	NE14 21S 4E	32° 28' 58"	106° 30' 2"	3-stamp mill	Au,Ag	1888-1890, 1892-1900	—	Dunham (1935), Lindgren et al. (1910, p. 210)
Organ	Morman	NE14 21S 4E	32° 28' 58"	106° 30' 2"	cyanide mill	Au,Ag	1905-1910	—	Dunham (1935)
Organ	Soledad Canyon	21 23S 4E	32° 17' 23"	106° 32' 44"	adobe furnance	Pb	prior to 1854	—	Dunham (1935)
Organ	Stephenson-Bennett	11,14 22S 3E	32° 24' 9"	106° 36' 2"	mill	Pb,Zn	1908-1911, 1933-1934	—	Anderson (1957), Lindgren et al. (1910), NMBMMR file data
Organ	Sulphur millsite	5 23S 4E	32° 20' 6"	106° 30' 56"	mill	Au,Ag	?	—	
Organ	Sunol	13 21S 4E	32° 28' 53"	106° 29' 15"	10-stamp mill	Au,Ag	1890-1900	—	Dunham (1935)
Organ	Texas Canyon	34,35 22S 4E	32° 21' 2"	106° 30' 56"	2-stamp mill, floatation	Au,Ag	1898-1900,1939	flotation mill may never have operated	—
San Andres	San Andres	18 18S 4E	32° 44' 12"	106° 34' 5"	mill and smelter	Pb	1890-1904	smelter never operated, mill was unsuccessful	—
Tonuco	Tonuco	6 20S 1W	32° 36' 3"	106° 58' 54"	mill	F	1922	—	Ladoo (1923)
Tortugas Mountains	Tortugas	23,24 23S 2E	32° 17' 49"	106° 41' 46"	mill	F	1927-1933	—	Dunham (1935)

DISTRICT	NAME OF MILL	LOCATION	LATITUDE	LONGITUDE	TYPE OF MILL	COMMODITIES	YEARS OPERATED	COMMENTS	REFERENCES
Grant County									
	Iron Creek	17 16S 9W	32° 54' 42"	107° 47' 41"	mill	Ag	?	—	NMBMMR file data
Bayard	Bayard	4 17S 12W	32° 51' 10"	108° 4' 53"	smelter	Cu	?	—	Hatton et al. (1992)
Burro Mountains	Beaumont	E13 19S 16W	32° 39' 8"	108° 26' 39"	stamp mill	Au	1880s	—	Gillerman (1964, p. 68)
Burro Mountains	Black Hawk	29 17S 12W	32° 48' 15"	108° 5' 54"	flotation mill	Zn,Pb	1938-1946	—	Anderson (1957)
Burro Mountains	Black Hawk	29 17S 12W	32° 48' 15"	108° 5' 54"	flotation mill	Zn,Pb,Ag	1946-1953	—	Anderson (1957)
Burro Mountains	Black Hawk	29 17S 12W	32° 48' 15"	108° 5' 54"	flotation mill	Zn,Pb,Cu,Ag	1928-1938	—	Anderson (1957)
Burro Mountains	*Burro Chief (Tyrone)	15 19S 15W	32° 38' 58"	108° 22' 42"	SX-EW plant	Cu	1985-present	—	Hatton et al. (1994)
Burro Mountains	*Mathis	19 17S 12W	32° 48' 38"	108° 7' 5"	mill	clay, limestone	1979-present	—	Hatton et al. (1994)
Burro Mountains	Ohio	17 19S 15W	32° 39' 15"	108° 24' 30"	leaching in open pit	Cu	1969-1970	—	Richter and Lawerence (1986)
Burro Mountains	St Louis	22? 19S 15W	32° 37' 57"	108° 23' 19"	smelter, leaching	Cu,Ag	1905-1908	—	NMBMMR file data
Burro Mountains	Tyrone	22 19S 15W	32° 38' 25"	108° 22' 20"	concentrator	Cu,Ag	1913-1921	—	Gillerman (1964, p. 42)
Burro Mountains	Tyrone	22 19S 15W	32° 38' 25"	108° 22' 20"	flotation, precipitation	Cu,Ag,Au	1969-1992	—	—
Chloride Flat	Two Ikes	32 17S 14W	32° 46' 46"	108° 18' 12"	3 arrastras	Ag	1872	—	Milbauer (1983)
Chloride Flat	Two Ikes	32 17S 14W	32° 46' 46"	108° 18' 12"	ball pulverizer, smelter	Ag	1872	—	Milbauer (1983)
Cora Miller	Cora Miller	6 17S 16W	32° 51' 14"	108° 32' 10"	mill	Ag	?	—	Gillerman (1964, p. 42)
Eureka	American	1 28S 16W	31° 54' 27"	108° 25' 47"	smelter	Au, Ag, Cu	1880s	—	—
Eureka	Hornet	1 28S 16W	31° 53' 48"	108° 25' 40"	smelter	Au, Ag, Cu	1880s	—	—
Fierro-Hanover	Anson (Anton)	9 17S 12W	32° 50' 17"	108° 5' 48"	water-jacket smelter	Cu	1888	—	Kniffin (1930)
Fierro-Hanover	Black Hawk	NE 29 17S 12W	32° 48' 15"	108° 6' 00"	flotation	Ag,Pb	1928-1953	—	NMBMMR file data
Fierro-Hanover	Bullfrog	31 17S 12W	32° 46' 54"	108° 7' 00"	differential mill	Zn,Pb,Ag,Cu,Au	1943-1953, 1970-1971	—	Anderson (1957)
Fierro-Hanover	Cleaveland	2 17S 14W	32° 51' 58"	108° 15' 4"	mill	Zn,Pb,Cu,Ag,Au	1915-1950	—	Anderson (1957)
Fierro-Hanover	*Continental No. 1	4,9 17S 12W	32° 50' 30"	108° 5' 9"	flotation mill	Cu,Zn,magnetite	1967-1988,1992-present	—	NMBMMR file data
Fierro-Hanover	*Continental No. 2	9 17S 12W	32° 50' 30"	108° 5' 9"	flotation mill	Cu,Zn,magnetite	1973-1988,1992-present	—	NMBMMR file data
Fierro-Hanover	Ground Hog	17S 12W	32° 46' 15"	108° 06' 21"	concentrator	Zn,Pb,Cu,Ag	—	—	NMBMMR file data

DISTRICT	NAME OF MILL	LOCATION	LATITUDE	LONGITUDE	TYPE OF MILL	COMMODITIES	YEARS OPERATED	COMMENTS	REFERENCES
Fierro-Hanover	Hanover	3,4 17S 12W	32° 51' 15"	108° 4' 45"	electricmagnetic mill	Zn,Fe	1916-1927	—	NMBMMR file data
Fierro-Hanover	Hanover	3,4 17S 12W	32° 51' 15"	108° 4' 45"	flotation mill	Zn,Pb	1927-1931,1937-	—	Anderson (1957)
Fierro-Hanover	Hanover	3,4 17S 12W	32° 51' 15"	108° 4' 45"	mill	Fe,Zn	1914-1919	—	NMBMMR file data, Kniffin (1930)
Fierro-Hanover	Hanover	3,4 17S 12W	32° 51' 15"	108° 4' 45"	smelter	Cu	1861	—	Milbauer (1983)
Fierro-Hanover	Ivanhoe	W 33 17S 12W	32° 46' 50"	108° 5' 46"	mill	Cu,Ag,Au.Pb	1904-1912?	—	NMBMMR file data
Georgetown	Fresh and Magruder (Chino)	6,7 17S 11W	32° 51' 2"	108° 1' 9"	smelter	Cu,Ag	1873-1877?	—	Milbauer (1983)
Georgetown	Old Georgetown	7 17S 11W	32° 51' 00"	108° 1' 16"	mill	Ag	1979-1982	—	FN 2/1/95
Georgetown	Meredith and Ailman	NE10 17S 11W	32° 50' 54"	107° 57' 38"	mill	Ag	1885	along Mimbres River	NMBMMR photo collection #550
Gold Hill	Good Luck (Co-Op)	SE29, SW28 21S 16W	32° 26' 59"	108° 30' 11"	flotation mill	Ag,Pb	1920-1926	—	Gillerman (1964, p. 116), NMBMMR file data
Gold Hill	Indian Springs-Gods Truth	?	?	?	amalgamation mill	Au,Ag	1936-1940	—	NMBMMR file data
Gold Hill	Standard	NW6 22S 16W	32° 25' 17"	108° 32' 1"	10 stamp mill	Au	late 1800s-early 1900s	—	Elston (1960)
Gold Hill	Cline Point	NW31 21S 16W	32° 26' 11"	108° 31' 51"	cyandation plant	Au	early 1900s	in Gold Hill	Elston (1960)
Gold Hill	Gold Hill	NW31 21S 16W	32° 26' 09"	108° 31' 45"	10 stamp mill	Au	?	—	Elston (1960)
Gold Hill	Connie Lynn	SE17 22S 16W	32° 23' 03"	108° 30' 28"	cyandation plant	Au	1958-1959	—	Elston (1960)
Gold Hill	Western Belle	?	?	?	5 stamp mill	Au	?	—	Elston (1960)
Gold Hill	Cline Mill	NE2 22S 17W	32° 25' 37"	108° 33' 21"	2 stamp mill	Au	1900s-1940	at Cline Ranch	Elston (1960)
Lone Mountain	Lone Mountain	N 27 18S 13W	32° 43' 30"	108° 11' 00"	10 stamp mill	Au,Ag	1871-1873	—	Jones (1904)
Pinos Altos	Arizona		32° 50' 55"	108° 14' 30"	20 stamp mill, concentrator	Au,Ag,Cu	1906	—	NMBMMR file data
Piños Altos	Mountain Key	1 17S 14W	32° 51' 52"	108° 14' 59"	20 stamp mill	Au	1887	—	Jones (1904)
Piños Altos	Piños Altos	6 17S 13W	32° 51' 54"	108° 13' 17"	15 stamp mill	Au	1867-1871	2nd mill built in New Mexico	Jones (1904)
Piños Altos	Savannah (Alessandra)	?	?	?	flotation mill	Au,Cu	1919	200 tpy	NMBMMR file data
Piños Altos	Seneca	?	?	?	5 stamp mill	Au,Ag	1872	—	Milbauer (1983)

DISTRICT	NAME OF MILL	LOCATION	LATITUDE	LONGITUDE	TYPE OF MILL	COMMODITIES	YEARS OPERATED	COMMENTS	REFERENCES
Piños Altos	Silver Cell	7,8 17S 13W	32° 50' 48"	108° 13' 15"	smelter		1903	—	—
Piños Altos	Skillicorn (Mud Turtle)	?	?	?	4 arrastras	Au,Ag	1885	along Bear Creek	Jones (1904)
Santa Rita	*Chino	33 18S 12W	32° 41' 55"	108° 5' 18"	mill	Cu,Au,Ag, sulfuric acid	1980-present	600,000 tpy	—
Santa Rita	*Chino SX-EW	32,33 18S 12W	32° 41' 42"	108° 5' 53"	SX-EW plant	Cu	1988-present	—	—
Santa Rita	Hurley	31,32 18S 12W	32° 42' 15"	108° 6' 49"	concentrating plant	Cu	1910-1939	—	Shimmin (1927)
Santa Rita	*Hurley smelter	31,32 18S 12W	32° 42' 5"	108° 6' 52"	smelter	Cu,Au,Ag,Mo,sulfuric acid	1939-present	—	—
Santa Rita	Santa Rita	32? 18S 12W	32° 41' 58"	108° 6' 20"	stamp mill	Cu	1881	unsucessful operation	Northrop (1959), Sully (1908)
Santa Rita	smelter	32? 18S 12W	32° 41' 58"	108° 6' 20"	smelter	Cu	1809-	several small smelters	Milbauer (1983), Sully (1908)
Steeple Rock	Carlisle	1 17S 21W	32° 50' 10"	108° 57' 50"	60 stamp mill	Au,Ag	1880-1896	—	McLemore (1993)
Steeple Rock	Carlisle	1 17S 21W	32° 50' 10"	108° 57' 50"	smelter	Cu,Pb,Ag,Au	1887-1920	—	McLemore (1993)
Steeple Rock	East Camp	6 17S 20W	32° 50' 28"	108° 55' 47"	flotation, cyanide mill	Au,Ag,Cu	1940-1946	cyanide 1940-42, flotation 1943-46	McLemore (1993), NMBMMR file data
Steeple Rock	National Bank	35 16S 21W	32° 52' 30"	108° 52' 00"	mill	Au,Ag	late 1890s-1900	—	McLemore (1993)
Telegraph	Great Eagle	23 18S 18W	32° 43' 35"	108° 40' 35"	mill	F	1919-1921	—	Gillerman (1964, p. 161)
Telegraph	Telegraph	SW32 17S 17W	32° 46' 49"	108° 37' 16"	15 stamp mill	Au	1885	—	Gillerman (1964, p. 160), Lindgren et al. (1910)
Telegraph	Telegraph	SW32 17S 17W	32° 46' 49"	108° 37' 16"	leaching plant	Cu	1903-1905	—	Gillerman (1964, p. 160), Lindgren et al. (1910)
White Signal	Seller	SW 30 20S 14W	32° 32' 2"	108° 20' 15"	placer mill	Au	1937	—	NMBMMR file data
Hidalgo County									—
Animas	American Fluorite Co.	34 30S 18W	31° 38' 40"	108° 39' 35"	mill	F	1971-1975	sample of concentrates collected GI4,5	McAnulty (1978), FN 4/19/94
Animas Valley	*Hidalgo smelter	22-27,34-36 29S 17W	31° 44' 55"	108° 32' 8"	smelter	Cu,Au,Ag sulfuric acid	1979-present	224,000 tpy	Hatton et al. (1994)
Big Hatchet Mountains	Sheridan	23 31S 15W	31 35 51	108 20 12	mill	Pb,Zn	?	—	NMBMMR file data
Eureka	America	36 27S 16W	31° 54' 18"	108° 25' 55"	rod mill	Cu, Pb,Zn,Ag	1926-1930s	—	NMBMMR file data
Lordsburg	Aberdeen	NW 24 23S 19W	32° 17' 32"	108° 45' 12"	concentrator	Cu, Au, Ag	1902-1906	—	NMBMMR file data

DISTRICT	NAME OF MILL	LOCATION	LATITUDE	LONGITUDE	TYPE OF MILL	COMMODITIES	YEARS OPERATED	COMMENTS	REFERENCES
Lordsburg	Anita-Nellie Bly	E 11 23S 19W	32° 19' 9"	108° 45' 44"	leaching, flotation mill	Cu,Ag	1924-1931	—	NMBMMR file data
Lordsburg	Bonney	14,23 23S 19W	32° 17' 53"	108° 45' 39"	blast smelter	Cu	1910	—	NMBMMR file data
Lordsburg	Bonney	14,23 23S 19W	32° 17' 53"	108° 45' 39"	mill	Cu	1936-1968, 1975	—	NMBMMR file data
Lordsburg	Federal Resources	23 23S 19W	32° 17' 33"	108° 45' 52"	mill	Cu	1979	—	Siemers and Austin (1979)
Lordsburg	Last Chance?	SW13 23S 19W	32° 17' 55"	108° 45' 15"	flotation mill	Cu	1922-1926	—	NMBMMR file data
Lordsburg	Lordsburg Group	22S 18W	32° 17' 53"	108° 45' 39"	heap leach	Cu	1985-1987	—	—
Lordsburg	Mullberry	14,23 23S 19W	32° 17' 53"	108° 45' 39"	concnetrator	Cu	1912	—	NMBMMR fiel data
McGhee	Carbonate Hill	SE 34 24S 21W	32° 10' 11"	108° 59' 1"	mill	Au,Ag	?	—	—
Steins	Beck	C 31 23S 21W	32° 15' 42"	109° 2' 22"	concentrator	Au,Ag	1888-1908	—	NMBMMR file data
Steins	Volcano	W17 23S 21W	32° 18' 16"	109° 1' 7"	10 stamp mill	Au	?	—	—
Sylvanite	Buckhorn	27 28S 16W	31° 50' 39"	108° 27' 46"	amalgamation	Au,Ag	1937	—	NMBMMR file data
Luna County									
Carrizallilo	Carizallilo	C 22 28S 11W	31° 51' 25"	107° 57' 6"	smelter	Ag,Au,slag	?	—	Gates (1985)
Cooke's peak	Graphic	32 20S 8W	32° 31' 42"	107° 40' 59"	flotation mill	Ag,Pb	1922-1924	—	NMBMMR file data
Cooke's Peak	Faywood	12-15 20S 9W	32° 33' 47"	107° 44' 44"	mill	F	1940s	—	Elston (1960)
Cooke's Peak	Lucky	24 20S 9W	32° 33' 13"	107° 43' 8"	concemtrator	Pb,Zn	—	—	NMBMMR file data
Deming	ASARCO	20 23S 9W	32° 17' 2"	107° 47' 45"	flotation mill	Zn,Ag,Pb,Cu	1949-198?	—	Griswold (1961), NMBMMR file data
Deming	*Cyprus Pinos Altos	20 23S 9W	32° 17' 2"	107° 47' 45"	mill	Cu,Zn,Ag,Au	present	formerly operated by ASARCO	Hatton et al. (1994)
Deming	La Purisima	25 23S 9W	32° 16' 34"	107° 43' 28"	flotation mill	F	1931-1954	—	Griswold (1961), NMBMMR file data
Deming	Peru	18 23S 9W	32° 18' 10 "	107° 48' 28"	flotation mill	Zn,Pb	1928-1961	—	Griswold (1961)
Deming	*Southwest American Minerals	25 23S 9W	32° 16' 34"	107° 43' 28"	mill	Mn	1976-present	Deming was the site for Mn stockpiles during World War II and in 1953-1955.	Agey et al. (1959), Hatton et al. (1994)
Little Florida Mountains	Black Rock	?	?	?	concnetrator	Mn	1926-1936	—	NMBMMR file data
Little Florida Mountains	Mangnaese	19 24S 7W	32° 12' 12"	107° 35' 29"	mill	Mn	1923-1940	—	DeVaney et al. (1942)
Tres Hermanas	Canon	14 28S 9W	34° 52' 27"	107° 43' 25"	leaching	Cu	1959	—	Griswold (1961)
Victorio	Rambler	32 24S 12W	32° 10' 38"	108° 5' 42"	gravity mill	Cu,Pb,Zn	prior to 1961	—	Griswold (1961)

TYPES OF DEPOSITS

Numerous classifications have been applied to mineral deposits (Eckstrand, 1984; Guilbert and Park, 1986; Cox and Singer, 1986; Roberts and Sheahan, 1988; Sheahan and Cherry, 1993). In New Mexico, North and McLemore (1986, 1988) classified the metal deposits of New Mexico according to age, mineral assemblages, form, alteration, tectonic setting, and perceived origin. This classification, with a few modifications and additions, is retained in this paper (Table 10); there are 25 types of deposits in the Mimbres Resource Area. It is beyond the scope of this report to describe each deposit type; the reader is referred to Cox and Singer (1986), North and McLemore (1986, 1988), McLemore and Lueth (in press) and McLemore (in press a, b) for specific details.

TABLE 10—Types of deposits in the Mimbres Resource Area, New Mexico (after North and McLemore, 1986, 1988; McLemore, in press a; McLemore and Lueth, in press; Cox and Singer, 1986).

NMBMMR CLASSIFFICATION	USGS CLASSIFICATION	USGS MODEL NUMBER
Placer gold	Gold placers	39a
Tungsten placers	Tungsten placers	none
Volcanic-epithermal vein	Quartz-adularia, quartz-alunite, epithermal manganese, rhyolite-hosted tin	25b,c,d,e,g, 25h
Epithermal Mn	Epithermal Mn	25g
Great Plains Margin	Copper porphyry, polymetallic veins, copper skarns, iron skarns, placer gold	17, 22c, 18a,b, 18d, 39a
Rio Grande Rift barite-fluorite-galena (formerly sedimentary-hydrothrmal)	none	none
Carbonate-hosted Pb-Zn replacement	Polymetallic replacement	19a
Carbonate-hosted Ag-Mn replacement	Polymetallic replacement, replacement manganese	19a,b
Carbonate-hosted Mn replacement	Replacement Mn	19b
Polymetallic veins	Polymetallic veins	22c
Laramide vein	Polymetallic veins	22c
Laramide Cu and Pb-Zn skarn	Skarn	18a, 19a
Porphyry Cu, Cu-Mo	Porphyry copper	17, 21a
Porphyry Mo-W	Porphyry Mo-W	16
W-Be contact-metasomatic deposits	W-Be contact metasomatic deposits	14a
Fluorite veins	Ffluorite veins	26b
Replacement iron	Iron skarn	18d
Sedimentary iron	Oolitic iron	34f
Gypsum	none	none
Limestone	none	none
Perlite	none	none
Clay	none	none
Scoria	none	none
Precambrian vein and replacement	Polymetallic veins, fluorite veins	22c, 26b
Pegmatite	Pegmatite	none

GEOLOGY AND MINERAL OCCURRENCES OF THE MINING DISTRICTS OF DOÑA ANA COUNTY

by Virginia T. McLemore and David M. Sutphin

Introduction

Doña Ana County was one of the first counties created in New Mexico in 1852 and forms the eastern part of the Mimbres Resource Area (Fig. 1). It is the only county commemorating a woman, named after an aristocratic lady of the 17th century (Julyan, 1986, 1996). Las Cruces, Spanish for crosses, is the second largest city in New Mexico and got its name from a collection of crosses marking a burial ground of people killed by Apache Indians in the 1840s. It lies on El Camino Real, the major trading route from Mexico to Santa Fe, and is on the Rio Grande. Today, the metropolitan area of El Paso, Texas, and Juarez, Mexico, with a combined population of nearly 2 million lies along the southern county boundary and has a large economic and political impact on the less populated Doña Ana County. Santa Theresa, south of Las Cruces and west of El Paso is an international port of entry.

Minerals have been and still are a significant contribution to the economy of Doña Ana County; although agriculture, construction, and light industry are currently economically more important. The White Sands Missile Range forms the northeastern portion of the county and is withdrawn from mineral entry. Metals production began in the 1830s in the Organ Mountains at the Stephenson-Bennett mine (Table 1; Dunham, 1935). By 1910, all metals mining districts had been discovered and prospected. The majority of the past metal production has come from the Organ Mountains district, east of Las Cruces (Table 2), which is the 6th largest lead producing district in New Mexico (McLemore and Lueth, 1995, in press). Current production from the county consists of aggregate (ie. sand and gravel), clay and shale for brick manufacture, scoria, travertine, and minor dimension stone (Hatton et al., 1994). The Eagle mill near El Paso (Brickland) manufactures bricks for the nearby popultaion centers. Juarez, Mexico, is the home of two cement plants, a hydrofluoric acid plant, and a brick plant.

Aden district

Location and mining history

Scoria deposits are found in the Aden (Potrillo, Black Mountain) district in the Potrillo Mountains and adjacent areas in Doña Ana and Luna Counties, an area encompassing over 500 km^2 (Fig. 1). Aden Cone was named by the railroad company in the 1880s after Rock of Aden on the sea route from Suez to India (Julyan, 1996). More than 150 cinder cones occur in this area (Seager and Mack, 1994) and only a few have been quarried (Table 11). Total production is unknown, but estimated production from 1950-1994 amounted to approximately $10 million (Table 12). In the West Potrillo Mountains, Mt. Riley, and Aden Lava Flow Wilderness Study Areas, Kilburn et al. (1988) estimates an inferred resource of at least 400 million cubic yards.

TABLE 11—Selected scoria (volcanic cinders) deposits in Doña Ana and Luna Counties. Status—A, active in 1993 (Hatton et al., 1994); M, prior production; O, occurrence, no known production. Aspect ratio is the ratio of height to basal diameter (Osburn, 1979, 1982). Aspect ratios were recalculated using 7½ topographic maps. *Within Wilderness Study Area. MRDS—Mineral Resource Data System, U> S> Geological Survey.

NUMBER ON FIGURE FIG. 7	NAME	LOCATION section, township, range	STATUS	ASPECT RATIO	DIAMETER OF BASE (FT)	HEIGHT (FT)	RESERVES (MILL CU YDS) (GESE, 1985)	DESCRIPTION	REFERENCES
1	Santo Tomas Mt.	sec. 31 T24S R2E	A	0.12 0.15	775 990	90 150	0.6	Red and black scoria with lava flows. At least 12 m zone of red scoria.	Osburn (1979), Cima (1978), this report; MRDS #TC36110.
2	Black Bear Mt. (Black Mt.)	sec. 1, 12 T25S R1E	A	0.12	1300	162	2.2	Red and black scoria in four cinder cones.	Osburn (1979), this report; MRDS #TC36096
3	Little Black Mt.	NE¼ sec. 24 T24S R1E	M	0.11	1000	110	0.4	Red and black scoria with spatter material in two cinder cones.	Osburn (1979), this report
4	Donna Ana Mt.	sec. 15 T24S R4W	A	0.13	2000	254	2.6	—	Osburn (1979)
5	Providence	sec. 32 T24S R4W	M	0.25	1300	330	—	—	This report
6	Aden	sec. 9 T25S R3W	M	0.15	1700	250	1.9	—	Osburn (1979), MRDS #TC36107
7	Volcano #1	sec. 22 T25S R3W	M	0.17	2200	380	3.8	—	Osburn (1979)
8	Unknown	sec. 29 T25S R4W	O	0.07	1400	100	4.6	—	Osburn (1979)
9	Unknown	sec. 23 T25S R3W	M	0.11	2000	210	3.0	—	Osburn (1979)
10	Headquarters Hill	sec. 25, 36 T25S R3W	O	0.08	1800	150	4.6	—	Osburn (1979)
11	*USBM #9	sec. 4, 5 T26S R2W	M	0.10	1300	130	7.0	Gray to red scoria with spatter.	Osburn (1979), Gese (1985)
12	Unknown	sec. 6 T26S R3W	O	0.15	3600	550	9.3	—	Osburn (1979)
13	*USBM #10	sec. 7 T26S R3W	O	0.16	2400	385	40.3	Gray scoria	Osburn (1979), Gese (1985)
14	*USBM #13	sec. 13 T26S R4W	O	0.15	2300	350	17.0	Well sorted, black scoria	Osburn (1979), Gese (1985)
15	*USBM #11	sec. 18 T26S R3W	O	0.13	2000	260	11.2	Gray scoria, well sorted	Osburn (1979), Gese (1985)
16	*USBM #19	sec. 30 T26S R3W	O	0.13	2500	340	23.2	Brownish black scoria, well sorted	Gese (1985)

NUMBER ON FIGURE FIG. 7	NAME	LOCATION section, township, range	STATUS	ASPECT RATIO	DIAMETER OF BASE (FT)	HEIGHT (FT)	RESERVES (MILL CU YDS) (GESE, 1985)	DESCRIPTION	REFERENCES
17	*USBM #20	sec. 4 T27S R3W	O	0.11	1600	190	3.4	Gray and red scoria, poorly sorted	Gese (1985)
18	*USBM #21	sec. 4 T27S R3W	O	0.15	1200	190	1.4	Moderately sorted, red scoria	Gese (1985), this report
19	*USBM #22	sec. 7 T27S R3W	O	0.10	2300	230	8.6	Red-brown scoria, poorly sorted	Gese (1985)
20	*USBM #23	sec. 7 T27S R3W	O	0.12	2000	240	13.0	Red scoria, poorly sorted	Gese (1985)
21	*USBM #24	sec. 12 T27S R4W	O	0.14	1800	260	4.6	Red to black scoria, poorly sorted	Gese (1985)
22	*USBM #25	sec. 1 T27S R4W	O	0.16	1400	230	6.4	Red scoria, poorly sorted	Gese (1985)
23	*USBM #36	sec. 35, 36 T27S R4W	O	0.13	3200	440	38.0	Well sorted, red scoria	Gese (1985)
24	*USBM #37	sec. 35 T27S R4W	O	0.12	3000	380	33.8	Well sorted, gray-red scoria	Gese (1985)
25	*USBM #38 (Potrillo)	sec. 25 T27S R4W	O	0.14	2400	340	12.0	Well sorted, red scoria	Gese (1985)
26	*USBM #39	sec. 26 T27S R4W	O	0.12	2000	250	10.2	Moderately sorted, red-brown scoria	Gese (1985)
27	*USBM #40	sec. 30 T27S R3W	O	0.12	2500	320	18.1	Moderately sorted, red-brown scoria	Gese (1985)
28	*USBM #41	sec. 20 T27S R3W	O	0.15	2400	380	23.1	Black to red scoria, moderately sorted	Gese (1985)
29	*USBM #42	sec. 27 T27S R3W	O	0.17	2800	490	20.8	Well sorted, black scoria	Gese (1985)
30	*USBM #60	sec. 20 T28S R3W	O	0.11	3601	400	68.8	Moderately sorted, brown to red scoria	Gese (1985)
31	*USBM #62	sec. 7 T28S R3W	O	0.15	2600	400	23.4	Moderately sorted, black scoria	Gese (1985)
32	*USBM #63	sec. 23 T28S R4W	M	0.13	1300	170	16.2	Moderately sorted, red-brown scoria	Gese (1985)
33	Guzmans Lookout Mt.	sec. 35 T28S R4W	M	0.14	1900	270	—	Black scoria	This report
34	Chaparral claims	sec. 6 T29S R3W	M	0.05	3000	140	—	Black and red scoria	This report
35	Unknown	sec. 23, 26, T28S R4W	M	0.14	2200	300	—	Black and red scoria	This report
36	Unknown	NE¼ sec. 34 T24S R4W	M	0.05	2150	115	—	Scoria	MRDS #TC36062
37	Black Mountain (near Deming)	sec. 3, 4 T23S R10W	O	0.21	2500	530	—	Black cinder	Griswold (1961, p. 23), Weber (1965), MRDS #TC36068

TABLE 12—Scoria production in Doña Ana and Luna Counties, 1950-1994 (from New Mexico State Mines Inspector, Annual Reports, 1950-1988). W—withheld (company confidential data). Production after 1988 is withheld. * Fiscal year ending June 30.

YEAR	VOLUME (SHORT TONS)	VALUE ($)
1950*	64,470	4,298
1951*	77	4,559
1952*	59,800	20,000
1953*	95,912	95,912
1954*	73,529	73,529
1955*	84,839 cu yds	93,312
1956*	77,183 cu yds	115,774
1957*	57,706 cu yds	86,558
1958*	58,482 cu yds	87,723
1959*	84,101 cu yds	126,152
1960*	230,770 cu yds	96,103
1961*	88,940 cu yds	153,827
1962*	105,131 cu yds	138,891
1963	48,000 cu yds	72,400
1964	59,900 cu yds	91,620
1965	96,316 cu yds	151,260
1966	68,546 cu yds	108,392
1967	57,018 cu yds	153,891
1968	64,281 cu yds	168,856
1969	74,726 cu yds	206,939
1970	60,559 cu yds	186,216
1971	74,286 cu yds	163,215
1972	W	W
1973	W	W
1974	W	W
1975	55,626	215,268
1976	W	W
1977	W	W
1978	W	W
1979	W	W
1980	48,273	278,261
1981	43,992	248,480
1982	W	W
1983	W	W
1984	W	W
1985	W	W
1986	60,988	29,163
1987	40,573	21,856
1988	44,665	18,166
1989-1994	W	W
TOTAL ESTIMATED PRODUCTION (1950-1994)	582,000	10,000,000

Scoria deposits

Scoria and pumice are pyroclastic deposits formed as volcanic fragments ejected during explosive volcanic eruptions. Scoria (volcanic cinder) is red to black to gray, vesicular, basaltic (50-60% SiO_2) volcanic fragments. Most scoria deposits occur as loose, poorly consolidated, poor to well sorted cones or mounds of stratified fragments (Geitgey, 1994; Peterson and Mason, 1983; Osburn, 1979, 1982; Cima, 1978). The ejected material ranges in size from minor quantities of volcanic ash or cinder (< 2 mm in diameter), scoria (2-100 mm in diameter), and volcanic bombs (smooth-sided) and blocks (angular fragments) which are greater than 100 mm in diameter. Most volcanic cinder cones contain approximately 75% scoria (Cima, 1978; Osburn, 1979, 1982). Scoria is not to be confused with pumice. Scoria is denser and more coarsely cellular or vesicular than most pumice (Peterson and Mason, 1983). Pumice is light in color ranging from white to gray to pale yellow, pink, or brown and is also vesicular but of a dacitic to rhyolitic composition (60-70% SiO_2) (Greitgey, 1994; Harben and Bates, 1984).

The vesicular nature of scoria results in lower density and higher porosity than most rock types. These properties result in commercial use as lightweight aggregates, insulators, absorbents, and abrasives (Geitgey, 1994; Harden and Bates, 1984).

Most scoria in New Mexico is used currently to manufacture cinder block and concrete. In the 1950s, scoria was used in railroad ballast and road aggregate. Scoria is quarried from open pits by digging and ripping with tractors and rippers, stockpiled, and then crushed and screened (Osburn, 1982). Some scoria is also currently used as a decorative stone for landscaping. Use in landscaping depends upon select size and color; reddish-brown color is more popular. Cinders are also used on highways during winter storms to improve traction. Other uses include roofing granules and erosion control. Scoria typically has a higher crushing strength than pumice and is more desirable for certain aggregate uses.

Economic considerations of scoria include the color, grain size, sorting, density, and consolidation of the scoria. Another property affecting the economics of a deposit is the aspect ratio (Osburn, 1979, 1982). The aspect ratio is the ratio of the height to average basal diameter of the cinder cone or volcano. The most economic deposits have aspect ratios between 0.1 and 0.2 (Osburn, 1982). Cones with lower aspect ratios (<0.1) tend to have thick lava flows which are undesirable in mining. Cones with higher aspect ratios (>0.2) tend to consist of large amounts of agglutinate (scoria blocks welded together with lava material) and approach spatter cones. The agglutinate deposits require drilling and blasting which increases the production costs. Scoria is typically a low-cost commodity and is marketed locally. In Doña Ana County, most scoria is utilized in the Las Cruces and El Paso areas because of the close proximity to the quarries.

Scoria resources in Doña Ana and Luna Counties are large and should be sufficient to meet local demand in the near future (Austin et al., 1982; Osburn, 1982). Much of the Aden district is designated as Wilderness Study Areas; however, the active operations are outside of these restricted areas.

Bear Canyon district

Location and Mining History

The Bear Canyon district, also known as the Stevens or San Augustin district, is in the southern San Andres Mountains and extends from Bear Canyon (north of Black Mountain) northward to Little San Nicolas Canyon (north of Goat Mountain). Shafts, adits, and prospect pits occur along the foothills (lower contact deposits) and near the crest (upper contact deposits)(Table 13, Fig 6). The district was discovered in 1900 by J. Bennett (Dunham, 1935; Talmage and Wootton, 1937). Production occurred a few years later. Less than 10,000 pounds of copper, 100 ounces of silver, and some lead have been produced from the district (Tables 1, 4; Dunham, 1935; McLemore, 1994b). In 1932, 50 short tons of barite was produced from the Stevens mine (Williams, 1966). The district lies entirely within the White Sands Missile Range and is withdrawn from mineral entry.

TABLE 13—Mines and prospects in the Bear Canyon district, Doña Ana County, New Mexico, shown in Figure 6. Location includes section, township, and range. FN—unpublished field notes, V. T. McLemore.

MINE NAME (ALIAS)	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	YEARS OF PRODUCTION	DEVELOPMENT	REFERENCES
Fairview (Lower contact)	SW28 20S 5E	32° 31' 55", 106° 26' 17"	Ba, Cu, Pb, Ag	unknown	pit (<10 ft deep)	Dunham (1935), Anderson (1957), Williams et al. (1964), McLemore (1994b), Smith (1981), FN 10/10/93
Stevens (International)	SW28 20S 5E	32° 32' 16", 106° 26' 23"	Ba, Cu, Pb, Ag, F, V, Mo	1932, early 1950s	70 ft shaft, 60 ft adit	Dunham (1935), Schilling (1965), Smith (1981), FN 10/10/93
unknown	NW 33 20S 5E	32° 32' 16", 106° 26' 50"	Ba, F	none	shallow pit (<10 ft deep)	FN 10/10/93
Upper contact	NW19 20S 5E	32° 32' 10", 106° 28' 40"	Ba, Cu, Pb, Ag, F	1932, early 1950s	shaft, adit	Dunham (1935)
Upper contact	SE19 20S 5E	32° 33' 37", 106° 28' 15"	Ba, Cu ,Pb, Ag, F	early 1900s	shaft, adit, pits	Dunham (1935)
unknown	SE26 20S 4E, NE 35 20S 4E	32° 32' 10", 106° 28' 40"	Ba, Cu, Pb, Ag, F	unknown	30 ft shaft, pits	Seager (1981); FN 10/10/93
unknown	SW13 20S 4E	32° 33' 48", 106° 30' 3"	Ba, Cu, Pb, Ag, F	unknown	pit	Dunham (1935)
unknown	W30 20S 5E	32° 32' 20", 106° 29' 00"	Ba, Cu ,Pb, Ag, F	none	200 ft shaft, caved adit	Dunham (1935), F. Kimbler (written communication, 1982)

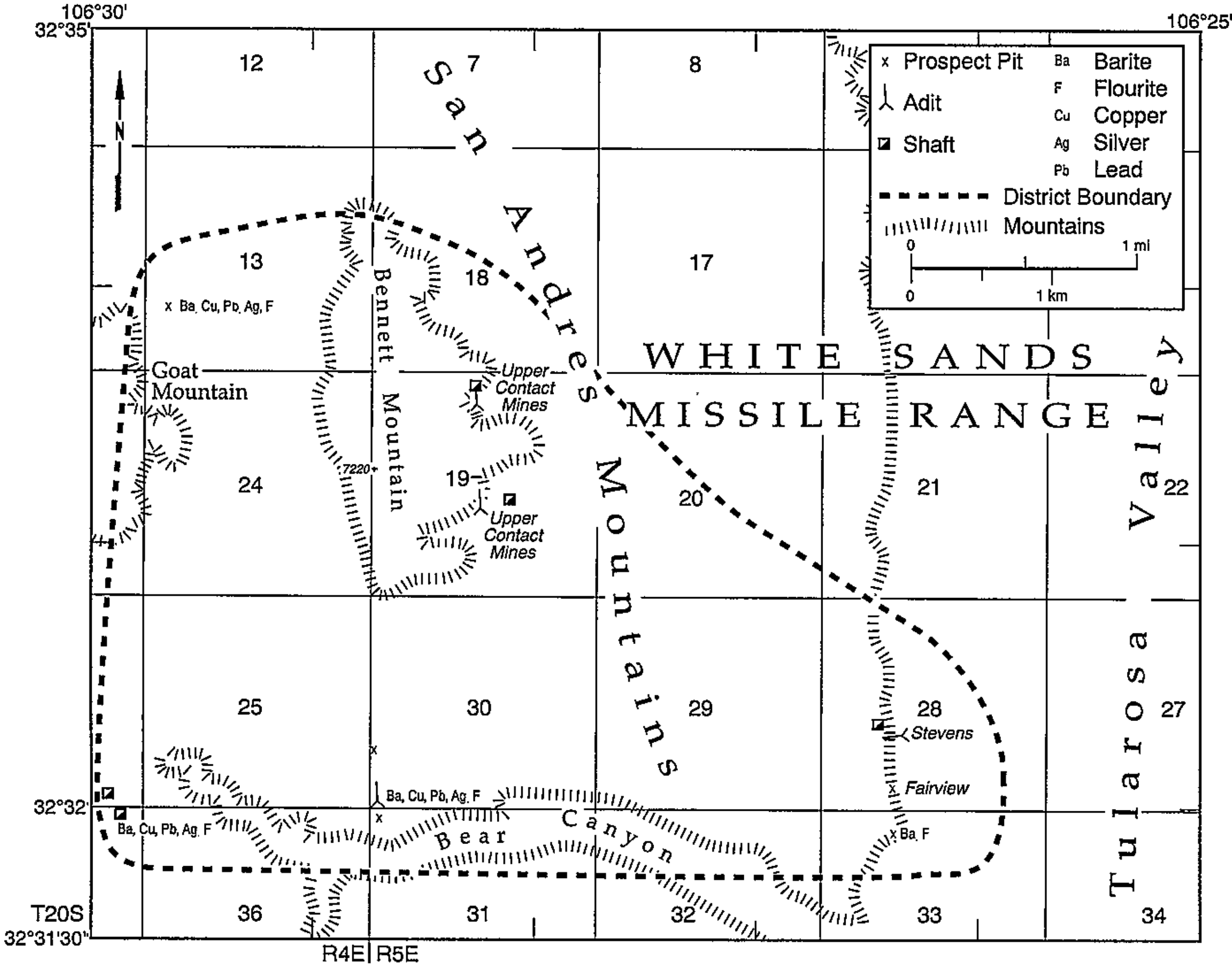

Figure 6—Mines and prospects in the Bear Canyon district, Doña Ana County, New Mexico.

Geology

The Bear Canyon district consists of westward-dipping, Cambrian through Mississippian sedimentary rocks in either fault or unconformable contact with Proterozoic granitic and metamorphic rocks (Dunham, 1935; Bachman and Myers, 1963, 1969). Thrust faults (low angle), locally mineralized, in the southern portion of the range have placed Proterozoic rocks over Ordovician and Cambrian sedimentary rocks (Dunham, 1935; Bachman and Myers, 1969). Younger sedimentary rocks of Pennsylvanian through Tertiary age overlie the rocks west of the district. A series of sills and dikes of presumably Tertiary age intrude the sedimentary rocks south of Bear Canyon on Quartzite Mountain (Bachman and Myers, 1969; Seager, 1981). These sills are sericitized, quartz-feldspar porphyry. Basaltic, dioritic dikes intrude the sedimentary rocks north of Bear Mountain and are highly altered and weathered (Bachman and Myers, 1969). Normal faults are common in the southern portion of the district and locally are mineralized.

Mineral Deposits

Rio Grande Rift barite-fluorite-galena deposits are found scattered throughout the area and are found in limestones and dolomites along the low-angle fault between the Ordovician sedimentary rocks and Proterozoic granite in the foothills (lower contact deposits) and within the Silurian dolomites beneath the Percha Shale (Devonian) along the crest (upper contact deposits)(Fig. 6; Dunham, 1935; Williams et al., 1964; Bachman and Myers, 1969; Smith, 1981; McLemore, 1994b). The deposits consist of predominantly veins, breccia cement, cavity-fillings, and minor irregular replacement deposits along faults, fractures, unconformities, and bedding planes in dolomitic limestone. The Percha Shale and Proterozoic granitic and metamorphic rocks may have acted as an impermeable cap for upward migrating mineralizing fluids. Barite, fluorite, calcite, and quartz are predominant minerals in these deposits. Locally, galena, malachite, and wulfenite are found (C.W. Plumb, unpublished report, Nov. 1925 on file at NMBMMR archives). Assays as high as 2.6 oz/short ton Ag, 12.2% Cu and 34.8% Pb have been reported (W.E. Koch, unpublished report, July 1911 on file at NMBMMR archives). Assays of samples collected for this study are in Table 14. These assays are selected samples and do not represent economic grades, but do indicate the presence of local concentrations of these metals in the deposits. The deposits along the upper contact near the crest are remote and inaccessible and are uneconomical. The deposits along the lower contact are uneconomic because they are small and low grade.

TABLE 14—Chemical analyses of samples collected from the lower contact in the Bear Canyon district, October 10, 1993. Analyses by the NMBMMR Chemical Laboratory (Au, Ag by fire assay; Cu, Pb, Zn, by FAAS after *aqua regia* digestion; Hg by cold vapor AA) and * by the USGS Chemical Laboratory (by ICP). —no data.

FIELD NO.	LAB NO.	Au (ppm)	Ag (oz/ton)	Ag* (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mo* (ppm)	Hg (ppm)	LOCATION, DESCRIPTION
VM007R	542	<0.7	0.00	—	34	220	42	1	0.14	SE26 20S 4E, dump select sample
VM008R	543	<0.7	0.00	—	38	63	103	—	<0.10	SE26 20S 4E, dump, select of jasperiod
VM009R	544	<0.7	0.00	—	5000	580	210	2	<0.10	SE26 20S 4E, 2 ft chip of jasperiod below shaft
VM010R	748	<0.7	0.00	5.4	880	440	99	3	—	SE26 20S 4E, grab sample of dump
VM011R	749	<0.7	0.00	1.9	650	14000	130	140	—	SW28 20S 5E, Stevens, grab sample of dump
VM012R	750	<0.7	0.00	—	340	51000	<50	—	—	SW28 20S 5E, Stevens, grab sample of dump
SA001R*	D554764	0.002	—	—	8	38	—	22	<0.02	SW29 20S 5E, hematite in limestone
SA002R*	D554765	0.006	—	—	32	54	—	9	<0.02	SW29 20S 5E, silicified limestone
SA003R*	D554766	<0.002	—	—	170	17	—	2	<0.02	SW29 20S 5E, quartz-pyrite vein
SA004R*	D554767	<0.002	—	—	15	<15	—	2	<0.02	SW29 20S 5E, quartz-iron oxides vein
SA005R*	D554768	<0.002	—	—	2	<15	—	<2	<0.02	SW29 20S 5E, quartz-iron oxides vein
SA006R*	D554769	0.010	—	—	120	32000	—	26	<0.02	SW28 20S 5E, Fairview, barite-galena zone
SA007R*	D554770	<0.002	—	—	—	—	—	—	<0.02	SW28 20S 5E, Fairview, barite-galena
SA008R*	D554771	0.150	—	—	—	—	—	—	0.18	SW28 20S 5E, Fairview, limestone

Black Mountain district

Location and Mining History

The Black Mountain district lies north of the Organ Mountains district in the southern San Andres Mountains and consists of Black Mountain (Fig. 1). The district, also known as Kent, Organ, and Gold Camp districts, was discovered in 1883 by Pat Breen. The Mountain Chief and Black Mountain mines are the only productive mines in the district (Table 15) and produced less than $12,000 of copper (<10,000 pounds), gold (600 ounces), silver (<1,000 ounces), fluorite (1,100 short tons), and some lead from 1883 to the early 1900s (Tables 1, 4; Dunham, 1935; Williams, 1966; McAnulty, 1978; McLemore, 1994b). It lies on the White Sands Missile Range and is closed to public access.

TABLE 15—Mines and prospects in the Black Mountain district, Doña County. Location includes section, township, and range.

MINE NAME	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	YEARS OF PRODUCTION	DEVELOPMENT	REFERENCES
Bighorn	12 21S 4E	32° 29' 47", 106° 29' 16"	Au, Pb	none	500 ft adit	Dunham (1935)
Black Mountain	SE1 21S 4E	32° 30' 25", 106° 29' 5"	Cu, Au, Ag, Pb, F, Ba	1883-1900s	pit	McLemore (1994b)
Mountain Chief	NW11 21S 4E	32° 29' 56", 106° 30' 21"	Au	1883	60 ft shaft	Dunham (1935), Seager (1981)

Geology

Rio Grande Rift barite-fluorite-galena deposits are found scattered throughout the Black Mountain area and are hosted by Ordovician dolomites and limestones of the El Paso Formation which are in fault contact with Proterozoic granite and metamorphic rocks (Dunham, 1935; Talmage and Wootton, 1937; Seager, 1981). North- and west-trending faults cut the rocks. The area lies on a gravity gradient between a gravity high to the north and a gravity low to the south which corresponds to the Organ Mountains batholith.

Mineral Deposits

The Mountain Chief mine in NW¼ sec. 11, T21S, R4E is on the south side of Black Mountain and consists of a 60-ft shaft and prospect pits. It is an irregular replacement body in Fusselman Dolomite and consists of gold, quartz, calcite, limonite, pyrite, and chlorite (Dunham, 1935). The relatively large amount of gold production reported is unusual for these types of deposits; unfortunately the deposits are remote and inaccessible and were not examined during this study. Two additional, but minor, prospects are found in the district (Table 15). Irregular replacement bodies of galena were developed along a vein trending N50°W in Paleozoic dolomite at the Bighorn deposit. A small barite-galena deposit occurs at the summit of Black Mountain in sec. 1, T21S, R4E (Dunham, 1935). Percha Shale forms a cap on the deposit. None of these deposits are economic. Geochemical anamolies in stream-sediments from the area include elevated concentrations of Cu, Pb, Mo, Sb, and Zn,.

Brickland (Cerro de Cristo Rey) district

Location and mining history

The Brickland district is on the flank of Cerro de Cristo Rey (also known as Cerro de Muleros) in southern New Mexico at the junction between Doña Ana County, El Paso County, Texas, and Chihuahua, Mexico (Fig. 1). Clay and shale for brick manufacture have been produced from the three states since the early 1900s. Plants are located in New Mexico and Juarez, Mexico. Limestone has been quarried from the Cretaceous units for use in cement (Kottlowski, 1962). These materials, along with silica sand also have been used for smelter flux by the ASARCO smelter periodically.

Geology

The clay and shale deposit is in the Mesilla Valley Formation (Cretaceous), which crops out on the eastern flank of Cerro de Cristo Rey laccolith, a Tertiary andesitic intrusion. The overlying quartz-rich Anapra Sandstone has been mined sporadically for silica flux for the nearby ASARCO smelter and for aggregate. Limestone is found in the Edwards Limestone and Buda Formation.

Mineral deposits

The clay and shale are mined by open pit quarrying, followed by crushing, screening, and firing at 900-1000°C (Ntisimanyana, 1990).

Limestone was sporadically quarried from the Edwards Limestone by the Southwestern Portland Cement Co. A sample of the limestone contained 93.5% $CaCO_3$, 2.1% $MgCO_3$, 3.2 SiO_2, and 0.8% Al_2O_3 (Kottlowski, 1962). Another sample of limestone from the younger Buda Formation contained 93.3% $CaCO_3$, 1.3% $MgCO_3$, 3.7% SiO_2, and 0.7% Al_2O_3 (Kottlowski, 1962). However, these limestones are interbedded with quartz sandstones and shales and would not yield a mineable high-calcium limestone (Kottlowski, 1962).

Doña Ana Mountains district

Location and Mining History

The Doña Ana Mountains lie east of Doña Ana and the mineral deposits consist of volcanic-epithermal vein deposits that were discovered about 1900 (Table 16; Fig. 1). A small amount of copper and approximately 100 ounces of gold and 5,000 ounces of silver have been produced (Table 1; North and McLemore, 1986). Marble and tactite outcrops are locally common in these mountains, suggesting potential for Pb-Zn and Au skarn deposits (Table 16).

TABLE 16—Mines and prospects in the Doña Ana Mountains district, Doña County. Location includes section, township, and range. FN—V. T. McLemore, unpublished field notes.

MINE NAME (ALAIS)	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	YEARS OF PRODUCTION	DEVELOPMENT	REFERENCES
East Dagger Flat (Malachite)	N20 21S 2E	32° 28' 30", 106° 45' 40"	Au, Cu, Ag	early 1900s	25 ft shaft, 50 ft shaft, pit, cut	Seager et al. (1976), FN 5/28/95
Piedra Blanca (Wagner Canyon, Gonzales)	SE15 21S 1E	32° 28' 40", 106° 49' 35"	Au, Mn, Ag	unknown	pit	Seager et al. (1976), Farnham (1961)
unknown	10,15 21S 1E	32° 29' 15", 106° 49' 30"	marble, Pb, Cu, Ag	unknown	pits	Farnham (1961), FN 5/25/95
unknown	C15 21S 1E	32° 29' 10", 106° 48' 30"	Au?, Ag?	none	pits	FN 5/28/95
unknown	NW15 21S 1E	32° 29' 55", 106° 48' 30"	Zn?, Au?, Ag?	none	pits	FN 5/28/95

Geology

Rocks in the Doña Ana Mountains range in age from Permian through Recent (Seager et al., 1976). Sedimentary rocks are the oldest rocks and range in age from Permian through Eocene. The sedimentary rocks have been intruded by an Eocene andesite and an Oligocene monzonite. The eruption of the 2,500 ft-thick Doña Ana Rhyolite (ash-flow tuff) initiated cauldera collapse. Age dates of the ash-flow tuff and monzonite porphyry are 33.9±1.3 and 34.6±1.3 Ma (K-Ar; Seager et al., 1976; NMBMMR age data files). The cauldera is approximately 7-8 mi in diameter and was filled by rhyolite flows, ash-flow tuffs, domes, and breccias. Rhyolite and monzonite dikes intruded the older rocks. Late Tertiary uplift and westward tilting have exposed the mountain range (Seager et al., 1976). The area is characterized by a gravity and magnetic high, which is related to the cauldera and subsequent intrusions. The area is characterized by elevated radiometric U, Th, and K.

Mineral Deposits

The Piedra Blanca prospect consists of thin quartz veins along a 4-ft wide rhyolite dike which strikes N80°W and dips 85°N. The dike intrudes Cleofas Andesite (Seager et al., 1976). Three shafts 80 ft, 25 ft, and 50 ft deep and several shallow pits, have exposed the deposit (Dunham, 1935; Seager et al., 1976). The vein is less than 2 ft wide and consists of quartz, iron oxides, manganese oxides, chlorite, calcite, and pyrite (Dunham, 1935; Farnham, 1961; Seager et al., 1976). Silicification of the rhyolite and andesite is pervasive (Seager et al., 1976). Two separate assays of a high-grade ore shoot in 1913 indicated 13.5 oz/short ton Au, 1,835 oz/short ton Ag and 13.6 oz/short ton Au, 1,526 oz/short ton Ag (Dunham, 1935). Another sample assayed 6.6% Mn (Farnham, 1961). Assays of samples collected for this report are in Table 17. Another occurrence, similar to the Piedra Blanca, is found along a north-trending dike in sec. 15, T21S, R1E. A 20-ft shaft and pits expose the thin quartz veins containing traces of pyrite.

TABLE 17—Chemical analyses of samples collected from the Doña Ana Mountains district. Analyses by the NMBMMR Chemical Laboratory (Au, Ag by fire assay; Cu, Pb, Zn by FAAS after *aqua regia* digestion).

FIELD NO.	LAB NO.	Au (oz/ton)	Ag (oz/ton)	Cu (ppm)	Pb (ppm)	Zn (ppm)	LOCATION, DESCRIPTION
DM1	70	—	—	2100	12	61	N20 21S 2E, East Dagger Flat,grab sample of dump
DM2	571	0.00	0.00	1500	<50	120	N20 21S 2E, East Dagger Flat, grab sample of dump
DM3	572	0.00	0.00	310	<50	84	N20 21S 2E, East Dagger Flat, grab sample of dump
DM4	573	0.00	0.00	120	<50	84	N20 21S 2E, East Dagger Flat, grab sample of dump
DM5	574	0.00	0.00	<50	75	150	SE15 21S 1E, Piedra Blanca, select sample of dump
DM6	575	0.00	6.12	<50	63	87	10 21S 1E, select sample of dump
DM7	576	0.00	0.00	50	<50	110	C15 21S 1E, sample of tactite
DM8	577	0.00	0.00	63	<50	330	C15 21S 1E, 3 ft chip of tactite zone
DM9	578	0.00	0.00	<50	67	110	NW15 21S 1E, select sample of dump

Similar veins occur in sec. 20, T21S, R2E near Dagger Flat and are exposed by two shafts, 50 ft and 25 ft deep, a cut and shallow pit (V. T. McLemore, unpublished field notes May 28, 1995; Seager et al., 1976). Quartz and malachite occur along fractures in the Cleofas Andesite. Several prospects northwest of Doña Ana Peak have exposed manganese veins (Table 16).

Marble occurs in sec. 10 and 15, T21S, R1E and tactite crops out in sec. 15 and 16, T21S, R1E. Marble has been quarried for local use as rip-rap and road fill. The marble varies in color from white to pink, but is highly fractured and contains impurities and is not suitable for use as large blocks of dimension stone. Traces of iron oxides, pyrite, and chalcopyrite are found, but the metal potential is low (Table 19). However, one sample assayed 6.12 oz/short ton Ag (DM6, Table 16). The tactite consists of fine-grained garnet and iron oxides with traces of pyrite. The marble and tactite are similar in appearance to mineralized skarns elsewhere in the Mimbres Resource Area.

Iron Hill district

Location and Mining History

The Iron Hill district, also known as the Robledo district, is located in the southwestern Robledo Mountains (Fig. 1). The district was discovered in the early 1930s; but total production is unknown. Nearly two dozen pits, shafts, and adits occur in the area exposing sedimentary iron deposits (Dunham, 1935; Kelley, 1949; Harrer and Kelly, 1963). The Gilliland group of deposits occur in sec. 2, T22S, R1W and the Iron Hill deposits occur in sec. 16, T22S, R1W. The Robledo Mountains Wilderness Study Area lies to the north of the district.

Geology

Ordovician through Permian and Eocene sedimentary rocks are exposed in the Robledo Mountains and are overlain by Tertiary volcanic and sedimentary rocks and Quaternary deposits (Hawley et al., 1975). The iron deposits are hosted by limestones of the Hueco Formation (Permian)(F. E. Kottlowski, personal communication, May 10, 1995). Rhyolite sills, dikes, and domes form the northern portion of the range and the Cedar Hills to the west (Hawley et al., 1975; Seager and Clemons, 1975). The large sill between Robledo Peak and Lookout Peak has been dated as 36.1±1.3 Ma (NMBMMR age data files). The district forms the northern part of a gravity high which coincides with the Doña Ana Mountains cauldera.

Mineral Deposits

The Iron Hill deposits consist predominantly of hematite, goethite, and limonite with local concentrations of manganese oxides, gypsum, calcite, quartz, and ocher (Dunham, 1935; Kelley, 1949). The deposits occur as lenticular replacements, breccia cement, and cavity fillings in limestones. Numerous bodies range in size from small replacement pods to massive zones 200 ft long and 120 ft wide (Dunham, 1935). The deposits both parallel and cut across bedding; the ore is porous and banded with common crustations, botryoidal, and stalactitic textures (Kelley, 1949; Harrer and Kelly, 1963).

The orgin of these deposits is speculative. Dunham (1935) suggests that they were formed as a result of leaching of hematite cement from overlying Permian sedimentary rocks (the Abo tonque of the Hueco Formation) and precipiatated in voids in the underlying middle Hueco limestones. Kelley (1949) suggests that these deposits could be formed by meteoric or magmatic waters of varying temperatures.

In 1949, Kelley (1949) estimated the indicated reserves at Iron Hill as 5,000 short tons and the inferred reserves as 15,000 short tons, both with a grade of 50-55% Fe. Despite these reserves, it is unlikely that these deposits will be mined in the near future because of small tonnage, low grade, poor quality, and inaccessiblity.

Travertine

Travertine occurs in the district along the Cedar Hills and other north-trending faults (Hawley et al., 1975; Clemons, 1976); some of the larger deposits are in sec. 23 and 25, T21S, R1W. Banded travertine, known locally as "Radium Springs marble or onyx", occurs as veins and apron-like deposits in sec. 25, T21S, R1W. It is quarried and used as decorative stone. The active Rainbow pit is in sec. 23, T21S, R1W and produces 96 cu ft/day (Hatton et al., 1994). Additional pits occur in secs. 23, 26, 35, T21S, R2W (Clemons, 1976). The travertine varies in color from pink, orange, lavender, white, brown, and gold.

Northern Franklin Mountains district

Location and Mining History

The Northern Franklin Mountains district, discovered in 1914, is in the New Mexico portion of the northern Franklin Mountains, which extend southward into Texas (Fig. 1).. A small amount of lead and silver were produced from a Rio Grande Rift deposit (NMBMMR production data). Several hundred short tons of jarosite from a possible epithermal deposit and bedded gypsum also have been produced from the area (Table 18).

TABLE 18—Mines and prospects in the Northern Franklin Mountains, Doña Ana County. Location includes section, township, and range. FN—unpublished field notes, V. T. McLemore.

MINE NAME	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	DEVELOPMENT	REFERENCES
Copiapo	NE8 26S 4E	32° 3' 47", 106° 32' 58"	jarosite, Ag, Au, Cu	200 ft shaft, 6 pits	Dunham (1935), Kelley and Matheny (1983), NMBMMR file data; FN 11/11/93
Creators mine	NE34,NW35 26S 4E	32° 0' 27", 106° 30' 48"	Au?, Ag?	35 ft inclined shaft	Kelley and Matheny (1983), FN 11/11/93
unknown	NE27 26S 4E	32° 1' 25", 106° 30' 57"	jarosite	pit	Dunham (1935), Kelley and Matheny (1983)
Caever?	NE32,NW33 26S 4E	32° 00' 26", 106° 32' 52"	gypsum	pits	Kelley and Matheny (1983), FN 11/11/93
unknown	NE34 26S 4E	32° 00' 26", 106° 30' 53"	shale	pit	Kelley and Matheny (1983)
unknown	SE32 25S 4E	31° 59' 34", 106° 32' 32"	Pb, Zn, Ag, Ba, F	pits, 50 ft, 2-10 ft shafts, 110 ft adit	Dunham (1935), Kelley and Matheny (1983), FN 4/27/95

Geology

The northern Franklin Mountains consist of Ordovician through Permian carbonates and shales (Harbour, 1972; Kelley and Matheny, 1983). These rocks have been folded, probably during the Larimide compressional event. North-trending low-angle and high-angle normal faults offset the Paleozoic rocks in places (Kelley and Matheny, 1983). Quaternary piedmont and alluvial deposits form the lower foothills, covering the older rocks.

Proterozoic rocks underlie Paleozoic rocks in Hitt Canyon, just south of the New Mexico-Texas state line (Harbour, 1972). The rocks are correlated with the Mundy Breccia and Lanoria Quartzite (Proterozoic) found in the central and southern Franklin Mountains. In addition, Proterozoic granite porphyry and granite are also found in Hitt Canyon. These Proterozoic rocks probably underlie the northern Franklin Mountains in New Mexico.

Mineral Deposits

Veins and replacements of barite, fluorite, lead, calcite, iron oxides, and quartz occur in dolomitic limestones of the Fusselman Formation, which are typical of Rio Grande Rift deposits elsewhere in New Mexico. Dunham (1935) reports an assay of 4 oz/short ton Ag from one vein in SE¼ sec. 32, T25S, T4E and that small shipments of argentiferous galena were made. Additional assays are in Table 19. The largest vein is less than 3 ft wide and several hundred feet long. Brecciation and jasperoid are common in the canyon. Local geochemical anomalies of Pb, Be, Zn, Mo, Sb, Cd, and As occur in the stream sediments.

TABLE 19—Chemical analyses of samples collected from the Northern Franklin Mountains district (SE¼, 32, T25S, R4E). Analyses by the NMBMMR Chemical Laboratory (Au, Ag by fire assay; Cu, Pb, Zn by FAAS after *aqua regia* digestion).

FIELD NO.	LAB NO.	Au (oz/ton)	Ag (oz/ton)	Cu (ppm)	Pb (ppm)	Zn (ppm)	DESCRIPTION
NF1	579	0.00	0.00	54	93	190	4 ft chip sample along face at end of adit
NF2	580	0.00	0.00	<50	7500	5400	select sample of dump at adit
NF4	581	0.00	0.00	<50	18000	86	grab sample of dump of 50 ft shaft

Copper is found in Proterozoic Castner Marble near the contact with Proterozoic granite in Hitt Canyon, just south of the New Mexico-Texas state line (Harbour, 1972; Deen, 1976; Goodell, 1976). Small, discontinous contact-metasomatic deposits at Hitt Canyon consists of bornite, pyrite, covellite, chalcopyrite, marcasite, and pyrrhotite (Deen, 1976; Goodell, 1976). A sample assayed 5.84% Cu, 0.016% Pb, and 0.81% Zn (Goodell, 1976). Shallow prospect pits have exposed the deposits. In addition, iron deposits have replaced the Castner Limestone (Proterozoic) where the limestone has been intruded by granite, approximately 1.8 mi south of the state line. Iron occurs as siderite and rarely exceeds 40% Fe (Harbour, 1972). Similar deposits may occur in Proterozoic rocks that occur beneath the northern Franklin Mountains in New Mexico.

Jarosite

The Copiapo jarosite mine is located in the northern Franklin Mountains at Webb Gap (NE¼ sec. 8, T26S, R4E). Development consists of a 200 ft inclined shaft with four levels and six prospect pits. Several hundred short tons of material were mined in 1925-28 by F. Schneider Co. for use as pigment in paints.

The deposit occurs along a north-trending, low-angle, fault zone (N10°E 40-50°E) within the Bishop Cap Member of the Magdalena Group (Pennsylvanian)(Fig. 7; Kelley and Matheny, 1983). At the shaft, the deposit is 10-15 ft wide for an approximate length of 100-200 ft. The deposit pinches out to the north; a drift at the 100 ft level is only 20 ft long to the north and 100 ft long to the south (Dunham, 1935). The deposit thins to the south (<10 ft wide). The host limestone strikes N13°W and dips 40°W.

The deposit consists of veins and replacement bodies along the fault zone and contains jarosite (red to yellow to orange), limonite, hematite (red to black to brown), gypsum, calcite, and aragonite. Malachite stains are reported coating fractures at the bottom of the shaft (Dunham, 1935). Jarosite occurs only within the upper 100 ft (NMBMMR file data). Assays of selected samples are in Table 20. A crude zonation is present. The zone adjacent to the footwall consists of black to dark brown hematite and limonite and is approximately 1-2 ft wide. Jarosite, limonite, and hematite of various colors form the central zone, which ranges in thickness from 2 to 10 ft. The outer zone, adjacent to the hangingwall consists of white calcareous to clayey material with zones of hematite and jarosite cutting it.

TABLE 20—Assays of samples from the Copiapo jarosite prospect, Doña Ana County. Samples are located on Figure 7. Analyses by the NMBMMR Chemical Laboratory (Au, Ag by fire assay; Cu, Pb, Zn by FAAS after *aqua regia* digestion; Hg by cold vapor AA) and * by the USGS Chemical Laboratory (by ICP). — no data.

LAB NO.	SAMPLE NO.	Au (oz/ton)	Ag (oz/ton)	Cu ppm	Pb ppm	Zn ppm	Hg ppm	Fe%	As* ppm	Mo* ppm	Cd* ppm	Tl* (ppm)
3050	black dump	0.00	1.12	32	45	650	0.29	55	1400	46	2	5
3051	yellow dump	0.00	3.14	9.7	30	120	0.92	29	1500	25	1	>100
3052	red ochre	0.00	0.20	16	61	240	0.34	2.4	<15	13	2	3
3053	3 ft channel	0.00	0.00	12	22	44	0.1	1.9	330	8	1	2
3054	yellow ochre	0.00	0.04	11	27	200	0.34	27	—	—	—	—

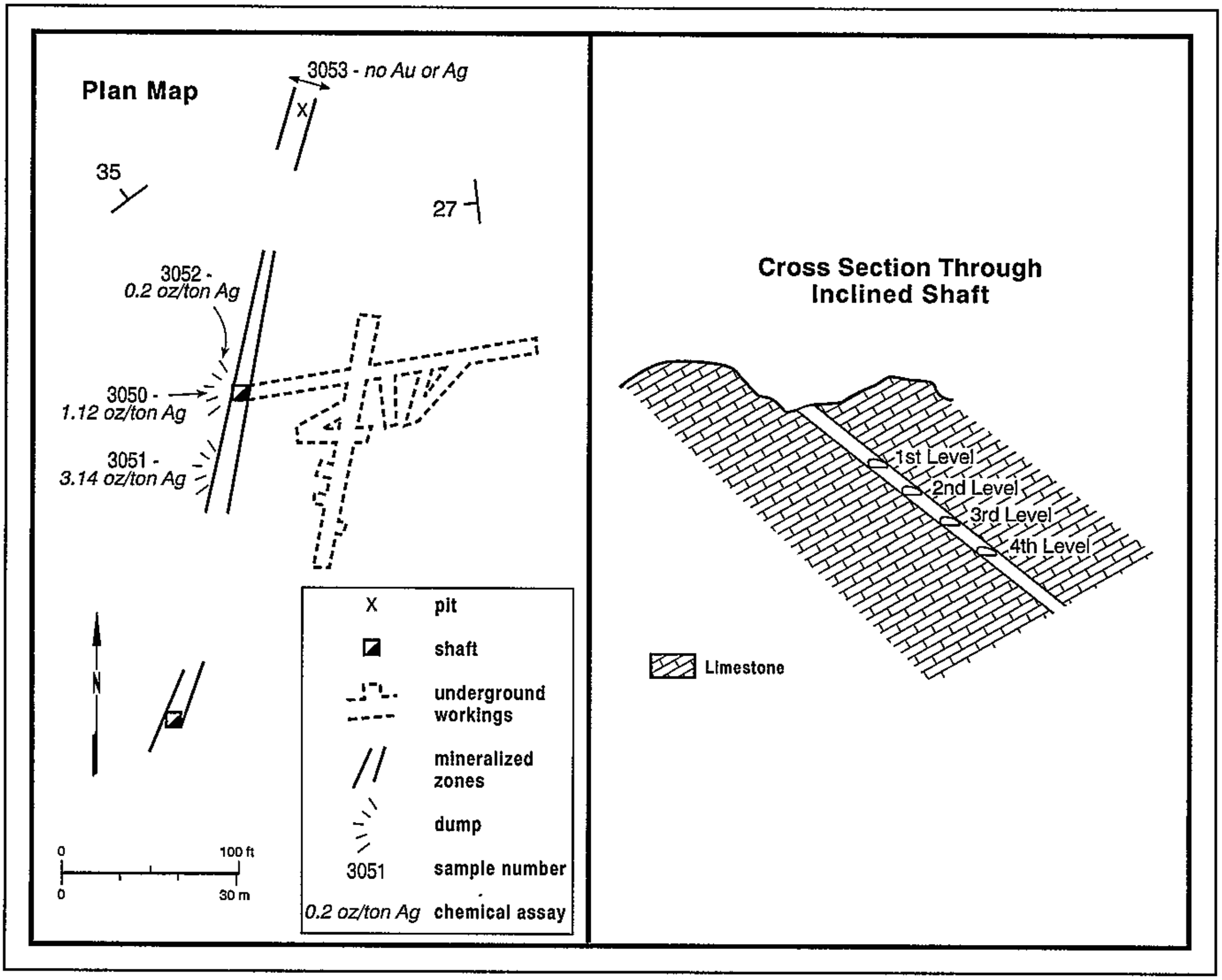

Figure 7—Map of Copiapo jarosite mine, showing underground workings (modified from M. H. Berliner, written communication, 1949) and assays of surface samples (NMBMMR file data; samples assayed by NMBMMR chemical laboratory).

The origin of the deposit is speculative. The mineralogy and crude zonation are suggestive of a supergene origin. The minerals are poorly crystalline to very-fine grained, which is consistent with a supergene origin. Sulfur isotope analyses are required to confirm a supergene origin. It is possible that this deposit overlies epithermal base- or precious-metal deposits, but drilling would be required to confirm their presence. The economic potential for future use as paint pigment is probably low, because of small size and far distance from paint manufacturers.

Additional small, isolated occurrences of jarosite, limonite, and hematite occur throughout the limestones in sec. 22 and 27, T26S, R4E. These occurrences are predominantly fracture coatings and uneconomical.

Gypsum and Limestone

Gypsum and limestone have been quarried in the northern Franklin Mountains. Gypsum occurs in two beds of the Hueco Formation at Anthony Gap; each bed was over 100 ft thick (Harbour, 1972). The gypsum was quarried arround 1932 for use by the El Paso Cement Company (Dunham, 1935). Limestone also has been quarried in the New Mexico and Texas parts of the area, probably for aggregate.

Organ Mountains district

Location and Mining History

The Organ Mountains district is in the Organ Mountains near Organ (Fig. 1) and includes the Mineral Hill, Bishops Cap, Gold Camp, Modoc, South Canyon, Soledad Canyon, and Texas Canyon subdistricts. Mineralization was discovered in the 1830s and perhaps as early as 1797 (Dunham, 1935). Metal production from the district amounts to $2.7 million worth of copper, lead, zinc, silver and gold (Table 2, 21). Other mineral production from the Organ Mountains district amounts to 600 short tons of barite; 1,650 short tons of fluorite; 14 pounds of uranium; and 9 pounds of vanadium (Tables 4, 5, 6). Bismuth occurs locally; a small amount was produced from the Texas Canyon mine (Dasch, 1965) and other ore shipments were penalized for bismuth at the smelter. Uranium and barite were produced from the Bishops Cap area (Table 4, 5; Williams et al., 1964; McLemore, 1983). In addition local occurrences of Fe, Mn, Mo, Sn, Te, and W are reported (Table 1).

From the 1960s through the early 1980s, several companies have explored the Organ Mountains for potential porphyry copper-molybdenum deposits. Kerr-McGee drilled 18 holes in 1963. AMAX drilled 6 holes in 1969; followed by six more holes in 1970 by Bear Creek. Conoco drilled 14 holes in the 1972-1976. More than 60 drill holes have been drilled northeast of Organ, ranging in depth from 195 to 3,100 ft (Newcomer and Giordano, 1986). Studies of lithology, alteration assembalges, mineral zoning, and stockwork veining suggest that a porphyry copper and/or copper-molybdenum deposit may occur in the Organ Mountains district (Fig. 8). Drilling has not delineated any ore bodies, but assays range from 0.001 to 0.065% Cu and as high as 0.15% Mo (Newcomer, 1984; Newcomer and Giordano, 1986). The Abandoned Mine Lands Bureau has reclaimed the Stephenson-Bennett, Modoc, Memphis, and several smaller mines in the vicinity of the Memphis mine from 1989 to 1994.

TABLE 21—Metal production from the Organ Mountains district, Doña Ana County (U.S. Geological Survey, 1902-1927; U.S. Bureau of Mines, 1927-1990; Dunham,1935; Anderson, 1957; Jones,1965; Seager,1981). [e]—estimated production.

YEAR	ORE (SHORT TONS)	COPPER (LBS)	GOLD (OZ)	SILVER (OZ)	LEAD (LBS)	ZINC (LBS)	TOTAL VALUE ($)
1869	—	—	—	15,152	—	—	—
1871	—	—	—	7,576	—	—	—
1882	—	—	571[e]	—	—	—	20,000
1883	—	—	2,430[e]	—	—	—	85,000
1884	—	—	143[e]	34,884	—	—	43,721
1885	—	—	230[e]	9,303	—	—	17,954
1889	—	—	142[e]	64,031	1,863,158	—	137,808
1890	—	—	14[e]	22,092	107,232	—	28,521
1891	—	—	20[e]	20,294	201,637	—	29,461
1892	—	—	19[e]	91,118	1,100,000	—	125,022
1893	—	—	285[e]	24,806	1,250,000	—	75,598
1894	—	—	600[e]	3,000	166,667	—	28,390
1895	—	—	429[e]	91,738	853,664	—	101,946
1986	—	—	514[e]	104,479	—	—	89,045
1897	—	—	153[e]	16,717	234,325	—	23,805
1898	—	—	124[e]	11,135	123,368	—	15,607
1899	—	—	124[e]	10,859	108,614	—	15,752
1900	—	712,385	82[e]	6,532	179,976	—	133,097
1901	—	515,162	104[e]	15,275	165,116	—	105,951
1902	—	—	97[e]	192	9,950	—	3,910
1903	—	611,796	—	9,671	147,610	—	95,140
1904	5,580	40,000	—	24,101	1,581,488	—	87,103
1905	6,566	96,058	325	21,776	327,707	30,000	52,150
1906	16,220	434,000	—	34,051	1,207,193	—	175,727
1907	6,084	776,125	0.29	25,612	675,189	—	267,920
1908	3,090	21,150	—	9,283	379,697	—	23,660
1909	2,816	10,600	12	16,975	772,023	—	43,650
1910	2	—	—	15	705	—	39
1911	5	353	—	111	1,561	—	173
1912	78	6,685	0.82	1,790	26,129	—	3,397
1913	155	10,189	1.45	1,232	9,557	—	2,774
1914	451	78,180	45	3,564	29,897	—	14,462
1915	1,599	241,749	117	8,552	2,251,383	—	49,859
1916	2,615	206,187	24	7,948	34,696	106,679	73,144
1917	417	16,121	5	4,705	162,965	—	22,391
1918	6,076	110,676	5	45,661	1,616,479	114,000	198,251
1919	1,856	319,323	—	4,726	29,981	—	66,276
1920	1,407	168,853	2	4,779	120,100	12,852	46,971
1921	47	—	—	676	20,000	—	1,576
1922	43	—	—	413	12,576	—	1,104
1923	25	—	—	—	14,000	—	952
1924	55	8,893	—	300	2,064	—	1,531
1925	221	1,313	—	2,684	55,400	—	6,868
1926	2,462	12,377	5	5,131	235,200	—	23,855
1927	218	1,923	4	1,862	71,651	—	5,899
1928	827	39,000	0.5	3,959	105,897	—	14,088
1929	2,340	28,665	—	9,516	326,238	—	30,670
1930	897	17,000	151	1,587	11,000	—	6,484
1931	462	40,000	23	576	20,000	—	5,022
1932	35	—	0.29	227	—	2,000	130
1933	305	3,000	9	2,060	80,000	—	4,069
1934	1,119	1,900	8	2,673	63,700	—	4,518

YEAR	ORE (SHORT TONS)	COPPER (LBS)	GOLD (OZ)	SILVER (OZ)	LEAD (LBS)	ZINC (LBS)	TOTAL VALUE ($)
1935	13	—	—	736	200	—	537
1936	2	—	—	22	300	—	34
1937	56	800	7	477	7,900	—	1,175
1938	133	6,500	103	322	—	—	4,786
1939	159	2,800	70	392	4,600	—	3,233
1940	237	2,800	111	509	2,300	—	4,678
1941	47	—	—	97	12,000	12,000	1,653
1942	880	6,200	92	—	—	211,000	23,593
1943	1,627	15,000	—	938	5,000	363,000	42,196
1944	12	400	—	180	1,200	—	278
1945	—	—	—	—	—	—	—
1946	—	—	110	4,000	—	525	—
1947	—	1,100	2	1,792	51,000	—	9,267
1948	—	2,000	2	1,548	32,000	18,000	10,027
1949	—	28,000	—	201	2,000	40,000	11,290
1950	—	30,000	1	1,687	16,000	512,000	82,666
1951	—	10,000	5	1,306	6,000	256,000	51,407
1952	—	—	—	179	8,000	—	1,612
1953	—	—	—	—	—	—	—
1954	—	—	—	—	—	—	—
1955	6	—	—	5	2,000	—	303
REPORTED TOTAL 1869-1955	67,245	4,635,263	7,322.35	819,790	16,906,293	1,678,056	2,659,176
ESTIMATED TOTAL 1849-1961	—	4,636,000	11,500	820,000	25,000,000	1,700,000	2,700,000

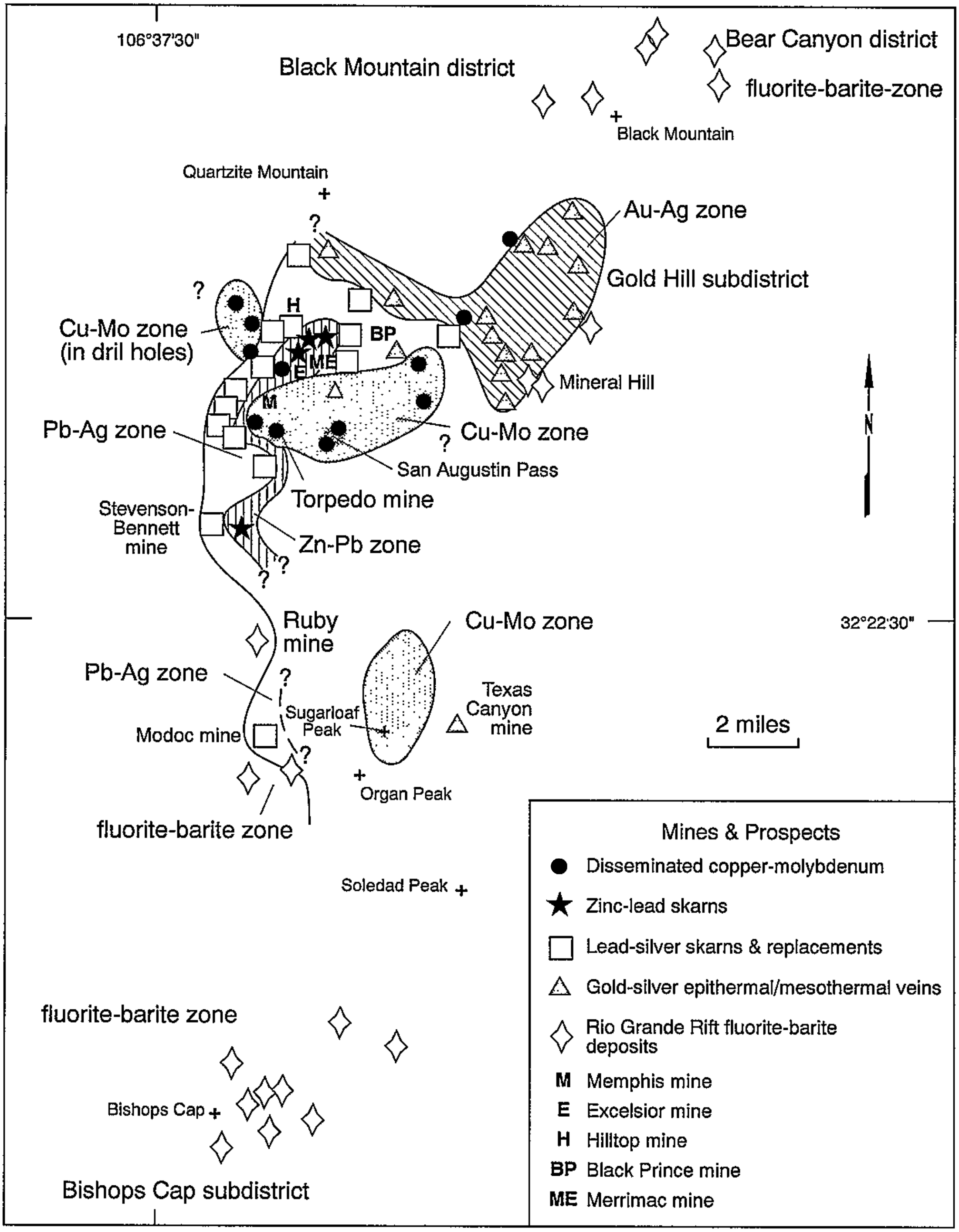

Figure 8—District zoning in the Organ Mountains, Doña Ana County, New Mexico (modified from Dunham, 1935; Seager, 1981).

TABLE 22—Mines and prospects in the Organ Mountains mining district. Location includes section, township, and range. FN—unpublished field notes, V.T. McLemore. WC—written communication. PC —personal communication. NMBMMR file data—unpublished file data in the NMBMMR archives.

AREA	MINE NAME	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	YEARS OF PRODUCTION	DEVELOPMENT	PRODUCTION	TYPE OF DEPOSIT	REFERENCES
Bishop Cap	unknown	24 24S 3E	32° 11' 57", 106° 34' 38"	Ba, U, F	1944	pits	unknown	fluorite vein	McLemore (1983), Seager (1973), FN 3/17/89
Bishop Cap	Hiebert	NW25 24S 3E	32° 11' 50", 106° 35' 45"	Ba, U, F	1944	35 ft adit, caved adit	unknown	fluorite vein	Seager (1973), Macer (1978), FN 3/17/89
Bishop Cap	unknown	SE19 24S 4E	32° 11' 59", 106° 33' 48"	Ba, F	none	shaft	none	fluorite vein	Seager (1973)
Bishop Cap	unknown	SW26 24S 3E	32° 11' 8", 106 36' 25"	Ba, U, F	unknown	pits	unknown	fluorite vein	Seager (1973)
Bishop Cap	Blue Star	NE25 24S 3E	32° 11' 24", 107° 35' 42"	Ba, U, F, Pb, Cu	1944, 1955	2 adits, pits	12 short tons BaSO4, 12 short tons 0.06% U3O8	fluorite veins, carbonate-hosted Pb-Zn	McLemore (1983), Seager (1973), FN 3/17/89
Bishop Cap	Bishop Cap (Gonzales)	NE35 24S 3E	32° 10' 48", 106° 35' 22"	Ba, U, F	1944	pits, 3 adits	100 short tons	fluorite veins, carbonate-hosted Pb-Zn	Seager (1973), FN 3/17/89
Bishop Cap	Grants prospect	NW25 24S 3E	32° 11' 20", 106° 36' 10"	Ba, U, F	1944, 1969-1972	pits, adits	138 short tons	fluorite vein	Seager (1973), FN 3/17/89
Bishop Cap	Garcia and Morris	NW36 24S 3E	32° 11' 10", 106° 35' 52"	Ba, U, F	unknown	pits	unknown	fluorite vein	Seager (1973), Williams (1966), McAnulty (1978), FN 3/17/89
Cu porphyry	Organ copper porphyry	24,25 21S 3E	32° 27' 20", 106° 35' 12"	Cu, Au, Ag, Mo	none	drill holes	none	Cu-Mo porphyry	NMBMMR file data, Newcomer (1984), Newcomer and Giordano (1986), Seager and McCurry (1988)
Devil's Canyon	Devil's Canyon (White Spar)	33 23S 4E, 4 24S 4E	32° 15' 26", 106° 32' 2"	Ba, F	1932-1934	pits, 25 ft shaft	small	Rio Grande Rift	Dunham (1935), Seager (1981), McAnulty (1978)
Devil's Canyon	Boulder Canyon	C32 23S 4E	32° 15' 51", 106° 32' 58"	Ba, F	unknown	none	unknown	Rio Grande Rift	Dunham (1935), Seager (1981)
Devil's Canyon	Magnesia (South Canyon)	N35 23S 4E	32° 15' 58", 106° 30' 14"	magnesite	none	pits	none	—	—
Gold Camp	Sally	13 21S 4E	32° 29' 6", 106° 29' 00"	Au, Ag	unknown	>100 ft shaft, 10 ft shaft, pit	unknown	vein	Dunham (1935); FN 10/14/93
Gold Camp	High Grade	13 21S 4E	32° 28' 48", 106° 29' 20"	Au, Ag	unknown	pits	unknown	vein	—
Gold Camp	Stonewall Jackson	13 21S 4E	32° 28' 37", 106° 29' 17"	Au, Ag	unknown	pits	unknown	vein	—
Gold Camp	Dolphin	14 21S 4E	32° 29' 0", 106° 29' 42"	Au, Ag	unknown	pits	unknown	vein	—
Gold Camp	H and H Beryl	14,15 21S 4E	32° 29' 57", 106° 30' 40"	beryl, feldspar, topaz	none	pit	none	pegmatite	—

AREA	MINE NAME	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	YEARS OF PRODUCTION	DEVELOPMENT	PRODUCTION	TYPE OF DEPOSIT	REFERENCES
Gold Camp	Santa Cruz (Rattlesnake Ridge)	24 21S 4E, 19,30 21S 5E	32° 28' 2", 106° 28' 15"	Au, Ag, Cu, F	1933-1934	shaft, pits	unknown Au,Ag, 25 short tons fluorite in 1944	vein	Dunham (1935), Williams (1966), FN 2/20/94
Gold Camp	Moneymetalist	25,26,35 21S 4E	32° 27' 48", 107° 29' 52"	Ag, Au, Cu	unknown	pits	unknown	vein	FN 2/20/94
Gold Camp	Maggie G	35 21S 4E	32° 26' 9", 106° 30' 00"	Au, Ag, Cu	1932	100 ft shaft, pits	small	veins	Dunham (1935)
Gold Camp	Old Homestead (Antelope Hill)	36 21S 3E, 31 21S 4E	32° 28' 10", 106° 32' 12"	Au, Ag	none	pits	none	vein?	—
Gold Camp	sec. 10	NE10 21S 4E	32° 29' 58", 106° 30' 47"	Au, Ag	none	50 ft shaft	none	vein	FN 10/14/93
Gold Camp	Morman	NE14 21S 4E	32° 28' 58", 106° 30' 2"	Au, Ag, Cu	1880s-1917	50-175 ft shafts, pits	$40,000 Au, <500 short tons Au,Ag,Cu 1902-17	veins	Dunahm (1935), FN 10/14/93
Gold Camp	Dona Dora	NE26 21S 4E	32° 27' 10", 106° 30' 14"	Au, Ag, Pb, Zn	1900s	1850 ft adit, shaft	small	vein	Dunham (1935), Seager (1981), Lindgren et al. (1910), FN 2/20/94
Gold Camp	*Black Hawk*	*NE27 21S 4E*	*32° 27' 30", 106° 30' 52"*	*Pb, Cu*	*unknown*	*150 ft adit, pits*	*unknown*	vein	*Dunham (1935), FN 10/13/93*
Gold Camp	Rock of Ages	NE35 21S 4E	32° 26' 25", 106° 30' 17"	Au, Ag, Cu	unknown	125 ft shaft, 100 ft adit, 75 ft shaft	small	vein	Dunham (1935), FN 10/12/93
Gold Camp	Dixie Group (Galena)	NW11 21S 4E	32° 30' 1", 106° 30' 40"	Au, Ag, Cu, Pb	none	80 ft shaft	none	vein	FN 10/14/93
Gold Camp	sec. 11	NW11 21S 4E	32° 29' 59", 106° 30' 35"	Au, Ag	none	pit	none	vein	FN 10/14/93
Gold Camp	Buck Deer	NW21 21S 4E	32° 28' 00", 106° 32' 25"	Au, Cu, Pb, Ag	none	cut	none	vein	Dunham (1935), FN 10/13/93
Gold Camp	Bonney Spring	SE12 21S 4E	32° 29' 40", 106° 29' 12"	Au, Ag	unknown	shaft	unknown	vein	Seager (1981)
Gold Camp	Green Girl	SE13 21S 4E	32° 28' 54", 106° 29' 15"	Au, Ag, Cu	none	pits	none	vein	Dunham (1935)
Gold Camp	Sunol	SE13 21S 4E	32° 28' 53", 106° 29' 15"	Cu, Au, Ag	1890-1900	3 shafts, deepest 200 ft, pits	unknown	vein	Dunham (1935), FN 10/14/93
Gold Camp	Black Prince (Carbonate Chief, San Augustin)	SE20 21S 4E	32° 27' 42", 106° 33' 13"	Ag, Pb	1916	2 adits, pits	$1000 Ag, <500 short tons Ag,Au,Pb,Zn	carbonate-hosted Pb-Zn	Lindgren et al. (1910), Dunham (1935), Seager (1981), Albritton and Nelson (1943)
Gold Camp	Eureka	SE22 21S 4E	32° 28' 2", 106° 31' 18"	Cu, Ag	none	60 ft adit, cut	none	vein	Dunham (1935)
Gold Camp	*Phamacist*	*SE22 21S 4E*	*32° 26' 58", 106° 30' 53"*	*Au, Ag, Cu*	*1900s*	*80 ft shaft, 195 ft adit*	unknown	veins	*Dunham (1935)*
Gold Camp	Tennessee (Hidden Treasure, Section 25)	SW25 21S 4E	32° 27' 19", 106° 29' 31"	Ag, Au, Cu, Pb, Zn, F	1945-1949	pits, shaft, adits	10,730 short tons fluorite	vein	Williams (1966), Seager (1981), FN 10/12/93

AREA	MINE NAME	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	YEARS OF PRODUCTION	DEVELOPMENT	PRODUCTION	TYPE OF DEPOSIT	REFERENCES
Gold Camp	Dummy B	SW26 21S 4E	32° 27' 00", 106° 30' 38"	Ag, Pb	unknown	100 ft adit, shaft	unknown	vein	Dunham (1935)
Gold Camp	Golden Lily (H and H)	SW26 21S 4E	32° 26' 50", 106° 30' 20"	F, Cu	1946	75 ft adit, 390 ft adit, 15 ft shaft	100 short tons fluorite	fluorite vein	Dunham (1935), Williams (1966), FN 2/20/94
Gold Camp	Pagoda	SW26 21S 4E	32° 27' 00", 106° 30' 00"	Au, Pb, Zn, Ag	1934	60 ft decline, pit	unknown	veins	Dunham (1935), FN 10/12/39, 2/20/94
San Augustin	Swanson-Lauer (WS30)	19,20 21S 4E	32° 28' 15", 106° 33' 30"	U, Mn	none	pits	none	carbonate-hosted Mn-U?	NMBMMR file data, FN 10/13/93
San Augustin	Chippewa (west of Excelsior)	25 21S 3E	32° 27' 20", 106° 34' 32"	Pb, Zn, Cu, Ag	none	pits	none	carbonate-hosted Pb-Zn	NMBMMR file data
San Augustin	Big Three group	25,30 21S 3E	32° 27' 00", 106° 34' 53"	Ag, Pb, Cu, Zn	1904,1909,1912	shafts, pits	<100 short tons Ag,Au,Cu,Pb	vein	Dunham (1935), Seager (1981)
San Augustin	Hard Scrabble	25,36 21S 3E	32° 26' 43", 106° 34' 40"	Au, Ag	none	pit	none	vein	—
San Augustin	Mullins	30 21S 4E	32° 26' 59", 106° 33' 58"	Ag, Pb, Zn, Cu	none	30 ft shaft	none	carbonate-hosted Pb-Zn	Albritton and Nelson (1943)
San Augustin	Hornspoon (Hawkeye, Section 30,Old Priest)	30,31 21S 4E	32° 26' 18", 106° 34' 20"	Ag, Pb, Zn, Cu, Sb	1941	pits, adits, shafts	6.28 short tons $8.84/ton Pb and Zn	carbonate-hosted Pb-Zn	Dunham (1935), Albritton and Nelson (1943)
San Augustin	Silver Set	25 21S 3E	32° 27' 20", 106° 34' 40"	Au, Ag	none	pit	none	carbonate-hosted Pb-Zn	—
San Augustin	Silver Leaf	35,36 21S 3E	32° 26' 5", 106° 35' 2"	Au, Ag	none	pit	none	carbonate-hosted Pb-Zn	—
San Augustin	Scrap Iron (Bootlegger)	36 21S 3E	32° 26' 28", 106° 34' 42"	Pb, Zn	1926	pit	<10 short tons Au,Ag,Cu,Pb	carbonate-hosted Pb-Zn	—
San Augustin	Short Cut	36 21S 3E	32° 26' 34", 106° 34' 44"	Pb, Zn, Cu, Ag	1882	pit	unknown	carbonated hosted Pb-Zn	—
San Augustin	Girard	35,36 21S 3E	32° 26' 12", 106° 35' 3"	Ag, Pb	unknown	200 ft shaft	unknown	carbonate-hosted Pb-Zn	NMBMMR file data
San Augustin	Homestake	35,36 21S 3E		Ag, Cu, Pb	unknown	shaft	unknown	carbonate-hosted Pb-Zn	Glover (1975)
San Augustin	Black Quartz and Captain Smith (Spanish American, AML 21-24)	36 21S 3E	32° 25' 5", 106° 34' 12"	Ag, Au, Pb	unknown	50 ft shaft, 100 ft decline, pit	unknown	carbonate-hosted Pb-Zn	Seager (1981), FN 12/5/89
San Augustin	May Day	36 21S 3E	32° 25' 42", 106° 35' 12"	Ag, Au, Pb	unknown	pit	unknown	carbonate-hosted Pb-Zn	—
San Augustin	Memphis	36 21S 3E	32° 25' 52", 106° 35' 30"	Cu, Pb, Zn, Ag, Bi	1884-1929	200 ft shaft, cuts	$200,000-400,000 Cu,Pb,Zn	Cu,Pb-Zn skarn	Dunham (1935), Glover (1975), FN 12/5/89
San Augustin	Quickstrike (Fin de Cicle, la Veta Madre)	N32 21S 4E	32° 26' 14", 106° 33' 17"	Ag, Au, Pb, Cu, Bi	unknown	adits, pits	minor	Ag in pegmatite	Dunham (1935), Seager (1981), FN 2/19/94

AREA	MINE NAME	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	YEARS OF PRODUCTION	DEVELOPMENT	PRODUCTION	TYPE OF DEPOSIT	REFERENCES
San Augustin	Copper Bar	NE1 22S 3E	32° 20' 31", 106° 34' 20"	Cu, Ag, Au	1903	50 ft shaft	<10 short tons Ag,Cu	carbonate-hosted Pb-Zn	Dunham (1935), FN 12/5/89
San Augustin	unknown	NE17 21S 4E	32° 29' 4", 106° 38' 3"	Ag, Pb	unknown	pits	unknown	carbonate-hosted Pb-Zn	Dunham (1935)
San Augustin	Old Tuff Nut	NE25 21S 3E	32° 27' 30", 106° 34' 30"	Ag, Pb	prior to 1935	shaft	unknown	carbonate-hosted Pb-Zn	Dunham (1935), FN 10/13/93
San Augustin	Iron Mask	NE30 21S 4E	32° 27' 30", 106° 33' 33"	Ag, Pb, Au	unknown	pits	unknown	carbonate-hosted Ag-Pb-Zn	—
San Augustin	Little Buck	NE30 21S 4E	32° 27' 24", 106° 34' 9"	Ag, Au, Pb, Zn	1890s,1920	adits, shafts	$50,000-60,000	carbonate-hosted Pb-Zn, Pb-Zn skarn	Dunham (1935), Seager (1981), Albritton and Nelson (1943), FN 10/13/93
San Augustin	Merrimac	NE30 21S 4E	32° 27' 21", 106° 34' 21"	Au, Ag, Cu, Pb, Zn, W	1916,1943, 1950-1951	shafts, adits	660 short tons 15% Zn, 2,000 short tons	carbanate-hosted Pb-Zn, Pb-Zn skarn	Dunham (1935), Albritton and Nelson (1943), FN 10/13/93
San Augustin	Rickardite (Fisk)	NE30,NW29 21S 4E	32° 27' 22", 106° 33' 53"	Ag, Pb, Zn, Cu, Te	1906,1915, 1941	pits, shafts	$2,000 Zn 1915, 34 short tons Zn 1941	carbonate-hosted Pb-Zn, Pb-Zn skarn	Dunham (1935), Albritton and Nelson (1943), FN 10/13/93
San Augustin	Crested Butte	NE31 21S 4E	32° 26' 19", 106° 34' 20"	Ag, Au, Pb	1934	pits	<10 short tons Ag	vein	Dunham (1935)
San Augustin	Corpus Christi	NE33 21S 4E	32° 27' 32", 106° 31' 43"	Cu, Pb, Au, Ag	none	pit, 87 ft shaft	none	vein	Albritton and Nelson (1943)
San Augustin	Homestake	NE35 21S 3E	32° 26' 13", 106° 35' 48"	Pb, Ag, Au, Bi	1912-1913,1928,1934	20 ft pit	$25,000 to 1927, <100 short tons Au,Ag,Pb	carbonate-hosted Pb-Zn	Dunham (1935), FN 12/5/89
San Augustin	Galloway	NE5 22S 4E	32° 25' 24", 106° 33' 21"	Ag, Pb	1896	180 ft shaft	$35,000, 97 oz Ag	vein	Dunham (1935)
San Augustin	Hilltop (Eureka)	NW29 21S 4E	32° 27' 27", 106° 33' 28"	Pb, Cu, Ag, Au, Zn, Te	1926	8000 ft workings including adits, shafts	$50,000-60,000	carbonate-hosted Pb-Zn, Pb-Zn skarn	Dunham (1935), Lindgren et al. (1910), Seager (1981), Albritton and Nelson (1943), FN 10/13/93
San Augustin	Gray Eagle	NW5 22S 4E	32° 25' 55", 106° 33' 20"	Ag, Cu, Pb	1924-1935	400 ft adit	$30,000, up to 102 oz/t Ag, 6% Cu	pegmatite	Dunham (1935)
San Augustin	unknown	SE17 21S 4E	32° 28' 00", 106° 32' 52"	Ag	none	pit	none	carbonate-hosted silver	—
San Augustin	Smith (Kittie Delund)	SE18 21S 4E	32° 28' 43", 106° 34' 7"	Ag	prior to 1935	incline, shafts	$30,000	carbonate-hosted silver	Dunham (1935)
San Augustin	Cowpuncher	SE25 21S 3E	32° 27' 2", 106° 34' 47"	Cu, Bi	1900s,1943	78 ft shaft	7 short tons 8% Cu, 0.58% Bi	Cu-Pb-Zn skarn	Albritton and Nelson (1943)
San Augustin	Excelsior	SE25 21S 3E	32° 27' 8", 106° 35' 8"	Cu, Ag, Au, Zn, Te, Bi, Pb	1914-17,1929	175 ft shaft	$60,000, <500 short tons Au,Ag,Cu	carbonate-hosted Pb-Zn	Dunham (1935), FN 2/20/94
San Augustin	H and H (Billie H, Dona Loga)	SE28 21S 4E	32° 26' 57", 106° 31' 50"	Ag, Au, Cu, Mo	unknown	2 adits, 265 ft adit	unknown	vein	—

AREA	MINE NAME	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	YEARS OF PRODUCTION	DEVELOPMENT	PRODUCTION	TYPE OF DEPOSIT	REFERENCES
San Augustin	Cobre Grande	SE30 21S 4E	32° 27' 2", 106° 33' 48"	Cu, Ag, Cu	none	pits, shafts	none	Cu skarn	Dunham (1935)
San Augustin	Lewis (Lodge)	SE30 21S 4E	32° 26' 56", 106° 33' 47"	Ag, Au, Pb, Zn	1943	adit, pits	Zn	carbonate-hosted Pb-Zn, Cu-Pb-Zn skarn	Albritton and Nelson (1943)
San Augustin	Philadelphia (AML 18-19)	SE35,SW36 21S 3E	32° 25' 52", 106° 35' 31"	Ag, Pb, Zn	1910,1930,1934	3 shafts, incline	small	veins, carbonate-hosted Pb-Zn	Dunham (1935), Albritton and Nelson (1943), Glover (1975), FN 12/5/89
San Augustin	Silver Jim	SW18 21S 4E	32° 28' 44", 106° 34' 21"	Ag, Pb	1890s	adit, shaft	unknown	carbonate-hosted silver	Dunham (1935)
San Augustin	Copper Buckle	SW24 21S 3E	32° 28' 40", 106° 34' 2"	Cu, Au, Fe	none	16 ft pit	none	carbonate-hosted Pb-Zn	Albritton and Nelson (1943)
San Augustin	Lady Hopkins	SW28 21S 4E	32° 27' 20", 106° 32' 35"	Au, Ag, Fe	none	249 ft, 255 ft adits, 50 ft shaft	none	vein	Dunham (1935)
San Augustin	Copper Bullion	SW29 21S 4E	32° 27' 4", 106° 33' 14"	Ag, Cu, Au	none	pit	none	Cu skarn	Dunham (1935)
San Augustin	Silver Coinage	SW29 21S 4E	32° 26' 48", 106° 33' 44"	Ag, Au, Pb, Cu, Zn	1935	275 ft adit	10 short tons	vein	—
San Augustin	Davy King	SW30 21S 4E	32° 27' 22", 106° 34' 34"	Ag, Au, Pb	small	250 ft shaft	small	vein	Dunham (1935)
San Augustin	Ben Nevis (King Soloman, Maggie Dodd)	SW32 21S 4E	32° 26' 4", 106° 33' 35"	Ag, Pb, Cu, Zn, Te, Bi	unknown	2 adits	unknown	Ag in pegmatite	Dunham (1935), Seager (1981)
Texas Canyon	Texas Canyon (Sunrise)	SE34 22S 4E	32° 21' 2", 106° 30' 56"	Au, Ag, Pb, Cu, Ba, Te, Mo, Bi	1890-1939	4 adits, pits	12.7 short tons 10.8 oz/tAg, 0.3 oz/tAu, 0.64%Cu, 0.1%Bi	veins	Dunham (1935), Seager (1981), Albritton and Nelson (1943)
west side	Poor Mans Friend	1,7 22S 3E	32° 25' 47", 106° 35' 31"	Au, Ag, Pb	1926-1927	pits, adits, shaft	1 oz/t Au, 40.5 oz/t Ag, 15.9% Pb	veins	Jeske (1987)
west side	Stephenson-Bennett	11,14 22S 3E	32° 24' 5", 106° 35' 55"	Pb, Cu, Zn, Au, Ag, Mo	1847-1934	extensive underground workings	$1,150,000 worth of Pb,Zn,Cu,Ag,Au	carbonate-hosted Pb-Zn	Glover (1975), Eveleth (1983), Seager (1981), Jeske (1987), FN 1/31/94
west side	Modoc-Orejon	36 22S 3E	32° 20' 40", 106° 34' 47"	Pb, Cu, Zn, Au, Ag, F	1879-1917	shafts, pits, adits	$200,000 or more, <2000 short tons Ag,Pb 1902-17	carbonate-hosted Pb-Zn-Ag	Dunham (1935), Glover (1975), Jeske (1987), FN 12/10/93
west side	Silver Cliff	6,7 23S 4E	32° 20' 14", 106° 35' 12"	F, Ba	none	pits	none	fluorite vein	Dunham (1935), Williams (1966)
west side	unknown	N36 22S 3E		Au, Ag, Pb, F	unknown	>100 ft shaft, 2 pits	unknown	vein	Jeske (1987)
west side	Orejon	NE1 23S 3E	30° 20' 10", 106° 34' 50"	Pb, Cu, Zn, Au, Ag, F	prior to 1910, 1920	100 ft adit, 125 ft incline	<10 short tons Pb,Zn,Ag	carbonate-hosted Pb-Zn-Ag	Dunham (1935), Glover (1975), Jeske (1987), Seager (1981), FN 12/10/93

AREA	MINE NAME	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	YEARS OF PRODUCTION	DEVELOPMENT	PRODUCTION	TYPE OF DEPOSIT	REFERENCES
west side	Fillmore Canyon	NE1 23S 3E, NW6 23S 4E	32° 20' 15", 106° 35' 10"	F	none	3 pits	none	fluorite vein, Rio Grande Rift	Glover (1975), McAnulty (1978), Seager (1981)
west side	unknown (135-137)	NE13 22S 3E	32° 23' 58", 106° 34' 42"	Au, Ag	none	22 ft shaft	none	vein	Jeske (1987)
west side	unknown (119-128)	NE14 22S 3E	32° 24' 2", 106° 35' 30"	Au, Ag, F	none	30 ft adit, pits, 13 ft adit, 16 ft adit	none	vein	Jeske (1987)
west side	unknown (145-160)	NE23 22S 3E	32° 22' 4", 106° 36' 22"	Ag, Pb, Zn, F	none	pits, 28 ft shaft, 44 ft adit, 16 ft adit	none	vein	Jeske (1987)
west side	unknown (140-142)	NE24 22S 3E	32° 22' 6", 106° 34' 52"	Au, Ag, Cu, Pb, Zn, F	none	54 ft shaft	none	vein	Jeske (1987)
west side	unknown	NE30 22S 4E		Mo	none	outcrop	none	disseminations of Mo	V. Lueth, PC, 5/26/95
west side	unknown	NE7 22S 4E	32° 24' 52", 106° 34' 2"	Au	none	pit	none	vein	McAnulty and McAnulty (WC, 1979)
west side	unknown	NW12 22S 4E	32° 24' 44", 106° 29' 50"	Mo	none	adit	none	vein	McAnulty and McAnulty (WC, 1979)
west side	unknown (129-134)	NW13 22S 3E	32° 23' 12", 106° 34' 58"	Au, Ag	none	pits	none	vein	Jeske (1987)
west side	Ruby	NW25 22S 3E	30° 22' 3", 106° 35' 38"	Ba, F	1933	adit, pit	400 short tons fluorite	fluorite vein	Dunham (1935), Glover (1975), McAnulty (1978), Seager (1981), Jeske (1987)
west side	unknown (161)	NW25 22S 3E	32° 22' 04", 106° 35' 34"	Au, Ag, F	none	pit	none	fluorite vein	Jeske (1987)
west side	unknown (187-194)	NW36 22S 3E	32° 21' 19", 106° 35' 27"	Au, Pb, F	unknown	91 ft adit, 165 ft adit, 3 pits	unnown	fluorite vein	Jeske (1987)
west side	Soledad Canyon	SE13 23S 3E	32° 18' 10", 106° 34' 4"	Au, F	none	pit	none	vein	—
west side	unknown (143-144)	SE14 22S 3E	32° 22' 32", 106° 36' 25"	Ag, F	none	pit	none	vein	Jeske (1987)
west side	unknown (181-183)	SW25 22S 3E	32° 21' 44", 106° 35' 22"	Au, Ag, Pb, Zn, F	none	18 ft shaft, pit	none	vein	Jeske (1987)
west side	Torpedo (Foy)	W1 22S 3E	32° 25' 28", 106° 35' 35"	Cu, Ag, Pb, Zn	1890-1961	4 shafts 200-500 ft deep	$800,000, <5000 short tons Ag,Cu,Pb,Zn 1908-61	carbonate-hosted Cu-Pb-Zn, porphyry copper?	Dunham (1935), Soulè (1951), Albritton and Nelson (1943), Glover (1975)
west side	Franklin? (USBM69-84)	11,12 22S 3E	32° 23' 24", 106° 36' 19"	Au, Ag, F	none	pits, 65,27,94,30,13 ft adit, adits, pits	none	vein	Jeske (1987)

Geology

The Organ Mountains form a west-tilted block exposing rocks ranging in age from Proterozoic through Quaternary. The oldest rocks in the area are Proterozoic granitic rocks which are overlain by as much as 8,500 ft of Paleozoic sedimentary rocks, mostly of marine origin (Seager, 1981). These rocks were deformed during the Laramide compressional event. In the Oligocene, the Organ batholith and volcanic rocks associated with the Organ caldera were emplaced (Seager, 1981; Newcomer and Giordano, 1986; Seager and McCurry, 1988). The Organ batholith is a complex pluton made up of multiple intrusions (Seager, 1981; Seager and McCurry, 1988); three major phases are the granite of Granite Peak, Sugarloaf Peak quartz monzonite and Organ Needle quartz syenite. All three phases are related to mineral deposits. The Sugarloaf Peak quartz monzonite has been dated as 34.4±0.3 Ma ($^{40}Ar/^{39}Ar$, hornblende, McLemore et al., 1995). A gravity low coincides with the Sugarloaf Peak quartz monzonite which may be a result of widespread sericitic alteration. Rhyolite dikes have intruded the Organ batholith locally and also are related to mineralization. Uplift and erosion produced younger sedimentary deposits and the rugged topography characteristic of the Organ Mountains.

Mineral Deposits

Six types of deposits are distributed in five zones in the Organ Mountains district (Table 1)(Fig. 8; Dunham, 1935; Seager, 1981; Seager and McCurry, 1988). Copper-molybdenum deposits form a core, surrounded by zinc-lead, lead-zinc, gold-silver, and outer fluorite-barite zones (Fig. 8). This district-wide zoning is best preserved in the northern Organ Mountains where disseminated copper and molybdenum occurrences have been encountered in drill holes northwest of Organ and may represent a faulted portion of a porphyry copper-molybdenum deposit (Newcomer and Giordano, 1986).

A zone of disseminated and vein pyrite occurs to the east at San Augustin Pass in the Sugarloaf Peak quartz monzonite, the last and most volatile-rich phase of the Organ batholith, and is located in the center of the northern part of the district. Silver-bearing pegmatites, dated as 30.8±0.1 Ma ($^{40}Ar/^{39}Ar$, K-feldspar), occur near San Augustin Pass in the Sugarloaf Peak quartz monzonite (Dunham, 1935; McLemore et al., 1995). Copper-breccia deposits occur west of the Sugarloaf Peak quartz monzonite at the Torpedo and Memphis mines. A transition from disseminated copper and molybdenum to copper skarns and breccias to zinc-lead skarns and replacement deposits occurs in carbonates northwest of the Memphis mine and near the Excelsior mine in the northern portion of the district (Lueth, 1988). The Homestake and Memphis deposits are zinc-lead skarns. The Merrimac mine is predominantly zinc replacements; lead with silver becomes more dominant to the east. The Hilltop and Black Prince mines are predominantly carbonate-hosted lead-silver deposits. The Stephenson-Bennett is a carbonate-hosted lead-silver and zinc-lead deposit (polymetallic replacement). Gold and silver epithermal/mesothermal veins occur in the Proterozoic rocks in the Gold Hill area, east of the Sugarloaf Peak quartz monzonite (Fig. 9). Silver decreases to the north and barite becomes dominant. The Modoc and Orejon deposits along the west side of the Organ Mountains are lead-zinc skarn and replacement deposits and may be related to a third copper-molybdenum zone is in the central Organ Mountains near Organ Peak (Fig. 10). An outer zone, surrounding the Organ Mountains batholith, consists of Rio Grande Rift barite-fluorite-galena deposits, locally with copper, silver, uranium, and vanadium; examples include the Bishops Cap (Fig. 11) and the Ruby mines. Assays of samples collected from the district are in Table 23.

TABLE 23—Chemical analyses of samples from the Organ Mountains district, Doña Ana County. Analyses by the NMBMMR Chemical Laboratory (Au, Ag by fire assay; Cu, Pb, Zn by FAAS after *aqua regia* digestion; Hg by cold vapor AA) and * by U.S. Geological Survey Chemical Laboratory (Au by ICP). —no data.

LAB NO.	FIELD NO.	Au oz/ton	Au* (ppm)	Ag oz/ton	Cu (ppm)	Pb (ppm)	Zn (ppm)	Hg ppm	Te* (ppm)	DESCRIPTION
1355	SB-1	0.00	0.042	37.7	3000	110000	5000	0.13	17.0	Bennett-back on level 3
1356	SB-2	0.00	0.004	0.00	200000	4000	110000	0.37	<0.1	Bennett-2 ft chip on level 3
1357	SB-3	0.00	0.018	0.00	12000	10000	190000	0.80	2.0	Bennett-6 inch chip on level 3
1358	SB-4	0.00	0.014	0.00	20000	3000	120000	0.89	45.0	Bennett-1 ft chip on level 3
1359	SB-5	0.00	0.030	1.62	13000	20000	96000	1.20	10.0	Bennett-grab of rib
1360	SB-6	0.00	0.200	9.75	310	71000	34000	0.00	65.0	Page-grab, level 3
1361	SB-7	0.00	<0.002	0.00	30	10	130	0.04	1.0	Bennett-200 level
1362	SB-8	0.00	0.014	0.00	770	610	800	0.50	1.0	Bennett-200 level
1363	SB-9	0.00	<0.002	0.00	21	140	310	0.28	1.0	Bennett-quartz vein 200 level
1364	SB-10	0.00	0.022	0.24	520	38000	100000	0.04	10.0	sphalerite at Bennett shaft
1365	SB-11	0.00	<0.002	0.00	460	7000	8000	0.15	7.0	Bennett
1366	SB-12	0.00	<0.002	0.00	610	10000	13000	0.30	3.0	talc zone-Bennett

LAB NO.	FIELD NO.	Au oz/ton	Au* (ppm)	Ag oz/ton	Cu (ppm)	Pb (ppm)	Zn (ppm)	Hg ppm	Te* (ppm)	DESCRIPTION
1367	SB-13	0.00	0.100	0.42	260	23000	24000	0.03	7.0	south Stephenson
1368	SB-14	0.00	0.020	0.00	70	100000	42000	0.00	80.0	north Stephenson
1370	MoDoc A	0.00	—	0.00	20	37	98	0.05	<0.1	Modoc, 2 ft chip along face, main decline
1371	MoDoc B	0.00	—	0.00	22	28000	92000	0.13	0.2	Modoc, 1 ft chip along face of stope, main decline
1372	MoDoc C	0.00	—	0.78	23	36000	8000	0.09	0.2	Modoc, 3 ft chip along face, main decline
1373	MoDoc D	0.00	—	0.00	44	8000	7000	0.84	0.1	Modoc, dump, main decline
1374	MoDoc F	0.00	—	0.00	36	120	170	0.11	0.3	Modoc, grab along fault, southern adit
1375	MoDoc G	0.00	—	0.80	34	210	85	0.15	0.4	Modoc, grab of dump, southern adit
1376	Organ 18,19	0.00	<0.002	0.00	190	61	100	0.04	1.7	grab of dump
1377	Memphis	0.00	0.240	1.46	24000	11000	160000	0.07	12.0	grab of dump
1378	Organ 22	0.00	0.004	0.00	52	2000	1000	0.04	2.2	grab of dump
1380	Organ 7	0.00	<0.002	0.00	7000	87	560	0.06	0.7	grab of dump
1381	Organ 10	0.00	<0.002	0.00	33	20	43	0.11	<0.1	grab of dump
1382	Organ 21	0.00	0.038	0.00	210	22000	3000	0.00	23.0	grab of dump
1384	Organ 250	0.00	0.004	0.00	33	610	110	0.15	2.2	grab of vein
1385	Organ 25	0.00	<0.002	0.00	200	4000	660	0.15	0.4	grab of dump
1386	Organ 23	0.00	0.008	0.00	8000	9000	100000	0.50	5.1	chip along back of 50 ft level
754	Min Hill 25	0.00	—	0.00	210	29	<50	—	0.1	Mineral Hill, grab sample of dump
755	Min Hill 26	0.00	—	5.70	4300	1500	120	—	0.7	Mineral Hill, grab sample of dump
756	Rock of Ages	0.00	—	2.76	2600	380	56	—	0.5	Rock of Ages, grab sample of dump
757	Silver King A	0.00	—	7.42	520	2500	270	—	43.0	Silver King, 4 ft chip sample across vein
726	Silver King B	0.00	—	54.50	1200	3000	1500	—	0.2	Silver King, grab sample of dump
557	Dora 1	0.24	—	0.00	830	20000	9000	—	—	Dona Dora, select sample of dump
558	Dora 2	0.00	—	0.00	340	1100	54	—	—	Dona Dora, select sample of dump
559	Dora 3	0.00	—	0.00	1200	600	24000	—	—	Dona Dora, select sample of dump
739	Dora 4	0.00	—	0.46	820	2200	150	—	—	Dona Dora, select sample of dump
740	HH1	0.00	—	0.00	<50	48	73	—	—	H&H, grab sample of dump
741	HH2	0.00	—	0.00	140	71	110	—	—	H&H, 3 ft chip of face
742	HH3	0.00	—	0.00	73	44	150	—	—	H&H, 1 ft channel sample across vein
743	VM146	0.00	—	0.12	3200	87	320	—	—	H&H, upper dump
744	VM147	0.00	—	0.00	800	150	15000	—	—	H&H, lower dump
758	VM94-1	0.00	—	0.00	<50	110	<50	—	—	dike at Excell mine
759	VM94-2	0.00	—	0.00	620	20	<50	—	—	stock at Excell mine
551	VM94-4	0.00	—	0.00	<50	460	200	—	—	Rattlesnake, grab sample of dump
552	VM94-5	0.00	—	0.00	<50	<50	11	—	—	5 ft chip across altered dike
553	VM94-6	0.00	—	0.00	<50	<50	60	—	—	5 ft chip across altered dike
554	VM94-7	0.00	—	0.00	<50	<50	32	—	—	select sample of dump
555	VM94-8	0.00	—	0.00	1600	<50	110	—	—	4 ft chip across back of adit
556	VM94-9	0.00	—	0.00	<50	75	37	—	—	chip across shear zone
760	Quick 1	0.00	—	7.94	130	1200	39	—	—	Quickstrike, 4 ft chip across face of adit
761	Quick 2	0.00	—	0.00	190	570	380	—	—	Quickstrike, chip sample of back
762	Quick 3	0.00	—	0.00	50	250	520	—	—	Quickstrike, clay zone
763	Quick 4	0.00	—	2.74	310	4200	780	—	—	Quickstrike,chip of face at quartz vein
764	Quick 5	0.00	—	1.04	190	3100	140	—	—	Quickstrike, clay zone
765	Quick 6	0.00	—	9.74	131	7800	1300	—	—	Quickstrike, select sample of dump
727	Mer A	0.00	—	0.78	28000	1800	35000	—	23.0	Merrimac, 4 ft chip of pilar
728	Mer B	0.00	—	0.18	5500	4200	252000	—	7.5	Merrimac, grab sample of dump
729	VM23R	0.00	—	0.00	<50	45	260	—	0.3	Merrimac, chip sample at adit
730	VM24R	0.00	—	0.00	<50	120	270	—	0.4	Merrimac, chip sample at shaft
731	Fe 30	0.00	—	0.00	<50	41	130	—	0.1	Hilltop, chip of outcrop of iron skarn
732	Fe 29	0.00	—	0.00	<50	30	230	—	0.2	Hilltop, chip of outcrop of iron skarn
733	VM27R	0.06	—	2.60	2300	66000	45000	—	160.0	Hilltop, grab sample of dump, east adit
734	VM28R	0..00	—	0.00	<50	545	480	—	0.9	Hilltop, grab sample of dump, west adit

FIGURE 9—Gold-silver veins in Proterozoic granite and diabase at the Rock of Ages mine at Mineral Hill in the Organ Mountains district (V. T. McLemore photo).

FIGURE 10—Galena pockets in limestone at the Modoc mine, Organ Mountains district (V. T. McLemore photo).

FIGURE 11—Banded calcite, fluorite, and manganese oxides at the Bishops Cap mine, Organ Mountains district (V. T. McLemore photo).

Alteration, mineralization, and data from drilling indicate that at least three porphyry copper-molybdenum systems probably occur in the Organ Mountains, but the potential for an economic porphyry deposit is low (Schilling, 1965; Luddington et al., 1988). The potential for copper breccia, skarn, carbonate-hosted Pb-Zn replacement, epithermal/mesothermal vein, and fluorite deposits in the Organ Mountains is moderate (Luddington et al., 1988). Other metals occur in the district, such as bismuth (Dasch, 1965), tungsten (Dale and McKinney, 1959), tellurium, tin, and manganese. The Torpedo mine contains an estimated 600,000 short tons of 4-5% Cu in reserves (Soulé, 1951). The Stephenson-Bennett mine contains an estimated 35,000 short tons of ore grading 2.9 oz/short ton Ag, 10.55% Pb, and 13% Zn (Jeske, 1987). The Ruby mine contains an estimated 230,000 short tons of 18% fluorspar (Jeske, 1987).

Marble

Marble occurs sporadically along the intrusive contact between the limestone and rhyolite and quartz monzonite porphyry north of Organ (Dunham, 1935; Seager, 1981). The marble is typically white and locally contains disseminations of pyrite, garnet, and epidote. One of the largest deposits is at the Hilltop mine where the adit penetrates approximately 300 ft of white marble interbedded with unaltered limestone. The economic potential of these marble deposits is probably low because of small size, distance to potential markets, and location within the White Sands Missile Range.

Potrillo Mountains district

Location and Mining History

The Potrillo Mountains are southeast of Las Cruces and form a continuous ridge 7-8 miles long that rises above the Potrillo basalt field (Fig. 1). The district was discovered in 1883, but very little information exists on the early discovery or prospecting of this isolated region. Dunham (1935) and unpublished reports indicate that some gold, copper, silver, and possibly lead were produced from the area in the late 1800s and early 1900s, but actual production figures are unknown. Heylman (1986) reports that John Graham discovered a pocket of gold in a Cretaceous quartzite in the northern portion of the East Potrillo Mountains. It is unlikely that total production exceeded a few thousand dollars. Mines and prospects are listed in Table 24 and located in Figure 12.

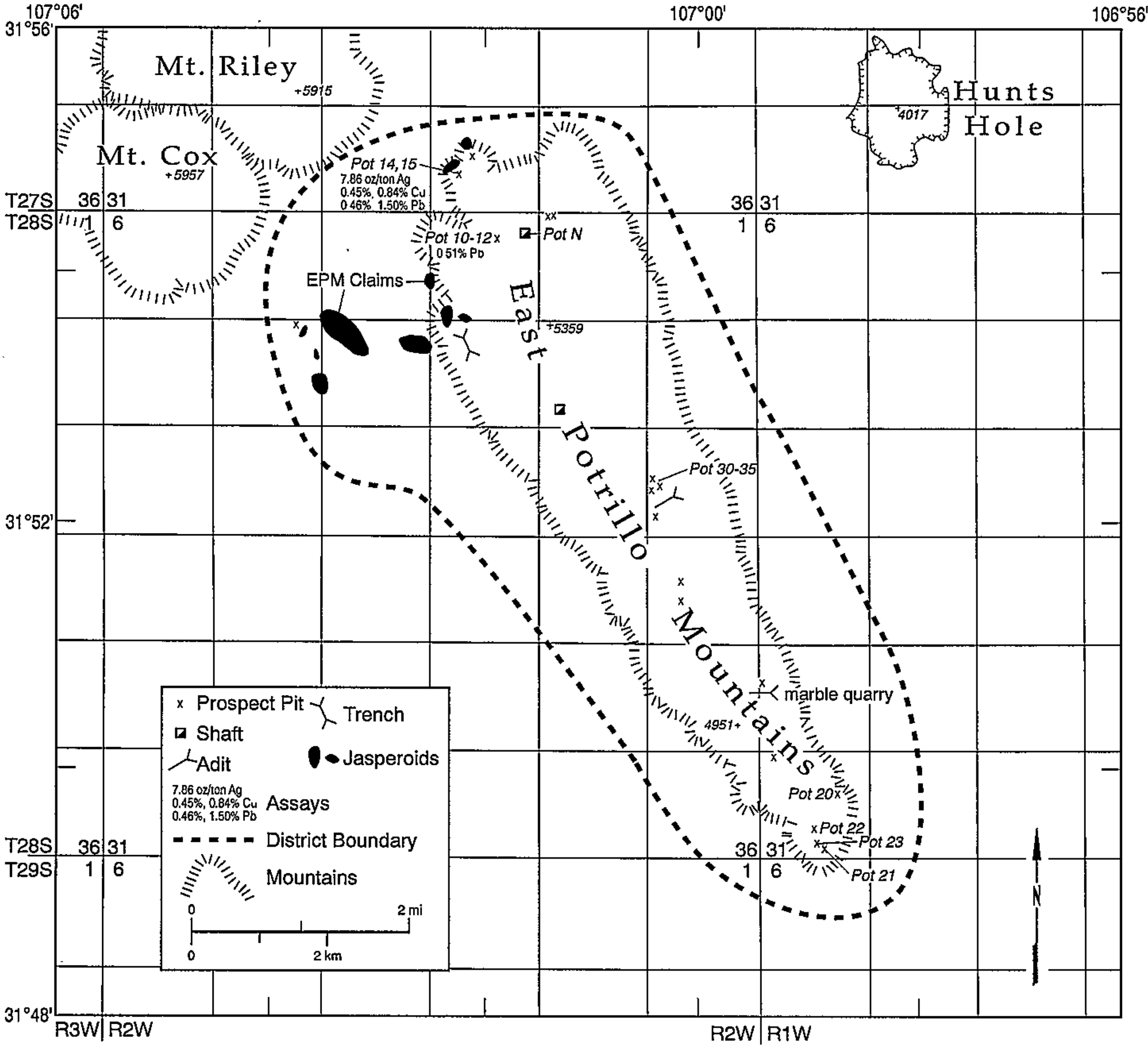

Figure 12—Mines and prospects in the Potrillo Mountains, Doña Ana County, New Mexico. Chemical analyses by NMBMMR laboratory.

In 1970, the EPM (East Potrillo Mountains) mining claims were filed on the northeastern portion of the range by J. Peter Rogowski and William A. Bowers (Table 24; Jenkins, 1977). Subsequently, several companies including Phelps Dodge Corp., Anaconda Minerals, Corp., and Exxon Minerals, Inc. have examined the area, but no discoveries have been announced. Exxon drilled 10 holes to depths ranging from 25 to 465 ft and located several mineralized zones containing high silver values (Gese, 1985). There is no current activity in the Potrillo Mountains which are adjacent to the West Potrillo Mountains and Mt. Riley Wilderness Study Areas.

TABLE 24—Mines and prospects in the Potrillo Mountains, Doña Ana County; located in Figure 12. Location includes section, township, and range. FN—unpublished field notes, V. T. McLemore.

MINE NAME (Sample Number)	LOCATION	LATITUDE	LONGITUDE	COMMODITIES	DEVELOPMENT	REFERENCES
unknown (POT 14, 15)	SW34 27S 2W	31° 54' 50"	107° 2' 15"	Ba, Pb, Zn, Cu, F, Ag	approx. 30 ft shaft, pits, shafts	Seager and Mack (1994), FN 12/27/93
unknown (W shaft)	NE3 28S 2W	31° 54' 10"	107° 1' 40"	Ba, Pb, Zn, Cu, F, Ag	approx. 25 ft inclined shaft	Seager and Mack (1994), Bowers (1960), Jenkins (1977), FN 11/15/93
unknown (POT 10, 11, 12)	NW3 28S 2W	31° 54' 40"	107° 2' 5"	Ba, Zn, Pb, Ag, Mn, Cu	approx. 25 ft inclined shaft, approx. 20 ft shaft	Seager and Mack (1994), Bowers (1960), Jenkins (1977), FN 12/27/93
unknown	NW2 28S 2W	31° 54' 30"	107° 1' 20"	Ba, Zn, Pb, Ag	pits	Jenkins (1977)
unknown	SW11 28S 2W	31° 52' 10"	107° 1' 20"	Cu, Ba	20 ft shaft	Bowers (1960)
unknown	NW10 28S 2W	31° 53' 30"	107° 2' 5"	Ba, Zn ,Pb, Ag	pits, trench	Gese (1985)
EPM claims (NW 4)	NW9 29S 2W	31° 53' 30"	107° 2' 35"	Ag, Ba, Cu, F	outcrop	Jenkins (1977)
EPM claims	NE8 28S 2W	31° 53' 35"	107° 3' 20"	Ba, Zn, Pb, Ag	pits	Jenkins (1977)
EPM claims (POT 13, SW¼ cent)	SW4 28S 2W	31° 53' 43"	107° 3' 30"	Cu, Ag, Au	pits	Seager and Mack (1994)
EPM claims	SE5 28S 2W	31° 53' 40"	107° 3' 35"	Ba, Pb, Zn, Cu, F, Ag	pits	Gese (1985), Jenkins (1977), FN 12/27/93
unknown (POT 30-33, 35)	SW13 29S 2W	31° 52' 10"	107° 00' 10"	Cu, Ag, Au	115 ft adit, 5 ft adit, 15 ft adit, 3 pits	FN 12/27/93
unknown	W24 29S 2W	31° 51' 20"	107° 00' 5"	Cu, Ag, Au	2 pits	Seager and Mack (1994)
unknown (POT 20)	NE31 29S 1W	31° 49' 45"	106° 58' 50"	Cu, Ag, Au ,Fe	30-50 ft inclined shaft, adit, pits	FN 11/16/94
unknown (POT 21, 22, 23)	SE31 29S 1W	31° 49' 30"	106° 58' 55"	Cu, Ag, Au	pits	FN 11/16/94
unknown	NW31 29S 1W	31° 50' 5"	106° 59' 30"	Ag, Au, Pb, Ba, Zn	pits	FN 11/16/94
Marble quarry	SE25 28S 2W	31° 50' 35"	106° 59' 25"	probably a travertine	caved 50 ft decline trending N65°W, 1500 ft dia quarry	Seager and Mack (1994), Bowers (1960), Gese (1985), Dunham (1935), FN 11/16/93

Geology

The East Potrillo Mountains consist of approximately 4,400 ft of sedimentary and volcanic rocks ranging in age from Permian through Holocene (Bowers, 1960; Jenkins, 1977; Seager and Mack, 1994). Permian and Cretaceous sedimentary rocks crop out in the East Potrillo Mountains which are surrounded by basaltic flows of Quaternary age. Mt. Riley and Mt. Cox, northwest of the range, consist of fine-grained microporphyritic andesite to rhyodacite to rhyolite and are probably remnents of a single viscous lava dome (Millican, 1971; Seager and Mack, 1994). An age determination of the Mt. Riley rhyolite is reported as 31.7±1.1 Ma (K-Ar, whole rock, Marvin et al., 1988). Clastic rocks correlated with the Love Ranch Formation (Eocene) and volcanic rocks of the Rubio Peak Formation (Late Eocene–early Oligocene) crop out along the flanks of Mt. Riley and Mt. Cox (Seager, 1989). A concealed pluton is indicated by a zone of high seismic velocity at a depth of 2,100 ft. The area is characterized by a large gravity anomaly which is also consistent with a pluton at depth. The mineral deposits occur in the Permian limestone and locally in Cretaceous sandstones exposed in the East Potrillo Mountains.

Mineral Deposits

Rio Grande Rift barite-fluorite-galena deposits occur in limestones of Permian age, either the Hueco Limestone or the San Andres Formation (Table 24; Jenkins, 1977; Seager and Mack, 1994). Jasperiod is common in areas of mineralized limestones and is found throughout sec. 34, T27S, R7W and secs. 3, 4, 9, 10, T28S, R2W

(Fig. 12). Jasperiod occurs as pods of varying sizes along faults, fractures, breccia zones, and bedding planes. The zones are brown to gray to yellow to red and consist of quartz, calcite, barite, iron and manganese oxides, and trace amounts of galena, pyrite, sphalerite, malachite, and cerusite. Locally jarosite is present (Jenkins, 1977). Textures are variable and include brecciation, jigsaw-puzzle, xenomorphic, reticulated, granular, ribbon-rock (banded), and massive (Jenkins, 1977). Temperatures of homogenization (corrected for pressure) range from 185° to 238° C (Jenkins, 1977). Geochemical sampling of jasperiods exposed at the surface by various companies, Jenkins (1977), Gese (1985), Jones et al. (1987), and this study (Table 25), indicate zones of anomously high values of silver, copper, lead, zinc, molybdenum, and other metals. The area is characterized by anomously high concentrations of Zn and spotty As, Ba, Co, Mn, and Ti in stream-sediment samples.

TABLE 25—Assays of samples collected from the Potrillo Mountains, Doña Ana County, located in Figure 12. No Au or $BaSO_4$ were detected in any samples. Analyses by the NMBMMR Chemical Laboratory (Au, Ag by fire assay; Cu, Pb, Zn by FAAS after *aqua regia* digestion; Hg by cold vapor AA). —no data.

LAB NO.	SAMPLE NO.	LATITUDE, LONGITUDE	Ag (oz/ton)	Cu ppm	Pb ppm	Zn ppm	Hg ppm	CaF_2 %	S%	DECRIPTION OF SAMPLE
3055	W shaft	31° 54' 10", 107° 1' 40"	0.00	3	28	14	0.69	0.16	—	dump
3056	SW 4 cent	31° 53' 30", 107° 2' 35"	0.00	25	14	22	0.1	0.68	—	outcrop
152	Pot 10	31° 54' 40", 107° 2' 5"	0.00	44	5100	370	2.9	0.4	3.1	select dump
153	Pot 11	31° 54' 38", 107° 2' 5"	0.00	620	2,000	40	2.5	<0.15	4	select dump
154	Pot 12	31° 54' 36", 107° 2' 5"	0.00	16	400	130	0.3	<0.15	<0.2	3 ft chip jasperiod
155	Pot 13	31° 53' 43", 107° 3' 30"	0.00	14	91	22	0.1	<0.15	0.2	jasperiod
156	Pot 14	31° 54' 46", 107° 2' 15"	7.86	8400	1,000	41000	2.9	<0.15	1.2	jasperiod
157	Pot 15	31° 54' 45", 107° 2' 15"	0.00	4500	4600	450	2.8	<0.15	1.5	jasperiod
1387	Mt. Riley	31° 55' 20", 107° 5' 15"	—	16	29	82	0.17	—	—	outcrop
1388	Mt. Cox	31° 54' 50", 107° 5' 15"	—	24	22	63	0.06	—	—	outcrop
1389	Mt. Cox west	31° 54' 50", 107° 5' 10"	—	21	19	65	0.04	—	—	outcrop
1390	Pot 20	31° 49' 45", 106° 58' 50"	0.00	22	63	19	<0.1	—	—	outcrop
1391	Pot 21	31° 49' 30", 106° 58' 55"	0.00	28	59	23	0.05	—	—	outcrop
1392	Pot 22	31° 49' 30", 106° 58' 55"	0.00	87	59	22	0.07	0.12	—	outcrop
1393	Pot 23	31° 49' 30", 106° 58' 55"	0.00	21	30	18	0.06	—	—	outcrop
1369	marble quarry	31° 50' 35", 106° 59' 25"	0.00	22000	52	18	0.04	—	—	outcrop
18	Pot 30	31° 52' 10", 107° 00' 10"	0.00	7	27	18	<0.1	—	—	outcrop
19	Pot 31	31° 52' 10", 107° 00' 10"	0.00	6.5	24	28	0.34	—	—	outcrop
20	Pot 32	31° 52' 10", 107° 00' 10"	3.54	36000	24	26	<0.1	—	—	outcrop
21	Pot 33	31° 52' 10", 107° 00' 10"	0.00	63000	81	82	0.19	—	—	outcrop
22	Pot 35	31° 52' 10", 107° 00' 10"	0.00	1500	41	26	<0.1	—	—	outcrop

Travertine deposits

A travertine is found in the southern end of the East Potrillo Mountains (sec. 24, T28S, R2W, Table 24, Fig. 12). It has been described as a marble, but is probably a fissure-ridge type of travertine deposit that is fault controlled (Barker et al., 1996). The deposit is developed by a small quarry (approximately 300-400 ft long and 100 ft wide) and a short decline (15 ft long). Production is unknown, but presumed small because of the small size of the quarry. A stockpile of travertine mixed with limestone and calcareous soil remains at the site in 1993.

The travertine is white with thin black bands (up to several centimeters wide). Most travertine occurs as small pods or blocks that are fractured and broken. The largest slabs are only a few feet wide. It is recrystallized limestone of the Hueco Formation (Permian; Hoffer, 1976; Seager and Mack, 1994) and occurs along the range-bounding fault (Robledo fault of Hoffer, 1976). The host limestone strikes N10°W and dips 25°W.

The economic potential of this occurrence is low under current economic conditions. The deposit is too small and too fractured to have any major potential as dimension stone, but could be used locally as a decorative stone or as road fill.

Rincon district

Location and Mining History

The Rincon district, also known as the Hatch and Woolfer Canyon districts, lies in the southern Caballo Mountains in northern Doña Ana County (Fig. 1) and was discovered in the early 1900s. This district includes a large area of scattered barite and manganese deposits from north of the Doña Ana-Sierra County line southward to Rincon (Fig. 13). Production from the Rincon district amounts to 10,250 short tons of barite and 1,529 long tons of 27-40% Mn (Farnham, 1961; Dorr, 1965; Williams et al., 1964; Filsinger, 1988). Mines and prospects are listed in Table 26.

TABLE 26—Mines and prospects in the Rincon district, Doña Ana County, located in Figure 13. Location includes section, township, and range. FN—unpublished field notes, V. T. McLemore.

MINE NAME	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	YEARS OF PRODUCTION	DEVELOPMENT	PRODUCTION	TYPE OF DEPOSIT	REFERENCES
Horseshoe (Bonanza?)	1,12 18S 3W	32° 46' 7", 107° 6' 19"	Ba, Mn	none	open pit	none	Rio Grande Rift	Seager and Hawley (1973), FN 5/27/95
unknown	NW1 18S 3W	32° 46' 20", 107° 6' 28"	Ba	none	6 ft shaft	none	Rio Grande Rift	Filsinger (1988)
Prickly Pear	NE 2 18S 3W	32° 46' 19", 107° 6' 48"	Ba	none	open pit	none	Rio Grande Rift	Filsinger (1988), FN 5/27/95
unknown	SW3 18S 3W	32° 46' 07", 107° 8' 27"	Ba	none	pits	none	Rio Grande Rift	Filsinger (1988)
Luchini	9 18S 3W	32° 45' 52", 107 8' 42"	Mn	none	pits	none	epithermal manganese	—
Blackie (Velarde, Sheriff)	10 18S 3W	32° 45' 49", 107° 08' 22"	Mn, W	1917-1955	open pits	200 short tons 20-40% Mn	epithermal manganese	Wells (1918), Farnham (1961), Filsinger (1988)
Upper Palm Park	10,11 18S 3W	32° 44' 58", 107° 7' 28"	Ba, F, Cu, Pb, Zn	1949-1979	open pit	10,250 short tons BaSO4	Rio Grande Rift	Filsinger (1988), FN 5/27/95
Lower Palm Park	14, 15, 23 18S 3W	32° 44' 33", 107 7' 7"	Mn	1918	pit	none	epithermal manganese	Seager and Hawley (1973)
ABC prosepects (Snooper)	4,5 19S 2W	32° 41' 24", 107° 3' 44"	Mn, Ba, F	none	200 ft adit, 8 ft pit, quarry	none	Rio Grande Rift	McLemore (1983), FN 12/26/94
Rincon (Cook)	5 19S 2W	32° 40' 57", 107° 3' 42"	Mn, U	1918-1958	100 ft adit, shafts, pits	1,592 short tons 27.6-40% Mn	epithermal manganese	Farnham (1961), FN 12/26/94
Morgan (Lucky Strike)	W5 19S 2W	32° 41' 20", 107° 04' 26"	Mn, U	1918, 1942	2 50 ft shafts, 600 ft adit, adits	471 short tons 30-40% Mn 1918, 500 short tons Mn in 1942	epithermal manganese	Wells (1918), Seager and Hawley (1973)
Cook placers	W5 19S 2W	32° 41' 02", 107° 4' 20"	Mn	unknown	pit	none	placer	FN 12/26/94
Rooster Cone	SE32 20S 2W	32° 31' 18", 107° 3' 46"	Mn	none	pits	none	epithermal manganese	—
unknown	SW24 T18S R3W	32° 43' 28", 107° 6' 47"	travertine	none	none	none	travertine	Seager and Hawley (1973)

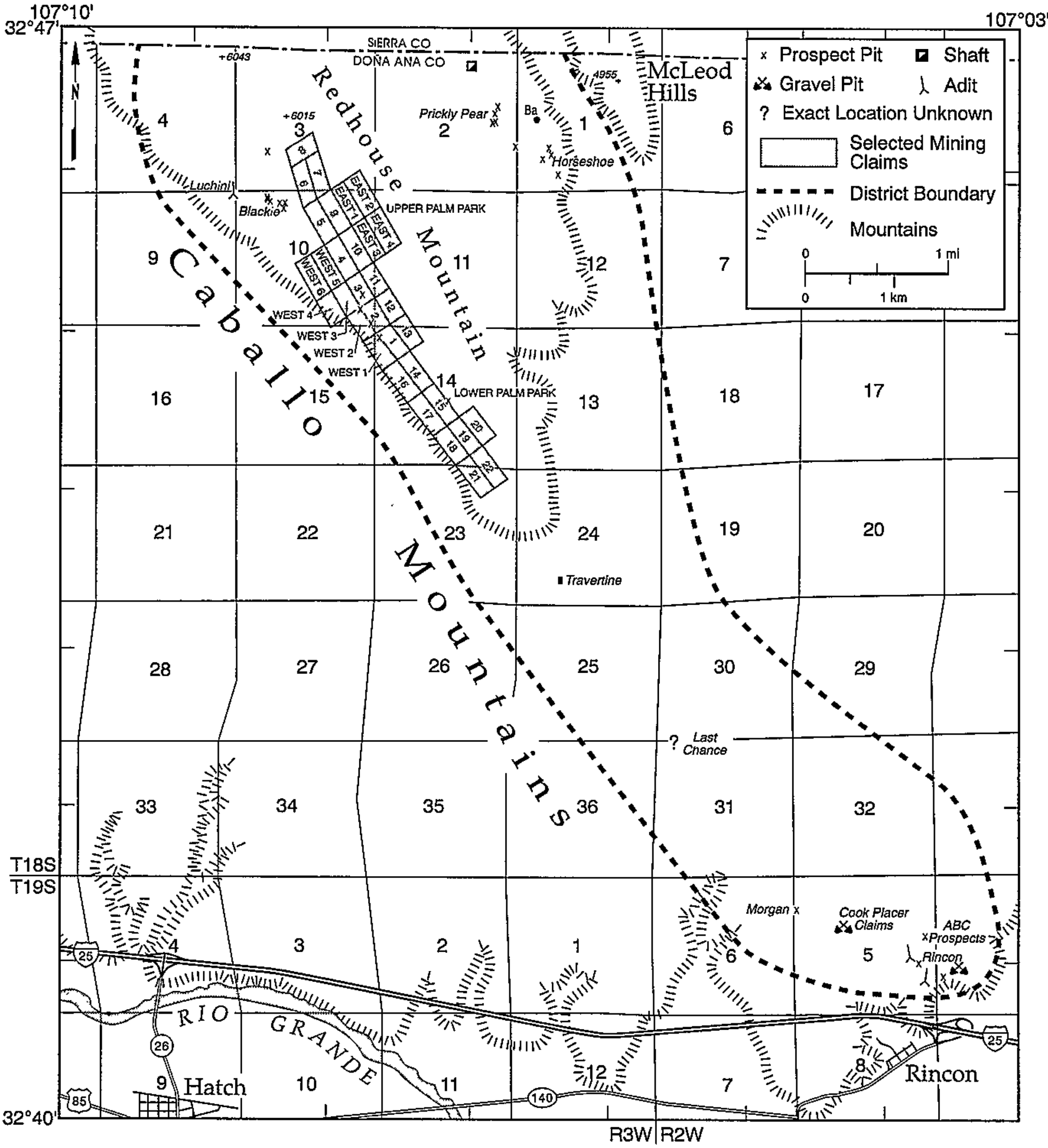

Figure 13—Mines and prospects in the Rincon district, Doña Ana County, New Mexico.

Geology

The Rincon district consists of Paleozoic rocks that were deformed during the Laramide compressional event (Seager and Hawley, 1973; Seager and Clemons, 1975). These rocks were then overlain by less deformed Tertiary-Quaternary sedimentary and volcanic rocks. High-angle normal faults have offset the rocks and localized barite and manganese as veins and replacements in limestones and volcanic rocks. Local rhyolite dikes and sills have intruded the sedimentary rocks.

Mineral Deposits

Rio Grande Rift barite-fluorite-galena deposits occur in the Fusselman Dolomite (Silurian), stratigraphically below the Percha Shale (Devonian). The Palm Park deposit is the largest (Fig. 14) and consists of calcite, barite, fluorite, and trace amounts of malachite, azurite, pyrite, galena, chalcopyrite, sphalerite, covellite, and quartz (Filsinger, 1988). Assays range from <0.02-0.11% Cu, 0.01-11.5% Pb, and 0-2.9 oz/short ton Ag (Filsinger, 1988). Brecciation, banded ore, and veins are common textures. Jasperiod is common throughout the district. Manganese and iron oxides are locally pervasive. Fluid inclusion temperatures range from 163° to 341°C (barite, fluorite, quartz) and have moderate salinities (4.8-17.0% eq. NaCl), indicating formation by mixing of saline connate-meteoric waters with heated hydrothermal fluids, possibly of a magmatic origin. The Horseshoe and Prickly Pear deposits are smaller, but similar to the Palm Park deposit. A rhyolite sill intrudes the Paleozoic sedimentary rocks north of the Horseshoe deposit where jasperiod formed. In one locality, jasperiod contains rhyolite fragments (Filsinger, 1988). These relationships suggest that the barite deposits are probably younger than the rhyolite sill, which is probably mid-Tertiary in age. Stratigraphic relationships at the Morgan mine suggest a Miocene age for the manganese deposit (Seager and Hawley, 1973), a similar age is likely for the barite deposits.

FIGURE 14—View looking to the northeast of the upper and lower Palm Park mine, Rincon district, Doña Ana County (V. T. McLemore photo).

Drill data indicates that the Palm Park deposit contains 1.5 million short tons of ore grading 27% $BaSO_4$ with a specific gravity of 3.07 (Filsinger, 1988). The Horseshoe deposit could contain as much as 50,000 short tons of 5-20% $BaSO_4$, but in thin deposits (less than 5 ft thick). The Prickly Pear deposit could contain as much as 200,000 short tons of 5-25% $BaSO_4$, but also in thin deposits (less than 5 ft thick)(Filsinger, 1988). These barite deposits are uneconomic at present and would be mined only if petroleum exploration increases the demand for barite in drilling muds. However, the high whiteness and brightness of the barite is suitable for certain paints and fillers and could be produced if these specialized markets were developed nearby.

Epithermal manganese deposits are common in the Rincon district. The Blackie (Verlarde, Sheriff) mine is the largest and consists of replacements, veins, and open-space fillings of manganese oxides, calcite, manganiferous calcite, iron oxides, quartz, and, locally, barite. Manganese oxides also form cement in breccias and sandstones. The deposits are hosted by dolomites, dolomitic limestones, and sandstones of the Bat Cave and Cable Canyon Formations and Upham Dolomite (Ordovician). Assays of samples collected from this area are in Table 27. The area is characterized by elevated concentrations of Ba, Co, Mn, Ti, and local Cu, Pb, and Zn anomalies in stream-sediment samples. These deposits are low tonnage, low grade, and uneconomic.

TABLE 27—Chemical analyses of samples from selected mines and prospects in the Rincon district, Doña Ana County. No gold or silver were detected by fire assay. Analyses by the NMBMMR Chemical Laboratory (Cu, Mn by FAAS after *aqua regia* digestion; Hg by cold vapor AA). —no data.

LAB NO.	SAMPLE NO.	LATITUDE, LONGITUDE	Cu (ppm)	Mn (ppm)	Hg (ppm)	CaF_2 %	SAMPLE DESCRIPTION
23	Rincon 1	32° 40' 57", 107° 3' 42"	—	240,000	<0.1	—	Rincon, grab sample of dump
24	Rincon 2	32° 40' 57", 107° 3' 42"	17	—	<0.1	15.4	Rincon, grab sample of dump
25	Rincon 3	32° 41' 24", 107° 3' 44"	9.5	—	<0.1	8.6	ABC Mining, chip sample

Travertine

Travertine is common in the Rincon district and surrounding area. Travertine occurs in the Palm Park Formation (Eocene) in the northern Rincon quadrangle (Fig. 13; Seager and Hawley, 1973). The travertine varies in color from white, pink, brown, and gray; is up to 6 ft thick; and is banded (Barker et al., 1996). Many other deposits have not been mapped. The deposits are typically small and would meet only local needs as a decorative stone.

San Andrecito-Hembrillo district

Location and Mining History

The San Andrecito-Hembrillo district is in the San Andres Mountains in northern Doña Ana and southern Sierra Counties (Fig. 1) and includes the San Andrecito, Deadman, Lost Man, Hembrillo, and Hospital Canyons and the adjacent slopes. Rio Grande Rift barite-fluorite-galena, Precambrian vein and replacement, and talc deposits are found in the district (Table 28; McLemore, 1994b). Very little information exists on the discovery, history, or production of these small deposits. Many mines could not be located in 1993-1994. The Green Crawford and Hembrillo Canyon prospects were worked in the late 1890s or early 1900s. Additional production occurred from the Green Crawford during 1920-1930 and from the Hembrillo Canyon prospects in 1914, 1915, and 1918 (Anderson, 1957; NMBMMR file data). Total metal production from the district probably amounts to less than $10,000 worth of copper (<10,000 lbs), lead, and silver (<100 oz) (Dunham, 1935; NMBMMR file data). Total talc production from 1920 to 1945 was approximately 12,062 short tons (Fitzsimmons and Kelley, 1980; Chidester et al., 1964). The entire district is within the White Sands Missile Range and withdrawn from mineral entry.

TABLE 28—Mines and prospects in the San Andrecito-Hembrillo district, Doña Ana County. Location includes section, township, and range. FN—unpublished field notes, V. T. McLemore.

MINE NAME	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	YEARS OF PRODUCTION	DEVELOPMENT	PRODUCTION	REFERENCES
Green Crawford	NW31 17S 4E	32° 47' 20", 106° 34' 40"	Cu, Pb, Zn, Ag	1914-1915,1918,1920-1930	130 ft, 70 ft adit, 30 ft winze, 30 ft raise, pits	<$10,000, <10,000 lbs Cu, <100 oz Ag from district	Dunham (1935), McLemore (1994b), Seager (1994), FN 10/11/93
Hembrillo Canyon (Lot OM-69?)	SE9 16S 3E	33° 55' 55", 106° 38' 30"	Ba, Pb, Cu, Ag, F	late 1890s	12 ft, 75-100 ft shafts, 2 pits	minor	Dunham (1935), Anderson (1957), Williams et al. (1964), McLemore (1994b); FN 10/10/93
Hospital Canyon	SE18 16S 4E	32° 54' 58", 106° 33' 52"	Cu, Ag	unknown	15 ft shaft, pits	unknown	FN 2/19/94
Hembrillo	E12 16S 3E	32° 56' 5", 106° 35' 14"	talc	1917-1930, 1942-1945	open pits, adits	12,602 short tons talc	Fitzsimmons and Kelley (1980), Chidester et al. (1964)
Red Rock	1 16S 3E	32° 57' 2", 106° 35' 48"	talc	1917-1930, 1942-1945	open pits, adits	combined with Hembrillo	Fitzsimmons and Kelley (1980), Chidester et al. (1964)

Geology

The oldest rocks exposed in the San Andrecito-Hembrillo district are Proterozoic granite, quartz-feldspar-mica schist, quartzite, amphibolite, phyllite, and talc schist. The rocks are metamorphosed and foliated with regional strikes of N30-45°W and steep westerly dips. Sedimentary rocks ranging in age from Paleozoic through Cenozoic crop out in the area (Seager, 1994). The total Cambrian to Cretaceous section is about 7,200 ft (Kottlowski and LeMone, 1994). Rio Grande Rift deposits are found in the Lead Camp Limestone (Pennsylvanian) and along faults in the Bliss Sandstone (Cambrian). Vein and replacement deposits containing base and precious metals and talc deposits occur in the Proterozoic rocks. A Tertiary andesite dike intrudes the sedimentary rocks at Victorio Peak and contains disseminated pyrite and chalcopyrite (F.E. Kottlowski, oral communication, June 15, 1995).

Mineral deposits

There are three types of deposits found in the San Andrecito-Hembrillo district: Rio Grande Rift, Precambrian vein and replacement and talc deposits (Table 28). The Proterozoic talc deposits are the most extensive, and reserves are still present. The Rio Grande Rift barite-fluorite-galena deposits are small, but all of the reported metal production has come from them. Minor vein and replacement deposits occur along faults and adjacent to amphibolite dikes in Proterozoic rocks south of Hembrillo Canyon in Hospital Canyon.

Talc deposits occur in Proterozoic granite and metamorphic rocks in Hembrillo Canyon along the Sierra-Doña Ana County line (Chidester et al., 1964; Fitzsimmons and Kelley, 1980). The deposits are lense shaped and measure approximately 100 ft long and 8-12 ft wide. A reserve of 6,500 short tons is reported by Fitzsimmons and Kelley (1980). Development consists of adits and pits.

The central portion of the talc lenses consists predominantly of relatively pure talc. The outer part is 2-3 ft wide and consists of talc, carbonate minerals, and chlorite. The talc grades into banded quartz-chlorite phyllite and schist. Foliation is subparallel to foliation of the metamorphic rocks, indicating a Proterozoic age.

Rio Grande Rift barite-fluorite-galena deposits occur in the Lead Camp Limestone (Pennsylvanian) and Ordovician limestones. The most extensive development is at the Green Crawford mine (NW¼ sec. 31, T17S, R4E) and Hembrillo Canyon prospects (SE¼ sec. 9, T16S, R3E). Prospects were also found in Hospital Canyon (SW¼ sec. 18, T16S, R4E). Additional prospect pits are reported to occur along veins in Lost Man Canyon (Dunham, 1935; The Mining World, April 23, 1910, p. 868), but these prospects could not be located during this study.

The Green Crawford mine is in San Andrecito Canyon and development consists of two adits, several prospect pits, and shallow shafts on opposite sides of the canyon (Fig. 15). The north adit is approximately 130 ft long with a 30 ft winze and a raise. Prospect pits and a shaft also develop portions of the north vein upslope from the adit. The south adit is less than 70 ft long with a 30 ft raise. Prospect pits and trenches also expose portions of the south vein.

The deposit consists of a silicified zone, less than 3 ft wide and 100-300 ft long, which occur along two north-trending faults that cut sandstones of the Bliss Formation (Cambrian) and limestones of the El Paso and Montoya Groups (Ordovician; Seager, 1994). The vein north of the canyon has a strike of N55°E and a dip of 80°E; whereas the vein south of the canyon has a strike of N25°E and a dip of 87°E. Additional veins may be present in the area but are covered by talus material. The veins are simple fissure-fillings which consist of covellite, chalcocite, chalcopyrite, cuprite, malachite, and azurite in a gangue of quartz, calcite, iron oxides, and a trace of barite. Chalcanthite coats some walls along the adits. The host rocks have been silicified and replaced by iron oxides adjacent to the veins. A sample of ore reportedly assayed no gold, trace of silver, and 27.93% Cu (Dunham, 1935). Assays of samples (Fig. 15) collected for this report are in Table 29.

TABLE 29—Chemical analyses of samples from the Green Crawford, Hospital Canyon, and Hembrillo Canyon mines. Location of samples from Green Crawford mines in Figure 15. Analyses by the NMBMMR Chemical Laboratory (Cu, Mn by FAAS after *aqua regia* digestion; Hg by cold vapor AA) and * by USGA laboratories by ICP. —no data.

FIELD NO.	LAB NO.	Au (oz/ton)	As* (ppm)	Ag (oz/ton)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Hg (ppm)	LOCATION, DESCRIPTION
A (VM001R)	536	0.00	160	0.00	11,000	68	48	<0.10	Green Crawford, select dump sample, north adit
B (VM002R)	537	0.00	210	0.00	5,100	31	18	<0.10	Green Crawford, 1 ft chip across north vein
C (VM003R)	538	0.00	—	0.00	—	—	—	0.78	Green Crawford, 1.5 ft chip sample acrsoo back north vein
D (VM004R)	539	0.00	—	0.00	163,000	52	28	0.44	Green Crawford, select dump sample, north vein
E (VM005R)	540	0.00	<10	3.36	3,200	34	29	0.15	Green Crawford, 3 ft chip sample across south vein
F (VM006R)	541	0.00	—	0.00	178,000	68	49	<0.10	Green Crawford, select dump sample, south vein
Hos 2	549	0.00	—	0.00	<50	310	61	<0.02	Hospital Canyon, chip across 15 ft quartzite
Hos 3	550	0.00	—	0.00	<50	89	100	<0.02	Hospital Canyon, chip across 10 ft face in pit
Hos 4	596	—	—	—	2,600	1200	280	—	Hospital Canyon, grab sample of dump at pit
Hospital	753	0.00	—	0.00	<50	14	<50	—	Hospital Canyon, chip of quartzite
Hembrillo	735	0.00	—	0.38	1,400	37000	79	—	Hembrillo Canyon, grab sample of dump of south pit
VM013R	751	0.00	—	0.00	580	42000	<50	—	Hembrillo Canyon, grab sample of dump
Hembrillo	737	0.00	—	0.00	1,600	16000	1700	—	Hembrillo Canyon, grab sample of dump of north pit
VM014R	752	0.00	—	0.00	250	35000	80	—	Hembrillo Canyon, grab sample of dump of north pit

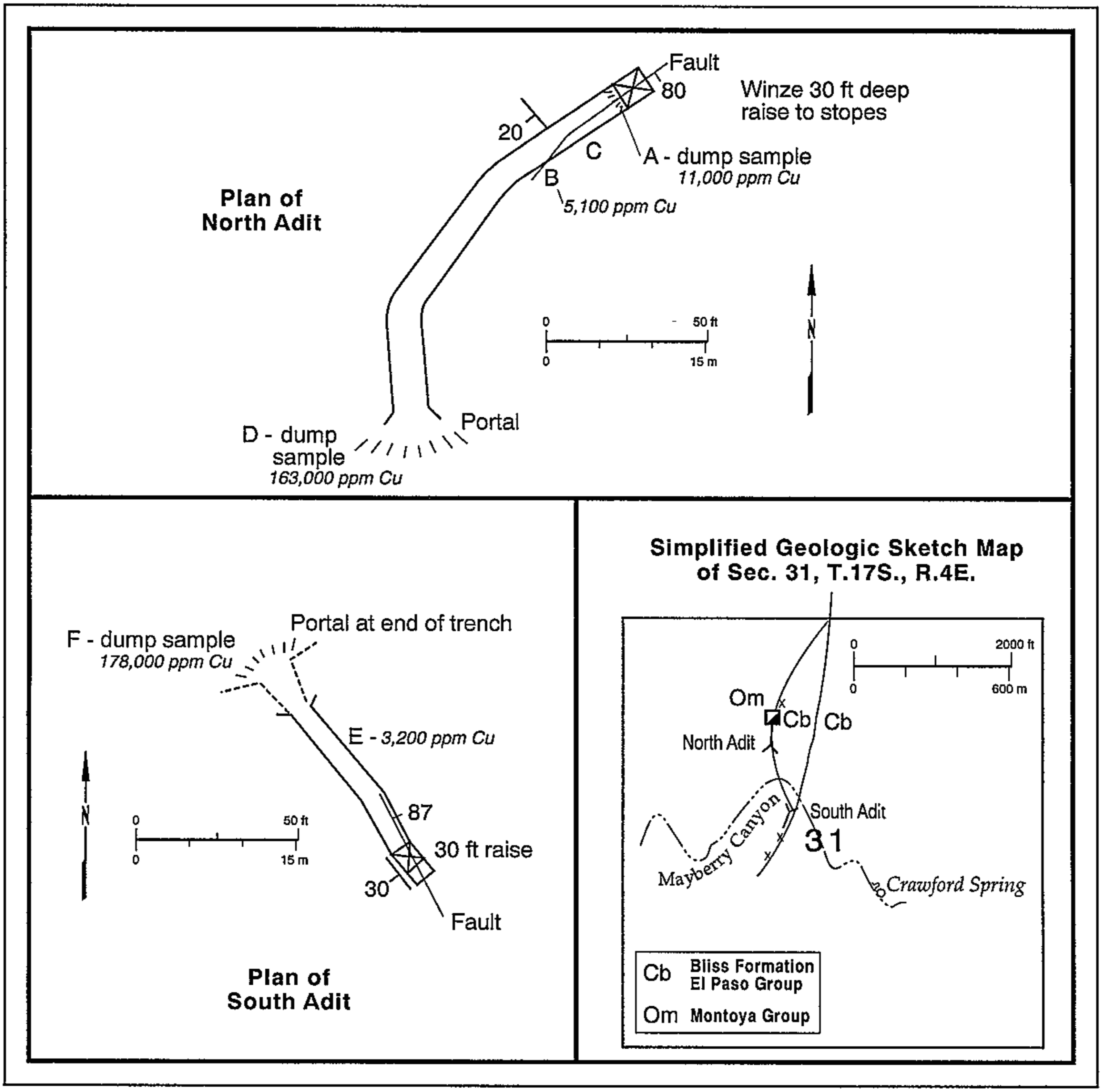

Figure 15—Simplified geologic sketch and plan map of the Green Crawford mines, Doña Ana County, New Mexico. Brunton and pace survey (10/11/93). Geology simplified from Seager (1994). Chemical assays in Table 29.

The Hembrillo Canyon prospects in Hembrillo Canyon consist of two shafts, 12 and 75-100 ft deep, and two shallow prospect pits. The deposits may be part of the Lot OM-69 prospect described by Williams et al. (1964); however, Williams et al. (1964) places the Lot OM-69 prospect in sec. 10, T16S, R3E instead of sec. 9. A reconnaissance of section 10 failed to locate any additional veins or prospects. The Hembrillo Canyon prospects consist of thin veins and small replacement bodies in limestones within a faulted block of Lead Camp Limestone (Pennsylvanian; Seager, 1994). The deposit is less than 300 ft long and consists of galena, barite, quartz, calcite, iron oxides, and possibly traces of wulfenite. A sample of the Lot OM-69 prospect reportedly contained 77.8% $BaSO_4$, 14.8% SiO_2, and 0.3% $CaCO_3$ (Williams et al., 1964). Samples collected for this report are in Table 29.

The barite-fluorite-galena deposits in the San Andrecito-Hembrillo district are classified as Rio Grande Rift (formerly sedimentary-hydrothermal) deposits by North and McLemore (1986). Certainly, the deposits in limestone in Hembrillo Canyon are characteristic of Rio Grande Rift deposits. However, the veins at the Green Crawford mine have textures similar to epithermal veins, but there is no indication of any igneous intrusive activity. A basaltic to andesitic dike does intrude the Paleozoic sediments north of the Green Crawford mine, but there is no indication of any relationship between the two. Therefore, the veins at the Green Crawford are classified as a variation of Rio Grande Rift deposits until further study.

Prospect pits and a 15 ft shaft occurs in SW¼ sec. 18, T16S, R4E in Hospital Canyon (V. T. McLemore, unpublished field notes, February 19, 1994) along quartz-calcite veins that cut Proterozoic amphibolite. Alteration consists of hematite and local sericite. Trace amounts of malachite are present on the dump.

Additional veins of copper and barite are reported to occur in the San Andrecito-Hembrillo district, but could not be located during this study. The Kendrick copper prospect is reported to occur on the east slope of the mountains between San Andrecito and Deadman Canyons (Dunham, 1935). An adit was reportedly driven along a copper vein in Hospital Canyon (The Mining World, April 23, 1910, p. 868).

San Andres Canyon district

Location and Mining History

The San Andres Canyon district is in San Andres Canyon in the San Andres Mountains (Fig. 1) and consists of the San Andres lead deposit (SE¼ sec. 18, T18S, R4E), a Rio Grande Rift barite-fluorite-galena deposit. The deposit was discovered and developed in 1900. Development consists of a 100 ft open cut, 550 ft adit with a 130 ft drift and a winze, and several shallow pits and shafts (Dunham, 1935; Smith, 1981), but all are caved and inaccessible in 1993. A mill and smelter were erected in 1900 to 1904 and consisted of a crusher, screens, rolls, and 15 jigs. Capacity was expected to be 100 tpd. However, the mill and smelter were built before any reserves were delineated and the entire operation failed with <10,000 lbs each of lead and copper production (Table 2; Dunham, 1935). Only the foundations are left.

Geology

Sedimentary rocks ranging in age from Paleozoic through Cenozoic crop out in the area. The total Cambrian to Cretaceous section is about 7,200 ft (Kottlowski and LeMone, 1994). Rio Grande Rift deposits are found in the Fusselman Formation (Silurian). North-trending normal faults cut the sedimentary rocks in places (Bachman and Myers, 1969).

Mineral Deposits

The deposit is a small, irregular replacement body in the dolomite of the Fusselman Formation adjacent to a north-trending fault that strikes N15°W and dips steeply to the west (Dunham, 1935; Bachman and Myers, 1963, 1969; Smith, 1981). The deposit is about 200 ft long and up to 20 ft wide (Dunham, 1935) and consists of barite, quartz, minor galena, calcite, fluorite, iron oxides, and clay. Samples collected for this report assayed as high as 2.2 ppm Ag, 170 ppm Cu, 24,000 ppm Pb, and 31 ppm Zn (SA010R-SA012R, USGS laboratories). The deposit is characteristic of Rio Grande Rift deposits elsewhere in New Mexico (North and McLemore, 1986; McLemore and Barker, 1985).

Tonuco Mountain district

Location and mining history

Tonuco Mountain mining district, also known as the San Diego Mountain district, is located on the east side of the Rio Grande, southeast of Rincon and consists of two small en echelon uplifts; Tonuco and West Selden Hills (Fig. 1; Seager et al., 1971). Rio Grande Rift fluorite-barite-galena veins in Proterozoic rocks were discovered in 1900 (Table 26) and from 1919 to 1935, 200 tons of barite and 7,720 tons of fluorite were produced (Table 4; Rothrock et al., 1946; Clippinger, 1949; Williams et al., 1964; McAnulty, 1978). A fluorite mill was erected at the Tonuco mine in 1922 (Ladoo, 1923).

TABLE 30—Mines and prospects in the Tonoco mining district, Doña Ana County. Location includes section, township, and range. FN—unpublished field notes, V. T. McLemore. NMBMMR files—unpublished file data in the New Mexico Bureau of Mines and Mineral Resource archives.

MINE NAME	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
San Diego Mountain	31 19S 1W, 6 20S 1W	32° 36' 21", 106° 59' 3"	Ba, F	pits, adits	Rio Grande Rift	Rothrock et al. (1961), FN 4/18/96
Russel Soper	NW36 19S 2W	32° 36' 41", 106° 59' 34"	U, Ba, F, travertine	none	Rio Grande Rift	McLemore (1983)
Tonuco	6 20S 1W, 31 19S 1W	32° 36' 3", 106° 58' 54"	F, Ba	5 adits 70-440 ft, cuts, pits	Rio Grande Rift	NMBMMR files
Beal (Beulah May, Glorietta)	S31 19S 1W	32° 36' 35", 106° 58' 58"	Ba, F	350 ft adit, adits, pits	Rio Grande Rift	NMBMMR files, FN 4/18/96
Iron Mask (Hust)	SE20 20S 1W	32° 32' 53", 106° 57 30"	Mn, Fe	pit	replacement manganese	Farnham (1961)
Garcia (Fortune, Windy Blow)	SE26 20S 1W	32° 32' 4", 106° 54' 27"	Mn	pit	replacement manganese	Farnham (1961)
unknown	SE20, SW21 T20S R1W	32° 32' 48", 106° 57' 28"	travertine	pits	travertine	FN 12/26/94
San Diego (Russel Snoper)	SE36 T19S R2W	32° 36' 47" 107° 00' 7"	travertine, U	pit	travertine	Boyd and Wolf (1953), Seager (1975)
unnamed	T19S R1W	32° 36' 48" 106° 58' 58"	barite	none (150 ft long vein)	Rio Grande Rift	FN 4/18/96

Geology

Proterozoic granite and sedimentary rocks of the Bliss Sandstone and El Paso Group are exposed in the Tonuco block. More than 8,000 ft of Tertiary volcanic and sedimentary rocks overlies the Proterozoic and Paleozoic rocks (Seager et al., 1971). High-angle normal faults have uplifted the block.

Mineral Deposits

The fluorite-barite veins are typically small (less than one foot wide), discontinous, and trend north to northwest. The veins occur along faults and fractures in Proterozoic rocks and as open-space fillings in the silicified Hayner Ranch Formation (Miocene). The Beal vein is several hundred feet long, less than 2 ft wide, strikes N25°W, and dips 70°SW. Samples from the Beal claims assayed 21.4-38.7% CaF_2 and 28.1-49.2% $BaSO_4$ (NMBMMR files). Most of the fluorite has been mined out. The Tonuco vein is 1,000 ft long, less than 10 ft wide, strikes N70°W, and dips 60°SW. A sample assayed 35.7% CaF_2 and 47.2% $BaSO_4$ (NMBMMR files). Both veins consist of barite, quartz, calcite, iron and manganese oxides, and fluorite. Stratigraphic relations indicate that the veins are probably Miocene (Seager et al., 1971). A barren, Miocene sandstone overlies the vein in the northern part of San Diego Mountain.

The manganese deposits are small and discontinous. Manganese and iron oxides and calcite are common to most deposits. The Garcia deposit occurs in fractures trending N60°W in sandstone. It is 60 ft long, 3-5 ft wide, and consists of a few hundred tons of 5-10% Mn. The Iron Mask consists of at least three bodies ranging in size from 4-10 ft wide and 20-60 ft long.

Travertine

Radioactive travertine occurs along the northwest base of San Diego Mountain (Boyd and Wolf, 1953; Seager et al., 1971; Seager, 1975) and was formed by springs during the Pleistocene (Barker et al., 1996). Travertine was quarried in the Buckle Bar area of Selden Hills (SE20, SW21, T20S, R1W). Most of it is white in color. Most of these deposits are small and they would meet only local needs for decorative stone.

Tortugas Mountain district

Location and Mining History

Tortugas Mountain, also known as "A" Mountain, is located east of Las Cruces in sec. 23, 24, T 23S, R2E (Fig. 1) and the district was discovered in 1900. Rio Grande Rift deposits of barite, fluorite, and manganse occur along the faults in Permian limestones and dolomites (Dunham, 1935; McAnulty, 1978; Macer, 1978; King and Kelley, 1980). From 1919-1943, 20,751 short tons of fluorite and 100 short tons of barite were produced (Williams et al. 1964; McAnulty, 1978). Numerous adits, shafts and pits developed the veins for a stike length of

1,200 ft and a depth of 286 ft (Dunham, 1935); the New Mexico Abandoned Mine Lands Bureau reclaimed the area in 1990 and the deposits are now inaccesible. At least eight drill holes have been drilled south and east of Tortugas Mountain for geothermal resources (Gross and Icerman, 1983).

Geology

Tortugas Mountain is a west-tilting horst block that consists of silicified and dolomitized Permian limestones and shales and Tertiary to Recent unconsolidated sedimentary rocks (King and Kelley, 1980). Normal faults trending north or N30°W have cut and offset the Permian rocks; many of these faults are mineralized and silicified (King and Kelley, 1980). It is estimated that approximately 2,000 ft of limestone underlies Tortugas Mountain (Gross and Icerman, 1983).

Mineral Deposits

Numerous faults and fracture zones in the Tortugas Mountains are mineralized by fluorite-calcite veins. The largest fluorite-calcite vein, up to 10 ft thick, occurs along the Tortugas fault and has been mined to 530 ft (Rothrock et al., 1946; King and Kelley, 1980). Ore averaged 77.4% CaF_2, 15.68% $CaCO_3$, and 6.51% SiO_2 (Ladoo, 1927). Fluid inclusion analyses indicate formation temperatures of 180° to 191°C and low salinities of less than 2% eq. NaCl (Macer, 1978; North and Tuff, 1986), and were probably formed by meteroric hydrothermal fluids. It is unlikely that ore remaining in the pillars underground at the Tortugas mine would be sufficient tonnage to be produced under current economic conditions (G.B. Griswold, unpublished report, December 1980, on file at NMBMMR archives). Tortugas Mountain is characterized by anomous local concentrations of Co, La, Mn, Mo, Pb, Th, and U in stream-sediment samples.

Travertine

A small travertine deposit occurs on the northern part of the mountain (sec. 23, 24, T2E, R23S). The deposit is white to gray and probably only suitable for local use.

GEOLOGY AND MINERAL OCCURRENCES OF THE MINING DISTRICTS OF LUNA COUNTY

by Virginia T. McLemore and David M. Sutphin

Introduction

Luna County was established in 1901 from the western portion of Doña Ana County and was named after a prominent political figure of the times, Don Salomon Luna. Deming is the largest city and the county seat. The southern boundary is with Chihuahua, Mexico, and Columbus, New Mexico is an international port of entry. Three state parks are found in the county: Rockhound (Little Florida Mountains), Pancho Villa (at Columbus), and City of Rocks (north of Deming).

Spanish explorers undoubtedly traveled through Luna County in the early 1700s. However, the first reported exploration did not occur until the 1870s with the discovery of the Cooke's Peak, Florida Mountains, and Victorio districts (Table 1). Total metal production from Luna County amounts to more than $6.5 million worth of copper, gold, silver, lead, and zinc since 1902 (Table 31). Two of the state's largest lead and zinc producing districts are in Luna County; the Cooke's Peak district ranks 5th in lead production and 9th in zinc production and the Victorio district ranks 7th in lead production (McLemore and Lueth, 1995; in press). Currently, agate, manganese, clay, and sand and gravel are being produced from Luna County (Hatton et al., 1994).

TABLE 31—Reported metal production from Luna County, New Mexico (U. S. Geological Survey, 1902-1927 and U. S. Bureau of Mines, 1927-1990; Griswold, 1961). — none reported.

YEAR	ORE (SHORT TONS)	COPPER (LBS)	GOLD (OZ)	SILVER (OZ)	LEAD (LBS)	ZINC (LBS)	TOTAL VALUE ($)
pre-1902	—	—	—	—	—	—	4,300,000
1902	—	—	—	10,382	711,825	—	34,400
1903	—	—	—	6,168	1,355,965	—	61,800
1904	1,576	16,000	82	8,549	671,772	—	37,605
1905	1,346	—	—	5,199	463,956	225,000	38,221
1906	1,994	—	20	11,265	831,193	103,836	61,673
1907	2,048	—	665	8,633	1,022,773	—	73,646
1908	288	5,934	—	1,077	127,535	—	6,713
1909	1,163	1,115	155	6,916	682,906	—	36,314
1910	525	47	1	2,484	298,112	—	14,490
1911	229	1,814	5	1,278	98,888	—	5,458
1912	3,090	—	245	24,265	827,556	458,594	89,493
1913	5,185	1,453	536	41,664	1,158,682	702,028	126,771
1914	2,127	2,181	11	2,975	416,923	—	58,694
1915	2,082	4,080	24	2,795	148,766	—	116,405
1916	7,630	2,663	171	18,077	868,724	—	441,255
1917	4,943	319	252	15,142	721,117	1,635,500	246,612
1918	2,910	3,150	397	16,442	490,493	463,445	102,432
1919	1,850	1,479	238	11,183	383,248	31,575	40,343
1920	1,481	3,864	323	11,611	359,488	21,098	50,506
1921	676	—	72	4,709	144,468	—	12,698
1922	248	1,679	18	976	43,000	24,228	5,322
1923	536	1,041	63	2,312	85,472	—	9,332
1924	1,161	573	10	3,024	306,198	—	26,799
1925	2,626	2,500	47	6,603	595,020	119,300	66,751
1926	1,148	2,450	7	1,984	183,300	70,000	21,644
1927	1,125	367	16	2,058	206,080	—	14,523
1928	40	—	4	188	9,000	—	717
1929	453	2,585	12	1,666	40,700	—	4,151
1930	374	500	15	904	51,000	—	3,269
1931	—	—	—	—	—	—	—
1932	39	—	27	156	—	—	71
1933	28	—	—	143	20,000	—	796
1934	79	200	1	1,245	49,100	—	2,670
1935	54	—	6	380	7,400	—	786
1936	76	250	4	745	16,700	—	1,515
1937	1,037	3,000	94	3,722	74,400	—	10,908
1938	3,645	6,000	397	13,676	256,700	—	35,146

YEAR	ORE (SHORT TONS)	COPPER (LBS)	GOLD (OZ)	SILVER (OZ)	LEAD (LBS)	ZINC (LBS)	TOTAL VALUE ($)
1939	3,599	9,500	455	17,397	332,800	9,000	44,832
1940	1,061	2,600	113	4,175	107,000	49,000	15,655
1941	45	200	—	218	26,400	—	1,684
1942	122	—	14	339	32,000	32,000	5,851
1943	61	—	—	—	6,000	22,000	2,826
1944	—	—	—	—	—	—	—
1945	—	—	—	—	—	—	—
1946	2	—	—	26	—	—	21
1947	1,400	2,900	25	3,093	134,500	42,600	28,806
1948	350	—	2	958	82,000	—	15,615
1949	69	—	—	221	38,000	—	6,204
1950	91	—	1	336	10,000	—	1,689
1951	2,793	6,000	10	2,970	464,000	522,000	179,766
1952	—	2,000	3	1,222	190,000	188,000	63,493
1953	12	—	—	63	4,000	—	581
1954	3	—	—	19	—	—	17
1955	57	—	1	175	2,000	—	491
1956	141	2,100	—	227	9,300	—	2,558
1957	58	—	—	272	6,000	2,000	1,336
1958	—	—	—	—	—	—	—
1961	49	2,000	—	73	—	—	637
1962	48	—	—	374	6,000	1,000	1,006
1964	21	2,000	—	110	—	—	761
1965	168	—	—	345	14,000	4,000	3,294
1966	13	1,000	—	12	1,000	—	267
1968	13	1,000	—	—	—	—	335
1969	1	—	—	93	—	—	167
TOTAL 1902-1969	61,100	96,544	4,542	283,314	14,956,476	4,726,204	6,522,655

Camel Mountain-Eagle Nest Area

Location and mining history

The Camel Mountain-Eagle Nest area is located along the Doña Ana-Luna County boundary, west of the Potrillo Mountains in southeastern Luna County (Fig. 1, 16). No production is reported from the area; only a few shallow prospect pits and shafts (Table 32) have exposed the small, discontinous volcanic-epithermal veins and carbonate-hosted Ag-Mn replacement deposits.

TABLE 32—Prospects in the Camel Mountain-Eagle Nest area, Luna County, New Mexico (Griswold, 1961; Gese, 1985; V. T. McLemore, unpublished field notes, 5/15/93, 4/28/95, 5/29/95). Prospects are shown in Figure 16. Location includes section, township, and range.

MINE NAME	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	DEVELOPMENT	ROCK TYPE	TYPE OF DEPOSIT
Eagle Nest	NW35 27S 5W	31° 55' 5", 107° 19' 30"	Ag, Pb, Zn, Ba	40 ft shaft	rhyolite	volcanic-epithermal
Camel Mountain	NE13 29S 5W	31° 47' 15", 107° 17' 45"	Au, Ag?	10 ft shaft, 2 pits	rhyolite, limestone	volcanic-epithermal
Prospect Hill	NE9 29S 5W	31° 47' 45", 107° 20' 40"	Zn, Ba, Ag?	pits (<10 ft deep)	diorite, limestone xenolith	carbonate-hosted Ag-Mn replacement

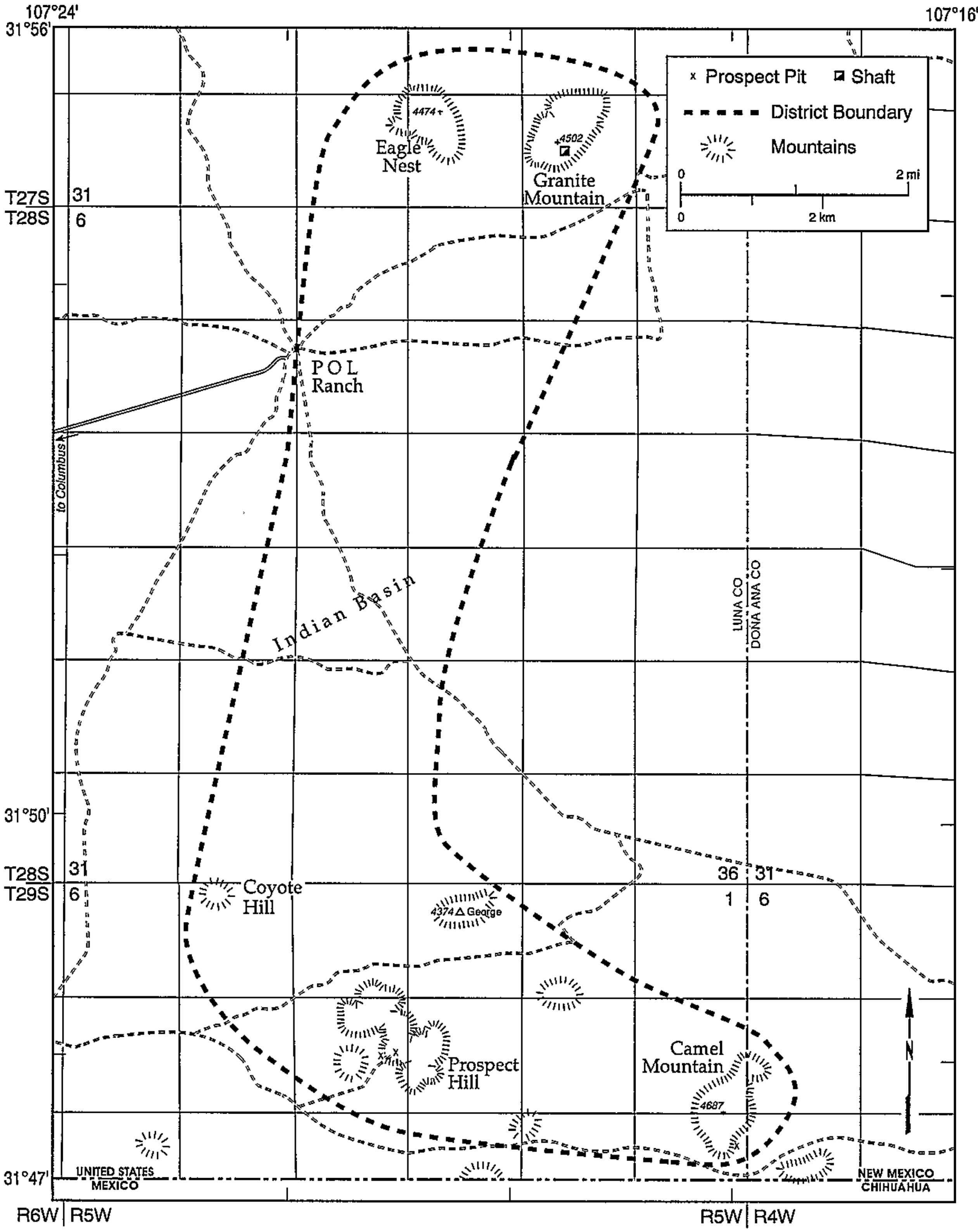

Figure 16—Mines and prospects in the Camel Mountain-Eagle Nest district, Luna County, New Mexico.

Geology

The area consists of several small, isolated hills of poorly exposed igneous rocks that have intruded Paleozoic and Mesozoic limestone, such as at Prospect Hill. Tertiary volcanic and sedimentary rocks form other hills, such as at Camel Mountain (Fig. 17). Two of the more prominent hills are the Eagle Nest (Fig. 18) and Granite Hills, where granite of suspected Proterozoic age is overlain by Cretaceous-Tertiary sedimentary rocks. Permian sedimentary rocks are exposed at Eagle Nest Hill. Seismic surveys indicate the presence of elevated velocity rocks within 900-1,200 ft of the surface, which could represent carbonate rocks. Porphyritic andesite to diorite has intruded the Proteozoic(?) granite and Cretaceous-Tertiary sedimentary rocks (Broderick, 1984; Seager and Mack, 1990; V. T. McLemore, unpublished field notes, May 29, 1995). Normal faults have uplifted these hills during Basin and Range extension (Seager, 1989). The hills are surrounded by blow sand and other Recent alluvial deposits which may conceal additional, more economically promising, volcanic-epithermal vein and carbonate-hosted replacement deposits.

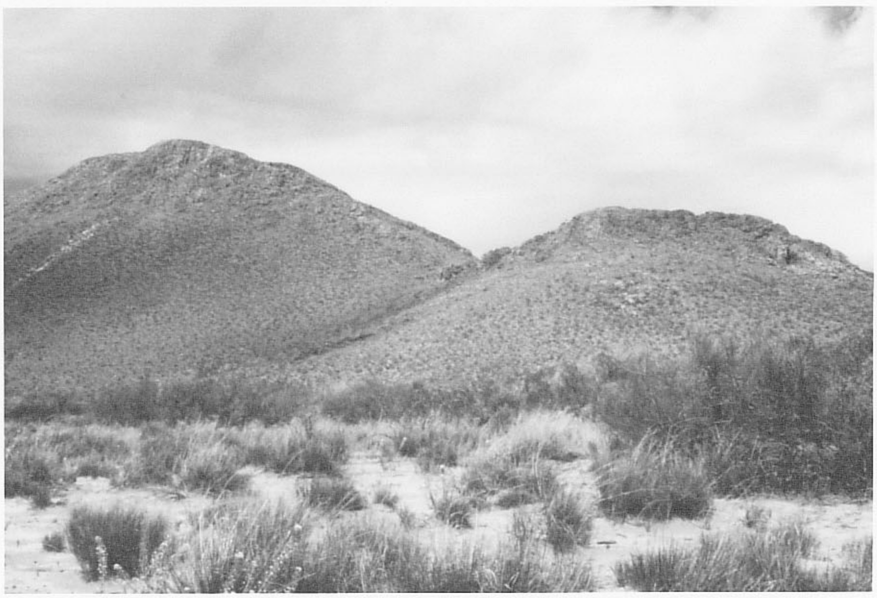

FIGURE 17—Camel Mountain, looking north. A prospect pit is on the top of the east ridge which is formed by a rhyolite dike (V. T. McLemore photo).

FIGURE 18—Eagle Nest Hill, looking north. A prospect pit is near the western crest (V. T. McLemore photo).

Mineral deposits

The Camel Mountain prospects consist of volcanic-epithermal veins filling fault and fracture zones near a rhyolite dike striking N70°E (Fig. 17). The veins consist of iron and manganese oxides, calcite, fluorite, and quartz. Two samples assayed 0.028 oz/short ton Au, no Ag, 7.2-9.6 ppm Cu, 33-32 ppm Pb, 350-87 ppm Zn, and <0.20-0.06 ppm Hg (#2485, NMBMMR chemical laboratory). Gese (1985) reports an assay of 0.2 oz/short ton Ag, 39 ppm Pb, 76 ppm Zn, and 2.1% Mn.

The Prospect Hill prospects consist of small, discontinous carbonate-hosted replacement bodies of quartz, calcite, barite, gehlenite, and clinohumite (Griswold, 1961). No metallic sulfides have been found. Gehlenite and clinohumite are rare silicate minerals valued as mineral specimens (Griswold, 1961). Gese (1985) reports a sample assayed 55 ppm Zn. A sample collected for this report assayed 78 ppm Cu, 110 ppm Pb, 67 ppm Zn and <0.18 ppm Hg.

The Eagle Nest area (Fig. 16) is perhaps the most economically interesting area in the district. A volcanic-epithermal vein of quartz, calcite, siderite, iron oxides, pyrite, barite, fluorite, sphalerite, and galena occur along a mafic dike in a fault trending N50°E (Fig. 19; V. T. McLemore, unpublished field notes, May 29, 1995; Broderick, 1984; Gese, 1985). Chloritic and sericitic alteration, locally pervasive, affect adjacent conglomeratic rocks. Gese (1985) reports a dump sample assayed 5.7 oz/short ton Ag, 4.5% Pb, and 1.6% Zn.

FIGURE 19—Vein containing calcite, quartz, siderite, galena, and pyrite striking east-west at Eagle Nest Hill (V. T. McLemore photo).

The mineral resource potential of this area is speculative at best. No production is reported. Geochemical anomalies in the stream-sediment samples are scattered and low; anomalous concentrations of As, Co, Cr, K, Mn, and Ti occur locally. However, the presence of volcanic and intrusive rocks provides a source of metals and heat for mineral deposits. The lack of exposure of outcrops in the area presents challenges for exploration.

Carrizalillo district

Location and Mining History

The Carrizalillo district includes a broad region in southwestern Luna County that consists of the Carrizalillo Hills, Cedar Mountains, and Klondike Hills (Fig. 20, 21). The district also is known as the Cedar Hills and Stonewall districts. The mineral occurrences are scattered throughout all three ranges and consist of volcanic-epithermal and Rio Grande Rift deposits (Table 33). The district was first prospected in the late 1800s; but very little is known concerning the mining history and developement. Numerous pits, shafts, and a few adits occur in the area, but none are very extensive. Ruins of a smelter occur near Hermanas (22, T28S, R11W). Only a small area is disturbed with very little slag, suggesting that production was probably small (Gates, 1985). Copper, gold, silver, and lead production in the late 1800s, 1947-1948, and 1956 has been minor; less than 1,000 oz Ag, less than 100 oz Au, and less than 1,000 pounds each of copper and lead have been produced from 1946 to 1956. Recent exploration by various companies, including Canyon Resources, Dome Exploration (in 1985), Westmont (in 1989) and FMC Corp. has failed to discover any mineral deposits. The Cedar Mountains Wilderness Study Area occurs in the center of the Cedar Mountains.

TABLE 33—Mines and prospects in the Carrizalillo mining district, Luna County, New Mexico, located in Figure 20 and 21. Location includes section, township, and range.

MINE NAME (ALAIS)	LOCATION	LATITUDE	LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
unknown (E,D)	S14 29S 11W	31° 47' 4"	107° 55' 57"	Au, Ag, Ba	pits	volcanic-epithermal	Gates (1985)
unknown (G)	C35 28S 1W	31° 49' 36"	107° 56'1"	Au, Ag	pit	volcanic-epithermal	Gates (1985)
unknown (C)	C14 29S 1W	31° 47' 19"	107° 56' 11"	Au, Ag	pit	volcanic-epithermal	Gates (1985)
unknown (A)	S11 29S 11W	31° 47' 34"	107° 56' 13"	Au, Ag, Ba	20 ft shaft	volcanic-epithermal	Gates (1985)
Calumet (High Hope #1-8) (B,EE,FF)	NW NW14 T29S R11W	31° 47' 28"	107° 56' 17"	Cu, Au, Ag	shaft, adit, pits	volcanic-epithermal	Griswold (1961), Gates (1985)
unknown (J,M)	NW34 28S 1W	31° 49' 57"	107° 57' 35"	Au, Ag, Cu	20 ft shaft, pit	volcanic-epithermal	Gates (1985)
Johnson Mountain (Larsch and Dumont)	SE28 28S 11W	31° 50' 10"	107° 57' 40"	Cu, Au, Ag	pit, 20 ft shaft, 34 ft shaft, 20 ft shaft	volcanic-epithermal	Griswold (1961), Gates (1985), NMBMMR file data
unknown (F)	SE16 29S 11W	31° 47' 4"	107° 57' 46"	Au, Ag, Cu	10 ft shaft, pits	volcanic-epithermal	Gates (1985)
Johnson Mountain (N,K,L)	NE33 28S 11W	31° 49' 46"	107° 57' 52"	Cu, Au, Ag, Ba	pits, shaft	volcanic-epithermal	Griswold (1961), Gates (1985)
Hermanas (Y)	S22 28S 11W	31° 51' 1"	107° 57' 7"	Au, Ag, Cu	30 ft shafts, pits	volcanic-epithermal	Gates (1985)
unknown (S,T,HH,GG,X)	NW33 28S 11W	31° 50' 5"	107° 58' 21"	Au, Ag	pits, 30 ft shaft, adit	volcanic-epithermal	Gates (1985)
unknown (CC,Z,AA)	NW28 28S 11W	31° 50' 48"	107° 58' 3"	Au, Ag	pit	volcanic-epithermal	Gates (1985)
Hermanas Thunder-Egg	16,17 28S 11W	31° 52' 45"	107° 58' 40"	agate, geodes	pits	igneous	Griswold (1961)
Baker Egg No. 1 placer	17 28S 11W	31° 52' 35"	107° 58' 41"	agate, quartz geodes	pits	igneous	Hatton et al. (1994)
unknown (DD)	SE20 28S 11W	31° 51' 3"	107° 58' 45"	Au, Ag	pit	volcanic-epithermal	Gates (1985)
unknown (II)	SW21 28S 11W	31° 51' 19"	107° 58' 61"	Au, Ag	20 ft shaft	volcanic-epithermal	Gates (1985)
unknown (O)	S33 28S 11W	31° 49' 33"	107° 58' 8"	Au, Ag	pit	volcanic-epithermal	Gates (1985)
Mine Tank	W7 27S 13W	31° 58' 21"	108° 12' 41"	Cu?	100 ft shaft	volcanic-epithermal	Varnell (1976)
Burdick	27 27S 12W	31° 55' 47"	108° 3' 18"	Cu, Au, Ag	2 shafts (less than 100 ft deep)	volcanic-epithermal	Griswold (1961)
unknown	SE16 28S 12W	31° 52' 15"	108° 4' 6"	Cu	shaft, pits	volcanic-epithermal	—
unknown	SE2 27S 13W	31° 58' 49"	108° 7' 59"	Cu?	pits	Rio Grande Rift	—
Lucky	2 27S 13W	31° 59' 11"	108° 8' 15"	Pb, Cu	2 shafts (less than 100 ft deep), pits	Rio Grande Rift	Griswold (1961), Varnell (1976)
unknown	SW2 27S 13W	31° 58' 58"	108° 8' 41"	Cu?	pit	Rio Grande Rift	Varnell (1976)
Klondike Hills	22, 23 26S 3W	32° 1' 47"	108° 8' 54"	Cu	shafts, trenches	Rio Grande Rift	Griswold (1961), Rupert (1986)
unknown	NE27 26S 13W	32° 1' 10"	108° 9' 28"	Cu	60 ft shaft	Rio Grande Rift	Rupert (1986), Thorman and Drewes (1981)
unknown	NW27 26S 3W	32° 1' 12"	108° 9' 49"	Cu	pit	Rio Grande Rift	Rupert (1986)

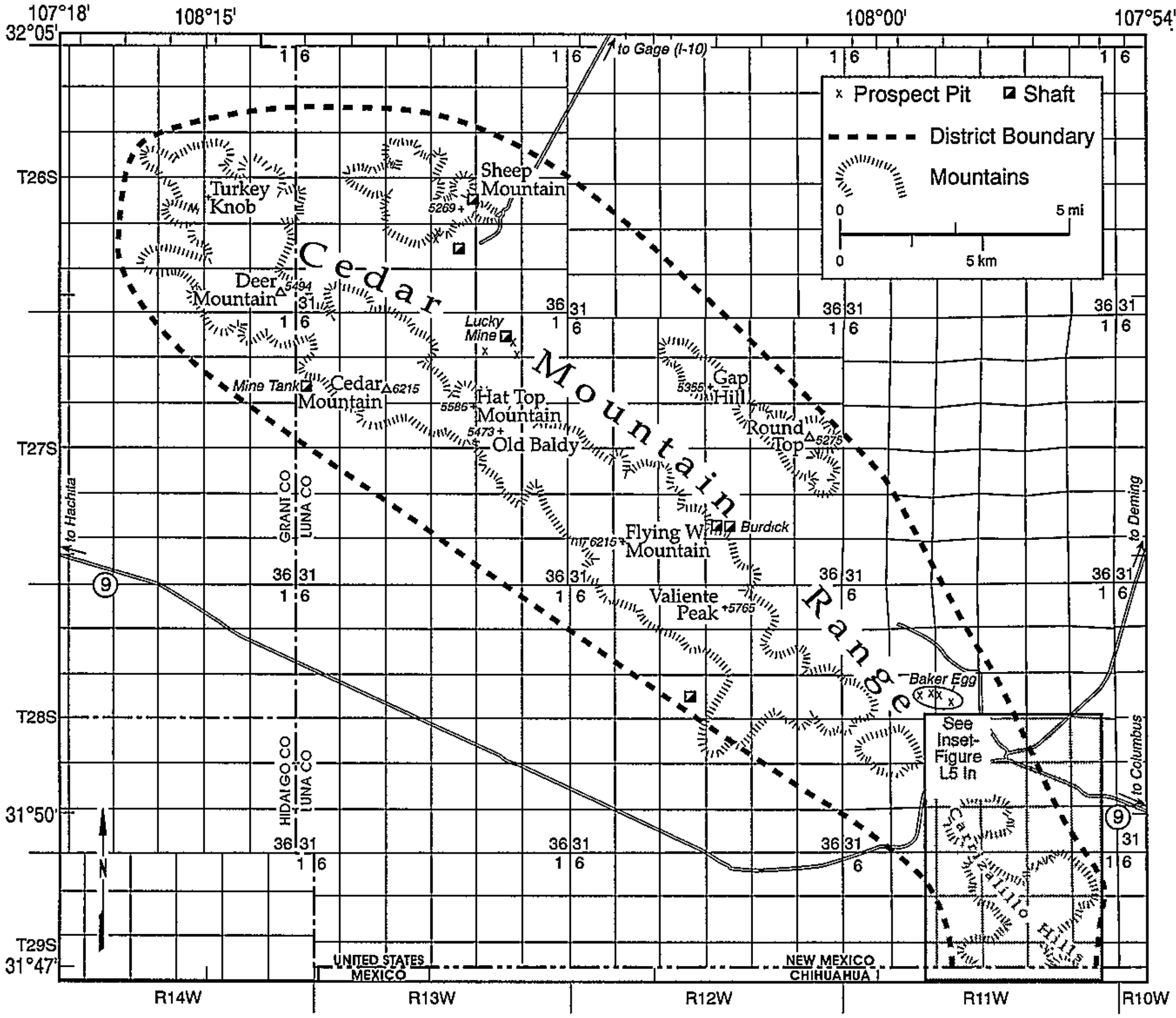

Figure 20—Mines and prospects in the Carrizalillo mining district, Luna County, New Mexico.

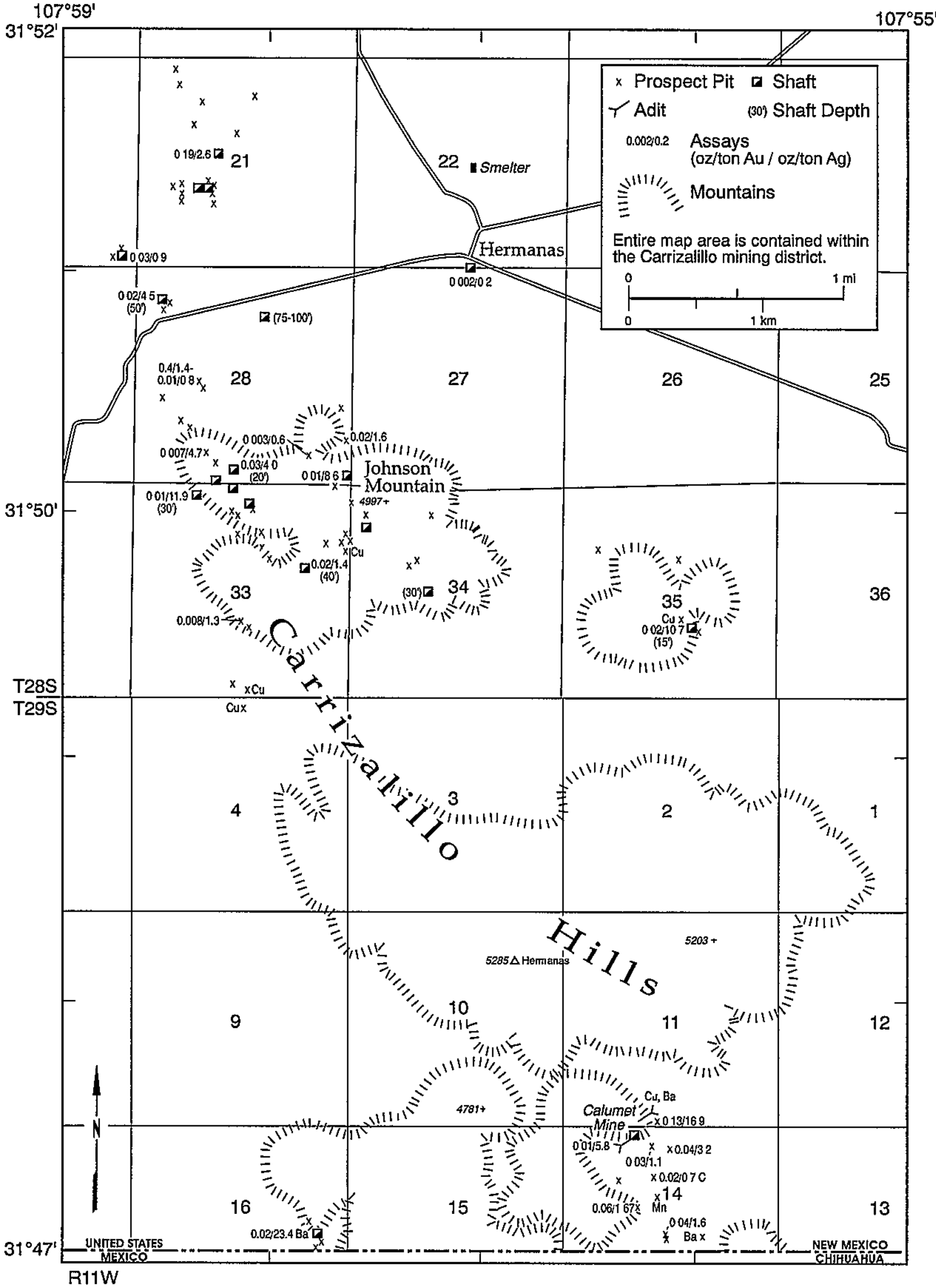

Figure 21—Mines and prospects in the Carrizalillo Hills, southern Carrizalillo mining district, Luna County, New Mexico (chemical analyses from Gates, 1985).

Geology

The Carrizalillo Hills and Cedar Mountains consist predominantly of Tertiary calc-alkaline basaltic and andesitic flows, rhyolitic ash-flow tuffs, and volcanic breccias, tuffs, and andesite flows (Griswold, 1961; Bromfield and Wruke, 1961; Varnell, 1976; Thorman and Drewes, 1981; Gates, 1985; Seager and Clemons, 1988). Calc-alkaline, peraluminous rhyolite dikes and domes have intruded the volcanics. The ash-flow tuffs are outflow sheets from distal calderas. In the southern Cedar Mountains and Klondike Hills, Cambrian-Ordovician through Cretaceous sandstones, shales, and limestones are exposed (Griswold, 1961; Varnell, 1976). The Cedar Mountains form a homocline that is offset by normal faults. Faulting is predominantly northwest, except in the vicinity of the rhyolite domes. In the Klondike Hills, Proterozoic granite dated as 1390 Ma (Rb-Sr) is overlain by Cambrian through Cretaceous sedimentary rocks (Rupert, 1986; Rupert and Clemons, 1990).

Mineral deposits

Small, discontinuous volcanic-epithermal vein and Rio Grande Rift deposits occur scattered throughout the area (Fig. 20, 21). Volcanic-epithermal quartz veins and stringers with local galena, chalcopyrite, and sphalerite fill faults and occur along the contacts of rhyolite and andesite dikes in the Carrizalillo Hills. The largest deposit is the Calumet mine which accounts for most of the production (Table 33); the veins occur along a rhyolite dike intuding andesite and contain malachite, limonite, quartz, manganese oxides, and calcite (Griswold, 1961; Gates, 1985). The vein strikes N20°W and dips 60°W and is less than 3 ft wide. Minor production also occurred from the Hermanas mine in 1946. Additional calcite veins occur in the area near the Johnson Ranch (Table 33). Assays of veins range as high as 0.18 oz/short ton Au, 16.88 oz/short ton Ag, and 35,200 ppm Cu (Gates, 1985). Quartz veins and breccia zones are up to 20 ft wide. Manganese oxides, quartz, calcite, chrysocolla, malachite, and azurite are common.

In the Cedar Mountains, the Lucky mine consists of carbonate-hosted Pb-Zn replacement and vein deposits along a north-east-trending fault in Paleozoic limestone (Griswold, 1961). Steeply dipping vein and replacement deposits contain galena, quartz, calcite, and malachite. Jasperiods are common.

In the Klondike Hills, localized zones in carbonate rocks belonging to the Hachita Formation (Mississippian) and Hitt Canyon Member of the El Paso Formation (Ordovician) are replaced by silica, copper, and lead minerals forming jasperiods, and are especially common along faults (Rupert, 1986).

Silicification and argillic alteration is widespread in the limestones, andesites, and rhyolites in the Carrizalillo district (Griswold, 1961; Varnell, 1976; Gates, 1985; Seager and Clemons, 1988), and may be responsible for a large, regional gravity low. Jasperiods occur as void fillings and replacement deposits in the Paleozoic limestones and locally contain trace amounts of pyrite, galena, barite, and malachite. Argillic alteration is characterized by chlorite, calcite, clays, quartz, and, locally, epidote. Silicification and potassic metasomatism also are associated with quartz-calcite veins, many of which carry gold and silver. Potassic alteration is characterized by K-feldspar, clays, sericite, chlorite, quartz, calcite, and iron oxides (Seager and Clemons, 1988). Argillic alteration increases in intensity towards many of the veins.

Reports of a molybdenum discovery in the area (Leonard, 1982) could not be confirmed, but the geology, alteration, and geochemistry suggests such a possiblity. Geochemical anomalies in the stream-sediment samples are scattered and low. Anomalous concentrations of As, Ba, Cd, Co, Cr, La, Mn, Sb, Th, and Y occur in stream-sediments from throughout the area.

Cooke's Peak district

Location and Mining History

The Cooke's Peak district, also known as the Jose district, is the most productive district in Luna County and is located in the Cooke's Range in northern Luna County (Fig. 1). Cooke's Peak was named after Captian Philip St. George Cooke, leader of the Morman Battalion that passed through the area in 1846-1847. The district is adjacent to and extends into the Cooke's Range Wilderness Study Area. The eastern group of deposits are known as the Cooke's subdistrict and the prospects on the western side are known as the Jose subdistrict. The district was discovered in 1876 and by 1900, approximately $3 million worth of ore was produced from carbonate-hosted Pb-Zn replacement and polymetallic vein deposits. Estimated total production from 1876 to 1965 is $4 million worth of lead, zinc, copper, silver, and gold, including >50 million lbs Pb and 7 lbs Zn (Table 34). The average grade produced from 1902 to 1947 was 15.3% Pb, 11.5% Zn, and 2.51 oz/short ton Ag (Griswold, 1961). In addition, 452 short tons of fluorite and 450 long tons of 33-46% Mn have been produced from carbonate-hosted deposits (Tables 4, 8; Rothrock et al., 1946; Elston, 1957; Farnham, 1961). Newmont Exploration Ltd. examined the district in the late 1980s and drilled several holes; the results of their exploration program are unknown.

TABLE 34—Reported metal production from the Cooke's Peak district, Luna County (from U.S. Geological Survey, 1902-1927; U.S. Bureau of Mines, 1927-1990; Jicha, 1954). — none reported.

YEAR	ORE (SHORT TONS)	COPPER (LBS)	GOLD (OZ)	SILVER (OZ)	LEAD (LBS)	ZINC (LBS)	TOTAL VALUE ($)
1902	1,778	—	—	9,275	663,300	—	31,176
1903	2,050	—	—	5,748	1,343,361	—	—
1904	1,078	—	—	4,401	576,795	—	27,355
1905	846	—	—	5,199	463,956	—	24,977
1906	1,133	—	—	7,519	627,544	—	40,883
1907	811	—	615	4,739	592,151	—	47,225
1908	253	—	—	1,009	127,535	—	5,891
1909	695	46	—	4,317	597,488	—	27,943
1910	457	47	—	1,917	242,137	—	11,695
1911	45	—	—	200	32,638	—	1,575
1912	927	—	—	960	142,680	433,129	36,897
1913	1,271	1,395	—	1,248	255,901	695,697	51,189
1914	1,995	2,181	302	2,423	381,324	793,585	57,043
1915	1,352	—	7	432	64,382	647,210	83,506
1916	2,562	—	—	433	56,275	1,390,119	190,444
1917	2,330	99	1	3,602	272,140	1,067,853	135,340
1918	1,252	3,150	1.5	1,947	156,549	463,445	56,046
1919	122	941	—	745	26,473	31,575	4,717
1920	136	2,223	.5	1,322	52,738	21,098	7,788
1921	—	—	—	—	—	—	—
1922	81	1,130	—	72	9,087	24,228	2,106
1923	8	13	—	15	1,988	—	153
1924	454	573	—	1,658	152,199	—	13,432
1925	1,740	1,200	5.3	2,657	416,230	119,300	47,402
1926	319	242	—	492	106,500	42,000	12,011
1927	1,006	367	12	1,334	162,238	—	11,283
1928-1931	—	—	—	—	—	—	—
1933	28	—	.29	143	20,000	—	796
1934-1935	—	—	—	—	—	—	—
1936	3	—	—	7	1,000	—	51
1937	6	—	.11	13	1,300	—	91
1938	50	—	--	393	46,700	—	2,402
1939	106	800	2	595	54,000	9,000	3,563
1940	152	--	—	152	27,000	49,000	4,545
1941	45	200	—	218	26,400	—	1,684
1942	17	—	14	97	11,000	—	1,296
1943-1946	—	—	—	—	—	—	—
1947	77	—	—	95	15,900	—	2,376
1948	408	—	—	326	58,000	—	10,677
1949	69	—	—	221	38,000	—	6,204
1950	5	—	—	9	2,000	—	278
1951	2,714	6,000	10	2,939	456,000	495,400	173,513
1952	749	2,000	3	1,201	189,500	187,000	63,228
1953	12	—	—	63	4,000	—	581
1954	3	—	—	19	—	—	17
1955	—	—	—	—	—	—	—
1956	4	—	—	101	9,300	—	1,551
TOTAL 1902-1956	29,159	22,607	672	70,862	8,483,509	6,469,702	1,248,506
ESTIMATED TOTAL 1876-1965	—	23,000	<1,000	71,000	50,000,000	7,000,000	4,000,000

Geology

Paleozoic through Cretaceous sedimentary rocks unconformably overlie Proterozoic granite in the district (Jicha; 1954); the mineral deposits are predominantly in the Fusselman Dolomite (Silurian), beneath the Percha Shale (Devonian). The sedimentary rocks in the district form a plunging anticline. Cooke's Peak consists of intrusive granodiorite porphyry which has been dated as 38.8±1.4 Ma (biotite, K-Ar; Loring and Loring, 1980); dikes radiate outwards from the center. Fractures in the Cooke's Peak district parallel some of these dikes.

Mineral Deposits

The major deposits of the Cooke's Peak district are carbonate-hosted Pb-Zn replacements and veins (Table 35) and occur along northeast-trending fractures in the Fusselman Dolomite (Silurian) beneath jasperiod bodies and/or the Percha Shale. Locally, the shale is iron-stained and silicified. The jasperiods contain fluorite, calcite, quartz, and locally pyrite and cerussite. The ore bodies range in shape from irregular, tabular to kidney-shaped (mantos) to pipe-like (chimneys); most bodies are small and less than 100 ft long, 50 ft wide, and as much as 20 ft thick (Jicha, 1954). They are controlled by faults, fractures, and, locally, anticlinal folds. Veins along faults are common in the western portion of the district and locally widen into tabular replacement bodies (Elston, 1957). Individual mines rarely produced more than 2,000 short tons of ore (Table 36). The primary ore minerals are galena and sphalerite in a gangue of pyrite, fluorite, and ankerite (Jicha, 1954). Oxide minerals include cerussite, smithsonite, and anglesite. Plumbojarosite was discovered in the district in 1905 (Clarke et al., 1905). Lead typically exceeds zinc and copper in abundance in most mines in the district. However, ore at the Summit mine averaged 16% Pb, 23% Zn, and 1.7 oz/short ton Ag (NMBMMR file data). The upper levels were oxidized and have been completely mined out. Silicification, known as jasperiods, is prevalent in the district and surrounds most ore bodies; brecciation and recementation are common.

Small pockets of ore, typically as polymetallic veins, occur in the granodiorite porphyry and in the Sarten Sandstone (Cretaceous). They contain quartz, pyrite, calcite, chalcopyrite, galena, and sphalerite. These veins were generally higher grade than the carbonate-hosted deposits, but much smaller in size (Jicha, 1954). Disseminations of sulfides, typically pyrite and chalcopyrite, are locally present in the granodiorite.

Fluorite and manganese are common in the district. The Lookout and Section 27 mines were produced for fluorite (Table 35). The Ruth was the most productive manganese mine. Placer manganese deposits in the southern part of the district were worked in 1959 by Q.M. Drunzer (Griswold, 1961).

Most exploration in the district concentrated on extending known ore bodies. Much of the Fusselman Dolomite west of the district may have potential, especially beneath the Percha Shale and in the vicinity of jasperiods (Jicha, 1954); drilling is required to assess the potential. Local Ba, Be, Cr, and Mn anomalies occur in stream-sediment samples from the area.

TABLE 35—Mines and prospects from the Cooke's Peak mining district, Luna County, New Mexico. Only mines and prospects with known locations are listed. Location includes section, township, and range.

MINE NAME (ALIAS)	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
Section 13 (unknown)	13 21S 9W	32° 28' 52", 107° 43' 16"	Au	pit	polymetallic vein	NMBMMR file data
Hope, Faith, & Constant	25 N36 20S 9W	32° 32' 11", 107° 43' 36"	Pb, Zn, Cu, Ag	shafts, pits	polymetallic vein	NMBMMR file data
Section 27 prospect	NW of SW 27 20S 9W	32° 32' 13", 107° 45' 53"	F	50 ft long by 30 ft deep open-cut	fluorite veins	Williams (1966), Elston (1957)
Rimrock 1,2,3,4	N14 20S 9W	32° 32' 27", 107° 44' 41"	Ag, Cu, Pb	shafts, pits	carbonate-hosted Pb-Zn replacement	NMBMMR file data
Contention Group	24 20S 9W	32° 33' 15", 107° 43' 29"	Au, Ag, Cu, Pb, Zn	shafts, pits	carbonate-hosted Pb-Zn replacement	NMBMMR file data
Mickey (Big Lead-Silver)	24 20S 9W	32° 33' 16", 107° 43' 22"	Pb, Ag	shafts, pits	carbonate-hosted Pb-Zn replacement	NMBMMR file data
Desdemona Group (ASARCO, Mahoney, Othello, Monte Cristo, Suprise, Webster, Bryan)	NE24 20S 9W	32° 33' 22", 107° 43''' 12"	Pb, Zn, Ag, Cu, Au	many shallow shafts, adits, opencuts, trenches, pits	carbonate-hosted Pb-Zn replacement	Lindgren et al. (1910), Jicha (1954), Griswold (1961), NMBMMR file data
Webster (incl. Bryan)	N1/2 24 20S 9W	32° 33' 24", 107° 43' 30"	Pb, Ag	several shallow surface opencuts	carbonate-hosted Pb-Zn replacement	NMBMMR file data
Cooks section	13 & 24 20S 9W	32° 33' 25", 107° 43' 14"	Pb, Zn, Ag	shallow shafts and adits	carbonate-hosted Pb-Zn replacement	NMBMMR file data
Monte Cristo, Othello, and Desdemona	NE24 20S 9W	32° 33' 28", 107° 43' 19	Ag, Cu, Pb	shafts, pits	carbonate-hosted Pb-Zn replacement	NMBMMR file data
Tillous Mine (Lonesome Peach no 2 claim)	NW23 20S 9W	32° 33' 29", 107° 44' 46"	Pb, Zn	shafts, pits	carbonate-hosted Pb-Zn replacement	NMBMMR file data
Busted Banker (Summit and U.S. Depository)	NW24, SW14 20S 9W	32° 33' 35", 107° 43' 52"	Pb, Ag	numerous shallow shafts and pits	carbonate-hosted Pb-Zn replacement	NMBMMR file data
Surprise (Mahoney Shaft #1)	N24 20S 9W	32° 33' 36", 107° 43' 29"	Ag, Pb	shafts, pits	carbonate-hosted Pb-Zn replacement	NMBMMR file data

MINE NAME (ALIAS)	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
Grand Central	13,24 20S 9W	32° 33' 40", 107° 43' 40"	Au,Ag,Pb	numerous shallow shafts and pits	carbonate-hosted Pb-Zn replacement	NMBMMR file data
Ethel Group	13 20S 9W	32° 33' 45", 107° 44' 01"	Ag, Pb	shafts, pits	carbonate-hosted Pb-Zn	NMBMMR file data
85 (Ethel mine)	SW1/4 14 20S 9W	32° 33' 46", 107° 44' 55"	Pb, Zn, Ag, Cu, Au	many shallow shafts and pits, some adits	carbonate-hosted Pb-Zn replacement	NMBMMR file data
Summit Group (Summit, US Depository, Busted Banker)	SW13 20S 9W	32° 33' 47", 107° 43' 46"	Pb, Zn, Ag, Cu	several shallow shafts and adits	carbonate-hosted Pb-Zn replacement	Lindgren et al. (1910), Jicha (1954), NMBMMR file data
Montezuma	SW13 20S 9W	32° 33' 50", 107° 43' 46"	Ag, Cu, Pb	shafts, pits	carbonate-hosted Pb-Zn replacement	NMBMMR file data
Inez (McDaniels Group, Inez, Vision, Day Dream)	SW13 20S 9W	32° 33' 54", 107° 43' 42"	Pb, Ag, Zn, Cu, Au	several shallow shafts and adits	carbonate-hosted Pb-Zn replacement	Jicha (1954)
Faywood (Faywood Lead Co Mine, John Dennis, Reithel, Onstett)	SW14 20S 9W	32° 33' 55", 107° 44' 40"	Pb, Zn, Ag	several shallow shafts and short adits	carbonate-hosted Pb-Zn replacement	Lindgren et al. (1910), Jicha (1954), NMBMMR file data
Gladys	W13 20S 9W	32° 34' 04", 107° 43' 54"	Pb, Ag	shafts, pits	carbonate-hosted Pb-Zn replacement	NMBMMR file data
Lookout Mountain	14 20S 9W	32° 34' 13", 107° 44' 09"	Pb, Zn, Ag, Au	shafts, pits	carbonate-hosted Pb-Zn	NMBMMR file data
Lookout (Bond Prospects)	SE11 NW13 20S 9W	32° 34' 35", 107° 44' 05"	F, Pb, U, Au, Ag, Cu	a small pit	carbonate-hosted Pb-Zn	Rothrock et al. (1946), McLemore (1983)
Ironclad Group	S5 20S 8W	32° 35' 30", 107° 41' 12"	Mn	shafts, pits	carbonate-hosted Mn	Farnham (1961)
Nunn (Black Hawk)	NE1/4 5 20S 8W	32° 36' 09", 107° 40' 50"	Mn	shafts, pits	carbonate-hosted Mn	Farnham (1961), NMBMMR file data
unknown	27 19S 9W	32° 37' 33", 107° 46' 01"	F	shafts, pits	fluorite veins	NMBMMR file data
Section 21 (unknown)	21 19S 9W	32° 38' 20", 107° 46' 25"	F	shafts, pits	fluorite veins	NMBMMR file data

TABLE 36—Metal production from individual mines in the Cooke's Peak district, Luna County, New Mexico (Jicha, 1954; NMBMMR file data). Jicha (1954) listed some mines under their alais name; those mines are included under the accepted name used in Table 35. Location includes section, township and range. ? location unknown. — no production.

MINE	LOCATION	PERIOD	ORE (short tons)	GOLD (oz)	SILVER (oz)	COPPER (lbs)	LEAD (lbs)	ZINC (lbs)
Busted Banker	24, 14 20S 9W	1941	12	—	43	111	7,109	—
Gladys	12,13 20S 9W	1941-1947	51	—	52	44	9,085	—
Desdemona	24 20S 9W	1904-1942	9,073	9.5	14,974	2,271	2,214,698	2,984,645
Lookout	14 20S 9W	1938-1942	71	0.85	541	—	61,970	10,888
Contention	24 20S 9W	1904-1918	1,488	0.2	1,412	3,292	108,944	880,531
Inez	13 20S 9W	1904-1927	1,756	11.62	3,292	2,647	637,812	105,327
Summit	13 20S 9W	1904-1949	3,325	0.34	5,594	140	1,063,802	1,530,888
Poe	?	1914	922	3.18	1,274	481	307,973	481,553
Mickey	24 20S 9W	1941-1942	29	—	159	—	27,417	—
Old Commodore	?	1910-1912	27	—	171	—	29,195	—
Hope, Faith, and Constant	25,36 20S 9W	1909-1919	63	—	675	—	50,399	—
White Oaks	?	1906-1908	301	—	3,102	—	386,878	—
West Side	?	1912	55	—	49	—	7,382	—
Clara K	?	1911-1912	29	—	126	—	21,634	—
Sycamore, Burrell and Florida	?	1923-1924	19	—	37	16	4,640	—
Little Mary	?	1918	13	—	51	—	8,931	—
85 Group	14 20S 9W	1936-1947, 1949	148	14.95	590	188	89,781	17,159
Faywood	14 20S 9W	1904-1937	2,371	0.39	13,899	12	1,285,402	239,442
Sunny Slope	?	1909	15	0.15	39	4,917	—	—
Rimrock	?	1948-1956	234	—	391	149	61,679	—
Mocking Bird	?	1902	100	—	115	—	18,500	—
Montezuma	13 20S 9W	1947-1948	7	—	1	8	1,971	—
Goodwill	?	1947-1948	214	—	124	29	22,807	—

Florida Mountains district

Location and Mining History

The Florida Mountains district, discovered in 1876, is located east of Deming (Fig. 1) and includes only the main Florida Mountains, south of Florida Gap. The district is adjacent to the Florida Mountains Wilderness Study Area. From 1880 to 1956, 5,000 lbs Cu, <10 oz Au, 8,000 oz Ag, and >30,000 lbs Pb worth approximately $102,000 were produced from carbonate-hosted Pb-Zn replacement and polymetallic vein deposits in the district (Table 37). The Mahoney and Silver Cave mines are the largest metal producers. In addition, 200 short tons of fluorite and 1,421 long tons of 22-30% Mn have been produced from epithermal veins in the area (Tables 4, 8; Rothrock et al., 1946; Farnham, 1961). Manganese was mined from veins on the southeast slopes during the Government purchasing program in the 1950s.

TABLE 37—Reported metal production from the Florida Mountains, Luna County (from U.S. Geological Survey, 1902-1927; U.S. Bureau of Mines, 1927-1990; Griswold, 1961). — none reported.

YEAR	ORE (SHORT TONS)	COPPER (LBS)	GOLD (OZ)	SILVER (OZ)	LEAD (LBS)	TOTAL VALUE ($)
1934	38	200	—	170	15,000	681
1935	—	—	—	—	—	—
1936	19	100	0.20	80	4,200	271
1937	22	1,850	0.12	6,100	4,780	478
1948	2	—	—	12	2,000	369
1956	35	2,000	—	29	—	876
TOTAL 1934-1956	116	4,150	0.32	6,391	25,980	2,675
ESTIMATED TOTAL 1880-1956	—	5,000	<10	8,000	>30,000	102,000

Geology

The Florida Mountains form the northern portion of the Laramide thrust belt as defined by Drewes (1991b) and are along the Texas lineament. Rocks in the area consist of Paleozoic through lower Tertiary sedimentary rocks overlying Proterozoic and Cambrian granite and syenite plutons (Clemons and Brown, 1983; Clemons, 1984). Tertiary rhyolite, diorite, and andesite intrudes the older lithologies; a rhyolite west of Florida Peak was dated as 29.1±1.3 Ma (feldspar, K-Ar; Clemons and Brown, 1983). Laramide tilting, thrusting and uplift, followed by Tertiary basin and range uplift have deformed the rocks. The district coincides with gravity and magnetic highs.

Mineral Deposits

Carbonate-hosted Pb-Zn replacement deposits occur throughout the district (Table 38). The carbonate-hosted deposits are typically in Fusselman Dolomite and follow fracture and/or fault zones. The deposits occur as fissure veins or manto-replacement bodies that contain smithsonite, cerussite, malachite, azurite, barite, quartz, calcite, and local galena and sphalerite (Griswold, 1961). Lead typically exceeds zinc and copper in abundance. The deposits are typically small, less than 5 ft wide and several hundred feet long.

Polymetallic veins also occur along fractures and faults within Proterozoic granite, Cambrian syenite, and Tertiary agglomerate (Table 38). The Park mine occurs along a fault separating Proterozoic granite and Paleozoic sedimentary rocks. Production from these veins has been small, but locally, they are higher in grade than the carbonate-hosted Pb-Zn replacement deposits. The veins are typically less than 5 ft wide, several hundred feet long, of variable dips, and contain quartz, pyrite, calcite, iron and manganese oxides, chalcopyrite, and local galena, sphalerite, fluorite, and barite.

Fluorite occurs as veins, void filllings, and replacements of limestones (Table 38). Breccias and jasperiods are common. Most of the fluorite veins and fissures occur along faults and fractures. Fluorite and quartz are the predominant minerals in a gangue of calcite, clay, and rare barite and pyrite. Fluid inclusion data of fluorite from the Florida Mountains indicates formation from low temperature (146-194° C) and low salinity (6.2-8.4 eq. wt.% NaCl) fluids, suggesting a meteoric origin (North and Tuff, 1986).

The Waddell Atir mine was first prospected in 1910 (Williams et al., 1964), but there is no reported production. In 1980, Barite Corporation of America drove a 775-ft long adit to intersect the vein, but did not find enough ore to produce. The vein strikes N60°E and dips 55°SE and consists of barite, fluorite, galena, calcite, and quartz. It is 5-12 ft wide and 200 ft long and occurs in Cambrian syenite. A sample assayed 41% $BaSO_4$, 19.7% CaF_2, and 1.8% Pb (Williams et al., 1964).

Epithermal and carbonate-hosted manganese deposits occur throughout the Florida Mountains. The veins and replacements are typically small; veins are generally less than 3 ft wide and the largest replacement deposits at the Birchfield mine are only 8 ft wide. The deposits follow bedding planes which strike northeast. Locally, the deposits form cross cutting pipe-like bodies, i.e. chimneys.

The potential for additional barite-fluorite and manganese deposits in the Florida Mountains is probably good, but not likely to be produced in the near future because of poor market conditions. Additional carbonate-hosted Pb-Zn and vein deposits are likely to be found along strike of most deposits. Areas of alluvial cover should also be examined. Anomolous As, Ba, Be, Cd, Cr, Cu, La, Mn, Nb, Pb, Sn, Th, Y, and Zn occur in stream-sediment samples from the area.

TABLE 38—Mines and prospects in the Florida Mountains, Luna County, New Mexico. Location includes section, township, and range.

MINE NAME	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	YEARS OF PRODUCTION	DEVELOPMENT	PRODUCTION	TYPE OF DEPOSIT	REFERENCES
Anniversary	SW1 26S 8W	32° 04' 23", 107° 36' 51"	F	1970	pits	200 short tons 60% fluorite	barite-fluorite veins	McAnaulty (1978)
Big Pocket	SE13 26S 8W	32° 2' 30", 107° 36' 7"	Mn	?	pits	8 short tons 25% Mn	epithermal manganese	NMBMMR file data
Birchfield Mn (San-Tex, Birchfield Group)	SE31, SW32 25S 7W	32° 05' 11", 107° 35' 34"	Mn	1942 - 1958	1 long adit, 2 shafts, pits, trenches	1,420 short tons 25% Mn	carbonate-hosted Mn replacement	Griswold (1961), Farnham (1961)
Birchfield Zinc	SW32 25S 7W	32° 05' 11", 107° 34' 18"	Zn, Mn, Ag	late 1940s	pits	small	carbonate-hosted Pb-Zn replacement	Griswold (1961)
Bradley (Edna Belle, Lead Carbonate, Soldedad, Bear)	SE18 25S 7W	32° 07' 37", 107° 35' 52"	Pb, Ag, Cu (Zn)	1903 - 1930	2 shallow shafts, adit, pits	small	polymetallic vein	Griswold (1961), Clemons (1982), NMBMMR file data
Copper Queen	SW14 26S 7W	32° 3' 10", 107° 36' 10"	Pb, Ag, Zn	?	shaft, pits	unknown	polymetallic vein	Clemons (1984)
Granada (Georgia Bell)	18 & 19 25S 7W	32° 7' 10", 107° 36' 10"	Ag, Cu	1904	pits	<300 short tons Cu, Ag	polymetallic vein	Clemons and Brown (1983), Brown (1982)
Lobo	SE19 25S 7W	32° 6' 50", 107° 36' 20"	Cu	?	pits, shaft	unknown	polymetallic vein	NMBMMR file data
Lucky John (Mahoney)	W1 26S 8W	32° 04' 32", 107° 36 44"	Zn, Pb, Ag, (Cu)	1916 - 1927	1 long adit, shafts, many trenches and prospect pits	1390 short tons 5.8 oz/short ton Ag, 24% Pb, 33% Zn	carbonate-hosted Pb-Zn replacement	Griswold, (1961), Clemons and Brown (1983)
Priser	SE12 26S 8W	32° 33' 30", 107° 36' 44"	Mn, F	?	pits, adit	unknown	polymetallic veins	Clemons and Brown (1983)
San Antonio (Sunrise, Sunset)	SE10 25S 8W	32° 08' 30", 107° 39' 12"	Pb, Ag, (Zn)	last in 1947	short adit, prospect pits	small	carbonate-hosted Pb-Zn replacement	Griswold (1961), Clemons (1984)
Shaw	35 25S 8W	32° 5' 10", 107° 38' 15"	Cu	none	adit	none	polymetallic vein	NMBMMR file data
Silver Cave (Cave mine, Pocohonta)	7 26S 7W, 12 8W	32° 03' 17", 107° 36' 07"	Pb, Ag, (Zn)	1881-1885	inclined shaft, vertical shaft, pit, adit	1,800 short tons worth $60,000	carbonate-hosted Pb-Zn replacement	Griswold (1961), Darton (1916), Brown (1982)
Silver Cane	12 26S 8W	32° 3' 20", 107° 36' 10"	Pb, Ag, Zn	?	pits	unknown	carbonate-hosted Pb-Zn replacement	NMBMMR file data
Stenson (Alabama, Georgia, S. Carolina, Western, Sunny Slope)	SW14 25S 8W	32° 07' 48", 107° 38' 33"	Cu, Ag	last in 1956	3 adits and a shaft	small	polymetallic vein	Griswold (1961), Lindgren et al. (1910), Clemons (1984)

MINE NAME	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	YEARS OF PRODUCTION	DEVELOPMENT	PRODUCTION	TYPE OF DEPOSIT	REFERENCES
Stubb	NW18 25S 7W	32° 8' 5", 107° 36' 45"	Mn	?	shafts	unknown	epithermal manganese	Clemons (1982)
The Park (Hilltop Claim)	SE35 25S 8W	32° 05' 05", 107° 38' 09"	Zn, Pb	none	2 short adits, pits	none	carbonate-hosted Pb-Zn replacement	Griswold, (1961)
unknown	NE2 25S 8W	32° 9' 59", 107° 38' 32"	Mn?	?	shaft	unknown	epithermal manganese	NMBMMR file data
unknown	NE NE 6 26S 7W	32° 4' 55", 107° 35' 10"	Mn	?	pits	unknown	epithermal manganese	NMBMMR file data
unknown	NW9 26S 8W	32° 3' 45", 107° 39' 55"	Cu	none	pit	unknown	polymetallic vein	Clemons (1984)
Waddell Atir (Waddell Prospect, Atir)	SE24 25S 8W	32° 06' 50", 107° 37' 17"	Pb, Ba, F	none	90 ft adit, 775 ft adit	none	fluorite veins	Williams (1966), Williams et al. (1964)
Wet King (Pacheco, South Side, Wet King)	NE 23, NW 24 26S 8W	32° 01' 13", 107° 37' 10"	Mn	World War I - 1955	2 shafts, several pits and trenches	806 short tons 21% Mn	epithermal manganese	Griswold (1961), Farnham (1961)
White King (San-Tex)	NE31 25S 7W	32° 05' 43", 107° 36' 04"	Mn	WWII, 1950s	pit, shaft	small tonnage during WWII and in 1950s	epithermal manganese	Farnham (1961)

Fluorite Ridge district

Location and Mining History

The Fluorite Ridge mining district is located approximately 10 mi north-northeast of Deming, south of Cooke's Peak, and is south of the Cooke's Range Wilderness Study Area (FFFig. 1). The deposits occur in two areas: Lower Camp in the southeast and the Upper Camp in the central part of the ridge. The district also includes the hills to the south that contain manganese deposits and Goat Ridge to the west. The district was discovered in 1907 and production began in 1909. Three types of deposits occur in the district: Rio Grande Rift barite-fluorite-galena deposits, epithermal fluorite veins, and epithermal manganese veins. There has been no base- or precious-metal production from the district. Fluorite production from 1909 to 1954 was 93,827 short tons (Table 39). The Saddler and Greenleaf mines are the largest fluorite producers. Much of the ore was shipped to Deming. Less than 1,000 short short tons of low-grade manganese ore has been produced from the southern part of the district, primarily from the Ruth and Starkey mines (Table 39).

TABLE 39—Mines and prospects from the Fluorite Ridge mining district, Luna County, New Mexico. Location includes section, township, and range.

MINE NAME	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	YEARS OF PRODUCTION	DEVELOPMENT	PRODUCTION	TYPE OF DEPOSIT	REFERENCES
Lucky Bullet (Black Bird)	28 22S 8W	31°50' 34", 107°39' 43"	Mn	1953	pits	13.96 short tons Mn	epithermal manganese	Farnham (1961)
unknown	N35 22S 8W	32° 21' 10", 107° 38' 20"	Mn	unknown	pits, shafts	unknown	epithermal manganese	—
Ruth (Starkey)	S 28 & 33 22S 8W	32° 21'20", 107° 40' 20"	Mn	1950s	pits	with Starkey mine	epithermal manganese	Griswold (1961), Farnham (1961)
Starkey (Ruth, Liberty)	N33 22S 8W	32° 21' 20", 107° 40' 25"	Mn	1918-1959	60 cuts, adits, 3 shafts	830 short tons 34-46% Mn	epithermal manganese	Farnham (1961), Wells (1918)
Doubtful	SE21, NW27 22S 8W	32° 22' 20", 107° 40' 00"	Mn	1953-1954	5 pits, 80 ft shaft	28 long tons 35% Mn	epithermal manganese	Farnham (1961)
unknown	NW20 22S 8W	32° 22' 58", 107° 41' 47"	F	none	pit	none	fluorite veins	Clemons (1982)
Duke of Luxembourg	NE SE18 22S 9W	32° 23'10", 107° 43' 10"	F	none	100 ft shaft	with Greenleaf	fluorite veins	FN 6/30/95, NMBMMR file data

MINE NAME	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	YEARS OF PRODUCTION	DEVELOPMENT	PRODUCTION	TYPE OF DEPOSIT	REFERENCES
White Bluff	6, NW7 22S 8W	32° 23' 50", 107° 43' 39"	F	none	15 ft pits	none	fluorite veins	McAnulty (1978)
Gratton (Sadler, Deckart Shaft, Spar nos.1,2,3 claims)	NW12 22S 9W	32° 24' 44", 107° 43' 39"	F	1934 - 1951	434 ft shaft with levels, shallow shafts, pits	12,000 short tons fluorite	fluorite veins	Griswold (1961), Johnston (1928)
Goat Ridge	E32 21S 9W	32° 26' 08", 107° 47' 19"	F	none	prospect pits and exploratory trenches	none	Rio Grande Rift barite-fluorite	McAnaulty (1978)
Goat Ridge	4 22S 9W	32° 25' 50", 107° 47' 00"	travertine	?	pits	unknown	travertine	Griswold (1961)
Valley Mine	NW SW 17 22S 8W	32° 23' 25", 107°41' 47"	F	1949 - 1950	75 ft shaft, trenches	607 short tons fluorite	fluorite veins	Griswold (1961), Williams (1966), McAnulty (1978)
Greenleaf #1-4 (Howard Mine)	NE18 22S 8W	32° 23' 36", 107° 42' 24"	F	1939 - 1954	500 ft shaft with 8 levels (plugged)	41,900 short tons fluorite	fluorite veins	Griswold (1961), Rothrock et al.(1946), McAnulty (1978), Russell (1947a), FN 6/30/95
San Juan Mine	E2 of NW 18 22S 8W	32° 23' 42", 107° 42' 23"	F (Ba)	?	2 shafts 620 ft apart, at least 24 pits.	333 short tons fluorite	fluorite veins	Rothrock et al. (1946), Williams (1966), McAnulty (1978)
Sadler (Susan no. 1 claim)	NW18 22S 8W	32° 23'46", 107° 42' 46"	F, Zn	1909 - 1947	1,000 ft of drifts, crosscuts, tunnels, 2 shafts	34,283 short tons fluorite	fluorite veins	Griswold (1961), Williams (1966)
Hilltop Spar (Hilltop)	NE NE13 22S 9W	32° 23' 53 107° 43' 03	F	1949	4 vert shafts 75 ft deep 50 ft apart, 20 ft pit	36 short tons fluorite	Rio Grande Rift barite-fluorite	Rothrock et al. (1946), Williams (1966), McAnulty (1978)
Lucky Mine	NE NW 18 22S 8W	32° 23' 57" 107° 42' 31"	F	1943 - 1953	400 ft shaft, 4 levels with short drifts	1,663 short tons fluorite	fluorite veins	Williams (1966), Johnston (1928), McAnulty (1978)
Whitehill Prospect	NE12 22S 9W	32° 24' 38", 107° 43' 36"	F	?	20 ft vertical shaft	5 short tons fluorite	fluorite veins	Williams (1966), Rothrock et al. (1946)
Tip Top Prospect	S2 01, N2 12 22S 9W	32° 24' 49", 107°43' 27"	F	none	3 surface pits from 1.000 to 1.200 ft apart	Nnne	Rio Grande Rift barite-fluorite	Rothrock et al. (1946), Williams (1966), McAnulty (1978)
Greenspar (Grattan, Cox Prospect)	SE SE2 22S 9W	32° 24' 58", 107°44' 08"	F	1924 - late 1940s	110 ft vert shaft with working levels	3,000 short tons fluorite	fluorite veins	Rothrock et al. (1946), Williams (1966)

Geology

Fluorite Ridge consists predominantly of granodiorite porphyry, which is similar to the intrusive rock in the Cooke's Peak district that has been dated as 38.8±1.4 Ma (biotite, K-Ar, Loring and Loring, 1980; Clemons, 1982). A dike cutting the northern exposure of the porphyry on Fluorite Ridge has a date of 37.6±2.0 Ma (whole rock, K-Ar; Clemons, 1982). Griswold (1961) interpretes the Fluorite Ridge granodiorite porphyry to be a separate pluton from the Cooke's Peak porphyry, but the age determination of the cross cutting dike would suggest the two are of a similar age. The porphyry is surrounded by Proterozoic granite and Cambrian, Permian, Pennyslvanian, Cretaceous, and early Tertiary sedimentary rocks (Clemons, 1982). The entire district is faulted, and the sedimentary rocks form a dome with the granodiorite porphyry in the center.

Mineral Deposits

Numerous mines and prospects have developed the veins on Fluorite Ridge (Table 39). Most of the fluorite veins and fissures occur along faults and fractures; the largest veins occur at intersections of fault and fracture zones (Rothrock et al., 1946; Russell, 1947a). One group of faults strikes N17-27°E and the other group strikes N6°E-N18°W (Burchard, 1911). The Tip Top and Hilltop Spar deposits occur as fillings in solution cavities in the limestone (Table 39; Rothrock et al., 1946) and are typical of Rio Grande Rift barite-fluorite-galena deposits elsewhere in the state (McLemore and Barker, 1985; McLemore and Lueth, 1995, in press). In all deposits, fluorite and quartz are the predominant minerals in a gangue of calcite, clay, and rare barite and pyrite. Brecciation, crustification, vug filling, and recementation are common and consistent with an epithermal origin. The veins occur mostly in the granodiorite porphyry, but smaller veins do cut most of the lithologies on Fluorite Ridge. The veins range in size to as much as 20 ft wide and 100 ft long (Burchard, 1911; Rothrock et al., 1946). Grades in 1911 ranged from 60.9 to 95.6% CaF_2 by hand sorting (Burchard, 1911); lower grades were shipped in later years with less hand sorting.

Temperatures of homogenization in fluid inclusions of fluorites from the district range from 170 to 223°C and salitinites are less than 10 eq. wt.% NaCl (Hill, 1994). Geochemical, fluid inclusion, and stable-isotopic data indicate that the fluorite in the Fluorite Ridge district was formed from low salinity, low temperature meteoric fluids (Hill, 1994). Fluorite in Gila conglomerate and in a basaltic dike at the Gratton mine, indicates a late Tertiary or early Quaternary age of deposition (Griswold, 1961).

Most of the veins were never explored at depth and fluorite resources undoubtedly remain. Additional fluorite most likely occurs in the subsurface surrounding the ridge and in the area between the Greenleaf and Valley mines. Anomalous concentrations of As, Be, Ba, Cd, Cr, Cu, Mn, Pb, Th, Ti, and Zn occur in stream-sediment samples from the area, suggesting that the veins should be analyzed for potential base and precious metals, which could occur at depth.

Travertine occurs at Goat Ridge and could be quarried for local use.

Little Florida Mountains district

Location and Mining History

The Little Florida Mountains are northeast of the Florida Mountains; Florida Gap separates the two ranges (Fig. 1). Rock Hound State Park is in the southwestern part of the range. Two types of deposits occur in the district (also known as Black Rock): epithermal fluorite veins and epithermal manganese veins (Fig. 27). No precious or base metals have been produced from the district. Fluorite production, mostly from the Spar mine, is estimated as 13,428 short tons (McAnulty, 1978). Manganese production is reported as 19,527 long tons of ore and 21,393 long tons of concentrate (Table 8; Farnham, 1961). The Manganese mine was one of the larger manganese mines in the district (DeVaney et al., 1942). Production of manganese ceased in 1959 when the Federal government ended it's buying program. In 1923, a small mill was erected at the Luna mine for processing manganese, but the gravity concentration was not efficient and the mill closed.

Geology

The Little Florida Mountains consists predominantly of interbedded andesite, dacite, ash-flow tuff, rhyolite, and fanglomerate intruded by rhyolite domes and dikes (Lasky, 1940; Clemons, 1982). An ash-flow tuff, near the base of the stratigraphic section has been dated as 37.3±1.4 Ma (biotite, K-Ar; Clemons, 1982). A rhyolite near Rock Hound State Park has been dated as 23.6±1.0 Ma (whole rock, K-Ar; Clemons, 1982). Seismic data indicates that there is only 600 ft of volcanics in the subsurface.

Mineral Deposits

The deposits in the Little Florida Mountains consist of epithermal fluorite and manganese veins in fanglomerate and Tertiary volcanic rocks (Table 40). The fanglomerate is interpretated as being 23.6 Ma, similar in age as the rhyolite (Clemons, 1982); therefore mineralization is younger than 23.6 Ma. Silicification is common in breccias along faults (called jasperiods by Lasky, 1940).

Fluorite and barite occurs in veins along faults with manganese oxides, calcite, quartz, and rare pyrite and galena (Griswold, 1961; McAnulty, 1978). Most veins can be traced easily in outcrop by prominent silicified breccias. Local veins are as much as 6 ft thick; most are less than 3 ft thick. Brecciation, crustification, and silicification are common and indicative of an epithermal origin. The ore grades are estimated as 20-60% CaF_2 (Griswold, 1961). Barite is predominant at the Apache mine (sec. SE¼ 7, T24S, R7W); whereas fluorite is predominant at the Spar mine (sec. 7, 8, T24,S R7W). A sample at the Spar (Florida) mine assayed 74% $BaSO_4$ and 9.5% CaF_2 (Williams et al., 1964). The fluorite veins are typical of Rio Grande Rift deposits elsewhere.

The manganese veins occur along faults and fracture zones and as breccia cement in the fanglomerate and contain various manganese oxides. Few ore shoots contained more than 60,000 short tons of ore (Lasky, 1940). Most deposits decreased in size and grade at 200-400 ft depths and manganiferous calcite becomes more abundant (Farnham, 1961). The average grade is 15-20% Mn with varying amounts of silica, calcite, iron, phosphorus, and barite. Trace amounts of copper, lead, zinc, silver, and arsenic are present locally in some veins (Lasky, 1940); but can not be recovered economically.

Barite and fluorite can be mined in the Little Florida Mountains only if there is a local demand for these commodities. It is unlikely that manganese will be mined again in the Little Florida Mountains, even though manganese resources are still present, because of low grades and thin deposits. Lasky (1940) estimated that 550,000-1,000,000 short tons of manganese ore remains in reserves, but Farnham (1961) estimates remaining reserves are less than 75,000 short tons of 10-18% Mn. Anomolous concentrations of As, Ba, Be, Cd, Cr, Cu, La, Mn, Pb, Ti, and Zn are found in stream-sediment samples from the area.

Rock Hound State Park is one of the few state parks in the United States that allows collecting of rocks and minerals within the park boundaries. Visitors from throughout the United States collect agates, geodes, and jasper; total production from the park is unknown.

TABLE 40—Mines and prospects of the Little Florida Mountains mining district, Luna County, New Mexico. Location includes section, township, and range.

MINE NAME	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	YEARS OF PRODUCTION	DEVELOPMENT	PRODUCTION	TYPE OF DEPOSIT	REFERENCES
American no. 29 Claim	N18 24S 7W	32° 33' 30", 107° 35' 44"	Mn	1952-1955	pits, shaft	>487.7 long tons 21% Mn	epithermal manganese	Farnham (1961)
Apache (North End, Duryea)	SE7 24S 7W	32° 13' 57", 107° 35' 43"	F, Ba	1951-1953	pits	220 short tons	epithermal fluorite	Williams (1966)
Estrella	7 24S 7W	32° 14' 03", 107° 36' 00"	Mn	1953	pits, 15 ft shaft	2 short tons 13.5% Mn	epithermal manganese	Farnham (1961), Lasky (1940), FN 7/2/95
Fierro No. 1 (American No. 15)	E18 24S7W	32° 13' 14", 107° 35' 33"	Mn	1952-1955	pits, 150 ft shaft	8.5 short tons 32.5% Mn	epithermal manganese	Farnham (1961)
Fierro No. 2 (American No. 11)	SE18 24S 7W	32° 12' 58", 107° 35' 30"	Mn	1953	pits, 108 ft shaft	22 short tons	epithermal manganese	Farnham (1961)
Frederick Group	SW32 24S 7W	32° 10' 26", 107° 35' 07"	Mn	1953	pits, 2 100 ft shafts	6.7 short tons 21% Mn	epithermal manganese	Farnham (1961), Lasky (1940)
Killion	NE19 24S 7W	32° 12' 14", 107° 35' 27"	Mn	1920s-1939, 1944	pits, adits, inclined shaft	110 short tons	epithermal manganese	Griswold (1961), Farnham (1961), Lasky (1940)
Little Florida Mountains clay deposit	N5 25S 7W	32° 10' 00", 107° 34' 59"	Kaolin	unknown	pits	unknown	Residual deposit of clay in igneous rocks	Patterson and Holmes (1977), Lasky (1940)
Luna (American Group, Killion Mine, West mine)	S18 24S 7W	32° 12' 58", 107° 35' 57"	Mn	1928-1955	inclined shaft, vertical shaft, 5 levels, 2,000 ft drifts	8,105 short tons	epithermal manganese	Lasky (1940), Griswold (1961), FN 7/2/95
Manganese Valley Group (Pluto)	E19 24S 7W	32° 12' 12", 107° 35' 29"	Mn, Co	1918 -1957	adits, shafts with 4 working levels, 6,000 ft of drifts	32,704 short tons	epithermal manganese	Lasky (1940), Farnham (1961)
Muller	SW5 25S 7W	32° 9' 25", 107° 35' 01"	Mn	1955	20 ft shaft	few 10s short tons	epithermal manganese	Farnham (1961)
Pluto	NW29 24S 7W	32° 11' 40", 107° 35' 1"	Mn	none	pits	none	epithermal manganese	Lasky (1940)
Spar (Florida Fluorspar Mine, Duryea Claims)	SE7,SW8 24S 7W	32° 13' 51", 107° 35' 22"	F, Ba	1919-1951	1 vertical shaft, 2 inclined shafts, many pits and trenches	13,208 short tons	epithemal fluorite	Griswold (1961), Johnston (1928), Lasky (1940), Williams et al. (1964), McAnulty (1978), FN 7/2/95

Old Hadley district

Location and Mining History

The Old Hadley (or Graphic) district, sometimes described as part of the Cooke's Peak district (Griswold, 1961), is located east of the Cooke's Peak district in northern Luna County (Fig. 1). The district is adjacent to the Cooke's Range Wilderness Study Area. Production from 1880 to 1929 is estimated as 150 ounces gold, 550 ounces of silver, and minor copper, lead, and zinc from volcanic-epithermal veins (Table 2). ASARCO examined the district in the late 1980s and drilled at least one hole; the results of their exploration program are unknown.

Geology

The dominant rock in the district is the Macho andesite of Tertiary age which is overlain in places by the Rubio Peak Formation (Tertiary; Jicha, 1954). A latite tuff from the Macho andesite is dated as 40.7±1.4 Ma (biotite, K-Ar; Loring and Loring, 1980). Numerous faults cut the andesite. Silicification and argillic alteration is prominent; acid-sulfate alteration, characterized by alunite and kaolinite, is locally pervasive in Rattlesnake Canyon (Hall, 1978).

Mineral Deposits

Volcanic-epithermal veins occur in altered Macho andesite in the Old Hadley district (Table 41). The veins are steeply dipping, associated with gypsum and clay alteration, as much as 300 ft long, and typically less than 4 ft wide. Silicification is prevalent adjacent to the veins. The veins trend N0-15°W to N55-65°E and parallel faults and fracture zones. They contain chalcopyrite, galena, sphalerite, and oxidized minerals such as malachite, azurite, chrysocolla, cuprite, and melaconite in a gangue of quartz, barite, pyrite, iron oxides, sericite, chlorite, and other clay minerals (Jicha, 1954). Brecciation, silicification, vug filling, and recementation are common. The veins are similar to those in the Cooke's Peak district, except the Old Hadley veins contain more gold, barite, and quartz. Anomalous concentrations of As, Bi, Cd, Mo, Pb, Sn, U, and Zn occur in stream-sediment samples in the area and spotty concentrations of Ag and Sb are found locally.

TABLE 41—Mines and prospects in the Old Hadley mining district, Luna County, New Mexico. All of these deposits are volcanic-epithermal vein deposits. Location includes section, township, and range. FN—V. T. McLemore, unpublished field notes.

MINE NAME/ ALIAS	LOCATION	LATITUDE	LONGITUDE	COMMODITIES	DEVELOPMENT	PRODUCTION	REFERENCES
unknown	NW29 20S 8W	32° 30' 33"	107° 41' 08"	U, Pb, Cu	shafts, pits, adits, trenches - reclaimed	none	FN 7/2/95, NMBMMR file data
Rattlesnake Canyon	N1/2 4 21S 8W	32° 30' 49"	107° 40' 28"	Au, Ag, Cu	pits, shafts	unknown	FN 7/2/95
Rattlesnake Canyon	SW32 20S 8W	32° 30' 55"	107° 41' 00"	alunite	pits	none	Hall (1978), FN 7/2/95
Keystone Group (incl Daylight and Coliseum lodes)	32 20S 8W	32 31' 34"	107° 40' 59"	Pb, Ag	shafts, pits, adits, trenches	unknown	NMBMMR file data
Hadley	29,32 20S 8W	32° 31' 41"	107° 41' 00"	Cu, Pb, Ag, Au	shafts, pits, adits, trenches	12 short tons containing 57 oz Ag, 2,832 lbs Cu, 447 lbs Pb	Jicha (1954), NMBMMR file data
Native Silver Group (incl. Native Silver, Hub, Rock Island Millsite)	29,32 20S 8W	32° 31' 41"	107° 41' 09"	Pb, Ag	shafts, pits, adits, trenches	unknown	NMBMMR file data
Graphic (Hadley, Keystone, Native Silver, Daylight, Coliseum, Hub, Rock Island)	32 20S 8W	32° 31' 42"	107° 40' 59"	Pb, Ag, Cu, Zn	main shaft, 6 levels, 2,250 ft of drifts and stopes	22 short tons containing 150 oz Au, 476 oz Ag, 94 lbs Cu, 7,233 lbs Pb	Lindgren et al., (1910), Jicha (1954), NMBMMR file data
Copperton	29,32 20S 8W	32° 31' 49"	107° 41' 01"	Cu, Au	pits	none	NMBMMR file data
Jumbo	32 20S 8W	32° 31' 50"	107° 41' 01"	Pb, Zn, Ag, Au	shafts, pits, adits, trenches	1 ton containing 11 oz Ag, 361 lbs Pb	Jicha (1954), NMBMMR file data
Rockland Lode (Rock Island)	29,32 2OS 8W	32° 31' 51"	107° 40' 51"	Au	shafts, pits	unknown	NMBMMR file data
unknown	SE29 20S 8W	32° 31' 43"	107° 40' 58"	Au, Ag	2 shafts >100 ft deep, pits	unknown	FN 7/2/95

Tres Hermanas district

Location and Mining History

The Tres Hermanas district is located near Columbus, in southern Luna County (Fig. 22), and was discovered in 1881. Total production from the Laramide skarn and Laramide vein deposits in the district is unknown, but is estimated from 1885-1957 as $600,000 worth of copper, gold, silver, lead, and zinc, including 200,000 lbs Pb and 1 million lbs Zn (Table 42). The Cincinnati, Hancock, and Mahoney mines were active in 1905 (Lindgren et al., 1910) and the Mahoney mine remained in production until 1920 (Griswold, 1961). In 1906-1907, ore was shipped to the Mississippi Valley area for smelting (Lindgren, 1909). The results of drilling in the Tres Hermanas Mountains in the early 1980s are unknown.

TABLE 42 —Reported metal production from the Tres Hermanas district, Luna County (from U.S. Geological Survey, 1902-1927; U.S. Bureau of Mines, 1927-1990; Griswold, 1961). — none reported.

YEAR	ORE (SHORT TONS)	COPPER (LBS)	GOLD (OZ)	SILVER (OZ)	LEAD (LBS)	ZINC (LBS)	TOTAL VALUE ($)
1915	169	—	—	—	—	110,188	—
1916	650	—	—	54	8,400	431,360	—
1917	412	—	—	194	15,544	281,122	—
1918	137	—	—	180	27,420	74,686	—
1919	—	—	—	—	—	—	—
1920	41	—	—	381	34,604	—	—
1921-1925	—	—	—	—	—	—	—
1926	19	—	—	135	14,668	—	—
1927-1933	—	—	—	—	—	—	—
1934	41	—	.92	1,075	34,100	—	1,989
1935	14	—	.6	121	2,500	—	208
1936	54	150	4.00	647	11,400	—	1,179
1937-1939	—	—	—	—	—	—	—
1940	6	—	—	42	1,300	—	95
1941	—	—	—	—	—	—	—
1942	105	—	—	242	21,000	32,000	4,555
1943	61	—	—	—	6,000	22,000	2,826
1946	2	—	—	26	—	—	21
1947	24	300	—	344	500	—	446
1948	67	—	1.00	273	4,000	—	998
1950	13	—	—	52	2,000	—	317
1951	79	—	—	31	8,000	26,600	6,253
1952	7	—	—	21	500	1,000	265
1956	92	100	—	97	—	—	131
1957	5	—	—	33	1,200	—	202
PRODUCTION 1915-1957	1,998	550	7	3,948	193,136	978,956	19,485
ESTIMATED PRODUCTION 1885-1957	—	550	7	4,000	200,000	1,000,000	1,000,000

Geology

The Tres Hermanas Mountains consist predominantly of a quartz monzonite stock, dated as 50.3±2.6 Ma (hornblende, K-Ar; Leonard, 1982) and are surrounded by a thick sequence of predominantly Paleozoic and Cretaceous sedimentary rocks and Tertiary volcanic rocks (Balk, 1961; Griswold, 1961; Leonard, 1982). Thrust faults are common; in the West Lime Hills, Permian rocks are thrusted over Lower Cretaceous rocks (Drewes, 1991a). Many of the Paleozoic limestones have been metamorphosed by the quartz monzonite (Homme, 1958; Homme and Rosenzweig, 1970). A chemical variation with time from older metaluminous andesites, dacites, and rhyolites to younger alkaline rhyolite and latite occurs in the calc-alkaline rocks in the Tres Hermanas Mountains (Leonard, 1982).

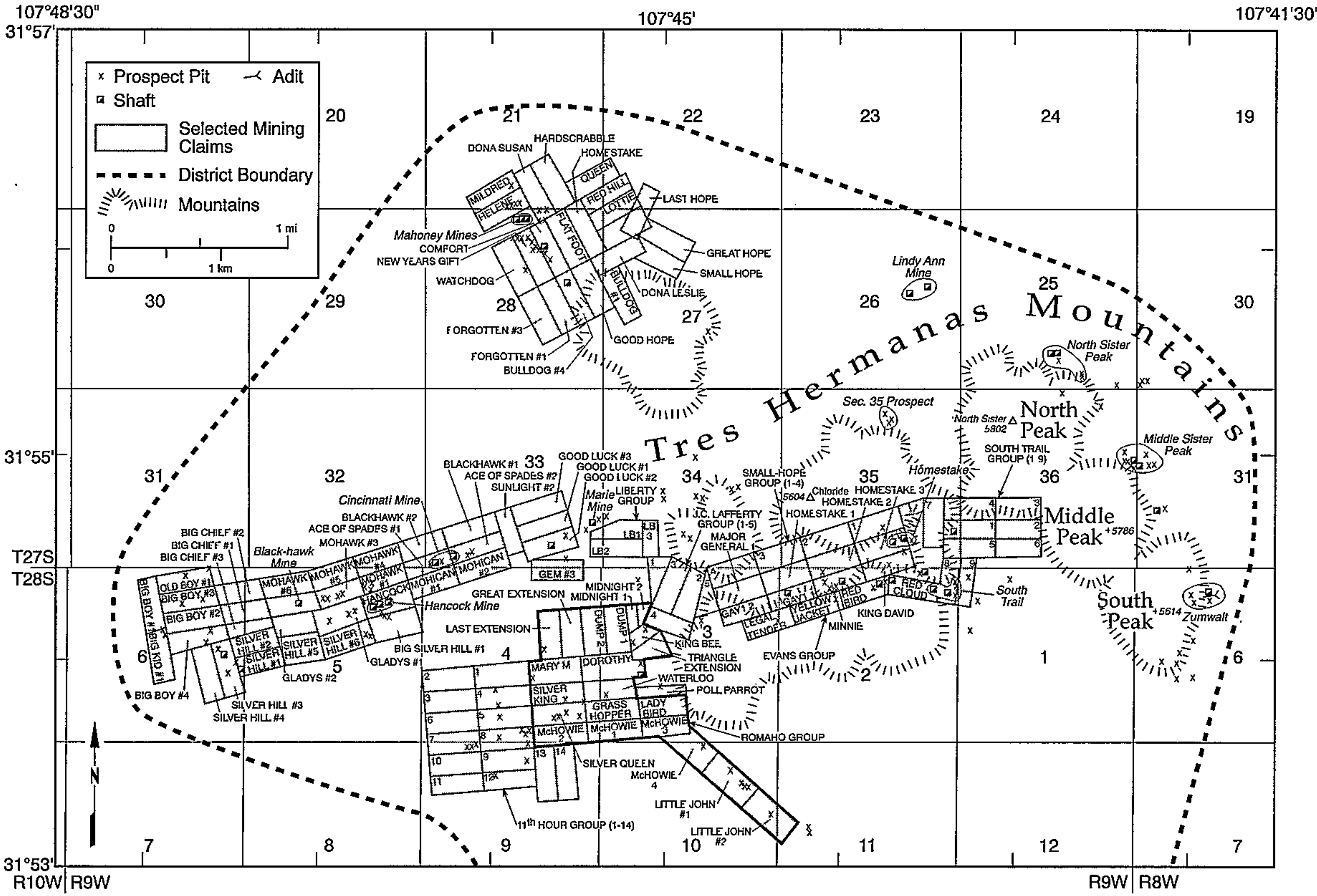

Figure 22—Mines and prospects in the Tres Hermanas mining district, Luna County, New Mexico.

Mineral Deposits

Three types of deposits occur in the Tres Hermanas district (Table 43, Fig. 22): Laramide veins and Laramide skarn. The age of the mineral deposits is Tertiary; they most likely formed after intrusion of the quartz monzonite but prior to intrusion of the basaltic dikes (Griswold, 1961; Doraibabu and Proctor, 1973). Geochemical data are consistent with a source of mineralization from the quartz monzonite, although locally the older bedrock may have contributed metals (Doraibabu and Proctor, 1973). Multiple periods of mineralization are likely, because of the variations in mineralization styles and alteration.

The most productive deposits are the Laramide skarns which occur in the Escabosa Limestone (Mississippian) and overlying Pennsylvanian sedimentary rocks (Table 43). The replacement deposits are tabular to pod-shaped and are controlled by fractures and faults which trend east-west and north-south. Silicification is common near these deposits (Griswold, 1961). Ore minerals consist predominantly of sphalerite, galena, chalcopyrite, willemite, smithsonite, and other oxidized lead-zinc minerals in a gangue of calcite, quartz, pyrite, and calc-silicate minerals (Wade, 1913; Homme and Rosenwieg, 1970). Ore at the Mahoney mine averaged 26.7% Pb, 34.5% Zn, and 5.9 oz/short ton Ag. Gold assays range as high as 1,500 ppb Au (Griswold et al., 1989). The Mahoney and Lindy Ann mines are the largest producers (Table 43). Skarns are locally common in the limestone xenoliths and limestones adjacent to the stock (Table 43). Scheelite is reported in a tactite near South Peak (Griswold, 1961).

Fissure veins in quartz monzonite contain galena, willemite, smithsonite, and hydrozincite, and samples assayed 29-37% Zn, 11-40% Pb, and 2 oz/short ton Ag (Lindgren, 1909). Veins also occur along faults and fractures in Paleozoic sedimentary clastic rocks, quartz monzonite, and Tertiary volcanic rocks. The most productive veins, such as the Cincinnati, trend east-west; the north-trending veins have been less productive (Table 43; Doraibabu and Proctor, 1973). The Cincinnati vein strikes N75°E, dips 75-80° S, and is 10,000 ft long. Most veins are less than 4 ft wide. Disseminated pyrite, chalcopyrite, sphalerite, and galena occur sporadically throughout the quartz monzonite stock (Table 43), suggesting the potential for a porphyry copper and/or copper-molybdenum deposit; although the stock is not extensively altered as typical porphyry copper deposits. However, drilling in the stock has failed to reveal any economic concentrations (Griswold, 1961; NMBMMR file data).

Most of the mines in the Tres Hermanas district are shallow; only a few reach depths of 300-500 ft. None of the deposits have been explored at greater depths, especially in the Mahoney and Cincinnati mines (Griswold, 1961). Areas of pyrite disseminations need examination, for example secs. 26, 27, T27S, R9W. Where alluvium covers the extensions of these deposits is also favorable, but requires drilling. Anomolous concentrations of As, Ba, Be, Co, Cd, La, Mn, Mo, Pb, Sb, Th, Ti, Y, and Zn are found in stream-sediment samples from the area.

Marble occurs adjacent to the quartz monzonite surrounding the Tres Hermanas Mountains (Griswold, 1961; Leornard, 1982). The marble was originally Paleozioc, is medium- to coarse-grained, and contains local intercalculated bands of garnet. The quantity of resources of marble for dimension stone is unknown. Yellow and white travertine (Mexican onyx) occurs in bands as much as 5 ft thick in latite on the southern slopes of the Tres Hermanas Mountains (sec. 24, T28S, R9W) and could be mined for local use. Spurrite, a rare pale-gray to purple mineral, is valued by collectors and used as an ornamental stone, and occurs in a limestone xenolith in quartz monzonite on the east slope of South Sister Peak (Griswold, 1961).

TABLE 43 —Mines and prospects in the Tres Hermanas mining district, Luna County, New Mexico, located in Figure 22. Location includes section, township, and range.

MINE NAME (ALIAS)	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
Mahoney Group	SE21,NE28 27S 9W	31° 56' 02", 107° 45' 43"	Zn, Pb, Ag, Au	several shafts with 4 levels, adits, pits	Laramide Pb-Zn skarn	Lindgren (1909), Griswold (1961), NMBMMR file data
Bulldog group	NE28 27S 9W	31° 55' 55", 107° 45' 20"	Zn	shaft	Laramide Pb-Zn skarn	NMBMMR file data
Lindy Ann Mine (Gym Kana)	E2 26 27S 9W	31° 55' 48", 107° 43' 35"	Pb, Ag, Zn	shallow shaft, short adits, pits	Laramide Pb-Zn skarn	Griswold (1961), Balk (1961), Doraibabu and Proctor (1973)
unknown	SE27 27S 9W	31° 55' 38", 107° 44' 45"	Pb, Zn	pits	Laramide vein	NMBMMR file data
North Sister Peak Prospect (Grass Root)	25 27S 9W	31° 55' 30", 107° 42' 45"	Pb, U, Ag	prospect pits and 3 shafts	Laramide Pb-Zn skarn	Griswold (1961)
Big Boy & Mohawk Group	4-6 28S 31, 33 27S 9W	31° 55' 11", 107° 47' 31"	Mn, Zn, Pb, Ag	pits	Laramide vein	NMBMMR file data
Unnamed - Middle Sister Peak	31 27S 8W	31° 55' 01", 107° 42' 28"	Pb, Zn, U	shafts, pits, trenches	Laramide vein	Griswold (1961), Balk (1961)
Kentucky Mines	36 27S 9W	31° 54' 58", 107° 42' 18"	Ag, Pb	pits	Laramide Pb-Zn skarn	NMBMMR file data
Gold Flat	SE34 27S 9W	31° 54' 55", 107° 44' 58"	Pb, Zn	pits	Laramide vein, disseminated	NMBMMR file data
unknown -	34 27S 9W	31° 54' 49", 107° 44' 48"	Pb, Zn	pits	Laramide vein	NMBMMR file data
Homestead (Homestake)	SE35 27S 9W	31° 54' 45", 107° 43' 40"	Ag, Cu, Zn	shafts, pits	Laramide vein	NMBMMR file data
South Trail	SW36 27S 9W	31° 54' 45", 107° 42' 10"	Pb, Zn, Ag	pits, shafts	Laramide vein	NMBMMR file data
Unnamed - Middle Sister Peak	31 27S 8W	31° 54' 45", 107° 42' 10"	Pb, Zn, U	Trench	Laramide vein	Griswold (1961), Balk (1961)
Marie	SE33 27S 9W	31° 54' 41", 107° 45' 24"	Pb, Ag, Zn, Au	50 ft shaft, several pits	Laramide vein	Griswold (1961), Balk (1961), Doraibabu and Proctor (1973)
Section 35 (Rambler No 1, Homestake Group)	SE35 27S 9W	31° 54' 40", 107° 43' 40"	Cu, Pb, Zn, Au(?), U	2 shafts (50+ feet deep), pits	Laramide vein, disseminated	McLemore (1983), Griswold (1961), Balk (1961)
Small Hope Group (1-4)	34,35 27S 9W	31° 54' 34", 107° 44' 12"	Pb, Zn	pits	Laramide vein	NMBMMR file data
Cincinnati	SW33 27S 9W	31° 54' 32", 107° 46' 14"	Pb, Ag, Au, Zn	shaft (300 - 500 ft), 80 ft shaft, pits	Laramide vein	Lindgren (1909), Griswold (1961), NMBMMR file data
Liberty Group (1-3)	33,34 27S 9W	31° 54' 31", 107° 45' 08"	Pb, Zn	pits	Laramide vein	NMBMMR file data
Red Bird	N2 28S 9W	31° 54' 25", 107° 43' 40"	Au, Ag, Cu, Pb	shafts, pits	Laramide vein	NMBMMR file data
Section 2 (South Trail Group)	2 28S 9W	31° 54' 25", 107° 43 25"	Cu, Pb, Zn, Mn, U	3 shafts, several pits	Laramide vein	Griswold (1961), Balk (1961)
Zumwalt (Sister Peak)	6 28S 8W	31° 54' 25", 107° 41' 58"	Mn, fluorescent calcite, U	200 ft adit, 50 ft shaft, 20 ft shaft, pits	Laramide vein	Griswold (1961), Balk (1961), Northrop (1959)
Major General	NE3 28S 9W	31° 54' 22", 107° 44' 34"	Pb, Zn	pits	Laramide vein	NMBMMR file data
Evans Group	2,3 28S 9W	31° 54' 20", 107° 44' 06"	Pb, Zn	pits	Laramide vein	NMBMMR file data
Silver Hill	NE6 28S 9W	31° 54' 18", 107° 47' 30"	Pb, Zn	shafts, pits	Laramide Pb-Zn skarn	NMBMMR file data
Black Hawk	NW5 28S 9W	31° 54' 18", 107° 47' 06"	Pb, Ag, Mn	main shaft, numerous pits	Laramide Pb-Zn skarn	Griswold (1961), Farnham (1961), Balk (1961), NMBMMR file data
Hancock	NE5 28S 9W	31° 54' 17", 107° 46' 39"	Pb, Ag, Au, Zn	400 ft shaft, shafts, pits	Laramide vein	Griswold (1961), Balk (1961), Doraibabu et al. (1972)
JC Lafferty Group (1-5)	3 28S 9W	31° 54' 15", 107° 44' 58"	Pb, Zn	pits	Laramide vein	NMBMMR file data
unknown	6 28S 8W	31° 54' 03", 107° 42' 03"	Pb, Zn	6 prospect pits	Laramide vein	NMBMMR file data

MINE NAME (ALIAS)	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
Dorothy	SE3 28S 9W	31° 53' 58", 107° 45' 15"	Au, Ag, Cu, Pb	shafts	Laramide vein	NMBMMR file data
Poll Parrot	S3 28S 9W	31° 53' 52", 107° 45' 01"	Pb, Zn	pits	Laramide vein	NMBMMR file data
Romaho Group	3,4,10,11 28S 9W	31° 53' 49", 107° 45' 28"	Pb, Zn	pits	Laramide vein, disseminated	NMBMMR file data
Eleventh Hour Group (1-14)	4,5,9 28S 9W	31° 53' 40", 107° 46' 03"	Pb, Zn	pits	Laramide vein	NMBMMR file data
Little John	NE10 28S 9W	31° 53' 25", 107° 44' 50"	Pb, Zn	pits	Laramide vein, disseminated	NMBMMR file data
Canon	NE1/4 14 28S 9W	31° 52' 27", 107° 43' 24"	Cu	1 inclined shaft, 1 vertical shaft, 2 cuts	Laramide vein	Griswold (1961)
Section 24	SE24 28S 9W	31° 51' 15", 107° 42' 25"	Ca, U	20-30 ft shaft, large open pit	Laramide vein	Balk (1961)
Section 25 (near Section 24)	NE25 28S 9W	31° 50' 58", 107° 42' 27"	Pb, Zn	pits	Laramide vein	NMBMMR file data
unknown	35 28S 9W	31° 49' 27", 107° 43' 23"	Pb, Zn	5 prospect pits	Laramide vein	NMBMMR file data
Lindberg	24 28S 9W	31° 51' 10", 107° 42' 30"	travertine	pits	travertine	Griswold (1961)

Victorio district

Location and mining history

The Victorio district is in central Luna County, west of Deming (Fig. 23) and was discovered in the late 1800s. Production of carbonate-hosted Pb-Zn (Ag, Cu) replacement deposits began about 1880. Most of the early production was from the Chance and Jessie mines where $800,000-$1,600,000 worth of lead, zinc, and silver were produced (Jones, 1904; Lindgren et al., 1910). Mining continued until 1957. An estimated 70,000 to 130,000 short tons of ore were mined between 1880 and 1957 and yielded approximately $2.3 million worth of lead, zinc, silver, gold, and copper, including 17.5 million lbs Pb and >60,000 lbs Zn (Table 44; McLemore and Lueth, 1995, in press).

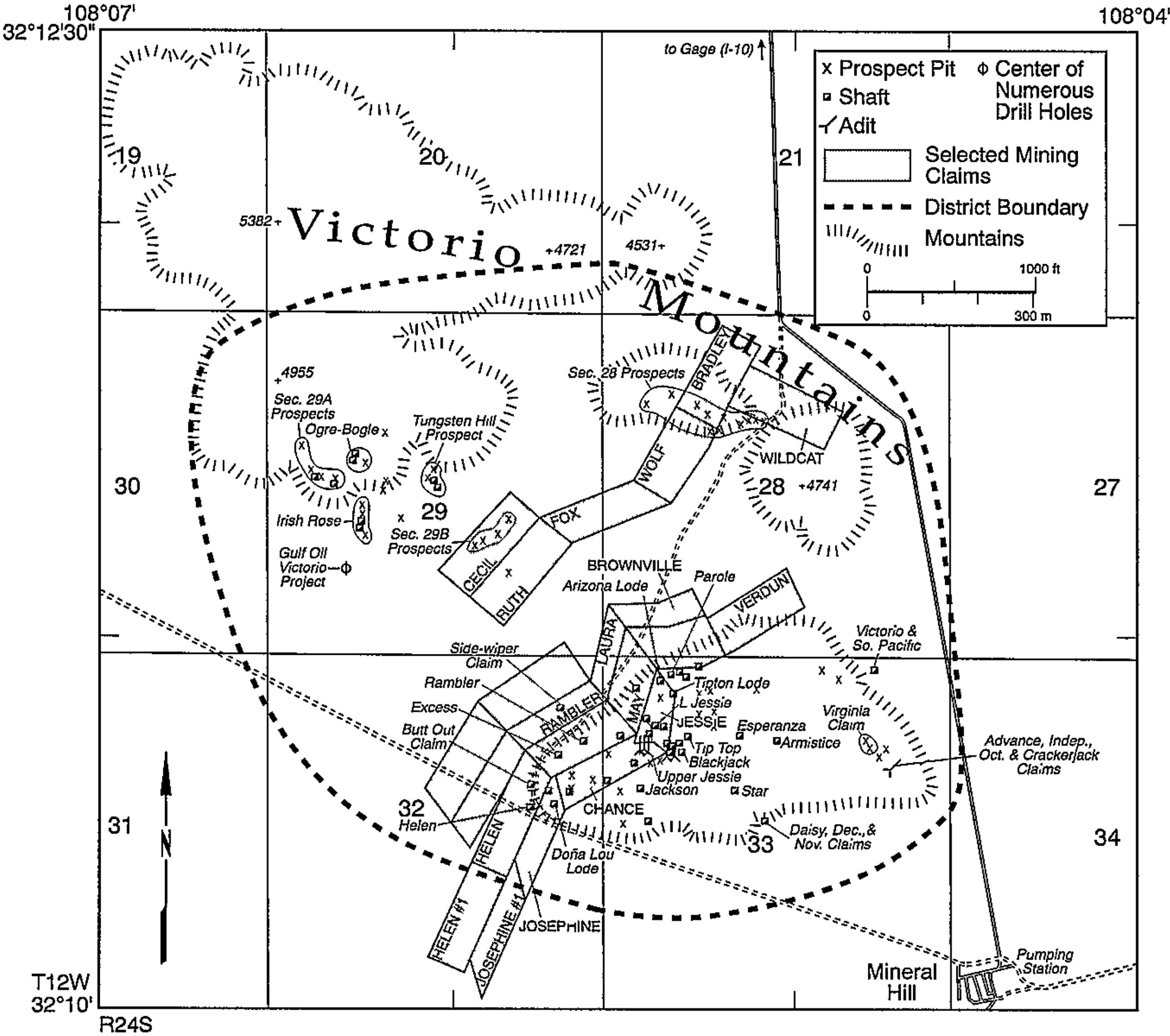

Figure 23—Mines and prospects in theVictorio mining district, Luna County, New Mexico.

TABLE 44—Reported metal production from the Victorio district, Luna County (from U.S. Geological Survey, 1902-1927; U.S. Bureau of Mines, 1927-1990; Griswold, 1961). — none reported.

YEAR	ORE (SHORT TONS)	COPPER (LBS)	GOLD (OZ)	SILVER (OZ)	LEAD (LBS)	ZINC (LBS)	TOTAL VALUE ($)
1880-1903	—	—	—	—	—	—	1,150,000
1904	274	—	—	2,047	76,465	—	6,170
1905	—	—	—	—	—	—	—
1906	620	—	19.98	2,876	186,000	—	12,971
1907	1,200	—	—	3,600	408,000	—	24,992
1908	—	—	—	—	—	—	—
1909	183	1,069	—	2,460	85,418	—	5,381
1910	22	—	—	267	21,318	—	1,085
1911	180	1,598	5.03	883	66,250	—	3,753
1912	2,123	—	275.11	23,305	684,867	7,865	51,382
1913	3,895	58	536.24	40,416	902,781	—	75,227
1914	132	—	—	552	35,599	—	1,851
1915	216	2,320	—	1,476	53,958	—	4,147
1916	1,804	—	171.01	8,436	381,000	—	35,375
1917	1,505	270	—	11,301	428,907	—	51,449
1918	1,631	—	—	14,358	323,493	—	45,497
1919	1,728	538	238.30	10,438	356,775	—	35,626
1920	1,331	1,641	—	10,167	298,113	—	41,894
1921	676	—	71.98	4,709	144,467	—	12,698
1922	158	—	—	583	28,622	—	2,529
1923	468	1,028	62.89	2,195	64,930	—	7,796
1924	285	—	—	485	47,975	—	4,295
1925	609	1,000	—	2,833	116,600	—	13,075
1926	129	—	7.20	633	22,500	—	2,344
1927	28	—	—	224	7,398	—	638
1928	40	—	—	188	9,000	—	717
1929	278	284	—	1,004	27,000	—	2,516
1930-1934	—	—	—	—	—	—	—
1935	40	—	5.60	259	4,900	—	578
1936	<1	—	—	11	100	—	14
1937	1,009	2,815	93.40	3,589	67,000	—	10,339
1938	3,595	6,000	397.4	13,283	210,000	—	32,744
1939	3,493	8,700	453	16,802	278,800	—	41,269
1940	903	2,600	113	3,981	78,700	—	11,015
1941-1946	—	—	—	—	—	—	—
1947	1,509	2,400	24	2,535	107,800	42,600	24,316
1948	119	—	1.0	347	18,000	—	3,571
1949	—	—	—	—	—	—	—
1950	73	—	1.0	275	6,000	—	1,094
1951-1954	—	—	—	—	—	—	—
1955	57	—	1	175	2,000	—	491
1956	—	—	—	—	—	—	—
1957	53	—	—	239	4,809	2,000	1,134
TOTAL 1904-1957	30,367	32,271	2,477.14	186,882	6,233,492	52,465	569,973
ESTIMATED TOTAL 1880-1959	70,000-130,000	41,000	12,200	581,500	17,500,000	>60,000	2,330,700

Beryllium and tungsten contact-metasomatic deposits were discovered in the Victorio Mountains in the 1900s (Griswold, 1961; Holser, 1953; Dale and McKinney, 1959). In 1942, approximately 20,000 short tons of ore containing an average of 1% WO_3 were produced from the Irish Rose claim and was worth nearly $70,000 (Dale and McKinney, 1959). The ore contained mostly scheelite with some galena, smithsonite, and helvite. In addition, 19.6 short tons of 60% WO_3 (Hobbs, 1965) were produced from the mine.

Recent exploration has been modest. Gulf Minerals Resources, Inc. delineated a subeconomic porphyry Mo-Be-W deposit in 1977-1983, northwest of Mine Hill. At a cut off grade of 0.02% WO_3, resources were estimated as 57,703,000 short tons of 0.129% Mo and 0.142% WO_3. Open pit resources were estimated as 11,900,000 short tons of 0.076% WO_3 and 0.023% Be (Bell, 1983). In 1987-1988, Cominco American Resources examined the district for gold potential, but the results are unknown. Other exploration companies also have examined the district in recent years, but no production has occurred since 1957.

Most of the workings are on Mine Hill in the southern part of the Victorio Mountains (Griswold, 1961). Several shafts are 276 ft deep and underground workings are extensive (Griswold, 1961; V. T. McLemore, unpublished field notes, December 1993). Most of these workings have been closed by the New Mexico Abandoned Mine Lands Bureau in 1994.

Geology

The oldest rocks exposed in the area are Ordovician limestones, dolomites, and calcarenites of the El Paso Limestone, which is about 240 ft thick (Kottlowski, 1960, 1963; Thoman and Drewes, 1980). The El Paso Limestone unconformably overlies the Bliss Sandstone (Cambrian-Ordovician) in the subsurface and is conformably overlain by the Montoya Group (Ordovician). In the Victorio Mountains, the Montoya Group is 300 ft thick and consists of limestones and dolomites (Kottlowski, 1960) in four formations (from oldest to youngest): Cable Canyon Sandstone, Upham Dolomite, Aleman Formation, and Cutter Dolomite (Kottlowski, 1960; Thoman and Drewes, 1980). The Fusselman Dolomite (Silurian) lies conformably on the Montoya Group and consists of 30-710 ft of dolomite, which is commonly divided into four informal units (from oldest to youngest): gray member, lower black member, tan member, and upper black member (Kottlowski, 1960). The crest of the mountains consists of volcanic rocks; andesite is dated as 41.7±2 Ma (zircon, fission track; Thoman and Drewes, 1980). The Victorio granite is dated as 32.2±1.6 Ma (K-Ar, biotite; Bell, 1983) and the granitic porphyry at the Irish Rose mine is dated as 36.3±1.4 (K-Ar; Bell, 1983).

The district is part of the Laramide thrust belt as defined by Drewes (1991b) and is along the Texas lineament. The rocks dip to the north and are offset by faults. The area is also part of a large gravity anomaly which corresponds to near-surface carbonate rocks. Seismic data indicates these rocks are within 2,400 ft of the surface. The area is characterized by a slight areomagnetic radiometric U anomaly with low K and Th, which is characteristic of mineralized carbonate rocks in southwestern New Mexico.

Mineral Deposits

Two types of deposits are present in the Victorio Mountains (Table 45): carbonate-hosted Pb-Zn replacement and W-Be-Mo vein and tactite deposits (Richter and Lawerence, 1983; North and McLemore, 1986). In addition, Gulf Mineral Resources, Inc. delineated a subeconomic stratiform, pyrometasomatic Mo-W-Be deposit northwest of Mine Hill (Bell, 1983). In addition, limestone was quarried for aggregate.

The carbonate-hosted Pb-Zn replacment deposits occur as oxidized replacement and vein deposits within Ordovician and Silurian dolomites and limestones (Fig. 24). The more productive deposits occur along faults or fractures that strike N30-65°E and dip steeply east (Fig. 25). Brecciation, dissolution, and recrystallization of the dolomites are common in the vicinity of the mineral deposits. The faults exhibit both pre- and post-mineralization movement (Griswold, 1961). Ore minerals include galena, smithsonite, cerussite, and anglesite with rare sphalerite and chalcopyrite in a gangue of quartz, calcite, and iron oxides. Lead typically exceeds zinc and copper in abundance. Ore at the Rambler mine averaged 12.5% Pb and 3.9% Zn (NMBMMR file data). Gold assays range as high as 5,500 ppb Au (Griswold et al. 1989). Some veins are as much as 900 ft long. Assays of samples collected for this report are in Table 46.

The tungsten-beryllium deposits occur as veins and tactites within the Ordovician limestones and dolomites in the vicinity of rhyolite intrusives. Ore minerals include helvite, wolframite, scheelite, molybdenite, galena, sphalerite, and beryl in a gangue of quartz, calcite, and local grossularite, tremolite, pyroxene, idocrase, and phlogopite (Holser, 1953; Warner et al., 1959; Richter and Lawerence, 1983).

Gulf Minerals Resources, Inc. drilled 71 drill holes northwest of Mine Hill and found a subeconomic Mo-W-Be deposit at depths ranging from 900 to 1,500 ft (Bell, 1983). Ore minerals include molybdenite, powellite, scheelite, beryl, helvite, bismuthinite, and wolframite.

The area surrounding Mine Hill that is covered by alluvium should be further examined and drilled for additional carbonate-hosted deposits. Anomolous concentrations of Be, Co, Mn, Pb, and Zn are found in stream-sediment samples from the area.

FIGURE 24—Closeup view of a 3-ft wide vein in limestone at Mine Hill, Victorio mining district. Center of vein consists of calcite, smithsonite, anglesite, cerussite, and iron oxides (V. T. McLemore photo).

FIGURE 25—Fissure vein in limestone at the Parole mine, Mine Hill, Victorio mining district. Limestone to the left of the vein is relatively unaltered, whereas the limestone to the right of the vein is replaced by iron and manganese oxides (V. T. McLemore photo).

TABLE 45—Mines and prospects in the Victorio mining district, Luna County, located in Figure 23. Location includes section, township, and range. FN—V. T. McLemore, unpublished field notes.

MINE NAME	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
Helen Group (Helen and Josephine Lodes)	C of SE32 24S 12W	32° 10' 21", 108° 05' 51"	Au,Ag,Cu,Pb	shaft	carbonate-hosted Pb-Zn replacment	Griswold (1961), FN 2/28/94
Dona Lou	SE of NE32 24S 12W	32° 10' 32", 108° 05' 42"	Ag,Pb,Zn	shafts, pits	carbonate-hosted Pb-Zn replacment	NMBMMR file data
Star	SE of NW33 24S 12W	32° 10' 33", 108° 05' 09"	Ag,Pb,Zn	shafts, pits	carbonate-hosted Pb-Zn replacment	Griswold (1961)
Daisy, December, and November Claims	C33 24S 12W	32° 10' 34", 108° 05' 03"	Ag,Pb,Zn	shafts, pits	carbonate-hosted Pb-Zn replacment	NMBMMR file data
Jackson	SW of NW33 24S 12W	32° 10' 34", 108° 05' 27"	Ag,Pb,Zn	shafts, pits	carbonate-hosted Pb-Zn replacment	Griswold (1961)
Butt-Out	SE of NE32 24S 12W	32° 10' 34", 108° 05' 45"	Ag,Pb,Zn	shafts, pits	carbonate-hosted Pb-Zn replacment	NMBMMR file data
Excess	NE32 24S 12W	32° 10' 37", 108° 05' 46"	Pb, Ag, Au, Zn	shaft with 150 ft of drift	carbonate-hosted Pb-Zn replacment	Lindgren, et al (1910), Griswold (1961), NMBMMR file data
Side-Wiper	NE of NE32 24S 12W	32° 10' 38", 108° 05' 40"	Ag,Pb,Zn	shafts, pits	carbonate-hosted Pb-Zn replacment	NMBMMR file data
Rambler (Helen, Rover)	NE32 24S 12W	32° 10' 38", 108° 05' 42"	Pb, Ag, Au	300 ft	carbonate-hosted Pb-Zn replacment	Lindgren et al. (1910), FN 2/28/94
Blackjack	C of NE33 24S 12W	32° 10' 39", 108° 05' 18"	Ag,Pb,Zn	shafts, pits	carbonate-hosted Pb-Zn replacment	NMBMMR file data
Advance, Independence, October, and Crackerjack	E of NE33 24S 12W	32° 10' 41", 108° 04' 36"	Cu,Pb	150 ft adit	carbonate-hosted Pb-Zn replacment	FN 12/28/93, NMBMMR file data
Virginia	NE33 24S 12W	32° 10' 41", 108° 04' 47"	Pb, Ag	surface only	carbonate-hosted Pb-Zn replacment	Lindgren, et al (1910), NMBMMR file data
Armistice	NE33 24S 12W	32° 10' 41", 108° 05''' 02"	Ag,Pb,Zn	shafts, pits	carbonate-hosted Pb-Zn replacment	Griswold (1961)
Tip Top	C of NW33 24S 12W	32° 10' 41", 108° 05' 18"	Ag,Pb,Zn	shafts, pits	carbonate-hosted Pb-Zn	Griswold (1961)
Burke Mine (Jessie, Chance & Jessie)	NW33 24S 12W	32° 10' 41", 108° 05' 22"	Ag, Pb, Au, Cu, Zn	300 ft adit	carbonate-hosted Pb-Zn replacment	Lindgren, et al (1910), Griswold (1961), NMBMMR file data
Esperanza (Estrella, El Progreso)	E of NW33 24S 12W	32° 10' 42", 108° 05' 08"	Ag,Pb,Zn	shafts, pits	carbonate-hosted Pb-Zn replacment	Griswold (1961)
Tipton	N of NW33 24S 12W	32° 10' 48", 108° 05' 20"	Ag,Pb,Zn	shafts, pits	carbonate-hosted Pb-Zn replacment	NMBMMR file data
Jessie Group (Jessie, Laura, May)	NW33 24S 12W	32° 10' 49", 108° 05' 28"	Ag,Pb	adit, shaft	carbonate-hosted Pb-Zn replacment	Griswold (1961), FN 12/28/94
Arizona	N of NW33 24S 12W	32° 10' 50", 108° 05' 22"	Ag,Pb,Zn	shafts, pits	carbonate-hosted Pb-Zn	NMBMMR file data
Florida (Corbett and Wyman, St. Louis, Chance)	N1/2 33 24S 12W	32° 10' 50", 108° 4' 50"	Ag, Pb, Au, Cu, Fe	250 ft, 180 ft,: 45 ft shafts	carbonate-hosted Pb-Zn replacment	NMBMMR file data
Parole	NW33 24S 12W	32° 10' 52", 108° 05' 19"	Pb, Ag	shaft ,shallow prospect pits	carbonate-hosted Pb-Zn replacment	Griswold (1961), Thorman and Drewes (1980), FN 2/29/94

MINE NAME	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
Victorio (Chance, Hearst, S. Pacific, Duryea, Verdun, Brownville,Tiger Armistice)	N33 24S 12W	32° 10' 53", 108° 04' 48"	Pb,Ag	shafts, adits, 7000-8000 ft of workings	carbonate-hosted Pb-Zn replacment	Lindgren et al. (1910), Griswold (1961), NMBMMR file data
Victorio Project	SW29 24S 12W	32° 11' 07", 108° 06' 20"	Mo, W, Be, F	71 diamond drill holes (165,000 ft)	W-Be contact-metasomatic deposits, porphyry W-Mo	NMBMMR file data
Section 29B prospects (Cecil, Ruth, & Fox Claims)	29 24S 12W	32° 11' 15", 108° 05' 50"	Pb, Cu,W	shafts, pits	carbonate-hosted Pb-Zn replacment	Griswold (1961), FN 2/29/94, NMBMMR file data
Irish Rose (Eloi and Morlock Claims)	SW29 24S 12W	32° 11' 15", 108° 06' 17"	W, Be, Pb	Inclined shaft 150 ft deep	carbonate-hosted Pb-Zn replacment	Griswold (1961), Holser (1953), FN 2/29/94
Tungsten Hill Prospect	C29 24S 12W	32° 11' 21", 108° 06' 04"	W, Be, Pb, Zn	80 ft shaft, 20 ft shaft, pits	carbonate-hosted Pb-Zn replacment	Holser (1953), McLemore (1983), FN 2/29/94
Name unknown -- Section 29A prospects	29 24S 12W	32° 11' 22", 108° 06' 25"	W	shafts, pits	W-Be contact-metasomatic deposits	Griswold (1961), FN 2/29/94, NMBMMR file data
Ogre-Bogle (Tedfords Prospect)	SW29, SE30 24S 12W	32° 11' 25", 108° 06' 18"	W, Pb, Zn, Be	approximately 20 test pits	carbonate-hosted Pb-Zn replacment	Dale and McKinney (1959), FN 2/29/94
Section 28 prospects (Wolf, Bradley, & Wildcat Claims)	NW1/4 28 24S 12W	32° 11' 35", 108° 05' 10"	Pb, Ag, Au, Cu	numerous prospect pits	carbonate-hosted Pb-Zn replacment	Griswold (1961), FN 2/29/94, NMBMMR file data

Table 46—Chemical analyses of samples collected from the Victorio district, Luna County. All samples contained <0.50 ppm Mo. Cu, Pb, Zn by FAAS at NMBMMR Chemical laboratories and Au by ICP and Hg by cold vapor AA by USGS Chemical laboratories.

LAB NO.	FIELD NO.	Cu ppm	Pb ppm	Zn ppm	Au ppm	Hg ppm	SAMPLE DESCRIPTION
158	VIC 3	8,200	13,800	22,900	1.5	6.6	3 ft chip across back at portal of adit
159	VIC 4	130	4,900	13,700	1.0	1.5	grab of pillar at winze in Little Jessie adit
160	VIC 5	10	52	85	0.006	0.20	grab of rib of vein at Little Jessie adit
161	VIC 4M	320	39,700	1,100	1.1	0.57	2 ft chip of vein in Helen mine, 1st level
162	VIC 4B	1,000	3,300	3,500	0.10	0.25	4 ft chip across face in Helen mine, 1st level
163	VIC 4C	48,000	8,200	171,400	0.5	3.2	chip of vein in Helen mine, 1st level
164	VIC 132	141	3,700	680	0.50	0.08	dump sample, Jessie
165	VIC 34D	1,700	49,000	40,000	0.50	0.15	muck sample at 100 ft of Helen
166	VIC 34	700	14,800	3,200	2.7	1.5	muck sample at 100 ft of Helen
167	VIC 144	4,000	14,000	9,100	0.02	0.32	dump sample, Parole
168	VIC 42	890	14,000	3,400	0.30	0.41	sample of rib at Excess
169	VIC 48	1,400	5,400	30,700	0.05	0.58	sample of rib at Rover, 1st level
170	VIC 49C	550	1,200	1,700	1.4	0.72	sample of rib at Rover, 1st level
171	VIC 50B	730	5,600	1,800	0.1	0.24	grab of muck pile, Rover, 1st level
172	VIC 50	420	22,700	5,800	0.40	0.54	sample of rib at Rover, 1st level
173	VIC 80B	890	118,000	95	0.60	0.35	dump sample, Rover
174	VIC 200	42,000	123,000	15,000	0.50	1.4	dump sample at Tungsten Hill mine

GEOLOGY AND MINERAL OCCURRENCES OF THE MINING DISTRICTS OF HIDALGO COUNTY

Virginia T. McLemore and David M. Sutphin

Introduction

Hidalgo County was established in 1919 from the southwestern part of Grant County (Fig. 1) and was named to commemorate the Treaty of Guadalupe Hidalgo, which ended the Mexican War in 1848 and ceded New Mexico, Arizona, and California to the United States. It is one of the least populated counties in New Mexico; Lordsburg is the county seat and largest city.

Mining has been important to the economy of Hidalgo County and up until the 1960s, Hidalgo County typically ranked second (behind Grant County) in base- and precious-metal production in New Mexico (Elston, 1960, 1965). McGhee Peak mining district is the 8th largest zinc and lead producing district in New Mexico and Lordsburg is the 10th largest lead and zinc producing district in the state (McLemore and Lueth, 1995, in press). Prospecting began in 1870, but no serious production occurred until arrival of the railroad in Lordsburg in 1880. By 1930, all 13 mining districts were discovered (Table 1). Copper-gold veins were mined in the Lordsburg district for silica flux in 1990-1994. Total production from 1880 to 1994 exceeds $50 million worth of copper, lead, zinc, silver, and gold; most of the production value came from the Lordsburg district (Table 47; Elston, 1960, 1965). Current production includes silica sand and clay for use as smelter flux (Brockman and Pratt mines) and sand and gravel as aggregate (Hatton et al., 1994). The Hidalgo (or Playas) smelter was built in 1979 in the Animas Valley and is currently producing copper, silver, gold, and sulfuric acid (Table 9; Hatton et al., 1994).

TABLE 47—Reported metal production from Hidalgo County, 1920-1957 (from U.S. Geological Survey, 1902-1927; U.S. Bureau of Mines, 1927-1990). Production prior to 1920 was included with Grant County. Zinc production is for ore actually produced; zinc was discarded for many years. — none reported. [e]—estimated.

YEAR	ORE (SHORT TONS)	COPPER (LBS)	GOLD (OZ)	SILVER (OZ)	LEAD (LBS)	ZINC (LBS)	TOTAL VALUE ($)
1920	56,817	2,786,114	7,433	202,477	211,274	—	—
1921	13,179	582,140	1,143	65,693	160,423	—	—
1922	62,064	3,232,983	5,588	191,706	—	—	—
1923	97,546	4,337,238	10,494	149,783	223,957	—	—
1924	89,081	4,929,679	9,299	116,006	220,726	—	—
1925	109,370	5,076,140	10,779	136,568	468,200	—	—
1926	99,333	4,773,072	11,716	135,505	642,200	—	—
1927	98,940	4,078,588	9,550	92,896	232,159	—	—
1928	97,884	4,681,243	10,532	122,171	754,551	—	—
1929	93,672	4,285,114	10,621	170,244	1,047,715	—	—
1930	105,177	4,863,500	14,027	194,104	504,200	—	—
1931	96,316	3,991,000	11,289	138,893	204,000	—	—
1932	—	—	—	—	—	—	—
1933	266	21,000	111	1,849	24,000	—	5,176
1934	1,655	35,600	675	10,386	19,500	—	33,880
1935	3,075	89,000	993	16,178	47,500	—	55,665
1936	21,585	817,000	13,876	32,417	91,000	—	152,953
1937	75,081	3,810,000	2,169	76,896	132,000	—	604,192
1938	113,760	6,380,400	4,132	138,736	159,600	—	866,915
1939	117,040	6,376,000	4,406	135,982	52,600	—	912,089
1940	128,289	6,561,000	2,502	81,945	157,000	9,000	895,652
1941	123,557	7,468,800	1,357	67,815	221,000	80,000	995,634
1942	126,017	6,716,000	1,374	135,045	292,000	197,000	994,643
1943	113,903	5,023,000	1,477	98,259	278,000	87,000	804,804
1944	132,975	4,718,000	2,317	115,051	349,000	78,000	836,651
1945	13,765	2,294,000	1,411	92,347	690,000	—	484,084
1946	41,208	2,392,000	1,582	100,963	215,000	—	547,887
1947	43,266	3,540,900	1,847	192,643	713,500	96,600	1,097,008
1948	46,338	3,426,000	1,700	178,853	354,000	322,000	1,071,005
1949	82,549	3,870,000	1,987	156,641	762,000	72,000	1,103,027
1950	74,404	4,124,000	714	96,295	310,000	8,000	1,012,920
1951	72,895	3,042,000	755	90,806	466,000	66,000	937,403

YEAR	ORE (SHORT TONS)	COPPER (LBS)	GOLD (OZ)	SILVER (OZ)	LEAD (LBS)	ZINC (LBS)	TOTAL VALUE ($)
1952	66,630[e]	2,950,000	820	72,606	288,000	118,000	—
1953	84,570	3,988,000	1,212	101,222	112,000	4,000	—
1954	101,104	4,436,000	369	73,218	46,000	—	—
1955	123,059	4,510,000	684	83,802	22,000	8,000	—
1956	88,192	4,244,000	543	60,784	37,400	—	—
1957	84,002	3,435,300	495	30,697	7,600	1,500	—
TOTAL 1920-1957	2,892,564	141,885,000[e]	161,979	3,957,482	10,517,000[e]	1,148,000[e]	13,420,000[e]

Antelope Wells-Dog Mountains district

Location and Mining History

The Antelope Wells-Dog Mountains mining district is in the Alamo Hueco, White, and Dog Mountains along the New Mexico-Mexico border in the New Mexico panhandle (Fig. 1). In 1954, T.C. Boyles shipped 5.6 long tons of 37.9% Mn from the Rusty Ruthlee mine to Deming (Farnham, 1961). Manganese is widespread in the area as epithermal veins (Table 48, Fig. 26). The only other identified mineral deposits in the district consist of small showings of uranium which occur in fault breccias. Two exploration pits were dug in 1954, each approximately 10 ft deep, at the Opportunity claims, where there is a small occurrence of radioactivity. About 2 short tons of ore were milled and results indicated that the uranium was intimately associated with opal and quartz and could not be separated (Reiter, 1980). Mineral specimens of radioactive opal are collected at the Opportunity claims. Manganese veins and lenses occur locally throughout the area. At one site, a 6-ft deep prospect pit was dug in travertine, but no deposits of commercial value were identified. The Alamo Hueco Mountains Wilderness Study Area lies north of the district.

TABLE 48—Mines and prospects in the Antelope Wells-Dog Mountains mining district, Hidalgo County, New Mexico, located in Figure 26. Location includes section, township, and range.

MINE NAME (ALAIS)	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	ROCK TYPE	TYPE OF DEPOSIT	REFERENCES
Anomaly No. 14	NW 14 34S 16W	31° 21' 10", 108° 25' 52"	U	granite	epithermal Mn-U	Zeller (1975), McLemore (1983), Allison and Ove (1957)
Opportunity claims (Neglect, Dog Mountains)	SE 15 34S 15W	31° 20' 50", 108° 21' 00"	U	rhyolite	epithermal Mn-U	Everhart (1967), Zeller (1959), May et al. (1981), Walton et al. (1982), McLemore (1983), Reiter (1980)
unknown	SE 16 33S 14W	31° 25' 55", 108° 15' 40"	U, Mn	rhyolite	epithermal Mn-U (25g)	Reiter (1980)
Boles	8 34S 17W	31° 21' 45", 108° 35' 25"	Mn, U	rhyolite?	epithermal Mn-U (25g)	McLemore (1983), Elston (1960)
unknown	SE 11 34S 16W	31° 21' 30", 108° 35' 55"	Mn, travertine	travertine	epithermal Mn (25g)	Reiter (1980)
Rusty Ruthlee	17,18 34S 17W	31° 21' 55", 108° 35' 55"	Mn	rhyolite, andesite	epithermal Mn (25g)	Farnham (1961)
Guano	SE 35 32S 16W	31° 28' 30", 108° 25' 50"	guano	basalt	guano	Elston (1965), Reiter (1980)

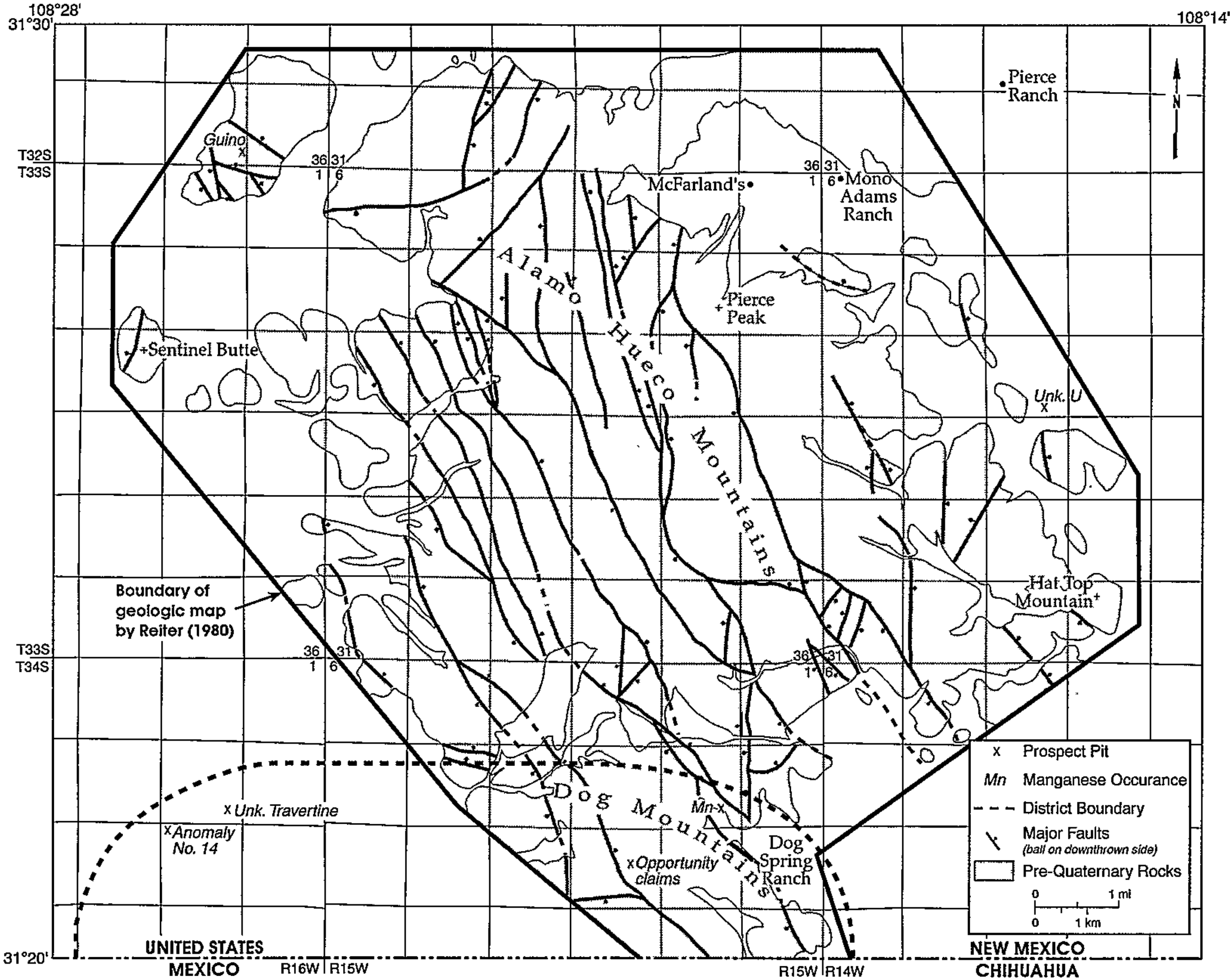

Figure 26—Mines and prospects in the Antelope Wells-Dog Mountains mining district, Hidalgo County, New Mexico (modified from Reiter,1980).

Geology

The Alamo Hueco, White, and Dog Mountains consist of layered mid-Tertiary volcanic rocks overlying a conglomerate containing limestone and sandstone cobbles. The conglomerate resembles the Timberlake Fanglomerate of the central Animas Mountains (Zeller, 1959; Zeller and Alper, 1965; Deal et al., 1978; Reiter, 1980). Ash-flow tuffs of the Alamo Hueco Mountains are outflow sheets, primarilary from sources in the Animas Mountains. Brecciated zones are present in some volcanic units. Some tuffs are interbedded with sedimentary units that may represent lake beds. Northwest- to north-northwest-trending faults have intensely broken the range. The area borders on the eastern part of the San Luis caldera, dated at 23-24 Ma (Deal et al., 1978). The district is associated with a magnetic low and a general gravity low between two gravity highs. The area coincides with moderate aeroradiometric K, U, and Th anomalies.

Mineral Deposits

Epithermal veins of manganese and uranium have been identified in the Alamo Hueco and Dog Mountains (Table 48). Analysis of stream sediments in the area indicates scattered high anomalies of As, Be, Bi, Cd, Cr, Cu, K, La, Mn, Mo, Nb, Th, Y, and Zn. Travertine and guano also occur in the area.

At the Opportunity claims, uranium occurs in a highly fractured and opalized zone at the intersection of two normal faults in the volcanic rocks (Everhart, 1957; McLemore, 1982, 1983). Samples assayed 0.02-0.77% U_3O_8 (McLemore, 1982, 1983). Mineralized breccia was traced for 450-600 ft to the northwest along strike. Radioactive veins of opal and quartz approximately 1-2 inches thick surround angular clasts of Tertiary rhyolite of the Oak Creek and Gillespie Tuffs. The opal is attractive and collected by mineral dealers.

Jasper and opaline quartz veins are found in several major fault zones in the southern part of the area (Reiter, 1980). Red, brown, and orange jasper veins and pods up to 9 ft long were identified at the intersection of two faults in sec. 16, T33S, R14W (Table 48). No analysis has been done to determine whether the veins contain appreciable amounts of uranium. These mineralized areas need to be examined and sampled to determine their mineral-resource potential.

Extensive travertine deposits, with manganese, occur in the Bluff Creek Canyon Formation in the southern part of the area (Reiter, 1980). There are two travertine beds, each about 3 ft thick, separated by a thin sandstone unit. Psilomelane bands up to 1 inch thick form the lowermost parts of the travertine beds. Prospect pits have developed the deposit, but production, if any, is unknown. Guano is found in a cave in sec. 16, T33S, R14W (Reiter, 1980).

Apache No. 2 district

Location and Mining History

The Apache No. 2 (Anderson, Hachita) mining district, located in the Apache Hills in easternmost Hidalgo County, was discovered in the late 1870s (Fig. 1, 27). The nearby Fremont district to the south is in the Sierra Rica. An estimated $107,000 worth of copper, silver, lead, gold, and zinc have been produced from the Apache No. 2 district from 1880 to 1956, including 1.3 million lbs Cu and 300,000 lbs Pb (Table 49; Elston, 1965). The chief products of the district have been copper ore containing gold and silver. Bismuth was recovered from some ore, and some rich silver ore was shipped (Lasky and Wootton, 1933). A considerable amount of scheelite occurs in the Apache deposit (Lasky and Wootton, 1933).

TABLE 49—Reported metal production from the Apache No. 2 mining district, Hidalgo County, New Mexico (from U.S. Bureau of Mines, 1927-1990). Most of the production came from the Apache mine. Small quantities of bismuth have also been produced. For years omitted, there are no reported production figures. — none reported.

YEAR	ORE (SHORT TONS)	COPPER (LBS)	GOLD (OZ)	SILVER (OZ)	LEAD (LBS)	ZINC (LBS)	TOTAL VALUE ($)
1927	4,800	144,000	—	7,200	—	—	—
1939	164	5,600	37	3,636	5,000	—	4,580
1942	30	—	—	—	—	14,300	1,330
1943	332	22,900	3	2,125	57,000	—	8,868
1944	231	400	1	1,236	49,600	—	4,936
1956	50	3,500	—	85	—	—	1,565
TOTAL 1927-1956	5,607	176,400	41	14,282	111,600	14,300	21,279
ESTIMATED TOTAL 1880-1956	—	1,300,000	300	125,000	300,000	20,000	107,000

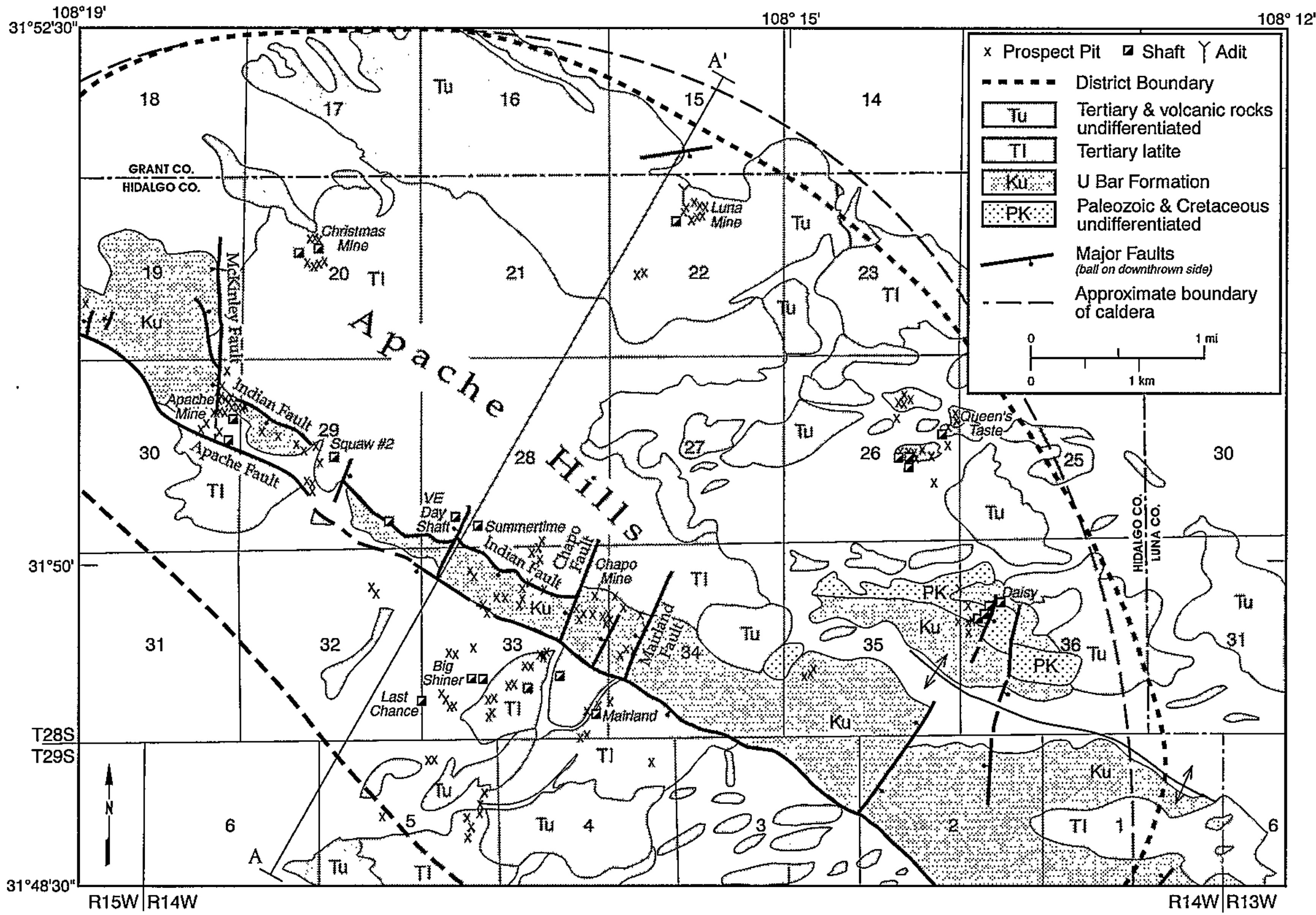

Figure 27—Mines and prospects in the Apache No. 2 mining district, Hidalgo County, New Mexico (modified from Strongin, 1957, and Peterson, 1976).

Three major mines, the Apache, Chapo, and Daisy, are located in the district (Fig. 34; Table 50). The Apache mine was first operated by Chihuahua Indians who carted ore to Chihuahua for smelting (Strongin, 1957). Robert Anderson operated the mine for a number of years starting in 1880. Most mining was between 1900 and 1908. In the early days, rich silver ore consisted mostly of cerargyrite. Later, oxidized copper ore was shipped containing 3-4% Cu, 0.03-0.04 oz/ton Au, and 6 oz/ton Ag; the ore was rich in calcite and was in demand as a smelter flux. From 1915 to 1919, large quantities of silver-copper ore with bismuth in calcite gangue were shipped. From 1927 to 1929, a considerable tonnage of ore averaging 1.5% Cu and 1.5 oz/ton Ag was shipped. Additionally, several cars of ore were shipped averaging 12 oz/ton Ag and 10% Pb. Since that time, only relatively small amounts of ore have been shipped. The last known operation of the Daisy mine was in 1908, when ore was shipped assaying 18% Cu, 18 oz/ton Ag, and 0.03-0.14 oz/ton Au. Total production from the Daisy mine is estimated to be less than $10,000 (Strongin, 1957). The only production data available for the Chapo mine is that in 1940 some unknown amount of copper-gold ore was shipped (Strongin, 1957).

TABLE 50—Mines and prospects in the Apache No.2 mining district, Hidalgo County, New Mexico, located in Figure 27. Location includes section, township, and range.

MINE NAME (ALIAS)	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	YEARS OF PRODUCTION	DEVELOPMENT	PRODUCTION	TYPE OF DEPOSIT	REFERENCES
Apache (Indian, Squaw Monarch, Copper Crown, Cochise, Navajo, Papoose)	NE30 28S 14W	31° 50' 43", 108° 18' 18"	Cu, Ag, Pb, Zn, Au, Bi, W	1870s - 1956	300, 470 ft shafts, 7500 ft of drifts and crosscuts, opencut, pits	50,000 tons ore since 1870	skarn, carbonate-hosted Pb-Zn	Lindgren et al. (1910), Anderson (1957), Dale and McKinney (1959), Strongin (1957)
Big Shiner	SW33 28S 14W	31° 49' 35", 108° 16' 52"	Cu, Pb, Zn	none	inclined shaft, vertical shaft	none	carbonate-hosted Pb-Zn	Strongin (1957)
Chapo (VE Day, Chappo, Chapel)	NE33 28S 14W	31° 49' 24", 108° 16' 17"	Cu, Pb, Ag, Au	1916 - 1940	180 ft shaft, several prospect pits	40 carloads 4-8% Cu	skarn, carbonate-hosted Pb-Zn	Strongin (1957), Peterson (1976), NMBMMR file data
Christmas (Geiger, Geiger no 2)	20 28S 14W	31° 51' 31", 108° 17' 37"	Cu, Pb, Zn, Mo	none	inclined stope 100 ft long, other shallow workings	some	carbonate-hosted Pb-Zn	Peterson (1976), Strongin (1957)
Daisy	36 28S 14W	31° 49' 46", 108° 13' 55"	Cu, Pb, Zn, Ag, Mo	1860s,1908	opencuts, shafts no more than 40 ft deep	$8,000 Cu-Ag-Au ore	carbonate-hosted Pb-Zn	Peterson (1976), Lindgren et al. (1910), Strongin (1957)
Last Chance	SE32,SW33 28S 14W	31° 49' 20", 108° 17' 04"	Cu, Pb, Zn, Mo	1948, 1949	250 ft shaft, prospect holes	in 1948 - 80 tons Cu-Ag ore	carbonate-hosted Pb-Zn	Peterson (1976), Strongin (1957)
Luna (Lobo nos 1-4, Eaves, Continental)	22 28S 14W	31° 51' 41", 108° 15' 34"	Cu, Pb, Zn, Mo	1930, 1940s	shaft 150 ft deep, 50 ft adit	26 tons ore averaging 15-20% Pb, 16% Zn, 4-5 oz Ag, 1% Cu	carbonate-hosted Pb-Zn	Peterson (1976), Strongin (1957), NMBMMR file data
Mairland	SW34 28S 14W	31° 49' 31", 108° 15' 58"	Cu, Pb	1950	inclined shaft 60 ft deep	1 carload of Pb-Ag ore	carbonate-hosted Pb-Zn	Strongin (1957)
Prospects N30E of Last Chance	SW3 28S 14W	31° 49' 30", 108° 16' 47"	Pb, Zn	none	a few shallow holes	none	carbonate-hosted Pb-Zn	Strongin (1957)
Quartz prospect	NW9 29S 14W	31° 48' 19", 108° 16' 24"	Pb	none	3 prospect pits	none	carbonate-hosted Pb-Zn	Strongin (1957)

MINE NAME (ALIAS)	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	YEARS OF PRODUCTION	DEVELOPMENT	PRODUCTION	TYPE OF DEPOSIT	REFERENCES
Queen's Taste (Lead Queen)	NE26 28S 14W	31° 50' 36", 108° 14' 04"	Cu, Pb, Zn, Mo	1930,1931,1937,1949	prospect pits and shafts	a few tons of Pb-Ag ore	carbonate-hosted Pb-Zn	Peterson (1976), Strongin (1957)
Summertime	SW28 28S 14W	31° 50' 08", 108° 16' 50"	Cu, Pb, Zn, Mo	none	shaft near VE Day shaft	none	carbonate-hosted Pb-Zn	Peterson (1976)
Unknown	5 29S 14W	31° 48' 44", 108° 16' 49"	Cu,Pb	none	7 pits	none	carbonate-hosted Pb-Zn	NMBMMR file data
workings NE of Big Shiner	NW33 28S 14W	31° 49' 48", 108° 16' 41"	Cu, Pb	none	shallow inclined pits	none	carbonate-hosted Pb-Zn	Strongin (1957)

Geology

The Apache Hills consist of Tertiary volcanic rocks overlying Cretaceous sedimentary rocks and Paleozoic limestone (Strongin, 1957; Peterson, 1976). The main volcanic rocks belong to the Chapo Formation, which is dated as 30.66±1.15 Ma (K-feldspar, K-Ar; Deal et al., 1978). These rocks were intruded by the Apache quartz monzonite porphyry stock dated at 27.18±0.63 Ma (K-Ar, feldspar; Peterson, 1976; Deal et al., 1978). Irregular dikes and sills of monzonite porphyry are present in the Cretaceous rocks, and propylitic and silicic alteration is pervasive. The district lies within the region of gravity and magnetic highs that form a geophysical trend including the Fremont district. The area coincides with a low aeroradiometric K and Th and slightly elevated U aeroradiometric anomaly, which is characteristic of mineralized carbonate rocks in the Mimbres Resource Area.

Mineral deposits

Three types of deposits occur in the district: skarns, carbonate-hosted Pb-Zn replacements and polymetallic veins (Table 50). Oxidized skarn and carbonate-hosted lead-zinc deposits with copper sulfides occur in strata of Cretaceous U-Bar Limestone at the contact with the quartz monzonite. The deposits extend into the Sierra Rica of Mexico. Additional copper skarns are associated with monzonite and rhyolite dikes that were probably a part of a resurgent magma of the Apache caldera (Elston et al., 1979; Deal et al., 1978). Mineralization occurred after emplacement of a massive dike of xenolith-rich rhyolite porphyry along the Apache fault which follows the southwestern margin of the resurgent quartz monzonite stock (Elston, 1983). A thin but persistent zone of oxidized copper skarns extends along the contact between the dike and Cretaceous limestone. The rhyolite is younger than, but probably related to, the Apache Hills quartz monzonite stock. Predominant ore minerals include malachite, azurite, and chrysocolla; an ore shipment in 1914 assayed 1.55% Cu and 2 oz/ton Ag (Wade, 1914).

The Apache ore body is an irregularly-shaped skarn deposit in Cretaceous limestone and is associated with the quartz monzonite porphyry that intruded the limestone (Lindgren et al., 1910). Ore deposition was controlled by major north-trending structures. The most prominent of these structures is the McKinley fault which hosts the Apache deposit on its southeast side and is only slightly mineralized with galena, sphalerite, and chalcopyrite. Zones of skarn development in the limestone beds formed near the irregular contact with the igneous rocks. At the main shaft, the limestone has been recyrstallized to a coarse-grained calcite; nearby, the same limestone has been altered to a greenish or brown garnet and calcite. The Apache ore body consisted of large and small stringers, shoots, and pods of ore randomly distributed throughout the sediments (Strongin, 1957). Most of the material mined consisted of sedimentary rocks cut by sulfide-filled fractures that contains little or no calc-silicate minerals. Veins containing andradite garnet, epidote, hematite, fluorite, and chalcopyrite occur locally. Ore minerals include galena, sphalerite, and associated cerargyrite in a gangue of calcite, garnet, limonite, and pyrite. Scheelite, cuproscheelite, and bismutite were identified in dump samples of recrystallized limestone (Strongin, 1957). The richest ore shipped from the Apache mine contained 0.05 oz/ton Au, 12.7 oz/ton Ag, 21% Pb, 4% Cu, and 25% Zn (Elston, 1960). Dump and chip samples collected in the mid-1980s assayed as high as 1.3% Cu, 800 ppm Mo, 6.0% Pb, 0.2% Zn, and 5.1 oz/ton Ag (Peterson, 1976).

The Daisy mine, a carbonate-hosted Pb-Zn deposit, consists of fissure-filling veins and replacements in brecciated limestone and is confined to northeast-trending faults. The veins pinch and swell, but are generally 2-3 ft thick. Stringers of iron and copper minerals occur in the breccia and replace the limestone adjacent to the faults. The deposits are similar to those at the mines in the Fremont mining district. Chalcopyrite and pyrite occur in quartz-calcite veins; native bismuth and tenorite have been reported. Oxidized minerals include malachite, azurite, chrysocolla, jarosite, hematite, limonite, and pyrolusite (Strongin, 1957). A sample assayed 0.4% Cu, 22 ppm Mo, 850 ppm Pb, 625 ppm Zn, and 2.1 oz/ton Ag (Peterson, 1976).

Quartz veins locally containing lead, silver, and copper cut andesite of the Last Chance Formation and basalt and rhyolite dikes (Strongin, 1957). Extent of the veins is unknown. Chloritic alteration is common along the veins. Samples at the Chapo mine assayed as high as 2.61% Cu, 5.95% Zn, 4.72% Pb, 0.01 oz/ton Au, 1.5 oz/ton Ag, and 0.004% Mo (NMBMMR file data). A sample from the Luna mine assayed 2.0% Cu, 225 ppm Mo, 5.2% Pb, and 2.8% Zn; whereas a sample from the Summertime mine assayed 1.1% Cu, 66 ppm Mo, 200 ppm Pb, and 100 ppm Zn (Peterson, 1976). Gold assays from various pits range as high as 910 ppb Au (Griswold et al., 1989).

Very little exploratory work has been done in this district. Undiscovered ore bodies undoubtly exist, but discovery of a large deposit would be required to pay for exploration. The favorable areas for exploration would be intersections of the marblized limestone, Indian and McKinley-Chapo faults, and other north or north-east trending faults (Strongin, 1957; Elston, 1960). Anomalously high concentrations of As, Be, Bi, Cd, Co, Cu, K, La, Mn, Mo, Pb, Sb, Th, U, Y, and Zn occur in stream-sediment samples collected from drainages in the area.

Big Hatchet Mountains district

Location and Mining History

The Big Hatchet Mountains mining district is in the Big Hatchet Mountains in southern Hidalgo County (Fig. 28). Only a few prospects have been discovered in the district (Table 51) and production is small. The mines are located in the Big Hatchet State Game Refuge and the Big Hatchet Wilderness Study Area. Prospecting began in the mountains in 1917, and some extensive occurrences of gypsum and minor carbonate-hosted Pb-Zn (Ag) replacement deposits have been discovered. Early production records are not available or are ambiguous, but total production from 1920 to 1931 is estimated as less than $2,000 (Table 2; Elston, 1965). In 1917, one carload of zinc was shipped from the Sheridan mine, and in 1919 a small lot was shipped from the Brock mine (Elston, 1960). Since then, the only known production has been several truck loads of agricultural-grade gypsum (50%-70% $CaSO_4 \cdot 2H_2O$) that were produced in the 1950s and 1960s.

TABLE 51—Mines and prospects in the Big Hatchet Mountains mining district, Hidalgo County, New Mexico, located in Figure 28. Location includes section, township, and range.

MINE NAME (ALIAS)	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	DEVELOPMENT	HOST	TYPE OF DEPOSIT	REFERENCES
Anomaly no 12	31 30S 15W	32° 39' 30", 108° 24' 5"	U	none	Proterozoic granite	vein	Allison and Ove (1957), McLemore (1983)
Anomaly no 13	NE1/4 20 32S 14W	31° 29' 50", 108° 16' 55"	U	none	Tertiary rhyolite tuff	vein	McLemore (1983), Zeller (1975), Allison and Ove (1957)
Lead Queen	E35 31S 15W	31° 34' 00", 108° 19' 45"	Pb, Zn, Ag (Cd)	adit, pits	Horquilla Limestone	carbonate-hosted Pb-Zn replacement	Hammarstrom, et al. (1988), Drewes et al. (1988), Scott (1986)
Proverbial (Proverbial Group)	SW21 31S 15W	31°36'5", 108° 22' 35"	Gypsum	Small quarry	Permian Epitah Dolomite	gypsum	Drewes et al. (1988), Scott (1986)
Sheridan (Carbonate King group)	15,22,23 31S 15W	31° 36' 5", 108° 20' 55"	Pb, Zn, Ag	adit, pits, shaft	late Paleozoic limestone	carbonate-hosted Pb-Zn replacement	Elston (1960), Hammarstrom et al, (1988), Drewes et al. (1988), Scott (1986)
unknown	SE17 31S 15W	31° 35' 5", 108° 22' 40"	Ba	pits	Horquilla Limestone	carbonate-hosted Pb-Zn replacement	Drewes et al. (1988)
unknown	NW SE 15 31S 15W	31° 36' 35", 108° 20' 55"	Ba	pits	Permian Epitah Dolomite	carbonate-hosted Pb-Zn replacement	Drewes et al. (1988)
unknown (Chaney Canyon, USBM 145)	SW31 30S 15W	31° 39' 5", 108° 24' 40"	Pb?	pits	Horquilla Limestone	carbonate-hosted Pb-Zn replacement	Scott (1986)
unknown (USBM 11-13)	S5 31S 15W	31° 38' 25", 108° 23' 15"	Pb, Zn	pits	Horquilla Limestone	carbonate-hosted Pb-Zn replacement	Scott (1986)

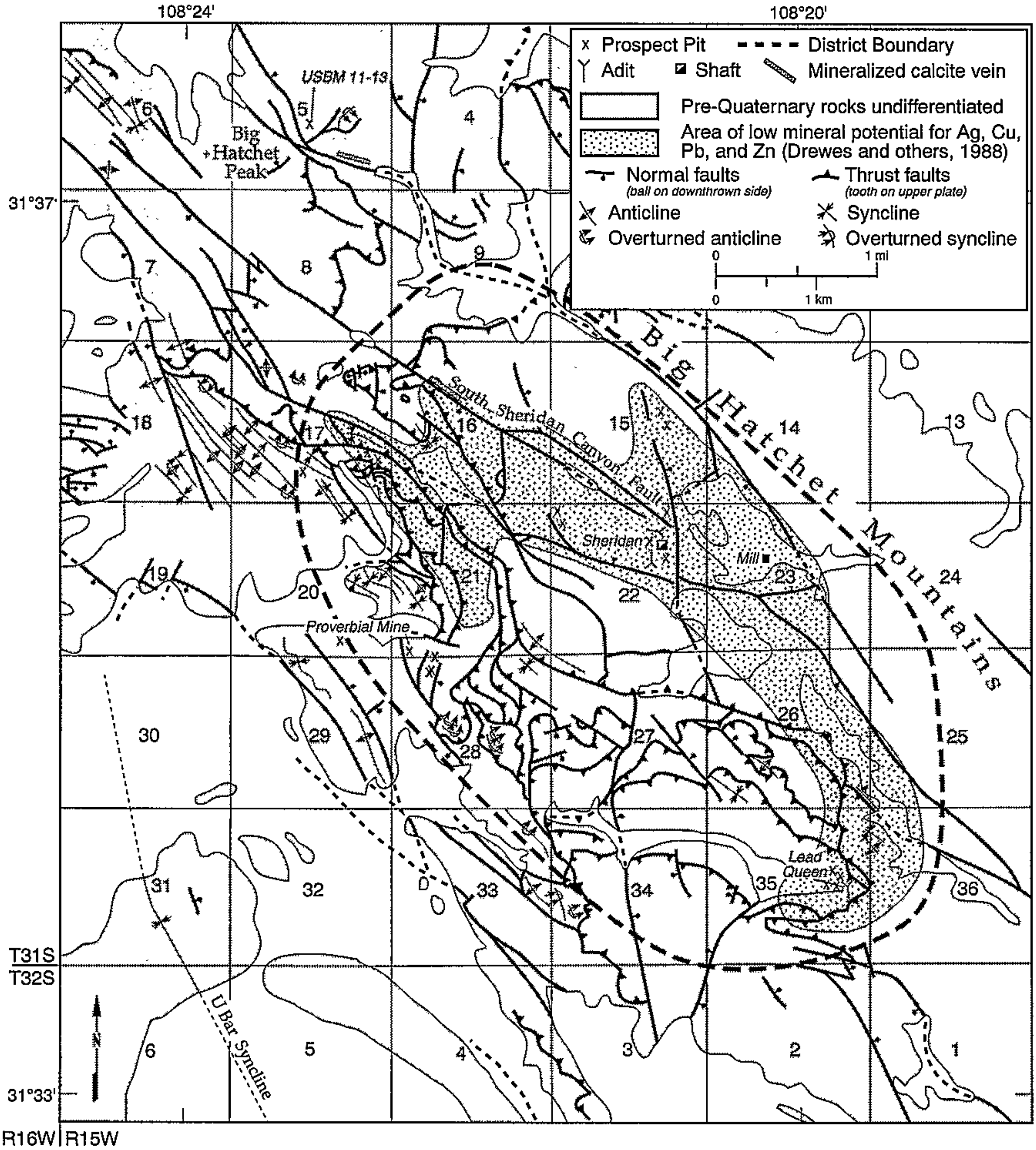

Figure 28—Mines and prospects in the Big Hatchet Mountains mining district, Hidalgo County, New Mexico (modified from Drewes, et al., 1988).

Geology

The Big Hatchet Mountains consist of faulted and tilted Paleozoic limestones and Cretaceous shales and sandstones that show few signs of mineralization or alteration (Lindgren et al., 1910; Drewes, 1991b). The rocks in the district consist predominantly of Horquilla Limestone and Earp Formation, with a thin, thrusted band of Oligocene andesite or basaltic-andesite. Outcrops of Colina Limestone rest upon the Earp Formation. Thrust faults occur on the western side of the district. Small carbonate-hosted Pb-Zn replacement deposits have been identified along the faults. The district is associated with large gravity and magnetic lows and a low aeroradiometric K and Th and slightly elevated U aeroradiometric anomaly.

Mineral deposits

Two types of mineral deposits have been identified in the Big Hatchet Mountains mining district, small carbonate-hosted Pb-Zn replacement deposits of presumably Tertiary age and bedded gypsum deposits in Epitaph Dolomite (Permain). Additionally, Lower Cretaceous evaporite gypsum occurs in the foothills south of the Big Hatchet Mountains in the Hell-To-Finish Formation. The replacement Pb-Zn deposits occur in two areas of the district, at the Sheridan mine in the northern part of the district, and at the Lead Queen mine in the southern part (Fig. 35; Table 51). Marine gypsum deposits occur in the western part of the district where gypsum has been quarried at the Proverbial mine.

At the Sheridan and Lead Queen mines, lead-silver-zinc oxide and sulfide minerals occur with calcite and limonite-manganese-stained gouge along bedding planes and faults in Horquilla Limestone (Pennsylvanian-Permian). Smithsonite and galena occur along a fault at the Sheridan mine (Scott, 1986; Drewes et al., 1988). The fault is less than 4 ft wide and was traced for 160 ft underground. Samples assayed as high as 0.39% Cd, 16.6% Pb, 1.8 oz/ton Ag, and 36.1% Zn (Scott, 1986; Drewes et al., 1988). Silver is associated with the lead minerals and cadimium is associated with the zinc minerals. The remaining indicated resources at the Sheridan mine are estimated as 4,500 short tons of material averaging 3.2% Pb, 0.4 oz/ton Ag, and 2.2% Zn (Scott, 1986; Drewes et al., 1988). Further exploration down dip and along strike could discover additional resources. However, these resources are probably low grade, small tonnage, and they are subeconomic at present.

The Lead Queen mine contains less calcite, more galena, and greater concentrations of cadmium, lead, silver, and zinc than found at the Sheridan mine (Scott, 1986; Drewes et al., 1988). Samples assayed as high as 0.12% Cd, 0.01% Cu, 33.2% Pb, 7.4 oz/ton Ag, and 16.9% Zn. Three mineralized faults at the mine were estimated to contain a total of 2,900 short tons of material averaging 0.21% Pb, 01.1 oz/ton Ag, and 0.5% Zn (Scott, 1986; Drewes et al., 1988). As with the Sheridan mine, the low grade and small tonnage reported for the Lead Queen mine makes the deposit subeconomic. However, further exploration down dip and along strike could discover additional resources.

Drewes et al. (1988) determined that the Big Hatchet Mountains mining district has a relatively low potential for copper, lead, silver, zinc, uranium, and industrial rock and mineral resources. The area along Sheridan Canyon fault between Mine Canyon Tank and Hell To Get To Tank was identified as a geologic terrane having mineral potential, in part, because of the presence of the Lead Queen, Sheridan, and numerous other prospects.

Additional sites of subeconomic resources were identified in the area as having mineral potential, such as east of Sheridan Canyon fault. These sites occur in the vicinity of several calcite veins. Most of these veins are less than 3 ft thick and are typically barren of metals, but some contain small, local amounts of Ag, As, Ba, Cu, and Zn (Drewes et al., 1988). Geochemical anomalies of As, Cd, Sn, and Ti are scattered in stream-sediments samples in the Big Hatchet Mountains, and selected samples contain anomalously high concentrations of Co, Mn, Nb, and U on the south end of the range.

At the Proverbial mine, gypsum occurs in an outcrop of Epitaph Dolomite and can be seen in a quarry as a distorted, dome-like structure having an exposed thickness of approximately 30 ft. The deposit contains a large amount of gypsum, anhydrite, and impurities such as clay, dolomite, limestone, and shale. Samples from the Proverbial mine contained 60-80% $CaSO_4{\cdot}2H_2O$. Gypsum is a low-value, high-tonnage commodity where the location of the deposits and the distance to market play important roles in whether or not the deposits are developed. The Proverbial mine in the Big Hatchet Mountains is quite distant from a market and precludes development of the deposit for the foreseeable future.

Weber and Kottlowski (1959) describes deposits of Permian gypsum exposed at the southwestern edge of the Big Hatchet Mountains, in sec. 20, 21, 28, and 29, T31S, R15W. The exposure covers about 23 acres and has a thickness estimated between 200 and 300 ft. The contorted gypsum is interbedded with dolomites. The large thickness was suggested by Weber and Kottlowski (1959) is possibly due to plastic flow of the gypsum at the base of overthrust sheets.

Weber and Kottlowski (1959) reports that outcrops of Lower Cretaceous gypsum are exposed in the foothills south of the Big Hatchet Mountains in two places. One outcrop is in a gully near the center of NW¼ NW¼ sec. 10, T32S, R15W, and the other is to the north in a gully in NW¼ SW¼ SW¼ sec. 3, T32S, R15W. At least two beds of gypsum have been identified interbedded with red shale, red sandstone, and marine limestone in the uppermost part of the Hell-to-Finish Formation and below the limestones of the U-Bar Formation. Estimated combined maximum thickness of the two beds is about 60 ft, and they have been traced for approximately one quarter of a mile. The gypsum deposits appear to be of high purity, but again, are too far from a market to be of commercial interest.

Brockman district

The Brockman district (sec. 1, T26S, R17W) consists of the Brockman silica quarry, operated by Phelps Dodge Corp., near Playas in southern Hidalgo County (Fig. 1). Silica sand has been produced from the Mojado Formation (Cretaceous) since the early 1900s for use as flux in nearby smelters. Less than $1 million has been produced since the early 1900s. Capacity is approximatley 70,000 short tons/year (Austin et al., 1982).

Fremont district

Location and Mining History

The Fremont mining district is located in the northwestern Sierra Rica about 15 mi southeast of Hachita. It is at the junction of Luna and Hidalgo Counties, and the international boundary between the United States and Mexico forms its southeastern border (Fig. 1) and most known mineral deposits in the district are in Mexico. The district was discovered in 1860. In the past, the Fremont mining district has produced a small amount of base and precious metals from volcanic-epithermal vein and carbonate-hosted Pb-Zn replacment deposits (McLemore, in press b; McLemore and Lueth, 1995, in press). The district has produced 190,000 lbs Pb, 10,000 oz Ag, 2,000 lbs Cu, 10 oz Au, and 4,000 lbs Zn (Table 52). Most of this production has come from the International mine (Table 52) which is located near the eastern tip of the area. Other mines in the district have had little or no production.

TABLE 52—Reported metal production from the Fremont mining district, Hidalgo and Luna Counties, New Mexico (from U.S. Bureau of Mines, 1927-1990). For 1949 and 1950, there are no reported prodcution figures. —none reported.

YEAR	ORE (SHORT TONS)	COPPER (LBS)	GOLD (OZ)	SILVER (OZ)	LEAD (LBS)	ZINC (LBS)	TOTAL VALUE ($)
1947	183	400	1	318	14,800	—	2,538
1948	90	—	2	53	4,000	—	834
1951	6	—	—	6	1,700	—	299
TOTAL 1947-1951	279	400	3	377	20,500	—	3,671
ESTIMATED TOTAL 1880-1951	—	2,000	10	10,000	190,000	4,000	17,000

Since the discovery of lead, zinc, copper, silver, and gold deposits in 1880, the International mine has produced approximately 879 short tons of ore (Griswold, 1961). The best ore was a 10-short ton shipment grading 40% Pb and $62 per ton silver (at 95 cents per ounce; Lindgren et al., 1910). Between 1910 and 1959, 14 railroad cars of approximate 50 short tons each and another 129 short tons were shipped. Additional shipments probably were made, but not reported. The Napone mine yielded 35 lbs of U_3O_8 in 1955 (Table 5).

Geology

The Fremont mining district is on the edge of the Apache Hills caldera and forms the eastern part of the intermediate zone of the Cordilleran orogenic belt (Drewes, 1991b). It is characterized by gravity and magnetic highs. The rocks range in age from Paleozoic to Quaternary (Strongin, 1957; Peterson, 1976; Griswold, 1961; Drewes, 1991b). Thrust faults are common. Paleozoic carbonate rocks and Cretaceous clastic rocks are overlain by Tertiary volcanic rocks and intruded by quartz monzonite and monzonite stocks. The main volcanic rocks belong to the Chapo Formation, which is dated as 30.66±1.15 Ma (K-feldspar, K-Ar; Deal et al., 1978). The monzonite is dated as 27.03±0.59 Ma (K-Ar, feldspar; Peterson, 1976; Deal et al., 1978). Rhyolite, latite, felsite, and lamprophyre dikes are common. The limestones are silicified and the volcanic rocks exhibit argillic alteration.

The area is associated with gravity and magnetic highs. The area is associated with a low aeroradiometric K and Th and slightly elevated U aeroradiometric anomaly.

Mineral deposits

The deposits in the district are volcanic-epithermal vein and carbonate-hosted Pb-Zn replacement deposits (Table 53). Only a few localized geochemical anomalies (As, Bi, Cd, Pb, and Sb) are found in stream sediments from the area.

TABLE 53—Mines and prospects from the Fremont mining district, Hidalgo and Luna Counties, New Mexico. Location includes section, township, and range.

MINE NAME (ALIAS)	LOCATION	LATITUDE	LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
American	SE25 29S 14W	31° 45' 15"	108° 12' 40"	Cu, Ag	shallow pits	volcanic-epithermal	Lindgren, et al (1910), Elston (1960)
Barnett (Nutshell)	SE25 29S 14W	31° 45' 14"	108° 12' 38"	Cu, Ag, Au	90 ft shaft	carbonate-hosted Pb-Zn replacement	Lindgren et al. (1910)
Casher (Ford)	SW9 29S 13W	31° 47' 35"	108° 10' 15"	Pb, Zn	2 small adits, pits	carbonate-hosted Pb-Zn replacement	Strongin (1957), Elston (1960)
Copper Valley (Silver Valley)	NE22 29S 14W	31° 45' 35"	108° 46 00"	Pb,Cu	pits, shaft	volcanic-epithermal	Strongin (1957)
Doyle (Conveldo)	SE25 29S 14W	31° 45' 18"	108° 12' 35"	Pb, Zn, Ag	2 shallow shafts	carbonate-hosted Pb-Zn replacement	Lindgren et al. (1910)
Eagle (Occidental Mines, Volney Mine, Fitch Bi-Mo Property, Yucca)	SE25 29S 14W	31° 45' 16"	108° 13' 00"	Pb, Ag, Cu, Au, Bi	several shallow shafts, short adits, and prospect	carbonate-hosted Pb-Zn replacement	Cooper (1962), Lindgren et al. (1910), Strongin (1957), NMBMMR file data
Faith	SE35 29S 14W	31° 44' 30"	108° 13' 48"	Pb, Zn	several pits	carbonate-hosted Pb-Zn replacement	NMBMMR file data
International (Keno, Rector, Rattlesnake, Silver Fox, Pick and Shovel)	NE16 29S 13W	31° 47' 08"	108° 10' 08"	Pb, Ag, Au, Zn, Cu	3 shafts ranging from 100-250 ft, pits & trenches	carbonate-hosted Pb-Zn replacement	Griswold (1961), Zeller (1970), Lasky (1947), Hammarstrom et al. (1988)
Napone (Nutshell, Yucca, Occidental)	SE 25 29S 14W	31° 45' 20"	108° 12' 33"	U, Pb, Zn, Cu, Au, Mn, Ag	Inclined 100 ft shaft and opencut	carbonate-hosted Pb-Zn replacement	McLemore (1982), Hammarstrom, et al (1988), Strongin (1957), Elston (1960), FN 12/2/81
Vanadium Lead	SW27 29S 14W	31° 45' 30"	108° 15' 30"	Cu,Pb,V	pits	volcanic-epithermal	Strongin (1957)
Weatherford	NE 13 30S 14W	31° 42' 23"	108° 12' 34"	Cu	pits	carbonate-hosted Pb-Zn replacement	Strongin (1957)

The Napone (or Nutshell) mine, discovered in 1894, yielded several hundred short tons of lead-zinc ore prior to 1949. In 1953, 9.23 short tons of ore were produced that contained 35.06 pounds of U_3O_8 (0.19% U_3O_8) and 3.69 pounds V_2O_5 (0.02% V_2O_5). The deposit consists of replacement bodies and veins along bedding fractures and faults and is approximately 700 ft long. The ore bodies are en echelon and occur in areas of extensive brecciation and silicification of the limestone. The extent at depth is unknown. Uranium minerals (carnotite, autunite) are sporadically distributed in ore bodies consisting of galena, cerussite, smithsonite, sphalerite, pyrite, chalcopyrite, calcite, siderite, and quartz. One selected sample contained 0.13% U_3O_8 and 127 ppm Th (McLemore, 1983) and May et al. (1981) reports one assay of 0.47% U_3O_8. Ore assays range as high as 45.8% Pb, 30.8% Zn, and 1.03 oz/ton Ag (NMBMMR file data).

The International mine exploits a 4,000-ft long volcanic-epithermal vein in a fault cutting Lower Cretaceous sandstone, shale, and limestone conglomerate. The vein is mineralized for about 2,000 ft; about 1,000 ft of the mineralized vein is in Mexico (Griswold, 1961). The vein ranges from 1 to 10 ft wide on the surface and averages approximately 4 ft wide. Near the vein, the beds are contorted, suggesting tearings and left-lateral movement along the fault. The vein follows a 5-ft thick band of reddish grit fault gouge that was recemented with silica and calcite (Griswold, 1961). The ore minerals are galena, sphalerite, and chalcopyrite accompanied by quartz, calcite, iron oxides, and pyrite as gangue. Gold and silver are present, and oxide minerals are evident on the outcrop.

The Eagle mine consists of replacement bodies in limestone and minor veins along a fault striking N5°E (Elston, 1960). The mine produced in the 1880s and again in 1906-1907 and yielded 200 short tons of argentiferous galena that averaged 40% Pb and 20 oz/short ton Ag (Lindgren et al., 1910). Galena with quartz and calcite has replaced limestone with little or no recrystallization; iron staining is prevalent at the surface. Tungsten and bismuth have been reported to sporadically occur in the vein (NMBMMR file data).

Numerous other prospects and mines occur in the area (Table 53). Most are shallow and the mineral potential at depth is unknown. A core-drilling program might find additional ore in the vein, but the value of the ore would probably not pay for the cost of exploration, development, mining, and transportation (Griswold, 1961). Griswold (1961) reports that a perlite deposit had been reported in the volcanic hills north of the Sierra Rica, but he was unable to locate and confirm the occurrence.

Gillespie district

Location and Mining History

The Gillespie mining district, also known as the Red Hill district, is located in the Animas Mountains about 30 mi southwest of Hachita and 22 mi south of Playas (Fig. 29). The Cowboy Spring Wilderness Study Area lies south of the district. The district was discovered in 1880. A minor amount of Au, Ag, Cu, Pb, and Zn, amounting to $100,000, was produced from volcanic-epithermal veins from 1880 to 1950 (Table 54; Lasky and Wootton, 1933; Elston, 1965). Most of the ore was produced from the Red Hill mine which was active sporadically during that period. Ore grades for the Red Hill mine between 1905 and 1950 were 0.01 oz/short ton Au, 4.06 oz/short ton Ag, 0.18% Cu, 17.92% Pb, and 0.91% Zn. Workings consist of two inaccessible shafts and a 400-ft main shaft with two levels having about 1,000 ft of drifts and crosscuts.

TABLE 54—Reported metal production from the Gillespie mining district, Hidalgo and Luna Counties, New Mexico (from U. S. Geological Survey, 1902-1927; U. S. Bureau of Mines, 1927-1990; Elston, 1960). For years omitted, there are no reported production figures. — none reported.

YEAR	ORE (SHORT TONS)	COPPER (LBS)	GOLD (OZ)	SILVER (OZ)	LEAD (LBS)	ZINC (LBS)	TOTAL VALUE ($)
1908	37	—	—	192	14,400	—	700
1909	305	—	—	1,464	155,500	—	7,400
1910	29	—	—	273	12,300	—	680
1911	18	—	—	85	10,000	—	480
1922	128	—	—	738	87,200	—	5,200
1923	385	—	—	1,810	221,000	—	13,000
1924	269	—	—	941	124,000	—	10,700
1925	37	—	—	131	13,400	—	1,300
1926	several cars	—	—	?	?	—	?
1929	one car	—	—	?	?	—	?
1930	several cars	—	—	?	?	—	?
1931	284	700	1	1,162	107,000	—	4,350
1938	143	700	2.6	1,488	23,300	—	2,194
1941	88	200	1	398	32,200	—	2,177
1945	238	—	—	637	33,600	—	3,343
1947	849	700	1	2,548	110,100	—	18,342
1950	936	1,100	--	2,382	75,500	—	12,578
TOTAL 1908-1950	3,746	3,400	6	14,249	1,019,500	—	82,444
ESTIMATED TOTAL 1880-1950	—	15,000	20	20,000	1,800,000	2,000	100,000

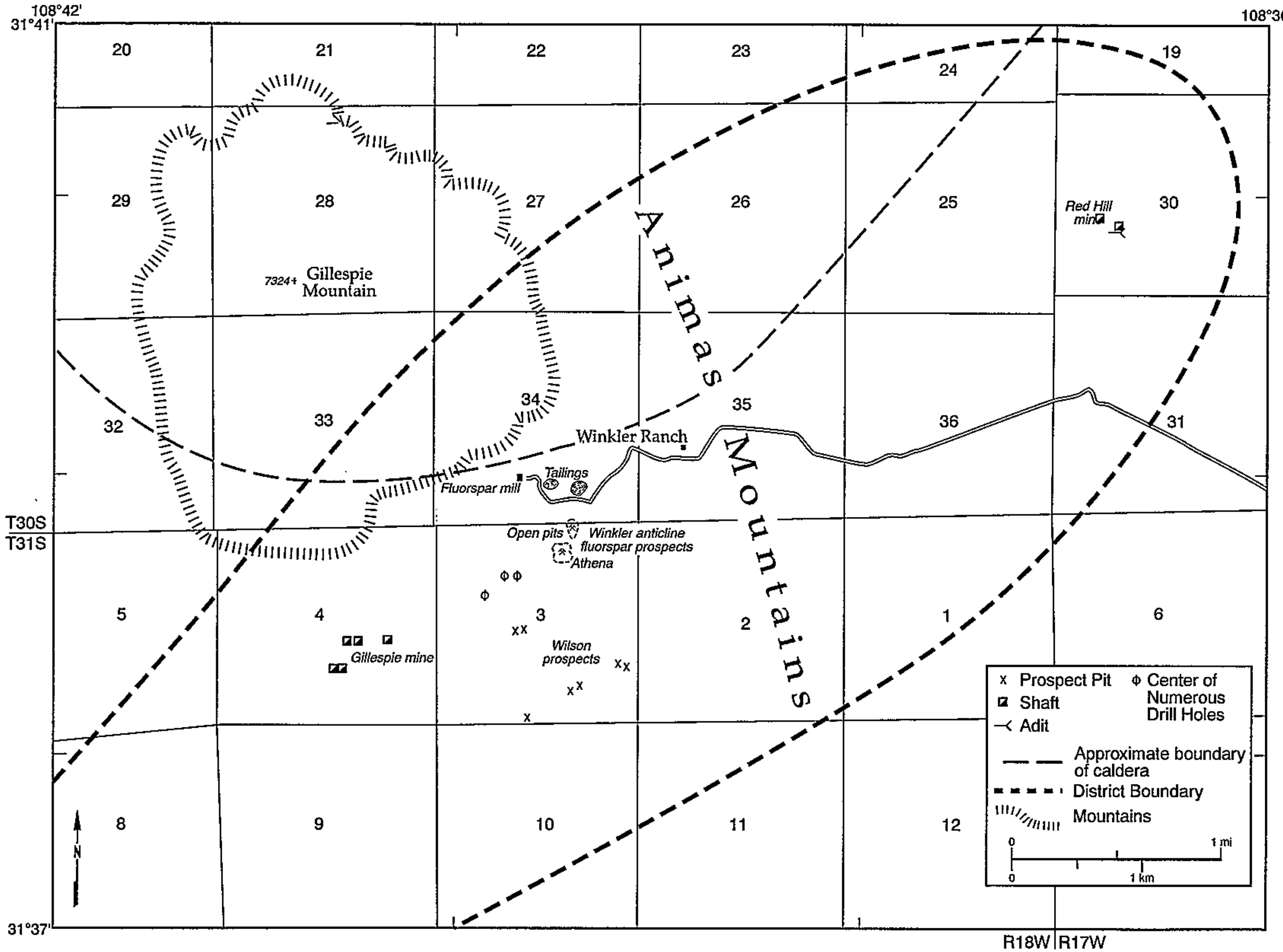

Figure 29—Mines and prospects in the Gillespie mining district, Hidalgo County, New Mexico.

The Gillespie deposit was discovered in 1880. Presently, the workings consists of shafts and numerous pits; the deepest is 100 ft (Zeller and Alper, 1965) A visit to the district in 1994 indicated that there had been development work at the Gillespie mine as late as 1991 in at least one of the shafts. No production has been reported for the Gillespie mine.

In 1960, fluorspar was discovered at the Athena prospects at the Winkler anticline (known then as the Volcano claims) southeast of the district. Several trenches and four shallow test shafts were dug, 50-100 ft deep percussion holes were drilled, and extensive sampling and geochemical testing were performed. A resource was identified of approximately 150,000 short tons of material containing 25-35% CaF_2, with copper and silver as potential byproducts. A mill was erected in sec. 34, T30S, R18W (Fig. 30) and 1,500 short tons fluorite was shipped in the 1970s (Phil Young, local rancher, oral communication, April 19, 1994). However, the ore was low grade and difficult to concentrate, so the mill was unsuccessful.

Manganese was also produced from several veins (Table 55). Approximately 276 long tons of 22-45% Mn was produced. Tungsten occurs in these veins, but there is no reported production (Dale and McKinney, 1959).

TABLE 55—Mines and prospects from the Gillespie mining district, Hidalgo County, New Mexico. Location includes section, township, and range.

MINE NAME (ALIAS)	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	DEVELOPMENT	PRODUCTION	TYPE OF DEPOSIT	REFERENCES
Athena Group (Volcano, Winkler anticline)	34 30S 18W, 3 31S 18W	31° 38' 25", 108° 39' 10"	F	pits, trenches, drill holes	1,500 tons of fluorite	epithermal fluorite	Ellis (1971), McAnulty (1972, 1978), FN 4/19/94
Combined Minerals Corp.	SE NE 31 29S 18W	31° 44' 27", 108° 42' 09"	Mn	70 ft shaft, pit	150 tons 40-45% Mn	epithermal manganese	Zeller and Alper (1965), FN 2/21/94
Gillespie	SE4 31S 18W	31° 38' 11", 108° 40' 36"	Ag, Cu	60-100 ft shaft, 40 ft shaft, pit	small	volcanic-epithermal vein	Zeller and Alper (1965), Ellis (1971), Elston (1960), FN 4/19/94
Peace	29 31S 19W	31° 34' 40", 108° 47' 35"	Mn, F	55 ft shaft, pits	20 tons 42.7% Mn, 6.6 tons 42.6% Mn	epithermal manganese	Farnham (1961)
Red Hill	SW 30 30S 17W	31° 40' 70", 108° 36' 48"	Pb, Ag, Cu, Zn, Au, Mo	400 ft shaft with levels, 2 shafts 20-40 ft, 50 ft adit	most of production from district	volcanic-epithermal	Elston (1965), Zeller and Alper (1965), FN 4/19/94
Wilson prospect (U-Bar fault prospects)	SW3 31S 18W	31° 34' 53", 108° 39' 10"	F	pits, trenches	none	epithermal fluorite	Ellis (1971), McAnulty (1978), FN 4/19/94
Lucky 3 and Black Streak	NE 30 29S 18W	31° 45' 27", 108° 42' 30"	Mn	shaft	6 tons 22.9% Mn	epithermal manganese	Farnham (1961), NMBMMR file data; FN 2/21/94
Ridge (Hodget, Broaddus, Plains)	SE 31 29S 18W	31° 44' 30", 108° 42' 25"	Mn,F,W	trench, pits, adits	100 tons 42% Mn	epithermal manganese	Dale and McKinney (1959), Zeller and Alper (1965), Williams, (1966), NMBMMBR file data, FN 2/21/94
unknown	SW 30 29S 18W	31° 45' 00", 108° 42' 35"	Mn	shaft	unknown	epithermal manganese	FN 2/21/94
unknown	SW 33 29S 18W	31° 44' 30", 108° 40' 30"	Mn	pit	none	epithermal manganes	NMBMMR files

FIGURE 30—Photo of the fluorite mill in 1994, looking north (abandoned) at the Winkler anticline, operated by the Mining and Milling Corporation of America, 1972-1975 (V. T. McLemore photo).

Geology

Laramide deformation accompanied andesitic and basaltic volcanism and intrusion of intermediate composition stocks; and was followed in the Oligocene by large-scale volcanism and formation of major ash-flow calderas (Elston et al., 1979). The district lies at the junction of the Animas Peak, Geronimo Trail, and Juniper calderas. In some of these calderas, porphyry stocks were intruded into the caldera during a resurgent magma pulse. The Juniper cauldera, in the Red Hill area, formed 35 Ma ago (Deal et al., 1978). In the Juniper caldera, the exposed Animas and Walnut Wells porphyries (Zeller and Alper, 1965) and a quartz monzonite stock that was located by drilling are evidence of magma resurgence (Elston et al., 1979). The Animas quartz monzonite was emplaced at 34.0 ±0.1 Ma ($^{40}Ar/^{39}Ar$, feldspar, McLemore et al., 1995). The major structural feature of the district is the Winkler anitcline. The area is characterized by low gravity, high magnetic, and low aeroradiometric K, U, and Th.

Mineral deposits

Mineralization consists of volcanic-epithermal veins of fluorite, gold-silver-lead, and manganese (Table 55). Four types of veins occur: silver-bearing (Gillespie mine), fluorspar (Winkler anticline deposits), oxidized lead-silver (Red Hill), and manganese (Combined Minerals Corporation mine). Silification is common near the veins. Stream-sediment geochemistry anomalies include Ag, As, Be, Co, K, La, Mn, Nb, Th, U, Y, and localized Au, Ti, and Sn.

The largest mine in the district is the Red Hill mine (Fig. 31) where a northwest-trending oxidized lead-silver vein cuts altered Tertiary quartz latite ash-flow tuff. The vein strikes N77°W, dips 75-85° NE, and consists mainly of cerussite, minor anglesite, and a small amount of residual galena, locally argentiferous (Zeller and Alper, 1965; Elston, 1965; V. T. McLemore, unpublished field notes, April 19, 1994). Malachite, chrysocolla, smithsonite, sphalerite, and wulfenite are also found (V. T. McLemore, unpublished field notes, April 19, 1994). Quartz and calcite are gangue minerals, with minor fluorite.

FIGURE 31—Photo of the Red Hill mine in 1994, Gillespie district. The vein is approximately3 ft wide and the hanging wall is altered to clay (V. T. McLemore photo).

FIGURE 32—Photo of the Gillespie mine in 1994, Gillespie district (V. T. McLemore, photo).

The Gillespie mine is situated on a small vein that strikes N65°E and dips 65°NW (Fig. 32). Host rocks are altered Pennsylvanian-Permian Horquilla Limestone and calcareous siltstone of the Earp Formation. Azurite and malachite occur on the dump; linnearite was found in a vug from a prospect pit. Calcite, quartz, siderite, and minor fluorite are gangue minerals. Siliffication is common.

The Winkler anticline fluorspar deposits occur as scattered pods and breccia cement in irregular fluorite-jasperoid replacement mantos. Pennsylvanian and Cretaceous limestones of the Horquilla Limestone and U-Bar Formation are the host rocks. Formation of the Winkler anticline produced fractures in the host rocks that allowed hydrothermal solutions to enter. Dissolution breccia occurs with fluorite filling open-spaces. Jasperoids are common. Clear, white, green, and purple fluorspar were identified in a gangue of quartz and calcite. Locally, trace amounts of sulfides occur with the fluorspar. The Texas Lime Co. drilled several holes in 1970-1971 and delineated estimated reserves of 150,000 short tons of 25-35 % fluorite (Scott, 1987). The majority of the material remains after production failed.

Manganese veins occur scattered throughout the district (Table 55; Zeller and Alper, 1965; V. T. McLemore, unpublished field notes, February 21, 1994). Volcanic rocks and the Animas quartz monzonite typically host the veins, which consist of manganese oxides, calcite, barite, fluorite, and rare quartz (Zeller and Alper, 1965). Ore produced from the Combined Minerals Corporation mine contained 40-45% Mn and less than 0.25% combined copper, lead, and zinc. The veins occur along normal faults that strike N14°E to N21°W, have steep dips, are typically less than 3 ft wide and several hundred feet long. The manganese-fluorite veins at the Ridge (Hodget) mine contain as much as 1% WO_3 and 39% Mn, but recovery of tungsten from manganese ore is not yet economically feasible (Dale and McKinney, 1959; NMBMMR file data). The veins are hosted by rhyolite, less than 2 ft wide in a zone less than 15 ft wide, and less than 150 ft long (Dale and McKinney, 1959; Williams, 1966).

Granite Gap district

Location and Mining History

The Granite Gap (or San Simon) mining district is located near the southern end of the central Peloncillo Mountains east of the Arizona-New Mexico state line and southwest of Lordsburg. Mines south of Blue Mountain and along Granite Gap are included in the district (Fig. 1). The Granite Gap Wilderness Study Area lies south of the district. Deposits in the district were first explored in about 1887, but large-scale mining operations did not begin until 1897 when control of several properties of the Granite Gap mines was consolidated (Gillerman, 1958). Two types of deposits occur in the district: carbonate-hosted Pb-Zn replacement and Laramide skarn deposits. Most production ended in 1915, although small amounts of ore were produced sporadically until 1926 and probably into the 1950s. Most of the production of lead and silver was shipped to Douglas, Arizona; Deming, New Mexico; and El Paso, Texas (Table 56). The total value of production until 1906 is estimated as at least $600,000 (Lindgren et al., 1910). The Crystal mine was being worked in 1954 and 1955, but total production is unknown. Total estimated production from the district amounts to $1.95 million, including more than 1.6 million lbs Pb and 91,000 oz Ag (Table 56). In addition, 3,000 short tons of 0.5% WO_3 was produced in 1943. In 1948, 5 short tons of 6% Sb was produced (Hobbs, 1965; Dasch, 1965).

TABLE 56—Reported metal production from the Granite Gap mining district, Hidalgo County, New Mexico (from U.S. Bureau of Mines, 1927-1990). Some of this production may have come from the McGhee Peak mining district. For years omitted, there are no reported production figures. —none reported.

YEAR	ORE (SHORT TONS)	COPPER (LBS)	GOLD (OZ)	SILVER (OZ)	LEAD (LBS)	ZINC (LBS)	TOTAL VALUE ($)
1934	200	—	26.62	6,960	—	—	5,429
1935	275	600	24.23	2,945	7,650	—	3,321
1936	156	150	23.40	2,980	600	—	3,169
1937	212	1,050	—	1,633	78,000	—	5,992
1938	15	—	59.60	20	100	—	2,104
1939	75	300	2	566	36,900	—	2,219
1940	1,030	700	2	1,575	76,600	9,000	5,666
1941	2,200	1,000	—	1,191	140,400	68,000	14,068
1942	2,590	900	117	44,242	67,600	69,100	46,620
1943	2,514	1,200	33	13,732	107,200	45,500	24,030
1944	37	200	—	76	6,600	—	609
1945	876	1,200	—	1,374	319,200	—	28,590
1946	—	—	—	—	—	—	—
1947	2,141	700	1	4,179	68,500	96,600	25,516
1948	2,096	7,000	13	4,359	190,000	184,000	64,401
1949	439	1,000	—	927	72,000	21,000	15,016
1950	119	800	—	1,097	63,400	—	9,718
1951	782	1,000	—	1,190	177,000	35,000	38,310
1952	982	—	—	1,695	183,000	114,000	49,921
1953	100	2,400	1.0	260	7,900	4,000	2,454
1955	67	200	—	51	4,500	6,000	1,529
TOTAL 1934-1955	16,906	20,400	303	91,052	1,606,750	652,200	348,682
ESTIMATED TOTAL 1897-1955	—	—	—	—	—	—	$1,950,000

Geology

The oldest rocks in the district are Proterozoic granite that crops out in a northwest-trending band in the northern part of the district north, of Preacher Mountain. Much of the remainder of the district consists mainly of Cretaceous and Paleozoic marine sedimentary rocks exposed in fault-bounded blocks. However, a large area in the southern part of the district, on either side of Granite Gap, has been intruded by Granite Gap granite (Cargo, 1959; Armstrong et al., 1978; Gebben, 1978; Richter et al., 1990). The granite is located mostly between Preacher Mountain and Granite Gap faults. Previously, Gillerman (1958) describes this granite as being Proterozoic and part of a fault-bound horst trending east-northeast transversing across the middle of the mountain range at Granite Gap. $^{40}Ar/^{39}Ar$ age determination of the Granite Gap pluton indicates emplacement near 33.2 Ma (McLemore et al., 1995). Several dikes, sills, and irregular masses of Tertiary granite porphyry intrude the Granite Gap granite and Cretaceous and Paleozoic rocks in the central Peloncillo Mountains (Fig. 33). The area is characterized by magnetic and gravity highs and high resistivity, which are consistent with intrusive rocks in the area.

Mineral deposits

Carbonate-hosted Pb-Zn replacement and skarn deposits are present in the Granite Gap mining district and are associated with Tertiary intrusions. The deposits occur in two geographic groups, those along the Preacher Mountain fault bounding the northern limit of the Granite Gap granite (Crystal mine) and those near the Granite Gap fault.

Both types of deposits have similar mineralogy and occur primarily in limestone. Veins deposits in the district are fissure fillings that occur mostly in limestone, as at the Granite Gap and Crystal mines. Skarn mineralization is less well developed than at the McGhee Peak district to the north. In the skarns, limestone is replaced by calc-silicate minerals, mainly garnet, and minor amounts of quartz, calcite, epidote, and wollastonite. Some zones contain 50-60% andradite garnet (Cargo, 1959). The deposits formed adjacent to Tertiary igneous intrusive rocks. Skarn mineralization was accompanied by the introduction of galena, sphalerite, and chalcopyrite (Armstrong et al., 1978). Tungsten is present in several mines (Table 57; Dale and McKinney, 1959).

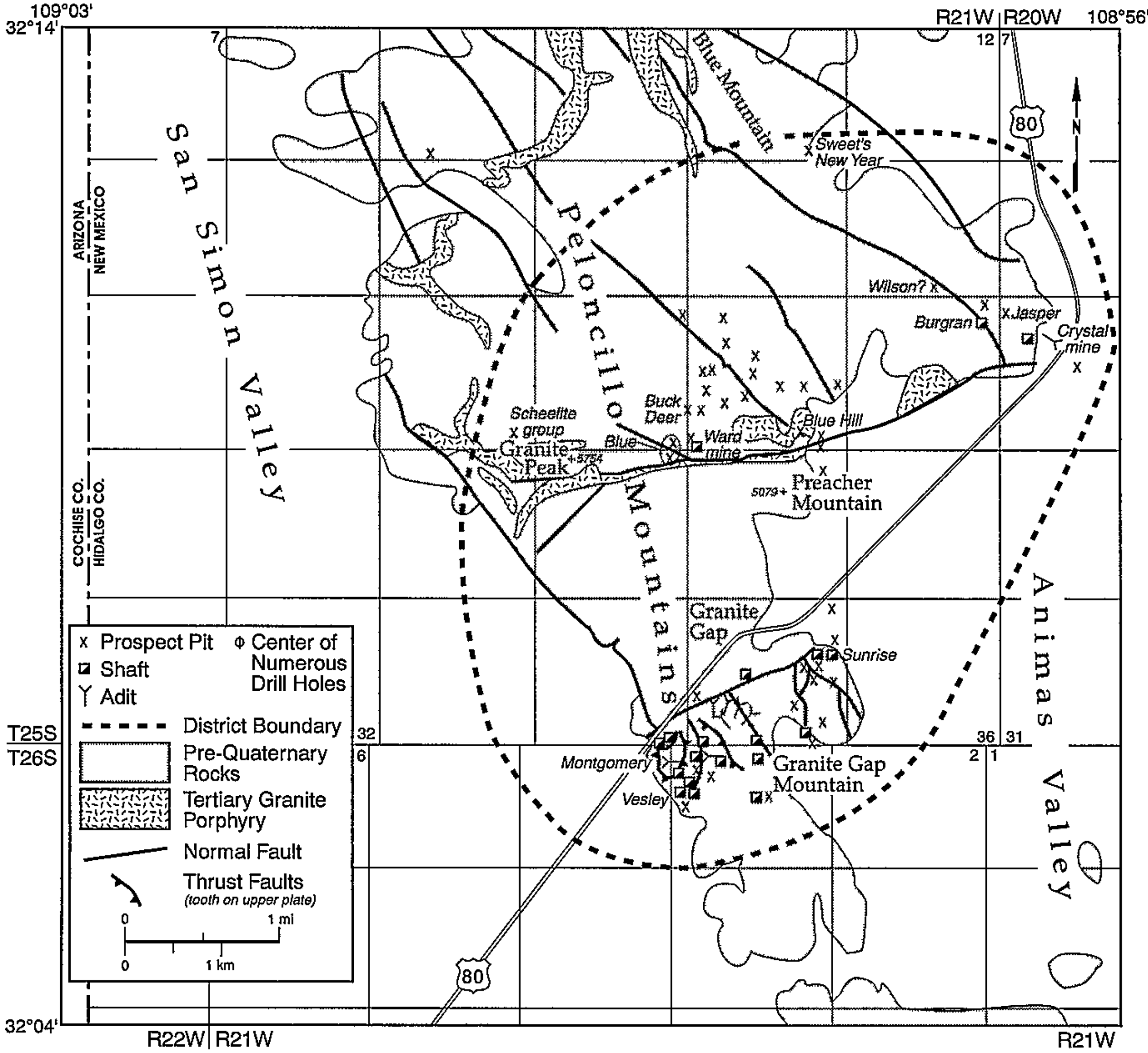

Figure 33—Mines and prospects in the Granite Gap mining districts, Hidalgo County, New Mexico (modified from Armstrong, et al., 1978, and Gillerman, 1958).

TABLE 57—Mines and prospects in the Granite Gap mining district, Hidalgo County, located in Figure 33. Location includes section, township, and range.

MINE NAME (ALIAS)	LOCATION	LATITUDE	LONGITUDE	COMMODITIES	DEVELOPMENT	HOST	TYPE OF DEPOSIT	REFERENCES
Blue (Blu and Murphy claims, McDonaldo)	27 25S 21W	32° 06' 41"	108° 58' 52"	Cu, Pb, Ag, Zn	several shallow shafts, pits	Pennsylvanian Horquilla Limestone	carbonate-hosted Pb-Zn replacement, Cu skarn	NMBMMR file data
Blue Hill	SE1/3 23 25S 21W	32° 06' 38"	108° 58' 09"	W	pits and trenches	Pennsylvanian Horquilla Limestone	carbonate-hosted Pb-Zn replacement, Pb-Zn-W skarn	Gillerman (1958), Dale and McKinney (1959)
Bob Montgomery Group	SE34 SW35 25S 21W	32° 04' 44"	108° 58' 40"	Pb, Zn, Ag	pits	Mississippian Escabora Limestone	carbonate-hosted Pb-Zn replacement	NMBMMR file data
Buck Deer	SW23, NW26 25S 21W	32° 06' 36"	108° 58' 48"	W	several pits and trenches up to 150 x 6 ft	Pennsylvanian Horquilla Limestone	carbonate-hosted Pb-Zn replacement, Pb-Zn-W skarn	Gillerman (1958), NMBMMR file data
Burgran	NE24 25S 21W (?)	32° 07' 15"	108° 56' 46"	Pb,Zn,Cu,Ag	shaft	Ordovician El Paso Limestone	carbonate-hosted Pb-Zn replacement	NMBMMR file data
Crystal	NW1/4 19 25S 20W	32° 07' 11"	108° 56' 42"	Pb, Zn, Cu,Ag	45 ft deep shaft and 180 ft long adit	Mississippian Escabora Limestone	carbonate-hosted Pb-Zn replacement, Pb-Zn skarn	Gillerman (1958), Cargo (1959), FN 4/18/94
Deposit east of Granite Gap	NE1/4 35 25S 21W	32° 05' 34"	108° 57' 57"	Pb, Cu	pits	Mississippian Escabora Limestone	carbonate-hosted Pb-Zn replacement	Drewes and Thorman (1980), NMBMMR file data
Granite Gap (Outlook, Montgomery, Worlds Fair, Silver Star)	34,35 25S, 03 26S 21W	32° 04' 36"	108° 58' 45"	Pb, Ag, Zn, Cu, Au, As, W, Ba	8 adits, 6 shafts	Mississippian Escabora Limestone	carbonate-hosted Pb-Zn replacement	Lindgren et al. (1910), Gillerman (1958), Armstrong et al. (1978), FN 4/18/94
Jasper	NW19 25S 20W (?)	32° 07' 16"	108° 56' 46"	Pb, Ag, Zn, Cu, Au, As, W, Ba	trench	Cret. Cintura Formation	carbonate-hosted Pb-Zn replacement	NMBMMR file data
Scheelite Group (Wilson)	NW27, NE28 25S 21W	32° 06' 20"	108° 59' 50"	W	Adit 7m long and open cut	Cret Bisbee Group	W skarn	Gillerman (1958), Dale and McKinney (1959)
Sunrise (Hilltop, Dooley, Dome, Killions)	NE35 25S 21W	32° 05' 20"	108° 58 01"	W, Pb, Cu, Ag	shafts, shallow pits, trenches, dozer cuts	Mississippian Escabora Limestone	carbonate-hosted Pb-Zn replacement	Dale and McKinney (1959), Armstrong et al. (1978)
Ward Tungsten (Baker-Standard Tungsten Mine)	22,23,26,27 25S 21W	32° 06' 31"	108° 58' 46"	W, Cu	50 ft shaft, dozer cuts, test pits	Pennsylvanian Horquilla Limestone	W skarn	Gillerman (1958), Dale and McKinney (1959)
Wilson	SE13 25S 21W	32° 07' 28"	108° 57' 05"	Pb,Zn	trench	Ordovician El Paso Limestone	carbonate-hosted Pb-Zn replacement	NMBMMR file data
unknown	35 25S 21W	32° 04' 53"	108° 58' 20"	Au,Ag,Cu	pits	Ordovician El Paso Limestone	carbonate-hosted Pb-Zn replacement	Gillerman (1958)
unknown	SW1/4 35 25S 21W	32° 05' 00"	108° 58' 01"	Cu, Pb, Zn	pits	Ordovician El Paso Limestone	carbonate-hosted Pb-Zn replacement	Gillerman (1958)
unknown	SW26 SE27 25S 21W	32° 05' 50"	108° 58' 05"	Cu	pits	Tertiary quartz monzonite	carbonate-hosted Pb-Zn replacement, Cu skarn	NMBMMR file data
unknown (Fluorite Pits)	N1/2 21 25S 21W	32° 07' 15"	109° 00' 35"	F	pits	Pennsylvanian Horquilla Limestone	fluorite veins	Gillerman (1958), NMBMMR file data
unknown Sec. 23 prospects	23 25S 21W	32° 06' 55"	108° 58' 22"	Pb,Cu,Zn,W	13 prospect pits	Pennsylvanian Horquilla Limestone	carbonate-hosted Pb-Zn replacement	NMBMMR file data

The primary ore minerals are sphalerite, galena, and chalcopyrite with minor tetrahedrite in a gangue of quartz, calcite, pyrrhotite, barite, and pyrite. Silver occurs as matildite blebs in galena; assays of 100-500 oz/ton Ag are common (Williams, 1978). Bismuth occurrs in arsenopyrite (Williams, 1978). Scheelite and molybdenite occur in some mines. At Granite Gap, the sulfides have been almost completely oxidized to limonite and manganese oxides. Jasperiods are common. Armstrong et al. (1978) found no metamorphism of the highly fractured and thrust-faulted limestone host rocks. It is likely, that skarn deposits developed nearer the intrusive bodies which were the main sources of heat and possibly of metals, and the carbonate-hosted lead-zinc replacement deposits formed at lower temperatures farther from the intrusions (McLemore and Lueth, 1995, in press). Regional geochemical anomalies of Be, Mo, Nb, Pb, Th, and U and localized anomalies of Ag, La, and Sn are found in stream-sediments samples from the area.

Tungsten occurs with the base- and precious-metals in some mines, especially along the Preacher Mountain fault (Cargo, 1959). At the Sunrise mine, scheelite with molybdenum occurs in quartz veins in the granite and as disseminations in the garnet zone along the contact; assays as high as 0.58% WO_3 are reported (Dale and McKinney, 1959). Scheelite occurs in small pods and zones as much as 6 ft wide in tactite at the Baker-Standard claims. Assays as high as 1.2% WO_3 are reported from the Buck Deer claims (Dale and McKinney, 1959).

Kimball district

Location and Mining History

The Kimball (or Steins Pass) mining district is located in the northern Peloncillo Mountains along the Arizona-New Mexico state line, north of the McGhee Peak mining district (Fig. 1). This district includes mines and prospects north of Steins Pass (I-10), as well as those in sec. 16, 17, 20, and 21, T24S, R 21W (Elston, 1960). Elston (1960) places the Charles mine in the McGhee Peak district, but it is a volcanic-epithermal vein deposit similar to other mines in the Kimball district and is included in this district in this report. The volcanic-epithermal vein deposits were discovered in the area in 1875, but serious mining did not begin until about 1883 (Wells and Wootton, 1932, 1940). Production from 1885 to 1933 was valued at over $500,000, including 400,000 oz Ag, 1,500 oz Au, 125,000 lbs Pb, 12,000 lbs Cu, and some zinc (Table 2). Most production was prior to 1910, but development continued until at least 1981. Silver was the chief product, but a considerable amount of gold was produced. The Volcano silver mine and the Beck gold mine were the main producers (Table 58). Some manganese was produced from the Black Face mine during World War II (Farnham, 1961).

TABLE 58—Mines and prospects from the Kimball mining district, Hidalgo County. Location includes section, township, and range.

MINE NAME (ALIAS)	LOCATION	LATITUDE	LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
Beck (National, Hattie Lee, Inez, Marion, Yankee, Gertrude, Blue Mare, Gold Standard, Jessie, Halcyon, Montezuma, Chicago)	N2 31 23S 21W	32° 15' 47"	109° 02' 22"	Ag, Au, Cu, Pb, Zn	300 ft shaft with 5000 ft of drifts	volcanic-epithermal	Lindgren et al (1910), Anderson (1957), Gillerman (1958), Elston (1960)
Black Face Manganese (Black Face Group, Princess Pat)	S1/2 07 23S 21W	32° 18' 50"	109° 02' 20"	Mn	several small opencuts and prospect pits	epithermal Mn	Farnham (1961), Richter and Lawrence (1983)
Charles (Moon-Star-Comet)	NE1/4 21 24S 21W	32° 12' 21"	108° 59' 56"	Cu, Pb, Ag	100 ft deep shaft with 2 levels and drifts.	volcanic-epithermal	Gillerman (1958), Armstrong et al. (1978), Richter and Lawrence (1983), NMBMMR file data
Coyle	SE1/4 17 23S 21W	32° 18' 00"	109° 01' 05"	Au, Ag	numerous shafts	volcanic-epithermal	Elston (1960), Richter and Lawrence (1983)
Ester	NW1/4 06 24S 21W	32° 15' 10"	109° 02' 20"	Cu, Fe	trenches, adit, shafts	volcanic-epithermal	Elston (1960), Richter and Lawrence (1983)
Federal Group (Eloro, El Oro, El Oro Values Claims)	16,17,20,21 23S 21W	32° 17' 49"	109° 01' 01"	Au, Ag	several shafts and adits	volcanic-epithermal	Lindgren et al. (1910), Elston (1960), Richter and Lawrence (1983)
Mineral Mountain	S17, N20 24S 21W	32° 12' 39"	109° 01' 25"	Ag, Pb, Cu, Zn	200 ft inclined shaft, several shallow shafts,pits	volcanic-epithermal	Lindgren et al. (1910), Gillerman (1958), Thorman and Drewes (1980), Elston (1960)
Red Snake	SW1/4 16 24S 21W	32° 12' 52"	109° 00' 51"	Au,Ag	shaft, trench, shallow pit	volcanic-epithermal	Elston (1960), Richter and Lawrence (1983)
Saddle and Silver	S08, N17 23S 21W	32° 18' 43"	109° 01' 27"	Au, Ag	Adit, 2 shafts	volcanic-epithermal	Elston (1960), Richter and Lawrence (1983)
Silver King	S1/2 16 24S 21W	32° 12' 48"	109° 00' 21"	Cu, Pb, Ag	flooded shaft, pit, 2 shallow trenches	volcanic-epithermal	Elston (1960), Richter and Lawrence (1983)
Sixty-Six Mine	NE1/4 20 23S 21W	32° 17' 50"	109° 01' 00"	Au, Ag	Shafts	volcanic-epithermal	Elston (1960), Richter and Lawrence (1983)
Volcano (Volcano, Kimball no 27 and no 3, Homestead, Grey Fox, Hornet, Maud, Mineral Park)	E2 17 23S 21W	32° 18' 16"	109° 01' 07"	Ag, Au, Pb, Cu, Au	several shafts with 1000 ft of drifts, tunnels, and stopes	volcanic-epithermal	Lindgren et al. (1910), Elston (1960), Richter and Lawrence (1983)
Wyman	S17 23S 21W	32° 18' 05"	109° 01' 02"	Au,Ag	1 shaft	volcanic-epithermal	Elston (1960)
unknown	SE8 NE17 23S 21W	32° 18' 40"	109° 00' 57"	Au,Ag	3 adits	volcanic-epithermal	NMBMMR file data
unknown	C7 24S 21W	32° 13' 59"	109° 02' 24"	Au,Ag	1 prospect	volcanic-epithermal	NMBMMR file data

The Volcano mine was the largest mine in the district having produced several hundred thousand dollars worth of silver ore before 1905 and shipping more than 4,000 short tons between 1909 and 1947 (Richter and Lawrence, 1983). The Beck mine was worked intermittently until 1936 and produced a considerable, but unknown, amount of gold-silver ore. In 1980, the Beck property was under development for cyanide leaching (Enders, 1981).

Geology

The district is located in the vicinity of rhyolite domes and flows to the north and west of the district. The area lies on an elongate gravity high and a magnetic low, which may represent a regional area of alteration. The rocks in the district are volcanic and igneous intrusive rocks, including rhyolite domes and flows, tuffs, and megabreccia. Much of the district consists of tuff of Steins, a light colored, densely welded ash-flow tuff. Richter et al. (1990) define the Steins cauldera in this area and the tuff of Steins is related to this cauldera. Lindgren et al. (1910) described the rocks as being quite similar to those in the Steeple Rock district to the north. Some faulting has occurred, and mineralized epithermal quartz veins have been identified in silicified brecciated fault zones in the igneous rocks.

Mineral deposits

Volcanic-epithermal veins occur in late Cretaceous or Tertiary volcanic rocks (Table 58) and consist of pyrite, chalcopyrite, galena, sphalerite, argentite, cerargyrite, and native gold (Lindgren et al., 1910; Lasky and Wootton, 1933; Elston, 1960). Most of the veins are oxidized, but some sulfides are present. Calcite is prevalent, especially near the surface. Stream-sediment geochemical anomalies include Ag, Cu, Pb, Sn, and spotty La and Mn.

The Volcano and Beck mines are the largest mines in the district. The Volcano mine sits on the 9,000 ft long northeast-trending Volcano vein, which reaches a width of as much as 45 ft. The vein is brecciated, fissure filling, and silicified and forms a prominent outcrop, because it is resistant to weathering. Ore was found in a quartz band on the hanging wall side of the brecciated zone. Cerargyrite was the main ore mineral in the oxidized zone.

The Beck mine is situated in the ENE- to WNW-trending Beck vein which extends for 3,000 ft in Tertiary andesitic rocks that have been cut by prominent dikes of monzonite porphyry (Enders, 1981; Richter and Lawrence, 1983). Argillic alteration is predominant. Ore minerals include cerargyrite, argentite, pyrargyrite, proustite, sphalerite, galena, chalcopyrite, bornite, and chalcocite with calcite, pyrite, clay, and quartz as gangue (Enders, 1981; Lindgren et al., 1910). Samples assayed as high as 1.05 oz/ton Au, 25.11 oz/ton Ag, 2.06% Cu, 0.33% Pb, 0.12% Zn, and low arsenic (<300 ppb), antimony (<10 ppm), and mercury (<300 ppb); most assays were much lower (Enders, 1981). Metal concentrations are higher in the upper levels of the mines, especially at the Beck mine (Enders, 1981). The most favorable areas for future exploration are the eastern extension of the Beck vein and the Ester mine area (Enders, 1981).

Epithermal manganese veins occur in rhylite porphyry at the Black Face mine in the northern part of the district (Table 58; Farnham, 1961). The veins are up to 700 ft long, strikes N70°E, and dips 75°N to vertical.

Lordsburg district

Location and Mining History

The Lordsburg mining district (also known as Virginia, Pyramid, Ralston, and Shakespeare) is located in the northern part of the Pyramid Mountains, just southwest of Lordsburg (Fig. 34). The first mining locations were made in the district in 1870, and some early attempts were made to ship silver ore from the Laramide vein deposits. It was not until the Southern Pacific Railroad reached Lordsburg in 1880 that mining began in earnest (Huntington, 1947). Between 1904 and 1933, the Lordsburg area produced more than 1.5 million short tons of copper, gold, silver, and lead ore valued at approximately $19.5 million (Table 59; Lasky, 1938a). Huntington (1947) reports that ore produced between 1904 and 1935 contained 2.58% Cu, 0.117 oz/ton Au, and 2.24 oz/ton Ag. In addition, a few hundred short tons of fluorite have been produced from two veins (Thorman and Drewes, 1978). Total production has been over $60 million and includes 11 million lbs Pb and 4.2 million lbs Zn. Reported production from the district acounts for more than 96% of total production value reported for Hidaglo County from 1880 to 1978. The district remains active for small, intermittent, silica-flux-mining operations. Placer gold has been reported (Johnson, 1972; McLemore, 1994a) and 3,527 short tons of fluorite were produced.

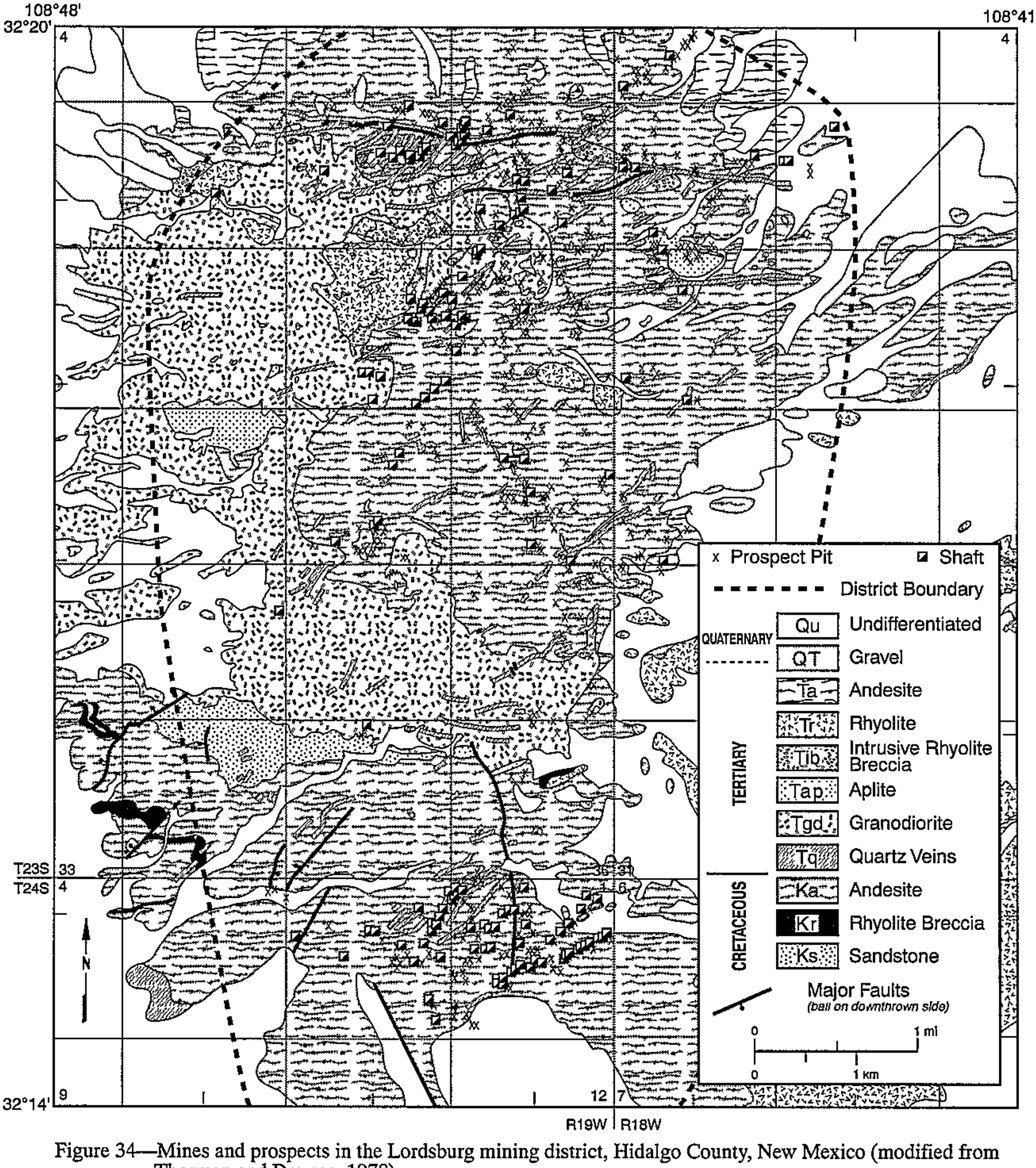

Figure 34—Mines and prospects in the Lordsburg mining district, Hidalgo County, New Mexico (modified from Thorman and Drewes, 1978).

TABLE 59—Reported metal production from the Lordsburg mining district, Hidalgo County, New Mexico (from U. S. Geological Survey, 1902-1927; U. S. Bureau of Mines, 1927-1990; Richter and Lawrence, 1983). For years omitted, there are no reported production figures. —none reported.

YEAR	ORE (SHORT TONS)	COPPER (LBS)	GOLD (OZ)	SILVER (OZ)	LEAD (LBS)	ZINC (LBS)	TOTAL VALUE ($)
1904	250	18,200	58.44	2,580	12,000	—	5,582
1905	366	48,000	0.5	7,584	—	—	12,079
1906	1,743	212,601	250	27,261	—	—	64,465
1907	5,645	463,335	423.81	31,303	10,522	—	122,646
1908	7,532	259,079	513.60	9,889	11,363	—	50,534
1909	10,690	589,969	1,256.93	50,154	8,862	—	129,140
1910	29,220	1,627,591	2,892.73	130,324	19,662	—	337,742
1911	46,139	2,455,336	5,160	182,448	2,157	—	510,354
1912	55,340	3,155,585	7,008	275,251	4,562	—	835,015
1913	31,284	1,601,461	2,672	154,779	14,572	—	397,580
1914	38,964	2,614,644	4,890	232,647	30,049	—	578,658
1915	92,093	3,890,365	10,781	374,325	38,723	—	1,094,795
1916	118,966	4,755,179	12,925	373,074	30,478	—	1,684,508
1917	99,532	4,261,956	11,882	295,443	41,442	—	1,656,130
1918	55,015	2,214,996	6,331	153,236	17,831	—	832,464
1919	77,002	3,516,457	8,467	242,733	53,264	—	1,103,753
1920	55,307	2,695,674	7,424	182,000	98,312	—	855,530
1921	11,593	579,295	1,112	35,119	13,134	—	133,426
1922	61,291	3,216,585	5,559	107,511	102,291	—	662,287
1923	96,587	4,314,122	10,477	141,538	46,185	—	970,624
1924	88,472	4,927,878	9,299	113,591	40,412	—	917,094
1925	108,219	5,064,140	10,780	126,781	69,700	—	118,887
1926	97,420	4,762,750	11,706	126,909	73,400	—	993,802
1927	93,406	3,933,496	9,547	77,155	46,381	—	759,290
1928	91,289	4,625,347	10,525	104,653	19,638	—	945,959
1929	83,090	4,248,193	10,612	159,163	59,080	—	1,055,597
1930	102,317	4,857,300	14,021	189,070	88,300	—	998,479
1931	96,032	3,991,700	11,288	137,731	96,700	—	640,080
1932	—	—	—	—	—	—	—
1933	256	21,000	105.41	1,820	19,000	—	4,863
1934	773	27,950	243.89	2,998	19,000	—	13,408
1935	1,658	78,000	439.97	11,370	28,100	—	31,169
1936	21,279	816,150	1,306.20	28,612	52,900	—	145,396
1937	74,752	3,807,890	2,143.4	75,196	53,200	—	597,073
1938	112,157	6,346,300	3,402.4	134,849	113,200	—	833,403
1939	116,330	6,367,900	4,230	131,471	6,000	—	899,835
1940	126,670	6,555,300	2,225	76,770	77,900	—	877,111
1941	121,145	7,467,300	1,270	63,886	48,000	—	974,657
1942	123,397	6,715,100	1,257	90,803	224,400	113,600	946,693
1943	110,963	4,991,900	1,440	82,350	113,800	41,500	770,924
1944	132,707	4,717,400	2,316	113,739	292,800	78,000	831,106
1945	84,773	2,292,800	1,411	90,336	337,200	—	452,151
1946	54,729	2,392,000	1,582	100,963	215,000	—	547,887
1947	70,893	3,539,300	1,845	185,561	530,400	—	1,052,139
1948	68,481	3,415,000	1,683	165,256	158,000	138,000	996,161
1949	81,640	3,868,000	1,981	149,312	683,000	51,000	1,080,704
1950	73,349	4,122,100	714	92,816	171,100	8,000	990,624
1951	72,107	3,041,000	755	89,610	287,300	31,000	898,794
1952	60,524	2,950,000	820	70,911	105,000	4,000	824,347
1953	84,324	3,975,000	1,205	100,844	124,000	—	1,240,513
1954	100,861	4,419,000	367	73,098	45,900	—	1,388,895
1955	122,992	4,509,800	684	83,751	17,500	2,000	1,784,748
1956	88,142	4,240,500	543	60,699	37,400	—	1,882,625
1957	83,887	3,432,100	495	30,685	7,500	1,500	1,079,405
TOTAL 1904-1957	3,643,593	173,010,024	222,326	6,151,958	4,816,820	468,600	39.611,161
ESTIMATED TOTAL 1885-1978	—	229,577,000	260,600	7,371,697	11,000,000	4,200,000	>60,000,000

Two principal producing mines in the district, the Eighty-five and Bonney mines, are located on the northeast-trending set of faults and has been mined over a strike length of 4,350 ft and a depth of nearly 2,000 ft (Clark, 1962, 1970). The Eighty-five mine was the most productive mine in the area. The Eighty-five group of claims produced virtually 90% of the ore from 1904 to 1935. This production, however, was dependent almost entirely on demand from copper smelters for siliceous-fluxing ore to reduce the melting point of the copper ore. The mines are paid for the gold and copper content and penalized for zinc. Mining activity was suspended when, in 1931, this demand ended. The ore at the Eighty-five mine came from the Emerald vein which was mined for a continuous length of about 2,000 ft and to a vertical depth of 1,900 ft and produced approximately 1.4 million short tons of ore. The average ore from this deposit contained 2.8% Cu, 1.23 oz/ton Ag, and 0.111 oz/ton Au (Lasky, 1938a).

The Bonney vein was probably the second largest producing vein in the district. Between 1910 and 1940, the Atwood group of claims, which includes the Atwood and Henry Clay mines, produced 36,630 short tons of ore, containing 3,330 oz Au, 136,364 oz Ag, 706 short tons Cu, and almost 115 short tons Pb (Huntington, 1947). By 1943, the Bonney mine had been developed to a vertical depth of 1,450 ft and for 2,000 ft along strike. Minimum width of the stopes was 4 ft and the maximum vein width was about 20 ft (Huntington, 1947). At that time, the Bonney mine was the principal producing mine in the district having maintained an annual production rate of 3,000 short tons per year for several years (Huntington, 1947).

Perlite has been mined from three quarries in the southern part of the district in 1953 and 1954. However, the presence of worthless stony rhyolite within the perlite deposits made production uneconomic. Perlite resources were conservatively estimated by Flege (1959) as 30 million cubic yards.

Geology

Host rocks in the district consist of Lower Cretaceous andesite to basalt flows at least 2,000 ft thick which were intruded by plugs of basalt and rhyolite breccias and plugs of white rhyolite (Fig. 34). The volcanics have been intruded by an irregular, horseshoe-shaped Laramide granodiorite porphyry stock (59.8±4.4 Ma, horndblende, K-Ar; Marvin et al., 1988) (Lasky, 1938a; Thorman and Drewes, 1978; Elston et al., 1979) and related granodiorite porphyry or aplite dikes. Plugs and dikes of quartz latite and dikes of white felsite cut the granodiorite. The volcanics correspond to large gravity and magnetic highs.

Five sets of faults occur in the area: northeast, east-west, northwest, east-northeast, and north-south and they are, for the most part, pre-mineralization and acted as channels for ore-forming solutions as well as sites of mineralization (Lasky, 1938a; Clark, 1962, 1970; Jones, 1907). In general, the faults dip vertically. Veins are accompanied by argillic and propylitic alteration (Clark, 1962; Agezo and Norman, 1994).

Mineral deposits

Deposits in the district are Laramide base- and precious-metal, fissure-filling veins in fault and fracture zones that transect the contact zone of the granodiorite porphyry pluton (Table 60; Wells, 1909; Clark, 1962, 1970; Richter and Lawrence, 1983). The vein deposits are genetically related to the emplacement of the pluton and consist of quartz and pyrite and lesser amounts of base-metal sulfides, chiefly chalcopyrite, galena, and sphalerite. District zoning is prevalent (Clark, 1970). Fluid inclusion studies indicate that the veins formed at 200->300° C by acidic fluids (pH 4.5-6.0; Agezo and Norman, 1994). Gold assays from prospect pits range as high as 3,100 ppb Au (Griswold et al., 1989). Geochemical anomalies from stream sediments in the area are anomalous in Ag, Co, Cr, Cu, Mn, Mo, and Pb, with local anomalies of Ba, Be, K, Nb, Sn, Th, and Y.

TABLE 60—Mines and prospects in the Lordsburg mining district, Hidalgo County, New Mexico. Location includes section, township, and range.

MINE NAME (ALIAS)	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
Ada Etta (Mikesell, Summit, Big Dike, Daisy, Monday, Florence May, Sterling, Lone Star, Copper Nugget 1 and 2)	NE10, NW11 23S 19W	32° 19' 22" 108° 46' 38"	Pb, Ag, Au, Cu	700 ft adit, numerous shallow shafts	Laramide veins	Lasky (1938a), Thorman and Drewes (1978), Richter and Lawrence (1983)
Anita (Tom Group, Old Virginia, Mono, Ontario, Dewey, Queen, McGinty, Lucy, Kathryn)	E1/2 11 23S 19W	32° 19' 09" 108° 45' 44"	Pb, Cu, Ag, Au, Zn	820 ft shaft with 5 levels, shafts, adits	Laramide veins	Lasky (1938a), Anderson (1957), Clark (1970), Flege (1959), Thorman and Drewes (1978)

MINE NAME (ALIAS)	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
Atwood (Atwood-Henry Clay, Yellow Jacket, Bessie, Florence, Southern, Valedon, Road, Plumbo, New Year, Alamo, Triangle)	E12, W07 23S 18W	32° 19' 06" 108° 44' 22"	Cu, Ag, Au, Pb, Zn	750 ft shaft, 6 levels, shallow shafts, adits, pits	Laramide veins	Lindgren et al. (1910), Lasky (1938a), Huntington (1947), Storms (1949), Clark (1970)
Battleship Group (Gila Monster Claim, Lookout, Flagship)	11 & 12 23S 19W	32° 19' 01" 108° 45' 08"	Cu, Au, Ag Pb, Zn	opencuts, pits, shallow shafts, 1 adit	Laramide veins	Lasky (1938a), Anderson (1957), Richter and Lawrence (1983), North and Eveleth (1981)
Big Three	NE25 23S 19W	32° 16' 57" 108° 44' 46"	Pb, Ag, Cu, Zn, Au	shallow pits and bulldozer cuts	Laramide veins	Clark (1970), Thorman and Drewes (1978), Elston (1960), Richter and Lawrence (1983)
Bluebird (Center Nos 1 and 2)	NW30 23S 18W	32° 16' 58" 108° 44' 11"	Pb, Ag, Au, Cu	shaft and several prospect pits	Laramide veins	Jones (1907), Thorman and Drewes (1978), Richter and Lawrence (1983)
Bonney (Banner, Manila-Misers Chest, Lone, Teddy, Cochise, Shoo Fly, Sunrise, Copper Dick, Mulberry, Happy Hooligan, Red, Blue, Green Copper)	SE14, NE23 23S 19W	32° 17' 53" 108° 45' 39"	Cu, Au, Ag, Pb, Zn	4 shafts and several prospect pits, 2,000 ft deep, 8 levels	Laramide veins	Lindgren et al. (1910), Lasky (1938a), Flege (1959), Clark (1970), Thorman and Drewes (1978)
Campbell	W1/2 02 24S 19W	32° 14' 50" 108° 46' 10"	F	shaft	Fluorite veins	Jones (1907), Lasky (1936b)
Century (Eigthy-Five Group)	SW 12 23S 19W	32° 18' 52" 108° 45' 21"	Pb, W	pits	Laramide veins	Lindgren et al. (1910), Lasky (1938a), Clark (1970), Thorman and Drewes (1978)
Clementine (Mikesell Properties, Phoenix Group, Copper Link, Anna Mary)	SW11 23S 19W	32° 19' 04" 108° 46' 19"	Pb, Ag, Cu	18 shallow shafts and 3 opencuts	Laramide veins	Clark (1970), Lasky (1938a), Thorman and Drewes (1978), Richter and Lawrence (1983)
Cobra Negra Group (Cobre Negro Mine, Black Sam, Tom Cat, Black Copper)	E2 14 23S 19W	32° 18' 16" 108° 45' 47"	Cu, Ag, Au, Pb	500 ft shaft with 700 ft of drifts, opencuts	Laramide veins	Lasky (1938a), Lindgren et al. (1910), Thorman and Drewes (1978), Richter and Lawrence (1983)
Comstock Group	T23S, R19W, 12, 13	32° 19' 43" 108° 44' 42"	Cu	14 shafts, trenches, pits, adits	Laramide veins	Elston (1960); FN 4/17/94
Copper Reef Group (Copper Reef Mine, Copper Reef no. 2 and 3)	NE13 23S 19W	32° 18' 23" 108° 44' 43"	Cu, Ag, Au	10 shallow shafts, 12 small opencuts	Laramide veins	Clark (1970), Lasky (1938a), Thorman and Drewes (1978), Richter and Lawrence (1983)
Eighty-Five (Superior, Dundee, Jim Crow Mines; Rockford, Playmate, 85, 86, 99, Emerald, Mohawk, Dewey)	SW12, NW13 23S 19W	32° 18" 52" 108° 45" 04"	Cu, Au, Ag, Pb, Zn	5 shafts, 16 working levels adit,	Laramide veins	Lasky (1938a), Clark (1970), Jones (1907), Lindren et al. (1910), Youtz (1931), Flege (1959)
Eldorado Group (Horn Silver Mine, Oro Fino, Oro Alto, Sunrise, Independence)	C13 23S 19W	32° 18" 19" 108° 45" 05"	Pb, Ag, Cu, Au	several shallow shafts and small prospect pits	Laramide veins	Jones (1907), Clark (1970), Thorman and Drewes (1978)
Fluorite Group (Kneyer Mines, Fluorite nos. 1 to 12, Diffenderfer Group)	34,35,2,3 23S & 24S, 19W	32° 15" 17" 108° 46" 58"	F	5 shafts, adit, and numerous shallow prospect pits	Fluorite veins	Rothrock et al. (1946), Flege (1959), Williams (1966), Thorman and Drewes (1978)
Francis Kay (Aberdeen, Atlantic, Francis Kay Sweet)	NW24 23S 19W	32° 17" 31" 108° 45" 13"	Pb, Ag, Cu, Au, Zn	2 shafts and several pits	Laramide veins	Jones (1907), Lindgren et al. (1910), Clark (1970), Thorman and Drewes (1978)
Gamco (La Rosa, Rosa)	C of S2 24 23S 19W	32° 17' 04" 108° 45' 01"	Pb, Ag, Cu, Au, Zn	200 ft shaft and several shallow prospect pits	Laramide veins	Clark (1970), Thorman and Drewes (1978), Richter and Lawrence (1983)

MINE NAME (ALIAS)	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
General Jerry Boyle (General Gerry Boyle Mine)	C07 23S 18W	32° 19' 12" 108° 44' 07"	Cu, Ag, Au, Pb	pits	Laramide veins	Lasky (1938a), Thorman and Drewes (1978), Richter and Lawrence (1983)
Goodsight (Bonnie Jean, Peton, Montana)	N1/2 12 23S 19W	32° 19' 23" 108° 45' 09"	Cu, Ag, Au, Pb	shallow shaft and numerous small pits	Laramide veins	Lasky (1938a), Clark (1970), Thorman and Drewes (1978)
Green King (Bluebird, White Cloud)	SW19, NW30 23S 18W	32° 16' 54" 108° 44' 23"	Pb, Ag, Au, Cu	3 shallow shafts and several prospect pits	Laramide veins	Lasky (1938a), Clark (1970), Thorman and Drewes (1978), NMBMMR file data, Elston (1960)
Henry Clay (Atwood-Henry Clay Group))	SE12 23S 19W	32° 19' 03" 108° 44' 47"	Cu, Ag, Pb, Zn, Au	800 ft shaft with 5 levels	Laramide veins	Lasky (1938a), Clark (1970), Huntington (1947), Flege (1959), Thorman and Drewes (1978)
Hobson Claim (part of the Eighty-Five Mine)	C12 23S 19W	32° 19' 06" 108° 45' 12"	Cu	pits	Laramide veins	Lasky (1938a), Thorman and Drewes (1978)
Homestake-Needmore (Homestake & Needmore extensions nos. 1 and 2)	S2 19 23S 18W	32° 17' 02" 108° 44' 20"	Pb, Ag, Cu, Au, F	3 shallow shafts and several prospect pits	Laramide veins	Clark (1970), Thorman and Drewes (1978), Elston (1960), Richter and Lawrence (1983)
Kirk's Perlite Industries Deposit	NW21 24S 17W	32° 12' 16" 108° 36' 01"	Pumice aggregate	pits	Volcanic	Weber (1968)
Lady Mary	SW18 23S 18W	32° 17' 57" 108° 44' 26"	Not specified	shaft and several pits	Laramide veins	Clark (1970), Thorman and Drewes (1978)
Last Chance (Last Chance, Clara Sutton)	E1/2 01 24S 19W	32° 14' 44" 108° 44' 53"	Ag, Pb, Cu, Au, Zn	shafts with 4 levels	Laramide veins	Lasky (1938a), Lindgren et al. (1910), Clark (1970), Elston (1960)
Leitendorf Hills Perlite (Kirks Perlite Industries)	NW18 25S 18W	32° 08' 11" 108° 44' 11"	Expanded perlite aggregate	open pit	volcanic	Weber (1968)
Lone Star Prospect (Stick-Porter Groups)	S25, N36 23S 19W	32° 16' 06" 108° 44' 53"	F	two shallow shafts and several pits	Fluorite veins	Rothrock et al. (1946), Williams (1966), Thorman and Drewes (1978)
Misers Chest (Copper Regent, S.W.B., Columbia, Ft. Savage, Little Annie, Virginia)	NE23 23S 19W	32° 17' 33" 108° 45' 51"	Cu, Ag, Au, Pb, Zn	600 ft shaft with 11 levels, opencuts, pits	Laramide veins	Lindren, et al (1910), Lasky (1938a), Anderson (1957), Flege (1959), Clark (1970)
Nellie Bly (Brother Gardner, Baltimore, Independence, Billy A)	NW01, NE02 24S 19W	32° 15' 02" 108° 45' 36"	Cu, Ag, Au, Pb, Zn	400 ft shaft with 6 levels	Laramide veins	Lindgren et al.(1910), Clark (1970), Jones (1907), Lasky (1938a)
Nellie Gray Mine (Trendt, March, Reynolds Group)	C S2 14 23S 19W	32° 17' 59" 108° 46' 03"	Cu	3 shafts	Laramide veins	Lasky (1938a), Flege (1959), Thorman and Drewes (1978)
Owl (Baldwin Mine, Aberdeen Claim, Morningstar)	NW SE 24 23S 19W	32° 17' 21" 108° 45' 01"	Pb, Zn, Cu, Ag, Au	160 ft shaft and several prospect pits	Laramide veins	Lasky (1938a), Lindgren et al. (1910), Clark (1970), Thorman and Drewes (1978)
Polyanna Mine	SE23 23S 19W	32° 17' 10" 108° 45' 58"	Cu	shafts	Laramide veins	Thorman and Drewes (1978)
Pyramid Mountains Deposit	01,11,12 24S 19W	32° 14' 05" 108° 45' 20"	Perlite	pits	volcanic	Flege (1959), Jaster (1956), Richter and Lawrence (1983)
Robert E Lee	NW01, NE02 24S 19W	32° 15' 10" 108° 45' 32"	Cu, Ag, Au, Pb	main shaft with 3 levels, several shallow shafts	Laramide veins	Lindgren et al. (1910), Lasky (1938a), Clark (1970), Jones (1907), Thorman and Drewes (1978)
Rosemary-Kingfisher Group	SW1/4 6,NW1/4 7 23S 18W	32° 19' 39" 108° 44' 21"	Pb, Ag	prospect pits and a shallow shaft	Laramide veins	Elston (1960)
Ruth	19, 18W, 24, 19W 23S	32° 17' 26" 108° 44' 32"	Zn, Pb, Cu, Ag, Au	500 ft inclined shaft, pits and trenches	Laramide veins	Anderson (1957), Clark (1970), Thorman and Drewes (1978), Elston (1960)

MINE NAME (ALIAS)	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
Section 34	NE34 22S 19W	32° 20' 59" 108° 47' 23"	Mn, U (?)	several pits, deepest 10 ft	Laramide vein	Thorman and Drewes (1978)
Silver Bell	SE1/4 O2 24S 19W	32° 14' 32" 108° 45' 47"	Not specified	shaft	Laramide veins	Clark (1970), Elston (1960)
Susie	NW1/4 01 24S 19W	32° 14' 55" 108° 45' 15"	Ag, Cu	shaft several hundred ft deep	Laramide veins	Clark (1970), Elston (1960)
Venus (Leitendorf, Viola, Century, Planet, Harlem, Winnie)	NE 01 24S 19W	32° 14' 57" 108° 44' 53"	Ag, Pb, Cu, Au	400 ft shaft with 2,500 ft of drifts and stopes	Laramide veins	Lindgren et al. (1910), Lasky (1938a), Clark (1970), Thorman and Drewes (1978), Elston (1960)
Waldo (Millsite Group)	E2 07 23S 18W	32° 19' 10" 108° 43' 37"	Pb, Zn, Cu, Ag, Au	3 shafts	Laramide veins	Lasky (1938a), Clark (1970), Thorman and Drewes (1978), Elston (1960)

Tourmaline is a characteristic gangue mineral. Granodiorite and basalt appear to be the most favorable host rocks. At least seven stages of brecciation occurred with six stages of mineralization (Lasky, 1938a). Vein filling occurred along with the faulting, and each reopening of the vein system is recognized by a change in the character of the mineralization. Only the second stage of mineralization yielded economic deposits. Ore minerals include chalcopyrite, galena, and sphalerite in a gangue of tourmaline, calcite, specularite, barite, sericite, manganosiderite, and fluorite. Oxidation and secondary enrichment occurred at variable depths (Lasky, 1936b). In some places, sulfides were found near the surface; oxidation and leaching were seen at the 1400-foot level in the Eighty-five mine (Huntington, 1947).

Ore at the Eight-five mine was found chiefly within or in contact with granodiorite, while the Bonney, Henry Clay, Atwood, and numerous others mines were in basalt (Lasky, 1938a; Clark, 1970). The Bonney vein strikes for more than 3,000 ft on the surface at N50°E, dips steeply northwest, and is located about 1,000 ft from the granodiorite contact. It averages 5 to 6 ft in width, but reachs a width of as much as 30 ft. At depth, the vein is nearly vertical. The vein reportedly contained approximately 2.6% Cu. Drilling showed that the amount of gold and silver decreased rapidly with depth, and the amount of silica gangue decreased from 75% in the upper levels to 45% at the 1500-ft level.

North of the Lordsburg mining district, approximately 10 mi north-northwest of Lordsburg, Raines et al. (1985) used Landsat images to identify a large, anomalously limonitic area in Cenozoic gravels. With additional geochemical and geophysical data, the area was interpreted as being a chemical trap that may contain concentrations of uranium similar to calcrete uranium deposits. It was thought that groundwater originating in the Burro Mountains with known uranium deposits, drains through the area and is forced near the surface by a buried bedrock ridge along the western side of the anomaly. Changes in groundwater chemistry may precipitate uranium along the eastern margin of the anomaly.

Fluorite occurs in veins in the southern part of the district (Williams, 1966; McAnulty, 1978). The deposits are lenticular, occur in a zone approximately one mile long, are less than 4 ft wide, and consist of fluorite, calcite, and quartz. Production averaged 60% CaF_2 (Williams, 1966). Fluorite from the area (sec. 2, T24S, R19W) had fluid inclusion homogenization temperatures of 142-174°C and salinities less than 1.4 eq. wt.% NaCl; boiling of fluids probably did not occur (Elston et al., 1983; Hill, 1994).

Commercial deposits of perlite occur in the southern part of the Lordsburg mining district. Perlite crops out in a northwest-southeast band nearly two miles long and as much as one half-mile wide (Flege, 1959). It is typically greenish to dark reddish brown and has a resinous luster. The perlite is banded and cut by stony rhyolite, which lessens its value. At the Leintendorf Hills perlite mine, perlite occurs in an exposed area of about 1 square mi as irregular lenses and seams of devitrified glass and alteration products in a volcanic dome of sodic rhyolite.

McGhee Peak district

Location and Mining History

The McGhee Peak mining district is located in the central part of the Peloncillo Mountains north of Granite Gap (Fig. 1) and contains the abandoned mining camp of McGheeville. Mineralized skarns were first identified in the district in 1894, but it was not until 1904 that the McGhee family acquired the mining rights to the area (Don McGhee, mine owner, oral communication, April 18, 1994). Carbonate-hosted Pb-Zn replacement and skarn deposits were mined and yielded 12 million lbs Pb, 10 million lbs Zn, 85,000 lbs Cu, 100 oz Au, and 200,000 oz Ag making this district the leading district in the county in lead and zinc production (Table 61). Recent drilling has located a porphyry copper deposit in the subsurface in the northwestern part of the district (Fig. 35).

TABLE 61—Mines and prospects in the McGhee Peak mining district, Hidalgo County, New Mexico, located in Figure 35. Location includes section, township, and range.

MINE NAME (ALIAS)	LOCATION	LATITUDE	LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
Carbonate Hill (McGhee properties, Oronogo and Carbon Hill, Silver Star)	SE34 24S 21W	32° 10' 11"	108° 59' 01"	Pb, Ag, Zn, Cu, Au	main shaft w/2400 ft of drifts,short adit & shafts	carbonate-hosted Pb-Zn replacement, skarn	Gillerman (1958), Armstrong et al. (1978), Anderson (1957), Thorman and Drewes (1980), FN 4/18/94
Carbonate Hill Extension	NW1/4 03 25S 21W	32° 10' 00"	108° 59' 31"	Pb, Zn, Ag	10 m adit with short drifts	carbonate-hosted Pb-Zn replacement, skarn	Gillerman (1958), Richter and Lawrence (1983)
Cyprus porphyry copper prospect	29, SE30, W28 24S 21W	32° 11' 10"	109° 01' 15"	Cu	22 drill-holes (labeled A-U on topo)	oxidized copper porphyry	NMBMMR file data
Duke	33 24S, 04 25S 21W	32° 10' 05"	108° 59' 55"	Pb, Zn, Ag	Small pits, shallow shafts, large opencut	carbonate-hosted Pb-Zn replacement	Gillerman (1958), Richter and Lawrence (1983), NMBMMR file data
Hamilton	NW1/4 11 25S 21W	32° 08' 57"	108° 58' 40"	Pb, Zn, Cu	2 shafts, w/ short drifts, several opencuts	carbonate-hosted Pb-Zn replacement	NMBMMR file data
Happy Promise (S and W no 6, Copper Queen)	NW1/4 03 25S 21W	32° 09' 45"	108° 59' 50"	Pb, Zn, Cu, Au, Ag	Adit	carbonate-hosted Pb-Zn replacement, skarn	Elston (1960), Richter and Lawrence (1983), NMBMMR file data
Johnny Bull (Sterling Price, South Virginia)	SW03, SE04 25S 21W	32° 09' 36"	108° 59' 52"	Cu, Ag, Pb, Zn	2 inclined shafts and an adit	carbonate-hosted Pb-Zn replacement, skarn	Lindgren et al. (1910), Gillerman (1958), Armstrong et al. (1978), Thorman and Drewes (1980)
Lizzie Paul	S1/2 20 24S 21W	32° 11' 50"	109° 01' 30"	Cu, Au	pits	carbonate-hosted Pb-Zn replacement	Lindgren et al (1910), Richter and Lawrence (1983)
Lucky Strike (Smokey, The Top)	SE3 25S 21W	32° 09' 10"	108° 59' 15"	Pb, Zn, Ag, Au, Cu	pits	carbonate-hosted Pb-Zn replacement	FN 4/18/94
unknown prospect in the vicinity of Cyprus porphyry Cu prospect	21,28,29,31-33 24S 21W	32° 11' 19"	109° 01' 23"	Pb, Zn, Ag, Au, Cu	19 prospects, 3 shafts	carbonate-hosted Pb-Zn replacement	NMBMMR file data
North Star	SE1/4 27 24S 21W	32° 10' 55"	108° 59' 10"	Pb, Zn, Ag	15 or 20 pits, 2 shallow shafts, 2 adits	carbonate-hosted Pb-Zn replacement	Gillerman (1958), Elston (1960), Richter and Lawrence (1983)
Rody	10 25S 21W	32° 08' 42"	108° 59' 14"	Pb, Zn	2 shallow shafts, several pits	carbonate-hosted Pb-Zn replacement, skarn	Elston (1960)
Silver Bell	NE1/4 05 25S 21W	32° 09' 46"	109° 01' 01"	Pb	150 ft shaft, prospect pits	carbonate-hosted Pb-Zn replacement	Elston (1960), Richter and Lawrence (1983), Lindgren et al. (1910)

MINE NAME (ALIAS)	LOCATION	LATITUDE	LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
Silver Hill	NW03 25S 21W	32° 09' 47"	108° 59' 40"	Pb, Zn, Ag, Cu, Au	inclined shaft with 5 levels	carbonate-hosted Pb-Zn replacement, skarn	Gillerman (1958), Armstrong et al. (1978), Thorman and Drewes (1980), Elston (1960)
Simonton (Silver Bell, Duke, Happy Promise, Silver Saddle, Big Jim, Big Boy, Rody, and The Top claims)	33 24S, 3-5 25S 21W	32° 10' 5"	109° 00' 15"	Pb, Zn, Ag, Au, Cu	pits	carbonate-hosted Pb-Zn replacement	Elston (1960)
Stella Maris #1 (Copper Queen ?)	03, 04 25S 21W	32° 09' 20"	108° 00' 30"	Pb, Zn, Ag, Au, Cu	shaft 20 m deep	carbonate-hosted Pb-Zn replacement, skarn	Lindgren et al. (1910), Gillerman (1958), Richter and Lawrence (1983)
Sweet's New Year Antimony Prospect (3.4 mi SSW of Road Forks)	11 25S 21W	32° 08' 18"	108° 58' 08"	Sb, Pb, Zn	65 ft trench, 7 ft open pit, 290 ft drill hole	carbonate-hosted Pb-Zn replacement	NMBMMR file data
Tenneco Van Ann Group	2,3,4,9,10,11 25S 21W	32° 09' 52"	109° 00' 18"	Pb, Zn, Ag, Au, Cu	pits	carbonate-hosted Pb-Zn replacement	NMBMMR file data
unknown	E1/2 2 25S 21W	32° 09' 35"	108° 58' 02"	Pb, Zn, Ag, Au, Cu	1 shaft	carbonate-hosted Pb-Zn replacement	NMBMMR file data
unknown	NE32 24S 21W	32° 11' 00"	109° 00' 2"	Pb, Zn, Ag, Au, Cu	shafts, pits, adits	carbonate-hosted Pb-Zn replacement	NMBMMR file data
unknown	S8 25S 21W	32° 13' 36"	109° 01' 18"	Pb, Zn, Ag, Au, Cu	1 prospect	carbonate-hosted Pb-Zn replacement	NMBMMR file data
unknown	S9 25S 21W	32° 08' 16"	109° 00' 42"	Pb, Zn, Ag, Au, Cu	1 prospect	carbonate-hosted Pb-Zn replacement	NMBMMR file data

Of the several mines and prospects in the district, the Carbonate Hill (or McGhee) mine was the largest and most productive, until June 1948, when fire destroyed the head frame, shaft timbers, and surface buildings (Anderson, 1957). Total value of production of the mine was probably greater than $1.5 million (Gillerman, 1958). Approximately 91% of the value of the reported production was from lead and zinc; 9% was from silver. Most recent production was in 1956. Approximately 100,000 tons was produced that averaged 6% Pb, 5-6.5% Zn, and 1-2 oz/ton Ag (Gillerman, 1958; Richter and Lawrence, 1983; Don McGhee, mine owner, oral communication, April 18, 1994). When visited in 1994, the head frame of the Carbonate Hill mine had deteriorated and was unsafe (Fig. 36).

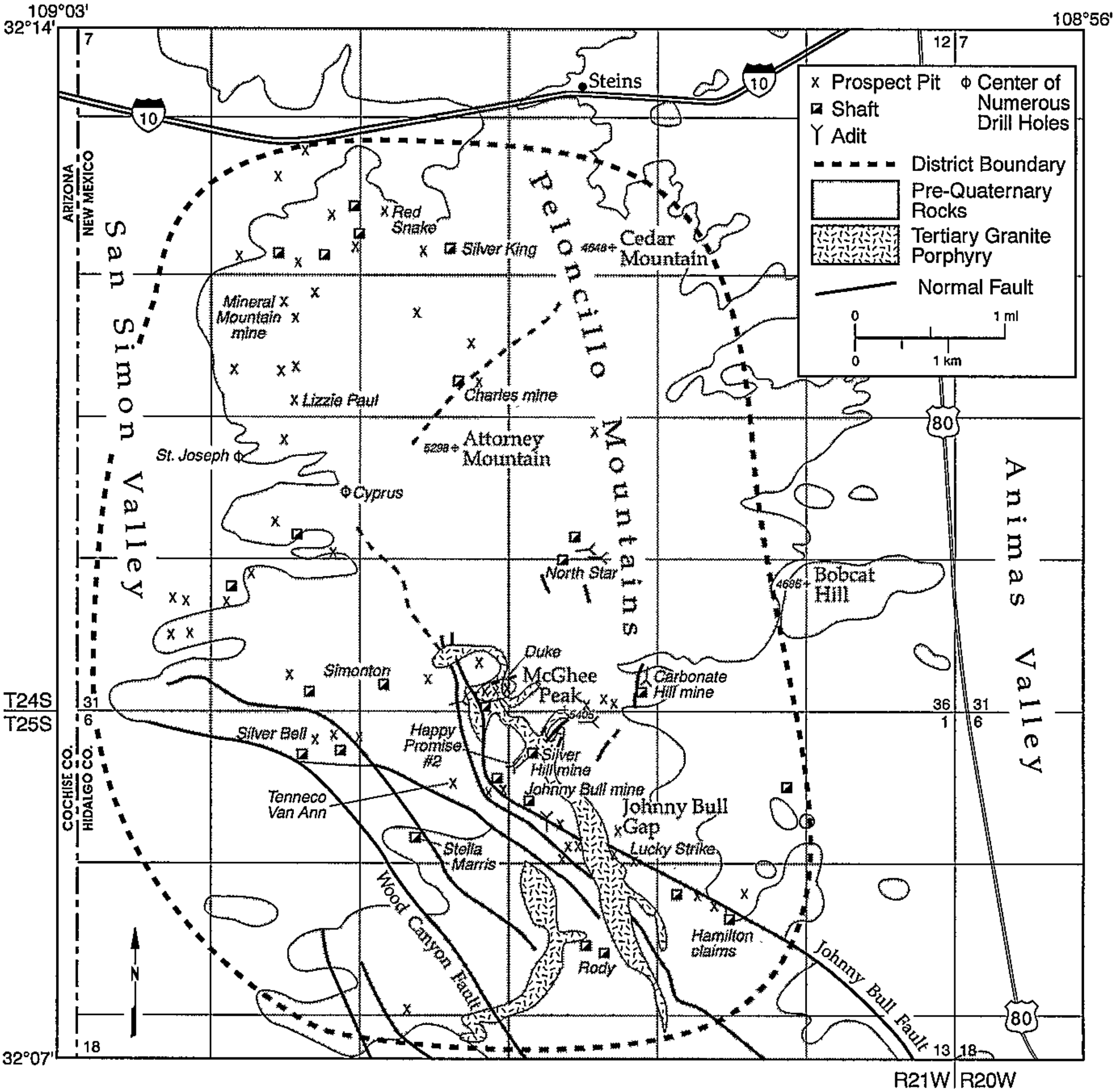

Figure 35—Mines and prospects in the McGhee Peak mining district, Hidalgo County, New Mexico (modified from Armstrong, et al., 1978).

FIGURE 36—Photo of the Carbonate Hill mine and mill, in 1994, looking west, Hidalgo County, (V. T. McLemore photo).

Geology

The central Peloncillo Mountains consist of fault Proterozoic to middle Tertiary extrusive rocks and intrusive igneous rocks and sedimentary rocks overlain by middle Tertiary to younger extrusive volcanic rocks (Armstrong et al., 1978). Paleozoic carbonate rocks and Mesozoic clastic rocks with a large portion of carbonate rocks underlie most of the mountains. The sedimentary rocks and Proterozoic granite are intruded and metamorphosed by a number of igneous rocks. South of the district, at Granite Gap, Tertiary granite was emplaced at 33.2 Ma (McLemore et al., 1995). Granite porphyry dikes and sills were intruded 29.8±0.9 to 32.5±1.0 Ma (biotite, K-feldspar, K-Ar; Hoggat et al., 1977). Fine-grained porphyritic to felsic rhyolite dikes that are probably related to the granite porphyry were intruded and were followed by quartz-latite porphyry dikes and sills at 27±0.8 to 25.8±0.8 Ma (biotite, plagioclase, K-Ar; Hoggat et al., 1977). Dikes and sills of porphyritic granite, rhyolite, and quartz latite may be quite extensive, being upwards of 100s of ft thick and up to 3,000 ft long. Although the dikes and sills vary somewhat in composition and texture, they are quite silicic. The district lies on an elongate gravity high which is consistent with the trend of the intrusive rocks.

Mineral Deposits

Many small, lead-zinc-copper-silver deposits occur in carbonate rocks adjacent to dikes and sills, particularly on the northeastern limb of the major anticlinal structure of the mountain range (Fig. 35; Table 61). Deposits proximal to intrusive rocks tend to be characterized by skarns with calc-silicate gangue mineralogy, while more distal deposits tend to be more stratigraphically and structurally controlled and are more typical of carbonate-hosted replacement deposits. Stream sediments include geochemical anomalies of Ba, Co, Cu, Mn, Mo, and Pb, and locally anomalous Be, Bi, and Cr.

The Carbonate Hill mine contains local skarn minerals, such as epidote, garnet and wollastonite; but most of the ore is sulfide-replacement of permeable beds, particularly fossiliferous zones, in Pennsylvanian Horquilla Limestone. Ore minerals include galena, cerussite, argentiferous galena, sphalerite, smithsonite, and chalcopyrite in a gangue of quartz, calcite, and garnet. Ore grade was approximately 6% Pb and 5% Zn. Workings consisted of a main shaft containing about 2,400 ft of drifts, a short adit, and several shallow shafts and pits. The main shaft reached a depth of about 600 ft, but the working levels were at a lesser depth.

The Johnny Bull mine, located about 1.25 miles southwest of the Carbonate Hill mine produced a considerable tonnage of copper ore prior to 1910 (Gillerman, 1958). It was one of the largest mines in the area at that time. The Johnny Bull mine is a copper skarn deposit in Horquilla Limestone adjacent to the northwest-trending Johnny Bull fault. The deposit is in the contact zone between limestone and a granite porphyry sill, about 1,000 ft west of the sill and has more copper than the Carbonate Hill deposit. Chalcopyrite, azurite, malachite, galena, bornite, and chrysocolla are ore minerals, in a gangue of garnet, calcite, quartz, pyroxene, epidote, and wollastonite. The mine consists of two inclined shafts; the deeper of which reaches a depth of 150 ft. The Johnny Bull mine had been reclaimed by 1958.

Drilling in the early 1970s and 1990s located a porphyry copper deposit at a depth of 100 ft in the northwestern part of the district (NMBMMR file data). Cyprus Minerals Corp. has filed claims in sec. 30 and 31, T24S, R21W. Pyritization and argillic alteration occurs in most drill holes.

Muir district

Location and Mining History

The Muir mining district is located in the southern Pyramid Mountains between the Lordsburg and Rincon districts (Ffig. 1) and these mines and prospects previously have been included in both districts by various geologists. Mineral occurrences in the district are mostly fluorite and volcanic-epithermal veins and have been included in the Lordsburg or Rincon districts by some geologists. Fire clay occurrences also are in the area. Past production and known resources in the Muir mining district are generally small, but the district has not been extensively explored. Approximately 100 ounces of silver ore has been produced from the Silver Tree mine, and $40,000-60,000 worth of fluorite has been produced from the Doubtful mine (Table 62), including 9,175 short tons of fluorspar ore containing about 60% CaF_2 between 1942 and 1953.

TABLE 62—Mineral occurrences of the Muir mining district, Hidalgo County. Location includes section, township, and range.

MINE NAME (ALIAS)	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	YEARS OF PRODUCTION	DEVELOPMENT	PRODUCTION	TYPE OF DEPOSIT	REFERENCES
Allen	SE7 25S 18W	32° 8' 28" 108° 44' 25"	Ag, Pb, Zn ,Sb	none	adit	none	volcanic-epithermal	Elston (1960); Elston et al. (1983)
Cedar	SE12 25S 18W	32° 8' 20" 108° 44' 30"	Ag,Pb,Zn	none	pit	none	volcanic-epithermal	NMBMMR file data
Doubtful (Animas, Lost Spar)	SE15 25S 19W	32° 7' 35" 108° 47' 10"	F, Mn	1940s, 1951-1952	shafts, adits	9,175 tons, $40,000-60,000	fluorite veins	Elston (1960), Williams (1966)
Fairview	SE17 25S 18W	32° 7' 35" 108° 42' 30"	Cu, Ag	none	pits	none	volcanic-epithermal	NMBMMR file data
Lucky Strike	1 25S 19W	32° 9' 45" 108° 45' 00"	Cu, Ag	none	pit	none	volcanic-epithermal	NMBMMR file data
Silver Tree (J.T.Muir, Kipp, Little Pyramid)	NE7 25S 18W	32° 8' 50" 108° 43' 45"	Ag, Pb, Zn, Sb	1943 or 1948	caved vertical shaft	one truckload of silver ore worth about $100	volcanic-epithermal	Elston (1960); Richter and Lawrence (1983)
Spar Bonanza	NE15 25S 19W	32° 7' 40" 108° 47' 10"	F	none	20 ft shaft, pit	none	fluorite veins	Rothrock et al. (1946), Elston (1960)
unknown	NE2 25S 19W	32° 9' 45" 108° 8' 35"	F	none	pit	none	fluorite veins	Elston (1960)
Woodcamp	SE6 25S 18W	32° 9' 30" 108° 47' 10"	Ag,Pb	none	shaft	none	volcanic-epithermal	NMBMMR file data
unknown	SE23 25S 18W	32° 6' 40" 108° 39' 50"	Cu?,Au?	none	pit	none	volcanic-epithermal	Elston (1960), NMBMMR file data

Geology

The district is aligned mostly along the northern interior wall of Muir caldera, a deeply eroded Oligocene ash-flow tuff caldera (Deal et al., 1978). The westernmost part of it is within the Lightning Dock Known Geothermal Resources Area (KGRA) where hot wells (70-115° C) supply greenhouses with hot water and heat.

The district lies on both gravity and magnetic highs--the magnetic high is probably caused by a felsic intrusion into the caldera and/or skarn mineralization.

Rocks associated with the Muir cauldera form most of the Pyramid Mountains. Pre-caldera rocks consist of Pennsylvanian and Cretaceous sedimentary rocks, late Cretaceous and/or early Tertiary basalt and andesite, and Oligocene andesite (Elston et al., 1983). In general, the volcanic rocks of the Pyramid Mountains are calc-alkaline, with rhyolite ash-flow tuffs, lava flows, and breccias being the most abundant rock types (Deal et al., 1978; Elston et al., 1983; Elston, 1994). The tuff of Woodhaul Canyon has been dated as 36.82±0.81 Ma (biotite, K-Ar; Deal et al., 1978) and approximates the age of the cauldera. A later group of Oligocene-early Miocene post-caldera ash-flow tuffs and basaltic flows are designated the Rimrock Mountain group. These tuffs originated beyond the Pyramid Mountains--some from the Animas Mountains to the south and some from unknown sources. Numerous diorite, monzonite porphyry, andesite, and rhyolite dikes and small stocks intrude the cauldera and older rocks (Elston et al., 1983). One andesite stock has an age date of 29.4±0.7 Ma (whole rock, K-Ar; Elston et al., 1983).

Mid-Tertiary geologic structures in the Pyramid Mountains are dominated by the Muir caldera (Deal et al., 1978; Elston et al., 1983; Elston, 1994). The caldera is an elongate structure with its long axis striking northwest roughly parallel to the pre-Tertiary basement structures in the region. It consists of an inner caldera in which a thick fill of ash-flow tuff accumulated, bordered by a collapsed caldera wall and three zones of successive ring-fracture felsic domes, flows, and moat deposits outside of the caldera wall. The caldera collapsed in two stages, each associated with a rhyolite ash-flow tuff sheet and ring-fracture domes. Ring-fracture zones and the caldera wall are preserved only on part of the northeast side. The remainder of the zones are hidden beneath Animas and Playas Valleys.

In the Pyramid Mountains, hyrdothermal alteration occurred during collapse of the Muir caldera in Oligocene time and again during Miocene or younger time via hot springs and shallow vein-forming hydrothermal fluids (Elston et al., 1983). The Oligocene alteration is widespread, but is unrelated to present thermal activity. The rhyolite of Jose Placecia Canyon and the tuff of Woodhaul Canyon are intensely argillized and pyrite is widespread (Elston et al., 1983). Modern geothermal activity may be a relict of widespread fault-controlled hot-spring activity over the last 20 Ma. Fluorine-bearing waters of the Lightning Dock KGRA may be a late-stage product of the hydrothermal activity.

Mineral deposits

Veins of several ages and mineral assemblages are scattered throughout the district (Fig. 45, Table 62). They are fault- and fracture-controlled, occur in the ring-fracture zone of the Muir cauldera, and are associated with argillic alteration characterized by chlorite, pyrite, and quartz. Fluorite was found in drill cuttings at the Cockrell Corp. No. 1 Federal well in sec. 21, T24S, R19W, indicating mineralization of Recent age (Elston et al., 1983). Stream-sediment geochemical anomalies include Ag, Ba, Be, Co, Mo, Pb, Y, and Zn, localized Cd and Nb, K to the west, and Cr and U in the northwest.

Fluorspar deposits at the Doubtful (Animas) vein, are unrelated to the adjacent porphyry which is the core of the resurgent dome of the Muir caldera (Elston, 1994). The deposit occurs in a fissure vein that strikes N20°W and dips 80°SW in fine-grained andesite, interpreted as being 36 Ma (Elston, 1994). Green and white, fine-grained to coarsely crystalline fluorite is interwoven with finely crystalline white quartz, manganese oxides, and manganiferous calcite. The fluorite material fills a series of nearly vertical veinlets and cements breccia along the veins. Average vein thickness is 4 ft, with the maximum thickness being 10 ft. A grab sample of stockpiled material contained 43.0% CaF_2, 28.6% SiO_2, and 19.5% $CaCO_3$ (Williams, 1966). Fluid inclusion studies indicate temperatures of homgenization of 137-349°C with evidence of boiling; salinities were below 9.47 eq. wt.% NaCl (Elston et al., 1983; Hill, 1994). The age of mineralization is most likely Miocene or younger (Elston et al., 1983).

Volcanic-epithermal veins at the Silver Tree and Allen mines occur in andesite of Holtkamp Canyon and tuff of Woodhaul Canyon (Elston et al., 1983). The veins consist of pyrite, quartz, galena, and stibnite. Additional volcanic-epithermal veins occur in the area (Table 62) and need to be examined to determine their mineral resource potential.

Pratt district

The Pratt district (sec. 33, T27S, R20W) consist of the Pratt shale and clay quarry, south of Pratt in Hidalgo County (Fig. 1). The Pennsylvanian shale has been mined sporadically since 1912 for use as refractory material in the nearby copper smelters. Production since 1912 is estimated as $150,000-200,000. Current capacity is 1,500 short tons/year.

Rincon district

Location and Mining History

The Rincon (or Animas) mining district is located in the northern part of the Animas Mountains southwest of Animas (Fig. 1) and contains carbonate-hosted Pb-Zn replacement, volcanic-epithermal, and carbonate-hosted Mn replacement deposits (Table 63). Prospecting began in the area in 1880. Production has been minor and amounts to approximately $320,000 worth of copper, silver, gold, and lead; including <10,000 lbs Cu and >10,000 oz Ag (Table 2).

TABLE 63—Mines and prospects of the Rincon mining district, Hidalgo County. Location includes section, township, and range.

MINE NAME (ALIAS)	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	YEARS OF PRODUCTION	DEVELOPMENT	PRODUCTION	TYPE OF DEPOSIT	REFERENCES
Blacktop no 1 claim	S12 28S 19W	31° 52' 40" 108° 44' 30"	Mn,Pb,Cu	none	pit	none	carbonate-hosted Mn replacement	Elston (1960)
Cowboy	NE23 28S 20W	31° 51' 30" 108° 51' 05"	Au	none	pit	none	volcanic epithermal	Elston (1960)
Fredington-bloom	SW7 28S 18W	31° 53' 00" 108° 43' 33"	Ag,Pb,Zn,Ba	1908-1909	adit	$10,000	carbonate-hosted Pb-Zn replacement	Elston (1960), Drewes (1986)
Zinc	SW7 28S 18W	31° 53' 05" 108° 43' 35"	Ag,Pb,Zn	none	pit	none	carbonate-hosted Pb-Zn replacement	Elston (1960), Drewes (1986)
White Rose	SW7 28S 18W	31° 53' 10" 108° 43' 25"	Ba,Pb	none	pit	none	carbonate-hosted Pb-Zn replacement	Elston (1960), Drewes (1986)
Page	SW17 28S 18W	31° 52' 00" 108° 42' 25"	Pb,Cu,Zn	none	80 ft shaft, pits	none	carbonate-hosted Pb-Zn replacement	Elston (1960), Drewes (1986)
Rincon	NW31 28S 18W	31° 49' 40" 108° 43' 20"	Ag,Pb,Zn	1940-1949	pits	$20,000 Ag	carbonate-hosted Pb-Zn	Elston (1960), Drewes (1986)
unknown	NW29 28S 18W	31° 50' 35" 108° 42' 45"	Ag	none	pit	none	carbonate-hosted Pb-Zn replacement	Drewes (1986)
unknown	C21 28S 18W	31° 51' 30" 108° 41' 10"	Ag,Cu	none	pit	none	volcanic-epithermal	Drewes (1986)
unknown	NW20 28S 18W	31° 52' 15" 108° 42' 45"	Ag,Cu,Pb,Zn	none	pit	none	volcanic-epithermal	Drewes (1986)
unknown	S34 28S 18W	31° 49' 35" 108° 40' 00"	Ag,Cu,Pb,Zn	none	pit	none	carbonate-hosted Pb-Zn replacement	Drewes (1986)

Geology

The oldest rocks in the northern Animas Mountains consist of Proterozoic basement of porphyritic, coarse-grained granite dated at 1,200 Ma (Soulé, 1972; Drewes, 1986). Resting unconformably on the granite are Paleozoic marine and Cretaceous clastic sedimentary rocks. Tertiary post-orogenic intrusive and volcanic rocks are the youngest rocks in the district. One of these intrusives is a quartz monzonite porphyry that has been dated as 34.0±0.1 Ma (K-feldspar, $^{40}Ar/^{39}Ar$; McLemore et al., 1995). Rhyolite dikes occur in the northern part of the district where they intrude along post-Laramide normal faults or as linear zones which expanded, thermally metamorphosed, and deformed the country rock (Soulé, 1972). The area is characterized by gravity and magnetic lows which may be related to regional hydrothermal alteration.

Mineral Deposits

The Rincon mine is a carbonate-hosted Pb-Zn replacement deposit hosted by light-gray, medium-bedded Horquilla Limestone southeast of a northeast-trending strike-slip fault. The mineralized limestone is 2-5 ft thick, brecciated and folded, and below a gray to black shale (Elston, 1960). The main workings are along two fault zones that strike N45°W, dip 56°NE and N80°E, dips 56°NW (Elston, 1960). Jasperiod is common. Ore minerals include galena, chalcopyrite, sphalerite, and hemimorphite.

The Fredingbloom, Zinc, and White Rose mines occur along a ridge of Escabrosa Limestone. The ore predominantly occurs in replacement deposits at or along faults. Smithsonite and anglesite are dominant minerals at the Fredingbloom and Zinc mines, whereas barite, galena, and sphalerite are dominant minerals at the White Rose mine (Elston, 1960). Chrysocolla is found at the Zinc mine. A sample from the Zinc mine assayed 35% Pb and 14% Zn (Elston, 1960).

The Cowboy mine is in a volcanic-epithermal vein in the Red Hill rhyolite (not to be confused with the Red Hill mine in the Gillespie district). Several small quartz veins occur in a zone less than 3 ft wide and a few tens of feet long. Quartz, iron and manganese oxides with trace amounts of pyrite and gold occur in the veins (Elston, 1960).

Additional carbonate-hosted Pb-Zn replacement and volcanic-epithermal vein deposits are found scattered throughout the district, but none have yielded large amounts of ore (Table 63). These deposits are typically small and similar to those described above. Economic potential appears low for most of the deposits, but they could be indicative of larger deposits at depth.

Small carbonate-hosted manganese deposits occur along faults and fractures within Paleozoic carbonate rocks at the Blacktop No. 1 claim. A grab sample of ore assayed 28.55% Mn, 0.27% Cu, 0.50% Pb, and 0.26% Zn (Elston, 1960).

Stream-sediment geochemical anomalies in the area include As, Cd, Cu, La, and Th, and local Nb and Pb.

Silver Tip district

Location and Mining History

The Silver Tip mining district is located in the southern Peloncillo Mountains, where it straddles the Arizona-New Mexico state line (Fig. 37). The district is named for the Silver Tip mine, a volcanic-epithermal vein deposit, which is located in Arizona about 0.3 mi west of the Arizona-New Mexico state line (sec. 25, T22S, R32E, Arizona baseline). The Silver Tip mine consists of a 240-ft adit and a 30-ft shaft (Hayes et al., 1983). The mine may have produced, but total production is unknown. There is no production from the New Mexico side of the district. Additional prospects occur along the Silver Tip vein. In the early 1980s, approximately 90 mining claims, mostly near the Silver Tip mine, were filed and in 1980, geophysical exploration was being conducted in and around the district. In the mid 1980s, a drilling program was conducted by Nicor Industries, Inc.; but no reserves were found. North of the district a small abandoned rock quarry remains where rhyolite tuff was quarried for local use as building stone.

Geology

The district lies within the Geronimo Trail caldera which is characterized by a gravity gradient and magnetic high. The Geronimo Trail tuff is dated as 24.2 ± 0.5 Ma (Deal et al., 1978). The caldera margin is delineated by an aeroradiometric Th and U high. The district consists of Oligocene and younger volcanic rocks that Deal et al. (1978) and Erb (1979) suspected were vented from a nearby volcanic center. Rocks in the district are rhyolitic ash-flow tuffs, volcanic breccia and epiclastic sedimentary breccias, and dacitic lavas. The oldest rhyolite tuffs are 27.1±1.5 Ma (zircon, fission track; Hayes, 1982). The breccias are largely volcanic with subordinate sedimentary rocks derived from the volcanic breccia. The dacitic lavas are from Oligocene porphyritic flows and domes. Some tuffaceous sandstone and conglomerate with interlayered tuff of probable Miocene age occur in the northern part of the district and small remnants of Pleistocene or Pliocene olivine basalt cap some of the higher hills (Hayes, 1982; Hayes and Brown, 1984). Rhyolite dikes and domes are common in the area (Emanuel, 1985; McIntyre, 1988). Parallel north-south-trending normal faults of little displacement cut the volcanic rocks. A structure truncates the Geronimo Trail cauldera that McIntyre (1988) interpreted as the Clanton Draw cauldera. The Skelton Canyon tuff marks the beginning of the collapse of this younger cauldera.

Mineral Deposits

The Silver Tip mine and several nearby prospects are located near the New Mexico part of the district in an area of argillic and advanced-argillic altered rocks that extends for about 0.5 mi into the New Mexico part of the district (Emanuel, 1985; McIntyre, 1988). The deposit is in a 1-10 ft thick, 1,500 ft long mineralized fault zone, which is part of the Geronimo Trail caldera ring-fracture zone. Pyrite is common and bromargyrite has been identified at the Silver Tip mine (Emanuel, 1985). Rock chip samples collected by Nicor Industries, Inc. are typically low and contain as high as 0.62 ppm Au, 8.5 ppm Ag, 225 ppm Cu, 490 ppm Pb, 1350 ppm Zn, and 235 ppm Mo (Emanuel, 1985). Argillic and local advanced-argillic alteration and silicification occurs along the fault zones.

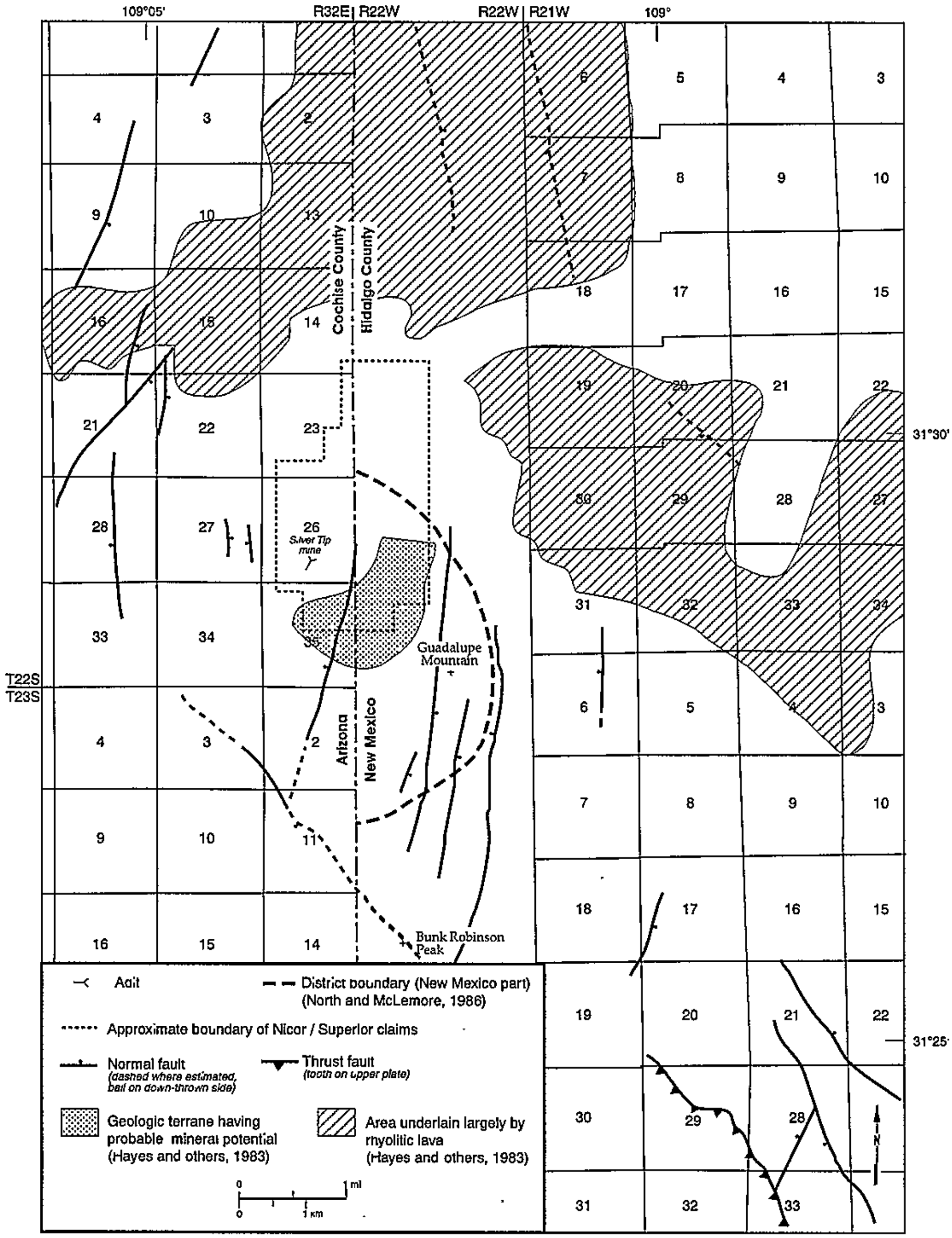

Figure 37—Mines and prospects in the Silver Tip mining district, Hidalgo County, New Mexico.

There is little additional field evidence of metallic mineralization in the district. Previous studies of the area include a 1980 mineral-resource survey of the Bunk Robinson Peak and Whitmire Canyon Roadless Areas of Arizona and New Mexico (Hayes, 1982; Hayes et al., 1983; Watts et al., 1983; Hayes and Brown, 1984) which identifies a zone of altered rocks having probable mineral potential for Ag, Au, Bi, Mo, Pb, and Zn. This zone stretches south and southwest for about 1.5 mi from the southern contact of a dacitic lava flow in the northern part of the district and consists of argillically altered rocks and anomalous As, Ba, Mo, and Pb in stream-sediment samples (Watts et al., 1983). Many of the mining claims are located along this zone. The quartz veins zone strike N10°W-N15°E, are up to 20 ft thick, and steeply dipping (McIntyre, 1988). Pyrite is locally abundant.

Northwest and east of the district, Hayes et al.(1983) delineated a tract of mostly dominant rhyolitic lava having anomalously high values of Be, Bi, Mo, and Sn in stream-sediment samples. These anomalies are not indicative of surficial weathering, and may suggest the possibility of mineralization at depth. Other geochemical samples include anomalous Be, Cu, La, Mo, Pb, and Zn and local Bi, Co, Nb, Th, U, and Y. The presence of obsidian layers as much as 8 ft thick in rhyolitic lava suggests that perlite resources could be present (Hayes et al., 1983).

Sylvanite district

Location and Mining History

The Sylvanite mining district is located south of the Eureka mining district in the Little Hatchet Mountains (Fig. 1). In some reports (Anderson, 1957; Johnson, 1972), the Sylvanite mining district is included with Eureka district to form the Hachita mining district. Laramide skarn, Laramide vein, and placer deposits occur in the district and production is estimated as approximately $315,000, including 2,500 oz Au, 130,000 lbs Cu, and 8,000 lbs Pb (Table 64). In the southern portion of the district, 5,632 short tons of scheelite-garnet ore grading 0.44% WO_3 was produced from a small skarn (Dale and McKinney, 1959). A carload of As was produced in 1924 (Dasch, 1965).

TABLE 64—Reported metal production from the Sylvanite mining district, Hidalgo County, New Mexico (from U. S. Geological Survey, 1902-1927; U. S. Bureau of Mines, 1927-1990). 650 tons of scheelite-garnet ore was produced grading 0.44% WO_3 (Dale and McKinney, 1959). For years omitted, there are no reported production figures. —none reported. [1] Includes <200 oz of placer gold production.

YEAR	ORE (SHORT TONS)	COPPER (LBS)	GOLD (OZ)	SILVER (OZ)	LEAD (LBS)	TOTAL VALUE ($)
1911	20	230	9	8	—	—
1933	10	—	5.71	29	500	313
1934	632	7,650	372.3	425	300	13,911
1935	1,101	10,000	472.1	1,770	10,650	19,052
1936	134	450	45.85	785	36,800	3,433
1937	42	800	13.2	31	--	583
1938	1,376	33,300	643	2,328	19,300	28,175
1939	440	2,000	113	206	100	4,308
1940	515	4,200	210	3,524	1,200	10,391
1941	124	300	86	2,340	400	4,732
1942	94	7,000	1	52	—	982
1945	—	—	—	—	—	—
1947	5	—	—	156	—	141
1948	535	4,000	2.0	9,185	2,000	9,609
1949	470	1,000	6.0	6,402	7,000	7,307
1953	146	10,600	6.0	118	100	3,372
1954	243	17,000	2.0	120	100	5,208
1957	115	3,200	--	12	100	988
TOTAL 1933-1957	6,002	101,730	1,987.16	27,491	78,550	112,505
ESTIMATED TOTAL 1902-1957	6,100	130,000	2,500[1]	35,000	80,000	315,000

The old mining town of Sylvanite is in the southwestern part of the area, approximately 12 mi southwest of Hachita. Copper was discovered in several locations in the area in the 1880s (Lindgren et al., 1910). In 1908, a worker at the Wake Up Charlie claims discovered placer gold and tetradymite in a small gulch east of Cottonwood Spring (Lasky, 1947). The tetradymite was misidentified as the mineral sylvanite, a gold telluride, which the prospector had seen at Cripple Creek. This led to the naming of the Sylvanite mining camp and to a gold rush (Jones, 1908a, b; Dinsmore, 1908; Martin, 1908).

After discovery, the placers were mined by hand using simple techniques and implements. Dry washers and rockers were employed in concentrating the gold because of the shortage of water (Lindgren et al., 1910). The placers were not extensive, and by March 1908, they had been largely abandoned. Despite early optimism, the value of the placer gold was not great (Anderson, 1957). Total placer production was estimated to be less than 200 oz, worth between $2,000 and $3,500 in gold (Table 64). The short duration of the gold rush is reflected in the history of the town of Sylvanite which was established in 1908 and had an average population that year of 500 to 1,000. By 1909, with abandonment of the placers, the population had dropped to 70. Placer gold can still be found in some of the arroyos (Johnson, 1972; McLemore, 1994a). An abandoned placer operation in sec.13, T28S, R16W appears to have been worked recently (V. T. McLemore, unpublished field notes, July 1, 1995).

Once the placers started giving out, prospecting for gold-bearing hard-rock deposits began. Most of the deposits that had been explored up to 1937 in the Little Hatchet Mountains were small. Mining was at such a small scale that none of the mines extended much below the water table, and those that did are now flooded. Moreover, at that time, all known shoots of minable size appeared to be mined out at least to the water table.

Lasky (1947) describes ten different types of mineral deposits in the area, of which only a relative few have accounted for the total past production (Elston, 1965). A few of these mines produced gold and other metals over a significant period. A small amount of scheelite was produced from the Eagle Point tungsten claims in 1943 (650 short tons of 0.44% WO_3; Dale and McKinney, 1959). The last ore shipment reported was in the early 1950s from the Hornet mine (Anderson, 1957). The Copper Dick deposit was discovered in the 1890s and produced copper, silver, gold, and lead from at least 1905 to 1954 from underground mining. An attempt to ship ore from an open cut at the Copper Dick mine was not successful.

In the 1960s through 1980s, several companies have examined the area for potential metal deposits. Exxon Corp. drilled ten holes (greater than 30,000 ft total) in the 1960s to 1970s. Phelps Dodge, Inc., also examined the area. In 1990, Champion Resources, Inc., drilled 27 holes (12,000 ft) and in 1991 to 1993, Challenger Gold joint ventured with Champion Resources and drilled 7 additional holes (7,000 ft). The results were not encouraging, although drilling did intercept 40 ft that assayed 0.06 oz/ton Au.

Geology

The oldest rocks in the district occur at the southern end of the mountains and in isolated hills, where Proterozoic porphyritic granite has been cut by northeast-trending aplite dikes (Lasky, 1947; Zeller, 1970). The younger rocks in the district include Paleozoic and Mesozoic sedimentary rocks and Tertiary volcanics. The sedimentary sequence begins with Bliss Sandstone resting unconformably upon the Proterozoic granite (Zeller, 1970; Lawton et al., 1993). Elsewhere in the Little Hatchet Mountains, massive Permian Horquilla Limestone is the oldest exposed sedimentary formation. Cretaceous sedimentary formations make up the bulk of the Little Hatchet Mountains. Early Tertiary Hidalgo Formation consists of volcanic rocks that rests unconformably upon the older sedimentary formations; a hornblende andesite at the base of the section has an age date of 71.44±0.19 Ma ($^{40}Ar/^{39}Ar$, hornblende; Lawton et al., 1993). The upper part of the volcanic rocks is truncated by a thrust fault. Middle-to-Late Tertiary volcanic rocks consist chiefly of rhyolite and latite pyroclastic rocks and rest with angular unconformity on the older rocks.

In the Little Hatchet Mountains, several Laramide-age stocks, dikes, and sills have intruded the Cretaceous sedimentary rocks, and the most highly mineralized areas are associated with these intrusions. The quartz monzonite and monzonite in the Sylvanite and Eureka districts is called the Sylvanite quartz monzonite stock (Zeller, 1970), but detailed studies are needed to determine if there is more than one intrusive phase. North of Hachita Peak, stocks and large sills of diorite form much of the eastern and northern slopes. The andesite contains altered zones. The youngest intusive rock appears to be the granite at Granite Pass, which has been dated as 43-48 Ma (zircon, fission track; Zeller, 1970). 40Ar/39Ar dating of K-feldspar yielded aplateau age of 32.33±0.18 Ma (V. T. McLemore, unpublished age determination). Rhyolite, felsite, and latite dikes have intruded this granite as well as the older intrusive rocks.

Mineral Deposits

Four types of deposits occur in the district: Laramide veins, Laramide skarns, disseminated pyrite in Tertiary intusive rocks, and gold placers (Table 65). Lasky (1947) describes ten different mineralogical associations: 1) disseminated pyrite in Tertiary intrusive rocks, 2) chalcopyrite skarns (Copper Dick mine), 3) pyrrhotite replacements (Clemmie mine), 4) chalcopyrite-tourmaline veins (Buckhorn mine), 5) arsenopyrite-tourmaline veins (Creeper mine), 6) tetrahydymite-native gold veins (Gold Hill mine), 7) chalcopyrite-barite veins (Santa Maria mine), 8) galena veins (Silver Trail mine), 9) quartz-pyrite-chalcopyrite veins (Broken Jug mine), and 10) fluorite-calcite-quartz veins. They are hosted in Cretaceous sedimentary rocks and Tertiary granitic or mafic intrusive rocks.

TABLE 65—Mines and prospects in the Sylvanite mining district, Hidalgo and Grant Counties (from Lindgren et al., 1910; Lasky, 1947; Dale and McKinney,1959; Zeller, 1970; Elston, 1960; Cooper, 1962; Hammarstrom et al., 1988; V. T. McLemore, unpublished field notes, 9/14/93, 7/1/95). Location includes section, township, and range.

MINE NAME (ALIAS)	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	YEARS OF PRODUCTION	DEVELOPMENT	HOST	TYPE OF DEPOSIT
Albert Bader Placer Deposits	20,21 28S 16W	31° 51' 15", 108° 29' 10"	Au	1908	pits, panning	Cenozoic alluvial gravels	placer gold
Broken Jug	NW35 28S 16W	31° 49' 58", 108°27'' 25"	Au, Cu	unknown	adit, pits	Sylvanite quartz monzonite stock	Laramide vein
Buckhorn (Wood, Russell , Barney)	NE 27 28S 16W	31° 50' 39", 108° 27' 46"	Au, Ag, Cu, Pb, Zn, Bi, Te	1880s - 1940	A shaft and an adit	Cret Hell-To-Finish Formation	Laramide vein
Cactus (Crump, Three Snakes)	NE10 29S 16W	31° 48' 06", 108° 27' 08"	W, Mo, As, Cu, Bi	1943	pits	Cret Mojada Formation	Laramide skarn
Clemmie	C2 29S 16W	31° 49' 30", 108° 25' 56"	Au, Bi, Te, Cu	1908 - 1910	50 ft shafts, 20 ft of drifts	Cret Hell-To-Finish Formation	Laramide skarn
Copper Dick	NE22 28S 16W	31° 51' 2", 108° 27' 38"	Cu, Ag, Au, Pb	1905 - 1954	100 ft shaft, pit, trench	Cret Hell-To-Finish Formation	Laramide skarn
Cottonwood Springs Placers (Livermore)	29 28S 16W	31° 50' 00", 108° 29' 26"	Au	Abandoned in 1908	pits	Cenozoic alluvial gravels	Placer gold
Creeper (Bonner claims)	NW34 28S 16W	31° 49' 43", 108° 28' 00"	As, Au, Te, Bi, Cu	none	adits (265, 165 ft), 60 ft shaft	Cret U Bar Formation	Laramide vein
Eagle Point	SW22 29S 16W	31° 45' 58", 108° 27' 24"	W, Mo, Pb, Cu, Ag, Zn	1943	opencut, trenches, adit	Penn. Horquilla Limestone	Laramide skarn
Gold Acres	3 29S 16W	31° 51' 26", 108° 27' 00"	Au,Ag, Cu, Zn, Pb	unknown	pits, shafts	Cret Hell-To-Finish Formation	Laramide skarn, placer gold
Gold Hill (Hardscrabble, Silver Lake,)	SW35 28S 16W	31° 49' 16", 108° 27' 07"	Au, Ag, Cu, Bi, Te	1908 - 1941	3 adits, pits	Cret Hell-To-Finish Formation	Laramide vein
Golden Eagle	NE34 28S 16W	31° 49' 50", 108° 27' 27"	Au, Ag, Cu	Pre 1910	30 ft shaft	Sylvanite quartz monzonite stock	Laramide vein
Green (Little Mildred, Martin)	SE34 16W 28S	31° 49' 30", 108° 27' 30"	Au, Ag, Cu	1920, 1935	adit	Cret Hell-To-Finish Formation	Laramide vein
Hachita (Omega, Omega 1 and 2)	NE28 28S 16W	31° 50' 25", 108° 28' 10"	Ba	—	2 shallow shafts, pits	Sylvanite quartz monzonite stock	Laramide vein
Hand Car	SW27 28S 16W	31° 50' 15", 108° 28' 00"	Au, Cu	—	opencuts, 20 ft shaft	Sylvanite quartz monzonite stock	Laramide vein
Jowell (Jarrell, Bar Z)	NE29 28S 16W	31° 50' 28", 108° 29' 15"	Cu, Ag, Au, Zn	1900s	65 and 90 ft deep shafts	Cret Hell-To-Finish Formation	Laramide skarn
King Solomon Mine	NE35 28S 16W	31° 49' 36", 108° 27' 13"	Cu, Au	unknown	pits	Sylvanite quartz monzonite stock	Laramide vein

MINE NAME (ALIAS)	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	YEARS OF PRODUCTION	DEVELOPMENT	HOST	TYPE OF DEPOSIT
Knickerbocker (Quartzite)	NE15 29S 16W	31° 47 '25", 108 27'' 10"	Ag	early 1880s	pits	Cret Majado Fromation	Laramide vein
Little Hatchet (Albert Bader Property, Santa Maria, Faria)	21 28S 16W	31° 51' 18", 108° 28' 45"	Pb, Cu, Ag, Au, Zn, Mo, V, Ba	—	3 shafts, 90-100 ft ,1200 ft of drifts	Cret Hell-To-Finish Formation	Laramide skarn
Pearl (Monte Cristo)	SE3 29S 16W	31° 48' 28", 108° 27' 25"	Au, Ag	1909	3 adits (60, 80, and 90 ft long)	Cret U Bar Formation	Laramide vein
Ridgewood (Adelina, Monrania)	SW35 29S 16W	31° 49' 16", 108° 27' 00"	Au, Cu, Ag	1909	Surface cuts, shaft, 40 ft adit	Cret Hell-To-Finish Formation	Laramide skarn
Silver Lake	SE34 28S 16W	31° 49' 48", 108° 27 '32"	Au, Ag, Cu	unknown	pits	Cret Hell-To-Finish Formation	Laramide skarn
Silver Trail	SE21 28S 16W	31° 51' 15", 108° 28' 45"	V, Pb, Zn, Cu, Ag	1909	pits, shaft	Cret hell-To-Finish Formation	Laramide vein
Wake-Up-Charlie	NE34 28S 16W	31° 49' 44", 108° 28' 07"	Au, Cu, Bi, Te	1908	2 shafts (60, 100 ft deep)	Sylvanite quartz monzonite stock	Laramide vein, placer gold
Yellow Jacket	NE24 28S 16W	31° 49' 30", 108° 28' 10"	Au, Cu, Pb, Ag	1908	shaft	Cret Hell-To-Finish	Laramide skarn
unknown	14 29S 16W	31° 47' 25", 108° 26' 15"	Ag	none	pits	Cret Majado Formation	Laramide vein
unknown	NW3 29S 16W	31° 49' 10", 108° 27' 45"	Cu, Au, Ag, Zn	unknown	adit	Tertiary diorite	Laramide vein
unknown	33,34 29S 16W	31° 50' 00", 108° 27' 40"	Au?,Ag?	none	pits	Sylvanite quartz monzonite stock	disseminated
unknown (Grant County)	SW13 28S 16W	31° 52' 25", 108° 26' 5"	Au	unknown	pits	Cenozoic alluvial gravels	placer gold

Gold in the district chiefly occurrs in quartz fissure-veins in the Sylvanite stock and in the adjacent limestone (Anderson, 1957), although there is excellent potential for gold-bearing skarn deposits. The veins typically consist of coarse-grained white quartz cutting and replacing altered host rocks (Lasky, 1947). Tourmaline occurs in the altered rocks and actinolite and chlorite occur in pockets in the quartz. Tetradymite may be the most abundant gold-bearing mineral. The veins are typically short, erratic, steeply dipping, pinch and swell, and less than 15 ft wide. Many occur near lamprophyre dikes. Samples from some of the earliest production reportedly assayed 216-300 oz/ton Au (Martin, 1908). Lasky (1938b) believes potential exists in the subsurface for similar deposits between the Sylvanite and Eureka districts.

The Eagle Point, Cactus Group, and Copper Dick mine are examples of the skarn deposits. A small tungsten skarn occurs in a garnetiferous zone along the contact between Horquilla Limestone and Tertiary intrusive rocks at the Eagle Point claims in the southern tip of the area (Fig. 38; Dale and McKinney, 1959; V. T. McLemore, unpublished field notes, July 2, 1995). Molybdenum is present, and garnet is a gangue mineral. The contacts between tungsten-copper-lead skarns with the limestone are irregular, but sharp (Fig. 39). Another small molybdenum- and tungsten-bearing skarn occurs in a garnetiferous zone in Howells Ridge Formation at the Cactus Group claims (Dale and McKinney, 1959; Hammarstrom et al., 1988; V. T. McLemore, unpublished field notes, September 14, 1993). Scheelite was the mineral of economic interest at these deposits.

The Copper Dick mine is a copper-garnet skarn deposit in at the intersection with a lamprophyre dike in Hell-to-Finish Formation limestone. Calc-silicate skarn-type minerals such as epidote, chlorite, and actinolite are present as gangue minerals. A small bismuth anomaly was discovered by Challenger Resources in the southern part of the district, which may be related to lead-zinc and/or gold skarns.

FIGURE 38—Eagle Point adit (looking east) with unaltered limestone to the right and skarn to the left, Sylvanite district, Hidalgo County (V. T. McLemore photo, 7/1/95).

FIGURE 39—Closeup of W-Cu-Pb skarn at the Eagle Point mine, Sylvanite district, Hidalgo County (V. T. McLemore photo, 7/1/95).

The Buckhorn mine is in metamorphosed limestone beds about 500 ft north of the Sylvanite stock. The mine is located at the west end of a vein outcrop having a general trend of S70°E and dipping 70° to 90° NE (Lasky, 1947). The vein averages 4-5 ft wide but varies from 1-15 ft, and lies between a lamprophyre dike and garnetized beds of metasediments. In some places, clay gouge and breccia occur along the vein. Native gold, silver, chalcopyrite, sphalerite, bismutite, and tellurobismuthite are ore minerals, and quartz, calcite, tourmaline, limonite, pyrite, and chlorite are gangue minerals.

At the Green mine, gold occurs in a pinch and swell-type vein in limestone conglomerate and garnet. Quartz monzonite of Sylvanite stock and dikes are associated igneous rocks. The most abundant metallic ore mineral is tetradymite (Lasky, 1947). Visible gold is recognized, occurs as grains and thin streaks in the quartz. The silver-gold ratio at the Green mine was about 1.5-2 times as much silver as gold; much of the silver occurred in hessite. Chemical analyses of selected samples from the Sylvanite mining district are shown in Table 66.

TABLE 66—Chemical analyses of samples from the Sylvanite mining district, Hidalgo County. Samples are representative dump samples. No gold was detected in any samples. Analyses by New Mexico Bureau of Mines and Mineral Resources chemical laboratory.

LAB NO.	FIELD NO.	SAMPLE DESCRIPTION	Cu (ppm)	Pb (ppm)	Zn (ppm)	As (ppm)	Hg (ppm)	Ag (oz/ton)
2939	SLY 1	sec. 10 prospects	100	65	15	16,000	0.25	0.00
2940	SLY 2	sec. 3 adit	10	38	15	240	0.25	0.00
2941	SLY 3	Creeper mine	290	20	23	15,500	0.24	0.00
2942	SLY 4	pit near Creeper mine	30	31	13	1,000	0.50	0.00
2943	SLY 5	Buckhorn	37	<12	11	65	0.25	0.00
2944	SLY 6	Copper Dick mine	42,000	95	160	1,200	0.50	0.92

Zones of disseminated pyrite occur in the monzonite near Cottonwood Spring. The monzonite is altered to jarosite, iron oxides, and pyrite. Unaltered, pre-ore lamprophyre dikes cut the altered monzonite, suggesting that the alteration is older than the mineralization (Lasky, 1947).

Gold placer deposits are found in many of the arroyos draining the lode deposits (Table 66). Panning of most arroyos could yield free gold. However, none of these placer deposits are large enough to be economic.

GEOLOGY AND MINERAL OCCURRENCES OF THE MINING DISTRICTS OF GRANT COUNTY

Virginia T. McLemore, David M. Sutphin, Daniel R. Hack, and Tim C. Pease

Introduction

Grant County was part of Doña Ana County until it was established in 1868; it included part of Luna County until 1909 and all of Hidalgo County until 1919. It is the largest metal producing county in New Mexico. Several world class deposits lie within its borders. The Chino copper mine at Santa Rita was probably first mined by Native American Indians for ornaments, tools, and trading purposes. Since becoming part of the United States in 1846, Grant County typically led the state in metals production. Table 67 shows annual production from 1869 to 1982.

TABLE 67—Metals production from Grant County, New Mexico from 1869 to 1982 (Lindgren et al., 1910; U. S. Geological Survey, 1902-1927; U. S. Bureau of Mines, 1927-1990). *—estimated.

YEAR	ORE (SHORT TONS)	COPPER (LBS)	GOLD LODE (OZ)	GOLD PLACER (OZ)	SILVER (OZ)	LEAD (LBS)	ZINC (LBS)	VALUE ($)
1869	—	—	8,500	—	—	—	—	170,000
1870	—	—	5,620	—	—	—	—	112,400
1871	—	—	—	—	68,182	—	—	90,000*
1872	—	—	17,500	—	—	—	—	350,000
1875	—	—	1,250	—	181,450	—	—	250,000*
1881	—	—	1,250	—	213,179	—	—	266,000*
1882	—	—	1,750	—	329,457	—	—	410,000*
1883	—	—	5,500	—	930,232	—	—	1,140,000*
1884	—	—	5,250	—	825,581	—	—	1,020,000*
1885	—	—	12,950	—	872,091	—	—	1,190,000*
1888	—	—	188	—	297,909	—	—	283,000*
1889	—	682,891	25,890	—	595,945	1,554,580	—	1,240,000*
1890	—	323,811	14,612	—	441,917	255,997	—	818,000*
1891	—	476,924	15,718	—	466,924	528,046	—	860,000*
1892	—	86,207	16,300	—	296,949	4,770,000	—	790,000*
1893	—	w	11,600	—	181,938	—	—	374,000*
1894	—	26,000	9,250	—	26,000	660,000	—	226,000*
1895	—	51,258	8,600	—	39,748	230,184	—	211,000*
1896	—	w	9,346	—	129,023	—	—	275,000*
1897	—	1,154,162	4,083	—	161,657	9,984,056	—	691,000*
1898	—	3,267,452	4,312	—	165,081	9,369,818	—	945,000*
1899	—	2,960,411	4,831	—	194,046	9,169,302	—	1,130,000*
1900	—	6,506,517	20,686	—	231,726	3,742,964	—	1,800,000*
1901	—	5,682,169	13,853	—	181,564	1,860,465	—	1,415,000*
1902	—	7,251,757	3,936	—	48,513	464,840	—	1,008,000*
1903	—	6,130,970	4,478	—	89,763	4,040,581	—	1,200,000*
1904	47,032	4,428,508	2,919	—	74,793	179,142	—	687,018
1905	81,160	5,291,222	1,796	529	86,629	321,035	257,203	954,026
1906	127,800	6,388,830	4,717	111	163,987	710,895	144,656	1,692,069
1907	146,746	8,046,315	5,285	183	224,279	1,394,390	73,729	1,947,582
1908	75,254	5,242,767	2,040	170	95,477	244,589	251,070	942,181
1909	89,520	5,176,585	1,656	173	74,198	215,070	203,278	769,590
1910	68,892	4,404,394	3,062	128	156,557	257,953	—	721,181
1911	93,770	3,918,928	5,430	196	221,882	694,247	306,895	772,481
1912	1,200,691	32,952,133	7,196	123	356,057	2,309,732	3,135,000	6,142,526
1913	—	53,436,177	4,981	79	206,215	446,805	2,553,322	8,674,423
1914	—	58,259,113	15,446	1,043	304,679	570,513	—	8,280,059
1915	2,523,275	72,487,200	17,661	—	508,552	2,251,383	—	13,418,994
1916	3,577,868	87,784,545	19,324	97	544,907	2,561,638	—	22,553,265
1917	4,315,341	101,373,641	19,565	—	487,558	3,224,477	13,335,127	30,118,686
1918	4,602,458	96,939,381	13,064	—	338,833	3,158,493	11,876,428	25,857,920
1919	2,059,588	50,075,911	11,722	52	336,499	1,587,419	4,567,328	10,351,937
1920	2,118,187	51,015,864	4,342	—	81,299	1,038,825	6,177,840	10,148,812
1921	540,858	13,634,563	835	—	106,272	96,844	95,000	1,891,507
1922	1,440,002	28,438,896	2,225	100	150,844	1,123,782	1,333,440	4,175,980
1923	2,944,179	56,825,912	4,063	63	94,392	1,574,727	13,061,000	9,514,477

YEAR	ORE (SHORT TONS)	COPPER (LBS)	GOLD LODE (OZ)	GOLD PLACER (OZ)	SILVER (OZ)	LEAD (LBS)	ZINC (LBS)	VALUE ($)
1924	2,864,260	69,498,084	3,600	50	43,064	1,301,812	16,921,000	10,412,584
1925	3,167,356	70,707,802	4,753	26	80,319	2,486,110	15,033,000	11,553,841
1926	3,642,883	75,909,600	5,606	31	118,485	3,122,300	14,767,000	12,175,113
1927	3,103,250	67,237,878	5,180	34	143,434	2,774,364	10,270,000	9,828,630
1928	3,740,623	81,131,090	5,626	—	153,453	2,822,328	15,512,000	12,998,855
1929	4,161,397	88,538,239	6,550	—	397,771	8,044,858	22,926,000	17,950,078
1930	2,676,456	57,604,600	3,836	—	413,379	8,047,500	30,783,000	9,607,008
1931	2,714,696	56,328,000	3,660	—	437,400	6,848,000	14,099,000	6,117,483
1932	1,233,213	26,527,000	45,551	—	480,376	7,056,800	10,241,000	2,371,152
1933	1,240,896	25,160,000	1,553	239	419,580	6,873,000	22,507,000	2,993,732
1934	1,142,917	21,826,600	2,715	334	362,572	5,829,100	18,218,000	3,086,134
1935	178,635	3,148,000	2,651	185	325,003	3,876,700	16,807,000	1,488,731
1936	224,962	4,451,300	1,860	70	444,475	5,418,000	21,436,000	2,142,344
1937	3,807,806	59,020,000	9,722	101	520,667	4,726,000	24,500,000	9,759,309
1938	2,004,701	33,161,400	8,581	184	307,426	825,400	33,421,000	5,397,501
1939	4,683,979	84,728,000	10,187	182	671,045	6,566,000	48,221,000	12,446,218
1940	6,820,523	130,050,000	15,198	478	716,376	7,188,000	60,157,000	19,903,024
1941	7,281,457	137,814,000	14,342	451	737,003	8,165,000	70,473,000	23,054,778
1942	8,020,719	152,837,000	5,645	209	298,323	7,134,000	86,086,000	27,394,284
1943	8,135,780	145,739,000	3,063	45	234,064	8,301,000	107,775,000	31,483,571
1944	7,730,912	133,814,000	2,850	—	268,307	10,383,000	92,197,000	29,696,534
1945	6,647,221	110,644,000	2,663	2	241,079	12,030,000	74,382,930	24,790,159
1946	6,424,874	97,707,000	1,910	1	145,932	6,885,000	65,179,000	24,715,635
1947	2,119,501	116,469,500	991	6	196,623	7,470,000	78,040,000	35,189,954
1948	7,458,231	145,640,000	1,490	—	249,047	8,620,000	72,884,000	43,117,982
1949	6,401,359	106,580,000	1,046	28	179,262	5,788,000	54,040,000	28,811,161
1950	7,761,354	127,406,000	2,291	6	201,075	5,138,000	54,648,000	35,216,472
1951	8,516,520	143,176,000	2,556	4	291,945	7,108,000	85,358,000	51,767,257
1952	8,851,842	148,088,000	1,756	—	337,916	9,676,000	97,672,000	97,280,000
1953	7,888,727	139,742,000	988	—	81,444	3,048,000	25,674,000	43,566,043
1954	6,607,942	116,368,000	3,121	4	32,458	28,000	2,000	34,471,398
1955	7,293,030	128,184,000	1,096	81	160,355	5,264,000	30,262,000	52,502,683
1956	8,576,389	142,455,600	2,505	2	275,946	9,661,500	67,733,600	71,677,487
1957	7,895,912	130,755,200	2,523	—	207,355	7,216,800	61,365,600	47,783,699
1958	5,830,995	110,150,000	2,158	—	71,141	1,158,000	17,152,000	30,994,424
1959	4,601,123	76,842,000	1,354	—	43,402	622,000	8,022,000	24,670,853
1960	7,631,818	129,320,000	2,342	—	78,308	1,072,000	23,090,000	44,768,820
1961	7,577,749	153,984,000	3,065	—	122,213	2,038,000	42,306,000	51,489,986
1962	7,539,492	160,256,000	4,956	—	176,752	2,084,000	44,002,000	54,976,166
1963	7,316,229	162,226,000	4,568	—	139,781	1,920,000	25,858,000	53,485,484
1964	7,774,341	168,488,000	3,844	—	128,785	1,716,000	57,396,000	63,245,650
1965	8,847,844	193,856,000	4,642	—	196,235	5,048,000	70,198,000	80,077,616
1966	9,277,455	212,042,000	3,760	—	136,520	1,266,000	55,730,000	87,275,697
1967	4,792,226	148,340,000	3,076	—	109,378	692,000	38,386,000	62,391,403
1968	6,943,962	179,316,000	4,692	—	143,921	462,000	34,030,000	80,186,099
1969	12,708,737	235,232,000	6,663	—	378,846	3,952,000	47,272,000	120,260,309
1970	20,645,300	327,412,000	6,174	—	731,900	7,094,000	33,144,000	196,622,646
1971	18,080,954	307,728,000	8,885	—	715,454	5,942,000	27,916,000	166,805,736
1972	18,973,847	319,904,000	11,883	—	884,649	7,162,000	25,462,000	171,574,101
1973	25,420,988	392,592,000	11,109	—	967,633	4,976,000	24,518,000	243,030,604
1974	25,488,124	380,788,000	14,081	—	1,103,175	4,240,000	26,980,000	312,431,057
1975	19,529,164	291,604,000	10,268	—	778,452	3,862,000	22,030,000	201,730,818
1976	25,162,212	344,596,000	13,578	—	886,261	w	w	245,395,095
1977	24,438,769	329,396,000	12,565	—	911,482	w	w	237,908,937
1978	21,873,800	281,219,400	9,777	—	w	w	w	198,118,258
1979	27,104,000	361,402,800	22,962	—	w	w	w	359,170,905
1980	22,236,333	328,666,800	15,755	—	w	—	w	372,559,733
1981	24,913,700	338,969,400	23,307	—	1,560,357	w	w	316,467,112
1982	9,243,000	w	1,927	—	w	w	w	120,462,893
1983-1995	w	w	w	—	w	w	w	w
TOTAL 1869-1982	571,025,106	9,894,038,707	769,638	5,800	32,388,069	331,621,364	2,195,454,446	4,926,770,758

Many districts in Grant County account for most of the metals production in New Mexico. The Chino (Santa Rita district) and Tyrone (Burro Mountains district) mines are the largest porphyry-copper deposits in New Mexico. The Chino mine is also the state's largest gold producer. The Burro Mountains district is the 2nd largest silver producing district in New Mexico, whereas the Bayard district ranks 3rd. The Bayard district is the 2nd largest silver producing district in the state. The Fierro-Hanover district ranks 3rd in copper production behind Santa Rita and Burro Mountains districts, and it ranks 4th in lead and 1st in zinc production. Other districts also are significant base- and precious-metals producers: Piños Altos (5th zinc, 6th copper, 10th gold), Copper Flat (6th in zinc), Carpenter (7th in zinc), and Steeple Rock (9th gold, 13th silver).

Currently, three metal mines are in production in the county: Chino (Santa Rita district), Tyrone (Burro Mountains district), and Continental (Fierro-Hanover district). The Hurley smelter at Hurley (Fig. 5) and solvent-extraction-electrowinning (SX-EW) plants at Tyrone and Santa Rita are operated by Phelps Dodge Mining Co. In addition, sand and gravel, limestone, and fire clay also are produced from the county (Hatton et al., 1994). Silica flux containing precious metals was produced from the Steeple Rock district in the early 1990s.

Silver City is the largest community in the county. The Gila and Mimbres Rivers cut through Grant County. The Gila Wilderness Area, one of the first areas in the U.S., has been withdrawn from mineral entry since its formation in 1924. Additional acreage has been added to the Gila Wilderness Area since then which amounts to 558,065 acres. The Aldo Leopold Wilderness Area was established in the Black Range in eastern Grant County in 1980; it totals 202,016 acres, including small portions in Sierra County. Much of the county is within the Gila National Forest (2,704,724 acres, including large portions in Catron County). The Gila Cliff Dwellings National Park lies just north of the county line in Catron County.

Alum Mountain district

Location and Mining History

The Alum Mountain mining district, also known as the Gila River, Alungen, and Copperas Creek districts, is located about 17 mi east-northeast of the Gila Fluorspar mining district (Fig. 1). It was first discovered in 1892. In 1945, 3 short tons of ore were produced containing 1 oz/ton Au and 21 oz/ton Ag from volcanic-epithermal vein deposits (Table 2). Approximately 1,100 short tons of meerschaum have been produced from three shafts in the area in 1885 (Northrop, 1959; Ratté et al., 1979). It is used in manufacturing articles such as cigar holders, pipes, and mouthpieces used by smokers. Some of the material was pressed into tobacco pipes and other material was used as an absorbent for nitroglycerine. The best meerschaum is impurity free and forms in blocks from which pipes can be carved. These may be very ornate with clay, amber, wood, metals, and other materials added to heighten their commercial appeal. Lower-grade material is processed to free it of impurities and pressed or molded into shape (Talmage and Wootton, 1937).

Geology

The district is situated on Gila Flats, between the northwest-southeast-trending Gila Hot Springs graben to the north and Sapillo graben to the south. The rocks in the district are part of the Oligocene volcanic complex of Alum Mountain (29.7±1.0 Ma; Ratté et al., 1979). The volcanic complex of Alum Mountain consists of andesitic flows and breccias, pyroclastic and volcanic rocks and associated small intrusive bodies. Surrounding the volcanic complex are the slightly younger latitic and andesitic lava flows of Gila Flat (29.6 ±1.1, 29.3±1.1 Ma; K-Ar, biotite, sanidine; Ratté et al., 1979).

All of the hydrothermally altered rocks in the Copperas Creek and Alum Mountain areas belongs to the volcanic complex of Alum Mountains (Fig. 40; Ratté et al., 1979). The altered rocks are confined to andesitic and latitic lava flows, flow breccia, and bedded volcaniclastic and pyroclastic rocks that are cut by small silicic rhyolitic and dacitic intrusive bodies. Most of these bodies are dikes and sills a few meters thick, but there are several larger bodies. In the southern part of the district, local fracture control is more evident, but shallow intrusive or venting activity is also present. The alteration is of a similar age as the host rocks (30 Ma; Ratté et al., 1979; Marvin et al., 1987). Ratté et al. (1979) interpretes that these highly argillized and silicified rocks on Alum Mountain represent solfaturic-type alteration commonly associated with volcanic vent activity. However, McLemore (1994c, in press b) presents the possibilty that this acid-sulfate alteration may be indicative of high-sulfidation gold deposits at depth (Cox and Singer, 1986; Rye et al., 1992).

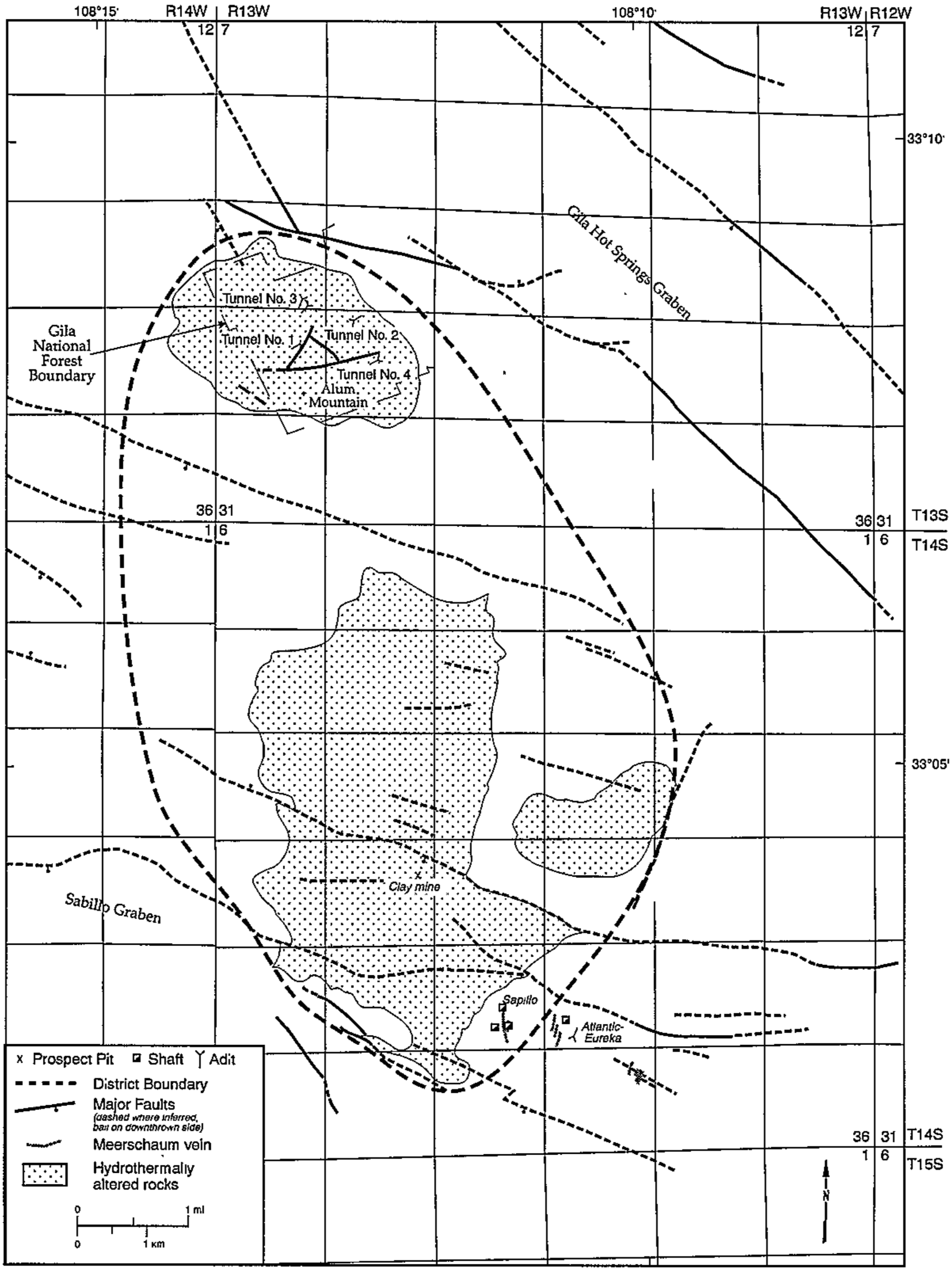

Figure 40—Mines and prospects in the Alum Mountain mining district, Grant County, New Mexico (modified from Wargo, 1959).

Quartz, opal, alunite, alum, and clays are the most abundant alteration products (Hayes, 1907). The district is named for the natural alum minerals that are found in deposits on Alum Mountain between Sapillo Creek and the Gila River and on both sides of Alum Canyon to the north. These minerals do not occur as original constituents of the rocks but are alteration products. Ratté et al. (1979) interprets the alteration at Alum Mountain probably to have resulted from hydrothermal solutions given off by a larger intrusion beneath the volcanic center.

Mineral deposits

Alteration caused by descending or ascending meteoric water has resulted in widespread solution and redeposition of hydrated-aluminum sulfates, mainly halotrichite and alunogen, and created unusually large deposits of these minerals (Ratté and Gaskill, 1975; Ratté et al., 1979). These deposits have been prospected (Table 68), and a large body of 90 million short tons of sodic alunite with significant quantities of microquartz, kaolinite, and iron oxides has been defined. Locally, zones contain 30% alunite, with quartz as the other main constituent. In late 1970s, a process in use in the former Soviet Union was being studied as an economic means of exploiting the alunite deposit (Hall, 1978; Ratté et al., 1979). Locally, gold and silver occur in quartz veins; one sample contained 0.28 oz/ton Au and 0.36 oz/ton Ag (Ratté et al., 1979).

Talmage and Wootton (1937) describes the meerschaum deposits as veins in Tertiary igneous rocks. The meerschaum occurs in the veins as impure nodules or in blocks some of which are several feet across (Table 68). In most instances, the meerschaum contains crystals of quartz or calcite, so that grinding and washing are required.

TABLE 68—Mines and prospects in the Alum Mountain mining district, Grant County, New Mexico. Location includes section, township, and range.

MINE NAME (ALIAS)	LOCATION	LATITUDE	LONGITUDE	COMMODITIES	DEVELOPMENT	REFERENCES
Atlantic-Eureka	SW27 14S 13W	33° 2' 55"	108° 10' 40"	meerscham, Au, Ag, Ga	shaft, adits, pits	Ratte et al. (1979)
Meerschaum (Sapillo)	SE28 14S 13W	33° 2' 55"	108° 11' 20"	meerscham, Au, Ag, Ga	3 shafts	Ratte et al. (1979)
Sapillo	NE34 14S 13W	33° 2' 40"	108° 10' 00"	meerscham, Au, Ag, Ga	pit	Ratte et al. (1979)
Tunnel No. 1, 3 (Alunogen 1,3, Alum Mountain deposit)	SE 19 13S 13W	33° 8' 40"	108°12' 58"	alum, alunite, Au, Ag, Ga	150 ft adit	Bush (1915), Ratte et al. (1979), Hall (1978)
Tunnel No. 2 (Alungen 2, Alum Mountain)	NW29 13S 13W	33° 8' 40"	108° 12' 35"	alum, alunite, Au, Ag, Ga	250 ft adit	Ratte et al. (1979), Hall (1978)
Tunnel No. 4 (Alungen 4)	C 29 13S 13W	33° 8' 15"	108° 13' 30"	alum, alunite, Au, Ag, Ga	100 ft adit	Ratte et al. (1979), Hall (1978)
clay pit (Cooperas Creek)	NE 20 14S 13W	33° 4' 10"	108° 12' 10"	meerscham, Au, Ag, Ga	pit	Ratte et al. (1979)

In the southern part of the district north of Copperas Creek and to the east, is an area where meerschaum (a common name for the mineral sepiolite) occurs in veins. Sepiolite is a hydrous silicate of magnesia having the composition $2MgO{\cdot}3SiO_2$, a specific gravity of 2, and a hardness of 2 to 2.5 (Sterrett, 1908). It is a tough, finely granular, white mineral. Much of it is so porous that, when dry, it will float in water. The popular name meerschaum is German for "sea foam," which belies this unusual property. Meerschaum is a product of the alteration of magnesian rocks or minerals, generally magnesite or serpentinite.

Bayard district

Location and Mining History

The Bayard (or Central) mining district is between Silver City and Santa Rita (Fig. 1). Some writers, such as Anderson (1957), have included deposits from the Santa Rita, Fierro-Hanover, and Bayard district into the Central mining district. Lasky (1936a), for example, notes that the Central mining district officially includes the Hanover, Fierro, and Santa Rita subdistricts and claims near the town of Central. This report restricts the Bayard district to the immediate vicinity of the town of Bayard (Table 69; Fig. 1); the Central district is not used in this report. The Bayard district was discovered in 1858 and total production is estimated as 110 million lbs Cu, 24,000 oz Au, 7.5 million oz Ag, 225 million lbs Pb, and 809 million lbs Zn (Table 2). Laramide veins and placer gold deposits are found in the district. Manganese has been produced from mines on the Manhattan and Pleasant View claims. The claims were originally patented in 1903 for lead and zinc and also produced several carloads each of high-grade lead-zinc ore (Farnham, 1961).

TABLE 69—Mines and prospects of the Bayard mining district, Grant County, New Mexico. Deposits are Laramide veins. Location includes section, township, and range.

MINE NAME (ALIAS)	LOCATION	LATITUDE	LONGITUDE	COMMODITIES	DEVELOPMENT	REFERENCES
Betty Jo (Johney, Rapp no 1)	NE01 18S 13W	32° 46' 40"	108° 08' 09"	Pb, Zn, Cu, Ag, Au	400 ft and 200 ft shafts	Lasky (1936a)
Bull Frog (Owl)	SE31 17S 12W	32° 46' 53"	108° 06' 59"	Zn, Pb, W	shaft	Richter and Lawrence (1983), NMBMMR file data
Copper Glance	SE32 17S 12W	32° 47' 07"	108° 05' 54"	Pb, Cu, Zn, Ag, Au	340 ft shaft with 4 levels and stopes, connects with Ivanhoe	Lasky (1936a)
Eighty-Eight	NW01 18S 13W	32° 46' 44"	108° 08' 41"	Pb, Cu, Zn, Ag, Au	shaft	NMBMMR file data
Gold Spot	SW06 18S 12W	32° 46' 15"	108° 07' 45"	Au, Pb, Mo	extensive underground workings	Lasky (1936a)
Ground Hog (San Jose, Denver, Lucky Bill, CG Bell)	N and W 18S 12W	32° 46' 10"	108° 06' 12"	Pb, Cu, Zn, Ag, Au, W	shaft	Richter and Lawrence (1983), NMBMMR file data
Ivanhoe	SW33 17S 12W	32° 47' 00"	108° 05' 45"	Pb, Cu, Zn, Ag, Au	210 ft shaft and 270 ft shaft	Spencer and Paige (1935), Lasky (1936a), Lasky and Hoagland (1948)
Lion (Rapp no 2)	SE31 17S 12W	32° 46' 45"	108° 07' 45"	Pb, Zn, Ag, Mo	107 ft shaft	Lasky (1936a)
Lion no 2	31 17S, 06 18S, 12W	32° 46' 45"	108° 07' 35"	Pb, Zn, Cu, Ag, Mo, V	100 ft shaft	Lasky (1936a)
Lost Mine	NW06 18S 12W	32° 46' 30"	108° 07' 45"	Au, Pb, Mo	shafts up to 100 ft deep, adits up to 185 ft long	Lasky (1936a)
Manhattan and Pleasant View	NW01 18S 13W	32° 46' 45"	108° 08' 30"	Mn, Pb, Zn	shafts 185 ft, 83 ft deep, open cuts	Farnham (1961), FN 12/8/93
Ninety	NW33 17S 12W	32° 47' 15"	108° 05' 30"	Pb, Cu, Zn, Ag, Au	390 ft shaft	Lindgren et al. (1910), Lasky (1936a)
Peerless, Peerless No. 2	NW of NW1 18S 13W	32° 46' 49"	108° 08' 40"	Zn, Pb, Cu, Ag, Au	shaft, 8 x 12 ft trench	Soulè (1947), Farnham (1966), Jones et al. (1970), Lasky (1936a), FN 12/8/93
Silver King	NE01 18S 13W	32° 46' 32"	108° 08' 11"	Pb, Ag, Au, Zn, Mo	shaft 167 ft deep	Lasky (1936a)
St Helena	NW01 18S 13W	32° 46' 32"	108° 08' 37"	Au, Pb	2 shafts 200 ft and 110 ft deep	Lasky (1936a)
Texas	NW02 18S 13W	32° 46' 45"	108° 09' 45"	Ag, Au, Pb, Zn	400 ft shaft	Lasky (1936a), Lindgren et al. (1910)
Three Brothers	NW31 17S 12W	32° 47' 30"	108° 07' 30"	Zn, Pb, Cu, Ag, Au	inclined shaft 156 ft deep with 400 ft of workings	Lasky (1936a), Jones and Hernon (1973)
Vigil (Little Goat)	NE31 17S 12W	32° 47' 15"	108° 07' 15"	Pb, Zn	shafts and adits	Lasky (1936a)

The San Jose claim, which has become part of the Ground Hog mining operation, is one of the oldest mining claims in the area (Lasky, 1936a). It was mined for copper, gold, and silver prior to 1869. The Ground Hog and Lucky Bill claims were located in 1900 after the vein had been exposed by stream erosion at the mouth of Lucky Bill Canyon in the northern end of Bayard Canyon.

Geology

The Bayard district and the surrounding rocks have been studied extensively because of the mineral wealth that has been produced there for over a hundred years. However, there appears to be no recent summary specifically of the geology and mineral production of the area. Lasky (1936a) provides a bibliography of studies to that time. Jones et al. (1967) updates the bibliography and offers a modern look at the geology of the Santa Rita quadrangle where the majority of the district is located.

The exposed rocks in the area range in age from Pennsylvanian to Recent. Rocks of Pennsylvanian and Cretaceous age are broken by faults, locally domed and folded by forceful injection of Late Cretaceous-Tertiary magma, and intruded by swarms of dikes trending in a northeasterly direction (Jones et al., 1967). In the southern part of the area, flat-lying volcanic rocks of Miocene(?) age overlie the older sedimentary rocks and form dissected plateaus. The Pennsylvanian rocks include the Oswaldo Formation, which consists of cherty limestone, thin beds of shale, and lenses of sandstone, and the Syrena Formation which is a limy shale and argillaceous limestone. Triassic, Jurassic, and Early Cretaceous beds are absent in the area. Late Cretaceous sedimentary rocks are the Beartooth Quartzite, a fine-grained crossbedded quartzite, and Colorado Formation consisting of a lower black shale member and an upper sandstone member.

At least 25 types of intrusive rocks occur in the Santa Rita quadrangle (Jones et al., 1967). The intrusions consist of sills, laccoliths, stocks, dikes, and plugs of Late Cretaceous (?) and Early Tertiary age. The volcanic rocks in the area include flows, dikes, tuffs, and plugs. The Rubio Peak Formation, a thick sequence of flows and tuffs, is overlain by Sugarlump Tuff which is in turn overlain by Kneeling Nun Rhyolite Tuff. These latter two units make up the bulk of San Jose Mountain in the southern part of the area. Quaternary sediments consist of semi-consolidated gravel deposits, hillside ruble and talus, and sand, gravel, and soil.

The Bayard area is near the trough on the eastern limb of the Pinos Altos-Central syncline. Four periods of faulting have been recognized in the Bayard area: 1) subsequent to the intrusion of the sills, along which granodiorite porphyry dikes were later injected, 2) after the injection of the dikes, 3) after the expulsion of the volcanic rocks, 4) near the end of the explosive stage of volcanic activity (none of the faults in the district can be truly labeled as being from this period, but the Bayard and Ground Hog faults may have originated at this time). All of the faults are normal, and the downthrown side is generally to the southeast (Lasky, 1936a).

Mineral deposits

The Laramide vein deposits in the Bayard district are chiefly precious- and base-metal fissure fillings and replacement bodies in faults and fractures. These deposits have been enriched both by supergene and hypogene processes. At the Ground Hog mine, granodiorite dikes have intruded quartz diorite porphyry of the Fort Bayard laccolith, within faulted masses of Colorado shale and along a fracture zone about 200 ft wide. The ore occurs within fractures and fracture zones in the granodiorite dikes and their wall rocks (Spencer and Paige, 1935). Hypogene ore-minerals include chalcopyrite, galena, and sphalerite. Supergene minerals include chalcocite pseudomorphs after galena, cerrusite, wulfenite, and goslarite. Vanadium as cuprodescloizite has been found underground at the Ground Hog (Lasky, 1930, 1936a).

At the Ivanhoe and Ninety mines, both now under mine waste dumps near the Chino mines concentrator, ore occurs as fissure filling and replacements along a contact between a granodiorite porphyry dike and shaly limestone and quartz diorite sill of the Colorado Formation. Chalcopyrite is irregularly distributed throughout, and narrow bands of fine-grained galena paralleling the fault are associated with sphalerite. Cerussite and pyritic chalcocite are abundant supergene minerals (Lindgren et al., 1910).

Veins on the Manhattan and Pleasant View claims consists of pyrölusite, wad, and some psilomelane associated with lead-carbonate and lead-zinc sulfides in a fissure zone in quartz diorite porphyry. The fissure ranges from 3 to 6 ft wide, strikes N30°E, and dips steeply southeast. Assays of samples are in Table 70. The manganese minerals occur in narrow stringers, in bands 2 ft wide, and small irregular veins and stringers as much as a foot or more in length (Farnham, 1961). Most of the shafts have been backfilled by the Abandoned Mine Lands program.

TABLE 70—Chemical analyses of samples collected from the Manhattan and Peerless claims. Analyzed by NMBMMR Chemical Laboratory (Lynn Brandvold, manager) by FAAS and fire assay for gold and silver. No gold was detected in these samples.

LAB NO.	SAMPLE NO.	Ag (oz/ton)	Cu ppm	Pb ppm	Zn%	Hg ppm	Fe%	Mn ppm	DESCRIPTION
3041	MAN A	0.00	1600	1,300	6.8	0.6	3.1	3,900	dump sample of main shaft
3042	MAN B	0.12	120	6,200	1.3	<0.1	6.4	17,500	dump sample of main shaft
3043	MAN C	0.56	180	4,500	0.45	0.1	5.6	10,600	8 ft chip across pit near main shaft
3044	MAN D	0.72	1000	1,200	4.3	0.4	4.1	12,400	select dump sample of ore pile
3045	MAN E	1.16	820	1,300	2.7	0.4	5.6	1,600	dump sample near smaller shaft
3046	MAN F	1.56	300	12,900	1.9	0.1	7.9	1,900	2 ft chip across vein at shaft portal
3047	MAN G	0.52	150	6,000	0.62	<0.1	5.0	4,300	sample of outcrop in arroyo
3048	MAN H	0.00	350	15,500	4.6	0.15	8.1	900	dump sample of 19 ft shaft
3049	MAN J	5.58	3800	669	10.9	0.29	7.4	495	dump sample of Peerless shaft

The placer region covers most of the drainage area of the pre-volcanic rocks; even the smallest arroyos and channels have yielded gold (Lasky, 1936a). The most productive placers were north of San Jose Mountain and east of the town of Central. The gold was derived from the fissure veins in the area. Experienced gold panners found gold content of the sands increased where the arroyo crossed a vein, then abruptly declined, only to increase again when another vein was crossed (Lasky, 1936a). Gold dust with a fineness of 0.705 is common, but nuggets the size of a small lima bean have been found. Less than 1,000 oz of gold has been produced from the placers (McLemore, 1994a; Johnson, 1972).

Black Hawk district

Location and Mining History

The Black Hawk or Bullard Peak mining district is in the northern Burro Mountains, approximately 21 mi west of Silver City. The district includes all of the mines and prospect pits within five miles to the east and south of Bullard Peak (Fig. 41). Mining began in the district in 1881 with the discovery of the unique silver-nickel-cobalt deposit at the Alhambra mine (Gillerman and Whitebread, 1956). Subsequent prospecting soon discovered additional deposits. Mining continued until 1893, when a decline in silver price and depletion of rich silver ore caused the mines to close. During 1917, the Black Hawk mine was dewatered, but had no recorded production. In 1920, pitchblende (uraninite) was recognized on mine dumps in the area, and in 1949 the area became of interest as a possible source of uranium, nickel, and cobalt. Types of deposits found in the Black Hawk mining district include: Laramide veins, tungsten placer deposits, and pegmatites. Total metal production from 1881-1960 is estimated as 3,000 lbs Cu, 1,000 oz Au, 1,286,000 oz Ag, and 4,000 lbs Pb (Table 71). In addition, 10,542 short tons of (2.7-71 % WO_3) tungsten ore (Richter and Lawrence, 1983; Dale and McKinney, 1959) and 615 short tons of fluorspar ore have been produced (Williams, 1966; McAnulty, 1978).

TABLE 71—Metals production from the Black Hawk mining district, Grant County, New Mexico (U.S. Bureau of Mines, 1927-1990; Lindgren et al., 1910). Additional production included with Burro Mountains district. e—estimated.

YEAR	ORE (SHORT TONS)	COPPER (LBS)	GOLD (OZ)	SILVER (OZ)	LEAD (LBS)	TOTAL VALUE ($)
1940	292	1,000	5	4,095	200	3,210
1946	67	1,100	9	542	3,600	1,323
TOTAL 1940-1946	359	2,100	14	4,637	3,800	4,533
ESTIMATED TOTAL 1881-1960	—	3,000[e]	1,000[e]	1,286,000[e]	4,000[e]	1,000,000[e]

Geology

The oldest rocks in the Black Hawk mining district belong to the Proterozoic Bullard Peak Group, which includes quartzite, amphibolite, migmatite, and various types of schist and gneiss (Hewitt, 1959; Gillerman, 1964). Intruding these rocks is Proterozoic quartz diorite gneiss, which is the predominant rock in the area and part of the Burro Mountain batholith that crops out extensively to the south and southwest of the area (Gillerman, 1964). The gneiss, which contains 35 ppm Co and 23 ppm Ni (Gerwe and Norman, 1985), is in turn intruded by Tertiary Twin Peaks monzonite porphry and other rock types. The Twin Peaks monzonite stock also occurs as dikes and irregular masses in the northern portion of the district (Gillerman, 1964). This monzonite contains approximately 20 ppm Co and 11 ppm Ni (Gerwe and Norman, 1985), is Late Cretaceous in age (72.5 ± 4.7 Ma; Hedlund, 1985a), and is asociated with the mineralized veins. A whole-rock sample of altered material adjacent to a vein has an age date of 65.3±1.2 Ma (K-Ar; Gerwe, 1986). Metamorphic and igneous rocks are overlain by Cretaceous quartzite and Tertiary rhyolite in the northern area of the district (Gillerman, 1964).

Two prominent fault systems trending slightly east of north are the main geologic structures in the district (Gillerman, 1964). Each fault system consists of a rather persistent fault from which other faults split off, trending to the northeast or northwest.

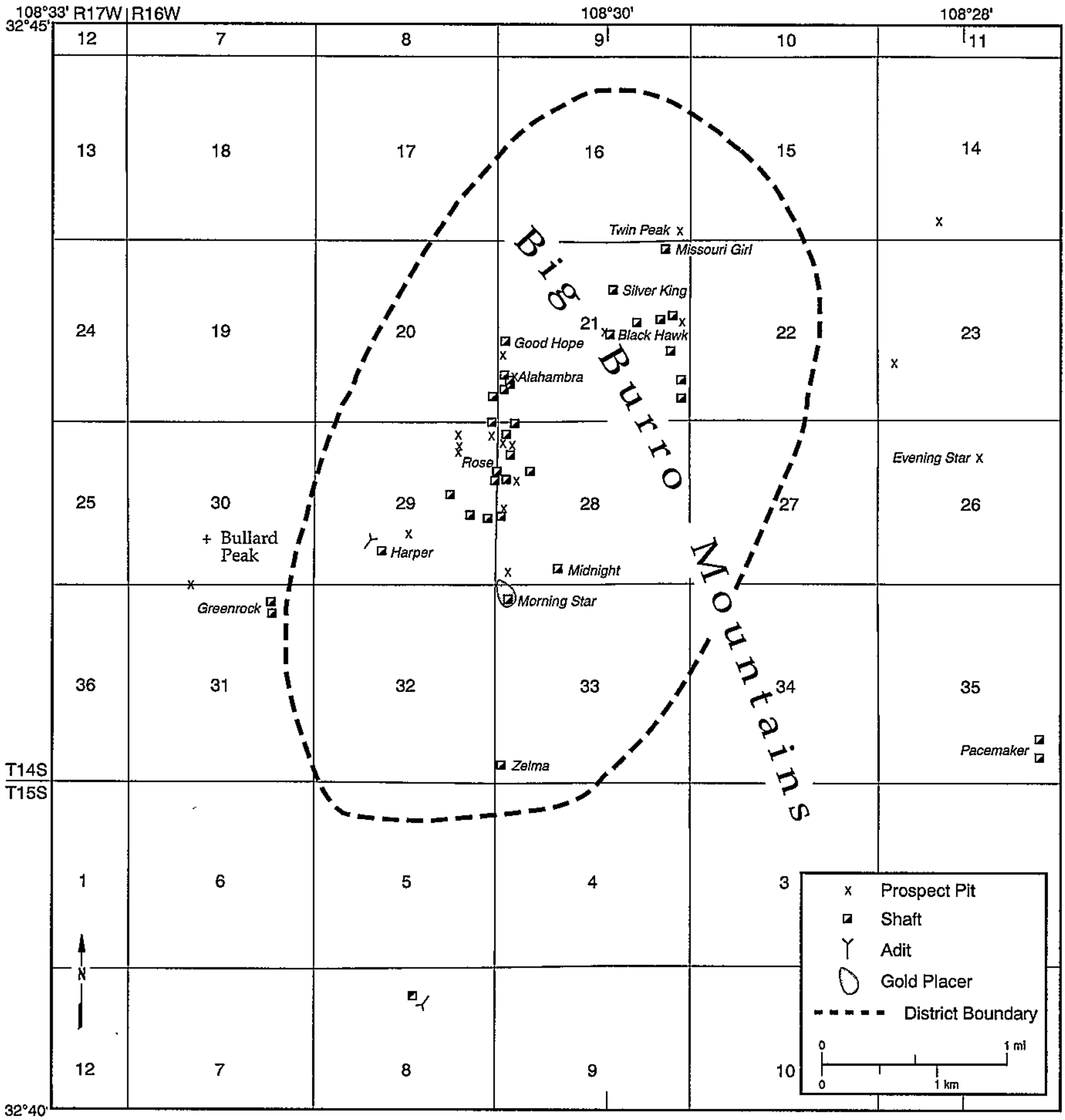

Figure 41—Mines and prospects in the Black Hawk mining district, Grant County, New Mexico.

Mineral deposits

The unusual nickel-cobalt-silver deposits of the Black Hawk mining district make the area one of special interest. Although similar deposits are described worldwide (Cobalt and Great Bear Lake in Canada and Joachimstahl in the former Czechoslovakia; Gillerman and Whitebread, 1956), few known deposits have nickel-cobalt-silver ore with uranium in carbonate gangue (Gillerman, 1964). In the Black Hawk district, the mineral deposits are simple fissure-filling veins mostly in the quartz diorite gneiss near bodies of monzonite porphyry. Four mineral assembalges occur: 1) silver-argentite-uraninite-niccolite-rammeisbergite, 2) silver-rammeisbergite-gersdorffite-nickel skutterudite, 3) chalcopyrite-tennantite-galena-sphalerite, and 4) acanthite-jalpaite-pearceite-covellite (Von Bargen, 1979, 1993). Pitchblende is found with minor pyrite, chalcopyrite, galena, and sphalerite. Other minerals occurring in these deposits are millerite, erythrite, annabergite, barite, manganocalcite, and various nickel and cobalt sulfarsenides and arsenides (Gillerman, 1964; Von Bargen, 1979, 1993). Deposits are most plentiful in a 1-mi-wide by as much as 3-mi-long area on the southwest side of Twin Peak stock (Gillerman, 1964). The veins can be traced for more than 1,000 ft and have reached as much as 600 ft vertically. They vary in width from 1 to 3 ft but may open to as much as 10 ft wide where they cut quartz diorite gneiss. The veins are inconspicuous in outcrop and are recognized by brown-stained, carbonate filling (Gillerman, 1964). The carbonates, largely calcite, dolomite, siderite, and ankerite, are the most common vein minerals. Quartz is rare, occurring as a dull yellow-green chert or chalcedony. A dump sampled assayed 0.005% U_3O_8, 0.08% Cu, 0.05% Pb, 0.06% Zn, and 0.0052% Ni (McLemore, 1983, #3745). Mineralization occurred about 65.3±1.2 Ma ago and at temperatures of 290°-410°C (Gewe, 1986). Low salinities of fluid inclusions (<2 eq. wt.% NaCl) suggest that the water in the system was meteoric (Gewe, 1986; Gewe and Norman, 1985).

Larmide veins consist of native silver, with silver occuring in the central part of the vein and nickel- and cobalt-bearing minerals, mostly nickel skutterudite, are on the vein margins (Gillerman, 1968). Uraninite is found mostly in the outermost zones associated with the nickel- and cobalt-bearing minerals, not with the silver. The carbonate vein-minerals form in a sequence where the carbonate species calcite, dolomite, ankerite, and siderite replace one another due to increased carbon dioxide in the mineralizing solutions at a constant temperature (Naumov et al., 1971).

Kissin (1988) notes that deposits having the five-element suite (silver-nickel-cobalt-arsenic-bismuth) in veins such as those in the Black Hawk area, indicate non-magmatic epigenetic mineralization resulting from continental rifting. The deposits form from mineralizing solutions that are rather oxidized and form where reduction, dilution, and cooling act as major constraints on deposition. The source of the nickel and cobalt in the Black Hawk district was probably leaching of the Proterozoic quartz diorite gneiss during the Laramide, because of its large areal extent. The Proterozoic quartz diorite gneiss has the highest nickel and cobalt concentrations of the predominant lithologies (Gerwe and Norman, 1985; Gewe, 1986; Von Bargen, 1979).

Gillerman and Whitebread (1956) reports that in May 1952, three 1,000 ft diamond drill holes were positioned to intersect the Black Hawk vein. The core was checked for radioactivity, but no anomalous readings were made. In 1982, the Black Hawk mine was being mined on a small scale for silver.

Tungsten deposits also occur in the area to the south and east of Bullard Peak (Table 72). Scheelite placer and lode deposits have been located by prospectors using ultraviolet lamps (Dale and McKinney, 1959). The deposits are found near Proterozoic pegmatites and amphibolites (Gillerman, 1964; Johnson, 1983). Pure scheelite seams are found associated with pegmatite dikes (Dale and McKinney, 1959) or along faults (Gillerman, 1964). Where found associated with quartz veins, scheelite commonly occurs at the vein margin, or as disseminations in the country rock (Gillerman, 1964).

TABLE 72—Mines and prospects in the Black Hawk mining district, Grant County, New Mexico. Location includes section, township, and range.

MINE NAME/ (ALIAS)	LOCATION	LATITUDE	LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
Alhambra (Butternut, Good Hope, Stonewall)	SW21 18S 16W	32° 43' 17"	108° 30' 32"	Ag, Ni, Co, U, Cu, Zn, Pb	350 ft shaft with 7 levels, shafts, adit	Laramide vein	Gillerman and Whitebread (1956), Gillerman (1959, 1964), FN 7/23/80
Astrologer	SW20 19S 16W	32° 38' 15"	108° 31' 12"	Ag, Au, Pb, Cu	2 shafts, 6 drifts	Laramide vein	Gillerman (1964)
Black Hawk (Solid Silver Mine, Silver Glance)	C21 18S 16W	32° 43' 33"	108° 29' 53"	Ag, Ni, Co, U, Zn, Cu, Pb, Au	497 ft shaft, 10 levels	Laramide vein	Lindgren et al. (1910), Leach (1916), Lovering (1956), Gillerman (1964), Hedlund (1978a, 1980)

MINE NAME/ (ALIAS)	LOCATION	LATITUDE	LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
Eccles	SE7 19S 16W	32° 39' 45"	108° 31' 45"	Ag	100 ft shaft	Laramide vein	Gillerman (1964)
Evening Star	NE26 18S 16W	32° 42' 45"	108° 28' 00"	W, Bi	trenches, prospect pits	Laramide vein	Dale and McKinney (1959), Gillerman (1964)
Giant	SE7 19S 16W	32° 39' 45"	108° 31' 42"	W	25 ft shaft, prospect pits	Pegmatite	Gillerman (1964)
Good Hope	W21 18S 16W	32° 43' 23"	108° 30' 35"	Ag, Ni, Co	120 ft shaft	Laramide vein	Gillerman (1964), Gillerman and Whitebread (1956)
Greenrock Group	30,31 18S 16W	32° 42' 25"	108° 31' 47"	W	15 and 20 ft shafts, pits	Pegmatite	Gillerman (1964), Dale and McKinney (1959), Hedlund (1980)
Harper	SW29 18S 16W	32° 41' 47"	108° 31' 25"	W	adit and shaft	Laramide vein	Hedlund (1980), Hewitt (1959)
Live Oak	NE19 19S 16W	32° 38' 40"	108° 31' 55"	Pb, Au, Cu	2 15-20 ft shafts, trench	Laramide vein	Gillerman (1964)
Long Lost Brother	NE23 19S 17W	32° 38' 40"	108° 34' 15"	F	18 ft shaft, prospect pits	Laramide vein	Rothrock et al. (1946), Gillerman (1952, 1964), Hewitt (1959)
Midnight	SW28 18S 16W	32° 42' 25"	108° 30' 15"	Ag, Ni, Co, U	80 ft shaft	Laramide vein	Gillerman (1964), Hedlund (1980),
Missouri Girl	NE21 18S 16W	32° 43' 54"	108° 29' 40"	Ag	90 ft shaft, level at 55 ft	Laramide vein	Gillerman (1964), Hedlund (1978a)
Morning Star	SW28, NW33 18S 16W	32° 42' 15"	108° 30' 46"	W	22 ft shaft, 3 100 ft cuts, prospect pits	Placer	Elston (1960), Lemmon and Tweto (1962), Gillerman (1964), Dale and McKinney (1959), Hedlund (1980)
Osmer Silver	SE29 18S 16W	32° 42' 10"	108° 29' 50"	Ag, U	40 ft shaft with drift	Laramide vein	FN 7/23/80
Pacemaker (Reed)	SE35 18S 16W	32° 41' 45"	108° 27' 45"	W, Mo	50 and 30 ft shafts, pits	Pegmatite	Gillerman (1964), Dale and McKinney (1959), Richter and Lawrence (1983)
Rice-Graves (Moneatta No. 2)	NW24 19S 17W	32° 38' 35"	108° 33' 20"	W	40 ft shaft, prospect pits	Laramide vein	Lemmon abd Tweto (1962), Dale and McKinney (1959), Hewitt (1959), Gillerman (1964), Hedlund (1980)
Rose	NE29 18S 16W	32° 42' 48"	108° 30' 39"	Ag, Ni, Co, U, Cu, Au	200 ft shaft with 4 levels, 100 ft shaft with 2 levels, 2 adits, pits	Laramide vein	Lindgren et al. (1910), Gillerman and Whitebread (1956), Gillerman (1964), Hedlund (1980)
Silver King (Hobson)	NE21 18S 16W	32° 43' 40"	108° 29' 54"	Ag, U	300 ft adit, inclined shaft	Laramide vein	Gillerman (1964), Hedlund (1978a), Gillerman and Whitebread (1956), FN 7/23/80
Twin Peaks	SE21 18S 16W	32° 44' 00"	108° 29' 40"	Ag, Pb, Fe, Mn	pit	Laramide vein	Gillerman (1964), Hedlund (1978a), Gillerman and Whitebread (1956)
unknown	30,31 18S 16W	32° 42' 15"	108° 31' 45"	W	trench	Laramide vein	Hedlund (1980)
unknown	N32 18S 16W	32° 42' 15"	108° 30' 59"	Au, Ag, W	pit	Laramide vein	Hedlund (1980)
unknown	NW8 19S 16W	32° 40' 15"	108° 31' 15"	W	adit and shaft	Laramide vein	Hedlund (1980)
unknown	SE21 18S 16W	32° 43' 16"	108° 29' 35"	Au, Ag, W	2 shafts	Laramide vein	Hedlund (1978a)
unknown	SW14 18S 16W	32° 43' 57"	108° 28' 17"	Au,Ag,W	pit	Laramide vein	Hedlund (1978a)
unknown	SW23 18S 16W	32° 43' 20"	108° 28' 30"	Au, Ag, W	pit	Laramide vein	Hedlund (1978a)
Zelma	SE32, SW33 18S 16W	32° 41' 28"	108° 30' 37"	W, Bi	70 ft adit, 25 ft shaft, pits	Laramide vein	Dale and McKinney (1959), Elston (1960, 1965), Gillerman (1964), Hedlund (1980)

Bound Ranch district

Location and Mining History

The Bound Ranch (Langford Hills) mining district lies in the southern Burro Mountains, approximately 16 mi south of the Tyrone porphyry-copper deposit and 4 mi southeast of Gold Hill mining district (Fig. 1). There has been only fluorite and tungsten produced from this district, beginning in the early 1900s (Tables 4, 6). A few of the deposits have been worked for fluorspar and gold, but the gold content was too low for continued mining (Table 73). The American mine, for example, initially operated during World War I, briefly in the early 1930s, again during World War II, and sporadically there after, producing 98 short tons of fluorspar ore in 1953 (Gillerman, 1964; Williams, 1966). The deposit was worked also for gold, but the gold content was low. The Double Strike (Valley Spar) deposit was opened originally as a gold mine in the early 1920s, but during World War II it was mined for fluorite. The Continental deposit produced fluorspar during World War II and probably before. The JAP Ranch and Windmill deposits had not produced as of 1951. Total production amounts to 3,230 short tons of fluorite and 4,150 short tons WO_3 have been produced from Hillside, Alpha, and Bluebird mines (Dale and McKinney, 1959; Hobbs, 1965).

TABLE 73—Mines and prospects of the Bound Ranch mining district, Grant County, New Mexico. These deposits are Laramide veins and fluorite veins. Location includes section, township, and range.

MINE NAME (ALIAS)	LOCATION	LATITUDE	LONGITUDE	COMMODITIES	DEVELOPMENT	PRODUCTION	REFERENCES
Alpha (Scheelite, Great Republic, Sunday)	NW27 22S 15W	32° 21' 56"	108° 22' 38"	W, Cu	shaft, pit	3,500 short tons WO_3	Dale and McKinney (1959), Gillerman (1964), NMBMMR file data
American (Spar)	SW15 22S 15W	32° 23' 22"	108° 22' 45"	F, Au	100 ft shaft, pit	98 short tons CaF_2	Gillerman (1952, 1964), Hedlund (1978d), NMBMMR file data
Bounds fluorspar prospect	SE20 22S 15W	32° 22' 28"	108° 24' 15"	F, Mn, Ni	2 shafts, adit	none	Gillerman (1964), Talmage and Wootton (1937)
Continental (Spar Valley, Signal Peak)	SE27 22S 15W	32° 21' 44"	108° 22' 21"	F, Au	3 shafts, pits	3 short tons CaF_2	Gillerman (1952, 1964), Williams (1966)
Double Strikes (Valley Spar, Rocky Trail)	SE4 22S 15W	32° 25' 7"	108° 23' 13"	F, Au	pits, shafts	none	Gillerman (1964), Rothrock et al. (1946), Williams (1966)
Fenceline	SW5 NW8 22S 15W	32° 24' 50"	108° 24' 59"	F	shaft, pit	121 short tons CaF_2	Gillerman (1952, 1964), Hedlund (1978d), NMBMMR file data
Grandview	SE13 NE24 22S 16W	32° 23' 4"	108° 26' 12"	F	shaft, 6 pits	6 short tons CaF_2	Gillerman (1952, 1964), Hedlund (1978d), NMBMMR file data
Grant County fluorspar prospect	NW8 22S 15W	32° 24' 27"	108° 24' 48"	F	shaft, trenches	none	Johnston (1928), Gillerman (1952, 1964), Hedlund (1978d), NMBMMR file data
Hillside (Myers)	SE26 22S 16W	32° 21' 44"	108° 27' 28"	W, Au, Ag, Mo	3 27-40 ft shafts	650 short tons WO_3	Dale and McKinney (1959), Gillerman (1952, 1964), Hedlund (1978d), NMBMMR file data
Hogback	S31 22S 15W	32° 20' 45"	108° 25' 35"	Cu	pit	none	Hedlund (1978f)
JAP Ranch		32° 21' 54"	108° 22' 13"	F	pit	none	Gillerman (1952, 1964), Hedlund (1978d)
Langford	SE25 22S 16W	32° 21' 36"	108° 26' 27"	F, U	pits	none	Lovering (1956), Gillerman (1964), McLemore (1983)
Windmill	NE9 22S 15W	32° 24' 32"	108° 23' 14"	F	pit, shaft	none	Williams (1966), Gillerman (1952, 1964), Hedlund (1978d), NMBMMR file data
unknown	13 22S 16W	32° 23' 30"	108° 26' 5"	F	pits	none	Hedlund (1978d)
unknown	22 22S 15W	32° 23' 5"	108° 22' 40"	F	pits	none	Hedlund (1978d)

Geology

Rocks in the Bound Ranch district consist of Proterozoic granite and include schists and quartzites that are intruded by several dikes of varying compositions and ages. The most wide-spread granite in the Burro Mountains is predominantly a grayish-orange, medium-grained variety containing a high percentage of quartz and potassium feldspar, minor albite, and minor biotite. The potassium feldspar is orthoclase or microcline, or both. Large poikilitic orthoclase phenocrysts containing inclusions of quartz, albite, biotite, and accessory minerals are locally present. Sphene, apatite, and magnetite are common accessory minerals; zircon, rutile, and tourmaline are locally present. Within the district, lenses of Proterozoic schist, amphibolite, quartzite and other metamorphic rocks are common in the granite as are Proterozoic aplite, pegmatite, and diabase dikes.

Northeast-trending faults are common in the district. These faults are commonly marked by mineralized zones. Mineral deposits in the Bound Ranch district consist mainly of fluorite fissure-filling veins that occur along faults in the Proterozoic granite.

Mineral deposits

Mineral deposits in the Bound Ranch district are chiefly fluorspar stringers and veins in Proterozoic granite (Table 73; Johnston, 1928; Rothrock et al., 1946; Gillerman, 1951, 1968). Fluorite is predominately green or purple, but it may be also white, yellow, or violet (Gillerman, 1951). The fluorite characteristically occurs as massive texture, but columnar or granular textures are locally common. Cube and octahedron forms are most common crystal forms, but at the American, Double Strike, and JAP Ranch deposits in the district, the dodecahedron modifying the cube form is common. At the Double Strike deposits cubes of fluorite modified by dodecahedrons, tetrahedrons, and hexoctahedrons have been found (Gillerman, 1951). Two or three stages of mineralization occurred in the vicinity of the Burro Mountains with violet fluorite usually representing the last stage (Rothrock et al., 1946; Gillerman, 1951). Quartz is the most common mineral associated with the fluorite with minor amounts of calcite, pyrite, chrysocolla, turquoise, malachite, hematite, limonite, native gold, silver, manganese oxide, halloysite, autunite, and uranophane.

The Double Strike, Windmill, American, Continental, and JAP Ranch deposits were localized along, or are near, the Malone fault and are mineralogically similar (Gillerman, 1951). The American, Continental, and Double Strike deposits have been mined for both fluorite and gold and have numerous shafts, pits, and trenches. The JAP Ranch and Windmill deposits are small and have been explored by shallow workings.

At the Continental deposit, fluorite occurs intermittently along a prominent fault over about 3,200 ft in veins associated with silicified fault gouge and breccia (Rothrock et al., 1946; Gillerman, 1951). The fault trends approximately to the north and dips 60° to 85° E and cuts Proterozoic gneiss, lenses of Proterozoic schist and quartzite, and middle Tertiary volcanic rocks. Fluorite is found in both the Proterozoic rocks and the volcanics, so mineralization post dates the middle Tertiary. At the deposit, fluorite is commonly clear green or yellow-green coarsely crystalline cubes having etched crystal faces. The only mineral associated with fluorite is quartz, although scheelite is present in a quartz vein about 600 ft to the west of the fluorspar vein.

The American deposit occurs as veins and breccia zones along faults that splay from the southwestern side of Malone fault within Proterozoic granite (Rothrock, et al., 1947; Gillerman, 1951). Pegmatite, aplite, diabase, and rhyolite dikes intrude the granite. Fluorite is most abundant within approximately 300 ft of the Malone fault and is not found farther than 700 ft from the fault. The veins are as much as 3 ft wide, and the breccia zones up to 30 ft wide. Fluorite occurs as almost pure coarsely crystalline green fluorite in veins and as a cementing material, with quartz, of the breccia material between veins. A 2-foot chip sample taken from a cut 45 feet northeast of the main shaft assayed 47.0% CaF_2 (Williams, 1966).

At the Double Strike deposit, fluorite occurs in three silicified breccia zones that range from 1 to 4 ft wide in faulted Proterozoic granite (Rothrock et al., 1946; Gillerman, 1951). As at the American deposit, the fluorite occurs as veins cutting the silicified fault gouge or as part of the breccia. At the Double Strike deposit two types of fluorite are present; purple and dark-green, coarsely crystalline fluorite was deposited before pale green and white fluorite having excellent crystal form.

At the JAP Ranch deposit, fluorite occurs sparingly in a fissure veinlet system. The deposit consists of pods and veinlets in a northeast-trending fault. Veinlets range from a few inches to 12 inches thick and crop out for a length of 80 ft. The fluorite is pale green and well crystallized as cubes and dodecahedrons (Williams, 1966).

Two to four miles southwest of Malone fault, are the Bounds, Fence Line, Grandview, and Grant County deposits (Table 73; Rothrock et al., 1946; Gillerman, 1951). These deposits are small and are similar to each other. At the Bounds deposit, coarsely crystalline green fluorite occurs in a vein 1 to 2 ft wide in granite that can be traced for 300 ft on the surface. Smaller veins outcrop nearby. At the Grandview deposit, a vein of clear green, coarsely crystalline fluorite 2 ft wide and a 1 to 2 foot wide zone of disseminated fluorite occur in a highly brecciated fracture zone in granite (Williams, 1966). The Fence Line and Grant County deposits occur along the same mineralized zone separated by a wide valley filled with Recent gravels. At the Grant County deposits, four subparallel veins have been exposed in several trenches.

Less than 2 miles south of the Grandview deposits, lies the Langford deposit that is economically unimportant, but is of interest because of the uranium minerals associated with the fluorite. Fluorite at the Langford deposit is in granite in a silicified breccia zone 5 ft wide and striking N15°W and dipping 62°NE (Gillerman, 1951). Mineralization consists of dark purple, fine-grained fluorite occurring as encrustations and as veinlets less than one-inch thick between breccia fragments. Uranium minerals occur in the breccia zone concentrated in the vicinity of the dark purple fluorite and possibly within it (Gillerman, 1951).

Scheelite and wolframite occur scattered throughout narrow quartz veins in several deposits (Table 73). Grades were typically low, but one shipment of 3.3 short tons of 60% WO_3 is reported from the Hillside and Alpha mines (Hobbs, 1965). Garnet, epidote, hornblende, calcite, and quartz are found with the scheelite at the Alpha mine (Gillerman, 1964).

Burro Mountains district

Location and Mining History

The Burro Mountains mining district includes parts of the Big Burro and Little Burro Mountains (Fig. 1). Copper minerals were first discovered in the district about 600 A.D. when Native American Indians mined turquoise for jewelry and trade, but it was not until the early 1860s that mining claims were filed. In about 1880 and 1881, extensive prospecting in western Grant County resulted in finding gold, silver, lead, and copper deposits. Mining began in the district shortly after discovery, and mining of rich silver ore continued until 1885. In 1885, a stamp mill that was erected on the Gila River, and in 1903 a leaching plant was constructed near the mill (Hewitt, 1959). The Tyrone ore body was mined by numerous underground operations from the 1870s until 1909 when Phelps Dodge Mining Co. consolidated 150 mining companies that operated in the area at the time. It was not until 1921 when underground mining ceased. During this time several high-grade areas averaging 2-3% Cu were mined out. From 1948 to the 1950s, a drilling program was employed to define the Tyrone orebody. Overburden stripping began in 1967, and open pit mining commenced in 1969, and a 272-year old underground mine was consumed by the pit. In 1990-1992, additional reserves were located.

Currently, Tyrone uses solvent extraction-electrowinning (SX-EW) technology to produce 148 to 150 million pounds of copper cathodes per year. During its history, mining at Tyrone has gone from underground to open pit, and from sulfide concentration to heap leaching. Advances in bio-leaching technology, would open huge tonnage of ore to further copper recovery (Bruce Kennedy, Phelps Dodge Mining Co., oral comm., April 1994).

Approximately 300 million short tons of ore grading 0.81% Cu were processed by the concentrator at Tyrone from 1969 to 1992 (Table 75). Approximately 425 million short tons of ore grading 0.35% Cu have been leached (R. J. Stegen, Phelps Dodge Mining Co., written communication, October 3, 1994). In addition, silver and gold were recovered from 1903 to 1992. Reserves are estimated as 230.2 million short tons of leach ore grading 0.35% Cu (Robert M. North, Phelps Dodge Mining Co., written communication, October, 1995).

While Tyrone is the largest producer, it is not the only producing mine in the district (Table 76). Total production from the district amounts to more than 5.24 billion lbs Cu, 50,000 oz Au, 10 million oz Ag, 200,000 lbs Pb, and 300,000 lbs Zn (Table 74). The Contact mine has had significant production (Gillerman, 1964). The 225-ft deep Contact shaft was sunk on the Contact vein hoping to find gold in silver, but it was worked in 1939 for base metals; 150 short tons of ore were shipped that year. In 1942 mining resumed, and between 1942 and 1944, 2,121 short tons of ore containing 6-7% combined Pb and Zn, 2 oz/ton Ag, 0.02- 0.03 oz/ton Au and 0.25% Cu were shipped. In 1943, the Contact mine was worked for manganese and 140 short tons of ore averaging 20% Mn were shipped. Turquiose has been produced from the district (Zalinski, 1907) as well as 172,539 short tons of fluorite and 30 lbs U_3O_8.

TABLE 74—Metals production from the Burro Mountains (Tyrone) mining district, Grant County, New Mexico (U. S. Geological Survey, 1902-1927; U. S. Bureau of Mines, 1927-1990). Includes minor production from the Black Hawk district.

YEAR	ORE (SHORT TONS)	COPPER (LBS)	GOLD (OZ)	SILVER (OZ)	LEAD (LBS)	ZINC (LBS)	TOTAL VALUE ($)
1904	18,421	973,231	—	—	—	—	124,574
1905	45,110	1,804,416	—	—	—	—	281,489
1906	66,285	2,608,005	—	—	—	—	503,345
1907	59,069	2,163,810	—	—	—	—	432,762
1908	20,097	801,841	13	387	—	—	106,319
1909	36,037	1,160,838	14	2,160	—	—	152,316
1910	2,632	80,205	20	1,769	—	—	11,562
1911	681	28,089	27	3,623	—	—	5,989
1912	286	51,583	—	63	—	—	8,550
1913	100	15,155	—	19	—	—	2,362
1914	9,804	285,014	—	739	—	—	38,316
1915	18,505	1,406,286	—	3,558	—	—	247,904
1916	270,325	8,392,329	69	23,491	—	—	2,081,396
1917	490,679	14,574,355	259	41,523	—	—	4,018,368
1918	607,899	17,100,044	288	50,323	—	—	4,279,994
1919	188,670	6,101,102	103	16,275	—	—	1,155,112
1920	231,559	6,605,669	104.5	27,656	—	—	1,247,748
1921	171,505	4,496,124	114	18,184	—	—	600,541
1922	—	—	—	—	—	—	—
1923	50,563	2,374,163	1	724	—	—	349,617
1924	3,846	2,665,093	—	—	—	—	349,127
1925	7,542	1,890,662	—	664	—	—	268,935
1926	1,403	678,250	21.5	2,476	20,000	—	98,545
1927	851	250,687	42	4,993	—	—	36,544
1928	6,640	889,347	25	1,805	—	—	129,645
1929	16,728	1,085,131	56	3,724	—	—	194,126
1933	—	—	1.11	—	—	—	23
1934	597	5,900	85.32	10,477	900	—	10,260
1935	758	13,700	81.45	4,615	950	—	7,343
1936	133	150	25.89	2,399	260	—	2,790
1937	9	50	11.60	40	100	—	449
1938	338	1,100	230.8	8,186	200	—	13,487
1939	142	6,400	7	1,002	—	—	1,591
1940	3	—	5	118	—	—	259
1941	17	2,287,000	14	509	—	—	270,718
1942	736	7,312,800	10	1,101	47,000	62,600	894,953
1943	3,209	4,189,000	15	3,683	104,000	190,000	576,034
1944	833	2,521,000	2	1,329	23,500	58,000	349,910
1947	8	2,297,900	1	128	1,400	—	479,132
1951	4	200	—	874	2,300	—	1,237
1953	6	700	—	11	—	—	211
1955	219	12,600	—	—	—	—	4,700
1956	1,581	17,600	315	348	1,000	—	8,267
TOTAL 1904-1956	2,333,830	97,147,529	1,962.17	238,976	201,610	310,600	19,346,550
1967-1975	w	w	—	—	—	—	w
1976	15,500,000	20,460,000	—	—	—	—	w
1977	15,100,000	19,328,000	—	—	—	—	w
1978-1981	w	w	—	—	—	—	w
1982	3,744,000	52,416,000	—	—	—	—	w
1983	8,625,000	134,550,000	—	—	—	—	w
1984	w	w	—	—	—	—	w
1985	17,600,000	314,000,000	—	—	—	—	w
1986	17,880,000	307,600,000	—	—	—	—	w
1987	17,120,000	301,300,000	—	—	—	—	w
1988	—	282,600,000	—	—	—	—	w
1989	—	306,000,000	—	—	—	—	w
1990	—	318,600,000	—	—	—	—	w

YEAR	ORE (SHORT TONS)	COPPER (LBS)	GOLD (OZ)	SILVER (OZ)	LEAD (LBS)	ZINC (LBS)	TOTAL VALUE ($)
1991	—	125,200,000	—	—	—	—	w
1992	—	17,000,000	—	—	—	—	w
ESTIMATED TOTAL 1967-1992 (Tyrone mine)	315,700,000	5,068,200,000	—	—	—	—	w
ESTIMATED TOTAL 1871-1992	318,000,000	5,240,000,000	>50,000	>10,000,000	>200,000	>300,000	>2,000,000,000

TABLE 75—Copper production from the Tyrone mine, Burro Mountains (Kolesar, 1982; U.S. Bureau of Mines, 1927-1990). 1914-1921 production by underground methods. 1967-1992 production by open pit methods. After 1992 production was mine-for-leach.

YEAR	TOTAL MATERIAL REMOVED	ORE TREATED BY CONCENTRATOR (short tons)	COPPER PRODUCED (short tons)
1914	na	9,804	114
1915	na	16,255	609
1916	na	253,782	3,674
1917	na	473,443	6,749
1918	na	585,083	7,906
1919	na	184,946	2,820
1920	na	231,152	3,384
1921	na	169,413	888
1922-1966	closed	none	none
1967	17,592,840	145,549	w
1968	46,127,000	2,739,057	w
1969	51,610,000	2,849,370	17,653
1970	43,030,318	9,147,522	60,743
1971	46,487,441	8,797,558	61,563
1972	56,851,312	11,425,236	78,417
1973	72,620,031	15,407,249	103,151
1974	69,124,839	15,230,458	98,387
1975	53,361,922	12,386,795	76,009
1976	70,930,958	15,586,995	91,614
1977	71,666,753	15,073,537	84,734
1978	68,607,043	14,981,372	82,215
1979	80,118,281	17,770,783	100,651
1980	w	w	w
1981	w	w	w
1982	w	3,744,000	26,208
1983	w	8,625,000	67,275
1984	w	w	w
1985	w	17,624,200	132,400
1986	w	17,882,400	312,800
1987	w	17,120,000	303,700
1988	w	w	141,300
1989	w	w	153,000
1990	w	w	159,300
1991	w	w	62,600
1992	w	w	78,700
1993	w	w	w
1994	w	w	w
1995	w	w	w
TOTAL ESTIMATED CONCENTRATE ORE 1914-1992	w	300,000,000	w
TOTAL ESTIMATED LEACHED ORE	w	425,000,000	w

TABLE 76—Mines and prospects in the Burro Mountains mining district, Grant County, New Mexico.

MINE NAME (ALIAS)	LOCATION	LATITUDE	LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
Ace High	E28 18S 15W	32° 42' 50"	108° 23' 45"	F	pits	flouorite veins	Gillerman (1952), Gillerman (1964), Williams (1966)
Afternoon	SE2 19S 15W	32° 40' 45"	108° 21' 30"	Ag, Zn, Pb, Cu	145 ft shaft	Laramide vein	Gillerman (1964), Hedlund (1978e)
Austin-Amazon (Frankie, Bull Dog, Aldorado)	NE35 19S 16W	32° 36' 49"	108° 27' 34"	Cu. Ag, Au, Mo, U	5 shafts, pits and opencuts	Laramide vein	Gillerman (1964), Hedlund (1978e), Richter and Lawernce (1983), FN 7/22/80
Beasely (National and Mayflower)	N18 19S 15W	32° 39' 28"	108° 25' 45"	Cu, Mo	3 shafts; 160, 110, 50 ft	Laramide veins	Gillerman (1964), Hedlund (1978e), Paige (1911), Richter and Lawrence (1983)
Beaumont	E13 19S 16W	32° 39' 15"	108° 26' 30"	Ag, Mo, Pb	shaft, shallow pits	Laramide veins	Gillerman (1964), Pratt (1967), Richter and Lawrence (1983)
Bismuth Lode	NE27 19S 16W	32° 37' 44"	108° 28' 48"	Bi	70 ft shaft, pits, shallow shafts	Laramide vein	Richter and Lawrence (1983), Gillerman (1964), Hedlund (1985a)
Bolton (Alexander, Jacobs Promise)	SE13, NE24 19S 16W	37° 38' 45"	108° 26' 45"	Cu, Mo	shallow shafts and pits	Laramide vein	Gillerman (1964), Hedlund (1978e), Paige (1911), Schilling (1964)
Boone (Oquaqua)	SE27 19S 15W	32° 37' 15"	108° 22' 45"	Cu	290 ft shaft	Laramide vein	Lindgren et al (1910), Paige (1911), Richter and Lawrence (1983)
Burro Chief Fluorspar	SE15 19S 15W	32° 38' 58"	108° 22' 43"	F, Cu	vertical shaft, adit, opencuts	fluorite veins, Laramide vein (?)	Rothrock et al (1946), Williams (1966), Gillerman (1964), McAnulty (1978)
Burro Mountains (Azure, Elizabeth Pocket, Turquoise)	NE16,NW 15 19S 15W	32° 39' 15"	108° 33' 33"	gem, Cu	underground workings and large open pits	Laramide vein	Hedlund (1978e), Carter (1977), Richter and Lawrence (1983)
California Gulch	NE of NE 17 19S 15W	32° 39' 35"	108° 24' 25"	F	pits and trenches, short adit, shallow shaft	fluorite veins	Williams (1966), Gillerman (1952, 1964), Hedlund (1985a)
Casino	W2 19S 15W	32° 41' 02"	108° 22' 16"	Ag, Au	pits, shafts	Laramide vein	Hedlund (1985a), Gillerman (1964)
Contact	W2 19S 15W	32° 41' 01"	108° 22' 07"	Cu, Pb, Zn, Mn, Ag, Au	shafts, adits, pits	Laramide vein	Hedlund (1985a), Gillerman (1964)
Copper King	W15 19S 15W	32° 39' 15"	108° 23' 15"	Cu	400 ft shaft	Laramide vein	Hedlund (1978e, 1985a), Richter and Lawrence (1983)
Copper Mountain	SW16 19S 15W	32° 38' 14"	108° 23' 27"	Cu	shafts, trenches, pits	Laramide vein	Gillerman (1964), Hedlund (1985a)
Emma and Surprise	SW25, NW36 19S 15W	32° 37' 00"	108° 21' 00"	Cu	shafts	Laramide vein	Gillerman (1964)
Foster Zinc (Badger)	NW26 19S 16W	32° 37' 45"	108° 28' 15"	Zn, Au	77 ft shaft, pits	Laramide vein	Gillerman (1964), Hedlund (1978e), Richter and Lawrence (1983)
Full Moon (Woodward)	NW2 19S 15W	32° 41' 25"	108° 22' 09"	Pb, Zn	2 shafts	Laramide vein	Richter and Lawrence (1983)
Gardner	C26 19S 16W	32° 37' 30"	108° 28' 00"	F	pits	fluorite veins	Gillerman (1952), Williams (1966)
Jersey Lily and Snowflake	NW34 18S 15W	32° 42' 00"	108° 22' 55"	Ag	shafts	Laramide vein	Gillerman (1964), Hedlund (1978e)
Liberty Bell (Copper Mountain)	SE 21, N28 19S 15W	32° 37' 54"	108° 23' 48"	Cu, Ag	3 adits, shaft, opencut	Porphyry Cu-Mo	Gillerman (1964), Hedlund (1978e), Richter and Lawrence (1983)
Little Burro Mountains Kaolin	SW3 19S 14W	32° 40' 53"	108° 18' 00"	Kaolin	pits	volcanic epithermal	Patterson and Holmes (1977)

MINE NAME (ALIAS)	LOCATION	LATITUDE	LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
Lone Pine	3 20S 16W	32° 36' 00"	108° 29' 15"	Pb, Ag, Cu	80 ft shaft	Laramide vein	Gillerman (1964)
Long Lost Brother	NE23 19S 17W			F, Mn	15 ft shaft	Laramide vein	Richter and Lawrence (1983), Gillerman (1968)
Montezuma	NW 19 19S 14W	32° 38' 45"	108° 19' 45"	Cu	pits, shafts	Laramide vein	Gillerman (1964), Richter and Lawrence (1983)
Moody	C of N8 20S 16W	32° 35' 12"	108° 31' 09"	Cu	shafts, pits	Laramide vein	Gillerman (1964), Hedlund (1980)
N of Surprise Shaft	SW25 19S 15W	32° 37' 20"	108° 20' 55"	Cu	pits	epithermal Mn	Gillerman (1964)
unknown	27,28,34 18S 15W	32° 42' 30"	108° 23' 00"	U	pits	Laramide vein	Gillerman (1964)
National Copper	SW17, SE18, 19S 15W	32 39' 15"	108° 25' 15"	Cu, Au	190 ft shaft, 350 ft adit	Laramide vein	Gillerman (1964), Paige (1911)
Neglected	NE25 20S 16W	32° 32' 42"	108° 26' 32"	Cu, Au, Pb, Zn, Bi	314 ft adit, 3 shafts, pits	Laramide vein	Gillerman (1964), Hedlund (1978e)
Nellie Bly	SW16 19S 15W	32° 38' 56"	108° 24' 18"	Cu	100 ft adit	Laramide vein	Richter and Lawrence (1983), Hedlund (1985a)
Oak Grove	E36 19S 15W	32° 36' 40"	108° 20' 33"	F	pit 3 m deep	fluorite vein	Gillerman (1952), Williams (1966)
Ohio and Little Rock	SE17 19S 15W	32° 39' 07"	108° 24' 42"	Cu, F	225 ft shaft, inclined shaft, open pit	Laramide vein	Gillerman (1964), Hedlund (1978e), Richter and Lawrence (1983)
Oil Center Tool	21 18S 15W	32° 44' 00"	108° 24' 00"	U	pits	Laramide vein	Butler et al. (1962)
Osmer Gold (Shamrock, Fisher Bros.)	22,23 19S 16W	32° 38' 30"	108° 28' 15"	Au, Ag, Bi, Cu	pits, 5 shafts	Laramide vein	Gillerman (1964), Richter and Lawrence (1983)
Pacemaker (Bullard Peak)	SE35 18S 16W	32° 41' 35"	108° 27' 45"	W, Mo	2 shafts, cuts	pegmatite, W veins	Dale and McKinney (1959), Schilling (1964)
Parker (Azure, New Azure)	C15 29S 15W	32° 39' 16"	108° 22' 45"	turquoise	2 large open pits	Laramide vein	Richter and Lawrence (1983), Hedlund (1985a)
Porterfield (Maroney)	SW15 19S 15W	32° 39' 57"	108° 23' 11"	turquoise	2 shafts and adit 170 ft long	Laramide vein	Richter and Lawrence (1983), Hedlund (1985a)
Red Hill, Turquoise	16 20S 15W			turquoise	pits, adit	Laramide vein	Richter and Lawrence (1983)
Shrine Fluorspar	NW13, NE14 19S 16W	32° 39' 18"	108° 27' 07"	F, Au, Ag	730 ft shaft, pits	fluorite veins	Rothrock et al. (1946), Gillerman (1964), McAnulty (1978), Hedlund (1978e)
Silver Dollar	NE33 19S 16W	32° 36' 52"	108° 29' 46"	Ag, Au, Pb, Cu	160 ft shaft	Laramide vein	Gillerman (1964), Hedlund (1978e)
Silver King-Mystery	N11 19S 15W	32° 40' 30"	108° 21' 45"	Au, Cu	shaft, adit	Laramide vein	Gillerman (1964), Hedlund (1978e)
Southern Star	NW16 19S 15W	32° 39' 30"	108° 24' 15"	Cu	3 adits and opencut	epithermal Mn	Gillerman (1964), Granger and Bauer (1951), Hedlund (1985a)
Spar Hill	S2 27 19S 16W	32° 37' 22"	108° 28' 43"	F	50 ft shaft, pits and trenches	fluorite veins	Gillerman (1964), Williams (1966), Hedlund (1978e), McAnulty (1978)
Tall Pine	SE24 19S 16W	32° 38' 05"	108° 26' 57"	Cu	pits	Laramide vein	Richter and Lawrence (1983)
Thompson Canyon (Brock)	18 20S 16W	32° 34' 10"	108° 32' 05"	Perlite	pits	Perlite	Gillerman (1964), Ballman (1960)
Tullock and Bostonian, Tall Pine	13,18 19S 14W,15W	32° 39' 45"	108° 20' 30"	Cu	3 shallow shafts	Laramide vein	Gillerman (1964), Richter and Lawrence (1983)
Tunuco	28 18S 15W	32° 42' 55"	108° 23' 45"	U, Cu	pits	Laramide vein	FN 9/23/82, McLemore (1983)
Two-Best-In-Three	W16 19S 15W	32° 39' 30"	108° 24' 00"	Cu, Au	367 ft adit	Laramide vein	Gillerman (1964), Hedlund (1978e), Richter and Lawrence (1983), Hedlund (1985a)

MINE NAME (ALIAS)	LOCATION	LATITUDE	LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
Tyrone Open-Pit (Gettysburg, Copper Gulf, Niagara)	15, 22-27 19S 15W	32° 38' 25"	108° 22' 20"	Cu, Au, Ag, Zn, Pb, F, Mo, U	open pit	porphyry Cu-Mo	Lindgren et al. (1910), Kolessar (1970, 1982), Paige (1922), Gillerman (1952), Williams (1966), FN 1994
Virtue	SW2 19S 15W	32° 40' 43"	108° 22' 18"	Ag	shaft	Laramide vein	Gillerman (1964), Hedlund (1985a)
Wallace Ranch	SE19, N30 16S 18W	32° 53' 30"	108° 45' 00"	Perlite	open pits and cuts	Perlite	Gillerman (1964)
White Bull	NW23 19S 16W	32° 38' 28"	108° 28' 30"	U, Th, REE	pits, shafts	pegmatite	McLemore (1983), FN 9/24/80
Wyman	W2 19S 15W	32° 41' 04"	108° 22' 08"	Ag	pits and shafts	Laramide vein	Hedlund (1985a), Gillerman (1964)

Geology

The Little Burro Mountains are located on the northeast side of the Mangas Valley. They are an isolated range of hills 18 mi long and 1 to 2 mi wide that trend northwest along a northeast tilted fault block along the west side of the northwest-trending Mangas fault. These mountains consist of Proterozoic granite and Cretaceous sedimentary rocks intruded by andesitic and rhyolitic rocks overlain by Tertiary volcanic flows (Kolesaar, 1970,1982; DuHamel et al., 1995). The Big Burro Mountains are southwest of Mangas Valley and consist of Proterozoic granite of the Burro Mountains batholith, which is emplaced into a series of schists, amphibolites, and quartzites of the Bullard Peak series. The granite has been intruded by Proterozoic diabase dikes and contains rhyolite dikes and plugs, and dikes and plugs of various rock types and the Tyrone stock, a quartz monzodiorite porphyry laccolith dated as 52.8±1.2 to 56.6±1.6 Ma (DuHamel et al., 1995). The exposed part of the laccolith is elliptical in shape and is 6 mi long by 4 mi wide (Kolesaar, 1982). Gila Conglomerate and Recent sands gravels fill Mangas Valley.

The Burro Mountain granite, which comprises about 90% of the batholith is the major component of the Big Burro Mountains. It is typically a medium- to coarse-grained equigranular granite with locally porphyritic occurrences. The color, texture, mineral and chemical composition, fracturing and jointing, and degree of weathering and alteration are quite variable (Gillerman, 1970).

Tyrone stock and smaller plugs and dikes of varying texture, composition, and age intrude the Burro Mountain batholith. The largest part of Tyrone stock is made up of quartz monzodiorite (Hedlund, 1985a), which is a medium light-gray, medium-grained massive quartz monzodiorite (Hedlund, 1978a, c). The remainder of the stock is mostly very light-gray to light brownish-gray quartz monzonite porphyry, pinkish-gray aplite, and very light-gray porphyritic quartz monzonite dikes as much as 35 m wide. Paleozoic strata and Mesozoic rocks are largely absent, except for some minor Mesozoic units in the Little Burro Mountains (Hedlund, 1985a)

Gillerman (1970) notes that structural features are most important in localizing the ore bodies, lithology being of secondary importance. Northeast-trending faults, fractures, and shear zones are the prominent structures in the area in and around the district. Five major faults have been recognized: Osmer, Bismuth-Foster-Beaumont, Austin-Amazon, Burro Chief, and Sprouse-Copeland. Other major faults, such as the Mangas and Walnut Creek faults, trend northwesterly. Mangas fault is an eastern boundary fault for the Big Burro mountain block, while the Walnut Creek fault lies within the block. Some of the faults have been intruded by rhyolite and quartz monzodiorite porphyry dikes, and subsequent movement along the faults has caused brecciation of the dikes. Mineral deposits in the district are dominated by the Tyrone porphyry-copper deposit, but deposits of precious and base metal, fluorite, uranium, clay, and dimension stone also occur in the district (Gillerman, 1964; Ricter and Lawrence, 1983; Hedlund, 1985a).

Mineral Deposits

Mineral deposits in the Little Burro Mountains part of the district are divided geographically by deposit type. Deposits in the central part of the Little Burro Mountains contain gold, silver, copper, lead, and zinc in fractures and faults and consist of gold, galena, sphalerite, chalcopyrite, pyrite, probably argentite, and their oxidation products. Pyrolusite and psilomelane are common and one deposit, the Contact mine, was mined for manganese in 1943 (Farnham, 1961). Proterozoic skarns containing scheelite can be found at the contact zones of the Burro Mountain granite with hornblendic schists of the Bullard Peak Series (Hedlund, 1985a). Deposits of fluorite, uranium, clay, and dimension stone occur also in the Little Burro Mountains.

Numerous mines and prospects occur in the district (Table 76; Gillerman, 1964; Hedlund, 1985a). Those of the Bostonian and Montezuma groups of claims in the eastern part of the district are typical of copper deposits in the southern part of the mountains. The host rocks for the numerous shafts, pits, and adits are Early Tertiary monzonite porphyry and quartz monzonite porphyry (possibly part of the Tyrone Stock) which has been intensely altered. Laramide veins strike generally northeast and are vertical to steeply dipping. The veins are quite narrow and can be traced for no more than a few hundred feet. Some of the deeper shafts in the area have been sunk along or close to Mangas fault in hope that mineralization was to be found there. Quartz-molybdenite veins (pyrite and chalcopyrite) occur at the northwest margin of the Tyrone Stock, and quartz-specularite veins occur at the eastern end of the Stock (Hedlund, 1985a). Some of the veins have siliceous and ferruginous cappings owing to extensive oxidation, but where erosion is rapid, the veins are relatively unoxidized.

One group of gold-silver-base metals deposits in the central Little Burro Mountains is the Contact group of claims (Gillerman, 1964). These workings exploit quartz-filled fissure veins along north-northeast-trending faults. Development at the group consists of the Contact and Virtue shafts, and the Virtue tunnel, all along the Contact vein. The Contact vein strikes N 60° E and dips 70° SE at the Virtue shaft and strikes N 20° E and dips 75° SE at the Contact shaft. It is 5-6 ft wide. The ratio of gold to silver at the Contact mine in 1944 was 4 to 1, and in 1960 it remained little changed at 3.5 to 1. The vein consists of quartz with minor pyrite and chalcopyrite, and abundant psilomelane, pyrolusite, argentiferous galena, and sphalerite. The vein lies along the contact between granite and andesite, and silicified fractures are seen along the vein. A sample from the Austin-Amazon mine assayed no gold, 0.64 oz/ton Ag, 7.4% Cu and 0.003% U_3O_8 (McLemore, 1983, #3745).

By far the most important deposit in the district in terms of production is the Tyrone porphyry copper deposit. The Tyrone ore body is a chalcocite blanket developed over the Tyrone stock (Kolesaar, 1970, 1982; DuHamel et al., 1995). At the Tyrone mine, most of the stock is a porphyritic quartz monzodiorite with abundant quartz, oligoclase, and sporadic chloritized biotite (Kolesaar, 1970, 1982), with the mineralized portion exhibiting pronounced potassic metasomatism and sericitic alteration. Fine-grained quartz monzonite dikes intrude the stock and the surrounding Proterozoic granite. The main ore body consists of a supergene blanket containing erratic chalcocite mineralization varying from a few feet to over 300 ft thick. Two main episodes of supergene enrichment occurred at 43.64-46.73 Ma and at 19.12 Ma, followed by a third weak, but younger supergene event (DuHamel et al., 1995; Cook, 1993, 1994). The ore in the oxidized zone consists of predominantly chrysocolla (varying from sky blue to black). Other ore minerals, such as malachite, azurite, cuprite, tenorite, native copper, turquoise, minor torbernite, and autunite, occur in kaolinized areas. Most of the minerals occur as disseminations and fracture fillings in the Stock, and to a limited extent in the Proterozoic granite (Hedlund, 1985a). The supergene cap consists of chalcocite and minor covellite. These minerals replace primary pyrite, chalcopyrite, and sphalerite. Trace molybdenite and bornite, with pyrite, chalcopyrite, sphalerite, and galena are hypogene minerals. Fluorite is found locally, and alunite is common in white veinlets. Overall, the ore is low grade, but within the mined area are several high-grade areas that averaged 2-3% Cu.

Within the ore body, breccia ore bodies occur that were described as intrusive breccias by Paige (1922) and hydrothermal breccias by DuHamel et al. (1995). They consist of fragments of granite and quartz monzonite porphyry and are 200-400 ft in diameter. The matrix of the breccia was finer grained breccia, and the breccia was itself fractured, with some ore minerals as partial matrix to fragments. The breccias are low in grade, but contain excellent supergene mineralization (DuHamel et al., 1995). Breccia pipes are found within the Tyrone stock and also within the granite country rock (Hedlund, 1985a).

Caprock Mountain district

Location and Mining History

The Caprock Mountain mining district is about 20 mi north-northwest of Lordsburg along the boundary between Grant and Hidalgo Counties (Fig. 42) and was discovered in 1917. The district lies just south of the Gila River on the northern and southern flanks of Caprock Mountain. The Gila Lower Box Wilderness Study Area lies northwest of the district. Epithermal manganese and fluorite veins in the district (Table 77) produced a few hundred short tons of manganese ore during World War I and were reopened during the World War II, producing additional limited production. In the 1950s, the mines produced intermittently from shallow pits and shafts. In 1959, six men were employed and mined approximately 30 short tons of ore daily from the Cliff Roy mine (Farnham, 1961). Hand-sorted ore and concentrates were sold to buyers in Deming or Socorro. Total production from the district is 1,148 long tons of 21-36% Mn and 3,339 long tons of concentrate ore grading 33-35% Mn (Farnham, 1961; Dorr, 1965).

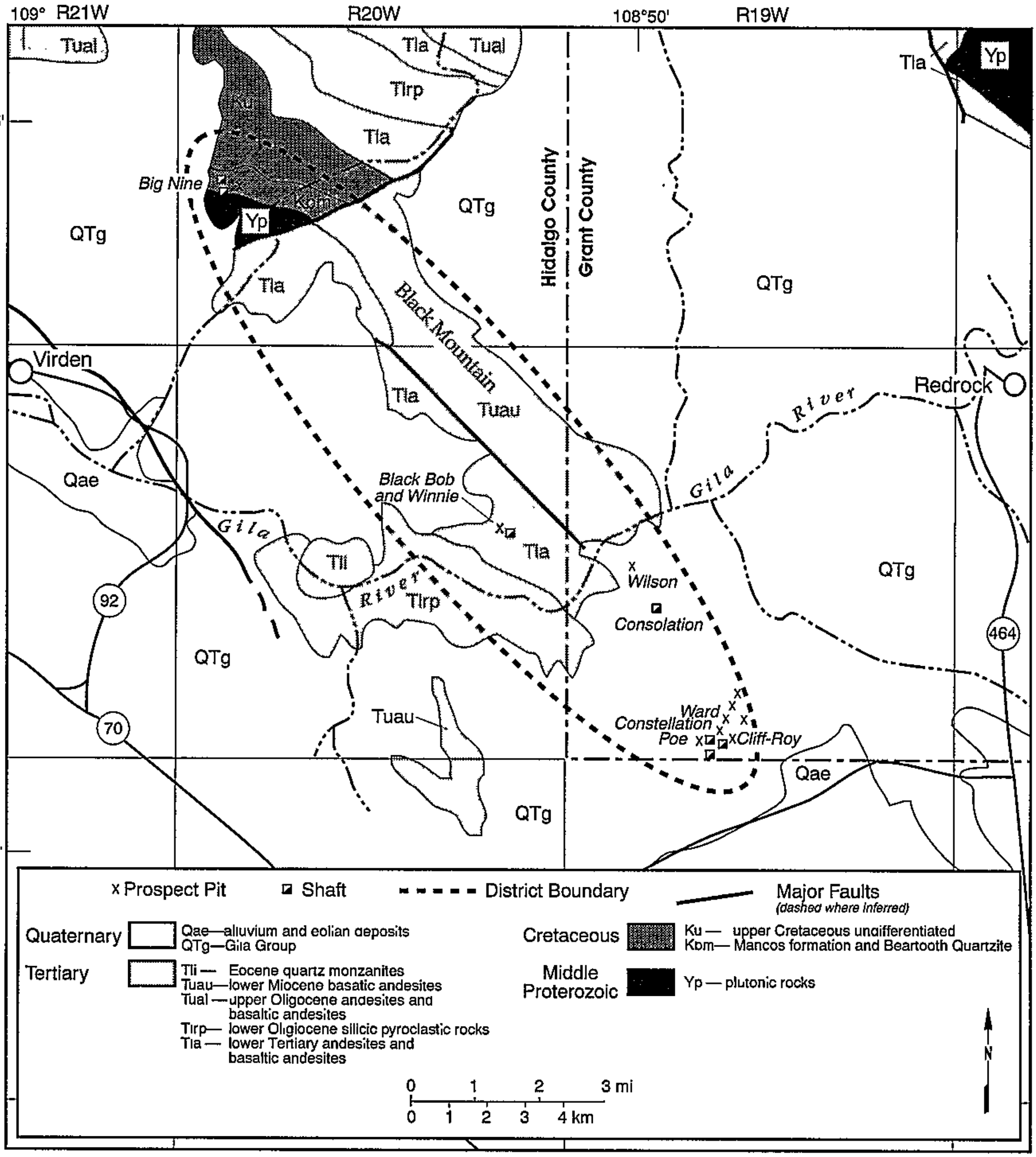

Figure 42—Mines and prospects in the Caprock Mountain mining district, Hidalgo and Grant Counties, New Mexico (modified from Gillerman, 1964, and O. J. Anderson, unpublished state geologic map, 1995).

TABLE 77—Mines and prospects in the Caprock mining district, Grant and Hidalgo Counites, located in Figure 42. Location includes section, township, and range.

MINE NAME (ALIAS)	LOCATION	LATITUDE	LONGITUDE	COMMODITIES	TYPE OF DEPOSIT	REFERENCES
Consolation (Consolation no 1, Black Diamond)	SW20 19S 19W	32° 38' 09"	108° 49' 48"	Mn	epithermal Mn	Elston (1963), Gillerman (1964), Farnham (1961), Richter and Lawrence (1983), Pradhan and Singh (1960)
Black Bob and Winnie	SW13 19S 20W	32° 39' 00"	108° 52' 05"	Mn	epithermal Mn	Farnham (1961), Gillerman (1964), Richter and Lawrence (1983), Pradhan and Singh (1960)
Cliff-Roy	SW33 19S 19W	32° 36' 23"	108° 48' 43"	Mn	epithermal Mn	Elston (1963), Wells (1918), Gillerman (1964), Farnham (1961), NMBMMR file data, Richter and Lawrence (1983)
Ward (Cliff Roy no 2)	NW33 19S 19W	32° 36' 44"	108° 48' 49"	Mn	epithermal Mn	Elston (1963), Richter and Lawrence (1983), Gillerman (1964)
Poe	SW33 19S 19W	32° 36' 29"	108° 48' 55"	Mn	epithermal Mn	Richter and Lawrence (1983)
Constellation	SE32 19S 19W	32° 36' 27"	108° 49' 10"	Mn	epithermal Mn	Richter and Lawrence (1983), Farnham (1961)
Wilson	SW20 19S 19W	32° 38' 21"	108° 49' 54"	Mn	epithermal Mn	
Big Nine	SE20 18S 20W	32° 43' 24"	108° 55' 44"	Mn, F	fluorite veins	Pradhan and Singh (1960), Williams (1966), Rothrock et al. (1946)

Geology

The oldest rocks in the area are Oligocene basaltic breccias and porphyritic basalt and andesite flows of the Cliff volcanic center. Miocene volcanic-conglomerate of the Gila Formation overlie the volcanic rocks and consists of a lower member of consolidated coarse conglomerate (the host rock at the Cliff Roy and Ward Mines) and a poorly consolidated upper member of thin sandstones interbedded with basalt and andesite flows; the basalt may be as young as Quaternary (Pradhan and Singh, 1960). These sandstones constitute the hanging wall of the vein at the Consolation mine, with basaltic andesite forming the footwall. Quaternary terrace gravels predominate to the northwest and southeast of the district, and minor Miocene and Oligocene rhyolite intrusives are found approximately a mile southwest (Drewes et al., 1985). At the Consolation vein, the basaltic andesite forming the footwall has been dated as 20.9±0.5 Ma (Elston, 1973, 1983).

Major structures in the Caprock Mountain district trend N45°W, and many of the well-defined faults and fracture zones with ore-bearing veins are parallel to this, most notably at the Consolation mine. Other veins trend N27°W, N30°W, and N35°W, with steep dips. The magnitude of displacements along the faults and the direction of motion are mostly unknown. The district coincides with a magnetic and gravity saddle.

Mineral Deposits

The epithermal manganese and fluorite deposits occur along steeply dipping fault and fracture zones, chiefly in the volcanic Gila Conglomerate (Fig. 41; Farnham, 1961). However, Pradhan and Singh (1960) stated that the veins did not show any particular preference for any type of host rock. At the largest deposit, the Cliff Roy, the veins are 2-8 ft wide, strikes N9°W, steeply dipping, and the ore grades upward into banded travertine. The ore minerals, chiefly psilomelane with minor pyrolusite, occur in disconnected, lenticular shoots ranging from a few tens of feet to 100 ft in length. In the ore shoots, the manganese minerals occur as irregular strands, bunches, and coatings surrounding the volcanic breccias fragments. Chalcedony, manganiferous calcite, and minor gypsum are gangue minerals. Much of the psilomelane contains small inclusions of milky chalcedony. A sample assayed 45% Mn, 3% SiO_2, and 0.15% P (Wells, 1918).

The Consolation mine yielded approximately 10,000 long tons of 8-10% Mn during the 1950s (Gillerman, 1964; Ryan, 1985; Richter and Lawrence, 1983; Richter et al., 1988). The deposit occurs in basaltic andesite along a fault trending N45°W for 120 ft and is 8-14 ft wide. Argillic alteration and iron staining occur at the Consolation mine as well as at the Black Bob, where a soft argillized brecciated basalt is the host rock (Gillerman, 1964; Pradhan and Singh, 1960).

The other deposits are similar in form and composition to the Cliff Roy, but are smaller in size. Locally, fluorite is common (Table 77). Geochemical anomalies in stream-sediment samples include Ag, Co, Cu, Mn, and Y and spotty La, Sn, Th, and Ti. It is unlikely that any of these deposits will be mined in the near future for manganese, because they are small tonnage, low grade, and inaccessible.

Carpenter District

Location and Mining History

The Carpenter (or Swartz, Schwartz) mining district occurs on the western slope of the Mimbres Mountains about 6 mi southwest of Kingston and about 10.5 mi east of Mimbres (Fig. 43). The area is mountainous and rugged. In the 1880s, mineralization was discovered cropping out at the Royal John property in the district (Soulé, 1950), and the district has been the site of a moderate amount of base-metals production from low-grade deposits (Table 2). The first recorded mining venture in the area was in 1906-07 at the Royal John mine, but that attempt was unsuccessful (Harley, 1934). The mine and mill were operated again from 1928 to 1930 by ASARCO and then by Albert Owen of the Black Range Mining Company. Production up to 1934 was estimated as 15,000 short tons ore (Harley, 1934). In 1943 and 1944, the U. S. Geological Survey and the U. S. Bureau of Mines conducted geological studies and undertook diamond drilling to determine the extent of mineralization in the area. The U. S. Bureau of Mines continued to examine the Royal John mine through 1948 and proposed additional development to increase reserves of low-grade lead-zinc ore.

At least five mines in the Grant County portion of the district have produced zinc, lead, and copper ores with minor amounts of silver and traces of gold. The Royal John mine is the district's largest producer having reported sporadic production from 1916 until, at least, 1969. Other mines in the district operated for shorter periods, chiefly the years during and shortly after World War II. Total production from 1891 to 1969 was approximately 12.5 million pounds Zn, 6 million pounds Pb, 310,000 lbs Cu, 60,000-180,000 oz Ag, and 300 oz Au (Table 78). Average ore grade was 7.95% Zn, 3.9% Pb, 1.1 oz/ton Ag, and 0.12% Cu (Table 78).

TABLE 78—Metals production from the Carpenter mining district, Grant County, New Mexico (U. S. Bureau of Mines, 1927-1990; Hedlund, 1985b).

YEAR	ORE (SHORT TONS)	COPPER (LBS)	GOLD (OZ)	SILVER (OZ)	LEAD (LBS)	ZINC (LBS)	TOTAL VALUE ($)
1938	80	—	—	—	25,000	32,000	2,686
1939	2,998	5,300	1	943	543,000	720,000	64,187
1940	3,159	20,100	6	2,492	472,700	602,000	65,814
1941	502	2,900	1	516	56,400	87,000	10,484
1942	7,838	24,600	9	8,301	546,000	1,196,800	157,079
1943	7,030	16,100	6	5,995	264,600	1,094,000	144,563
1944	6,820	15,000	5	8,273	328,000	858,000	132,135
1945	1,575	3,200	—	1,011	77,200	140,800	23,982
1946	877	1,600	1.0	661	46,200	132,200	21,992
1947	1,694	3,200	—	1,010	109,600	242,000	46,650
1948	2,059	5,000	—	1,652	154,000	284,000	67,918
1949	2,495	3,000	—	1,801	300,000	524,000	114,597
1950	1,863	3,100	3.0	3,738	110,400	285,700	59,606
1951	4,642	8,000	4.0	7,677	300,000	723,000	192,510
1952	5,023	9,000	1	8,900	401,000	768,000	202,317
1953	821	2,300	—	1,799	113,300	181,400	37,991
1954	17	—	—	335	14,300	2,000	2,478
1955	9	—	—	89	3,700	900	743
1956	—	—	—	—	—	—	—
1957	200	200	—	473	16,900	32,700	6,698
TOTAL 1938-1957	49,702	122,600	37	55,666	3,882,300	7,906,500	1,354,430
ESTIMATED TOTAL 1891-1969	75,000	310,000	300	60,000-180,000	6,000,000	12,500,000	1,360,000

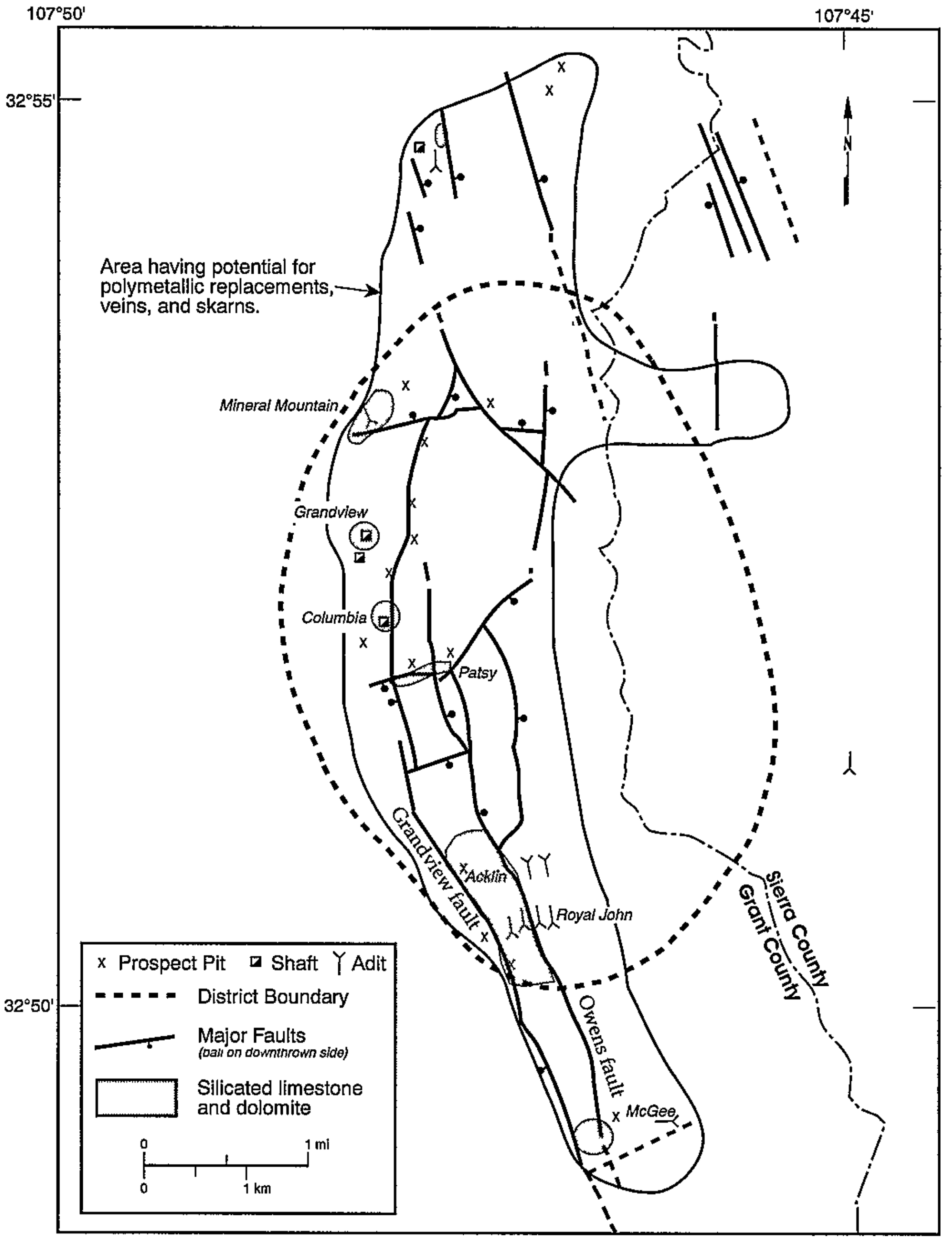

Figure 43—Mines and prospects in the Carpenter mining district, Grant County, New Mexico (modified from Hedlund, 1977).

Geology

The area lies within a horst of Paleozoic sedimentary rock between the north-trending and somewhat parallel Mimbres fault on the west and the Owens fault on the east. West of the Grandview mine, the Paleozoic sedimentary rocks are intruded by a mass of granite porphyry (Lindgren et al., 1910). At other places in the range, flows of andesites and rhyolites cover the sedimentary units. Soulé (1950) reports three types of igneous rocks near the Royal John mine: Cretaceous andesite agglomerate, Tertiary volcanics, and Tertiary intrusive andesite. The dominant structural feature in the district is a gently west-dipping homocline in the central and southern part of the district. Near the Grandview mine, there is a north striking doubly-plunging anticline with a core of Proterozoic granite (Hedlund, 1985b). A number of somewhat parallel faults cut the horst in the vicinity of the Royal John mine. Of these, the Discovery and Sunshine faults have been important economically with ore bodies occurring near them. Mineral deposits in the district are base-metal skarn and carbonate-hosted Pb-Zn replacement deposits in the Paleozoic carbonate rocks.

Mineral deposits

The geology of the mineral deposits within the Carpenter mining district has been described by Lindgren et al. (1910), Harley (1934), and Hedlund (1977a, 1985b). Ericksen et al. (1970) summarizes information from those reports. Hill (1946) and Soulé (1950) summarizes U. S. Bureau of Mines investigations in the district. Mine production is in Table 79 and list of mines and prospects is in Table 80.

The ore deposits consist chiefly of small and low-grade skarn and replacement deposits in the Montoya Dolomite, and are clearly related to rhyolitic plutons of Oligocene age (34.8±1.2 Ma, Hedlund, 1977b). Most of the veins are fault controlled, and the skarns containing bedded-replacement deposits are well developed in the upper silicated cherty beds of El Paso limestone (Hedlund, 1985b). At the Royal John mine, replacement ore bodies are within a horst bounded by the Owens and Grandview faults, which strike N10°-25°W. They are at the top of the cherty thin-bedded member of the Montoya Dolomite, are as much as 12-ft thick, and extend as far as 300 ft west of the Discovery fault (Soulé, 1950; Hedlund, 1985b). In another type of ore deposit, mineralization extends down along the faults into the cherty thin-bedded member of the Montoya Dolomite and throughout the lower massive limestone member beneath. Galena and sphalerite are the principal ore minerals and are associated with quartz, calcite, chalcopyrite, and pyrite. Skarn-type minerals such as abundant garnet, epidote, chlorite, and magnetite occur locally in the altered limestone. The beryllium mineral, helvite, was first discovered at the Grandview mine (Weissenborn, 1948). At the Royal John mine, dark-brown to black sphalerite was the main economic mineral with lesser quantities of galena. None of the calc-silicate skarn minerals were noted at the Royal John mine, although extensive silicification is present (Soulé, 1950).

At the Mineral Mountain mine, carbonate-hosted replacement deposits extend for about 30 ft along marmoritized and cherty limestone beds of the Lake Valley limestone. Mineralized faults, striking chiefly N30°W and N30°E, and dike margins contain minor galena, sphalerite, and pyrite (Hedlund, 1985b). At the Columbia mine, sulfides closely associated with tactite in El Paso Limestone are cut by a 105 ft thick rhyolite dike, which is the probable heat source (Hedlund, 1977a).

TABLE 79—Reported production from individual mines in the Carpenter mining district, Grant County, New Mexico (Hill, 1946; Hedlund, 1985b).

MINE	YEARS	ORE (SHORT TONS)	COPPER (LBS)	GOLD (OZ)	SILVER (OZ)	LEAD (LBS)	ZINC (LBS)
Royal John	1916-1949	31,322	18,270	9.4	41,378	1,913,257	3,160,526
	1956-1969	1,780	—	—	3,899	206,500	363,200
	TOTAL	33,102	18,270	9.4	45,277	2,119,757	3,523,726
Columbia	1924	1,709	6,480	—	2,307	207,627	369,888
	1943-1944	1,375	—	—	1,603	64,000	266,000
	TOTAL	3,084	6,480	—	3,910	271,627	635,888
Grandview	1938	80	—	—	—	35,662	39,862
	1938-1944	18,869	92,999	15.34	13,963	1,722,828	3,214,223
	TOTAL	18,949	92,999	15.34	13,963	1,758,490	3,254,085
Mineral Mountain	1924	46	3,282	231	220	6,800	—
GRAND TOTAL	1916-1969	55,181	121,031	255.74	63,370	4,156,674	7,413,699

TABLE 80—Mines and prospects of the Carpenter mining district, Grant County, New Mexico, located in Figure 42. Location includes section, township, and range.

MINE NAME (ALIAS)	LOCATION	LATITUDE	LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
Acklin		32° 50' 47"	107° 47' 07"	Zn, Pb, Cu, Ag	adit	carbonate-hosted Pb-Zn replacement	Hedlund (1977a)
Columbia (Fairview Group, Teel Property)	SW32 16S 9W	32° 52' 08"	107° 47' 54"	Zn, Pb, Ag, Cu	2 tunnels with 950 ft of workings	carbonate-hosted Pb-Zn replacement	Lindgren et al. (1910), Harley (1934), Hedlund (1977a)
Grandview (Teel Group)	NW32 16S 9W	32° 52' 37"	107° 48' 02"	Zn, Pb, Cu, Ag, Au, Be	adit with more than 10,00 ft of drifts and stopes	carbonate-hosted Pb-Zn replacement	Lindgren et al. (1910), Harley (1934), Hill (1946), Anderson (1957), Hedlund (1977a)
McGee		32° 49' 30"	107° 45' 58"	Zn, Pb, Cu, Ag	adit	carbonate-hosted Pb-Zn replacement	Hedlund (1977a)
Mineral Mountain	C of W29 16S 9W	32° 53' 14"	107° 48' 02"	Zn, Pb, Cu, Ag	short tunnel and several prospect pits	carbonate-hosted Pb-Zn replacement	Harley (1934), Ericksen et al. (1970), Hedlund (1977a)
Patsy	SE32 16S 9W	32° 51' 56"	107° 47' 26"	Zn, Pb, Cu, Ag	underground	carbonate-hosted Pb-Zn replacement	Lindgren et al. (1910), Harley (1934), Ericksen et al. (1970), Hedlund (1977a)
Rabb Canyon moonstone pegmatites (Rattlesnake, Owl)	unsurveyed	32° 53' 12"	107° 50' 43"	Moonstone	3 trenches and 1 cut	Gem (moonstone)	Kelley and Branson (1947), Carter (1977)
Royal John (Grand Central)	W9 17S 9W	32° 50' 27"	107° 47' 06"	Zn, Pb, Ag, Cu, Au	3 adits, 3 large opencuts, numerous shallow cuts and short adits	carbonate-hosted Pb-Zn replacement	Lindgren et al. (1910), Harley (1934), Hill (1946), Soulè (1950), Hedlund (1977a)
unknown adit	unsurveyed	32° 49' 25"	107° 45' 58"	Pb, Zn	adit	carbonate-hosted Pb-Zn replacement	—

Chloride Flat district

Location and Mining History

The Chloride Flat mining district is located 1.5 mi west northwest of Silver City (Fig. 1). In some designations, the Chloride Flat mining district is considered the Silver City or Boston Hill district (File and Northrop, 1966). Silver was first discovered in the area in 1871, but active mining did not begin for some years. The major silver-producing years were 1873 to 1893; subsequently mining was abandoned because of the low price of silver (Lindgren et al., 1910). Some additional silver production occurred as late as 1937 (Richter and Lawrence, 1983). Total production is estimated as 20,000 lbs Cu, 200 oz Au, 4 million oz Ag, and 500,000 lbs Pb (Table 81). The deposits are carbonate-hosted Ag-Mn replacment deposits.

The ore was valued for its fluxing qualities which permitted mining of low-grade material (Hernon, 1949). Although the district is better known for its silver ore, 2.7 million short tons of manganiferous-iron ore containing 12% Mn and 30-40% Fe were produced through 1962 (Tables 6, 8; Harrer, 1965), most of this from the Boston Hill mines. The early mining history of the Chloride Flat mining district, and the history and development of Silver City as a whole, was influenced by the 1871 discovery and subsequent development of rich silver deposits in the vicinity of the Chloride Flat mines (Entwiste, 1944). In this area supergene silver ore accounted for the bulk of production, with a small tonnage of manganiferous iron. The similarity of ores in the district to those of the neighboring silver districts caused considerable prospecting for silver, but very little was discovered.

TABLE 81—Metals production from the Chloride Flat mining district, Grant County, New Mexico (U.S. Bureau of Mines, 1927-1990; Anderson, 1957). e—estimated production.

YEAR	ORE (SHORT TONS)	COPPER (LBS)	GOLD (OZ)	SILVER (OZ)	LEAD (LBS)	TOTAL VALUE ($)
1873-1905[e]	100,000	—	—	—	—	3,000,000
1905-1914[e]	30,000	—	—	—	—	200,000
1921-1923[e]	18,000	—	—	—	—	85,000
SUBTOTAL 1873-1923[e]	148,000	—	—	—	—	3,285,000
1935	24	—	0.4	534	200	406
1936	528	400	—	4,567	1,300	3,634
1937	—	—	—	1,148	400	912
1939	2	—	—	28	400	38
1940	16	400	—	1,305	1,800	1,063
1941	9	500	—	436	800	415
1946	23	—	—	1,141	400	966
SUBTOTAL 1935-1946	602	1,300	0.4	9,159	5,300	7,434
ESTIMATED TOTAL 1873-1946[e]	148,602	20,000	200	4,000,000	500,000	5,000,000

Geology

The Chloride Flat district consists of a sequence of northeast-dipping Paleozoic sedimentary rocks, mostly limestone and shale, resting on Proterozoic granite (Lindgren et al., 1910). The rocks strike N35°W and dip 25° NE and have been cut by dikes and sills of gray porphyry which Lindgren et al. (1910) classified as granodiorite porphyry or quartz monzonite porphyry. The porphyry commonly cuts Percha Shale or Cretaceous shale (Colorado Formation). Oxidized silver and manganiferous-iron replacement and vein mineralization are related genetically to the porphyry intrusion with ore bodies having formed in Fusselman Dolomite at the contact with Percha Shale not far from the dikes.

The rocks in the vicinty of the Boston Hill mines consist mostly of Lower Paleozoic sedimentary rocks and Cretaceous shales. A large roughly circular mass of quartz monzonite porphyry and porphyry dikes have invaded the sedimentary rocks along the east side of the area.

The igneous rocks show slight to intense hydrothermal alteration. A large fault separates the Cretaceous rocks from the Lower Paleozoic rocks, and a felsic intrusion occurs in places between the porphyry and the Paleozoic rocks.

Mineral Deposits

The mineral deposits in the Chloride Flat district consist of cabonate-hosted Ag-Mn deposits of oxidized silver veins and replacements, generally associated with lead and manganese minerals (Table 82). The deposits form as irregular supergene-enriched bodies localized among a 3,000-ft-long zone of fractures, joints, and bedding plains in Fusselman Dolomite immediately beneath Percha Shale. Most of the faults are downthrown on the eastern side. As with several other districts in this study, the location of the ore bodies just below the shale is attributed to the comparatively impervious shale collecting and confining hydrothermal solutions in the upper part of the Fusselman Dolomite. In the ore bodies, much of the limestone has been altered, but other than silicification, the limestone shows no evidence of calc-silicate skarn development (Richter and Lawrence, 1983). Hernon (1949) notes that the ore bodies lie between dolomite walls that are altered to calcite.

TABLE 82—Mines and prospects of the Chloride Flat mining district, Grant County, New Mexico. Location includes section, township, and range.

MINE NAME (ALIAS)	LOCATION	LATITUDE	LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
Baltic (Tight Squeeze, Grand Center, Mary Belle)	SE32, SW33 17S 14W	32° 46' 48"	108° 18' 12"	Ag, Pb, Mn, Cu, Au	126 ft shaft, numerous shallow shafts, prospect pits	carbonate hosted Ag-Mn replacment	Lindgren et al. (1910), Anderson (1957), Cunningham (1974), NMBMMR files
Chloride Flat (Baltic, Bell, Providencia, 76, Silver Cross, Bremen)	14W; 32,33 17S, 4,5 18S	32° 47' 04"	108° 18' 14"	Ag, Mn, Fe, Pb, Cu, Au	numerous shafts and open cuts	carbonate hosted Ag-Mn replacment	Lindgren et al. (1910), Anderson (1957), Cunningham (1974), Farnham (1961), Entwistle (1944)
Boston Hill East (Silver Spot, Legal Tender, Iron Spike, Adonis, California, Atlas, and Luck Manganese)	SW3 W10 18S 14W	32° 45' 30"	108° 16' 45"	Mn, Fe	hundreds of open pits, open cuts, trenches, and shafts up to 150 ft deep	carbonate hosted Ag-Mn replacment	Farnham (1961), Entwistle (1938, 1944), Ellis (1930), Kelley (1949), Soulè (1948), Dorr (1965)
Boston Hill (Comanche, Raven, North Pit, Silver Pick, Second Value, Fierro no 1)	SE4, N9 18S 14W	32° 45' 30"	108° 17' 30"	Mn, Fe	hundreds of open pits up to 320 ft deep, open cuts, trenches.	carbonate hosted Ag-Mn replacment	Farnham (1961), Entwistle (1944), Kelley (1949)

The overlying Lake Valley Formation had undergone two periods of recrystallization. For one period, temperatures of 335 to 380 °C were determined; for the other period temperatures ranged between 165 to 260 °C. The upper range of temperatures were related to local Late Cretaceous-Tertiary igneous intrusions (Young, 1982). Limestone that has not been altered, has been replaced by metalic minerals that are represented by quartz, galena, argentite, and various oxidized compounds of lead and silver, and hematite, pyrolusite, magnetite, and limonite (Lindgren et al., 1910). Cerargyrite is the principal silver mineral along with native silver and argentite. Embolite, pearcite, argentiferous galena, and native silver are also present (Hernon, 1949). Bromyrite (silver bromide) and silver iodide were reported (Lindgren et al., 1910). Most of the silver was probably derived from primary argentite (Entwistle, 1944). Lead values were so low as to be of little value.

The principal occurrences of manganiferous iron ore at Chloride Flat are along a steeply dipping north-trending fracture zone that cuts the Fusselman Dolomite (Kelley, 1949; Farnham, 1961). The ore bodies are exposed for 2,000 ft along strike. They range from 50 to 250 ft long and from 30 to 60 ft wide. Several open cuts have been dug to exploit the bodies. The ore is a mixture of hematite and pyrolusite with some magnetite and limonite (Entwistle, 1944; Kelley, 1949). Mestitite, along with specularite, magnetite, and some sulfides were deposited by hydrothermal solutions beneath the Percha Shale. These were oxidized and concentrated to manganiferous iron ores by supergene processes above the water table. Kelley (1949) notes that at Chloride Flat the manganiferous-iron deposits were not as large as those at Boston Hill or were relatively less important as sources of manganiferous-iron because of their high silver content. Calcite, quartz, and barite in small amounts are the gangue minerals. Mineralization occurs along steeply dipping fault and fracture zones that cut the carbonate beds.

The manganiferous iron ore at Boston Hill is an intimate mixture of hematite and pyrolusite with some magnetite and limonite (Farnham, 1961). The color of the ore ranges from reddish brown to black. Gangue consists of small amounts of calcite, quartz, and barite. The brown to grayish-brown iron-magnesium carbonate mineral mesitite is the primary hypogene mineral in the area and the oxidation of mesitite by meteoric waters was responsible for the supergene mineralization that was mined (Entwistle, 1944). Only the deepest mine workings in the area penetrated the mesitite bodies. The ore mined from 1937 to 1944 assayed 12-13% Mn and 35-41% Fe.

The ore is found in irregular bodies localized along along steeply dipping fault and fracture zones replacing gently dipping beds of El Paso and Montoya dolomites, which crop out on the eastern half of the area, and Fusselman dolomites, which cover the western half and are overlain by Percha shale (Farnham, 1961). The north side of the mining area is bounded by the Boston Hill fault, which strikes N60°E and dips 70°NW or greater.

Copper Flat district

Location and Mining History

Copper Flat mining district is located near Bayard about two miles west-southwest of Hanover (Fig. 1) and was first prospected for copper in the late 1800s, and most of the shafts were sunk at that time (Mullen and Storms, 1948). A small amount of iron was produced from surface deposits between 1931 and 1937. In 1940, an extensive exploration program began which led to base- and precious-metal production between 1942 and 1947. From 1931 to 1937, 10,000 short tons of iron ore were mined from surface exposures. Between 1942 and 1947, ore containing approximately 27,000 short tons Zn was mined from underground workings, along with some Cu, Pb, Au, and Ag (Richter and Lawrence, 1983). Total production from the lead-zinc, copper, and iron skarns (18a, 19a) in the district is unknown.

Iron production from the magnetite mine was intermittent with data available for only two years, 1931 and 1937. Approximately 10,000 short tons of 55-58% Fe is reported as being produced from the district. The iron ore had an average composition of 57.6% Fe, 13.3% SiO_2, 0.5% Zn, and 0.047% P (Kelley, 1949). Silica content was considered moderately high. Reserves were estimated to be several tens of thousands of tons of material containing 50-55% Fe (Kelley, 1949).

Geology

The district is centered around the two small closely spaced outcrops of the Copper Flat stock, which are hypabyssal igneous plugs of intermediate composition that have intruded the Lake Valley Limestone and Oswaldo Formation country rocks (Kelley, 1949). Spencer and Paige (1935) describes the geology of the district and contains a cross-section that shows the two plugs connecting at relatively shallow depth.

Copper Flat stock, which is approximately 2,000 ft long and 1,000-1,200 ft wide (Jones et al., 1967), consists of granodiorite and is approximately on the axis of the Fort Bayard anticline. In the vicinity of the intrusions, a slight domal structure is imposed upon a broad fold. The stock appears to have intruded the surrounding rocks of the Oswaldo Formation without deforming them; although locally, they are disturbed near the contact and in some places dip toward the intrusive (Kelley, 1949). The contact aureole around the stock is 100-700 ft wide and consists of an inner zone of garnet containing principally magnetite and sulfides and an outer zone of marble (Spencer and Paige, 1935).

The larger plug is about 900 ft by 1,800 ft, and the smaller, northern one is about 400 ft by 1,300 ft. The larger plug is made up of light-gray, fine-grained granodiorite porphyry in which small phenocrysts of biotite, quartz, and colorless glassy feldspar are the only visible minerals (Spencer and Paige, 1935). A dike-like body of what is probably a later intrusion is seen near the center of the larger plug. In the smaller plug, the granodiorite is much like that of the larger one but it lacks quartz phenocrysts and has a slightly coarser texture.

Mineral deposits

Mineral deposits in the district consist of Laramide skarns and polymetallic replacements in Paleozoic carbonate rocks along the margins of the stock (Table 83). Two mines in the district, Copper Flat mine, primarily a zinc producer, and Copper Flat magnetite mine, an iron skarn, are the major deposits. The Copper Flat mine is located onthe south and east margin of Copper flat stock where polymetallic materialization has replaced Pennsylvanian Oswaldo Formation. The magnetite deposit occurs on the northwest side of the stock. A prominent replacement zone in Oswaldo Formation surrounds the pluton. In this zone, sphalerite and magnetite bodies have been located and exploited. The magnetite is generally found associated with sphalerite, but high-grade magnetite bodies having no sphalerite have been found (Mullen and Storms, 1948). The iron deposits have been mined on the northwest side of Copper Flat stock. Zinc mining has occurred on the south and east margin of the stock.

TABLE 83—Mines and prospects of the Copper Flat mining district, Grant County, New Mexico. Location includes section, township, and range.

MINE NAME (ALIAS)	LOCATION	LATITUDE	LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
Copper Flat Magnetite	S19 17S 12W	32° 48' 30"	108° 07 15"	Fe, Mn	open pit 217 ft long by 67 ft wide	Laramide skarn	Kelley (1949), Harrer and Kelly (1963)
Copper Flat (Cumberland, Congo, Sumpter, Laura R, Copper Carbonate, Lime, Copper Glance, Lexington)	SE19,NE30 17S 12W	32° 48' 24"	108° 07' 20"	Zn, Cu, Pb, Ag, Au	400 ft shaft, 2-300 ft shafts, shallow shafts, open pits	Laramide skarn	Spencer and Paige (1935), Mullen and Storms (1948), Anderson (1957), Hernon et al. (1964)

The Copper Flat mine occurs in limestones and shales of Lower Mississippian and Upper and Middle Pennsylvanian age that are intruded by Copper Flat stock. Around the periphery of the stock, Oswaldo Formation was folded as a result of outward-directed hydrostatic pressure from the forceful intrusion of magma. Subsequent alteration has produced silicates and marble from the original sedimentary rocks. A prominent replacement zone in Oswaldo Formation surrounds the pluton. In this zone, sphalerite and magnetite bodies have been located and exploited. The ore consists of sphalerite, chalcopyrite, and galena in magnetite gangue. The magnetite is generally found associated with sphalerite, but high-grade magnetite bodies having no sphalerite have been found (Mullen and Storms, 1948). In 1948, workings at the Copper Flat mine consisted of a 400 ft shaft, two 300 ft shafts, several shallow shafts, and numerous small open pits (Mullen and Storms, 1948).

The Copper Flat magnetite mine, which occurs in Oswaldo Formation on the northwestern margin of the smaller granodiorite plug, exploited high-grade magnetite bodies having no sphalerite. The ore is principally hematite with some magnetite and pyrolusite (Kelley, 1949). It is regularly banded with thin layers of white, light-pink, and gray gangue consisting of kaolin, calcite, and serpentinous material. Limonite is abundant as a result of weathering, and malachite disseminations and coatings are common. Some garnet was reported along the edges of the ore body. A few barren or low-grade areas were discovered in the ore body. The main massive ore bed was about 20 ft thick, and another medium-grade (30-40% Fe) bed of banded ore and silicate at least 10 ft thick overlies the main ore bed. Ore was produced from an open pit approximately 220 ft long by 70 ft wide (Richter and Lawrence, 1983).

Cora Miller district

Location and Mining History

The Cora Miller mining district is located northeast of the Telegraph district in the Mangas Creek area of the northern Burro Mountains (Fig.44). The district includes the Cora Miller mine (volcanic-epithermal vein deposit) and a few epithermal manganese deposits, along the south side of Mangas Creek. The silver mine was worked in the 1880s and produced a considerable amount of high-grade silver ore from fissure veins (Lindgren et al., 1910; Gillerman, 1964). Copper, gold, and lead were present in the silver ore. Since then, the mine has been virtually abandoned. The mine workings consist of a 175-ft shaft inclined at 85°, an upper adit at the level of the shaft collar, a lower adit at a depth of 75 ft, and a working level at 175 ft (Gillerman, 1964). Numerous open cuts, shallow shafts, and stopes explored the vein for 800 ft. Shallow workings at the mine site may have produced manganese in 1920 and in 1940-1942 (Wargo, 1959; Farnham, 1961). Total production is not known.

Geology

The rocks in the district are Tertiary rhyolites, flow breccias, and welded tuff with interbedded andesite and latite porphyry, and thin sandstone and conglomerate beds (Fig. 44). The mine is along the northern ring-fracture zone of the Schoolhouse Mountain caldera (Finnell, 1987).

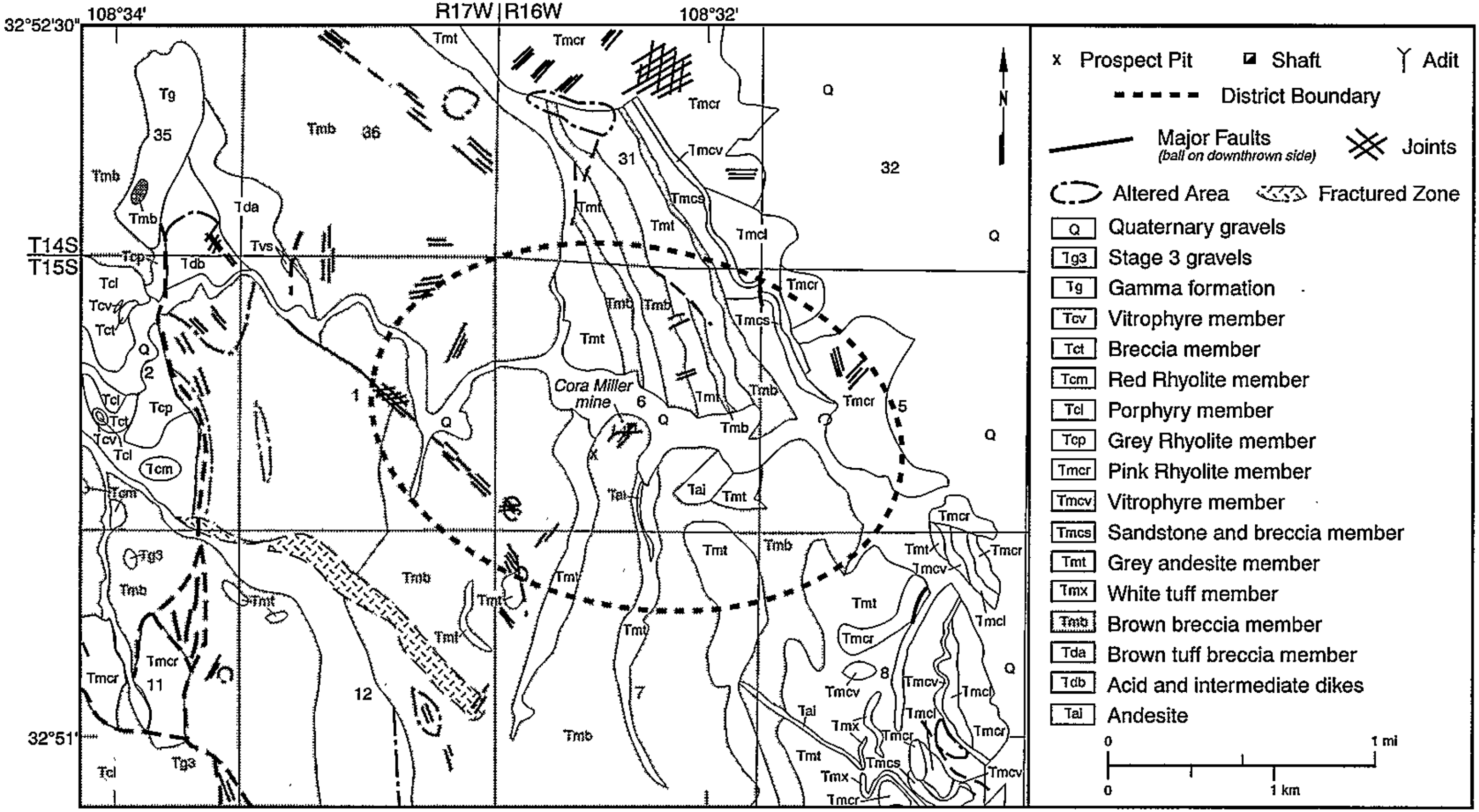

Figure 44—Mines and prospects in the Cora Miller mining district, Grant County, New Mexico (modified from Wargo, 1959).

Mineral deposits

At the Cora Miller mine, silver occurs in a volcanic-epithermal quartz fissure vein that strikes N70-75°E in Tertiary rhyolite ash-flow tuff. East of the mine the vein dips beneath the floodplain alluvium of Mangas Creek. The vein ranges in width from 4 to 5 ft at the mine, but narrows to less than a foot at the furthermost prospect pit. Gillerman (1964) notes that a small cross fault cuts the vein about 180 ft west of the shaft and a small offset was seen in the adit about 70 ft east of the shaft. No information is available on the minerals that were mined; quartz is the principal gangue mineral and malachite and gold are found in dump samples.

Wargo (1959) describes manganese-bearing vein deposits also occur in a breccia zone in shallow workings at the mine. Crushed breccia fragments within the fracture zone have been cemented and partially replaced by black manganese oxides. Vein quartz is present along portions of the vein.

Eureka district

Location and Mining History

The Eureka mining district occurs in the northern part of the Little Hatchet Mountains (Fig. 1). Mining activities in the Little Hatchet Mountains began in 1871. However, stone tools found in old turquoise pits are evidence of much earlier activity. Legend has it that the district was named "Eureka" when these old Native American mining tools were found. The American, Hornet, and King claims in the district were located in 1877-1878 at the same time when the Sylvanite district in the southern part of the mountains was prospected. The Eureka and Sylvanite mining districts were originally subdistricts of the Hachita district, which is no longer in use.

The earliest mining was at the Hornet mine; but, Apache Indians were hostile to mining and prospecting and made things difficult. By late 1878, when the U.S. Army visited the district, only 20 people resided there. Protection afforded by the army allowed the miners to return, and in 1881, ore shipments from the American mine were being recorded. In the early 1880s, smelters were built at both the American and Hornet mines, but neither smelter operated for very long due to technical difficulties. In 1885, a drop in the price of silver caused mining activities to subside until 1902, when the railroad connected the smelter towns of Douglas, Arizona, and El Paso, Texas, and stimulated production. The total value of ore produced to 1906 was not more than $500,000 (Lindgren et al., 1910). Total estimated production from the Laramide veins is approximately $1.59 million, including 2.9 million lbs Pb, 1.7 million lbs Zn, 500,000 lbs Cu, 5,000 oounces Au, and 450,000 ounces Ag (Table 84).

TABLE 84—Production from the Eureka mining district, Grant County, New Mexico (U. S. Bureau of Mines, 1927-1990; NMBMMR file data).

YEAR	ORE (SHORT TONS)	COPPER (LBS)	GOLD (OZ)	SILVER (OZ)	LEAD (LBS)	ZINC (LBS)	TOTAL VALUE ($)
1934	10	100	0.09	161	400	—	130
1935-1939	—	—	—	—	—	—	—
1940	98	300	1	1,163	4,400	—	1,116
1941	28	—	2	1,156	9,200	—	1,416
1942	48	200	--	1,194	12,300	—	1,697
1943	298	800	1	3,057	25,800	19,000	6,300
1944	260	600	--	2,385	31,700	25,000	7,163
1948	4,093	4,000	6	17,998	225,000	208,000	85,306
1949	12,017	6,000	7	19,493	341,000	276,000	107,171
1950	6,036	4,600	4	15,514	262,000	281,700	90,591
1951	6,031	5,800	25	19,526	353,400	402,700	154,380
1952	6,150	3,000	16	10,964	203,000	206,000	78,088
1953	450	100	1	650	14,600	6,200	3,278
1954	—	—	—	—	—	—	—
1955	888	600	5	3,107	52,600	53,400	17,616
1956	900	700	4	2,601	47,700	71,400	20,063
1957	1,500	300	18	4,257	130,800	35,600	27,408
1959	299	—	15	14,827	393,051	—	41,274
1960	429	—	20	23,877	609,066	—	63,755
1961	90	—	3	5,614	118,058	—	11,917
TOTAL 1934-1961	39,625	27,100	128	147,544	2,834,075	1,585,000	718,669
ESTIMATED TOTAL 1880-1961	—	500,000	5,000	450,000	2,900,000	1,700,000	1,590,000

Geology

In the district, the mountains consist of Cretaceous sedimentary and early Tertiary volcanic rocks intruded by Tertiary stocks, dikes, and sills. The oldest rocks in the district are Cretaceous sedimentary rocks consisting of thin bedded limestone, dolomite, and shale. Between Howells Ridge and Old Hachita, the Hidalgo Volcanics of early Tertiary age crop out. These rocks consist of altered andesite and andesite breccia with a few sedimentary units consisting of andesite detrital sediments. A hornblende andesite near the base of the section has an age date of 71.44±0.19 Ma ($^{40}Ar/^{39}Ar$, hornblende; Lawton et al., 1993). South and west of Old Hachita, the Hidalgo Volcanics have been intruded by the Sylvanite quartz monzonite stock and diorite. In the Little Hatchet Mountains, several Laramide stocks, dikes, and sills have intruded the Cretaceous sedimentary rocks, and the most highly mineralized areas are associated with these intrusive rocks. The quartz monzonite and monzonite in the Sylvanite and Eureka districts is called the Sylvanite quartz monzonite stock (Zeller, 1970), but detailed studies are needed to determine if there is more than one intrusive phase.

Mineral deposits

Mineral deposits in the Eureka district consist of Laramide veins in limestone and monzonite, Laramide skarns and replacements in metamorphosed limestone along the edge of the intrusive rocks, turquoise deposits, and disseminated quartz-specularite deposits (Table 85). Lasky (1947) divides the mineral deposits into seven types based on mineralogy: 1) disseminated pyrite in Tertiary intrusive rocks, 2) quartz-specularite deposits (sec. 2, 11, T28S, R16W), 3) lead-zinc skarns and replacements (Hornet), 4) arsenopyrite-lead-zinc veins (American, Miss Pickel), 5) manganosiderite-galena veins, 6) manganosiderite-tetrahedrite-galena veins (King 400, Silver King, Howard), and 7) quartz-pyrite-chalcopyrite veins (Copper King, Stiles).

TABLE 85—Mines and prospects in the Eureka mining district, Grant County (from Sterrett, 1911; Lindgren et al.,1910; Lasky, 1947; Zeller, 1970; V. T. McLemore, unpublished field notes, July 1-2, 1995; NMBMMR file data).

MINE NAME (ALIAS)	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	YEARS OF PRODUCTION	DEVELOPMENT	HOST	TYPE OF DEPOSIT
American (Alaska, Oregon, Maine, Florida, Monarch)	1 28S 16W, 36 27S 16W	31° 54' 27", 108° 25' 47"	Pb,Ag, Cu, Au, Zn	1881-1960	300 ft shaft, 2000 ft drifts	Sylvanite quartz monzonite stock, Cret Hell-To-Finish Form	Laramide vein
Copper King	SW31 27S 15W	31° 54' 30", 108° 25' 35"	Pb, Ag, Cu, Au, Zn, turquoise	unknown	pits	Cret U Bar Formation	Laramide skarn
Cricket	36 27S 16W	31° 54' 30", 108° 26' 15"	Pb,Ag, Cu, Au, Zn	unknown	pits	Sylvanite quartz monzonite stock	Laramide vein
Dugout	NC1 28S 16W	31° 54' 00", 108° 25' 47"	Pb,Ag, Cu, Au, Zn	unknown	pits	Tertiary volcanics	Laramide vein
Gold King Group (Fraction, Gold Howard, Lanny, Cpt. Henry, Golden Eagle, King Gold, Marylu)	36 27S 16W	31° 54' 55", 108° 26' 15"	Cu, Au, Ag, Zn, Pb, turquoise	unknown	shafts, adits, pits	Sylvanite quartz monzonite stock	Laramide vein
Hornet (Bonanza, Moab, Silver Crown, Nabob)	SE1 28S 16W	31° 53' 48", 108° 25' 40"	Zn, Pb,Ag, Cu, Au	1882-1958	150 ft shaft, 1200 ft drifts	Cret U Bar Formation	Laramide skarn
King 400	NW36 27S 16W	31° 54' 52", 108° 26 20"	Cu, Au, Ag, Zn, Pb	1878-1930s	shaft	Sylvanite quartz monzonite stock	Laramide vein
Last Chance	CE1 28S 16W	31° 53' 58", 108° 25' 40"	Cu,Au, Ag, Zn, Pb	unknown	pits	Cret U Bar Formation	Laramide skarn
Miss Pickel	NE3 28S 16W	31° 54' 40", 108° 27' 30"	Pb,Zn, As	1924-1937	shaft	Cret Hell-To-Finish	Laramide skarn
National group (Copper King, Silver King, Esmeraldo, Silver Queen)	SE36 27S 16W,SW1 27S 15W	31° 54' 38", 108° 25' 15"	Ag, Cu,Pb, Au,Zn, turquiose	1904-1929	50-217 ft shafts (5), 700 ft drifts	Cret U Bar Formation	Laramide skarn
Silver Bell	NE13 28S 16W, NW18 28S15W	31° 52' 35", 108 25' 35"	Pb,Ag, Cu, Au, Zn	unknown	pit	Cret Hell-To-Finish Formation	Laramide skarn

MINE NAME (ALIAS)	LOCATION	LATITUDE. LONGITUDE	COMMODITIES	YEARS OF PRODUCTION	DEVELOPMENT	HOST	TYPE OF DEPOSIT
Silver Tree	SC21 27S 16W	31° 56' 35", 108° 29' 00"	Pb,Ag, Cu, Au, Zn	unknown	shafts	Tertiary volcanics	Laramide vein
Sites Tunnel	NE35 27S 16W	31° 55' 10", 108° 26' 45"	Pb,Ag, Cu, Au, Zn	unknown	adit	Sylvanite quartz monzonite stock	Laramide vein
Turquoise Mountain (Gold King, Cameo, Azure, Calmea)	SW36 27S 16W	31° 54' 55", 108° 26' 15"	Cu, turquiose	1885-1905	pits, shafts	Sylvanite quartz monzonite stock	Laramide vein
unknown	NW35 27S 16W	31° 55' 00", 108° 27' 25"	Cu, Au, Ag, Zn, Pb	unknown	pits	Sylvanite quartz monzonite stock	Laramide vein
unknown (Beacon Hill)	NW34 27S 16W	31° 55' 00", 108° 27 '30"	Cu, Au, Ag, Zn, Pb	unknown	shaft	Sylvanite quartz monzonite stock	Laramide vein
unknown	SW23, NW26 27S 16W	31° 56' 30", 108° 27' 30"	Cu, Au, Ag, Zn, Pb	unknown	pits, shafts	Cret Majado Formation	Laramide vein
unknown (Hill 5758)	2,11 28S 16W	31° 53' 00", 108° 27' 40"	Fe	none	pits?	Sylvanite quartz monzonite stock	disseminated
unknown turquiose pit	NE2 28S 16W	31° 54' 00", 108° 26' 15"	Cu, turquoise	unknown	pit	Tertiary ash-flow tuff	Laramide vein, disseminated
Wasp	1 28S 16W	31° 53' 45", 108° 25' 35"	Pb,Zn,Ag, V, Cu	unknown	shaft	Cret U Bar Formation	Laramide skarn

Ore deposits at the American mine occur along a vein in metamorphosed limestone near the contact with a monzonite stock (Lasky, 1947). The limestone has been metamorphosed to marble and garnet. The vein strikes N50° E and dips 58° to 75° NW and can be traced in outcrop for about 1,000 ft before either end plunges beneath arroyo gravels. In the mine, the vein varies from 2 to 20 ft wide. Mineralized vein material contains galena, sphalerite, pyrite, arsenopyrite, and a trace of chalcopyrite. Gangue material includes manganosiderite, calcite, and sericite.

One example of an ore deposit that formed in the district without developing calc-silicate, skarn-type mineralization occurs at the Hornet mine. The Hornet mine was one of the earliest mining locations in the Little Hatchet Mountains and for a while it was the site of the greatest mining activity in the mountain range. The host rocks at the mine include limestone, Hidalgo Volcanics, and an irregular diorite sill that intrudes the contact between the limestone and the volcanic rocks. Ore at the mine consisted of three types: 1) lead carbonate ore stained black by manganese oxides and averaging 25 oz/ton Ag; 2) galena ore that was even richer in silver; and 3) zinc carbonate ore also rich in silver. The grade of material shipped between 1905 and 1927 was approximately 22 oz/ton Ag, 3.5% Zn, less than 1% Pb, and 0.05% Cu. Gangue was almost entirely coarse-grained calcite; pyrite occurred in unoxidized material.

Turquoise deposits were rediscovered about 1885 and worked intermittently for 25 years or more. Total production is unknown. Blue and green turquoise is found in veins in altered trachyte, andesite, and ash-flow tuff (Fig. 45, 46). Some bands were up to 7 ft wide (Sterrett, 1911); but most are smaller (Fig. 46). Impurities include jarosite, sericite, iron oxides, pyrite, and clay (Lasky, 1947; V. T. McLemore, July 1, 1995).

Zones of disseminated pyrite occur in the monzonite in the district. The monzonite is altered to and replaced by jarosite, iron oxides, and pyrite. Unaltered, pre-ore lamprophyre dikes cut the altered monzonite in the Sylvanite district to the south, suggesting that the alteration is older than the mineralization (Lasky, 1947).

A zone of disseminated quartz-specularite occurrs in sec. 2 and 11, T28S, R16W in the anticline of diorite and andesite breccia (Lasky, 1947). Iron was produced and used in the Hornet and American smelters. The rock is locally completely sericitized and replaced by quartz, sericite, and specularite.

FIGURE 45—Turquoise pit in sec. 2, T28S, R16W, Eureka district, Grant County (V. T. McLemore photo, 7/1/95).

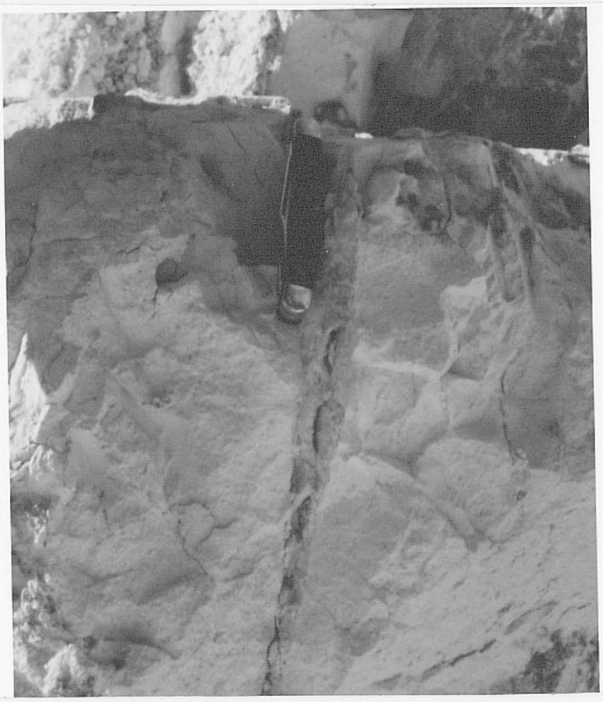

FIGURE 46—Turquoise vein with iron oxides (3 cm thick) in ash-flow tuff at Turquoise pit in sec. 2, T28S, R16W, Eureka district, Grant County (V. T. McLemore photo, 7/1/95).

Fierro-Hanover District

Location and Mining History

The Fierro-Hanover mining district is approximately 12 miles east-northeast of Silver City (Fig. 1) and was discovered in 1850. From 1890 to 1980s, 1.25 billion lbs Cu, >50,000 oz Au, >5 million oz Ag, >52 million lbs Pb, and 1.21 billion lbs Zn were produced (Table 2). In addition, more than 3,600,000 short tons of iron ore was mined intermittently from the district from 1891 to 1945 (Hillesland et al., 1994, 1995; Hernon, 1949) and approximately 670 long tons of ore containing 18.9-25.9% Mn was produced from the Lost Treasure, Gold Quartz, Hamlett, and Old Claim mines (Richter and Lawerence, 1983; Farnham, 1961).

Iron deposits in the Fierro-Hanover district were identified in the early years of copper development in the Fierro, Hanover, and Santa Rita areas (Kelley, 1949). Early accounts of mining in the area mention lodestone cliffs and large high-grade magnetite outcrops. During the 1880s and 1890s, iron ores from the Fierro and Hanover areas were used for smelter fluxes. Some iron-ore float may have been used as flux for nearby smelters even before the 1880s. In 1891, the railroad to Hanover was completed and iron ores for fluxing were shipped to copper smelters as far away as Socorro and El Paso. Supported mostly by production form the Fierro-Hanover mines, in 1889 and 1893 New Mexico ranked 16th and 24th respectively among States producing iron ore. In 1899, the railroad was completed to Fierro. The years of greatest production were the years 1916 to 1931 when annual production reached a maximum of 200,000 short tons, and the ore was shipped to Pueblo, Colorado (Hernon, 1949). Early in the mining history of the district, six major iron mines were operating. Large-scale iron mining ceased in 1931, but small amounts of ore were produced in 1936 and 1937 and again in 1942 to 1945. The average iron grade of the concentrates of near surface ores was 51.0% Fe, 13.38% MgO, and 7.28% SiO_2.

During World War I, the first manganese ore, about 275 longt tons, was shipped (Farnham, 1961). Production resumed during World War II, and another 248 longt tons of ore containing 22.2 to 25.9% Mn were shipped to Deming. Most of that ore was mined from the veins on the Lost Treasure No. 2 claim. During the 1950s, mining again was undertaken. During that time, 51 long tons averaging 18.9% Mn of sorted ore were shipped from the Gold Quartz claim and about 70 long tons containing 20% Mn from the Lost Treasure No. 2 vein. Mining was from open cuts and from underground. Much of the ore produced from the Lost Treasure vein was mined from an ore body near the southwest end of the vein's outcrop (Farnham, 1961). These workings were idle in 1959.

From 1967 to 1994, the Continental copper mine produced over 22,000,000 short tons ore containing 1.00-1.16% Cu and 0.41% Pb. Current reserves include 10,300,000 short tons of 0.92% Cu (open-pit), 3,600,000 short tons of 2.3% Cu (underground), and 80,000,000 short tons of 0.38% Cu as acid leachable chalcocite (Hillesland et al., 1994, 1995). In addition, reserves include 20% iron as magnetite, 0.4% Zn, and minor gold and silver. Preliminary leach tests by Cobre Mining show 80-85% recovery. Reserves at Hanover Mountain are estimated as 80 million short tons of 0.38% copper (Hillesland et al., 1995).

Geology

The district is centered around the Hanover-Fierro pluton, a north-trending elongate, discordant intrusion. The pluton consists of light gray, fine- to coarse-grain granodiorite porphyry. The sedimentary country rocks are intruded by the pluton and by quartz diorite sills, granodiorite and quartz monzonite dikes, and post-ore latite dikes.

Spencer and Paige (1935) first suggested that the pluton was laccolithic in part. Schmitt (1939) showed that pushing aside of folding strata by the intrusive was accompanied by thrust faulting upon which the older strata were emplaced. Aldrich (1974) determined that the Hanover-Fierro pluton has a funnel-shaped cross section, and summarized the events that occurred as the granodiorite was forcibly injected among the older rocks.

The district lies on the folded limestone and dolomite margin of Hanover-Fierro stock, which was intruded through a restricted Proterozoic channel and then expanded by both laccolithic bulging and pushing aside the overlying sedimentary rocks south of Barringer fault (Kelley, 1949). The intrusive is chiefly concordant and expanded outward and upward probably as a result of intrusion to shallow depth in well bedded rocks. Swarms of granodiorite porphyry dikes were intruded and fluids were injected along fractures, faults, and disturbed zones in and around the Tertiary stock which provided permeable channels that concentrated and directed the flow of mineralizing fluids (Hernon and Jones, 1968). The Barringer fault is a major fault and cuts the Continenal deposit (Fig. 47).

Mineral deposits in the district consist of the porphyry-copper related skarns, iron (magnetite) skarns, lesser zinc-lead skarns, and polymetallic veins and replacements that formed as a direct result of the intrusion of the granodiorite porphyry into Paleozoic and Cretaceous carbonate host rocks. Classic alteration associated with porphyry-copper deposits is not well developed at the Continental mine (Hillesland et al., 1995).

FIGURE 47—Baringer fault in the Continental pit, Fierro-Hanover district, Grant County (V. T. McLemore photo, 4/94).

Mineral deposits

The Fierro-Hanover district is one of the most zinc mineralized areas in New Mexico, predominantly as Laramide skarns (Fig. 48). The skarns are typically zoned (Fig. 47); garnet replacement bodies occur nearest the pluton grading outwards to clinopyroxene-garnet and clinopyroxene zones. Base-metal zoning is generally observed with copper associated with garnet and clinopyroxen-garnet zones nearest the pluton and lead-zinc in the outer clinopyroxene zone. Proximal Zn-Pb skarns occur around the southern lobe of the Hanover-Fierro pluton and distal Pb-Zn skarns occur along faults and dikes throughout the area (Jones et al., 1967; Forrester, 1972; Abramson, 1981; Meinert, 1987; Lueth, 1984; Turner, 1990; Turner and Bowman, 1993).

The major deposits in the district are owned by Cobre Mining Co., and include the Hanover Mountain porphyry copper and Continental copper skarn deposits. The Hanover Mountain deposit is a complex supergene chalcocite blanket in the Colorado Fromation and genetically related to Laramide intrusion of the Hanover-Fierro granodiorite stock (Table 86; Richter and Lawrence, 1983). The deposit occurs at the north end of Hanover-Fierro stock where the northwest-trending Barringer fault intersects with north- and east-trending fractures (Fig. 47). It consists of a zone of supergene copper minerals in the hanging wall of the Barringer fault which is associated with complex vein, disseminated and replacement veins (Richter and Lawrence, 1983; Hillesland et al., 1995). Cupriferous pyrite was the primary hypogene mineral; chalcocite is the most economically important supergene mineral, and generally forms a uniform blanket 100 to 500 feet (Hillesland et al., 1994, 1995). Chalcopyrite and sphalerite are common (Fig. 49).

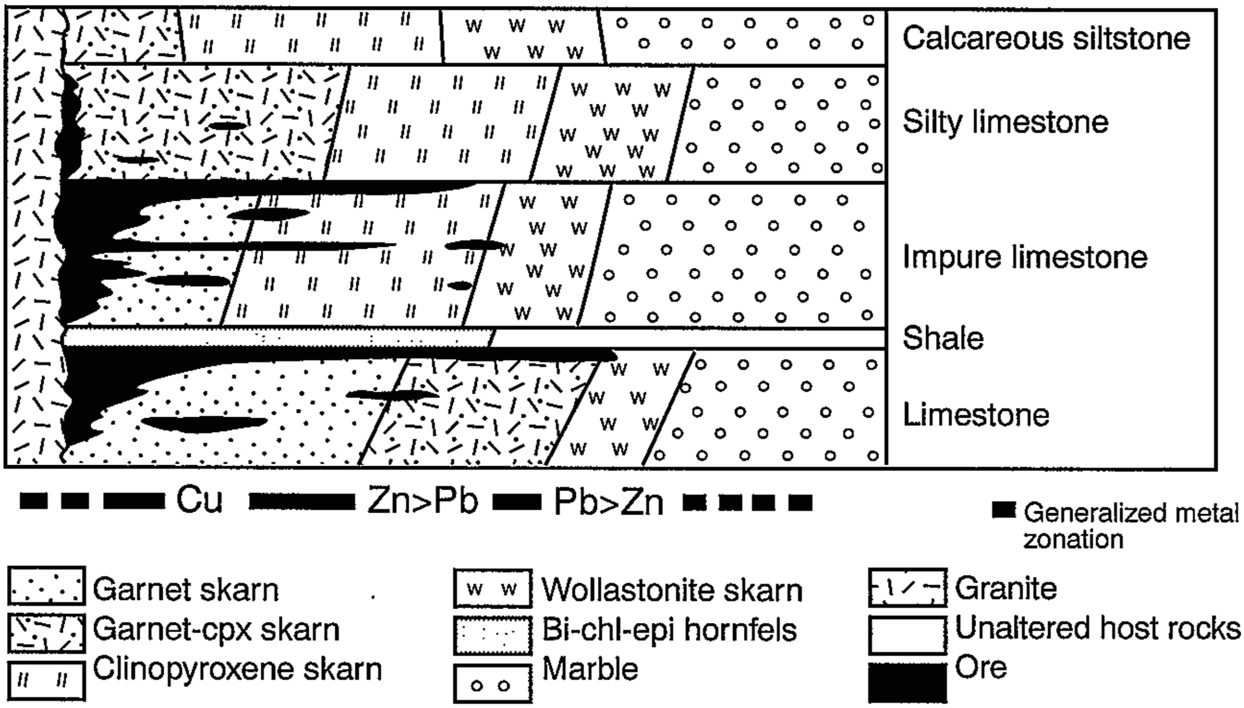

Figure 48—Generalized mineralization patterns in Laramide skarn deposits in southern New Mexico (modified from Lueth, 1984; McLemore and Lueth, in press). Garnet forms nearest to the stock in the purer limestones of the Lake Valley and Oswaldo Formations. Garnet-clinopyroxene forms adjacent to the stock in the argillaceous carbonate rocks. A hornsfel typically forms at the parting shale in the Oswaldo Formation. Wollastonite and marble typically forms the outer zones. Chalcopyrite typically occurs in the garnet zone and sphalerite occurs in the clinopyroxene zone and at the contact between the skarn and marble. Ore zones are generalized.

FIGURE 49—Chalcopyrite in skarn at the Continental pit, Fierro-Hanover district, Grant County (V. T. McLemore photo, 4/94).

Most of the copper reserves at the Continental mine are in the Syrena and upper part of the Lake Valley limestones north of the Barringer fault. Chalcopyrite is the chief ore mineral, with minor magnetite and iron-rich sphalerite erratically distributed at the garnet marble interface (Hillesland et al., 1994, 1995). Ore bodies are associated with the garnet-magnetite skarn, downdip of the Baringer fault. Supergene copper mineralization west of the main pit within the Colorado Formation is associated with the Hanover Mountain porphyry. Hydrothermal fluids from the Hanover-Fierro stock migrated up dip in adjacent sediments and were damed againest the Barringer fault, forming the copper skarns and replacement bodies (Hillesland et al., 1995).

TABLE 86—Mines and prospects of the Fierro-Hanover district, Grant County, New Mexico. Location includes section, township, and range.

MINE NAME (ALIAS)	LOCATION	LATITUDE	LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
Blackhawk (Combination)	NE1/4 29 17S 12W	32° 48' 15"	108 06' 00	Zn, Pb, Cu, Ag	shaft	Laramide skarn	Jones and Hernon (1973), Anderson (1957), Schmitt (1935, 1942)
Cupola	E1/2 21 17S 12W	32° 49' 00"	108° 05' 00"	Fe, Cu	drifts, small cuts, and pits	Laramide skarn	Kelley (1949), Harrer and Kelly (1963)
El Paso	N1/2 22 17S 12W	32° 49' 22"	108° 04' 21"	Fe	benches and open cuts	Laramide skarn	Kelley (1949), Harrer and Kelly (1963), Schilling (1964)
Emma (Davidson, Dewey, Bluebell)	W1/2 03 17S 12W	32° 51' 22"	108° 04' 44"	Cu, Fe	shaft	Laramide skarn	Spencer and Paige (1935)

MINE NAME (ALIAS)	LOCATION	LATITUDE	LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
Empire Zinc (Zinc Valley, Annie Fox, Robert E Lee, Black Wolf, Santa Fe no 1, Metal King, Uncle Sam, Southwestern)	SE16, NE21 17S 12W	32° 49' 02"	108° 05' 22"	Zn, Pb, Cu, Ag, Au	numerous shafts, adits, and pits	Laramide skarn	Spencer and Paige (1935), Anderson (1957), Hernon and Jones (1968), Jones and Hernon (1964), NMBMMR file data
Grant County	NE22, NW23 17S 12W	32° 49' 06"	108° 03' 53"	Zn, Pb, Ag	2 shafts, 2 adits, 800 ft of drifting	Laramide skarn	Jones et al. (1967), NMBMMR file data
"Hamlett	NW1/4 02 17S 12W	32° 51' 45"	108° 03' 30"	Fe, Mn	shallow pits and trenches	Laramide skarn, carbonate hosted Mn replacement	Farnham (1961), Harrer and Kelly (1963)
Hanover Mountain (Gilchrist Tunnel)	SW03, SE04 17S 12W	32° 51' 15"	108° 04' 45"	Cu	tunnels, shafts, surface workings	Cu porphyry / Laramide skarn	Lindgren et al. (1910), Spencer and Paige (1935), Harrer and Kelly (1963), Jones (1904), Kelly (1949)
Hobo	SE1/4 29 17S 12W	32° 47' 49"	108° 06' 11"	Zn, Pb, Cu, Ag	shaft	Laramide skarn	Jones and Hernon (1973)
Honey-Comb Claim	SW1/4 10 17S 12W	32° 50' 20"	108° 04' 28"	Cu, Zn, Au, Ag, Mo	shaft 120 ft deep	polymetallic vein	Lindgren et al (1910)
Humbolt	SW1/4 10 17S 12W	32° 50' 33"	108° 04' 19"	Fe	opencut and shaft	Laramide skarn	Kelley (1949), Harrer and Kelly (1963)
Ironhead (Pearson Shaft)	SW1/4 09 17S 12W	32° 50' 23"	108° 05' 40"	Fe, Zn, Pb	2 shafts 300 ft deep, tunnel, opencuts	Laramide skarn	Kelley (1949), Harrer and Kelly (1963), Jones and Hernon (1973)
Jim Fair (86 Mine, Jim Thayer, Gibhart, Nonpareil)	NW10 17S 12W	32° 50' 50"	108° 04' 31"	Fe	inclined adit with 3 levels, several large open pits	Laramide skarn	Lindgren et al (1910), Spencer and Paige (1935), Kelley (1949), Anderson (1957), Harrer and Kelly (1963)
Kearney	SW22, NW27 17S 12W	32° 48' 29"	108° 04' 36"	Zn, Pb, Cu, Ag, Au, Fe	2-625 ft vertical shafts, 3 levels	Laramide skarn	Anderson (1957), Jones et al., (1967), Storms and Faust (1949)
Lone Star (Copper Pillo)	SE1/4 16 17S 12W	32° 49' 30"	108° 05' 00"	Fe	surface	Laramide skarn	Kelley (1949), Harrer and Kelly (1963)
Lost Treasure and Gold Quartz Group (Hodges-Dowell, Fierro Manganese)	S1/2 35 16S 12W	32° 52' 15"	108° 03' 15"	Mn	open cuts and shafts 80 ft deep	carbonate hosted Mn replacement	Farnham (1961), Jones (1919)
Mabel	SW1/4 15 17S 12W	32° 49' 30"	108° 04' 30"	Zn, Ag	shaft 135 ft deep	polymetallic veins	Lindgren et al. (1910), Jones and Hernon (1973)
Maggie Bell (Copper Bottom)	NW1/4 22 17S 12W	32° 49' 15"	108° 04' 30"	Fe	open cuts	Laramide skarn	Kelley (1949), Harrer and Kelly (1963)
Magnetite	SE1/4 03 17S 12W	32° 51' 03"	108° 04' 03"	Fe	surface only	Laramide skarn	Kelley (1949)
Mountain Home (Mountain Chief, Chief, Fighting Tenth, Zincite, Live Oak, Midnight, Northstar)	SE17 17S 12W	32° 49' 26"	108° 06' 08"	Zn, Pb, Cu, Ag, Au, W	6 adits, 2 deep shafts, stopes, shallow shafts, winzes, raises, small pits	Laramide skarn	Jones et al. (1967), Dale and McKinney (1959), Schmitt (1935)
unknown	NE1/4 17 17S 12W	32° 50' 00"	108° 06' 15"	Mn	pit	carbonate hosted Mn replacement	Jones and Hernon (1973)

MINE NAME (ALIAS)	LOCATION	LATITUDE	LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
Nugent (Booth)	S1/2 22 17S 12W	32° 48' 33"	108° 04' 21	Fe	benches and shallow opencuts	Laramide skarn	Harrer and Kelly (1963), Kelley (1949)
Old Claim	NE35, NW36 16S 12W	32° 52' 40"	108° 02' 45"	Mn, Pb, Zn	open cuts	carbonate hosted Mn replacement	Farnham (1961)
Oswaldo (Booth Group, Nugent, Come by Chance, Voltaire, 6-8-1, Albino, Syrena)	SE of NE21 17S 12W	32° 48' 34"	108° 05' 00"	Zn, Pb, Cu, Ag, Au	500 ft vertical shaft w/ 2 working levels	Laramide skarn	Anderson (1957), Jones et al. (1967), NMBMMR file data
Pewabic (Pewaubic, Result, Walpool, Eclips)	NW22 17S 12W	32° 49' 07"	108° 04' 29"	Zn, Pb, Cu, Ag, Au	600 ft main shaft, extensive workings on 5 levels	Laramide skarn	Paige (1916), Spencer and Paige (1935), Schmitt (1939), Anderson (1959), Harrer and Kelley (1963)
Philadelphia	W1/2 22 17S 12W	32° 49' 00"	108° 04' 43"	Fe, Cu	drifts and opencuts	Laramide skarn	Paige (1908), Schmitt (1932)
Princess	C28 17S 12W	32° 48' 05"	108° 05' 28"		shaft	Laramide skarn	Richter and Lawrence (1983)
Queen (Copper Queen)	S1/2 15 17S 12W	32° 49' 40"	108° 04' 19"	Fe	pit	Laramide skarn	Harrer and Kelly (1963)
Republic (Republic no 1 and 2)	SE1/4 21 17S 12W	32° 48' 51"	108° 05' 00"	Zn	shaft and adits	Laramide skarn	Anderson (1957), Jones and Hernon (1973)
Republic (Union Hill)	SE09 NE16 17S 12W	32° 49' 45"	108 04' 45"	Fe, Cu, Zn	330 ft main shaft, extensive underground workings and opencuts	Laramide skarn	Kelley (1949)
Robert E Lee (Santa Fe no 1 claim)	N1/2 21 17S 12W	32° 49' 15"	108° 05' 30"	Fe	opencuts and tunnels	Laramide skarn	Kelley (1949), Harrer and Kelly (1963)
Shingle Canyon (Barringer, Maggie, Bell & Fletcher, March no 3, Jack McGee, San Pedro, Minerva, Copper Peak)	SE34 SW35 16S 12W	32° 52' 18"	108° 03' 37"	Zn, Pb, Cu, Ag	200 ft vertical shaft, inclined shaft, several small shafts, an adit	Laramide skarn	Anderson (1957), Jones et al. (1967), NMBMMR file data
Snowflake	S10 N15 17S 12W	32° 50' 14"	108° 04' 26"	Fe, Cu	opencuts and tunnels	Laramide skarn	Kelley (1949), Harrer and Kelley (1963)
Three Brothers	C26 16S 12W	32° 53' 05"	108° 03' 15	Pb, Zn, Mn	shaft	polymetallic veins	—
Thundercloud (Thunderbolt)	SW1/4 22 17S 12W	32° 48' 47"	108° 04' 46"	Zn, Pb	shaft	Laramide skarn	Lindgren et al. (1910)
Tourmaline Claim	SW1/4 10 17S 12W	32° 50' 35"	108° 04' 30"	Cu	shaft 230 ft deep	polymetallic veins	Lindgren et al. (1910)
Continental (Modoc,Anson S, Zuniga Mines, part of Hanover Mt, Sinks Shaft, Gibhart, UV Industries shaft)	E2,SE 3,4,9 17S 12W	32° 50' 32"	108° 05' 28"	Cu, Fe, Ag, Au, Zn, Pb	extensive underground workings being replaced by large open pit	copper skarn, porphyry copper	Lindgren et al. (1910), Kniffin (1930), Lasky (1936b), Anderson (1957), Harrer and Kelly (1963), NMBMMR
Union Hill-Republic (Union, Republic, Mother, Eastern, Copper King, Hartburn, Old Jack,others)	SE09 NE16 17S 12W	32° 50' 02"	108° 04' 56"	Fe, Cu, Zn, Pb, Ag, Au	numerous open pits and cuts, u/g access through Union Hill & Republic	Laramide skarn	Lindgren, et al. (1910), Kniffin (1930), Spencer and Paige (1935), Kelley (1949), Anderson (1957)

The iron deposits are along the sides of the pluton generally at the contact or a short distance from it. The ore bodies are lenticular masses having an average thickness of about 30 ft, but ranging in thickness from a few feet to over 200 ft. They range in length from 100 ft to 1,000 ft (Hernon, 1949). The ore bodies may be solid masses or contain zones of waste composed of limestone or wollastonite. Ore bodies are known to form in various stratigraphic positions from Bliss Sandstone to Fusselman Dolomite, but most of the higher grade iron deposits are in El Paso limestone (Kelley, 1949). This appears to be because of the close proximity of the intrusive to the limestone, less silication of the limestone beds, and greater susceptibility of the El Paso limestone to replacement by iron-bearing fluids. In several places, Bliss Sandstone lies between the pluton and El Paso Limestone, but the more siliceous sandstone was not as readily replaced as the limestone.

The minerals in the iron deposits include predominant magnetite, subordinate specularite, and minor chalmersite, pyrite, chalcopyrite, sphalerite, and sporadic molybdenite. Magnetite is altered to martite at or near the surface. Gangue minerals include unreplaced host rock, serpentine, and apatite (Hernon, 1949). Normal unoxidized iron ores contain about 0.6% Cu, and at some sites leaching and redeposition of copper has occurred at the contact between the iron ore and the intrusive.

The Pewabic mine, on the eastern part of the Hanover lobe of the Hanover-Fierro pluton, exploits pod-like sphalerite ore bodies, essentially uncontaminated by lead or copper, that were localized by the intersection of a thrust fault with nearly vertical post-silicate northeast fault zones (Schmitt, 1939). They are as much as 40 ft in diameter and 600 ft long. At the Empire Zinc mine, around the southwest margin of the Hanover-Fierro stock, blankets as thick as 135 ft and upright tabular bodies as much as 1,000 x 120 x 30 ft replace Lake Valley limestone along granodiorite dikes (Spencer and Paige, 1935). Ore from 1905 to 1969 averaged 8.75% Zn. At the Shingle Canyon mines (also owned by Cobre), Zn-Pb skarn occurs in limy mudstone and limestone-pebble conglomerate of the Permian Abo Formation in the footwall of the Barringer Fault, northeast of the stock (Anderson, 1957; Hernon et al., 1964). In 1939 to 1945, ore averaged 10.91% Zn, 3.25% Pb, and 0.11% Cu.

The Lost Treasure and Gold Quartz groups are the major source of manganese in the district. The deposit consists of replacement manganese bodies and lenticular fissure fillings in gently dipping Pennsylvanian Magdalena Group limestones along two subparallel faults about 1,000 ft apart striking N55-60° E. The Lost Treasure No. 2 vein ranges in width from 2 to 5 ft and can be traced along strike for 800 ft. In places, ore minerals have replaced the gently dipping limestone beds adjacent to the vein. The mineralized beds range from 2 to 3 ft thick and extend outward about 3 ft into the hanging wall of the vein. The Gold Quartz vein is traceable for 2,000 ft and varies from 2 to 6 ft in width. Pyrolusite and wad are the chief manganese minerals. Gangue minerals are abundant iron oxides, manganiferous calcite, and quartz (Farnham, 1961).

The Hamlett claims contains a small iron-manganese skarn deposit where limestone of the Magdalena Group has been contact metamorphosed. Manganiferous iron ore consisting of magnetite, hematite, and manganese oxides occurs in various-size lenses along fractures and in irregular masses scattered over and area several hundred feet square (Farnham, 1961). The larger masses are several feet wide and a few tens of feet long. Epidote, garnet, and pyroxene are alteration products.

Fleming district

Location and Mining History

The Fleming (or Bear Mountain) mining district is 6 mi northwest of Silver City on the slopes of Bear and Treasure Mountains where fluorspar, iron, manganese, and silver as Laramide veins have been identified (Fig. 50). Location and name of the district come from the old silver-mining camp called Fleming after John W. Fleming, a prospector, that was as active as the Apaches would permit from about 1882 to 1893 (Lindgren et al., 1910) and sporadically thereafter. At the Old Man mine, which first produced in the 1880s to 1893 and then produced sporadically until at least 1949, one ore chamber contained about $40,000 worth of silver. In all, about $250,000 worth of silver were produced in the district from 1882 to 1905 (Table 87). In 1937, 222 lbs of Pb were produced. About $300,000 worth of ore had been produced in the district by that time consisting of 1,000 ounces Au, 300,000 ounces Ag, 10,013 lbs Zn, 450 lbs Cu, and 465 lbs Pb (Table 87; Lasky and Wootton, 1933). In addition, a total of about 232 short tons of fluorspar were produced (Williams, 1966). From 1916 to 1959, the district's manganese deposits produced 1,860 ton of ore containing about 30% Mn and 20 ton of concentrate containing 45.8% Mn (Farnham, 1961). As of 1957, the district had not been active in recent years (Anderson, 1957).

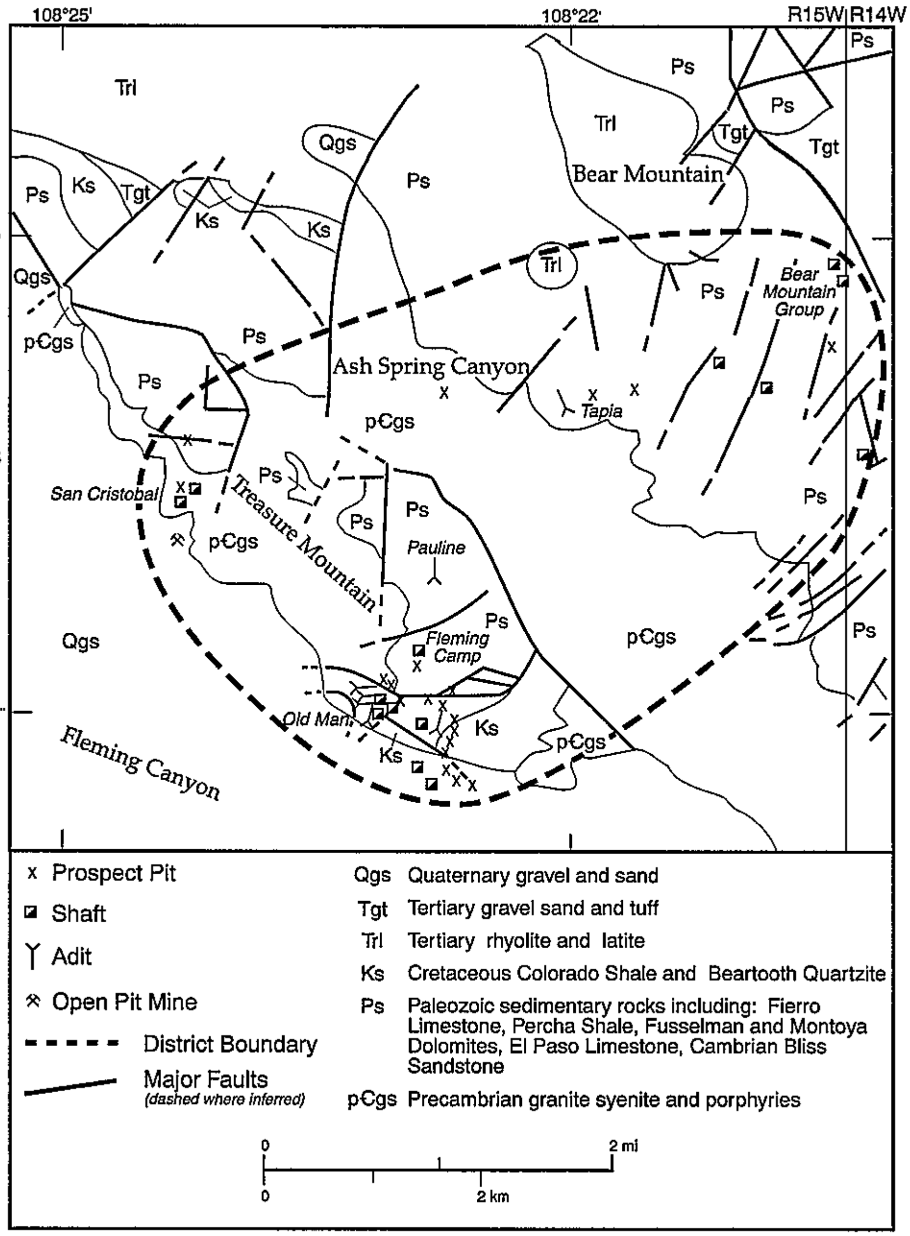

Figure 50—Mines and prospects in the Fleming mining district, Grant County, New Mexico (modified from Paige, 1916).

TABLE 87—Metals production from the Fleming mining district, Grant County, New Mexico (U.S. Bureau of Mines, 1927-1990; Anderson, 1957). e—estimated production.

YEAR	ORE (SHORT TONS)	COPPER (LBS)	GOLD (OZ)	SILVER (OZ)	LEAD (LBS)	ZINC (LBS)	TOTAL VALUE ($)
1936	382	50	50.37	5,698	240	—	6,192
1937	594	400	4.40	4,662	225	—	3,821
1948	460	—	—	832	—	—	753
TOTAL 1936-1948	1,436	450	54	11,192	465	10,013	10,647
ESTIMATED TOTAL 1882-1948	—	—	<1,000	300,000	—	—	300,000

Geology

The country rock in the vicinity of the Fleming Camp mine on Treasure Mountain is reddish-gray or reddish-brown Beartooth quartzite, and, in many locations, is brecciated or a conglomerate with angular pebbles. It is underlain by Fusselman dolomite (Lindgren et al., 1910; Hernon, 1949). Here, the ore occurred in irregular pockets in beds of quartzite, and the quartzite near the old stopes is traversed by numerous drusy veinlets of quartz with occasional finely-disseminated pyrite.

Bear Mountain Ridge, which hosts the Bear Mountain group mines, trends north-northwest and is composed mainly of sedimentary rocks, but north-striking Proterozoic granite and gneiss is exposed in an upthrust strip along the middle crest of the ridge. The crest in the southern part of the ridge is formed by east-dipping sediments overlying the granite, and west-dipping strata forms the crest of the ridge in the northern part of the ridge (Lindgren et al., 1910)

Mineral deposits

The deposits found in the district are listed in Table 88. Silver-bearing polymetallic veins occur at Fleming Camp as irregular oxidized bodies in Cretaceous Bearfoot Quartzite which overlies Fusselman Dolomite (Richter and Lawrence, 1983). Cerargyrite, native silver, and argentite are the chief ore minerals. Gold, copper, and lead minerals are reported and have been minor byproducts of silver mining. Gangue minerals are quartz, limonite, and pyrite. At the Pauline mine near Fleming Camp, silver-bearing minerals occur in a quartz fissure vein in Proterozoic granite (Richter and Lawrence, 1983).

Fluorite occurs in the district as a fissure fillings and cementing breccia fragments in El Paso Limestone. At the Ash Spring Canyon deposit, for example, the breccia zone is 3 to 6 ft wide in a vertical fault striking N65° E (Williams, 1966; Rothrock et al., 1946). Fluorite partly replaces the limestone wall rock. The vein is traceable for 100 ft on the surface before pinching out at both ends. The fluorite is light green and medium to coarsely crystalline. A grab sample of stockpiled material contained 26.3% CaF_2, 66.3% SiO_2, and less than 1% $BaSO_4$ and $CaCO_3$ (Williams, 1966). Stockpiled ore from the Cottonwood Canyon prospect assayed 52.1% CaF_2, 46.4% SiO_2, 0.5% $CaCO_3$, and less than 0.1% $BaSO_4$ (Williams, 1966). At the San Cristobal deposit, fluorite fills fissures in a pegmatite (footwall)-granite (hanging wall) contact zone. The vein trends N36°W and dips 73°SW (Williams, 1966). A sample of hand-sorted stockpiled ore contained 92.1% CaF_2 with minor $BaSO_4$.

Discontinuous oolitic ironstone deposits crop out extensively in northern Grant County in the Silver City Range and the Pinos Altos Mountains where they are isolated near the base of the Bliss Sandstone. In the district, deposits of this type occur in Ash Spring Canyon, where 2 ft of oolitic hematite overlies 13 ft of basal conglomeratic sandstone that rests upon pink granite (Kelley, 1949). Nowhere are the outcrops very continuous. A sample of the hematite bed contained 35.9% Fe, 0.30% P, 1.21% CaO, and 40.2% SiO_2.

Replacement manganese deposits occur in the district. For example, the Bear Mountain group of claims consists of irregular lenses of manganese ore that has replaced several beds of Oswaldo Formation limestone. Manganiferous material crops out in a 400 ft by 250 ft area which is crossed by two or more steeply dipping fracture zones with which the replacement deposits are associated. The fracture zones strike about N25°E and in some places are mineralized. However, most of the mineralization occurs in the limestone beds adjacent to the fracture zones. In some places, the limestone contains superimposed beds of ore having a thickness of as much as 60 ft. The chief manganese minerals are pyrolusite and wad. Psilomelane could be found near the surface. Calcite is the principal gangue mineral (Farnham, 1961).

TABLE 88—Mines and prospects of the of the Fleming mining district, Grant County, New Mexico. Location includes section, township, and range.

MINE NAME (ALIAS)	LOCATION	LATITUDE	LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
Ash Spring Canyon	N of E23 17S 15W	32° 49' 15"	108° 21' 40"	Fe	pit	sedimentary Fe	Kelley (1951), Harrer and Kelly (1963), Kelley (1949)
Bear Mountain (1916)	NE13 17S 15W, NW18 17S, 14W	32° 49' 53"	108° 20' 07"	Mn	2 shafts about 60 ft deep, several opencuts	epithermal Mn	Wells (1918), Farnham (1961), Cunningham (1974), Dorr (1965), Jones (1920)
Cottonwood Canyon	7 17S 15W	32° 50' 52"	108° 25' 47"	F	60 ft opencut, 50 ft adit	fluorite veins	Williams (1966), Johnston (1928), Talmage and Wootton (1937)
Eightyfive Mountain	9 17S 14W	32° 50' 20"	108° 18' 00"	Fe, W, Be	shafts, pits	W-Be skarn	NMBMMR file data
Fleming Camp	S27, N34 17S 15W	32° 47' 45"	108° 22' 50"	Ag	inclined shaft to a depth of 300 ft	Laramide vein	Lindgren et al. (1910)
Old Man	SW27, NW34 17S 15W	32° 47' 36"	108° 22' 56"	Ag, Au, Cu, Pb	numerous opencuts, shallow shafts, tunnels, and inclined adits	Laramide vein	Lindgren et al. (1910), Anderson (1957), Paige (1916)
Pauline	N27 17S 15W	32° 48' 18"	108° 22' 55"	Ag	adit	Laramide vein	Lindgren et al. (1910)
San Cristobal (Lone Spar, Lupe, Elena, Big John, Little John, Black Joe)	W21 17S 15W	32° 48' 45"	108° 24' 17"	F	2 30 ft shafts, 50 x 2 x 3 ft trench, 20 ft shallow trench	fluorite veins	Williams (1966)
Tapia	NW23 17S 15W	32° 49' 13"	108° 21' 45"	F, Ba	160 ft crosscut adit, 50 ft vertical raise, several small pits and opencuts	fluorite veins	Williams (1966), Rothrock et al. (1946)

Georgetown district

Location and Mining History

The Georgetown (Mimbres) mining district is located about 3 mi east of Fierro, west of the Mimbres River, northeast of Santa Rita district, and south of Bear Canyon in sec. 1, 2, and 12, T17S, R12W and 6, 7, and 18, T17S, R11W (Fig. 1). In 1866, silver was discovered in the district, but there was little mineral development there until 1873, when a period of major production began that lasted until 1893. The mining camp was booming in 1875, but the decline in the price of silver in the 1890s brought an end to mining (Anderson, 1957). The principal mines in the district were Naiad Queen, Commercial, and McGregor, all owned by the Mimbres Mining and Reduction Works Co. (Table 89). Both high-grade and concentrating ores were mined. Low-grade material was sent to a concentrating mill along the Mimbres River (Fig. 3). Most of the ore was oxidized. There has been very little mining activity and practically no mineral production since the 1890s. During the late 1970s and early 1980s, mine dumps were reprocessed and some gold and silver were recovered. Total production is estimated to be 3.9 million oz Ag having a value of about $3.5 million (Lasky and Wootton, 1933; Richter and Lawrence, 1983). Minor amounts of copper, lead, zinc, and gold were also produced.

TABLE 89—Mines and prospects in the Georgetown mining district, Grant County, New Mexico. These mines and prospects are carbonate-hosted silver (manganese, lead) deposits. From Jones et al. (1967), Richter and Lawrence (1983), NMBMMR file data, and V. T. McLemore, unpublished field notes, February 1, 1995. Location includes section, township, and range.

MINE NAME (ALAIS)	LOCATION	LATITUDE	LONGITUDE	COMMODITIES	DEVELOPMENT	MINERAL SURVEY NUMBER	PATENT NUMBER
Buena Vista	NE7 17S 11W	32° 50' 42"	108° 00 50"	Ag, Mn, V	40 ft shaft, pits	1376	?
Commercial	NW NW7 17S 11W	32° 50' 52"	108° 1' 21"	Ag, Mn, V	400 ft shaft	501	21669
Cramer (Glamogan)	NW7 17S 11W	32° 50' 45"	108° 1' 20"	Ag, Mn, V	250 ft, 20 ft shafts	161	16443
Edith	SE NW 7 17S 11W	32° 50' 40"	108° 01' 00"	Ag, Mn, V	adit	1376	157712
Imperial (Old Claim)	SW NE 7 17S 11W	32° 50' 40"	108° 00' 55"	Ag, Mn, V	pits	1376	157712
McGregor	NW7 17S 11W	32° 50' 55"	108° 1' 30"	Ag, Mn, V	100 ft shaft	41	3602
McNulty	NW7 17S 11W	32° 50' 55"	108° 1' 19"	Ag, Mn, V	shafts	144	16445
Naaid Queen (Naiad Queen)	NW7 17S 11W	32° 50' 50"	108° 1' 22"	Ag, Mn, V	600 ft, 100 ft shafts	47, 142	3453,22580
Satisfaction	NW7 17S 11W	32° 50' 53"	108° 1' 15"	Ag, Mn, V	160 ft shaft	40,143	2616,22580
Snow Flake	SE1 17S 11W	32° 51' 05"	108° 1' 32"	Ag, Mn, V	shaft	—	unpatented
Uncle Samuel (Sam)	6,7 17S 11W	32° 51' 05"	108° 1' 20"	Ag, Mn, V	shafts, pits	225	14499
unknown	SE7 17S 11W	32° 50' 20"	108° 00' 50"	Ag, Mn, V	shafts	—	unpatented
unknown	NW1,NE2 17S 11W	32° 51' 35"	108° 2' 35"	Ag, Mn, V	2 adits	—	unpatented

Geology

The sedimentary rocks in the district are Paleozoic in age and dip west-southwest at shallow angles (Jones et al., 1967). Several northeast-trending faults cut the Paleozoic sedimentary rocks. Near vertical, altered porphyry dikes, cut the limestones and shales. $^{40}Ar/^{39}Ar$ dating of K-feldspar from a porphyry dike indicates an isochron age of 71±2 Ma (V. T. McLemore, unpublished isochron age determination). The eastward limit of the district is restricted by the large northwest-trending Mimbres fault which has brought semi-consolidated gravel deposits in contact with with the Paleozoic sedimentary rocks (Hernon et al., 1964). Mineral deposits in the district consist of silver-bearing veins and replacements in Fusselman Dolomite directly below Percha Shale. They are similar in mineralogy and stratigraphic position to silver deposits in several other districts, such as Chloride Flat in the Silver City area. The district coincides with a slightly anomously high aeroradiometric U anomaly and low K and Th, which is characteristic of mineralized carbonate rocks in the southwestern New Mexico.

Mineral deposits

The carbonate-hosted Ag-Mn replacement deposits consist of irregular, oxidized bodies in Fusselman Dolomite beneath the Percha Shale (Table 89; Richter and Lawrence, 1983). The deposits occur in beds dipping 10° to 20° S. The host limestone was silicified, especially near the dikes, and vuggy in places. Most ore bodies occur in the vicinity of the porphyry dikes. Some of the ore bodies are localized near contacts with granodiorite porphyry. The ore was most valued for its cerargyrite content; native silver, argentite, smithsonite, bromyrite, pyragryrite, galena, and vanadinite were also present (Lasky and Wootton, 1933; NMBMMR file data). Some pockets of cerussite and other silver minerals were discovered. Argentiferous galena was probably the primary ore prior to oxidation. Ore shipments contained as much as 320 oz/ton Ag, 18.3% Pb, and 33.6% Zn; most shipments were lower in grade (NMBMMR file data). Assays of samples collected for this report are in Table 90. Vanadium is present in the dumps, as much as 0.7% V (Larsh, 1911). Early reports indicate that the miners had little knowledge of geologic relationships and did not examine faults for offsets of ore shoots. Detailed geologic mapping of the surface and undeground workings is needed to evaluate the mineral-resource potential.

TABLE 90—Chemical analyses of samples from the Georgetown district, Grant County.

LAB NO.	FIELD NO.	LOCATION	DESCRIPTION	Cu ppm	Pb%	Zn%	Hg ppm
52	George 1	NW7 17S 11W, near Cramer	dump sample	400	0.59	0.48	2.20
53	George 2	NW7 17S 11W, Cramer	dump sample	180	0.28	0.93	0.38
54	George 3	NW7 17S 11W, Uncle Sam	dump sample	230	1.20	0.11	0.92
55	George 4	NW7 17S 11W, Uncle Sam	dump sample	360	0.04	0.41	0.78

Gila Fluorspar district

Location and Mining History

The Gila Fluorspar (Brock Canyon) mining district is located in Gila River Canyon and the adjacent northern Piños Altos Mountains about 5 mi up river from the town of Gila (Fig. 1). Only fluorite has been produced from this district; no base- or precious-metals occur in econoic concentrations. In the 1880s, the Foster mine had the first recorded fluorspar production in New Mexico. Output was used as a flux in the lead-silver smelters in Silver City (Gillerman, 1964). Several fluorite mines in the district operated during World War I, in the 1920s, and during World War II, and a fluorspar mill was operated at Gila during the 1940s. In 1944, average daily mine production was 50 short tons of fluorspar, most of which was from the Clum mine. The government fluorspar program was terminated at the end of World War II and mining ceased except for occasional small shipments. Fluorspar mining came to a halt in 1955, and except for a short revival in 1959, the district remained dormant at least until 1964 (Gillerman, 1964). By the 1970s, rising prices had stimulated new exploration, and the Clum mine was reopened (Ratté et al., 1979). Some production is recorded for 8 of the 13 mines and prospects in the district (Williams, 1966). The Clum mine produced about 29,000 short tons averaging 52% CaF_2, and the Foster mine produced approximately 4,000 short tons. Total production for the district amounted to 47,586 short tons; most of this production was from the Clum and Foster mines (Table 91, 4).

TABLE 91—Mines and prospects of the Gila Fluorspar mining district, Grant County, New Mexico (from Rothrock et al., 1946; Gillerman, 1968; Russell, 1947b; Williams, 1966). Location includes section, township, and range.

MINE NAME (ALIAS)	LOCATION	LATITUDE, LONGITUDE	COMMODITIES	YEARS OF PRODUCTION	DEVELOPMENT	PRODUCTION
Aguilar (Blue Benny, Brock Canyon)	NE28 14S 16W	33° 3' 42" 108° 29' 53"	F	1944-1945	100 ft adit	236 short tons
Big Spar	NW32 14S 16W	33° 2' 56" 108° 31' 15"	F	1940s	adit, pits	7 short tons
Big Trail (Nut)	NW29 14S 16W	33° 3' 33" 108° 31' 17"	F	none	15 ft pit	none
Blue Spar (Blue Star)	NW33 14S 16W	33° 2' 44" 108° 30' 17"	F	1946-1948	30 ft shaft, 75, 30 ft adits, pits	1,000 short tons 61% CaF_2
Cedar Hill (Howard)	NW29 14S 16W	33° 3' 42" 108° 31' 7"	F	none	3 adits, pits	none
Clum	SW33 14S 16W	33° 2' 17" 108° 30 04"	F, Au, Ag, Ba	1885-1972	342 ft adit, 300 ft shaft, 160 ft adit, 160 ft shaft	28,888 short tons 52% CaF_2
Foster	C32 14S 16W	33° 2' 20" 108° 30' 57"	F	1880-1953	700 ft adit, 3 shafts	4,255 short tons
Green Spar	SW28 14S 16W	33° 3' 15" 108° 30' 12"	F	1949-1953	250 ft adit, trench	759 short tons
Last Chance	NE21 14S 16W	33° 4' 35" 108° 29' 49"	F	1943	300 ft adit, trenches	40 short tons
Thanksgiving	NW32 14S 16W	32° 2' 56" 108° 31' 23"	F	none	trenches	none
Victoria (Victory, Big Trail)	CW29 14S 16W	33° 3' 24" 108° 31' 20"	F	1944	shaft, pits	573 short tons 55% CaF_2
Watson Mountain	E21 14S 16W	33° 4' 13" 108° 29' 56"	F	1938-1940	160 ft adit, pits, trenches	360 short tons
unknown	NE33 14S 16W	33° 2' 55" 108° 29' 52"	F	none	pits	none
unknown	SE33 14S 16W	33° 2' 25" 108° 39' 52"	F	none	shaft	none

Geology

The rocks are in the volcanic complex of Brock Canyon, which consists of altered and unaltered latitic and latitic lava flows, volcanic breccias, and possible intrusive rocks unconformably overlain by silicic ash-flow tuffs on the north and Gila Conglomerate on the south. Age dates of lavas near the Clum mine range from 30.2±5.3 to 32.7±1.1 Ma (K-Ar, biotite; zircon, fission track; Ratté et al., 1979). Near the center of the district, the Gila River has deeply dissected the volcanic sequence and exposed more than 1,000 ft of intensely altered lava flows and tuffs of the volcanic complex on both sides of the river. In the area, the rocks are altered to clays and sericite with intense silicification (i.e. acid-sulfate alteration; McLemore, in press b) and pyritization related to fault or fracture control. In some fracture zones, bleaching and alteration of biotite has changed dark gray trachytic latite and andesite to a light gray or buff color. The diversity of lava flows, breccias, volcaniclastic rocks, and intense localized alteration suggests that the Brock Canyon volcanic center was exposed at the mouth of Gila River Canyon (Ratté et al., 1979). At the volcanic center, several small to large quartz-fluorite-calcite fissure-filling veins cut both altered and unaltered rocks. The veins are younger than the altered rocks of the volcanic center and may indicate greater mineralization at depth.

Mineral Deposits

The volcanic-epithermal fluorite vein deposits in the district occur in normal faults and fissures in the volcanic rocks (Table 90). Generally, the faults and fissures strike from a little east of north to northwest and dip steeply to the east or west (Gillerman, 1964; Backer, 1974; McOwen, 1993). The Foster vein strikes N45°E. Many of the faults are brecciated, with fluorite occurring as fissure filling, interstitial filling between breccia fragments, and replacements of breccia fragments and in some places the wall rock (Rothrock et al., 1946; Russell, 1947b; McAnulty, 1978; Gillerman, 1964; Ratté et al., 1979). Quartz is commonly associated with the fluorite. Silification and argillic alteration of the host rock are common. Fluid inclusion studies indicate that the veins were formed at 160-242° C and were low salinity fluids (0.7-5.0 eq. wt.% NaCl), typical of epithermal veins (Backer, 1974; Hill, 1994).

Three distinct textures of fluorspar ore are reported: 1) coarsely crystalline, clear, translucent to transparent, massive green fissure-filling fluorite with minor quartz; 2) fine- to medium-grained fluorite with inclusions of breccia and varying amounts of quartz; and 3) translucent to opaque, microcrystalline, white, red, gray, green, brown, or light blue fluorite with tiny quartz grains distributed throughout and locally banded. The latter two textures contain as much as 30% silica and are unsuited for metallurgical grade. The coarse-grained fluorite, however, has been shipped as metallurgical grade. Barite and pyrite are present locally.

At the Clum mine, fissure veins are developed along faults in Tertiary andesite and latite of the volcanic complex of Brock Canyon. Fluorite occurs in two veins occupying fault zones (McAnulty, 1978). The Clum vein strikes N5°W and dips 70- 80°SW. The East vein strikes N25- 33°E and dips 80°SW. The width of the mineralized fault zones averages about 3 ft, but locally may reach as much as 100 ft. The East vein is similar to the Clum vein but smaller. Finely crystalline white or red fluorite is present. Some coarse, green fluorite is found in veinlets. The workings consisted of a 300-ft shaft with lateral developments of greater than 1,000 ft (Williams, 1966). Two grab samples of stockpiled ore averaged 61.9% CaF_2, 23.5% SiO_2, 1.0% $CaCO_3$, and 7.4% rare-earth oxides (R_2O_3). McAnulty (1978) speculates that appreciable fluorite remains at the Clum deposits in known and undiscovered veins and suggests that if the cut-off grade for minable ore could be lowered to 25-30%, several thousand short tons of ore could be mined.

The other mines and prospects are similar, but most are smaller. Local samples contained low gold and silver assays (Ratté et al., 1979). Stream-sediment samples in the area contain elevated concentrations of Ag, Ba, Co, Cu, Mn, Nb, Pb, Y, and Zn (Ratté et al., 1979). The intense alteration, geochemical anomalies, and occurrence of veins suggests that this district could grade into precious metal veins at depth.

Gold Hill district

Location and Mining History

The Gold Hill mining district, also known as Camp Bobcat, is located in the western Burro Mountians approximately 12 mi northeast of Lordsburg, in Grant and Hidalgo Counties (Fig. 1). As with several of the mining districts in this study, the Gold Hill district has a history of intermittent and somewhat desultory mining. Gold was discovered in the area in 1884 at the Gold Chief claim and a stamp mill was erected in 1886 (Gillerman, 1964). By the 1890s, many small mines were active, and mining had reached its peak when the mining town of Gold Hill had a population of 500 people. By 1900 the shallow, free-milling oxidized ore was almost exhausted and production was in steep decline. Shortly after 1900, Frank Cline acquired the rights to several of the better mines in the district and mined them until his death in 1940.

From 1920 to 1926, several hundred short tons of high-grade silver ore were mined. It was during the 1920s that the Co-op mine produced more than $100,000 in silver (Richter and Lawrence, 1983). From 1932 to 1940, a revival in gold mining resulted in $18,934 worth of gold being produced. Mining was limited to the oxidized zone above the water table.

Prospecting and development of the larger pegmatites occurred between 1952 and 1955; but, the amount and concentration of the rare-earth minerals was so low that mining soon ceased. The same deposits also were mined as a source of mica; but the grade and tonnage were again too low, and the mines were abandoned. In 1954, the Bluebird gold mine was rehabilitated during exploration for tungsten. From 1956 to 1960, development work was undertaken at the Never Fail mine (Richter and Lawrence, 1983).

Total production from the district amounts to 6,845 lbs Cu, 1,620 oz Au, and some silver and lead amounting to more than $100,000 (Table 92). Prior to 1944, 3,000 short tons of ore averaging 50% CaF_2 were produced at the Bluebird mine, and from 1944 to 1949 the mine again was worked intermittently with minor production. Approximately 500 short tons of beryl was produced from the Grandview mine (Griffitts, 1965).

TABLE 92—Metals production from the Gold Hill mining district, Grant and Hidalgo (U. S. Bureau of Mines, 1927-1990).

YEAR	ORE (SHORT TONS)	COPPER (LBS)	GOLD (OZ)	SILVER (OZ)	LEAD (LBS)	TOTAL VALUE ($)
1933	40	—	19.25	17	—	404
1934	278	200	133.1	116	200	4,750
1935	96	400	70.61	114	1,100	2,631
1936	191	350	34.95	1,658	700	2,571
1937	107	260	17.6	305	800	930
1938	86	100	30.8	238	4,100	1,430
1939	59	200	68	243	7,200	2,904
1940	217	1,500	118	197	1,300	4,504
TOTAL 1933-1940	1,074	3,010	493	2,888	15,400	20,124
ESTIMATED TOTAL 1911-1941	5,686	6,845	1,620	3,000	16,000	>200,000

Geology

The hills are a northwest-trending range predominantly of Proterozoic Burro Mountains Granite (1550 Ma; Hedlund, 1978b) and are surrounded by Quaternary alluvial fans on the west end and by Tertiary volcanic rocks on the east side (Beard and Brookins, 1988). The oldest rocks in the district form the Bullard Peak Group of Hewitt (1959) and consist of migmatite, quartz-biotite gneiss, hornblende gneiss, and amphibolite. This intrusive episode was trailed by a pervasive retrograde event in which the more mafic rocks, like the diorite, were chloritized, sericitized, and epidotized. Proterozoic diabase dikes and plugs were subsequently intruded. These rocks are fractured and intruded by basaltic, rhyolite. and felsic dikes. Some dikes consists of white to very light gray rhyolite, which locally, contain disseminated and highly oxidized pyrite grains.

The Gold Hill mining district occurs at the junction of northwest-trending structural elements, indicated by diabase dikes trending N30°W, by pegmatites, and an east-northeast-trending fracture zone (Gillerman, 1964; Hedlund, 1978b; Beard, 1987). The Co-Op-McWhorter fault strikes N70° E in the area. The Co-Op mine is situated where the fault intersects the pegmatites. The area coincides with an aeroradiometric Th high.

Mineral Deposits

The mineral deposits in the district are Laramide veins, fluorite veins, gold placers, and pegmatites (Table 93). The veins are mostly gold-bearing quartz veins, but silver and base metals are major constituents locally. Fluorite veins occur on the eastern side of Gold Hill. In the northern part of the area the pegmatites contain rare-earth-element-bearing minerals. Geochemical anomalies in stream-sediment samples include Ag, Be, Co, Cu, Mn, Mo, Pb, and Zn.

TABLE 93—Mines and prospects of the Gold Hill mining district, Grant and Hidalgo Counties, New Mexico. Location includes section, township, and range.

MINE NAME (ALIAS)	LOCATION	LATITUDE	LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
American	15 22S 15W	32° 23' 02"	108° 22' 37"	F	shafts, pits	Laramide vein	Williams (1966)
Apache Gold	N1/2 36 21S 17W	32° 26' 25"	108° 32' 57"	Au, Ag	100 ft shaft, 1 pit	Laramide vein	NMBMMR file data
Aztec Gold	7 22S 16W	32° 24' 31"	108° 31' 32"	Au	several short inclines	Laramide vein	NMBMMR file data

MINE NAME (ALIAS)	LOCATION	LATITUDE	LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
Bluebird fluorite mine	14, 22, 23 21S 16W	32° 28' 30"	108° 27' 58"	F, Au	prospect pits, trenches, shallow shafts	Laramide vein	Hedlund (1978b), Gillerman (1952, 1964), Rothrock et al. (1946)
Bluebird tungsten deposit	SW6, NW7 22S 16W	32° 24' 48"	108° 32' 04"	Au, Pb, W	shaft (150 ft), shafts, adits	Laramide vein	Elston (1960), Dale and McKinney (1959)
Bruff	SE30 21S 16W	32° 26' 48"	108° 31' 35"	Au	shafts and shallow pits	Laramide vein	Gillerman (1964), Hedlund (1978b)
California--Harper Group	SW6 22S 16W	32° 25' 13"	108° 31' 52"	Au	pits	Laramide vein	Gillerman (1964), NMBMMR file data
Climax	NE18 22S 16W	32° 23' 36"	108° 31' 23"	Pb, Ag, Au	40 ft shaft, adit, trenches	Laramide vein	Hedlund (1978b), Gillerman (1964)
Co-Op (Good Luck, Mooner adit)	SE29, SW28 21S 16W	32° 26' 58"	108° 30' 12"	Pb, Ag, Au, Cu, Zn	1 adit (150 ft), shaft, pit, 1700 ft of drifts	Laramide vein	NMBMMR file data, Gillerman (1964), Lasky and Wootton (1933), FN 7/13/80
Crescent (Homestead)	NW6 22S 16W	32° 25' 36"	108° 31' 52"	Au	1 inclined shaft, several prospect pits	Laramide vein	NMBMMR file data, Elston (1960), Hedlund (1978b), Gillerman (1964)
Eighty-Seven--Boddy-McDonough Group	N1 22S 17W	32° 25' 32"	108° 32' 48"	Au, Ag	incline that follows vein, adit	Laramide vein	Elston (1960), NMBMMR file data
Engineers Group (Robert Lee, MKS, Marjorie)	NW1/4 7 22S 16W	32° 24' 35"	108° 31' 56"	Au, Ag, W	shafts, open pits, and inclines	Laramide vein	NMBMMR file data, Elston (1960), Dale and McKinney (1959)
Foster placer	NE1/2 31 21S 16W	32° 26' 30"	108° 31' 35"	Au	pits	placer gold	Elston (1960), Hedlund (1978b)
Golden Chief-Boddy-McDonough	NW6 22S 16W	32° 25' 25"	108° 32' 00"	Au	crosscut adit with drifts	Laramide vein	Gillerman (1964), Lindgren et al. (1910), NMBMMR file data
Golden Cross (Gold Bullion)	NW30 21S 16W	32° 27 '24"	108° 31' 52"	Au, Ag	several adits, shafts, and pits	Laramide vein	NMBMMR file data, Hedlund (1978b)
Grandview	13, 24 22S 16W	32° 23' 03"	108° 26' 10"	F	50 ft inclined shaft, 6 pits	Laramide vein	Williams (1966)
Indian Springs Mining Company (God's Tenth)	6,7 22S 16W	32° 22' 51"	108° 32' 06"	Au, Ag	opencuts, 3 or 4 shafts and adits	Laramide vein	NMBMMR file data
Jap Ranch	NE26 22S 15W	32° 21' 54"	108° 22' 13"	F	3 small pits 20-30 ft apart	Laramide vein	Gillerman (1952), Williams (1966), Hedlund (1978b)
Kelley	NE20 21S 16W	32° 28' 12"	108° 30' 36"	F	Opencut and a trench	Laramide vein	Hedlund (1978b)
Little Charley (Brushwood)	SE1,17W & SE6,16W 22S	32° 25' 12"	108° 32' 10"	Au, Ag	40-degree inclined shaft, shallow trench	Laramide vein	Elston (1960), NMBMMR file data
McWhorter Group (Hoboken, Contention, Gold Tunnel)	W231 21S 16W	32° 26' 10"	108° 32' 03"	Au	2 adits, a shaft, several prospect pits	Laramide vein	Hedlund (1978b), Gillerman (1964), NMBMMR file data
Mill (Golden Chief, Standard, California)	01 22S 17W	32° 25' 20"	108° 32' 25"	Au	2 shafts, 4 adit	Laramide vein	Gillerman (1964), Lindgren et al. (1910), NMBMMR file data
Minneapolis	C19 21S 16W	32° 27 '48"	108° 31' 37"	Au	adit, shaft	Laramide vein	NMBMMR file data, Hedlund (1978b)
Monarch Canyon	26 21S 17W	32° 27' 25"	108° 33' 30"	Pb	1 adit and 1 pit	Laramide vein	NMBMMR file data
unknown	01 22S 17W	32° 25' 00"	108° 32' 15"	Au	pits and a shaft	Laramide vein	NMBMMR file data
unknown	12,13 22S 17W	32° 24' 00"	108° 32' 45"	Au	3 shafts and several pits	Laramide vein	NMBMMR file data
unknown	23 21S 17W	32° 27' 57"	108° 33' 57"	Pb	pit	Laramide vein	NMBMMR file data

MINE NAME (ALIAS)	LOCATION	LATITUDE	LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
unknown	36 21S 17W	32° 25' 50"	108° 32' 45"	Au	pit	Laramide vein	NMBMMR file data
unknown	36 21S 17W	32° 26' 15"	108° 32' 52"	Au, Pb	pit	Laramide vein	NMBMMR file data
unknown	18, 19, 16W, 24, 17W 22S	32° 23' 04"	108° 32' 05"	Au, Ag	pits	Laramide vein	NMBMMR file data
unkown	30 21S 16W	32° 27' 00"	108° 31' 10"	Au	pit	Laramide vein	NMBMMR file data
Nancy Lee	NE6 22S 16W	32° 25' 25"	108° 31' 30"	Au, Ag, Cu, Pb	2 vertical shafts, several pits	Laramide vein	NMBMMR file data, Elston (1960), Gillerman (1964)
Never Fail (Connee Lynn, Connie Lynn)	SE17,NE20 22S 16W	32° 23' 06"	108° 30' 27"	Au, Pb, Ag	90 ft incl. shaft with drifts, 4 shafts, pits	Laramide vein	Elston (1960), Hedlund (1978b), Gillerman (1964), Jones (1904)
Noonday-Boddy-McDonough Group	NE1 22S 17W	32° 25' 31"	108° 33' 01"	Au, Ag	4 shallow pits	Laramide vein	Elston (1960), NMBMMR file data
North and South Pegmatite deposits	NE29 21S 16W	32° 27 '18"	108° 30' 27"	REE, (Th, U, Ta, Nb)	20 ft shaft, 40 ft adit, opencut, small pits	pegmatite	Hedlund (1978b), Boyd and Wolfe (1953), McLemore (1983), FN 7/13/80
Paul #5 and 6	13 22S 17W	32° 23' 46"	108° 32' 54"	Pb, Ag, U	pits	Laramide vein	NMBMMR file data
Pegmatites	15, 22 21S 17W	32° 28' 13"	108° 34' 39"	U, Th, REE	pit	Pegmatites	Elston (1960)
unknown	26 21S 17W	32° 27' 10"	108° 33' 29"	Au	pit	Laramide vein	NMBMMR file data
Reservation	NW3O 21S 16W	32° 27' 22"	108° 32' 02"	Au, Ag, Pb, Zn, Cu	3 shafts, 2 adits, pits	Laramide vein	NMBMMR file data, Gillerman (1964)
Rhoda (Beal, Ruby, Rugby, Sidney)	17W,6,7, 16W, 1,12 21S	32° 29' 26"	108° 32' 59"	beryl, U, Th	pits, 20 ft shaft, 10 ft adit, road cuts	pegmatite	O'Neill and Thiede (1982), Staatz (1974), Elston (1960), McLemore (1983)
Ruby (Ruby Silver)	29,30 21S 16W	32° 27' 03"	108° 31' 09"	Ag, Pb	4 shafts, shallow prospect pits	Laramide vein	Hedlund (1978b), Gillerman (1964)
Separ-Lordsburg	9,10 22S 17W	32° 24' 39"	108° 35' 16"	U	outcrop	Laramide vein	McLemore (1983)
Spanish Gold	1 22S 17W	32° 25' 13"	108° 33' 05"	Au	Open pit	Laramide vein	NMBMMR file data
Standard-Harper Group	NW6 22S 16W	32° 25' 15"	108° 31' 55"	Au	shaft, adit, 2 crosscuts	Laramide vein	Elston (1960), Lindgren et al. (1910), NMBMMR file data
Unnamed opencut #5	30 21S 16W	32° 27 '02"	108° 31' 27"	Au	opencut	Laramide vein	NMBMMR file data
Unnamed opencut #6	30 21S 16W	32° 27' 04"	108° 31' 48"	Au	opencut	Laramide vein	NMBMMR file data
Werney Mines (Opportunity)	26 21S 17W	32° 27' 20"	108° 33' 20"	Au	7 or 8 adits	Laramide vein	NMBMMR file data
White Rock (Thunderbird Uranium Corp)	SE1/4 13 21S 17W	32° 28' 35"	108° 32' 40"	REE, U, Th, Ta	opencuts, pits, trenches	pegmatite	Gillerman (1964), Boyd and Wolfe (1953), McLemore (1983)
White Rock Pegmatites	NE1/4 14 21S 17W CK OLD:	32° 28' 55"	108° 33' 11"	U, Th, REE, mica	pits, trenches, 10 ft adit	pegmatite	O'Neill and Thiede (1982), Hedlund (1978b), Gillerman (1964)
White Top	29 21S 16W	32° 27' 28"	108° 29' 58"	Be	shaft, test pits	pegmatite	Gillerman (1964), McLemore (1983), NMBMMR file data
Whitetop Hill	NE34 21S 16W	32° 26' 30"	108° 28' 30"	Be, Nb, Ta, REE	pits	pegmatite	Gillerman (1964), Hedlund (1978b), Meeves et al. (1966)
Wing Feather Lady	NE25 21S 17W	32° 27' 16"	108° 32' 32"	Au, Ag	pits	pegmatite	Gillerman (1964)
Yankey Girl	NE20 21S 16W	32° 28' 02"	108° 30' 24"	Cu, Pb, Zn	adit	Laramide vein	Hedlund (1978b)

The Laramide veins are of two types: gold-bearing quartz veins and silver-base-metal veins. Gold-bearing quartz veins are the most numerous deposits and the sites of nearly all mining operations. The gold placers formed from the weathering of gold-bearing quartz veins and occur in Holocene gravels in Gold Hill Canyon.

The gold-bearing quartz veins are simple hydrothermal fracture-fillings in Proterozoic granite or commonly along Proterozoic hornblende gneiss-granite contacts (Gillerman, 1964). Mineralization probably occurred in the Late Cretaceous or early Tertiary. The veins have banded drusy textures indicative of shallow to moderate emplacement. They are irregular and narrow and widen every few feet. Widths range from a few inches to 10 ft and can be traced for as much as 300 ft (Gillerman, 1964; Beard, 1987; NMBMMR file data). Almost all of the gold-bearing veins are localized in mafic rocks. They commonly are along the contact with of the mafic rocks, be it a basic dike, biotite schist, or amphibolite, and granite or granite gneiss. Little is known about the character of the primary ore that was mined. Galena, sphalerite, and possible ruby silver along with limonite and pyrite occur on mine dumps in the district. Minor amounts of scheelite and wolframite are found at the Bluebird mine, on the north side of Engineer Canyon in secs. 6 and 7, T22S, R16W (Hedlund, 1978b). At the Reservation mine, the host rock is mostly hornblende and mica schist with garnet gneiss nearby; andesite occurs locally in contact with the vein. The vein varies from 4 to 6 ft in width. In many of the stopes the ore contained 1-3 oz/ton Au. An equal amount of silver was found in some veins.

The silver-base metal veins occur chiefly in the southern and eastern parts of the district. They consist of primary argentiferous galena, pyrite, and sphalerite in calcite and quartz gangue (Gillerman, 1964). Cerussite, native silver, and limonite are in the oxidized parts of the vein. At the Co-Op mine, the highest silver values are associated with galena and pyrite in the sulfide zone and with cerussite and limonite in the oxidized zone. A negligible amount of gold is present.

Gold grades of the ore were widely variable, but are generally low. The average value of the ore ranged from $15 to $40 per ton, with some ore being valued as high as $125 per ton (Lindgren et al., 1910). Values cited by Gillerman (1964) for production in the 1930s, when gold was worth $35 an ounce, show that ore shipments for the Grant and Hidalgo County parts of the district averaged $15.41 and $25.41 a ton, respectively.

The rare-earth element pegmatites in the district occur in Burro Mountains granite (McLemore et al., 1988a,b). They vary in size from pods a few inches across to lens-shaped bodies several hundred feet long and almost as wide (Fig. 51). Two veins 2 ft wide and 46 ft long have been located. Minerals in the pegmatites include quartz, microcline, albite, muscovite, biotite, magnetite, garnet, fluorite, and rare-earth-bearing minerals, such as allanite, euxenite, samarkite, and cyrtolite (Fig. 52). Thorium, niobium, tantalum, and beryllium are present. One of the veins contains 0.05 to 0.72% Th. The pegmatites are zoned with coarse quartz at the core with small segregations of microcline (Gillerman, 1964). Surrounding the core is a quartz-perthite zone with muscovite and biotite. The next zone out is a quartz-albite-muscovite or quartz-albite-microcline zone. The outermost zone is quartz-microcline. At the South pegmatite, massive green fluorite occurs in the quartz-albite-muscovite zone.

At the Bluebird deposit on the northeast side of Gold Hill in the NE¼ sec. 22 and NW¼ sec. 23, T. 21 S., R. 16 W., fluorite occurs in stringers and veins 1 inch to 2 ft wide, within a breccia and sheeted zone 2 to 8 ft wide in Proterozoic granite. Fluorite is present as lenses 30 to 50 ft wide for 3,000 ft along the zone which strikes N85°W to N75°E and dips 70- 80°N. Coarsely crystalline masses of white, green, violet, and purple fluorite occur associated with quartz and silicified granite wallrock. Limonite is present as are calcite, pyrite and possibly some gold (Gillerman, 1964).

FIGURE 51—Feldspar in the White Top pegmatite, Gold Hill mining district, Grant County (V. T. McLemore photo).

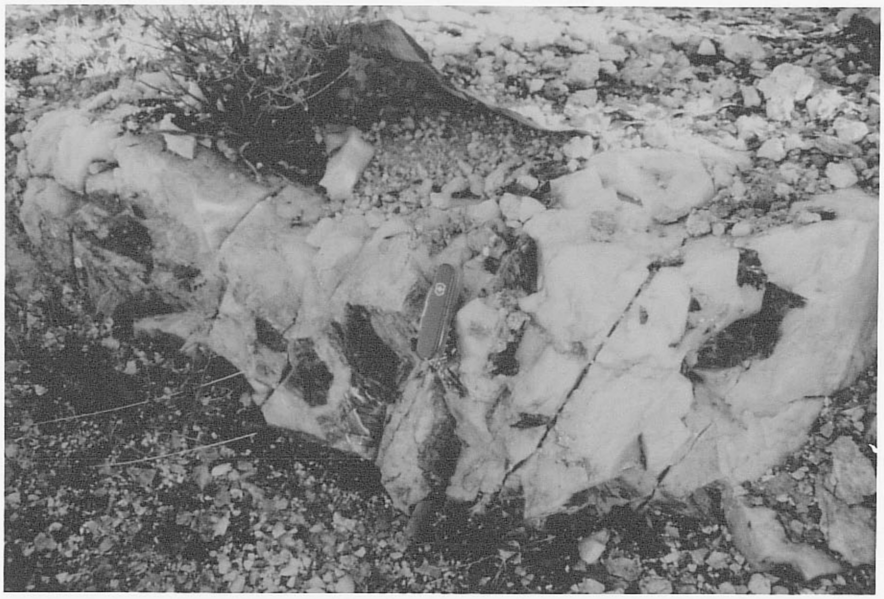

FIGURE 52—Microlite and smarskite in feldspar at the South pegmatite, Grant County (V. T. McLemore photo).

Lone Mountain Mining District

Location and Mining History

Lone Mountain mining district consists of low hills about 7 mi southeast of Silver City (Fig. 1). The district was discovered in 1871 by Frank Bisbee, for whom the historic Arizona copper-mining town took its name. Once rich silver ore was identified, a mill was erected and mining and milling continued for two or three years until the ore ran out and the mines were shut down (Lindgren et al., 1910; Pratt, 1967). Except for a small amount of manganiferous iron production during World War I, the area was dormant until 1920, when other silver discoveries were made, and from 1921 to 1923, when mining was again active. It was during this latter period, that lead was produced along with silver. These later discoveries continued to be worked sporadically in the late 1930s to 1950 (Table 04; Pratt, 1967). Since then to at least 1967, no additional silver has been produced. In 1942, 30 short tons of manganese ore averaging 39.5% Mn were produced (Farnham, 1961). From 1950 to 1955, another 800 short tons of sorted ore averaging 29.1% Mn was shipped to the government purchasing depot in Deming. As of 1967, the silver and manganese deposits were mostly mined out and nearly all of the shafts are caved or unsafe (Pratt, 1967). Total mineral production for the Lone Mountain mining district is shown in Table 93. Mineral deposits in the district consist of carbonate-hosted Ag-Mn deposits. Some of the deposits were mined for silver before turning to manganese production.

TABLE 94—Metals production from the Lone Mountain mining district, Grant County, New Mexico (U. S. Bureau of Mines, 1927-1990).

YEAR	ORE (SHORT TONS)	COPPER (LBS)	GOLD (OZ)	SILVER (OZ)	LEAD (LBS)	TOTAL VALUE ($)
1936	12	—	1	452	—	385
1938	1	—	—	68	—	44
1939	1	—	—	19	—	13
1948	2,509	—	3	13,356	—	12,193
1950	2,819	2,800	14	14,683	1,000	14,496
TOTAL 1936-1950	5,342	2,800	18	28,578	1,000	27,131
ESTIMATED TOTAL 1871-1950	—	5,000	<1,000	>100,000	5,000	>30,000

Geology

Geologically, the district has much in common with other local districts that have had small-scale mineral production. Lone Mountain consists of northeast-dipping Paleozoic, and Mesozoic sedimentary rocks, primarily limestone and dolomite, that were lifted up along a fault on the southwest (Lindgren et al., 1910). They rise about 500 ft above the surrounding plain of Quaternary conglomerate, colluvium, and alluvium. Rocks in the area range from Proterozoic to Recent. Proterozoic granite crops out at the western base of Lone Mountain (Pratt, 1967). The granite is overlain by about 4,000 ft of sedimentary rocks. From bottom to top, the sedimentary formations are the Bliss Sandstone, El Paso Dolomite, Montoya Group, Fusselman Dolomite, Percha Shale, Lake Valley Limestone, Magdalena Group, Abo (?) Formation, Beartooth Quartzite, and Colorado Formation. On the eastern flank of Lone Mountain, the Cameron Creek laccolith, an upper Cretaceous to Lower Tertiary biotite-quartz latite, was probably the intrusion suggested by Lindgren et al. (1910) as being related to the mineralization in the area. Pratt (1967), however, found no evidence that the mineralization was spatially or genetically related to the intrusive bodies recognized in his study. There are several dikes in the district. They range in composition from quartz latite to basalt. Most are only a few feet wide, but a few have an inferred length of as much as 3/4 mi. Most of the dikes filled already existing fractures or created new ones as they were emplaced.

Mineral deposits

Most of the silver and manganese deposits occur in main crosscutting fractures in carbonate rocks (Pratt, 1967). Some brecciation occurs along the fractures, and limestone has been locally silicified (Lindgren et al., 1910). The ore bodies did not indicate the strict stratigraphic control found in many silver deposits in the region. In the Lone Mountain area, the silver deposits are scattered throughout the Fusselman Dolomite, and one vein reaches down into the Upham Dolomite and Aleman Formation. Table 95 lists some of the mineral occurrences in the Lone Mountain district.

Cerargyrite was the most common ore mineral, but curved bundles of native silver wire were the richest ore (Lindgren et al., 1910). Argentite was reported as a primary ore mineral, and native copper was reported (Pratt, 1967). Limonite was plentiful as an oxidation product of pyrite. Other minerals seen in fractures or on the mine dumps include quartz, calcite, dolomite, and small amounts of anglesite, cerussite, willemite, and malachite (Pratt, 1967). The mineralized veins were a narrow 2 to 5 ft with ore veins nearly 8 ft thick. The veins were not very persistent, but, the ore they did contain was rich in silver (Lindgren et al., 1910).

TABLE 95—Mines and prospects of the Lone Mountain mining district, Grant County, New Mexico. Location includes section, township, and range.

MINE NAME (ALIAS)	LOCATION	LATITUDE	LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
Ben Hur (Rubie, Mayflower)	C35 18S 13W	32° 41' 46"	108° 09' 27"	Ag, Cu, Pb, Au	several shallow shafts and numerous small open cuts	carbonate hosted Ag-Mn replacement	Lindgren et al. (1910), Anderson (1957), Pratt (1967), NMBMMR file data
Lone Mountain Manganese (Tom Lyons, Sweet Home, Corliss, El Campo, Joe, Hilltop)	S20 18S 13W	32° 43' 44"	108° 12' 50"	Mn, Ag	3 shallow shafts, numerous opencuts and prospect pits	carbonate hosted Ag-Mn replacement	Farnham (1961), Pratt (1967), NMBMMR file data
Lone Mountain (Monarch, Home Ticket, New York, Eighty-Four)	N27 18S 13W	32° 43' 05"	108° 10' 36"	Ag, Pb	shallow shafts less than 100 ft deep	carbonate hosted Ag-Mn replacement	Lindgren et al. (1910), Pratt (1967)
Mineral Mountain (Causland Property)	NW29, NE30 18S 13W	32° 43' 11"	108° 13' 04"	Mn, Fe	10 shallow opencuts and benches, 2 shallow shafts, large open pit	carbonate hosted Mn replacement	Wells (1918), Farnham (1961), Harrer and Kelly (1963), Pratt (1967), NMBMMR file data
Monarch (New York, Good Hope)	S27, N34 18S 13W	32° 42' 21"	108° 10' 35"	Ag	100 ft shaft and several shallow prospect pits	carbonate hosted Ag-Mn replacement	Lindgren et al. (1910), Anderson (1957), Pratt (1967), NMBMMR file data
unknown	SW35 18S 13W	32° 41' 55"	108° 09' 35"	Ag, Mn	shafts, open pits, and open cuts	carbonate hosted Ag-Mn replacement	Pratt (1967)

Pratt (1967) finds that distinction between the district's silver deposits and its manganese deposits is only as a convenience in organizing the data and not on geologic criteria. This is, in part, because the ore bodies have been mined out and such information is not available, and because some of the same mines that produced silver during the early mining period later produced manganese.

Manganese deposits occur as irregular disconnected pod-like bodies along fracture zones that cut beds and replace Lake Valley Limestone just beneath the basal shale member of the Oswaldo Limestone of Magdalena Group (Farnham, 1961). The fractures are almost vertical and strikes north. The ore bodies range to as much as 60 ft long and 1 to 6 ft wide. Some fractures contained two or more ore bodies separated by tens of feet of unmineralized or sparsely mineralized material. Most of the ore runs along the fractures, but in some places the adjacent limestone beds have been replaced. The chief ore minerals are pyrolusite and wad. Iron oxides, jasper, and black and white calcite are the principal gangue minerals. According to Pratt (1967), the manganese resources are not exhausted but are unpromising. That report does suggest one small area favorable for prospecting for small manganese ore bodies.

The manganese deposits could be utilized a low-grade iron resource. The deposits are described as irregular masses of manganiferous hematite in shattered limestone on the flanks of Lone Mountain. The ore consists of hematite and pyrolusite with some wad, magnetite, calcite, and jasper. Ore from the Mineral Mountain group contained about 35% Fe and 15% Mn (Harrer and Kelly, 1963).

Concentration of detrital or placer magnetic iron oxides occurs as cobbles in stream beds (Pratt, 1967). The material is derived from Gila Conglomerate but the ultimate source was magnetite in iron skarn deposits adjacent to Hanover-Fierro stock. Geophysical methods could be used to discover such concentrations in paleochannels.

Malone District

Location and Mining History

The Malone mining district lies in the southwestern part of the Burro Mountains along the Malone fault (Fig. 1). John B. Malone discovered gold in the area in 1884 after years of placer-gold mining in nearby Gold Gulch and Thompson Canyon (Gillerman, 1964). Production prior to 1925 amounted to approximately $250,000 in gold and a little silver, most before 1900. In 1904, while gravels in many of the local gulches were being worked for placer gold, additional hard-rock discoveries were made just west of the old Malone mine. Total production after 1925 amounted to no more than $50,000. In the 1930s, renewed interest in the area led to new mining ventures and extensions to some older workings. From the 1940s, until at least 1964, mining has been intermittent. In 1961, Albert A. Leach of Lordsburg owned 13 unpatented claims covering most of the district (Gillerman, 1964). Total production from Laramide veins and placer gold deposits in the district amounts to approximately 12,000 oz Au, more than 10,000 oz Ag, 408 short tons of fluorite, and minor amounts of copper, lead and zinc. Mines and prospects are in Table 96.

TABLE 96—Mines and prospects of the Malone mining district, Grant County, New Mexico. Location includes section, township, and range.

MINE NAME (ALIAS)	LOCATION	LATITUDE	LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
Brock Perlite (Thompson Canyon)	NW8 20S 16W	32° 34' 09"	108° 31' 56"	Perlite	pits	perlite	Austin et al. (1982)
Gold Gulch Placers	S17, E20, W21 20S 16W	32° 33' 30"	108° 30' 45"	Au, Ag	several open cuts	placer	Gillerman (1964), Johnson (1972), Hedlund (1980), Jones (1904), NMBMMR file data
John Malone (Lost Frenchman Tunnel)	NE16 20S 16W	32° 34' 09"	108° 29' 55"	Ag, Cu	80 ft shaft, 40 ft adit	Laramide vein	Richter and Lawrence (1983)
Knight Peak	SE29 20S 16W	32° 32' 15"	108° 31' 00"	F	shallow pits	fluorite veins	Jones (1904), Gillerman (1964), Richter and Lawrence (1983)
Long Lost Brother	NE23 19S 17W	32° 38' 41"	108° 34' 13"	F, Mn	18 ft shaft, 30 ft long opencut	fluorite veins	Williams (1966)
Malone (Principal, Hillcrest, Patanka, Barranca, Fujima, Paracutin, Barria, Los Ancienos, others)	19,20,29,30 20S 16W	32° 32' 39"	108° 31' 32"	Au, Ag, Cu, Pb, Zn	shafts from 50 - 100 ft deep, short adits, trenches, shallow pits	Laramide vein	Jones (1904), Lasky and Wootton (1933), Gillerman (1964), Hedlund (1980), NMBMMR
Moody	N8 20S 16W	32° 35' 09"	108° 31' 08"	Cu, Fe	2 shafts	Laramide vein (?)	Richter and Lawrence (1983)
Pitman	C of N19 20S 16W	32° 33' 35"	108° 32' 10"	Mn, U	pit	epithemal Mn	O'Neill and Thiede (1982), Hedlund (1980), FN 7/22/80
Unknown (Little Cookie #1?)	18 20S 16W	32° 34' 05"	108° 32' 20"	Mn, U	shaft, pit	epithemal Mn	FN 7/22/80
Unknown (Ra-Tor Uranium claims?)	SE30 20S 16W	32° 32' 00"	108° 31' 51"	U, Sb, W	small pit, bulldozer trenches	epithemal Mn	O'Neill and Thiede (1982), Hedlund (1980), NMBMMR file data

Geology

The rocks in the district consist of Proterozoic Burro Mountain granite, mostly coarse- to medium-grained granite, on the southern side of the Malone fault and Tertiary rhyolite tuffs, perlite, and agglomerate on the northern side of the fault. The Malone fault strikes N20°W and dips 70°NE, and marks the western edge of Knight Peak graben.

Numerous fractures cut the granite adjacent to the fault, but the fault is not mineralized (Gillerman, 1964). The fractures trend mostly N45-85°W, with the exception of the Patanka vein which strikes N35°E and dips steeply to the southeast. The granite adjacent to the veins shows evidence of sericitic, kaolinitic, and hematitic alteration.

Mineral deposits

Fractures cutting the Burro Mountain granite adjacent to the Malone fault are mineralized up to 1,000 ft away, and granite between the fractures was mineralized at a few locations. The fractures are filled with gold-bearing quartz and pyrite veins with minor chalcopyrite, argentiferous galena, and sphalerite (Gillerman, 1964). The gold is extremely fine grained and can only be detected by chemical analysis. Mineralization appears to be rather shallow, as none of the mines in the area are greater than 100 ft deep (Table 95).

The shaft at the Malone mine, which was responsible for most of the district production in the 1880s and 1890s, is near the granite-rhyolite contact on the Esmeralda. At the Hillcrest vein, 1,800 feet to the north, a 100 ft shaft leads to drifts that follow along the vein, which strikes N85°W, and dips almost vertically. Shafts, pits, and adits explore the Barranca vein, which strikes N40°W and dips 70°NE, offsetting the Malone fault. At this location, the footwall is granite and the hanging wall is rhyolite (Gillerman, 1964).

Northern Cooke's Range district

Location and Mining History

The Northern Cooke's Range mining district lies at the northern end of the Cooke's Range near the southeastern tip of Grant County along the Luna County line (Fig. 1; Jicha, 1954). Mining in the Northern Cooke's Range district was on a small scale. The area is honeycombed with many small pits, adits, and stopes that have long since been abandoned (Table 97). The largest stope reported by Elston (1957) was only 15 ft high with a 25 ft by 15 ft plan view. Minor silver and lead along with fluorite has been produced from carbonate-hosted lead-zinc, fluorite veins, and Rio Grande Rift barite-fluorite-galena deposits.

Fluorite mining at the White Eagle mine probably began prior to 1918 (Elston, 1957). It was operated by four different lessees from 1933 to 1945. Production up to this point was estimated at 17,000 short tons of ore (Rothrock et al., 1946) The U. S. Bureau of Mines conducted a limited diamond drilling program from April to June of 1945, intersecting veins that assayed as much as 79.6% CaF_2 (Morris, 1974a). The Ozark-Mahoning Co. of Tulsa, OK leased the property in 1950 and shipped approximately 12,300 short tons of ore averaging 61.7% CaF_2 in 1953 and 1954. Southwest Fluorspar Co. of Deming leased the property from 1969 to 1972 and shipped about 5,500 short tons of ore. Total production from the White Eagle mine was approximately 62,300 short tons of ore, and from the Linda Vista and Wagon Tire mines totalled about 1,500 short tons (Morris, 1974a, b).

Geology

The range is a series of northwest-trending hills with low to moderate relief, bounded on the northeast by the N20°W striking Sarten fault and on the southwest by an inferred fault of similar orientation (Morris, 1974a, b). In the district, the oldest rocks exposed are Proterozoic in age and consist mainly of coarse, pink-to-gray, quartz-microcline-biotite granite and granite gneiss (Elston, 1957). These rocks are cut by quartz-microcline pegmatites and Tertiary (?) rhyolite dikes, outcropping over about three-fourths of the Northern Cooke's Range (Morris, 1974a). North of the district, the granite gneiss grades into hornblende-chlorite schist. The Proterozoic rocks are highly fractured and altered, particularly in near fluorite mineralization, biotite and orthoclase being chloritized and sericitized, respectively.

The Cooke's Range fault, which is the eastern range fault of the Cooke's Range, approximately bisects the district. Elston (1957) hypothesized that the fault probably splits into several branches beneath Tertiary and Quaternary gravels to the north. A hypothetical western range border fault is beneath Quaternary alluvium on the western side of the Cooke's Range. In the district, the Cooke's Range fault branches and rejoins forming a fault block of Paleozoic rocks. East of the fault block Tertiary Santa Fe fanglomerates and Quaternary alluvium are the predominant surficial rocks; west of the fault block, Proterozoic rocks are predominant or are overlain by Tertiary White Eagle rhyolite. The rhyolite consists of porphyritic rhyolite flows, sills, and dikes and is confined to the northern end of the Cooke's Range.

Sedimentary rocks outcrop only in a small portion of the Northern Cooke's Range (Morris, 1974a). In the fault block, Fusselman limestone, Percha shale and Lake Valley limestone are exposed. These rocks are highly shattered, but mineralization and silicification seem to be confined to the top of the Fusselman limestone where rising mineralizing solutions may have confronted a barrier in the name of impermeable Percha shale.

TABLE 97—Mines and prospects in the Northern Cooke's Range mining district, Grant County, New Mexico. Location includes section, township, and range.

MINE NAME (ALAISIS)	LOCATION	LATITUDE	LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
White Eagle Fluorspar	C of E2 34 19S 9W	32° 36' 45"	107° 45' 12"	F, trace Ba	235 ft and 550 ft shafts, cuts up to 100 ft deep	Rio Grande Rift	Rothrock et al. (1946), Williams (1966), McAnulty (1978), Soulè (1946)
Linda Vista (Buena Vista, Wagon Tire, Rainbow)	SW21 19S 9W	32° 38' 05"	107° 46' 46"	F	shafts from 30 to 80 ft deep, opencut, adits	Rio Grande Rift	Morris (1974a, b), Rothrock et al. (1946), Elston (1957), Williams (1966), McAnulty (1978)
Opencut	SW27 19S 9W			F	several shallow trenches	Rio Grande Rift	Morris (1974a, b)
Windlass	SW27 19S 9W			F	50 ft shaft	Rio Grande Rift	Morris (1974a, b)
Defense	NE28 19S 9W			F	2 pits and an adit	Rio Grande Rift	Morris (1974a, b), Rothrock et al. (1946)
Sulfide	N34 19S 9W			Ag, Pb, Zn, Fe, Mn	small pits, adits, and stopes	carbonate hosted Pb-Zn replacement	Morris (1974a, b), Elston (1957)

Mineral deposits

Deposits in the district consist of carbonate-hosted Pb-Zn replacement, fluorite veins, and Rio Grande Rift barite-fluorite-galena deposits (Table 97). Fluorite has three methods of occurrence: steeply dipping veins in andesite cutting Proterozoic rocks; as fracture fillings in narrow, siliceous veins in monzonite and andesite flows (Morris, 1974b); and as replacement, monto bodies in carbonate rocks. Mineralization is probably mid-Tertiary in age. At the bottom levels of the White Eagle mine, the vein has been offset approximately 35 ft by post-mineral faulting (Williams, 1966). Replacement fluorite occurs in a manto-like form in gently dipping andesite at the Linda Vista mine (Morris, 1974a). Silicification, argillization, chloritization, and sericitization are present in the Northern Cooke's Range district, and probably were an important factor in the deposition of fluorite (Morris, 1974a). At the Linda Vista mine, ore occurs in small, irregular veins occupying fault breccias in Tertiary volcanic rocsks. At the Defense prospect, half a mile southeast of the Linda Vista, siliceous fluorite occurs in stringers and pockets in Proterozoic granite (Rothrock et al., 1946)

Silver as cerargyrite had been mined in the district; sulfides are rare, with minor occurrences of galena (Morris, 1974b). Oxidizes such as cerussite, smithsonite, hemimorphite, and iron and manganese oxides and hydroxides were identified in old workings (Elston, 1957).

Piños Altos district

Location and Mining History

The Piños Altos mining district is located in the Pinos Altos Mountains about 8 mi northeast of Silver City (Fig. 1). Placer gold was discovered there in 1860. Later that same year, the Pacific vein was the first lode discovered in the district. Within two years, 30 mines were being worked by 300 men (Lindgren et al., 1910). Mining continued as disruptions, such as the Civil War and plundering by Apaches, would allow. During World War I, Piños Altos contributed a considerable tonnage of zinc ore containing sphalerite, chalcopyrite, and galena (Waldschmidt and Lloyd, 1949). The Pacific mine was the largest producer in the area having a total production to 1905 of over $1 million (Lindgren et al., 1910). By 1940, roughly 7.5 to 12% of the area's past production value was accounted for by placer gold, and the district had yielded over a total of $8 million worth of gold, silver, copper, lead, and zinc (Wells and Wootton, 1940).

The skarn that is now referred to as the Cyprus Piños Altos mine was discovered by the U. S. Mining, Smelting, and Refining Co in 1948. Exxon Minerals drilled 213 holes in the early 1970s, and Boliden Minerals drilled 135 more holes and drove 7,950 ft of development in 1982, estimating reserves at 1,015,979 short tons of 4.96% Cu, 2.54% Zn, 3.482 oz/short ton Ag, and 0.024 oz/short ton Au. Cyprus Metals took over in 1987, and began operation of the mine in a joint venture with St. Cloud Mining Co (Osterberg and Muller, 1994). The joint venture ended in 1989, and Cyprus continued until 1995. Production to date is 661,238 short tons of ore, containing 56,886,468 lb Cu, 18,515 oz Au, 1,805,180 oz Ag, and 31,210 lb Zn. Production from the entire district is estimated as 59.5 million lbs Cu, 169,000 oz Au, 2.6 million oz Ag, 6 million lbs Pb and 64 million lbs Zn (Table 98, 99). Some iron ore was also produced.

TABLE 98—Metals production from the Piños Altos mining district, Grant County, New Mexico (U. S. Geological Survey, 1902-1927; U. S. Bureau of Mines, 1927-1990; Osterberg and Muller, 1994).

YEAR	ORE (SHORT TONS)	COPPER (LBS)	GOLD LODE (OZ)	GOLD PLACER (OZ)	SILVER (OZ)	LEAD (LBS)	ZINC (LBS)	TOTAL VALUE ($)
1860-1904	—	—	—	—	—	—	—	[c]4,700,000
1904	4,718	104,068	2,403	375	37,228	2,653	—	92,587
1905	6,348	103,468	1,522	528	39,585	—	160,778	82,442
1906	14,074	328,788	4,338	111	83,566	—	—	211,409
1907	14,841	322,195	3,808	183	65,862	—	—	190,413
1908	1,451	34,514	414	72	8,941	3,953	—	21,528
1909	38	6,200	101	173	1,377	418	—	7,207
1910	20	269	66	121	233	2,226	—	4,119
1911	355	3,232	68	196	5,616	4,063	16,773	9,968
1912	6,169	96,507	386	123	15,864	50,289	929,176	102,581
1913	3,643	100,555	1,411	80	28,276	83,067	366,056	87,626
1914	3,686	129,587	5,524	1,047	23,256	29,994	48,840	169,497
1915	7,024	377,463	1,540	96	19,856	130,638	454,710	172,463
1916	46,471	122,716	570	97	17,816	152,696	6,741,925	967,621
1917	45,993	49,945	374	153	10,803	80,989	5,556,892	607,189
1918	28,983	12,227	95	33	2,243	40,028	3,013,802	284,324
1919	2,912	14,452	244	52	2,524	20,906	267,671	32,281
1920	1,444	2,456	151	27	2,000	40,325	43,247	13,083
1921	—	—	—	115	37	—	—	2,405
1922	7,880	26,193	926	101	55,820	673,847	—	117,639
1923	2,968	68,129	628	63	17,404	90,471	44,000	47,899
1924	388	4,320	105	50	1,979	62,135	—	10,069
1925	407	430	5	26	2,287	96,550	—	10,672
1926	3,488	8,400	268	31	4,578	152,800	170,000	35,178
1927	5,219	12,206	258	34	4,591	142,492	130,000	27,524
1928	1,229	1,000	41	45	812	27,466	18,000	5,089
1929	234	4,557	85	24	2,180	8,047	—	4,722
1930-1931	—	—	—	—	—	—	—	-
1932	—	13,100	654	—	3,280	13,400	—	15,688
1933	1,462	18,000	223	327	4,755	57,000	67,000	19,118
1934	3,183	28,600	1,047	99	11,583	134,400	—	54,808
1935	3,860	37,450	1,895	131	14,258	94,400	—	88,052
1936	1,437	18,500	729	58	6,425	37,900	24,000	37,188
1937	6,482	33,200	706	71	10,157	94,900	672,000	88,347
1938	1,834	11,900	626	76	7,195	81,800	—	34,185
1939	2,465	15,700	807	167	11,107	119,700	147,000	56,532
1940	4,122	24,400	1,058	470	8,952	117,700	410,000	94,318
1941	9,811	10,500	725	444	4,683	62,100	1,089,000	130,699
1942	720	11,000	178	165	2,420	31,000	79,400	24,518
1943	10,391	72,800	73	26	19,108	81,400	1,337,000	177,075
1944	7,649	26,200	—	221	18,585	304,300	1,015,400	164,588
1945	4,815	14,400	90	2	10,426	116,000	595,000	91,002
1946	652	4,300	265	1	2,729	29,100	161,000	35,026
1947	9,057	32,600	157	6	26,506	399,100	1,447,000	269,144
1948	16,519	61,000	133	—	30,573	756,000	2,111,000	461,649
1949	3,812	15,000	66	28	5,888	186,000	486,000	101,226
1950	2,407	6,200	4	6	4,656	132,800	287,100	64,550
1951	12,109	90,800	533	4	16,104	148,300	426,700	158,610
1952	8,409	60,000	—	396	11,816	101,000	220,000	91,855
1953	4	500	—	—	142	—	—	272
1954	1,005	11,000	111	4	1,643	2,000	—	9,031
1955	53	300	2	23	30	200	200	1,069
1956	—	—	—	2	—	—	—	70
1957	578	100	—	13	1,525	31,500	50,700	12,250
TOTAL 1904-1952	322,819	2,551,427	35,413	6,696	689,280	5,028,053	28,587,370	5,598,405
TOTAL 1990-1992	—	27,500,000	—	—	—	—	18,300,000	—
TOTAL 1987-1994	661,238	56,866,468	18,515	—	1,805,180	—	31,210,434	—
ESTIMATED TOTAL 1890-1994	—	59,500,000	169,000 (lode and placer)	—	2,600,000	6,000,000	64,000,000	>10,300,000

TABLE 99—Mines and prospects in the Piños Altos mining district, Grant County, New Mexico. * Currently active, but expected to close late 1995.

MINE NAME (ALIAS)	LOCATION	LATITUDE	LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
Arizona	NE12 17S 14W	32° 50' 42"	108° 14' 10"	Zn, Cu, Pb, Au, Ag	225 ft shaft	Laramide vein	Paige (1911), Jones et al. (1970)
Aztec (Manhattan, Asiatic, Golden Era)	SE01 17S 14W	32° 51' 24"	108° 14' 20"	Au, Ag, Cu, Zn, Pb	2 shafts, adit, maximum depth of 700 ft	Laramide vein	Lindgren et al. (1910), Paige (1911), Anderson (1957), Jones et al. (1970)
Black Diamond	SE32 16S 13W	32° 52' 05"	108° 12' 25"	Au, Ag	adits	Laramide vein	Jones et al. (1970)
Calumet (Bullion, Opalousas, Atachaflaya, Tchapitolous)	SE31 16S 13W	32° 52' 09"	108° 13' 29"	Au, Ag, Pb, Zn, Cu	4 shallow shafts	Laramide vein	Lindgren et al. (1910), Paige (1911), Jones et al. (1970)
Cleveland (Pershing adit)	35,36;01,02 16S,17S 14W	32° 51' 58"	108° 15' 04"	Zn, Pb, Cu, Ag, Au	2 adits, shallow shafts, pits and trenches	Laramide vein	Lindgren (1910), Lasky and Wootton (1933), Anderson (1957), Cunningham (1974), Soulè (1948)
Cyprus-Pinos Altos (Exxon, Boliden prospects)*	16S: W30 13W, SE25 14W	32° 53' 15"	108° 14' 10"	Cu, Zn, Pb, Ag, Fe, As, Sb	extensive underground and surface workings	Laramide skarn	McKnight and Fellows (1978), Finnel (1976), Osterberg and Muller (1994)
Deep Down-Atlantic	33,04 16S,17S 13W,13W	32° 52' 03"	108° 11' 51"	Au, Ag, Zn, Cu, Pb	2 shafts, about 700 ft deep	Laramide vein	Lindren et al. (1910), Paige (1911), Jones et al. (1970)
Gila	SE30 16S 13W	32° 53' 00"	108° 13' 10"	Au, Ag, Cu, Pb, Zn	3shafts	Laramide vein	NMBMMR files
Gopher (Golden Giant)	SE06 17S 13W	32° 51' 35"	108° 13' 15"	Au, Ag, Cu	465 ft shaft with 5 levels, prospect pits	Laramide vein	Jones et al. (1970)
Hazard (Osceola, Lacrosse, Platina, Scientific)	E33 16S 13W	32° 52' 26"	108° 11' 05"	Au, Ag, Pb, Cu	400 ft inclined shaft	Laramide vein	Metzger (1938), Anderson (1957), Jones et al. (1970), Finnel (1976)
Houston Thomas (Alpha, Omega, Lafayette, Manilla, Florida, Atlas, Caribou)	SE35, SW36 16S 14W	32° 52' 24"	108° 15' 03"	Zn, Pb, Ag, Cu, Au, Bi	2 adits, shaft, pits	Laramide skarn	Hernon (1949), Lindgren et al. (1910), Paige (1911), Anderson (1957), Soulè (1948)
Kept Woman (Mogul, Mina Grande, Juniper)	C of S6 17S 13W	32° 51' 09"	108° 13' 15"	Au, Ag, Cu, Pb	500 ft shaft, 2 300 ft shafts	Laramide vein	Lindgren et al. (1910), Metzger (1938), Anderson (1957), Jones et al. (1970), Paige (1911)
Lady Katherine	NW36 16S 14W	32° 52' 40"	108° 15' 05"	Cu, Zn, Ag, Bi	trench and adit	Laramide skarn	McKnight and Fellows (1978)
Langston (Pinos Altos)	C of N12 17S 14W	32° 50' 55"	108° 14' 33"	Zn, Pb, Cu, Au, Ag	218 ft inclined shaft, adit >250 ft long, caved adit	Laramide vein	Paige (1911), Anderson (1957), Jones et al. (1970)
Little Key	NE1 17S 14W	32° 52' 10"	108° 14' 00"	Au, Ag, Cu, Zn, Pb	200 ft shaft with drifts	Laramide vein	Paige (1911)
Mammoth	NE31 16S 13W	32° 52' 40"	108° 13' 25"	Au, Ag, Cu	250 ft shaft	Laramide vein	Paige (1911)
Mina Grande	SW06 17S 13W	32° 51' 03"	108° 13' 43"	Cu, Zn, Au, Ag, Pb	500 ft shaft and tunnel connected with Mogul workings	Laramide vein	Lindgren et al. (1910), Paige (1911)
Mogul	C06 17S 13W	32° 51' 25"	108° 13' 40"	Cu, Zn, Au, Ag, Pb	300 ft shaft, connected with Mina Grande workings	Laramide vein	Lindgren et al. (1910), Paige (1911)
Mountain Key (Wild Bill, Lock vein)	17S: NW6 13W, NE1 14W	32° 51' 52"	108° 14' 59"	Au, Ag, Pb, Cu, Zn	750 ft inclined shaft	Laramide vein	Lindgren et al. (1910), Paige (1911), Jones et al. (1970)
Ohio	NE1 17S 14W	32° 51 45"	108° 14' 20"	Au, Ag, Zn, Cu, Pb	shaft, tunnels, adits, some surface workings	Laramide vein	Paige (1911)

MINE NAME (ALIAS)	LOCATION	LATITUDE	LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
Pacific (Hearst, Gillett, and Thayer shafts)	SE1, NE12 17S 14W	32° 51' 03"	108° 14' 31"	Au, Ag, Cu, Zn, Pb	3 shafts with extensive workings on 9 levels	Laramide vein	Lindgren et al. (1910), Paige (1911), Bush (1915), Anderson (1957), Jones et al. (1970)
Portland	NW6 17S 13W	32° 51' 40"	108° 13' 55"	Zn, Pb, Cu, Mo	surface only	Laramide vein	Schilling (1964)
Silver Cell (Mangus, Black Tarier, Climax, Keystone, Wedge)	SE7, SW8 17S 13W	32° 50' 29"	108° 13' 07"	Ag, Cu, Au, Pb	400 ft inclined shaft, numerous shallow shafts	Laramide vein	Lindgren et al. (1910), Paige (1911), Bush (1915), Blood (1916), Jones et al. (1970), Jones (1904)
Silver Hill	SW12 17S 14W	32° 50' 39"	108° 14' 42"	Au, Ag, Zn, Pb, Cu	2 shallow shafts, 550 ft adit	Laramide vein	Bush (1915), Anderson (1957), Jones et al. (1970)
Tampico	S1,NW12 17S 14W	32° 51' 05"	108° 14' 40"	Zn, Ag, Au, Pb, Cu	300 ft shaft	Laramide vein	Lindgren et al. (1910), Paige (1911), Jones et al. (1970)

Geology

In the district, Late Cretaceous andesitic volcanic rocks rest unconformably on Cretaceous clastic rocks of the Beartooth Quartzite and Colorado Formation or Paleozoic carbonate rocks of the Magdalena Group. Within the area, the sedimentary and volcanic rocks have been intruded by Piños Altos stock, a medium grained, multi-phase quartz monzonite. The stock is part of the about 70 Ma Piños Altos intrusive complex which consists of the stock and variety of mafic to intermediate intrusions on its periphery (McKnight and Fellows, 1978). The mineral deposits in the area lie within Piños Altos stock or in the sedimentary and volcanic rocks in close proximity to the stock. The sedimentary units are carbonate rich at the base and siliciclastic at the top (Osterberg and Muller, 1994).

The braided structural pattern of the northwest- and northeast-trending faults is characteristic of porphyry systems (McKnight and Fellows, 1978). Northeast-trending dikes as fissure veins indicate northwest-southeast extension. Many of the fissure veins are mineralized and are exposed in the stock and the host rocks. East-west trending faults cross the northeast trending normal faults, dividing the district into several structural blocks (Osterberg and Muller, 1994).

Mineral deposits

The lode mineral deposits in the district consist of Laramide veins in intrusive rocks and lead-zinc skarns with a lesser amount of copper skarns in the limestones. Replacement and skarn deposits in Magdalena Group limestones were responsible for most of the district's past production (McKnight and Fellows, 1978). The most prolific mine in the past, for example, was the Cleveland mine which produced zinc, lead, copper, silver, and gold from a polymetallic replacement deposit, west of Piños Altos stock. Mines and prospects are in Table 99.

Chavez (1991) shows the paragenetic sequences of mineral deposition of base-metal and precious-metal vein and replacement deposits in the district. Early pyrite and pyrite-marcasite were followed by the initial episodes of copper deposition as chalcopyrite. Zinc was deposited as sphalerite succeeding the chalcopyrite. Another episode of copper mineralization as chalcocite, bornite, and chalcopyrite was accompanied by silver deposition as possibly stromeyerite and native silver, and by bismuth.

Skarns at the Cyprus Piños Altos mine (Fig. 53) occur in altered Lake Valley, Oswaldo, and Syrena Formations and in Beartooth Quartzite, all overlain by the Colorado Formation and capped by Cretaceous-Tertiary andesites and andesitc epiclastic breccias. The intrusive body is quartz monzonite and diorite. The central portion of the mine is occupied by a breccia body with diffuse and poorly defined margins, the central portion containing an intrusive matrix of diorite. Quartz monzonite fragments are not found in the breccia but quartz monzonite dikes and sills cut the breccia and its silica-pyrite alteration. Economic mineralization is predominantly chalcopyrite and bornite with minor chalcocite, covellite, native Cu, wittichenite, sphalerite, galena, arsenopyrite, native Ag, and others (Fig. 54). Gangue minerals include quartz, kaolinite-sericite, calcite, magnetite, hematite, goethite, and limonite (Osterberg and Muller, 1994).

FIGURE 53—Cyprus Piños Altos decline, Piños Altos district, Grant County (V. T. McLemore photo, 9/89).

FIGURE 54—Chalcopyrite-galena ore pod at the Piños Altos mine, Grant County (V. T. McLemore photo, 8/89).

Alteration and mineralization was a continuous process consisting of thermal-metamorphic, metasomatic, and retrograde stages. During the thermal metamorphism stage, the alteration depended on the composition of the original host rocks (McKnight and Fellows, 1978). The pure limestones and dolomites were simply recrystallized. If silica was available, wollastonite was formed. In argillaceous and silty limestones, a variety of calc-silicate skarn minerals were formed. Siltstones, mudstones, and shales were altered to a variety of hornfels. The metasomatic stage produced a lesser variety of skarn minerals. Andradite, quartz, and calcite make up most of the rock. Magnetite, pyrite, specularite, diopside, and base-metal sulfides occur in lesser amounts. Garnet replaces limestone beds in mass. Sulfides occur sporadically throughout the garnetized zones, and some sphalerite occurs in marble outside the skarn. Minerals produced during the retrograde stage of alteration are usually hydrous phases such as chlorite, clay, actinolite, talc, and sericite. The paragenetic sequence for the Cyprus Piños Altos deposit shows that calc-silicate minerals formed early followed by iron oxides and a variety of copper, zinc, silver, lead, and bismuth sulfides.

At the Lady Katherine mine, north of the Cleveland mine, fissure veins containing chalcopyrite and minor sphalerite occur with pyrite in Magdalena Group limestone that has been altered to the skarn-assemblage minerals garnet, diopside, actinolite, and calcite (McKnight and Fellows, 1978). Northeast of the Lady Katherine mine, the Exxon prospect is another skarn deposit associated with Piños Altos stock. McKnight and Fellows (1978) describes results of exploration at the prospect where drilling has located copper-zinc-silver sulfide mineralization in altered Magdalena Group, Lake Valley Limestone, and in Lower Paleozoic formations.

The Pacific mine is an example of one of the area's polymetallic fissure-vein deposits. The fissure veins cut fine-grained diorite porphyry and extend for over 4,000 ft at N60°E. On average, vein width is about 2.5 ft but may reach 10 to 12 ft. The vein consists of quartz, with calcite, barite and rhodochrosite with pyrite, chalcopyrite, galena, and sphalerite. Pyrite and chalcopyrite are generally more abundant than galena and sphalerite. The diorite porphyry wall rocks are altered to mostly chlorite and sericite for 1 or 2 inches away from the vein . Gold is associated with the pyrite, but the galena is not argentiferous.

Between Sycamore and Bear Creeks in the Piños Altos Mountains oolitic hematite deposits in Bliss Sandstone are exposed for a length of over 8,000 ft. The basal, oolitic-hematite-bearing part of the Bliss Sandstone in Sycamore Canyon contained 12 beds total in about 45 ft thick (Harrer and Kelly, 1963).

Gold placer deposits covered an area of about 1.5 mi^2 in Bear Creek, Rich, Whisky, and Santo Domingo Gulches (Johnson, 1972). The richest parts of the placers were probably worked out in the first few years after discovery, but they have been worked practically every year since. The gold was derived from eroded outcrops of oxidized base metal-gold-silver veins and replacements in the area (Johnson, 1972). Placer mining was hampered by an intermittent water supply as most production was done on a small scale by individuals using pans, rockers, and sluices. In 1935 and from 1939 to 1942, Bear Creek and Santo Domingo Gulches were dredged. Heavy summer rains, occasionally would rework the gravels and reconcentrate the gold (Wells and Wootton, 1940). Assays of placer gravels found that they contain as much as 40% heavy mineral sands containing 83% t magnetite, 3% garnet, 8% hematite, and $9.30 in Au per ton (at $20.67 per oz Au).

Ricolite district

Location and Mining History

The Ricolite mining district straddles the Gila River with the bulk of the district north of the river, extending up to Smith Canyon and Tank Draw and includes a few fluorite and manganese mines and prospects on the south bank of the river (Table 100). It includes the Ash Creek Canyon (or Ricolite Gulch) ricolite deposit located about five miles north-northwest of Redrock (Fig. 55). Ricolite is a banded, light to dark green talc-serpentinite used for ornamental stone and in building interiors (Gillerman, 1964). McMackin (1979) describes ricolite collected in the district as a mixture of serpentine talc and small chlorite flakes. Ricolite and massive serpentine were first quarried in Ash Creek Canyon the 1880s for use as an ornamental stone and in building interiors. In about 1888, a shipment was sent to Chicago where was used for wainscoting (Talmage and Wootton, 1937). Shipments totaling 90 short tons were made in 1946 (Benjovsky, 1946). McMackin (1979) gives details of modern collecting of ricolite for lapidary pieces.

Fluorite production south of the Gila River has been significant. The Hope prospect shipped 74 short tons of fluorite ore in 1942, and the Great Eagle mine shipped 15,215 short tons of ore from 1911 to 1944. Allied Chemical calculated 1975 reserves at 195,324,000 short tons ore at 43.1% CaF_2 (McAnulty, 1978).

Manganese production was localized in the northwest corner of the district. At the Black Eagle mine, 36 long tons of ore with 24.9% contained manganese were produced in 1942, and 405 long tons of ore averaging 19.5% Mn were produced from 1953 to 1954 (Farnham, 1961).

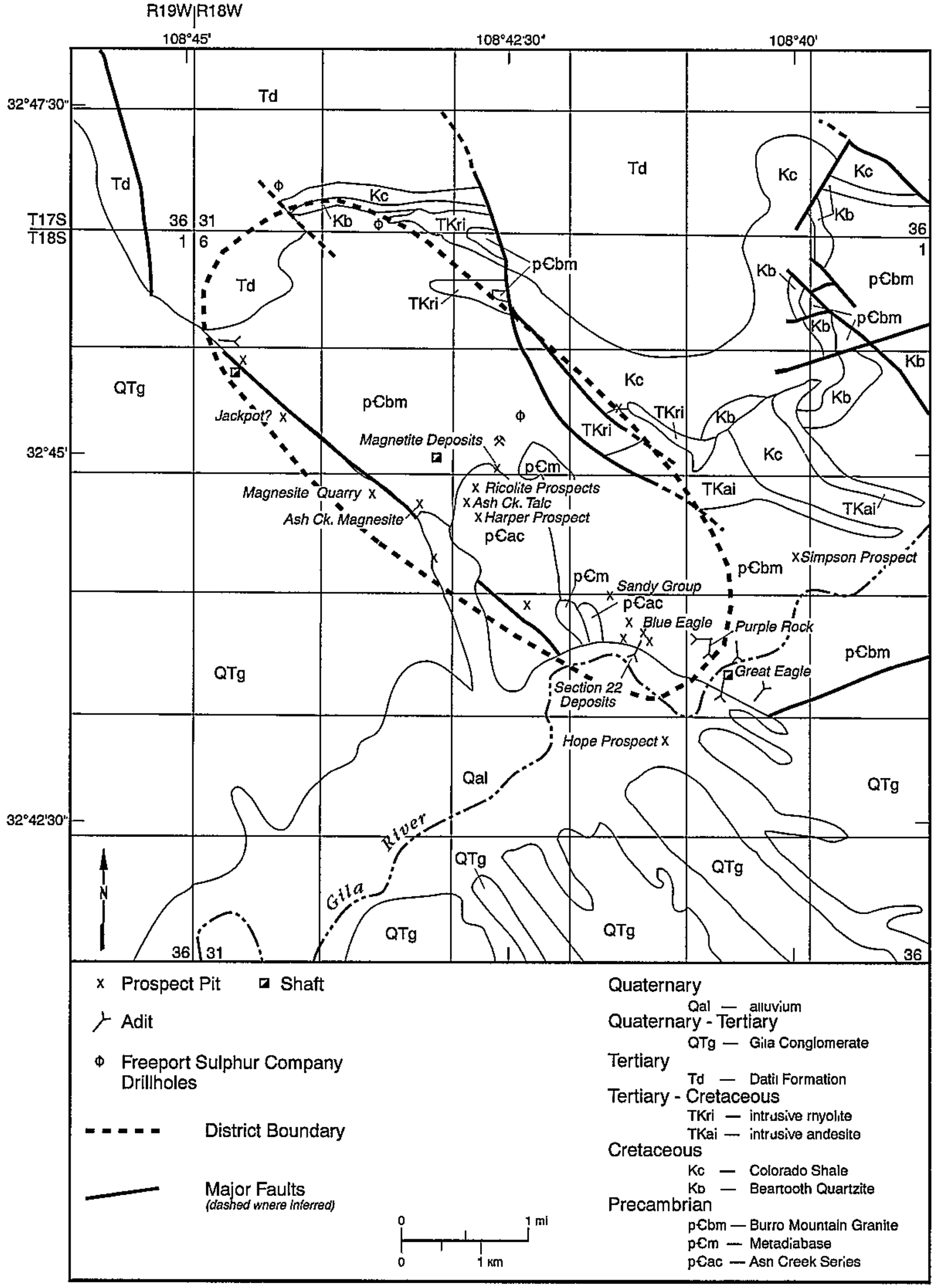

Figure 55— Mines and prospects of the Ricolite mining district, Grant County, New Mexico (modified from Gillerman, 1964).

Geology

The rocks in the vicinity of Ash Creek Canyon consist of Proterozoic granite and diabase in which tabular xenoliths of talc serpentinite occurs associated with serpentine marble and massive serpentinite (Kottlowski, 1965). Prior to the metamorphism, the Ash Creek rocks were layered sedimentary rocks consisting of siliceous dolomite with minor argillaceous limestone that may have formed on a stable continental shelf (Hewitt, 1959). Metamorphism of the sediments began with low-grade regional metamorphism followed by two or three periods of thermal metamorphism influenced by intrusion of anorthosite, diabase, or granite. Hewitt (1959) presents evidence that the diabase was the more effective agent of thermal metamorphism. Formation of the talc or serpentine was dependent upon the magnesium content of the original sedimentary rocks and was caused by hydrothermal reaction of quartz and dolomite (Gillerman, 1964). Locally, talc predominates over serpentine. The talc-rich variety is light cream in color and occurs in bands as much as several feet thick. Pods of relatively pure talc were thought by Kottlowski (1965) to be too small to be mined economically.

TABLE 100—Mines and prospects of the Ricolite mining district, Grant County, New Mexico, located in Figure 55. Location includes section, township, and range.

MINE NAME (ALIAS)	LOCATION	LATITUDE	LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
Ash Creek Magnesite	N17 18S 18W	32° 44' 40"	108° 43' 03"	Magnesite	pits	sedimentary magnesite	Gillerman (1964)
Harper Prospect	NW16 18S 18W	32° 44' 42"	108° 42' 40"	F,Mn	4 - 5 ft cut, 2 -3 ft deep	fluorite veins	Williams (1966)
Hope Prospect	NW26 18S 18W	32° 43' 02"	108° 40' 35"	F,Mn	20 ft pit	fluorite veins	Williams (1966), Hewitt (1959), Gillerman (1964), McAnulty (1978),
Jackpot Prospect	C7 18S 18W	32° 45' 12"	108° 44' 08"	F,Mn	shallow exploration pit, 20 ft pit	fluorite veins	Williams (1966), Gillerman (1964), Richter and Lawrence (1983)
Magnesite Quarry (Smith Canyon Magnesite)	N17 18S 18W	32° 44' 51"	108° 43' 29"	Magnesite	pits	hydrothermal magnesite	Gillerman (1964), Hewitt (1959), Richter and Lawrence (1983)
Magnetite deposits	SE9 18S 18W	32° 44' 55"	108° 42' 32"	Fe	pits	iron	Gillerman (1964), Richter and Lawrence (1983)
Ricolite prospects	NW16 18S 18W	32° 44' 51"	108° 42' 46"	marble, ricolite	numerous small open pits	metamorphic	Talmage and Wootton (1937), Gillerman (1964), Hedlund (1980)
Sandy Group	15,22 18S 18W	32° 44' 00"	108° 41' 25"	F, U	80 ft shaft, pits	fluorite veins	O'Neill and Thiede (1982), Hewitt (1959)
Section 9 mine	SE9 18S 18W	32° 45' 06"	108° 42' 17"	—	pits	—	—
Black Eagle (Black Jack Prospect, Black Eagle Group)	SW6 18S 18W	32° 45' 47"	108° 44' 53"	Mn, F	75 ft inclined adit, several shallow pits, small opencuts	epithermal Mn	Farnham (1961), Richter and Lawrence (1983)
Blue Eagle	NE21 18S 18W	32° 44' 01"	108° 42' 01"	F, U, Th	shallow trench	fluorite veins	Richter and Lawrence (1983), Hedlund (1980), Hewitt (1959)
Freeport Sulphur Company prospect	NE 9 18S 18W	32° 45' 25"	108° 42' 17"	Cu	4 diamond drill holes	possible porphyry Cu	Gillerman (1964)
Great Eagle Fluorspar (Old Glory, Spar, McCauly Zone)	NE22, W23 18S, 18W	32° 43' 35"	108° 40' 32"	F	110 ft shaft, 3 adits, 550 ft of trenching	fluorite veins	Ladoo (1927), Rothrock et al. (1946), McAnulty (1978), Hedlund (1980)
Section 22 deposits	NE22 18S18W	32° 43' 41"	108° 41' 03"	F	2 shafts, 2 adits, several pits	fluorite veins	Gillerman (1964)
Simpson Prospect	SW14 18S 18W	32° 44' 15"	108° 40' 00"	Mn	pits	epithermal Mn	Gillerman (1964), Hewitt (1959)
Purple Rock	NW23 18S 18W	32° 43' 45"	108° 40' 39"	F, U, W, Th	adits, shafts, pits	fluorite veins	Anderson (1957), Gillerman (1964), McAnulty (1978)

Mineral deposits

The ricolite occurs in xenoliths in Proterozoic metamorphic granite and metadiabase (Hewitt, 1959; Benjovsky, 1946). Fractures may be filled with calcite or quartz, and cross-fiber veins of asbestiform serpentine, chrysotile, are present (Kottlowski, 1965). It has been valued because of its striking color, its peculiar banded and mottled texture, and the ease with which it is carved or polished (Hewitt, 1959). It has found limited use for jewelry, bookends, paperweights, and other small lapidary objects, such as beads, pen stands, and bola ties. Good quality specimens will hold a good polish, but its softness limits its use. Ricolite occurs in the steeply dipping tabular xenoliths of serpentine-carbonate rocks of the Ash Creek Group (Hewitt, 1959). The xenoliths are composed of several varieties of hornfels and serpentinite. The largest xenolith is about one mile long with smaller xenoliths scattered nearby. Hewitt (1959) describes the ricolite as fine-grained talc serpentinite that has undisturbed banding similar to that of finely bedded sedimentary rocks. Most commonly, it ranges in color from light green yellow to very dark green, but shades of red, yellow, blue, and brown occur locally. The bands range from 0.1 mm to about 5 cm in thickness with the average being less than 1 cm. Chlorite, calcite, and quartz occur in the serpentinite, and mottled and massive canary-yellow serpentine is associated with the ricolite (Gillerman, 1968).

The productive fluorite deposits to the south of the Gila River are characterized by colorless to dark-green fluorite; most contain chert (Table 100). Different style of mineralization are found. At the White Eagle mine, the stratabound fluorite layers alternate with chert layers in a near trending vertical shear zone. At the Hope prospect, a pit exposes a vein of fluorite and chert breccia (Hewitt, 1959). North of the Gila River and near Tank Draw, fluorite occurs in shattered and brecciated shear zones in Proterozoic granite at the Blue Eagle and Jackpot prospects (Gillerman, 1964; Williams, 1966). At prospects located in section 22, just east of Blue Eagle, narrow fluorite veins occur in Proterozoic granite along Tertiary rhyolite dikes that strike N40-50°W. At the southeast corner of the district on the southern bank of the Gila River, the Great Eagle mine is in Proterozoic granite on a shear zone 30 to 40 feet that strikes N30-40°W and dips nearly vertically (Hewitt, 1959).

Proterozoic granite contacts Tertiary volcanic rocks and Gila conglomerate in the northwest corner of the district at the Black Eagle manganese mine. The deposit is along a major fault that strikes N15°W and dips 70°SW (Gillerman, 1964). Extensively kaolinized microcline is found in the granite enclosed by the vein, as well as in the granite footwall (Hewitt, 1959). At the Black Eagle mine in Tank Draw, manganese as pyrolusite, psilomelane, manganiferous calcite, and wad occurs as veins and pods along a northwest striking fault in a vein up to 8 ft thick (Farnham, 1961). At the Simpson prospect northeast of the Great Eagle mine, psilomelane and pyrolusite occur with fluorite as nodules and in veins (Gillerman, 1964).

Minor porphyry copper exploration was conducted by Freeport Sulphur Company in 1960 north of Ash Creek Canyon. Four holes up to 1,302 feet deep did not intersect sulphides, except for minor pyrite and oxidized pyrite in two of the holes, nor was evidence of hypogene mineralization found (Gillerman, 1964).

A small magnetite deposit is located just north of the ricolite prospects. Magnetite rich bands 1 to 2 ft across occur in serpentine in xenxoliths of metamorphosed rock in Proterozoic granite. Magnetite locally constitutes 90% of the rock, but the deposit is small and inaccessible (Kelley, 1949; Gillerman, 1964).

In Smith Canyon approximately a mile west of the ricolite prospects, replacement-type magnesite-quartz-dolomite beds in dolomite occur as lenses as much as 60 ft wide by 75 ft thick. There was no production at this location.

At Blue Eagle Fluorspar mine, approximately a mile northwest of the Great Eagle mine, radioactive fluorspar veins trend north-northwest in Proterozoic granite and diabase. Radioactivity is about twice the background count, and uranium and thorium are believed to be the radioactive elements present. There was no production at this location (NMBMMR file data; Hewitt, 1959).

San Francisco district

Location and Mining History

The San Francisco prospects district lies in northwestern Grant County, extends northward a few miles into Catron County, and comes within approximately three miles of the Arizona-New Mexico boundary (Fig. 1). Only the southern part is in the Mimbres Resource Area. The district was part of a mineral-resource assessment of the San Francisco Wilderness Study area and contiguous roadless area in Arizona and New Mexico (Ratté et al., 1982b). Much of this discussion comes from that research. The Grant County part of the district was determined by Ratté et al. (1982b) and Ratté and Lane (1984) as having indicators, such as associated veins and altered rocks, and a geologic setting conducive for the formation of mineral deposits.

The district may be the least-mined district in the Mimbres Resource Area. There has been practically no mining in the area in or around the district. As of 1980, there were no mining or patented mine claims in the district, but Ratté et al. (1982b) cites evidence of past prospecting activity, such as claim posts and prospect pits.

Geology

The district and the surrounding area consists chiefly of the Potholes Country graben area and of volcanic rocks, mainly andesite and basalt lava flows and lesser rhyolite flows and pyroclastic rocks of middle Tertiary age. The volcanic sequence is capped by Gila Conglomerate, which consists of fanglomerate and conglomerate. The Potholes Country graben runs roughly northwest-southeast through the center of the district and is bounded by northwest-trending faults. The main graben block is approximately two miles wide and is estimated to be down-dropped 600-800 ft (Ratte et al., 1982b). Near the southern edge of the graben sits a major rhyolite vent where the Rhyolite of the Potholes Country graben of Miocene age was extruded and intruded. The rhyolite is a high silica and high potassium series of lava flows, plugs, and pyroclastic rocks.

Mineral deposits

Along the San Francisco River in Arizona gold has been produced from placer deposits (North and McLemore, 1986) and a few prospects have been located on the northern side of the river in Catron County. There, quartz veins as much as 15 to 30 ft wide occur within and peripheral to the Potholes Country graben. Anomalous Mn, Ag, Au, Cu, Mo, Be, W, Sb, Ba, and B values have been found in the vein material in rhyolite intrusive rocks and may be indicative of mineralization at depth (Ratte et al., 1982b). Locally, the rocks have been hydrothermally altered especially around extrusive vents where manganese and iron oxides coat fractures and where the rhyolite has been bleached and silicified. Silicified zones in similar rhyolite in adjacent areas are anomalous in gold and silver (Ratté and Lane, 1984). The silica, potassium, rubidium and strontium, and niobium content of the rhyolite is suggestive of that associated with molybdenum, tin, and tungsten mineralization.

Ratté et al. (1982b) determined that the district had a low-to-moderate potential for epithermal precious- and base-metal mineralization. The potential for base-metal veins and replacement deposits or for porphyry copper deposits, however, could not be determined but is possible everywhere in the district beneath the Late Cenozoic volcanic rocks. The best evidence cited for this is the presence of major porphyry copper deposits in Late Cretaceous to Early Tertiary intrusive rocks only about 15 miles southwest of the district and the presence of pre-Tertiary rocks in exploratory drill holes a few miles to the north.

Santa Rita district

Mining History and Location

The Chino copper deposit in the Santa Rita district is the largest mineral producer in the study area and is located east of Hurley, New Mexico (Fig. 56). The Chino copper deposit was initially discovered by Native Americans who used it as a source of copper for implements and weapons. Mining by the Spanish in the Mimbres area did not amount to much until ca. 1798, when an Apache Indian told Col. Manuel Carrasco about the copper deposits at what is now known as Santa Rita. Carrasco interested Francisco Manuel Elguea to form a partnership and they were issued a land grant, the Santa Rita del Cobre Grant. By 1804 Elguea bought out Carrasco and began mining the copper at Santa Rita in earnest. Elguea found a ready market for copper in Mexico City. Raids by Indians and depletion of high-grade ore kept mining at a small scale. At that time, there was no process for economically extracting copper from the underlying low-grade sulfide ore. In the 1880s, attempts were made to use more modern mining and processing methods at the deposit. In 1881, a stamp mill and a smelter were built, and in 1883 the first diamond-drill holes were drilled for exploration. High transportation costs brought about the failure of this mining venture. In 1899, the Santa Rita Mining Co. bought the property and expanded the underground workings to explore for more ore, but it never found the main ore body.

In 1904, John M. Sully arrived at Santa Rita and recognized the similarity of ore at Santa Rita to that mined at Bingham Canyon. Sully thoroughly explored the area and attempted to obtain backers (Sully, 1908). In 1908, the Chino Copper Co. was formed and took over the Santa Rita Mining Co. Finally, in 1909 he obtained additional financial backing and in 1910 production began. The first concentrator mill was erected at Hurley in 1911; flotation concentration was added in 1914 (Hodges, 1931). That effort and those that followed have been successful at large-scale, high volume.

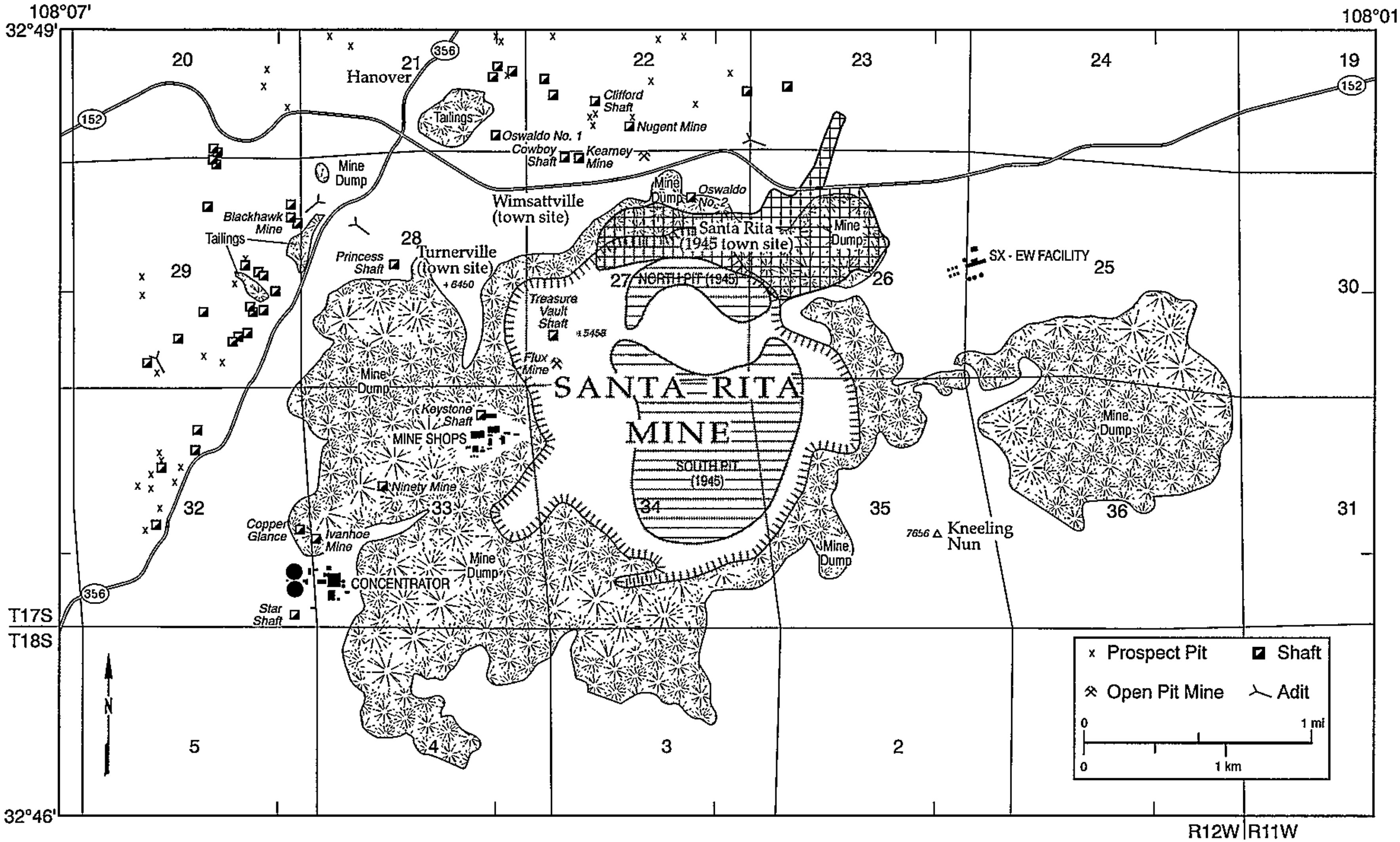

Figure 56—Mines and prospects in the Santa Rita mining district, Grant County, New Mexico. Most of these mines are either mined out by the open pit or are buried by the current mine tailings.

The mine has produced more than 9.08 billion lbs Cu, 500,000 oz Au, and 5.36 million oz Ag plus some molybdenum and iron ore from 1911 to 1993 (Table 2, 3, 6, 101; Long, 1995). In 1993, 108,568,000 short tons of 0.73% Cu were produced (Giancola, 1994). In 1995, reserves were estimated as 315.4 million short tons of concentrator ore grading 0.67% Cu and 720.5 million short tons of leach ore grading 0.24% Cu (Robert North, Phelps Dodge Corp., written communication, October 1995). Some iron ore was produced in 1943-1944.

TABLE 101—Selected production from the Chino mine, Santa Rita district, Grant County (U. S. Bureau of Mines, 1927-1990). In addition, >500,000 oz Au and >5,360,000 oz Ag have been produced.

YEAR	ORE (SHORT TONS)	COPPER (LBS)
1931	2,633,758	53,130,000
1932	1,167,965	23,146,500
1933	1,100,390	22,166,000
1934	1,000,400	19,470,000
1935-1936	w	w
1937	3,527,913	55,204,000
1938	1,791,462	32,950,000
1939	4,363,350	76,993,000
1940	6,412,869	117,319,889
1941	6,815,301	117,779,582
1942	7,498,835	125,407,629
1943	7,441,430	116,540,246
1944-1975	w	w
1976		114,404,000
1977	6,800,000	114,526,000
1978-1982	w	w
1983	w	212,520,000
1984	w	193,600,000
1985-1986	w	w
1987	155,716,000	244,200,000
1988	w	146,000,000
1989	w	175,400,000
1990	w	295,800,000
1991	w	314,800,000
1992	w	304,400,000
1993	w	w
1994	w	320,000,000
TOTAL 1911-1994	1,800,000,000	9,080,000,000

Geology

The district is in an area of Basin and Range structure, lying near a northwest-trending range of Paleozoic and Mesozoic sediments and Tertiary volcanics that die out to the north under a cover of Cenozoic volcanics and sediments (Rose and Baltosser, 1966). This range is horst bounded on the northeast by the northwest-trending Mimbres fault and on the southwest by an inferred northwest-trending fault lying under alluvium. Within this horst, the Paleozoic and Mesozoic sediments are exposed in an west trending belt 25 miles long and up to 10 miles wide, and a broad shallow syncline is present. The Tertiary volcanics cover the older rocks to the north and south, and Cretaceous rocks outcrop in the central part of the range, with lower Paleozoic units exposed in the northeast and west fringes. These features chiefly result from Basin and Range faulting, and erosion from the Late Tertiary to present. See Rose and Baltosser (1966) for more information on geology of the ore body.

Emplacement of the Santa Rita stock occurred in late Cretaceous or early Tertiary time; age determinations of the stock range from 55-56 Ma (Schwartz, 1959; McDowell, 1971; Robert North, Phelps Dodge Corp. written communication, October 1994). It was followed by intense hydrothermal alteration, sulfide concentration, supergene enrichment, and dike intrusion. The stock consists of a granodiorite to quartz monzonite porphyry having phenocrysts of slightly greenish striated feldspar and less regularly distributed prisms and flakes of biotite. The granodiorite porphyry is similar to that in Hanover-Fierro and Copper Flat stocks. The Hanover-Fierro and Santa Rita stocks may be derived from similar sources.

Dikes of granodiorite porphyry invaded the stock and surrounding rocks during mineralization. The rocks around the stock were notably altered by hydrothermal solutions that made their way down paths created by fractures in the stock as the magma cooled. Fracturing, hydrothermal alteration, intrusion of dikes, and deposition of ore may be regarded as episodes of extended magmatic activity. Mineralization is directly related to the amount of fracturing and alteration. The granodiorite dikes were subsquently followed by intrusion of quartz monzonite and finally latite to quartz latite dikes. These later dikes contain only supergene mineralization and are younger than the hypogene mineralization.

Mineral deposits

The largest porphyry-copper deposit in New Mexico is at Santa Rita, the Chino mine where copper sulfides occur in the upper, highly fractured granodiorite stock and adjacent sedimentary rocks (Fig. 56, 57). Several periods of supergene enrichment have further concentrated the ore (Cook, 1994). Adjacent copper skarns are becoming increasingly more important economically. Potassic, phyllic, argillic, and propylitic alteration zones are present, but are not everywhere concentric (Nielsen, 1968, 1970).

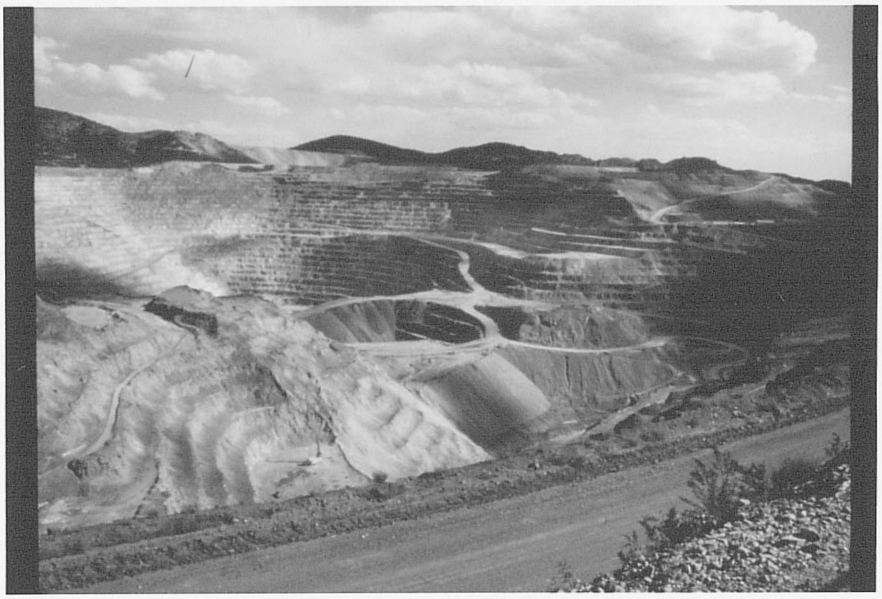

FIGURE 57—Santa Rita pit, looking south from overlook, Grant County (V. T. McLemore photo, May 1995).

Much of the ore formed in the sedimentary rocks adjacent to the granodiorite intrusion. This is especially true on the east side of the ore body where Abo Formation limestone, Beartooth Formation quartzite, and Colorado Formation shale all were mineralized. Hydrothermal alteration destroyed many of the distinguishing characteristics of the granodiorite and the host rocks, both sedimentary and igneous. The skarns in contact on the northwest and southeast sides are locally attributed to the stock underlying the sediment (Paul Novotny, Phelps Dodge Mining Co., written communication, 1994). The barren Whim Hill breccia is located at the cupola of the intrusive and is bounded on all sides by potasically altered granodiorite stock, and is barren of metals (Paul Novotny, Phelps Dodge Mining Co., written communication, 1994; Rose and Baltosser, 1966).

Early production from the Santa Rita deposit was largely from disseminated supergene chalcocite ores in the granodiorite stock dioritic sills, and Colorado Formation shales with production from chalcocite-pyrite skarn-type ore becoming more important as production advanced into the Oswaldo and Syrena Formations (Nielsen, 1968, 1970). Supergene minerals are chalcocite, chrysocolla, covellite, cuprite, native copper, malachite, and azurite. Primary minerals in the porphyry ore bodies are chalcocite, bornite, and molybdenite, while those in the replacement bodies are chalcopyrite and magnetite. The decrease of copper grade through time is apparent. In 1912, the grade was over 2% copper; in 1925, it was averaging 1.5%; in 1948 the grade was less than 1% (Gibson and Trujillo, 1966; Wunder and Trujillo, 1987); and in 1980 the copper grade was just 0.81%.

Steeple Rock district

Mining History and Location

The Steeple Rock mining district is located in the Summit Mountains in Grant County, New Mexico and Greenlee County, Arizona (Fig. 58). The district includes the Carlisle, Duncan, Twin Peaks, Hells Hole, Bitter Creek, and Goat Camp Springs subdistricts. The earliest report of exploration in the Steeple Rock district was in 1860 when the military dispatched troops from Ft. Thomas (near Duncan, Arizona) to assist miners in the area from interference by Apache Indians. Production began in 1880 when a 20-stamp amalgamating mill was erected at the Carlisle mine. By 1886, the mill was enlarged to 60 stamps. Most of the mines were located and under development by 1897. Production prior to 1904 is uncertain. The Carlisle mine was the largest producer and most of the production prior to 1904, about 112,000 short tons, is attributed to the Carlisle mine. Many of the mines closed in the early 1900s.

In 1933, the price of gold rose from $20.67 to $35 per ounce and many of the mines in the district were re-examined for gold potential. From 1934 to 1942, total production from the district amounted to about 30,000 oz Au and over 1 million oz Ag (Griggs and Wagner, 1966); most of this production came from the East Camp mines.

In 1942, the Federal government closed all silver and gold mines and only base-metal mines were allowed to operate. Production after 1947 was minor and sporadic (Table 102). An estimated $10 million worth of gold, silver, copper, lead, and zinc have been produced from the district since 1880 (Table 102, 103). In addition, about 11,000 short tons of fluorite and 2,000 long tons of ore containing 74,500 lbs of manganese were produced (McLemore, 1993; McAnulty, 1978; Griggs and Wagner, 1966; Farnham et al., 1961).

In the 1970s, 1980s, and 1990s exploration for gold in the district intensified and resulted in drilling and some production, mainly for silica flux. Queenstake Resources, Ltd. estimated reserves at the Jim Crow, Imperial, and Gold King veins as 155,535 short tons of ore averaging 0.11 oz/ton Au and 3.45 oz/ton Ag (Queenstake Resources, Ltd., press release, April 2, 1987). In the late 1980s and early 1990s, Biron Bay Resources Ltd., in joint venture with Nova Gold Ltd., drilled along the Summit vein and estimated reserves as 1,450,000 short tons of ore grading 0.179 oz/ton Au and 10.26 oz/ton Ag (Petroleum and Mining Review, May 1992, p. 2). None of these deposits have been mined.

Geology

The district lies on the southern edge of the Mogollon-Datil volcanic field (late Eocene-Oligocene), on the northern edge of the Burro uplift, and near the intersection of the northwest-trending Texas and northeast-trending Morenci lineaments (Fig. 58; McLemore, 1993).

Rocks exposed in the Steeple Rock district consist of a complex sequence of Oligocene to Miocene (34-27 Ma) andesite, basaltic andesite, and dacitic lavas interbedded with andesitic to dacitic tuffs, sandstones, volcanic breccias, and rhyolite ash-flow tuffs. These rocks were subsequently intruded by rhyolite plugs, dikes, and domes (33 and 28-17 Ma).

Faulting and tilting of the volcanic rocks in the district produced a series of half-grabens and horsts with a district-wide, regional northwest strike of foliation and bedding planes that dip northeast (Griggs and Wagner, 1966; Powers, 1976; Biggerstaff, 1974; McLemore, 1993). Rhyolite dikes, plugs, and domes were emplaced along some of these faults and then locally cut by younger faults. Most faults in the district are high-angle normal faults and are well exposed because they are filled with quartz veins and/or silicified, brecciated country rock. Some faults exhibit oblique-slip movement as evidenced by slickenslides and offsetting dikes or veins (Griggs and Wagner, 1966; McLemore, 1993).

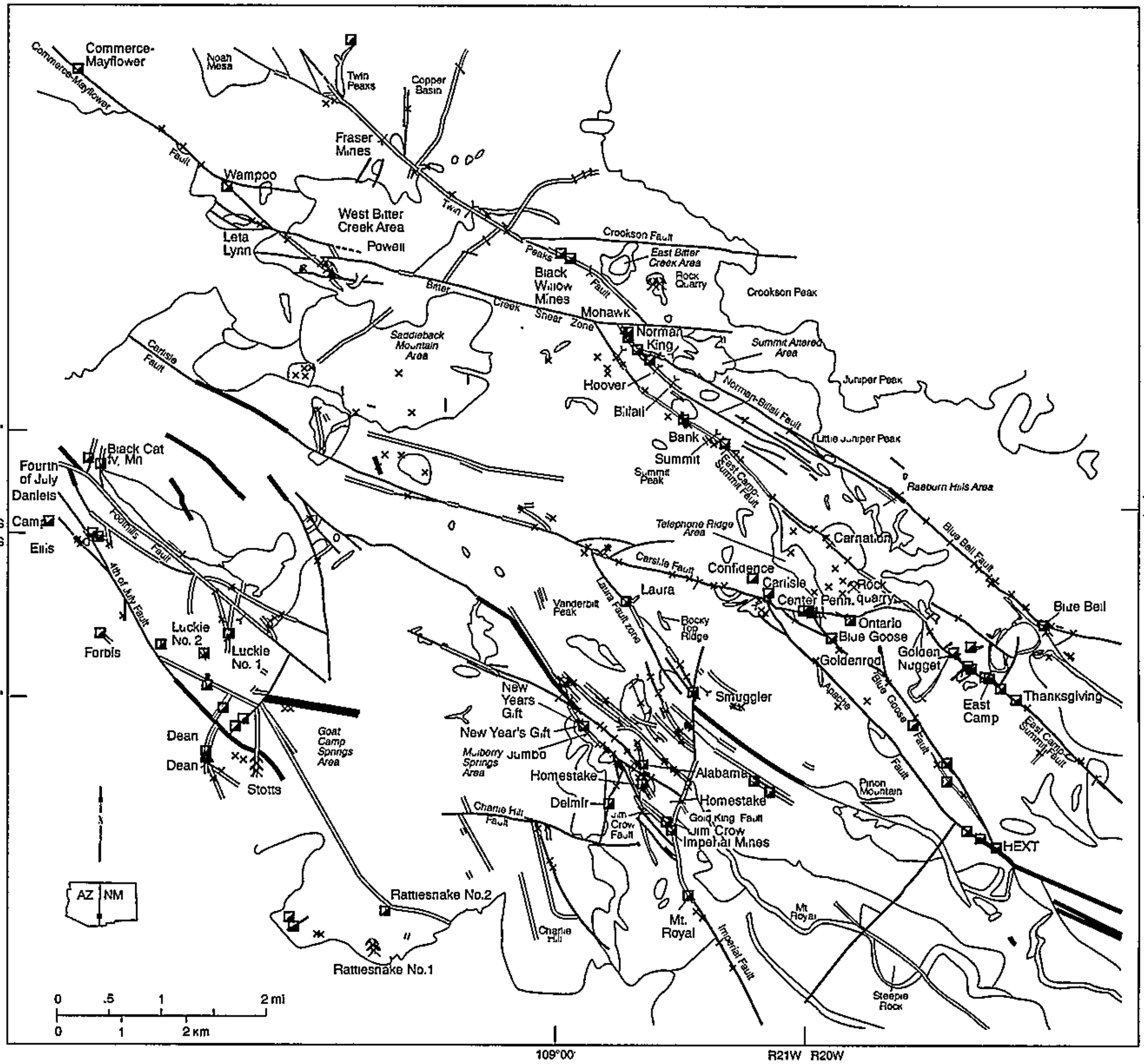

Figure 58–Mines and prospects in the Steeple Rock mining district, Grant County, New Mexico (McLemore, 1993).

TABLE 102—Production from the Steeple Rock district, Grant County, New Mexico and Greenlee County, Arizona. (NMBMMR files; U. S. Geological Survey, 1902-1927; U. S. Bureau of Mines, 1927-1990; Anderson, 1957; Griggs and Wagner, 1966; Keith et al., 1983; McLemore, 1993). e—estimated

YEAR	ORE (SHORT TONS)	COPPER (LBS)	GOLD (OZ)	SILVER (OZ)	LEAD (LBS)	ZINC (LBS)	TOTAL VALUE ($)
e1880-1897	112,000	—	e102,000	e1,618,000	—	—	e4,000,000
1904	4	—	?	?	—	—	?
1905	—	—	—	—	—	—	—
1906	—	—	—	—	—	—	—
1907	1,000	—	750	15,150	—	—	e25,500
1908	750	—	375	17,000	—	—	e16,800
1909	65	770	17	1,410	9,140	—	e1,600
1910	—		—	—	—	—	—
1911	224	—	143	5,902	—	—	e6,100
1912	269	3,706	402	5,157	950	—	e12,100
1913	381	7,602	417	1,453	7,914	—	e11,000
1914	41	1,342	42	88	—	—	e1,100
1915	295	7,276	229	11,031	3,000	—	e12,300
1916	165	17,500	124	3,491	6,753	—	e9,600
1917	5,202	68,502	88	10,642	617,989	139,490	e96,700
1918	82	10,677	39	999	6,775	—	e4,900
1919	228	11,027	27	3,817	157,812	—	e14,800
1920	2,111	5,837	642	3,566	36,937	—	e21,200
1921	91	—	45	2,363	1,000	—	e3,300
1922	—	—	—	—	—	—	—
1923	36	—	23	1,685	286	—	e1,900
1924-1927	—	—	—	—	—	—	—
1928	23	1,132	—	130	—	—	e200
1929	—	—	—	—	—	—	—
1930	50	121	15	891	23	—	e500
1931	—	—	—	—	—	—	—
1932	19	21	13	780	152	—	493
1933	5	31	2	94	216	—	64
1934	1,617	1,700	421	21,141	500	—	28,553
1935	1,377	2,200	407	19,470	—	—	28,414
1936	3,777	5,600	850	54,173	300	—	72,222
1937	16,147	57,550	5,552	200,863	68,175	55,000	364,258
1938	14,740	33,300	5,687	239,119	38,500	—	358,654
1939	12,772	13,000	4,487	237,030	19,000	—	320,183
1940	22,915	20,900	5,414	216,374	74,000	—	349,418
1941	39,018	53,200	6,685	252,509	226,000	—	432,697
1942	9,426	29,000	1,390	60,220	86,700	—	100,791
1943	11,645	202,800	250	20,870	683,000	703,500	177,158
1944	15,460	210,800	295	21,181	838,500	944,000	228,541
1945	19,366	232,200	963	25,494	1,079,500	1,156,400	309,004
1946	9,535	87,800	408	8,797	405,200	328,800	119,893
1947	1,348	10,500	61	1,010	42,800	40,800	16,930
1948	428	2,000	149	1,735	3,000	2,000	8,022
1949	347	2,000	101	1,409	3,000	3,000	6,050
1950	855	1,300	259	11,004	1,700	—	19,523
1951	2,288	19,700	271	11,259	36,400	36,700	37,418
1954	104	500	8	52	1,400	—	667
1955	2,619	2,900	376	28,410	—	300	39,990
1956	1,979	1,644	186	11,345	5	—	17,476
1957	115	169	10	680	239	—	e1,000
1960	?	?	?	?	?	?	8,383
TOTAL 1907-1957	198,919	1,126,307	37,623	1,529,794	4,456,866	3,409,990	3,285,402
TOTAL 1974-1991	e55,000	e40,000	e12,000	e226,000	e90,000	—	—
TWIN PEAKS SUBDISTRICT, GREENLEE COUNTY, ARIZONA							
TOTAL 1906-1970	2,000	15,000	500	10,500	17,000	—	—
TOTAL PRODUCTION, STEEPLE ROCK DISTRICT, ARIZONA AND NEW MEXICO							
TOTAL 1880- 1991	e365,000	e1,200,000	e151,000	e3,400,000	e5,000,000	e4,000,000	e10,000,000

TABLE 103—Mines and prospects in the Steeple Rock mining district and adjacent area, New Mexico and Arizona. From Griggs and Wagner (1966), Briggs (1981, 1982), Hedlund (1990a,b, 1993), McAnulty (1978), McLemore (1993) and unpublished reports (NMBMMR file data). Type of deposit: [1] Base-metal veins [2] Silver-gold veins [3] Copper veins [4] Fluorite [5] Manganese [6] Not in mapped area

NAME	LOCATION	YEARS OF PRODUCTION	DEVELOPMENT	METALS (MINOR)	PRODUCTION
Alabama Group[2]	14 17S 21W	1936-38, 1950-51	113 m shaft, pits	Au, Ag (Cu, Pb)	4000 short tons of 0.3 oz/ton Au, 13 oz/ton Ag, 0.03% Cu
Apache Box Canyon[2,6]	2,3,10,11 16S 21W	none	3 adits, 12 m shaft	Au, Ag, Cu	none
Big Horse Shoe[2]	11 17S 21W	1904	pits, shafts	Au (Ag)	<10 short tons
Billali[2]	26 16S 21W	1935-36, 1940	3 m shaft, adit	Au, Ag (Cu)	0.19 oz/ton Au, 12.2 oz/ton Ag
Black Cat[5]	33 6S 32E	1953-55	2 shafts, 15, 13 m deep	Mn, fluorite	86 short tons of 43.2% Mn
Black Widow[2,4]	22 16S 21W	1920s	20 m shaft	Au, Ag, fluorite	none
Blue Bell (Shamrock, Bluebird)[3]	8 17S 20W	late 1800s, 1909, 1916, 1918	61 m shaft	Au, Ag, Cu	<500 short tons of 0.6-0.9 oz/t Au, 10-12 oz/t Ag, 6-11% Cu
Blue Goose[2]	7 17S 20W	none	shaft	Au, Ag	none
Carlisle[1]	1 17S 21W	1880-1897, 1904, 1913, 1916-20, 1928, 1936-54, 1960	218 m shaft with 6 levels	Au, Ag, Cu, Pb, Zn	about $5 mill worth of metals, 0.2 oz/t Au, 3 oz/t Ag, 1% Cu, 4-5% Pb, 4-5% Zn
Carnation[2]	6 17S 20W	—	shaft, pits	Au, Ag	none
Center, Penns.[1]	1,12 17S 21W	1944-46, 1984-86	116 m	Au, Ag, Cu, Pb, Zn	0.4 oz/ton Au, 4 oz/ton Ag, 2% Pb, 0.4% Cu, 2.8% Zn
Center decline[1]	1 17S 21W	1987-present	158 m	Au, Ag, Cu, Pb, Zn	active
Commerce-Mayflower[3]	8,9 6S 32E	—	shaft, pits	Cu, Ag (Au)	some
Copper Basin[3,6]	10 6S 32E	—	shaft, pits	Cu, Ag (Au)	some
Daniels Camp[4,6]	5 7S 32E	—	shaft	fluorite	some
Davenport[2]	8 17S 20W	1981-82	decline, 65 m shaft	Au, Ag (Cu, Pb, Zn)	some
Dean[4]	15 7S 32E	—	shaft	fluorite	some
Delmir mine[3] (Delamar)	36 17S 21W	1915, 1917	shafts	Au, Ag, Cu, Pb	<200 short tons
East Camp Group[2]	8 17S 20W	1932, 1934-42, 1951, 1955-57, 1981-82	shafts	Au, Ag (Cu, Pb, Zn)	0.22 oz/ton Au, 15 oz/ton Ag
Forbis[4]	4,9 7S 32E	—	55 m shaft	fluorite	some
Fourth of July[4] (Ellis)	4 7S 32E	1936-42, 1960	46 m shaft	fluorite (Au, Ag, Cu)	3,190 short tons of 64% CaF_2
Fraser[2] (Fraser-Martin, Rival, Ethel)	17 16S 21E	1880-1958	4 shafts (deepest is 200 m)	Au, Ag, Cu	some in 1913-18, 1936, 1958, 1970s; up to 1 oz/ton Au
Golden Nugget[2]	8 17S 20W	none	65 m shaft	Au, Ag	some
Goldenrod[2]	7 17S 20W	none	44 m adit	Au, Ag	none
Hext[3]	20 17S 20W	—	shafts, adit, trenches	Cu, Au, Ag	unknown
Homestake[2]	14 17S 21W	1936, 1938-39, 1941	40 m shaft, adits	Au, Ag (Cu)	<500 short tons of 0.23 oz/ton Au, 6 oz/ton Ag
Hoover[2]	26 16S 21W	—	adit	Au, Ag	some (with Norman King)
Jim Crow-Imperial-Gold King[2]	23 17S 21W	Intermittently 1897-1985	several shafts	Au, Ag (Cu, Pb)	6,806 short tons of 0.17 oz/t Au and 7.6 oz/t Ag
Jumbo[2]	15 17S 20W	none	shaft	Au, Ag	none
Laura[2]	2 17S 21W	1860s, 1907-09, 1938-42, 1982	196 m shaft	Au, Ag (Cu, Pb)	11,800 short tons of 0.29 oz/ton Au, 9.6 oz/t Ag
Leta Lynn[4]	19 16S 21W	1971-72	shaft, trench	fluorite	3 short tons 65% CaF_2
Luckie[4]	3,10 7S 32E	1914-1944	open pit, shaft	fluorite	2,200 short tons 65-70% CaF_2
Mohawk[4]	26 16S 21W	1942-44, 1972	4 shafts	fluorite, Au, Ag	6,500 short tons 50-75% CaF_2
Mount Royal[2] (Golden Fleece)	23 17S 21W	1939-41, 1970-71, 1981	91 m shaft	Au, Ag (Cu, Zn)	2,542 short tons of 0.12 oz/ton Au, 3.0 oz/t Ag
National Bank #1[2] (Bank)	35 16S 21W	1936-37	61 m shaft	Au, Ag (Cu)	0.2 oz/t Au, 17 oz/t Ag
New Years Gift[2]	10 17S 21W	1915, 1919, 1940-41	82 m shaft	Au, Ag (Cu, Pb)	0.2 oz/t Au, 8-9 oz/t Ag

NAME	LOCATION	YEARS OF PRODUCTION	DEVELOPMENT	METALS (MINOR)	PRODUCTION
Norman King[2]	26 16S 21W	1919, 1921, 1923, 1930, 1932-33, 1935-42	152 m shaft	Au, Ag (Cu, Pb)	0.63 oz/ton Au, 43 oz/t Ag, 1919-1921; 0.18 oz/ton Au, 11 oz/ton Ag, 1936-40
Ontario[1]	7 17S 20W	1941, 1942, 1945, 1949	49 m shaft, 27 m adit	Au, Ag, Cu, Pb, Zn	<1,500 short tons of 0.24 oz/t Au, 13.6 oz/t Ag
Powell[4]	20 16S 21W	1942-43	trench, pits	fluorite	127 short tons 65% CaF_2
Rattlesnake[4]	20,29 18S 20W	1970s	pits	fluorite	120-150 short tons of CaF_2
Section 2 adit[2]	2 17S 20W	none	adit	Au, Ag	none
Smuggler[2]	11 17S 21W	1875	61 m adit	Au, Ag	some ($150,000)
Stotts-Ontario[4] (Phillips)	15 7S 32E		shafts, trenches, pits	fluorite	unknown
Summit Group[2] (Apex, Inspiration)	36 16S 21W	1936-40, 1979-83	shaft, 61 m adit	Au, Ag (Cu, Pb)	73,550 short tons of 0.13 oz/ton Au, 5.54 oz/ton Ag
Telluride[2,6]	10,15 15S 21W	none	3 m shaft, pits	Au, Ag, Cu	none
Thanksgiving[2] (Alberto)	8 17S 20W	1934-35, 1939	shaft	Au, Ag	<100 short tons ore
Twin Peaks[2,6] (Fraser, FreeGold, Rival, New Strike)	8 16S 21W	1912-14, 1916, 1935, 1937, 1939, 1946	5 shafts (up to 282 m deep)	Au, Ag (Cu)	<1,000 short tons ore
Yellow Jacket[3,6]	28 15S 21W	none	adit, shaft	Cu	none
Wampoo[3]	15 6S 32E	1923-1970	trench, 2 shafts, adit	Cu, Au, Ag	some

Mineral Deposits

The mineralization in the Steeple Rock district occurs as volcanic-epithermal precious- and base-metal fissure veins along faults (#25b,c,d,g). Five types of deposits occur in the district (Fig. 58; Table 103; McLemore, 1993): (1) base with precious metals, (2) precious metals, (3) copper-silver, (4) fluorite, and (5) manganese. A sixth type of deposit, high sulfidation (quartz-alunite) gold deposits, may occur in areas of acid-sulfate alteration; but no production has occurred (McLemore, 1993). District-wide zoning of the fissure veins is present. The base-metal veins, with significant amounts of gold and silver, occur only along the Carlisle fault and may represent the center of the district. Outward from the base-metal veins, precious-metal veins occur along northwest- and north-trending faults. Locally, these veins grade vertically downward to trace amounts of base-metal sulfides. Some precious-metal veins grade vertically upward to copper-silver veins without any gold. Fluorite and manganese veins occur along the fringe or outer margins of the district (McLemore, 1993). The epithermal veins are low-sulfidation (quartz-adularia) veins, structurally controlled, and deposited by low salinity (<5 eq. wt. % NaCl), slightly acidic to neutral pH fluids at temperatures between 240° and 325°C at relatively shallow depths (360-1300 m; McLemore, 1993; McLemore and Clark, 1993).

Several areas of acid-sulfate alteration which are cut by epithermal veins and are superimposed and surrounded by argillic to chloritic alteration have been mapped in the district by McLemore (1993). These areas of acid-sulfate alteration were formed in a magmatic-hydrothermal environment as evidence by mineral, chemical, and temperature zonation, preserved textures, sulfur isotopic data, and age determinations (McLemore, 1993). Some areas contain anomalous concentrations of gold. Therefore, these areas need to be examined for the potential of high-sulfidation (quartz-alunite) gold deposits.

Telegraph district

Mining history and production

The Telegraph mining district is located in the northern Big Burro Mountains (Fig. 1) and contains a diverse range of mineral deposits (Table 104, 105). Small Laramide vein and volcanic-epithermal deposits of precious- and base-metals, fluorite, manganese, uranium, and other commodities have been discovered and mined in the district. Total known production amounts to 1,700 lbs Cu, 1 oz Au, 1,350 oz Ag, 37,800 lbs Pb, minor Zn, 220 long tons of manganese ore, and 16,603 short tons of fluorite (Table 104, 105). In addition, stratabound uranium deposits occur in the Wild Horse Mesa area.

TABLE 104—Metals production from the Telegraph mining district, Grant County, New Mexico (U. S. Bureau of Mines, 1927-1990). In addition, a small amount of zinc was produced.

YEAR	ORE (SHORT TONS)	COPPER (LBS)	GOLD (OZ)	SILVER (OZ)	LEAD (LBS)	TOTAL VALUE ($)
1938	3	700	—	11	—	76
1940	62	600	1	571	28,200	1,919
1942	3	400	—	4	—	51
1941	23	—	—	710	5,900	841
1948	4	—	—	33	2,000	388
1951	3	—	—	21	1,700	313
TOTAL 1938-1951	98	1,700	1	1,350	37,800	3,588

TABLE 105—Mines and prospects of the Telegraph mining district, Grant County, New Mexico. Location includes section, township, and range.

MINE NAME (ALIAS)	LOCATION	LATITUDE	LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
Barite prospect	NW7 18S 16W	32° 45' 5"	108° 32' 32"	Ba, Ag, Cu	pit	volcanic-epithermal	FN 8/21/94
Barite No. 2	NE18 18S 16W	32° 44' 58"	108° 32' 25"	Ba	pits	volcanic-epithermal	Hedlund (1980)
Black Tower	NW22 16S 17W	32° 54' 15"	108° 35' 35"	Mn	180 ft adit	epithermal Mn	Farnham (1961), Gillerman (1964)
Blue Eagle	21 18S 18W	32° 50' 00"	108° 35' 00"	F	trench	fluorite veins	Richter and Lawrence (1983)
Cloverleaf Fluorspar (Blackmoor)	SW3 18S 17W	32° 46' 06"	108° 35' 38"	F	10 ft deep prospect pit, 50 ft shaft	fluorite veins	Elston (1960), Gillerman (1964), Williams (1966), Hewitt (1959), Gillerman (1952)
Foxtail Creek	SW31 17S 17W	32° 46' 50"	108° 38' 40"	Ag	shafts	volcanic-epithermal	Finnel (USGS unpub. data, 1976-80)
Great Eagle (Hope)	23 18S 18W	32° 50' 00"	108° 35' 00"	F	100 ft shaft, adits	fluorite veins	Richter and Lawrence (1983)
Hard Pan (German)	NW15 18S 17W	32° 44' 44"	108° 35' 27"	Pb, Zn, Cu	shaft and three adits	volcanic-epithermal	Hewitt (1959), Gillerman (1964), Hedlund (1980), NMBMMR file data
Harper	NW16 18S 18W	32° 44' 50"	108° 35' 00"	F	adit	fluorite veins	Richter and Lawrence (1983)
Hillside	SW22 16S 17W	32° 53' 45"	108° 35' 30"	Mn	surface	volcanic-epithermal	Farnham (1961)
Hummingbird	SE29, NE32 18S 17W	32° 42' 15"	108° 36' 50"	F, Ba	adit, opencut	fluorite veins	Williams (1966), McAnulty (1978), Hedlund (1980), NMBMMR file data
Jackpot	C7 18S 18W	32° 45' 00"	108° 32' 00"	F, Mn	pits	fluorite veins	Richter and Lawrence (1983)
Jennie	18, 19 17W, 24 18W 18S	32° 43' 42"	108° 38' 55"	Cu	adit, several prospect pits	volcanic-epithermal	Hewitt (1959), Gillerman (1964), Hedlund (1980)
Lead Mountain	SE36 17S 18W	32° 47' 00"	108° 39' 15"	Pb, Cu, F, Mn	adits	volcanic-epithermal	Gillerman (1964), Gillerman and Whitebread (1956)
May Day 1 and 2 (Yukon Group)	N2 18S 17W	32° 46' 31"	108° 34' 16"	U	No workings-outcrop only	volcanic-epithermal	Gillerman (1964), O'Neill and Thiede (1982)
Moneymetal	NE11 18S 16W	32° 45' 20"	108° 34' 58"	U	adit	volcanic-epithemal	Gillerman (1968), FN 8/20/94
Nichols and Winslow property	NW11 18S 17W	32° 45' 25"	108° 33' 45"	U	pits	volcanic-epithermal	Gillerman (1964)
Old Smokey Group (Lone Wolf)	NW12 17S 17W	32° 50' 35"	108° 33' 30"	Mn	pits	epihermal Mn	Farnham (1961), Richter and Lawrence (1983)
Prince Albert No. 1	1 18S 17W	32° 45' 55"	108° 33' 05"	U	15 ft adit, cut, pit	volcanic-epithermal	Gillerman (1964), O'Neill and Thiede (1982), FN 8/20/94

MINE NAME (ALIAS)	LOCATION	LATITUDE	LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
Prince Albert No. 2	E2 18S 17W	32° 46' 11"	108° 33' 46"	U	bulldozer stripping, outcrop, shallow pit	volcanic-epithermal	O'Neill and Thiede (1982), Gillerman (1964), FN 8/20/94
Purple Heart	SE3 18S 17W	32° 45' 56"	108° 34' 54"	F, U	65 ft inclined shaft, 108 ft vertical shaft, adit	volcanic-epithermal	Gillerman (1952), Hewitt (1959), Elston (1960), Gillerman (1964), Williams (1966), FN 8/19/94
Purple Rock mine	N22 18S 18W	32° 43' 40"	108° 41' 25"	U, W, Th, fluorite	adits, shafts, pits	volcanic-epithermal	FN 8/18/80, Gillerman (1964)
Rambling Ruby	E2 18S 17W	32° 46' 11"	108° 33' 45"	F, U, Cu	pits, shaft, trenches	volcanic-epithermal	Gillerman (1964), FN 8/20/94
Reed Fluorspar	C of N2 18S 17W	32° 46' 22"	108° 34' 13	F, U, Au	3 shafts (30-50 ft deep), 2 opencuts, a few prospect pits	volcanic-epithermal	Gillerman (1964), Williams (1966), FN 8/20/94
Sandy	12, 22 18S 18W	32° 44' 00"	108° 41' 25"	U, fluorite	80 ft shaft, pits	volcanic-epithermal	Hewitt (1959), McLemore (1983)
Slate Creek (Slate Canyon)	SW36 17S 18W	32° 47' 00"	108° 39' 30"	Pb, Zn, Cu	shaft, adit	volcanic-epithermal	Gillerman (1964), Gillerman and Whitebread (1956)
Springfield	9 18S 17W	32° 45' 15"	108° 36' 00"	U, Cu	2 shallow pits, one cut	volcanic-epithermal	O'Neill and Thiede (1982)
Telegraph (Tecumseh)	SW32 17S 17W	32° 46' 43"	108° 37' 28"	F, Mn, Ag	2 shallow shafts, 2 adits 200 ft	volcanic-epithermal	Jones (1904), Lindgren et al. (1910), Hewitt (1959), Gillerman (1964)
Union Hill Claims	NE10 18S 17W	32° 45' 25"	108° 34' 45"	Mo, Pb, Sb, W, Zn, U	180 ft adit, cuts, drilling	volcanic-epithermal	O'Neill and Thiede (1982), Gillerman (1964)
WF Claims (Aiello property)	NW12 18S 17W	32° 45' 40"	108° 33' 30"	U, Au	no workings-outcrop only	volcanic-epithermal	FN 8/5/82
unknown Cu prospect	SW17 18S 17W	32° 44' 20"	108° 37' 38"	Cu	2 pits	epithermal-vein	Richter and Lawrence (1983)
unknown	C1 18S 17W	32° 45' 55"	108° 33' 45"	Cu	20 ft shaft, 15 ft pit	epithermal-vein	FN 8/21/94

Of the several small mines and prospects in the district, the Telegraph mine is the best known. By 1905, the small Telegraph ore body had been depleted and the mining camp abandoned (Lindgren et al., 1910). No record of the mineralogy or production from the Telegraph mine has been located (Hewitt, 1959).

The Purple Heart mine in the Wild Horse Mesa area produced 1,288 short tons of fluorite ore from 1947 to 1953, and the Hummingbird mine produced 615 short tons of fluorite ore in the same period (Williams, 1966). Minor manganese production occurred in the district, the Black Tower claim producing 205 long tons of ore with 41-42% contained manganese from 1954 to 1957. The Hillside mine produced 15 long tons of ore with 24.6% contained manganese from 1952 to 1953. The Slate Creek mine produced 10 short tons of ore containing 0.36 ounces of gold, 100 ounces of silver, 40 pounds of copper, and 2,103 pounds of lead in 1941 (NMBMMR file data).

Geology

The northern Burro Mountains are composed mostly of granite, quartz diorite, and associated Proterozoic igneous rocks of the Burro Mountain batholith. Cretaceous sedimentary and volcanic rocks overlie the Proterozoic rocks in the northern part of the district. Gila Conglomerate and Recent gravels fill the valleys. Gillerman (1964, 1970) describes the quartz diorite that crops out extensively in the northern part of the Big Burro Mountains as white to pinkish-gray, coarse-grained, porphyritic, with a distinct foliated structure. It weathers tan and forms generally rounded outcrops with a knobby surface due to feldspar phenocrysts. The southern boundary of School House Mountain cauldera occurs in the northern part of the district (Wahl, 1980). Radial and ring-fracture faults are common and control much of the mineralization.

Mineral deposits

The abandoned Telegraph mine is located in an area where Beartooth quartzite is in fault contact with Burro Mountain granite by northwest-trending faults (Hewitt, 1959). The faults cut both quartzite and granite. A mineralized fissure vein strikes N28°E and dips 64°SE and is less than one foot thick where it crops out on the top of a nearby hill. At the entrance to the adit, the vein was probably less than three feet thick. In the adit, granite host rock is silicified and stained by iron and manganese oxides. Limonite stained quartz is common, and small nodules and veinlets of manganese oxides and botryoidal masses of psilomelane are observed in silicified granite and quartz-vein material (Hewitt, 1959). Lindgren et al. (1910) speculates that minute black specks within the vein probably carried the silver, but Hewitt (1959) found no silver in the vein material.

At Lead Mountain in the northern part of the district, two abandoned lead mines are found on a vein in a 5- to 10-ft-thick mineralized shear zone that strikes N30- 35°E and dips 58- 65°SE in Burro Mountains granite (Hewitt, 1959). Feldspar within the granite has been intensely altered to kaolinite up to 25 ft on both sides of the vein, and the altered granite contains quartz veinlets and minute pyrite cubes (Gillerman, 1964). Samples of the mine dump yielded columnar quartz and galena in lenses and as disseminated grains. Material on the dump was stained by chrysocolla, iron, and manganese oxides (Hewitt, 1959).

In Slate Creek Canyon, coarse galena, and minor amounts of sphalerite, bornite, and chalcopyrite have been found in a breccia zone in Beartooth quartzite along a fault striking N62°E and dipping 68°NW. Veins of milky to pale amethyst quartz up to 1 foot thick cut the quartzite, and quartz coats the breccia blocks and lines cavities between blocks. Hewitt (1959) speculated that exploration may yield larger bodies of galena beneath the quartzite.

Copper as malachite, chrysocolla, and tenorite was mined in the early 1900s at the Jennie mines in North Copper Canyon. The minerals coat the granite footwall and fill narrow fractures near a fault contact of granite and metadiabase that strikes N60°E and dips 65°SE (Gillerman, 1964).

Manganese at the Black Tower mine four miles south of Cliff occurs in a fracture zone in tuff and rhyolite (Gillerman, 1964).

In the Wild Horse Mesa area, volcanic-epithermal veins contain pyrite, quartz, sericite, gold, uranium, copper, and silver. Fluorite veins predominant (Fig. 59; Table 105). Silification is common (Fig. 88). Assays from these veins are in Table 106. The veins follow faults forming ring-fractures and radial fractures from the Schoolhouse Mountain caldera. At the Purple Heart mine, west of Wild Horse Mesa, fluorite occurs in two slightly radioactive veins striking N34-47°W as fracture filling and crustiform masses on granite fragments in a fault breccia zone (Hewitt, 1959). A sample assayed 0.3 oz/short ton Au and 1,265 ppm Mo (NMBMMR file data). Uranium occurs as veins along shear zones cutting the Proterozoic granite and Cretaceous Beartooth Quartzite, as veins and replacements along the unconformity between the Proterozoic granite and Cretaceous Beartooth Quartzite, and within fluorite veins cutting the Proterozoic granite. Other minor radioactive occurrences are found throughout the district, but there has been no production. Assays range from 0.009% to 0.59% U_3O_8. A sample from the Prince Albert #1 claim near Wild Horse Mesa assayed 0.09% U_3O_8 and trace gold (NMBMMR file data).

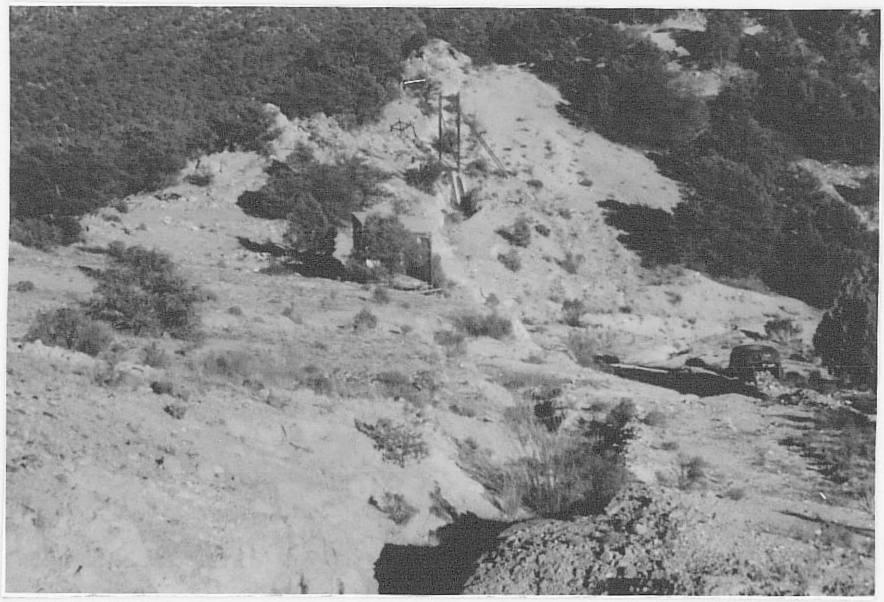

FIGURE 59—Jimmy Reed fluorite mine, looking west, Wild Horse Mesa area, Telegraph district, Grant County (V. T. McLemore photo, 9/94).

FIGURE 60—Silification along a fault in the Wild Horse Mesa area, Telegraph district, Grant County (V. T. McLemore photo, 9/94).

TABLE 106—Chemical analyses of samples from Wild Horse Mesa area, Telegraph district. Analyzed by Bondar-Clegg and Co. Ltd. (Au by fire assay; Ag, Cu, Pb, Zn, Mo by FAAS; As, Sb by INAA; Hg by cold vapor AA).

SAMPLE NO.	Au ppb	Ag ppm	Cu ppm	Pb ppm	Zn ppm	As ppm	Sb ppm	Mo ppm	Hg ppb	DESCRIPTION OF SAMPLE
WH 1	8	0.6	504	429	1,683	20.0	4.5	15	26	dump, Moneymetal vein
WH 2	7	0.4	28	1,367	758	58.0	12.0	75	28	dump, Moneymetal vein
WH 3	<5	<0.1	40	46	67	0.5	0.5	4	13	4 ft chip of Moneymetal vein
WH 4	<5	0.6	9	1,256	1,095	39.0	1.7	12	<5	4 ft chip of Moneymetal vein
WH 5A	<5	<0.1	105	42	79	1.6	1.6	<1	18	4 ft chip of vein, S11 18S 17W
WH 5B	<5	0.3	49	79	32	3.3	3.3	2	66	8 ft chip of vein, S11 18S 17W
WH 6A	<5	<0.1	21	27	32	0.6	0.6	3	15	10 ft chip of vein, S11 18S 17W
WH 6B	<5	<0.1	20	5	11	0.5	0.5	2	13	chip of vein, S11 18S 17W
WH 20	<5	0.3	5	10	366	5.3	1.4	5	<5	4 ft chip at portal, N20 18S 17W
WH 21	<5	0.3	4	14	412	4.3	1.1	4	<5	select dump, N20 18S 17W
WH 22	<5	<0.2	3	12	17	2.3	0.6	<1	<5	altered rhyolite, NE11 18S 17W
WH 23	<5	1.0	7	53	233	4.7	2.9	4	<5	5 ft chip across vein, Moneymetal adit
WH 24	<5	0.2	130	38	84	4.6	1.1	4	<5	Moneymetal pit
WH 25	40	3.2	9	50	134	63.0	1.9	16	<5	3 ft chip across vein, Prince Albert
WH 26	11	1.9	3	78	30	12.0	1.5	6	<5	3 ft chip across vein, Prince Albert
WH 27	<5	20.7	9138	114	30	3.0	2.2	3	<5	outcrop, SE36 17S 17W
WH 28	195	>50.0	>20,000	106	113	4.0	5.8	31	28	select dump, Rambling Ruby
WH 29	25	0.8	101	130	65	36.0	1.7	9	11	outcrop of Reed fault, NE2 18S 17W
WH 30	<5	<0.2	39	26	15	1.4	1.0	1	<5	1 ft chip across Reed fluorite vein
WH 31	<5	<0.2	6	60	12	1.8	0.4	2	7	1 ft chip across quartz vein, C1 18S 17W
WH 32	38	18.8	15,968	261	84	2.5	0.3	4	<5	select dump of 15 ft decline, C1 18S 17W
WH 33	<5	0.5	122	41	185	4.9	1.3	5	<5	dump, C1 18S 17W
WH 34	122	5.5	8,438	108	37	2.4	0.9	3	9	select dump, C1 18S 17W
WH 35	109	6.4	9,343	204	19	2.1	1.0	4	5	1.5 ft chip across vein, 20 ft shaft, C1 18S 17W
WH 36	245	2.7	161	351	299	<0.1	<0.2	5	<5	dump, NE13 18S 17W
WH 37	<5	0.7	169	8	42	1.9	0.7	3	<5	quartz pod in rhyolite, NE13 18S 17W
WH 38	<5	0.3	59	40	47	2.9	6.2	<1	<5	10 ft chip of vein at Barite prospect
WH 39	<5	3.4	151	80	248	7.2	4.9	2	16	6 ft chip of vein at Barite prospect
WH 40	<5	0.8	67	68	101	4.6	7.0	2	7	6 ft chip, Barite prospect
Purple Heart	1043	0.5	8	13	26	523.0	12.0	1265	277	dump at Purple Heart adit

White Signal district

Location and Mining History

The White Signal mining district is located approximately 15 miles south of Silver City on US-180 (Fig. 1). The district includes almost all of T20S, R14 and 15W. and a small area in the southeastern part of R16W (Gillerman, 1953, 1964). The White Signal mining district encompasses the southeastern part of the Burro Mountains and the isolated hills and plains south and southeast of the mountains. Mining in the district began in the 1870's or 1880's. Types of deposits found in the White Signal district include; Laramide veins, gold placer deposits, and pegmatites. From these deposits, the district has produced fluorspar, uranuim, radium, gold, silver, lead, bismuth, turquoise, garnet, and ocher (Tables 4, 5, 6). From 1880-1968, total estimated metal production amounted to 26,000 lbs Cu, 2,500 oz Ag, and 2,200 lbs Pb worth approximately $80,000 (Table 107). In addition, 1,700 oz Au and 10 lbs of garnet have been produced from placer gold deposits (Johnson, 1972; McLemore, 1994a). No deposit has been explored to a depth greater than 260 ft; average workings extend less than 100 ft deep (Gillerman, 1964).

TABLE 107—Metals production from the White Signal mining district, Grant County, New Mexico (USBM Mineral Yearbooks).

YEAR	ORE (SHORT TONS)	COPPER (LBS)	GOLD LODE (OZ)	GOLD PLACER (OZ)	SILVER (OZ)	LEAD (LBS)	TOTAL VALUE ($)
1933	10	—	11.42	15.14	3	—	550
1934	23	—	—	138.17	187	200	4,957
1935	—	—	—	48.46	8	—	1,702
1936	—	—	0.40	4.66	2	—	179
1937	—	—	—	30.40	5	—	1,068
1938	—	—	—	98.4	12	—	3,452
1939	14	100	13	14	7	—	960
1940	30	—	31	2	90	—	1,219
1941	68	5,400	25	4	346	—	1,898
1942	140	10,100	10	—	169	—	1,692
1943	26	1,500	—	—	7	—	200
1946	19	700	17	—	151	1,900	1,037
1954	1	100	—	—	2	—	31
1957	39	100	—	—	43	100	83
TOTAL 1933-1957	370	18,000	108	355	1,032	2,200	19,028
ESTIMATED TOTAL 1880-1968	2,000	26,000	1,700 (lode and placer)	—	2,500	2,200	80,000

Geology

The rocks of the White Signal mining district range in age from Proterozoic to Tertiary and are dominated by igneous intrusive rocks. The Proterozoic granite of the Burro Mountain pluton is the predominant country rock in the area (Gillerman, 1964). Pegmatites commonly intrude the granite in the eastern portion of the district. The oldest rocks in the area are the quartz-biotite and hornblende schists of the Bullard Peak Series, which occur as xenoliths in the Burro Mountains granite. Proterozoic diabase dikes are found throughout the area, but are most numerous in the south and western portions of the district and are associated with uranium veins (Gillerman, 1964). The dikes are as much as 50 ft wide and can be traced for more than a mile. Occasionally, they widen into irregular bodies. In many of the outcropping dikes, diabase has been altered to masses of chlorite, iron oxides, epidote, and clays. The Cretaceous-Tertiary Tyrone quartz monzonite porphry stock is found in the northwestern portions of the area and has an age date of 56.2±1.7 Ma (McDowell, 1971; Hedlund, 1978f, 1985a). Quartz monzonite dikes related to the Tyrone stock are common in the northern portion of the district. Plugs and dikes of Tertiary rhyolite are also common throughout the district; many are associated with the gold-uranium veins, whereas others cut the veins (Gillerman, 1964; Hedlund, 1978d,e,f,g). The rhyolites have age dates between 41.9±3.0 and 49.5±2.8 Ma (Hedlund, 1985a).

Faults in the district strike principally east-northeast and northwest. Many of the diabase dikes, as well as rhyolite and quartz monzonite dikes, have intruded along fault planes. This indicates that the faults may have developed during Proterozoic times (Gillerman, 1964). The more conspicuous faults

(Blue Jay, Uncle Sam, and Walnut Creek) range from a mile to several miles in length. Mineralization and alteration of rock types typically occurs at the intersections of faults, dikes, and fractures.

Mineral Deposits

Laramide vein deposits typically occur in brecciated fault zones, as fissure-fillings along fractures, and in mineralized zones occuring at the intersections of faults, fractures, and dikes (Table 108). The veins generally trend in the same east-northeast and northwest directions as the faults and appear to be related to the rhyolite intrusions dated as 40-50 Ma (Hedlund, 1985a). Because of the localized nature of these deposits at fault-dike intersections, they are usually discontinuous and small. Veins can rarely be traced more than 500 ft (Gillerman, 1964). The veins are variable in mineralogy; simple quartz-pyrite-gold, quartz-molybedenite, and more complex veins are common in the district (Hedlund, 1985a). The veins locally contain gold, native silver, argentite, chalcopyrite, sphalerite, galena, bismuthinite, and uraninite (Gillerman, 1964; Hedlund, 1985a). Assays as much as 15,300 ppb Au are reported in recent studies (O'Neill and Thiede, 1982; Hedlund, 1985a). Fluorite veins appear to be younger than the polymetallic veins. Silicification is common.

TABLE 108—Mines and prospects in the White Signal district, Grant County, New Mexico. Deposits are Laramide veins, unless otherwise described. Location includes section, township, and range.

MINE NAME (ALAIS)	LOCATION	LATITUDE	LONGITUDE	DEVELOPMENT	GEOLOGY	COMMODITIES	REFERENCES
Ace-in-the-Hole (Duece-in-the-Hole)	22 20S 15W	32° 32' 40"	108° 22' 50"	pits	granite	U, Cu, Au	—
Alhambra (Bluebell #2, Lindsey, Denver)	NE21 20S 15W	32° 33' 28"	108° 23' 50"	2 shafts (65 ft deep), trench, pits	vein along diabase dike	U, Cu, Au	Anderson (1980), O'neill and Thiede (1982), McLemore (1983), Gillerman (1964); FN 7/12/80
Apache Trail (Black Cat)	NE2 20S 15W	32° 36' 00"	108° 21' 20"	200 ft shaft, inclined shaft, pits	vein cut fault and diabase dike	U, Au, Cu, Bi, Ag	O'Neill and Thiede (1982), McLemore (1983), Hedlund (1978h)
Arrowhead	22 20S 15W	32° 32' 45"	108° 22' 50"	30 ft shaft, trench, pit	latite dike	U, Cu, Au	O'Neill and Thiede (1982), McLemore (1983)
Banner	26 20S 15W	32° 32' 40"	108° 22' 25"	caved shaft, pits	veins along Blue Jay fault	U, Cu, Au	McLemore (1983), O'Neill and Thiede (1982), Hedlund (1978h), Gillerman (1964)
Bisbee	SE27 20S 14W	32° 32' 00"	108° 22' 35"	80-90 ft shafts, 100 ft adit	granite	U, Cu, Au	McLemore (1983), O'Neill and Thiede (1982), Hedlund (1978h), Gillerman (1964)
Black Beauty	NE35 20S 15W	32° 31' 40"	108° 22' 5"	5 ft pit	veins along rhyolite dike	U, Cu, Au	McLemore (1983), Hedlund (1978h), FN 8/6/82
Black Tom	22 20S 14W	32° 32' 30"	108° 22' 50"	pit	fillings in granite	Mn	Richter and Lawrence (1983)
Blackman	NE26 20S 14W	32° 32' 35"	108° 22' 30"	pits, shafts	ffault in granite	Ag, Pb	Richter and Lawrence (1983)
Blue Bird	22 20S 15W	32° 32' 35"	108° 22' 45"	pits, shaft	granite	U, Cu, Au	—
Blue Jay (Shamrock, Raven, Janet B)	S23,N26 20S 15W	32° 32' 40"	108° 21' 50"	pits, trenches, shaft, drill holes (0-50 ft) deep	veins along Blue Jay fault	U, Cu, Au	McLemore (1983), Granger et al. (1952), Gillerman (1964), Gillerman and Lovering (1956); FN 7/12/80
Bouncing Bet	24 20S 15W	32° 33' 10"	108° 20' 30"	2 shafts, pits, trenches	vein along diabase dike	U, Cu, Au	McLemore (1983), O'Neill and Thiede (1982), Gillerman (1964), FN 8/20/80
Buckhorn	SE19 20S 15W	32° 33' 30"	108° 25' 30"	pit	granite	U, Cu, Au	O'Neill and Thiede (1982), Mclemore (1983)
Calamity	SE23 20S 15W	32° 32' 55"	108° 21' 30"	2 shafts (100 ft deep), trenches, pits	Blue Jay fault	U, Cu, Au	McLemore (1983), Anderson (1980)

MINE NAME (ALAIS)	LOCATION	LATITUDE	LONGITUDE	DEVELOPMENT	GEOLOGY	COMMODITIES	REFERENCES
California (Utah, Acme, Hill)	SE22 20S 15W	32° 33' 10"	108° 22' 40"	80 ft shaft with drifts on 70 ft level, 18 ft, 35 ft shafts, pits	along contact between granite and diabase dike	U, Cu, Au	McLemore (1983), O'Neill and Thiede (1982), Gillerman (1964), FN 7/12/80
Chapman turquoise	NE25 20S 15W	32° 32' 20"	108° 20' 20"	shaft, adit with glory hole	2 diverging veins and altered diabase dike	U, Cu, Au, turquoise	McLemore (1983), Gillerman (1964), FN 8/20/80
Combination	NE23 20S 15W	32° 33' 30"	108° 21' 25"	130 ft, 60 ft shaft, pits	granite	U, Cu, Au	McLemore (1983), O'Neill and Thiede (1982), Gillerman (1964)
Copeland (Crownpoint)	8 20S 15W			pits	granite	U, Cu, Au	McLemore (1983)
Copper Glance	NE23 20S 15W	32° 33' 00"	108° 21' 25"	85 ft shaft, trench, cut, pit	vein cuts rhyolite dike	Cu, Au, U	McLemore (1983), O'Neill and Thiede (1982), Gillerman (1964)
Dagger Point (AML 12-13)	SW27 20S 15W			50 ft, 30 ft shaft	granite	Cu, Au	FN 1/27/95
Edmonds	C34 20S 15W	32° 31' 29"	108° 22' 50"	shaft	granite	Pb, Zn, Cu, Au	McLemore (1983), O'Neill and Thiede (1982), Gillerman (1964)
Edwards	27 20S 15W	32° 32' 00"	108° 22' 35"	pit	granite	U, Cu, Au	McLemore (1983), O'Neill and Thiede (1982), Gillerman (1964)
Eugenie (Paddyford, Prevost, Star, AML 8)	23, NE26 20S 15W	32° 32' 30"	108° 21' 30"	80 ft shaft filled with water, drifts, pits, trenches	diabase dike	U, Cu, Au	McLemore (1983), O'Neill and Thiede (1982), Gillerman (1964), Anderson (1980), FN 1/27/95
Floyd Collins (Leachs, Artiminas mine #3)	W22,E21 20S 15W	32° 33' 15"	108° 23' 25"	40 ft, 80 ft shafts, pits	along contact between granite and diabase dike	U, Cu, Au	McLemore (1983), O'Neill and Thiede (1982), Gillerman (1964), Hilpert (1965), FN 7/12/80
Gold Lake placers	S20 20S 14W			pits	placer gold	Au	Gillerman (1964)
Golden Eagle	NE14 20S 15W	32° 34' 15"	108° 21' 40"	80-90 ft shaft, pits, drill holes	diabase dike	U, Cu, Au	McLemore (1983), O'Neill and Thiede (1982), Hedlund (1978h), Gillerman (1964), FN 7/12/80
High Noon	17,20 20S 15W	32° 33' 50"	108° 24' 30"	cut	pegmatite	U, Cu, Au	McLemore (1983), O'Neill and Thiede (1982), Hedlund (1978g), Gillerman (1964)
Homestake	11 20S 15W			pits	granite	U, Cu, Au	—
Hummer-Inez (Lone Jack, Good Luck, 7-X-V Ranch)	SW24 20S 15W	32° 32' 58"	108° 21' 5"	20-21 ft shafts, pits, adits	vein along diabase dike	U, Au	McLemore (1983), O'Neill and Thiede (1982), Hedlund (1978h), Gillerman (1964)
Jay (Joy, Sprouse, Copeland)	8,9,17 20S 15W			pits, shafts	granite	U, Au	Gillerman (1968)
Jersey Lilly (Snowflake)	34 18S 15W			shafts, adits	veins in granite	Ag, U	Richter and Lawrence (1983)
Lettie May (Black Hawk, Blue Birch,J and K, Little May)	15,22 20S 15W	32° 33' 31"	108° 22' 44"	2 shafts, 2 pits	veins in diabase	U, Cu, Au	McLemore (1983), O'Neill and Thiede (1982), Hedlund (1978g), Gillerman (1964)
Little Cookie	18 20S 15W			pits	granite	U, Cu, Au	McLemore (1983), O'Neill and Thiede (1982), Hedlund (1978g)
Lone Jack	24 20S 15W	32° 33' 12"	108° 21' 00"	pits	granite	U, Cu, Au	McLemore (1983), O'Neill and Thiede (1982)

MINE NAME (ALAIS)	LOCATION	LATITUDE	LONGITUDE	DEVELOPMENT	GEOLOGY	COMMODITIES	REFERENCES
Merry Widow	C22 20S 15W	32° 33' 10"	108° 23' 00"	168 ft shaft, 50 ft level, pits, trenches	diabase dike	U, Cu, Au, Bi	McLemore (1983), O'Neill and Thiede (1982), Hedlund (1978g), Gillerman (1964)
Monarch	19 20S 15W	32° 32' 50"	108° 26' 15"	2 shafts, pits, trenches	granite	U, Cu, Au	McLemore (1983)
Moneymaker	SW19 20S 15W			shafts, pits	rhyolite dike	U, Cu, Au, Pb, fluorite	Gillerman (1968)
Mose Timmer	NE21 21S 14W	32° 32' 50"	108° 24' 30"	180 ft shaft	barite-quartz vein in granite	barite, Pb, Ag	Richter and Lawrence (1983)
Nana	24 20S 15W	32° 33' 10"	108° 21' 10"	pits	granite	U, Cu, Au	—
New Years Gift	22 20S 15W	32° 33' 8"	108° 22' 18"	122 ft, 34 ft shafts covered by US 180	diabase dike	U, Cu, Au, Bi	McLemore (1983), O'Neill and Thiede (1982), Hedlund (1978g), Gillerman (1964)
Paymaster (Old Paymaster, Silver, AML 5-5A, 6-7)	21,28 20S 15W	32° 32' 50"	108° 24' 15"	2 shafts, adit, pits	granite	U, Cu, Au, Pb, Ag	McLemore (1983), O'Neill and Thiede (1982), Hedlund (1978g), Gillerman (1964)
Pegmatites (AML 3)	NW28 20S 15W	32° 32' 30"	108° 24' 20	2 pits	pegmatite	U, Cu, Au	McLemore (1983), O'Neill and Thiede (1982), Hedlund (1978g), Gillerman (1964), FN 7/25/80
Red Bird	22,23,26 20S 15W	32° 33' 00"	108° 22' 15"	200 ft shaft	rhyolite dike	U, Cu, Au	McLemore (1983), O'Neill and Thiede (1982), Hedlund (1978g), Gillerman (1964)
Red Dodson	E14 20S 15W	32° 34' 5"	108° 21' 30"	200 ft adit, 60-80 ft shaft, pits	diabase	U, Cu, Au, Bi, Ag	McLemore (1983), Hedlund (1978h), Gillerman (1964), FN 7/12/80
Red Hill	E14 20S 15W	32° 34' 15"	108° 24' 00"	3 pits, adit	granite	U, Cu, Au	McLemore (1983), O'Neill and Thiede (1982), Hedlund (1978g), Gillerman (1964)
Saddle Mountain	23, 24 20S 15W			drill holes, pits	porphyry Cu-Mo	U, Cu, Au	Richter and Lawrence (1983)
Shamrock	SE23 20S 15W	32° 33' 12"	108° 22' 5"	30 ft shaft, pits	diabase dikes	U, Cu, Au	McLemore (1983), O'Neill and Thiede (1982), Hedlund (1978g), Gillerman (1964), Anderson (1980)
Talcacite (AML 10)	SW25 20S 15W	32° 32' 40"	108° 21' 45"	50-100 ft shaft, 15 ft adit	vein	U, Cu, Au	FN 1/27/95
Timmer	SE15 20S 14W			50 ft shafts	veins in granite	Ag	Richter and Lawrence (1983)
Tunnel Site (Edna May, AML 9)	26 20S 15W	32° 32' 25"	108° 21' 20"	10 ft caved shaft, 250 ft adit with 20, 40 ft winzes	rhyolite dike	U, Cu, Au	McLemore (1983), O'Neill and Thiede (1982), Hedlund (1978g), Gillerman (1964), FN 1/27/95
Valley (Tullock, Anomaly 8)	SW25 20S 15W	32° 32' 20"	108° 21' 40"	3 shafts (deepest 260 ft), pits	diabase dikes	U, Cu, Au	McLemore (1983), O'Neill and Thiede (1982), Hedlund (1978g), Gillerman (1964), FN 7/21/80
Wisconsin (Paddyford, Fritze, Albertine, Janet D, Book)	SE23,24 20S 15W	32° 33' 5"	108° 21' 40"	120 ft shaft, pits	diabase dikes	U, Cu, Au	McLemore (1983), O'Neill and Thiede (1982), Hedlund (1978g), Gillerman (1964)

MINE NAME (ALAIS)	LOCATION	LATITUDE	LONGITUDE	DEVELOPMENT	GEOLOGY	COMMODITIES	REFERENCES
Uncle Sam	32 20S 14W			shats, pits, adits	fault zone in granite	U, Au, Ag, Cu, W	McLemore (1983)
unknown	1 20S 15W	32° 35' 57"	108° 20' 55"	pits	granite	U, Cu, Au	McLemore (1983), O'Neill and Thiede (1982), Hedlund (1978g), Gillerman (1964)
unknown	13 20S 15W	32° 34' 2"	108° 20' 50"	pits	granite	U, Cu, Au	McLemore (1983), O'Neill and Thiede (1982), Hedlund (1978g), Gillerman (1964)
unknown	C W28 20S 15W	32° 32' 20"	108° 24' 7"	pits, shaft	granite	U, Cu, Au	McLemore (1983), O'Neill and Thiede (1982), Hedlund (1978g), Gillerman (1964)
unknown	NE14 20S 15W	32° 34' 21"	108° 21' 43"	shaft	granite	U, Cu, Au	McLemore (1983), O'Neill and Thiede (1982), Hedlund (1978g), Gillerman (1964)
unknown	NE21 20S 15W	32° 33' 16"	108° 23' 25"	pits	granite	U, Cu, Au	McLemore (1983), O'Neill and Thiede (1982), Hedlund (1978g), Gillerman (1964)
unknown	NE23 20S 15W	32° 33' 33"	108° 21' 25"	shaft, pits	granite	U, Cu, Au	McLemore (1983), O'Neill and Thiede (1982), Hedlund (1978g), Gillerman (1964)
unknown	NE26 20S 15W	32° 32' 35"	108° 21' 30"	pits	granite	U, Cu, Au	McLemore (1983), O'Neill and Thiede (1982), Hedlund (1978g), Gillerman (1964)
unknown	NW14 20S 15W	32° 34' 14"	108° 20' 50"	pits	granite	U, Cu, Au	McLemore (1983), O'Neill and Thiede (1982), Hedlund (1978g), Gillerman (1964)
unknown	NW26 20S 15W	32° 32' 35"	108° 22' 00"	pits	granite	U, Cu, Au	McLemore (1983), O'Neill and Thiede (1982), Hedlund (1978g), Gillerman (1964)
unknown	SE26 20S 15W	32° 31' 45"	108° 21' 25"	pit	granite	U, Cu, Au	McLemore (1983), O'Neill and Thiede (1982), Hedlund (1978g), Gillerman (1964)
unknown	SE26 20S 15W	32° 32' 35"	108° 21' 20"	pit	granite	U, Cu, Au	McLemore (1983), O'Neill and Thiede (1982), Hedlund (1978g), Gillerman (1964)
unknown	SW27 20S 15W			outcrop	granite	U, Cu, Au	McLemore (1983), O'Neill and Thiede (1982), Hedlund (1978g), Gillerman (1964)
unknown	SW28 20S 15W			23 ft shaft with 2 short drifts	fractured granite	U, Cu, Au	FN 1/27/95
unknown (Anomaly #7)	25,36 20S 15W	32° 31' 16"	108° 20' 45"	none-outcrop	granite	U, Cu, Au	Hedlund (1978h), Mclemore (1983), FN 8/6/82

The uranium deposits in the area occur within the zone where the diabase has been oxidized, as concentrations of secondary uranium phosphates, or as disseminations in altered granite and dike rocks (Gillerman, 1964). These deposits consist of closely spaced fractures filled or coated with uranium phosphates usually 1 mm thick or less. Autunite and torbernite are the uranium-bearing minerals. They are associated with gold, copper, and silver in the oxidized zone. Below the oxidized zone, the primary ore minerals, such as native gold, chalcopyrite, argentiferous galena, and specular hematite, are not of sufficient abundance to exploit under present economic conditions. Bismuth minerals have been reported in some deposits (Gillerman, 1964). Most of the deposits in the area, with the exception of the Floyd Collins and Inez mines, were first mined for base- and precious-metals.

Rare earth-element-bearing pegmatitic pods or lenses occur in Burro Mountain granite in the western part of the area. These deposits are similar to those found a few miles to the south-southwest in the Gold Hill mining district (McLemore et al., 1988a, b). Allanite, euxenite, samarskite, and cyrtolite are the rare earth-element-bearing minerals present.

Several of the streams and dry washes in the Burro Mountains have reported placer gold deposits. According to Johnson (1972), the origin of placer gold in Thompson's Canyon and Gold Gulch is not specifically known, but it probably is derived from gold-bearing veins that occur in the adjacent mountains. In the Gold Lake area, placer gold originated from veinlets in a small granite knob which is surrounded by alluvium. Garnet was also produced from this area (Gillerman, 1964). Johnson (1972) reports that gold placers were worked in Thompson's Canyon and Gold Gulch in 1884 and possibly earlier. The amount of this early production is unknown. Most of the district's placer mining in this century took place in the 1930s.

Wilcox district

Location and Mining History

The Wilcox (Seventy-four) mining district is located in northwest Grant County and extends northwestward into Catron County (Fig. 1). Only about one third of the district is in Grant County. In the past, the district has been the site of active mining and exploration, but little production. Approximately 1,500 mining claims have been staked in the district since its discovery in 1879 (Ratte et al., 1979). The majority of these have been in the Catron County part of the district; but numerous claims, prospect pits, shafts, and adits are located in Grant County (Table 109; Fig. 61). This part of New Mexico was so inaccessible that early production was transported to the mill by pack train (Rothrock et al., 1946). At least 10,603 short tons fluorite, 17 oz Ag, <100 oz gold, some copper, and 5 short tons of tellurium ore have been produced from this district (Tables 2, 4; Ratte et al., 1979). It is not known what part of this production came from Grant County. In 1942, 2 tons of ore containing 17 oz Ag and some gold and copper were produced from the district.

TABLE 109—Mines and prospects of the Wilcox mining district, Grant County, New Mexico. Location includes section, township, and range.

MINE NAME (ALIAS)	LOCATION	LATITUDE	LONGITUDE	COMMODITIES	DEVELOPMENT	TYPE OF DEPOSIT	REFERENCES
Columbus Group (includes Chance Claim)	3 13S 18W	33° 12' 07"	108° 41' 22"	Au, Ag	200 ft adit	volcanic-epithermal (?)	Ratte et al. (1979)
Fairview	NW18 13S 17W	33° 10' 26"	108° 38' 18"	F	pits	fluorite veins (?)	Williams (1966)
Gold Spar (Bluebird, Rain Creek, and Good Hope mines)	SE11 13S 18W	33° 10' 54"	108° 40' 08"	F	2 opencuts, 60 ft adit, 275 ft tunnel	fluorite veins (?)	Johnston (1928), Rothrock et al. (1946), Gillerman (1964), Williams (1966), Ratte and Gaskill (1975)
Margie Ann	3 13S 18W	33° 12' 15"	108° 41' 30"	Au, Ag, Cu, Pb	150 ft adit, 60 ft winze	volcanic-epithermal (?)	Ratte et al. (1979)
Master	13 13S 18W	33° 10' 20"	108° 39' 15"	F	2 short caved adits	fluorite veins	Ratte et al. (1979)
Radioactive occurrences	13S; 1,12 18W, 6 17W	33° 11' 48"	108° 39' 21"	U	occurrences only	volcanic-epithermal	NMBMMR file data
Rainbow	NE13 13S 18W	33° 10' 38"	108° 39' 00"	F	opencuts and drifts	fluorite veins (?)	Williams (1966), Rothrock et al. (1946)
Seventy-Four Mountain	18 13S 17W	33° 10' 22"	108° 38' 24"	F	small opencut	fluorite veins (?)	Williams (1966), Rothrock et al. (1946)

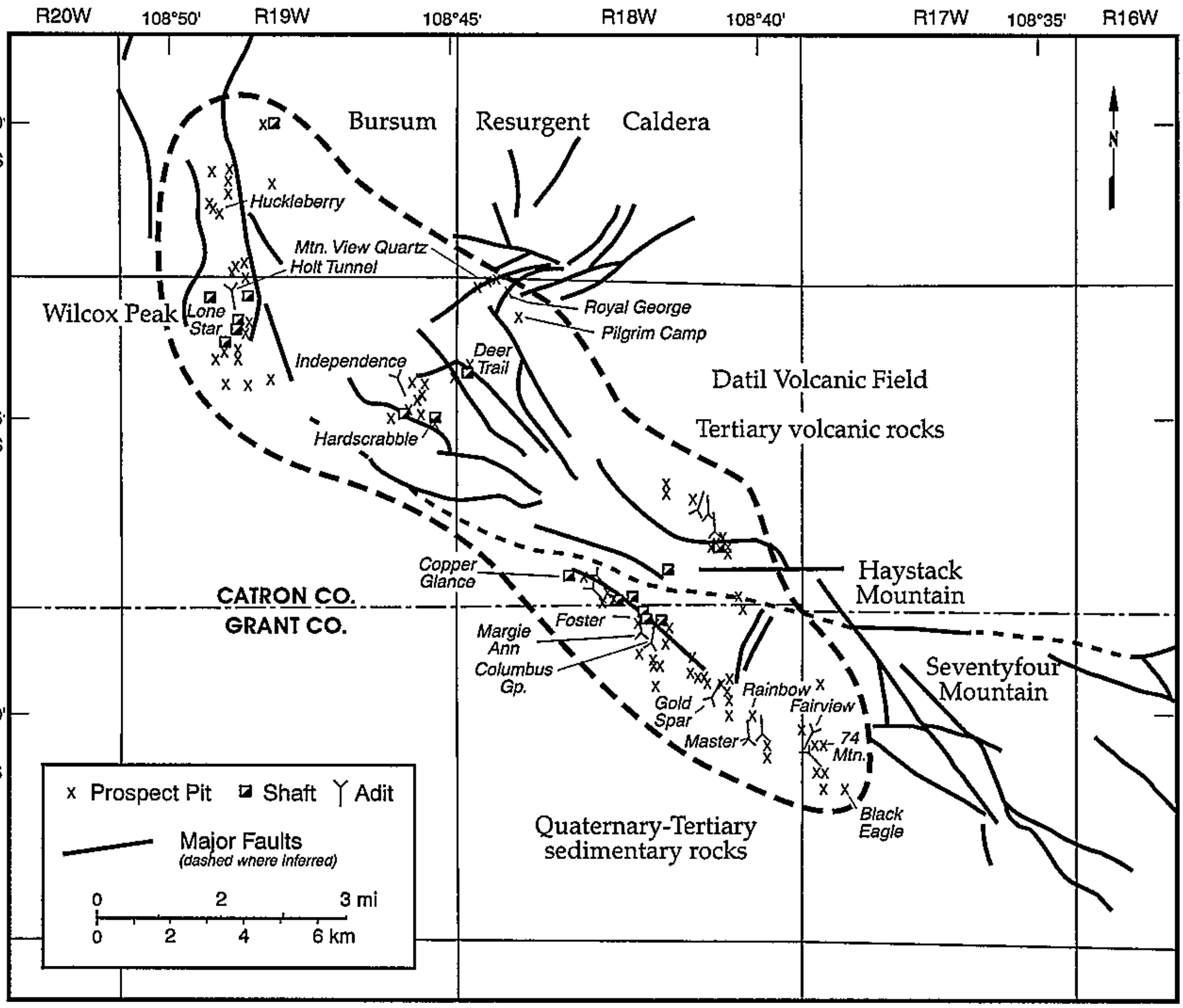

Figure 61—Mines and prospects in the Wilcox mining district, Grant and Catron Counties, New Mexico.

Geology

Rocks in the district are part of the Datil-Mogollon volcanic field which overlies several thousand feet of Mesozoic and Paleozoic sedimentary rocks. Proterozoic basement rocks underlie the sedimentary units unless they have been replaced by batholithic intrusions which are proposed to underlie much of the Tertiary volcanic field (Elston et al., 1976; Ratté et al., 1979). The rocks in the district are almost entirely of middle to late Tertiary age volcanic rocks except where they are overlain by younger conglomerates or are covered by surficial sand and gravel deposits (Ratte et al., 1979).

In the Grant County part of the district, the oldest volcanic formation is the Cooney quartz latite tuff of Oligocene age (32± 1.5 Ma, Bikerman, 1972; Marvin et al., 1987). Overlying the tuff are younger pre-Bursum caldera rocks of Miocene and Oligocene age (Elston, 1994). These rocks consist of the andesite and basaltic lava flows and flow breccias. Younger rhyolite flows and domes of Miocene and Oligocene age that consist of mainly flow-banded spherulitic to porphyritic rhyolite and associated pyroclastic and volcaniclastic rocks rest upon the younger pre-caldera rocks in the southern tip of the district (Ratté et al., 1979). The volcanic rocks of the Datil volcanic field may cover mineral deposits in the Mesozoic and Paleozoic sedimentary rocks or deeper in the volcanic blanket.

Mineral Deposits

The Wilcox mining district lies along a line of northwest-trending faults occurring along the western edge of the Datil Volcanic field between Seventyfour and Sheridan Mountains and are related to the Bursum caldera (Elston, 1994). Mineral deposits in the part of the district in the study area are volcanic-epithermal fluorite (±Au) and quartz veins in mineralized faults in the volcanic rocks between Haystack and Seventyfour Mountains. Epithermal manganese and barite can also be found. Brecciation and banded textures are common. Assays from the entire district range as high as 1.3 oz/ton Au, 16.16 oz/ton Ag, 7.05% Cu, 9.01% Zn (Ratte et al., 1979). In the Little Dry, Pine, and Sacaton Creek areas, samples assayed as much as 3,500 ppm Te (Ratte et al., 1979).

Mineralization in most of the district is controlled by north- and northwest-trending fractures zones, by rhyolitic intrusions in the ring-fracture zone of Bursum caldera, and by northeast-trending fractures in the resurgent dome of the Bursum caldera (Ratte et al., 1979).

The veins are widely scattered in the Wilcox district (Ratte et al., 1979) and relatively little subsurface exploration has occurred. Regional alteration consists of kaolinite, chlorite, and silicification. Local areas of acid-sulfate alteration with alunite occurs in the district and has been dated as 31-33 Ma (Marvin et al., 1987). The silicification and argillic and acid-sulfate alteration suggest potential exists for extensive deposits in the subsurface. Furthermore, the structural position of the Datil volcanic field is located near the intersection of major regional tectonic trends, and near major deposits of precious and base metals, iron, manganese (Ratte et al., 1979).

The majority of the mineral deposits in the Grant County part of Wilcox mining district are small fissure-filling fluorite veins. At the Margie Ann mine, for example, a 150-ft long adit was driven along a northwest-trending fault. A high-grade copper-bearing quartz vein is exposed along the east wall of the adit and a sample was taken across a small lens containing copper, silver, and gold (Ratte et al., 1979). It assayed 0.04 oz/ton Au, 3.66 oz/ton Ag, 7.05% Cu, and minor Pb, Bi, Mo, and W. At the Seventyfour Mountain prospect, narrow fluorite veins are in Cooney Quartz Latite Tuff adjacent to the footwall of a 30-ft-wide rhyolite dike striking N12°W and dipping 84°W, and in a crossfault that offsets the dike (Williams,1966). The vein adjacent to the dike consists of 6 inches of high-grade fluorspar and 6 inches of brecciated material containing some fluorspar. Total traceable length of the vein is approximately 100 ft. A sample contained 56.77% fluorite (Ratté et al., 1979). At the Rainbow prospect, three narrow fissure veins occur in rhyolite and andesite. They contain fluorspar in coarsely crystalline fissure-filling material. All three veins crop out on a very steep mountain slope within 100 ft of each other. The veins strike S35°W to S10°E and dip 80°W. Samples across two of the veins contain 55 and 78.9% CaF_2 (Williams, 1966).

At the Gold Spar mine, a breccia zone 1 to 10 ft wide has fluorite, calcite, and quartz as fracture fillings. High grade veins are from 12 inches to 5 feet in width, and are exposed for a maximum of 500 ft (Gillerman, 1964). Ore sold to the mill at Silver City assayed 74.0% CaF_2 (Williams, 1966).

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