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Silver and gold occurrences in New Mexico

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Abstract

Anomalous amounts of silver and/or gold have been identified in 153 mining districts or prospect areas of New Mexico. Production from most of these occurrences has been small; figures or estimates are given when known. Thirty-five districts have produced in excess of 10,000 troy ounces of gold or 200,000 ounces of silver.

Silver and gold in New Mexico occur in 14 distinct types of deposits ranging in age from Precambrian (Proterozoic) to Recent. Mid-Tertiary to Recent deposits include the placer, volcanic-epithermal, supergene copper–uranium (silver), and Great Plains Margin types. Late Cretaceous to mid-Tertiary deposits include the sedimentary-hydrothermal barite–fluorite–galena, carbonate-hosted silver (lead–manganese), lead–zinc and copper skarn, Laramide vein, and prophyry-copper types. Late Paleozoic to early Mesozoic deposits include the sedimentary-copper type and possibly some of the Permian Mississippi Valley type. Precambrian deposits include the vein and replacement and Precambrian massive-sulfide types. Deposits that have produced significant silver and/or gold as the primary product are the placer, volcanic-epithermal, Great Plains Margin, carbonate-hosted silver, and Laramide vein types. Deposits that have produced significant precious metals as a byproduct of base-metal mining include the carbonate-hosted lead–zinc, copper skarn, and porphyry-copper types.

Introduction

Precious metals in varying degrees of importance have been reported from 153 mining districts or geographical areas in New Mexico (map, Table 3). From 1848 through 1983 over 88,890,000 troy ounces of silver worth over $171 million and 2,500,000 troy ounces of gold worth over $156 million have been produced in New Mexico (R. W. Eveleth, pers. comm. 1985). Major producing districts are summarized in Table 1. The approximate boundaries of the districts and areas are shown on the map and keyed to dominant type of deposit. Silver is typically found in most of these areas, while gold may be absent. No deposits of platinum or platinum-group metals are known to occur in New Mexico, although trace amounts of platinum-group metals, selenium, and tellurium have been recovered during copper refining from highly concentrated anode slimes (Eveleth and Bieberman, 1984).

For the purposes of this report an occurrence is arbitrarily defined as a concentration of silver or gold greater than 200 times crustal abundance. The crustal abundances of gold and silver are 0.004 ppm (0.00015 oz/ton) and 0.070 ppm (0.002 oz/ton; Levinson, 1974), respectively. Boyle (1979) estimated terrestrial abundance of gold at 0.005 ppm and of silver at 0.050 ppm. Therefore, selected samples at each occurrence are reported to assay at least 0.8 ppm (0.02 oz/ton) gold or 14 ppm (0.41 oz/ton) silver. Any district that reported production of gold or silver is included as an occurrence.

The most accepted name of each district is listed in Table 3; common synonyms are listed in parentheses. In some cases the areas listed are not formal or even informal districts. These areas have been labeled prospects or areas in the table. Reported gold and/or silver production is also given in Table 3; estimated production is given in parentheses. Production figures listed in Table 3 represent the most accurate, up-to-date statistics available. Previous pubications have incorrectly reported total production for various reasons. In cases where the district is known (or strongly suspected) to have produced, but not enough information is available to provide a reasonable estimate, silver and/or gold are listed under "other commodities produced." Commodities listed in parentheses are known to occur in the district, but have not been produced.

Acknowledgments

This report is part of an on-going study of silver and gold deposits in New Mexico. Many people have assisted in providing assays, geologic data, and other information, and their help is greatly appreciated. We would especially like to thank Robert Eveleth for his comments and for allowing us to use his compilation of production data for silver and gold. Charles Chapin kindly allowed access to his file of radiometric-age determinations and made helpful comments during early discussions. Discussions with Robert Weber and James Robertson throughout the project were helpful and thought provoking.

TABLE 1—Districts in New Mexico which have produced over 10,000 troy ounces of gold or over 200,000 troy ounces of silver. *Precious-metal production is dominately the byproduct of copper, zinc, or lead production.

		Estimated production (Troy ounces)		
County	**District**	**Gold**	**Silver**	**Type of deposit**
Catron	Mogollon	365,000	>20,000,000	Volcanic-epithermal
Colfax	Elizabethtown–Baldy	471,400	unknown	Great Plains Margin; placer
Doña Ana	Organ*	11,500	750,000	Carbonate-hosted Pb–Zn
Grant	Bayard*	>2,500	6,500,000	Laramide vein
	Black Hawk	1,000	1,286,000	Laramide vein
	Burro Mountains*	>50,000	>10,000,000	Porphyry Cu; Laramide vein
	Chloride Flat	unknown	3,300,000	Carbonate-hosted Ag
	Eureka*	5,000	300,000	Cu skarn
	Fierro–Hanover*	>50,000	>5,000,000	Cu skarn
	Fleming	<1,000	300,000	Laramide vein
	Georgetown	unknown	3,850,000	Carbonate-hosted Ag
	Malone	12,000	unknown, probably significant (>10,000)	Laramide vein
	Piños Altos	150,000	800,000	Laramide vein; placer
	Santa Rita*	180,000	>2,500,000	Porphyry Cu
	Steeple Rock	135,000	4,500,000	Volcanic-epithermal
Hidalgo	Granite Gap*	unknown	500,000	Carbonate-hosted Pb–Zn
	Kimball	1,500	400,000	Volcanic-epithermal
	Lordsburg*	225,000	6,200,000	Laramide vein
	McGhee Peak*	unknown	200,000	Carbonate-hosted Pb–Zn
Lincoln	Nogal	15,000	20,000	Great Plains Margin
	White Oaks	163,000	unknown	Great Plains Margin
Luna	Victorio*	12,000	580,000	Carbonate-hosted Pb–Zn
Otero	Orogrande*	16,500	50,000	Great Plains Margin(?); placer
Rio Arriba	Hopewell	24,000	10,000	Precambrian vein; placer
Sandoval	Cochiti	42,000	210,000	Volcanic-epithermal
San Miguel	Willow Creek*	178,300	6,200,000	Precambrian massive sulfide
Santa Fe	New Placers	117,000	305,000	Great Plains Margin; placer
	Old Placers	200,000	small	Great Plains Margin; placer
Sierra	Chloride	2,500	1,300,000	Volcanic-epithermal
	Hermosa	unknown (small)	1,250,000	Carbonate-hosted Ag
	Hillsboro	165,000	unknown >25,000	Volcanic-epithermal
	Kingston	unknown	6,000,000	Carbonate-hosted Ag
	Lake Valley	unknown (small)	5,750,000	Carbonate-hosted Ag
Socorro	Magdalena*	3,500	4,000,000	Carbonate-hosted Pb–Zn
	Rosedale	27,750	10,000	Volcanic-epithermal
	Socorro Peak	unknown	750,000	Volcanic-epithermal

TABLE 2—Classification of silver- and gold-bearing deposits of New Mexico.

A Placer deposits (Tertiary–Quaternary)
B Volcanic-epithermal deposits (Late Cretaceous–Pliocene)
C Supergene-copper–uranium (silver) deposits (Miocene–Pliocene?)
D Great Plains Margin deposits (Oligocene–Miocene)
E Sedimentary-hydrothermal barite–fluorite–galena (copper/silver) deposits (early Tertiary?)
F Carbonate-hosted lead–zinc (copper, silver) deposits (Eocene–Oligocene)
G Carbonate-hosted silver (lead, manganese) deposits (Paleocene–Oligocene?)
H Lead–zinc and copper skarn deposits (Late Cretaceous–Eocene)
I Laramide vein deposits (Late Cretaceous–Eocene)
J Porphyry-copper deposits (Late Cretaceous–Eocene)
K Mississippi Valley-type deposits (Permian, here restricted to deposits adjacent to the Permian Basin)
L Sedimentary-copper deposits (Pennsylvanian–Triassic)
M Precambrian vein and replacement deposits (Precambrian)
N Precambrian massive-sulfide deposits (Precambrian)

TABLE 3—Silver and gold districts in New Mexico. District numbers refer to map. Letters designating types of deposits refer to Table 2.

District (synonyms)	Precious-metal production in troy ounces reported/ (estimated)		Other commodities produced/ (present)	Type(s) of deposit(s)	Description	References
	Gold	Silver				
Bernalillo County						
1. Coyote Canyon	0.2	69	Pb, F (Ba, Cu)	E, M	Veins filling faults and fissures in Precambrian schist, phyllite, and granite gneiss ("Sevilleta Metarhyolite"). Ba–F–Pb veins in Pennsylvanian Sandia and Madera Formations.	Elston, 1967; Ross, 1909; Myers and McKay, 1970; Fulp et al., 1982; USBM Minerals Yearbooks
2. Tijeras Canyon	42.4	1,093	Cu, Pb, F (U, Ba)	M, L, E	Veins and small stratiform ore bodies in Precambrian Tijeras greenstone. Stratabound sedimentary-copper deposits in Permian Abo Formation and Ba–F–Pb veins in Pennsylvanian Madera Group.	Kelley and Northrop, 1975; Hedlund et al., 1984; McLemore and Barker, 1985; Robertson et al. (in press); USBM Minerals Yearbooks
Catron County						
3. Mogollon	362,225 (365,000)	17,377,284 (>20,000,000+)	Cu, Pb, U (Zn, Mo)	B	Veins filling faults cutting Oligocene andesites, rhyolite and quartz-latite tuffs, rhyolites, breccia, and minor volcaniclastic rhyolites, in the ring-fracture zone of the Bursum caldera.	Ferguson, 1927; Ratté, 1981; Collins, 1957; Ratté and Stotelmeyer, 1984
4. Wilcox	—	17	Au, Cu, F, Te (Pb, Zn, Mo)	B	Veins filling faults and fissures cutting Oligocene andesites, tuffs, rhyolites, and volcaniclastic sediments in the ring-fracture zone of the Bursum caldera.	Ratté et al., 1979; Ratté and Stotelmeyer, 1984; USBM Minerals Yearbooks
Cibola County						
5. Zuni Mountains	2	273	Cu, F, Pb (U, V, Ba)	M, L, E(?)	Stratabound sedimentary-copper deposits and fluorite veins in Permian Abo Formation. Fluorite veins filling faults and fissures in Precambrian aplite, granite gneiss, and porphyritic aplite. Disseminated mineralization in shear zones and quartz veins in Precambrian porphyritic aplite.	Soulé, 1956; Goddard, 1966; Fulp and Woodward, 1981; Lindgren et al., 1910; USBM Minerals Yearbooks
Colfax County						
6. Cimmaroncito	(100)	(1,000)	Cu	D	Skarn deposits in Pennsylvanian limestones adjacent to Oligocene quartz-monzonite porphyry dikes.	Pettit, 1946; Lindgren et al., 1910
7. Elizabethtown–Baldy	(471,400)	—	Ag, Cu, Pb (W)	D, A	Veins filling fissures in Oligocene quartz-diorite sills and also in Cretaceous Pierre Shale. Minor skarn deposits in calcareous-shale beds in the Pierre Shale. Placers in dry washes and Moreno Creek derived from the lode deposits.	Clark and Read, 1972; Pettit, 1946; Lee, 1916; Lindgren et al., 1910; Dale and McKinney, 1959
Doña Ana County						
8. Black Mountain	(600)	—	Ag, Cu (Ba)	M, E	Veins in Precambrian rocks commonly at the contact of diorite dikes and granite. Irregular vein deposits along a normal fault between Precambrian granite and Ordovician El Paso Limestone, with minor replacement in the El Paso Limestone.	Seager, 1981; Dunham, 1935

TABLE 3 (continued)

District (synonyms)	Precious-metal production in troy ounces reported/ (estimated)		Other commodities produced/ (present)	Type(s) of deposit(s)	Description	References
	Gold	Silver				
9. Doña Ana Mountains	(100)	(5,000)	Cu	B	Veins at the contact of silicified rhyolite and altered Oligocene Cleofas andesite.	Seager et al., 1976; Dunham, 1935
10. Northern Franklin Mountains	—	—	Pb, Jarosite (F, Ba, Ag)	E	Veins filling faults in Silurian Fusselman Dolomite and along its disconformable contact with overlying Devonian Canutillo Formation. Minor replacement.	Dunham, 1935; Kelley and Matheny, 1983
11. Organ Mountains	11,435 (11,500)	(750,000)	Zn, Pb, Cu, F (W, Mn, Mo)	F	Replacement deposits in Ordovician Montoya Group, Silurian Fusselman Dolomite, Pennsylvanian Lead Camp Limestone, and Permian Hueco Formation localized by faults, Tertiary quartz-monzonite dikes, and, in the Fusselman, near the contact with overlying Devonian Percha Shale. Less important vein deposits in faults and fissures in Paleozoic sediments and the Oligocene Organ batholith complex (dominately quartz monzonite), and silver-bearing pegmatites in the Organ batholith.	Seager, 1981; Dunham, 1935; Albritton and Nelson, 1943; Dale and McKinney, 1959
12. Potrillo Mountains	—	—	Pb, Cu, Ag (Ba)	E	Small replacement bodies and veins in Permian Hueco Formation localized by faults.	Dunham, 1935; Jenkins, 1977
13. San Andrecito	—	—	(Ag, Cu, Pb)	E	Veins filling fissures in Cambrian Bliss Sandstone and Ordovician El Paso Limestone.	Dunham, 1935
14. San Andres Canyon	—	—	Pb (Ba, Ag)	E	Irregular replacement deposit in Silurian Fusselman Dolomite adjacent to a high-angle normal fault.	Dunham, 1935; Bachman and Myers, 1969
Eddy County						
15. Lone Eagle	—	21	Cu (U)	L	Stratabound sedimentary-copper deposit in sandstone of the Permian Yates Formation.	Soulé, 1956; Motts, 1962
16. Red Lake	—	—	Cu, Ag (Pb, Zn)	K	Secondary Cu–Pb–Zn mineralization in collapse breccias in the Permian Rustler Formation.	North, field notes 6/24/85
17. Two Ladies prospect	—	—	Pb (Zn, Ag)	K	Replacement of carbonate and open-space filling in collapse breccia in dolomite of the Permian Yates Formation.	North, field notes 1982
Grant County						
18. Alum Mountain (Gila River, Alunogen)	1	21	Alum (Cu, Pb, Zn)	B	Highly altered Oligocene andesite with shows of precious metals.	Ratté et al., 1979; Howard, 1967; Ratté and Stotelmeyer, 1984
19. Bayard	1,260 (>2,500+)	1,847,198 (6,500,000)	Cu, Pb, Zn, V	I	Veins filling faults and locally replacement deposits in favorable beds at depth.	Richter and Lawrence, 1983; Jones et al., 1967; Lasky, 1936
20. Black Hawk (Bullard Peak)	5 (1,000)	4,095 (1,286,000)	(W, Co, Ni, U, Bi, Mo, Zn, Pb, Cu)	I	Veins filling fissures and faults in Precambrian quartz-diorite gneiss and granite near the contact with (Upper Cretaceous–lower Tertiary) Twin Peaks monzonite-porphyry stock. Mineralization Late Cretaceous–early Tertiary (Laramide).	Gillerman and Whitebread, 1956; Von Bargen, 1979; Richter and Lawrence, 1983; Hedlund, 1978a, e; USBM Minerals Yearbooks; Dale and McKinney, 1959
21. Bound Ranch (Langford Hills)	—	—	W, F (Au, U)	I	Veins filling faults and fissures in Precambrian granite.	Gillerman, 1964; Richter and Lawrence, 1983; Dale and McKinney, 1959
22. Burro Mountains	(>50,000)	(>10,000,000)	Cu, Mo, Pb, Zn, turquoise, F (Bi, U)	J, I, A	Porphyry copper deposit in early Eocene quartz-monzonite porphyry of Tyrone and veins filling fissures and shears in Precambrian granite adjacent to the Tertiary stock. Minor placer deposits.	Richter and Lawrence, 1983; Gillerman, 1970; Paige, 1922; Kolessar, 1970, 1982; Hedlund, 1978a, c, d, e

TABLE 3 (continued)

District (synonyms)	Precious-metal production in troy ounces reported/ (estimated)		Other commodities produced/ (present)	Type(s) of deposit(s)	Description	References
	Gold	Silver				
23. Carpenter (Schwartz)	98.06	93,497	Cu, Pb, Zn (F, W, Be)	F	Veins filling faults in Ordovician Montoya Formation and Silurian Fusselman Dolomite, with some irregular replacement bodies. Some deposits also localized along andesite dikes.	Hill, 1946; Hedlund, 1977
24. Chloride Flat	14	8,018 (3,300,000)	Pb, Mn	G	Supergene-enriched replacement deposits in Silurian Fusselman Dolomite near the contact with overlying Devonian Percha Shale.	Richter and Lawrence, 1983; Cunningham, 1974; Entwistle, 1938, 1944; USBM Minerals Yearbooks
25. Copper Flat	—	—	Zn, Pb, Cu, Ag, Au	H	Skarn and replacement deposits in Pennsylvanian Oswaldo Formation adjacent to the lower Tertiary Copper Flat stock.	Richter and Lawrence, 1983; Jones et al., 1967; Mullen and Storms, 1948
26. Cora Miller	—	—	Ag (Mn)	B	Fissure quartz veins striking N70–75E, 3–5-ft wide in rhyolite ash-flow tuff.	Gillerman, 1964; Lindgren et al., 1910
27. Eureka (Hachita) (Hidalgo County)	3,175.27 (5,000)	296,086 (300,000)	Cu, Pb, As, Zn	H	Skarn and replacement deposits in limestone of the Cretaceous U-Bar Formation adjacent to a Cretaceous–Tertiary monzonite stock.	Lasky, 1947; Zeller, 1970; USBM Minerals Yearbooks
28. Fierro–Hanover	(>50,000)	(>5,000,000)	Cu, Zn, Pb, Fe	H	Skarn deposits chiefly in the Tierra Blanca Member (Hanover limestone) of the Mississippian Lake Valley Limestone and the Pennsylvanian Oswaldo Formation adjacent to granodiorite porphyry of the Paleocene Hanover–Fierro pluton, commonly localized by faults.	Forrester, 1972; Abramson, 1981; Jones et al., 1967
29. Fleming	54.77 (<1,000)	10,360 (300,000)	Cu, Pb	I	Irregular oxidized bodies in Cretaceous Beartooth Quartzite. Veins filling fissures in Precambrian granite.	Richter and Lawrence, 1983; Cunningham, 1974; USBM Minerals Yearbooks
30. Georgetown	—	(3,850,000)	—	G	Irregular oxidized bodies in Silurian Fusselman Formation localized by contact with overlying Devonian Percha Shale and Paleocene–Eocene granodiorite-porphyry dikes.	Richter and Lawrence, 1983; Jones et al., 1967
31. Gila Fluorspar	—	—	F (Au, Ag, U, Cu, Pb, Zn, Mo)	B	Fluorite veins in altered andesite and latite with minor amounts of precious metals.	Gillerman, 1964; Ratté et al., 1979; Ratté and Stotelmeyer, 1984
32. Gold Hill	308.43 (>1,000)	2,772	Pb, Cu	I, A	Veins in Precambrian granite and at the contact of Precambrian hornblende gneiss with granite. Placers along Gold Hill Canyon.	Richter and Lawrence, 1983; Hedlund, 1978b; USBM Minerals Yearbooks
33. Lone Mountain	18	28,578 (>100,000)	Pb, Mn	G	Veins filling fissures in Silurian Fusselman Dolomite.	Richter and Lawrence, 1983; Pratt, 1967; Howard, 1967
34. Malone	(12,000)	(probably >10,000)	Ag, Cu, Pb, Zn (U)	I	Veins filling faults in Precambrian granite and at the contact of granite with Precambrian mafic dikes.	Richter and Lawrence, 1983
35. Northern Cooke's Range	—	—	F, Pb, Ag (Zn)	F, E(?)	Veins in small faults and breccia zones in the upper part of the Silurian Fusselman Dolomite near the contact with overlying Devonian Percha Shale. Mineralization is restricted to a small fault block.	Elston, 1957; McAnulty, 1978
36. Pinos Altos	(150,000)	454,753 (800,000)	Zn, Pb, Cu (W)	I, A, H	Veins filling fissures in quartz-monzonite Pinos Altos stock (Late Cretaceous) and Late Cretaceous diorite porphyries and andesite breccias. Replacement deposits in Pennsylvanian Magdalena Group limestones west and northwest of the Pinos Altos stock. Placers derived from lodes.	Richter and Lawrence, 1983; Richter et al., 1983; Koschmann and Bergendahl, 1968; Jones et al., 1970; Paige, 1911; Dale and McKinney, 1959
37. San Francisco prospects (Catron County)	—	—	(Au, Ag, Cu, Mo, Sb)	B	Quartz veins with anomalous values as high as 5,000 ppm Mn, 100 ppm Ag, 4 ppm Au, 500 ppm Cu, and 100 ppm Sb in rhyolite intrusives; placer-gold deposits produced along San Francisco River in Arizona.	Ratté et al., 1982; U.S. Geological Survey et al., 1969

TABLE 3 (continued)

District (synonyms)	Precious-metal production in troy ounces reported/ (estimated)		Other commodities produced/ (present)	Type(s) of deposit(s)	Description	References
	Gold	Silver				
38. Santa Rita	(180,000)	(>2,500,000)	Cu, Mo (Zn, Pb, Sb, Fe)	J	Porphyry copper deposit in early Eocene Santa Rita quartz-monzonite stock.	Jones et al., 1967; Koschmann and Bergendahl, 1968; Rose and Baltosser, 1966
39. Steeple Rock	37,675 (135,000)	1,533,041 (4,500,000)	Cu, Pb, Zn (F, Be)	B	Veins and irregular replacement deposits filling faults in Oligocene volcanic rocks.	Biggerstaff, 1974; Griggs and Wagner, 1966; Briggs, 1981, 1982; Ratté et al., 1982
40. Telegraph (Red Rock)	1	1,296	Cu, Pb, Zn (F, Mn, U, Th)	I	Veins filling faults and fissures in Precambrian granite and Cretaceous Beartooth Quartzite.	Richter and Lawrence, 1983; McAnulty, 1978; USBM Minerals Yearbooks; Hewitt, 1959
41. White Signal	307.48 (1,000)	1,019 (2,500)	Cu, U, Bi, Pb (Th, Zn, F)	I	Veins filling faults and fissures in Precambrian granite and along the contact between granite and early Tertiary rhyolite dikes.	Richter and Lawrence, 1983; Gillerman, 1953, 1964; Hedlund, 1978e, f; Howard, 1967
Guadalupe County						
42. Pastura (Guadalupe)	2.0	42,494	Cu, Pb (U)	L	Stratabound sedimentary-copper deposits in sandstones of Triassic Santa Rosa Formation and Permian Grayburg–Queen Formations.	Soulé, 1956; McLemore, 1983a; Howard, 1967; Sandusky and Kaufman, 1972; McLemore and North, 1985
Harding County						
43. Bueyeros prospects	—	—	(Au)	B(?)	Gold values reported in quartz stringers in basalt north and west of Bueyeros.	Harley, 1940
44. Gallegos	—	—	(Cu, Ag, Au)	A, L	Placers reported in gravels of Ute Creek. Stratabound sedimentary-copper deposits reported in Triassic rocks west of Gallegos.	Harley, 1940; Everett, 1953
Hidalgo County						
45. Apache #2	41	8,082 (125,000)	Cu, Pb, Bi	F	Skarn deposits in limestones of the Cretaceous U-Bar Formation and Mojado Formation adjacent to Oligocene monzonite porphyry. Minor vein deposits filling faults and fissures in Tertiary volcanic rocks.	Peterson, 1976; Howard, 1967; USBM Minerals Yearbooks; Deal et al., 1978
46. Big Hatchet Mountains	—	—	Pb, Zn, Ag	F	Small replacement bodies in the Pennsylvanian–Permian Horquilla Limestone	Elston, 1965; Zeller, 1975
47. Fremont	(10)	(10,000)	Pb, Zn, Cu, U	B	Veins filling faults in limestone unit and red-bed unit of Cretaceous Howell's Ridge Formation, minor replacement of limestone.	Griswold, 1961; Strongin, 1957
48. Gillespie	4	(16,000)	Pb, Cu (F)	B	Veins filling fissures in Oligocene Oak Creek Tuff and Pennsylvanian–Permian Horquilla Limestone.	Elston, 1965; Zeller and Alper, 1965; Deal et al., 1978; USBM Minerals Yearbooks
49. Granite Gap	—	(500,000)	Au, Pb, Cu, Zn (W, Bi, F, U)	F	Veins and replacement deposits in Ordovician El Paso Group, Mississippian Escabrosa Limestone, and Pennsylvanian Horquilla Limestone adjacent to Oligocene quartz monzonite.	Richter and Lawrence, 1983; Richter et al., 1983; Drewes and Thorman, 1980b; Gillerman, 1958; Dale and McKinney, 1959; Armstrong et al., 1978
50. Kimball (Steins Pass)	(1,500)	(400,000)	Pb, Cu, Zn	B	Veins filling faults and fissures in Oligocene volcanic rocks, mainly rhyolite tuff and andesite.	Enders, 1981; Young, 1982; Richter and Lawrence, 1983
51. Lordsburg	223,750 (225,000)	6,190,816 (6,200,000)	Cu, Pb, Zn (F, Mo)	I	Veins filling fissures and faults in the contact zone between Late Cretaceous andesite flows and granodiorite-porphyry intrusive. Veins are found in both the volcanics and the intrusive.	Lasky, 1938; Richter and Lawrence, 1983; Richter et al., 1983; Thorman and Drewes, 1978

TABLE 3 (continued)

District (synonyms)	Precious-metal production in troy ounces reported/ (estimated)		Other commodities produced/ (present)	Type(s) of deposit(s)	Description	References
	Gold	Silver				
52. McGhee Peak	—	(200,000)	Pb, Cu, Au	F	Replacement deposits in Cretaceous Carbonate Hill Limestone and, to a lesser extent, Pennsylvanian Horquilla Limestone adjacent to dikes and sills of Oligocene felsic rocks. Minor veins in Cretaceous–Tertiary volcanic rocks.	Richter and Lawrence, 1983; Drewes and Thorman, 1980a
53. Rincon	—	(>10,000)	Cu, Pb, Au	F	Replacement deposits in Pennsylvanian–Permian Horquilla Limestone localized by minor faults.	Drewes and Thorman, 1980a; Soulé, 1972; Elston, 1965
54. Silver Tip (Bunk Robinson and Whitmore areas)	—	—	(Au, Ag, Pb, Mo, Zn, Bi)	B	Precious- and base-metal veins in kaolinized rhyolitic ash-flow tuff.	Hayes, 1982; Hayes and Brown, 1984
55. Sylvanite	1,971 (2,500)	27,454 (35,000)	Cu, Pb, W	H	Skarn deposits in Cretaceous Hell-To-Finish Formation adjacent to Cretaceous–Tertiary monzonite and quartz monzonite. Veins filling faults in monzonite and along the contacts of Cretaceous–Tertiary dikes and their host rocks (mainly monzonite–quartz monzonite).	Lasky, 1947; Zeller, 1970; Howard, 1967
Lincoln County						
56. Estey	—	124	Cu (U)	L	5tratabound sedimentary-copper deposits in arkoses and limestones of the Permian Abo Formation.	Soulé, 1956; Lasky and Wootton, 1933; USBM Minerals Yearbooks
57. Capitan Mountains prospects	—	—	U (Th, Cu, Ag, Fe)	D(?)	Iron vein deposits in Tertiary intrusives and iron skarn deposits in Permian sedimentary rocks adjacent to Tertiary intrusives. Selected samples assay as high as 0.62 ounces/ton (21 ppm) silver.	McLemore, 1983a; Kelley, 1949
58. Gallinas	5.58	22,405	F, Cu, Fe, Zn, Pb, REE (U, Th)	D, L	Veins filling fissures and breccia zones in Permian Yeso Formation and Tertiary trachyte porphyry. Stratabound sedimentary-copper deposits in Permian Yeso Formation.	Perhac, 1970; Griswold, 1959; Anderson, 1957; USBM Minerals Yearbooks
59. Jicarilla	1,858.53 (8,500)	136	Fe, Cu (Pb, Zn)	D, A	Vein and disseminated deposits in Oligocene monzonite porphyry. Skarn deposits in limestone beds of the Permian San Andres Formation adjacent to Oligocene intrusives. Placer-gold deposits derived largely from the vein deposits.	Griswold, 1959; Segerstrom and Ryberg, 1974; USBM Minerals Yearbooks
60. Nogal (Cedar Creek)	7,725.25 (15,000)	18,193 (20,000)	Cu, Pb, Zn (Mo)	D, A	Mineralization filling faults, fissures, and breccia pipes in Oligocene Sierra Blanca volcanics (andesite-flow breccias), Rialto stock (alkali syenite), Bonito Lake stock (biotite syenite), and Cretaceous Mesaverde Group shales and sandstones adjacent to the Vera Cruz laccolith (alaskite). Placers derived from lodes.	Thompson, 1973; Segerstrom et al., 1979; Griswold, 1959; Howard, 1967; Segerstrom and Stotelmeyer, 1984
61. Schelerville	—	—	Cu, Pb, Ag, Au	D	Veins localized along contacts between Tertiary volcanic rocks and Tertiary diorite and syenite dikes.	Griswold, 1959; Weber, 1964; Segerstrom et al., 1979
62. White Oaks	817.38 (163,000)	888	Cu, Pb, W, Fe	D, A	Mineralization filling faults, fissures, and breccias in Oligocene monzonite, monzonite porphyry, lamprophyre dikes, and volcanic rocks and Cretaceous Mesa Verde Group shale and sandstone. Minor placer deposits.	Griswold, 1959; Lindgren et al., 1910; Grainger, 1974; USBM Minerals Yearbooks
Luna County						
63. Carrizalillo	—	—	Pb, Cu, Ag, Au (U, Mn)	B	Veins filling faults and fissures in Tertiary rhyolite welded tuff, andesite, and Lower Cretaceous sediments. Some veins localized by rhyolite dikes cutting andesite.	Griswold, 1961; Bromfield and Wrucke, 1961

TABLE 3 (continued)

District (synonyms)	Precious-metal production in troy ounces reported/ (estimated)		Other commodities produced/ (present)	Type(s) of deposit(s)	Description	References
	Gold	Silver				
64. Cooke's Peak	(30)	65,287	Pb, Zn, Cu (F, Mn)	F	Replacement deposits in Silurian Fusselman Dolomite localized near the contact of overlying Devonian Percha Shale adjacent to the Eocene–Oligocene Cooke's Peak Granodiorite stock.	Jicha, 1954; Loring and Loring, 1980
65. Florida Mountains	3.33	8,034	Pb, Cu, Ba, F	E	Veins filling faults and fissures in Eocene Starvation Draw member (Rubio Peak Formation), Silurian Fusselman Dolomite, and Precambrian hornfels and quartz syenite.	Griswold, 1961; Clemons, 1982, 1984; Clemons and Brown, 1983; USBM Minerals Yearbooks
66. Old Hadley	150 (?)	533	Pb, Zn, Cu (Ba)	B	Veins filling fissures paralleling faults in Eocene–Oligocene Macho pyroxene andesite.	Jicha, 1954; Loring and Loring, 1980
67. Tres Hermanas	4.6	1,203	Zn, Pb, Cu (U, Mn, W)	F	Skarn deposits in Mississippian Escabrosa Limestone and Lower Pennsylvanian limestone adjacent to Eocene Tres Hermanas quartz-monzonite stock.	Griswold, 1961; Balk, 1962; USBM Minerals Yearbooks
68. Victorio	(12,000)	(580,000)	Pb, Zn, Cu, W (Be)	F	Replacement deposits localized by faults in Silurian Fusselman Dolomite.	Richter and Lawrence, 1983; Richter et al., 1983; Griswold, 1961; Thorman and Drewes, 1980
Mora County						
69. Coyote Creek	—	48	Cu, U (Pb, Se)	L	Stratabound sedimentary-copper deposits in arkoses and shales of the Pennsylvanian–Permian Sangre de Cristo Formation.	Soulé, 1956; Tschanz et al., 1958; McLemore, 1983a; Howard, 1967; USBM Minerals Yearbooks
70. Mora	—	—	Au	M, A	Gold in quartz lenses and veins in Precambrian metasediments. Placers derived from lodes.	Harley, 1940
Otero County						
71. Bent	—	1,189	Cu (U)	M, L	Stratabound sedimentary-copper deposits in sandstones of the Permian Abo Formation. Veins in Precambrian rocks.	Soulé, 1956; McLemore, 1983a; Lindgren et al., 1910
72. Cornudas Mountains	—	—	(Ag, Be, U, Au)	D	Fracture-filling veins in Tertiary mafic dikes and alkalic intrusives; selected sample assayed 0.78 oz/ton Ag and a trace (less than 0.02 oz/ton) of Au.	McLemore, field notes 8/81
73. Orogrande (Jarilla)	16,500	45,477 (50,000)	Cu, Pb, W (Zn)	D, A	Skarn deposits in Pennsylvanian Gobbler and Laborcita Formations adjacent to Eocene monzonite–quartz-monzonite stock. Placers derived from lode deposits.	Beane et al., 1975; North, 1982; Schmitt and Craddock, 1964
74. Sacramento (High Rolls)	4.82	756	Pb, Cu, Zn (U)	L, M	Copper and lead deposits with minor silver in sandstones and shales of Permian Abo Formation. In general, the copper ores contain little lead, the lead ores little copper. Veins in Precambrian rocks.	Jerome et al., 1965; Soulé, 1956; McLemore, 1983a; Howard, 1967; USBM Minerals Yearbooks
75. Tularosa	—	—	(Cu, Ag, U)	L	Stratabound sedimentary-copper deposits in Permian Abo Formation.	Soulé, 1956; McLemore, 1983a
Quay County						
76. Logan	—	—	(Cu, U, Ag, Au)	L	Stratabound sedimentary-copper deposits in shaly sandstone of Triassic Chinle Formation. Gold occurs with pyrite in shales.	Soulé, 1956; McLemore, 1983a; Harley, 1940
77. Red Peak	—	—	U (Cu, Ag, Ba)	L	Argentiferous chalcocite nodules and stratabound sedimentary-copper deposits in middle and upper units of Triassic Chinle Formation.	McLemore and North, 1985

TABLE 3 (continued)

District (synonyms)	Precious-metal production in troy ounces reported/ (estimated)		Other commodities produced/ (present)	Type(s) of deposit(s)	Description	References
	Gold	Silver				
Rio Arriba County						
78. Abiquiu	—	—	U (Cu, Ag)	L	Stratabound sedimentary-copper deposits in conglomerate and conglomeratic sandstone of the basal part of Triassic Chinle Formation.	Soulé, 1956; Bingler, 1968
79. Bromide #2	(300)	(4,500)	Cu, U	M	Veins in Precambrian Moppin metavolcanic series.	Bingler, 1968; Wobus and Manley, 1982
80. Chama Canyon prospects	—	—	(Cu, U, Ag)	L	Stratabound sedimentary-copper deposits in Permian Cutler Formation.	Light, 1982, 1983
81. Chama placers	(100)	—	—	A	Placers in sand and gravel deposits of the Rio Chama.	McLemore and North, 1984; Johnson, 1972
82. Cruces Basin prospects	—	—	(Ag, Mn, Cu, Be)	B(?)	Silver (0.5–0.9 oz/ton) associated with small deposits of manganese (0.14–6% Mn) along fractures and faults in the Tertiary Conejos quartz latite and underlying Precambrian gneiss and pegmatites.	Hannigan, 1984; Muehlberger, 1968
83. Coyote (Sandoval)	—	—	U (Cu, Ag)	L	Stratabound sedimentary-copper deposits in sandstones of the middle Permian Cutler Formation.	Soulé, 1956; Bingler, 1968; Smith et al., 1961
84. Gallinas (Sandoval)	—	—	U (Cu, Ag)	L	Stratabound sedimentary-copper deposits in shales and arkosic conglomerates of the Permian Abo Formation.	Soulé, 1956; McLemore, 1983a
85. Hopewell	(24,000)	(10,000)	Cu, Pb	M, A	Veins in Precambrian Moppin metavolcanic series. Placer deposits in gravels of Placer Creek.	Bingler, 1968; Wobus and Manley, 1982; Benjovsky, 1945; Robertson et al. (in press)
Sandoval County						
86. Cochiti	41,016 (42,000)	(208,895) (210,000)	Cu, Pb, Zn (U)	B	Veins filling faults and fissures in Tertiary andesite flows and flow breccias and monzonite stock. Some replacement of wall rock.	Wronkiewicz et al., 1984; Bundy, 1958; Elston, 1967; Lindgren et al., 1910
87. Jemez Springs	1.0	159	Cu, Pb (U)	L	Stratabound sedimentary-copper deposits in sandstone, siltstone, and limestone of the Permian Abo Formation.	Elston, 1967; McLemore, 1983a; Gott and Erickson, 1952; USBM Minerals Yearbooks
88. Nacimiento (Rio Arriba)	0.41	(75,068)	Cu, Pb, Zn (U, V)	L, M	Stratabound sedimentary-copper deposits in sandstones of the Triassic Chinle Formation (Agua Zarca Sandstone Member). Minor deposits in sandstones, shales, siltstones, and limestones of Permian Abo Formation and Pennsylvanian Madera Formation. Some veins in shear zones in Precambrian quartz monzonite with weak mineralization.	Soulé, 1956; McLemore, 1983a; Woodward et al., 1974; Elston, 1967; USBM Minerals Yearbooks
89. Placitas (Bernalillo County)	49	48	Pb, Cu, Zn (Ba, F)	E, M, A, L	Base-metal and barite–fluorite veins in faults and fissures in Precambrian Sandia Granite and metamorphic rocks and Pennsylvanian Madera and Sandia Formations. Copper, barite, and silver (up to 5.7 oz/ton) in mudstone and sandstone of the Chinle Formation. Small placer deposits reported in arroyos.	Kelley and Northrop, 1975; Wells and Wooton, 1940; Elston, 1967; Kness, 1982; Hedlund et al., 1984
San Miguel County						
90. El Porvenir	—	—	(Cu, Ag, Au, Th, U, Mo, F)	M, L	Veins filling fissures in Precambrian pegmatitic granite. Stratabound sedimentary-copper deposits in Pennsylvanian–Permian Sangre de Cristo Formation.	Harley, 1940; Anderson, 1957; Soulé, 1956; McLemore, 1983a; McLemore and North, 1985

TABLE 3 (continued)

District (synonyms)	Precious-metal production in troy ounces reported/ (estimated)		Other commodities produced/ (present)	Type(s) of deposit(s)	Description	References
	Gold	Silver				
91. Rociada (Mora County)	—	—	(Cu, Pb, Ag, Au, Zn, U, Mo)	M, L	Mineralized quartz veins in Precambrian granite. Minor stratabound sedimentary-copper deposits in coarse sandstone of Pennsylvanian–Permian Sangre de Cristo Formation.	Harley, 1940; Anderson, 1957; Soulé, 1956; McLemore and North, 1985; Robertson et al. (in press)
92. Sabinoso	—	—	U (Cu, Ag)	L	Stratabound sedimentary-copper–uranium deposits in channel sandstones of the lower and middle members of the Triassic Chinle Formation.	McLemore and Menzie, 1983; McLemore and North, 1985
93. Tecolote	19	128	Cu, Pb (U)	L	Stratabound sedimentary-copper deposits in arkose and sandstone, probably of the Pennsylvanian–Permian Sangre de Cristo Formation.	Soulé, 1956; Harley, 1940; Anderson, 1957; McLemore and North, 1985
94. Willow Creek (Pecos)	172,562.16 (178,300)	5,296,499 (6,200,000)	Zn, Pb, Cu	N	Volcanogenic massive sulfide deposits in metamorphosed sequence of Precambrian subaqueous volcanic rocks and volcaniclasitic sedimentary rocks. Also disseminated volcanogenic sulfide deposits.	Riesmeyer, 1978; Riesmeyer and Robertson, 1979; Harley, 1940; Krieger, 1932; Robertson et al. (in press)
Santa Fe County						
95. Cerillos	930.68	27,864	Cu, Pb, Zn, turquoise (U, Mo)	D(?)	Veins filling shear zones and faults in Oligocene hornblende monzonite, augite–biotite monzonite, and Espinoso Volcanics, and Cretaceous Mancos Shale.	Disbrow and Stoll, 1957; Elston, 1967; Akright, 1979
96. El Cuervo Butte (Crow) prospects	—	—	(Pb, Ba, Ag)	E	Barite–galena (± silver) veins along fault in Permian Yeso Formation and Glorieta Member of Permian San Andres Formation.	McLemore, 1984; McLemore and Barker, 1985; North and McLemore, 1985
97. Glorieta	—	—	(Cu, Ag, U)	L	Stratabound sedimentary-copper deposits in sandstones and arkoses of the Pennsylvanian–Permian Sangre de Cristo Formation.	Soulé, 1956; Elston, 1967; McLemore, 1983a
98. La Bajada	—	52	Cu, U (Zn)	C	Base-metal (with silver and uranium) vein filling a fault that cuts Oligocene Cieneguilla Limburgite and Espinasa Volcanics. Formed under low-temperature, near-surface conditions.	Lustig, 1957; Elston, 1967; McLemore, 1983a; Chenoweth, 1979; McLemore and North, 1984
99. New Placers	19,560 (117,000)	304,625 (305,000)	Cu, Pb, Zn (W)	D, A	Skarn deposits in limestone of the Pennsylvanian Madera Formation adjacent to Tertiary latite–monzonite-porphyry laccolith and rhyolite dikes. Also veins filling fissures in porphyry and Madera Formation and placers derived from the lode deposits.	Atkinson, 1961; Koschmann and Bergendahl, 1968; Elston, 1967
100. Old Placers	(200,000)	311	Ag, Cu, Pb (W)	D, A	Mineralization filling faults and fissures in Tertiary monzonite stock and adjacent Cretaceous Mesaverde Formation shales and sandstones. Disseminated mineralization in Ortiz mine breccia (Mesaverde Formation and latite porphyry clasts) associated with latite sills and dikes. Placers derived from lodes.	Elston, 1967; Wright, 1983; Bachman, 1975; Dale and McKinney, 1959
101. Santa Fe	—	—	(Cu, Pb, Zn, Ag, Au)	N	Disseminated volcanogenic sulfide deposits in Precambrian schist and phyllite.	Fulp, 1982; Robertson et al. (in press)
Sierra County						
102. Caballo Mountains	83.6	4,769	Cu, Pb, V, F, Mn (U, Th, Ba)	E, L	Veins filling fissures in Pennsylvanian Bar B Formation and Cambrian Bliss Formation. Stratabound sedimentary-copper deposits in Permian Abo Formation.	Kelley and Silver, 1952; Harley, 1934; McAnulty, 1978

TABLE 3 (continued)

District (synonyms)	Precious-metal production in troy ounces reported/ (estimated)		Other commodities produced/ (present)	Type(s) of deposit(s)	Description	References
	Gold	Silver				
103. Chloride	1,939.10 (2,500)	544,563 (1,300,000)	Cu, Pb, Zn	B	Veins filling faults in Tertiary andesite and latite flows, andesitic lahars, volcaniclastic sediments, and Pennsylvanian Madera Limestone.	Freeman and Harrison, 1984; Maxwell and Heyl, 1976; Harley, 1934
104. Cuchillo	—	(27,525)	Cu, Pb, Zn (U)	F, L	Skarn deposits in Pennsylvanian Madera Limestone near the contact with monzonite porphyry of the Cuchillo Mountain laccolith. Minor skarn deposits associated with rhyolite dikes. Stratabound sedimentary deposits in Abo Formation.	Harley, 1934; McMillian, 1979
105. Fra Cristobal Mountains prospects	—	—	(Cu, Pb, Ag, F, Ba, Mn)	E	Veins filling faults in Precambrian granite.	Harley, 1934; Allen, 1984
106. Goldsboro	—	—	Au, Ag	B	Veins in faults and fissures in Tertiary andesite, andesite breccia, and rhyolite tuff and flows.	Lasky, 1932
107. Grandview Canyon (Sulfur Canyon)	—	17	Cu, Bi, Au, Ag (W)	M	Veins filling fissures in Precambrian schist.	Harley, 1934; Robertson et al. (in press)
108. Hermosa (Palomas)	2.2	(1,250,000)	Pb, Cu, Zn	G	Veins and pods filling fault zones and fissures in Silurian Fusselman Dolomite and Ordovician Cutter and Aleman Formations. Irregular replacement deposits in Silurian Fusselman Dolomite near the contact with overlying Devonian Oñate Formation.	Shepard, 1984; Jahns, 1957; USBM Minerals Yearbooks
109. Hillsboro (Las Animas)	(165,000)	20,483 (>25,000)	Pb, Zn, Cu, V	B, A, J	Veins filling faults and fissures in Late Cretaceous andesitic flows of Copper Flat. Porphyry copper deposit in Late Cretaceous Copper Flat quartz-monzonite stock. Minor skarn and replacement deposits in Fusselman Formation. Placer deposits derived from lodes.	Hedlund, 1977; Harley, 1934; Dunn, 1982; Kuellmer, 1955; Segerstrom and Antweiler, 1975
110. Hot Springs (Mud Spring Mountains)	—	(40,000)	Cu, Pb	E(?)	Veinlets and disseminated mineralization in brecciated, iron-stained, stromatolitic limestone and dolomite of the Ordovician Bat Cave Formation.	Harley, 1934; Kelley and Silver, 1952
111. Kingston	54.06	(6,000,000)	Pb, Cu, Zn, Mn (W)	G	Replacement and vein deposits in Silurian Fusselman Dolomite localized by faults and the contact with overlying Devonian Percha Shale. Minor vein deposits in other Paleozoic and Precambrian rocks.	Hedlund, 1977; Dale and McKinney, 1959
112. Lake Valley	6.6	(5,750,000)	Mn, Pb, Cu (Mo, V)	G	Oxidized replacement deposits in Mississippian Lake Valley Limestone, the most important of which are near a fault contact with Tertiary Mimbres Peak Rhyolite.	Jicha, 1954; Harley, 1934; Creasey and Granger, 1953; USBM Minerals Yearbooks; Hewitt and Radtke, 1967
113. Macho	(100)	(20,000)	Pb (V)	B	Veins filling breccia zones and fissures in Tertiary Macho Andesite.	Jicha, 1954; Harley, 1934; USBM Minerals Yearbooks
114. Pittsburg	6,114.51 (8,000)	232	—	A	Placer deposits in Quaternary gravels derived from small Precambrian vein deposits.	Johnson, 1972; Harley, 1934
115. Salinas Peak	1.40	520	Cu, Pb, Zn	E	Veins in Paleozoic limestone and near the unconformable contact between Precambrian granite and overlying Cambrian Bliss Sandstone.	Lasky, 1932; Bachman and Harbour, 1970
116. Tierra Blanca	12	(165,000)	Cu, Pb, Zn (W)	G	Vein and replacement deposits in Silurian Fusselman Dolomite near the contact with overlying Devonian Percha Shale. Some veins in Tertiary rhyolite and in fractures in Cambrian Bliss Formation and Ordovician El Paso Limestone adjacent to rhyolite dikes and sills.	Hedlund, 1977; Harley, 1934; USBM Minerals Yearbooks; Dale and McKinney, 1959

TABLE 3 (continued)

District (synonyms)	Precious-metal production in troy ounces reported/ (estimated)		Other commodities produced/ (present)	Type(s) of deposit(s)	Description	References
	Gold	Silver				
Socorro County						
117. Abbe Spring	—	—	Cu, Ag	B	Veins filling faults between Triassic Chinle Formation and Cretaceous Dakota Sandstone. Mineralization in faults in Eocene Baca Formation reported by Mayerson (1979). Tertiary-age mineralization.	North, 1983; Chapin et al., 1979; Mayerson, 1979
118. Bear Mountains	—	—	(Cu, Ag, Sb)	B	Veins in Oligocene La Jara Peak Basaltic Andesite along the Hells Mesa fault.	North, 1985
119. Cat Mountain	53	1,302	Cu	B	Veins filling fissures in Oligocene Spears Formation and Permian Abo(?) Formation. Also disseminated copper–silver mineralization in Oligocene Rock House Canyon Tuff.	Wilkinson, 1976; North, 1983
120. Chupadero Mountains (Coyote Hills)	—	—	(Au, Ag, Cu, Pb, Zn)	M	Fracture-filling zones in Precambrian schist.	Bachman and Stotelmeyer, 1967
121. Chupadero (Minas de Chupadero)	—	—	Cu, Ag (U)	L	Sedimentary-copper deposits in Pennsylvanian Moya sandstone.	Jaworski, 1973; McLemore, 1983a
122. Council Rock	—	—	Pb, Ag (Ba)	B	Veins filling faults in Oligocene Spears Formation. Richest material at fault intersections.	Chamberlin, 1974
123. Hansonburg	7.11	12,157	Pb, F, Ba, Cu	E	Veins and irregular bodies filling open spaces in karstified Council Springs member of the Pennsylvanian Madera Limestone. Minor replacement.	Putnam et al., 1983; Kottlowski and Steensma, 1979
124. Hop Canyon (Mill Canyon)	81.70	1,137	Cu, Pb (Zn, Ba, U)	B	Veins in fissures and faults in Oligocene Hells Mesa Tuff, Sawmill Canyon Formation, and along white rhyolite dikes and, to a lesser extent, mafic dikes cutting Hells Mesa Tuff.	North, 1983
125. Joyita Hills	—	11 (50)	Pb, F, (Cu)	E	Veins in fissures in Precambrian gneiss and along the contact of Precambrian rocks with Oligocene volcanic rocks to the east and Pennsylvanian and Permian sedimentary rocks to the west.	Lasky, 1932
126. Ladron Mountains	—	—	U, Cu, Pb, Ag, F (Zn, Ba)	M, C	Veins filling fissures in Precambrian Capirote granite and Precambrian metasediments.	Chamberlin et al., 1982; McLemore, 1983a
127. Lemitar Mountains	—	—	Cu, Pb, Ba, Ag (F, Zn, U)	E	Veins with minor replacement occur along the unconformable contact of Precambrian rocks and overlying Paleozoic sedimentary rocks; along the contact of Precambrian mafic dikes intruding granite; associated with Ordovician carbonatite dikes; and in fissures in Paleozoic limestone.	McLemore, 1982a, 1983b
128. Luis Lopez	—	—	Mn (Au, Ag, Zn, W)	B	Trace amounts of silver and gold associated with manganese veins in Tertiary volcanic rocks.	Hewitt, 1964; Norman et al., 1983
129. Magdalena	3,129 (3,500)	(4,000,000)	Zn, Pb, Cu (F, Ba)	F	Skarn, replacement, and vein deposits in Mississippian Kelly Limestone and, to a lesser extent, in Pennsylvanian Sandia and Madera Formations associated with Tertiary Nitt stock (monzonite). Generally, replacement bodies are localized by north-trending faults.	Loughlin and Koschmann, 1942; Blakestad, 1976
130. Mockingbird Gap	—	117	Pb (Cu, Ba, F, Zn)	E	Veins filling faults between Precambrian granite and Paleozoic sedimentary rocks.	Lasky, 1932; Bachman, 1968; Bachman and Harbour, 1970
131. North Magdalena (Silver Hill)	—	149	Pb, Ba, Cu, V (Zn)	B	Veins filling faults and fissures in Oligocene La Jara Peak Basaltic Andesite.	Lasky, 1932; Simon, 1973; North, 1983
132. Rayo	—	—	(Cu, Ag)	L	Stratabound sedimentary-copper deposits in light-colored siliceous sandstones of the Permian Yeso Formation (Meseta Blanca Sandstone Member).	Soulé, 1956; LaPoint, 1979

TABLE 3 (continued)

District (synonyms)	Precious-metal production in troy ounces reported/ (estimated)		Other commodities produced/ (present)	Type(s) of deposit(s)	Description	References
	Gold	Silver				
133. Rosedale	27,750	5,363 (10,000)	(F)	B	Veins in faults cutting Oligocene South Canyon Tuff.	North, 1983; Neubert, 1983; Koschmann and Bergendahl, 1968
134. San Jose	887.8	12,917	Cu, Pb, Zn	B	Veins in faults cutting Oligocene Spears Formation and Vicks Peak Tuff.	North, 1983; Neubert, 1983; Lasky, 1932
135. San Lorenzo	—	—	Cu, Ag (U)	B	Veins filling faults in middle Tertiary andesite.	North, 1983
136. Socorro Peak	—	(750,000)	Pb (Ba, F)	B	Veins filling faults in late Miocene Socorro Peak Rhyolite and underlying Popotosa Formation. Some veins also cut Pennsylvanian Sandia and Madera Formations.	Chamberlin, 1980; Lasky, 1932
137. Taylor (Ojo Caliente #2)	—	—	Cu, Pb, Ag	B	Veins filling fissures in Oligocene andesite–latite flow in an intensely altered area.	Hillard, 1969; Lasky, 1932; North, 1983; Griffitts and Alminas, 1968
138. Water Canyon	196.32	2,064	Cu, Pb, Zn (Mn)	F	Vein, skarn, and replacement deposits in Mississippian Kelly Limestone, commonly localized by faults and veins filling faults between Precambrian and younger rocks.	Lasky, 1932; North, 1983; Hewitt and Radtke, 1967
Taos County						
139. La Virgen	—	—	(Cu, Ag, Pb, Zn)	N(?)	Volcanic-sulfide deposits(?) in Precambrian schists.	Robertson et al. (in press)
140. Picuris	14.75	1,351	Cu, W (U, Sb)	M	Mineralized quartz veins, disseminated mineralization, and oxidized-copper mineralization filling fractures in Precambrian Ortega Quartzite.	Williams, 1982; Montgomery, 1953; Lindgren et al., 1910; Schilling, 1960; USBM Minerals Yearbooks
141. Red River (Rio Hondo)	364.89	8,051	Cu, Pb, Zn, U (Mo)	D(?), M, A	Veins in Precambrian granitic rocks and Tertiary biotite granite, rhyolite, latite, and quartz veins. Mineralization is of Tertiary age. Placer deposits.	Clark and Read, 1972; Schilling, 1960; Park and McKinlay, 1948; Luddington et al., 1984
142. Rio Grande valley	(<1,000)	—	—	A	Placer-gold deposits in Recent gravels of the Rio Grande and Red River.	McLemore and North, 1984; Johnson, 1972
143. Twining	(80)	(1,000)	Cu	M	Veins and disseminated mineralization in Precambrian mafic gneiss. Mineralization is of Precambrian age.	Clark and Read, 1972; Restrepo, 1972; Park and McKinlay, 1948; Daggett, 1984; Robertson et al. (in press)
Torrance County						
144. Chupadera Iron prospects	—	—	Fe (Au)	D(?)	Iron deposits, either skarn or hydrothermal. Samples assay 0.02 oz/ton (0.7 ppm) Au.	McLemore, 1984, field notes 8/11/83
145. Edgewood	—	—	Ba (F, Pb, Ag)	E	Ba–F veins in Pennsylvanian Madera Formation.	McLemore and Barker, 1985
146. Manzano Mountains (Valencia County)	—	—	(Cu, Au, Ag, Pb)	M	Veins filling faults and shear zones in Precambrian argillaceous metasediments.	McLemore, field notes 1984; Maxwell and Light, 1984; Maxwell and Wobus, 1982; McLemore, 1984; Maxwell et al., 1984
147. Pedernal Hills	—	—	(Cu, Ag, Au, U)	M	Veins filling fissures in Precambrian granite and greenstones.	McLemore, 1984; J. Setter, pers. comm. 1984; Robertson et al. (in press)
148. Scholle (Socorro and Valencia Counties)	9.96	8,147	Cu, Ra, Pb (U, V)	L	Stratabound sedimentary-copper deposits in sandstones, limestones, siltstones, and shales of the Permian Bursum, Abo, and Yeso Formations.	Soulé, 1956; McLemore, 1982b, 1984; LaPoint, 1979
Union County						
149. Black Mesa	—	10	Cu (U, V)	L	Mineralization in clastic plugs and sandstones in Triassic Sheep Pen Sandstone.	Fay, 1983; Soulé, 1956; Baldwin and Muehlberger, 1954; USBM Minerals Yearbooks

TABLE 3 (continued)

District (synonyms)	Precious-metal production in troy ounces reported/ (estimated) Gold	Silver	Other commodities produced/ (present)	Type(s) of deposit(s)	Description	References
150. Folsom	—	—	(Au)	B, A	Gold reported in quartz stringers in Tertiary basalt. Small amounts of placer gold in Recent gravels of the Cimarron River valley.	Harley, 1940; Johnson, 1972
151. Peacock Canyon	—	—	(Cu, U, Ag, Au)	L	Stratabound sedimentary-copper deposits in sandstones of Triassic Chinle Formation.	Soulé, 1956
Valencia County						
152. Hell Canyon	2,724	3,349	Cu (Mo)	M	Veins filling shear zones in Precambrian greenstone.	Woodward et al., 1978, 1979; Myers and McKay, 1970; Robertson et al. (in press)
153. Romero Ranch (Rio Puerco) (Cibola County)	—	24	Cu (U)	L	Stratabound sedimentary-copper deposits in limestones and conglomerates of Triassic Chinle Formation.	McLemore, 1983a, field notes 1981; USBM Minerals Yearbooks

Classification of deposits

The classification of ore deposits has a long and interesting history. The genetic classification of Lindgren (1933) received wide acceptance from North American geologists and became something of a standard for the continent (with modifications) for nearly 40 years. With the wide acceptance of plate tectonics, classifications emerged placing ore deposits in specific plate-tectonic settings (Guild, 1971, 1978; Sillitoe, 1972, 1981; Shawe, 1977; Guilbert, 1981; Lipman, 1981; Mitchell, 1976; Mitchell and Garson, 1981; Sawkins, 1972, 1984). These tectonic classifications work fairly well for the Mesozoic and Cenozoic deposits of western North America. Difficulties arise with placing older deposits in a specific tectonic setting; Precambrian deposits are especially difficult to place in a plate-tectonic classification (Sangster, 1979).

Many Mesozoic and Cenozoic ore deposits of western North America are associated with contemporaneous magmatism, volcanism (Jerome and Cook, 1967), and tectonism (Billingsley and Locke, 1935, 1941). This igneous activity is now generally believed to be associated with the subduction of the Farallon plate beneath the North American plate that began in the Jurassic and extended into the Tertiary. For a complete discussion of the plate subduction and related events see Atwater (1970), Dickinson and Snyder (1978, 1979), Dickinson (1981), Damon et al. (1981), Lipman (1981), Cross and Pilger (1978, 1982), and Engebretson et al. (1984). In broad terms, igneous events and ore formation proceed from west to east through time—from the early Mesozoic into the Tertiary. The effects of subduction on continental crust as far inboard of the trench as New Mexico (>1,000 km) are thought to be due to rapid convergence and resulting low-angle subduction of the Farallon plate beneath the North American plate between about 80 and 50 m.y. ago, and subsequent slowing and steepening between 40 and 20 m.y. ago (Keith, 1978, 1982). In detail, however, the spatial and temporal distribution of ore deposits is considerably more complex.

New Mexico's ore deposits are particularly difficult to classify because of a considerable overlap of tectonic regimes through the Late Cretaceous and Tertiary, and an inadequate amount of recently published data on ore deposits and on the dating of associated igneous events. The classification presented here considers the following characteristics, in order of perceived importance: (1) the age of formation of the deposits; (2) their tectonic setting; (3) genetic processes, where known (e.g. skarns, porphyry-copper deposits, placers); (4) the mineralogy of the deposits; (5) host rocks; and (6) the form of the deposit. Only rarely are all six characteristics known and/or used in formulating any given class of deposit (porphyry-copper deposits come the closest).

Each of the six elements of classification has problems. Commonly age, tectonic setting, and genetic processes are unknown or poorly understood. The minealogy of the deposits can be greatly affected by zoning within a district, and host rock and form may be largely accidental. However, the system does divide the silver and gold deposits into 14 distinct classes (Table 2). The classification should serve as a guide to the types of deposits which might be found in the state and to the types of extensions which might be discovered in known districts. All the districts shown in Table 3 and on the map can be generally accommodated by the system. Some districts contain two or more distinct types of deposits and all types known are listed in Table 3 under "Type(s) of deposit(s)." The color given on the map reflects the most important silver- and/or gold-bearing deposits of the district.

Descriptions of deposits

Placer deposits

In the past, placer deposits have been an important source of gold in New Mexico (Fig. 1). Most of the placer deposits were formed by the late Tertiary through Recent erosion of Cretaceous and Tertiary deposits exposed by Tertiary uplift. In some cases, for example in the Hopewell district (#85, Fig. 1, Table 3), early Tertiary gravels were worked for their gold content. Concentration of gold from low-grade Precambrian deposits appears to have been an important source in some districts (e.g. Pittsburg district, #114).

The economic potential of placer deposits in New Mexico is minimal. Doubtless most, if not all, economic placers have been previously worked. Their future depends upon working the deposits employing large-volume methods with low-grade gravels. Lack of water has hampered some districts and new technology minimizing water use may stimulate activity. Districts with considerable production (>7,500 oz gold) include Elizabethtown–Baldy (#7), Old Placers (#100), New Placers (#99), Hillsboro (#109), Jicarilla (#59), Pinos Altos (#36), Hopewell (#85), Orogrande (#73), and Pittsburgh (#114).

Volcanic-epithermal deposits

Lindgren (1933) proposed the term epithermal for deposits formed at relatively low temperatures (50–200°C) and pressures. Schmitt (1950) realized that the maximum temperature of 200°C was too low for this type of deposit and suggested that the term epithermal be retained, but the upper temperature range be raised to about 300°C. Fluid-inclusion studies have shown that these deposits form at about 200–300°C from low-salinity solutions (<5 wt% NaCl equivalent; Roedder, 1984). The characteristics of these deposits and a model for their formation are outlined by Buchanan (1981). The term epithermal is retained here because of its wide acceptance. However, the class is restricted to volcanic terranes and areas immediately adjacent to volcanic fields (e.g. Abbe Spring district, #117, Fig. 2, Table 3; and Fremont district, #47).

The volcanic-epithermal deposits of New Mexico formed largely in ash-flow tuffs and andesites of Oligocene age, commonly adjacent to resurgent cauldrons (Elston, 1978). However, where dates are available, the ore deposits are 10–12 m.y. (or more) younger than caldera formations and, therefore, the relationship is probably one of a favorable plumbing system present in an area of recurrent high heat flow. Examples of volcanic-epithermal deposits are known from Upper Cretaceous andesite (Hillsboro district, #109) and upper Miocene rocks (Cochiti district, #86).

The volcanic-epithermal deposits of New Mexico are veins filling open spaces, mostly faults, in volcanic rocks and in sedimentary rocks within, and adjacent to, volcanic fields. The mineralogy of the deposits varies, probably in response to vertical zoning within the system as discussed by Buchanan (1981; precious metals above base metals). The Mogollon district (#3) is an excellent example of vertical zoning with silver (~20 oz/ton) and appreciable gold (~0.10 oz/ton) in the upper levels of veins, and grading into base metals with depth. Copper is important in some districts (e.g. Chloride district, #103), lead in others (e.g. North Magdalena district, #131), and antimony has been found (but not produced) in the Bear Mountains district (#118; North, 1985).

The volcanic-epithermal deposits of New Mexico were formed mostly in rocks which were part of a large volume of flows extruded between 35 and 20 m.y. ago. The regional tectonics during this period was largely neutral to extensional (Chapin, 1979). Numerous plutons and possibly associated skarn and replacement deposits (discussed below) were emplaced during this time. These deposits are equivalent to the epithermal ignimbrite deposits of Guilbert (1981, p. 9) and in part to the vein deposits of Sawkins (1984, pp. 38–49).

These deposits have in the past been significant producers of precious metals (Fig. 2). The more important districts include Mogollon (#3), Steeple Rock (#39), Cochiti (#86), Chloride (#103), Hillsboro (#109), Rosedale (#133), and Socorro Peak (#136). Given favorable precious-metal prices, future small-scale exploitation of these deposits is likely. Many of the veins are quartz-rich and the ores can be sold as flux to local smelters. The development of portable heap-leaching equipment may spur the recovery of precious metals from dumps in some districts (Eveleth, 1979).

Supergene-copper–uranium (silver) deposits

Two deposits in New Mexico, La Bajada (#98, Table 3) and Jeter in the Ladron Mountains (#126), are classified as supergene copper–uranium (silver). These deposits were formed at low temperatures along Tertiary faults. Copper, silver, molybdenum, and uranium occurs at both deposits. Lead, zinc, cobalt, nickel, germanium, and minor amounts of gold also occur at La Bajada. Uranium, vanadium, copper, and silver were produced from La Bajada (McLemore and North, 1984), but only uranium and vanadium were produced from the Jeter. Silver concentrations are low (less than 1 oz/ton) in both deposits, whereas uranium concentrations are moderately high (approximately 0.2%).

The mineralization occurs in veins along faults and appears to be controlled by organic material (Haji-Vassiliou and Kerr, 1972) or carbonaceous mudstone (Collins and Nye, 1957). Hydrothermal alteration and bleaching have occurred adjacent to both deposits, but intense silicification, common to many hydrothermal-vein deposits is absent. These deposits were possibly formed by low-temperature, mineralized waters. Precipitation occurred at favorable reducing environments along the faults, similar to formation of sandstone-uranium and copper deposits.

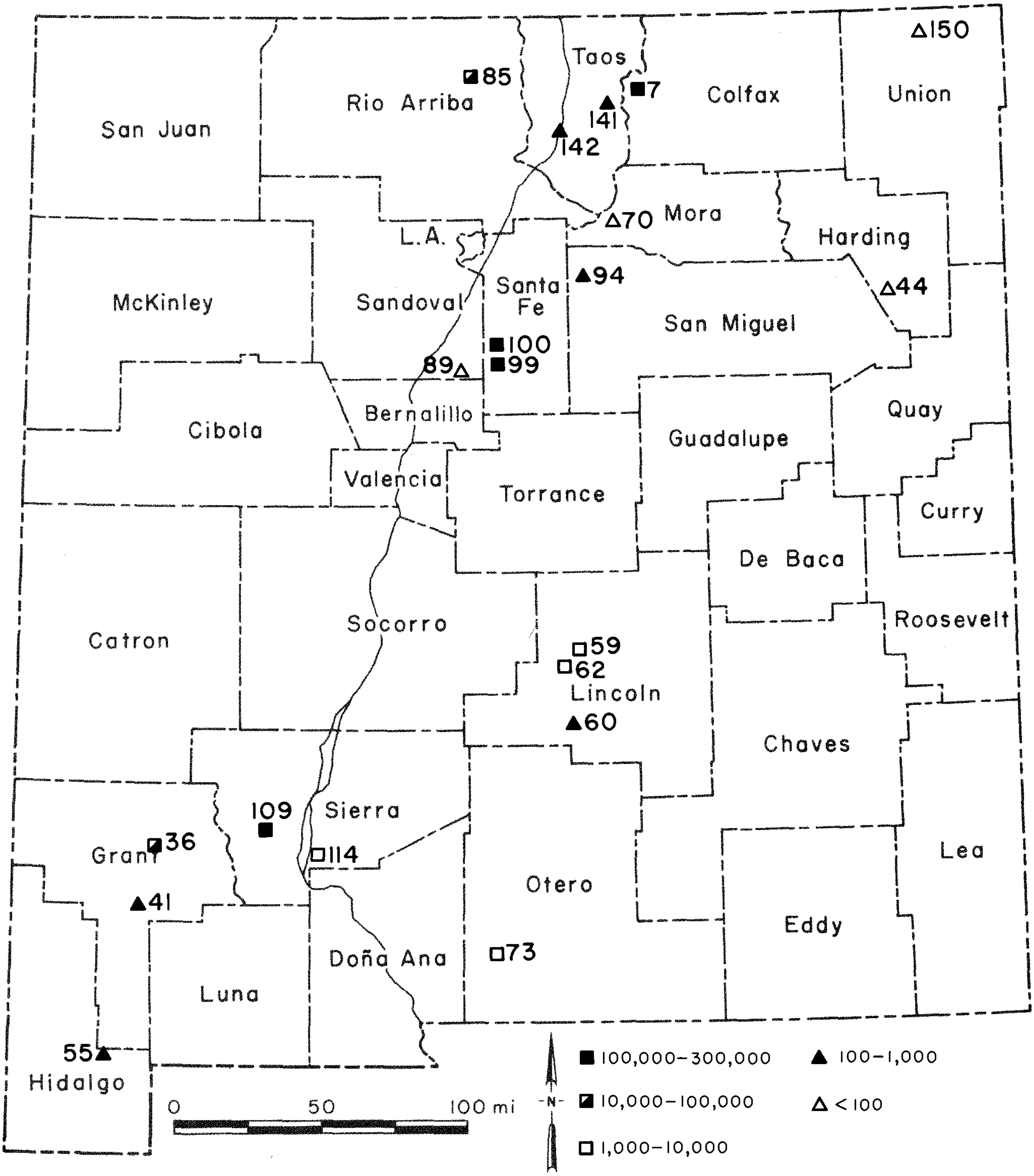

FIGURE 1—Placer gold deposits in New Mexico showing estimated gold production in troy ounces. Numbers refer to Table 3.

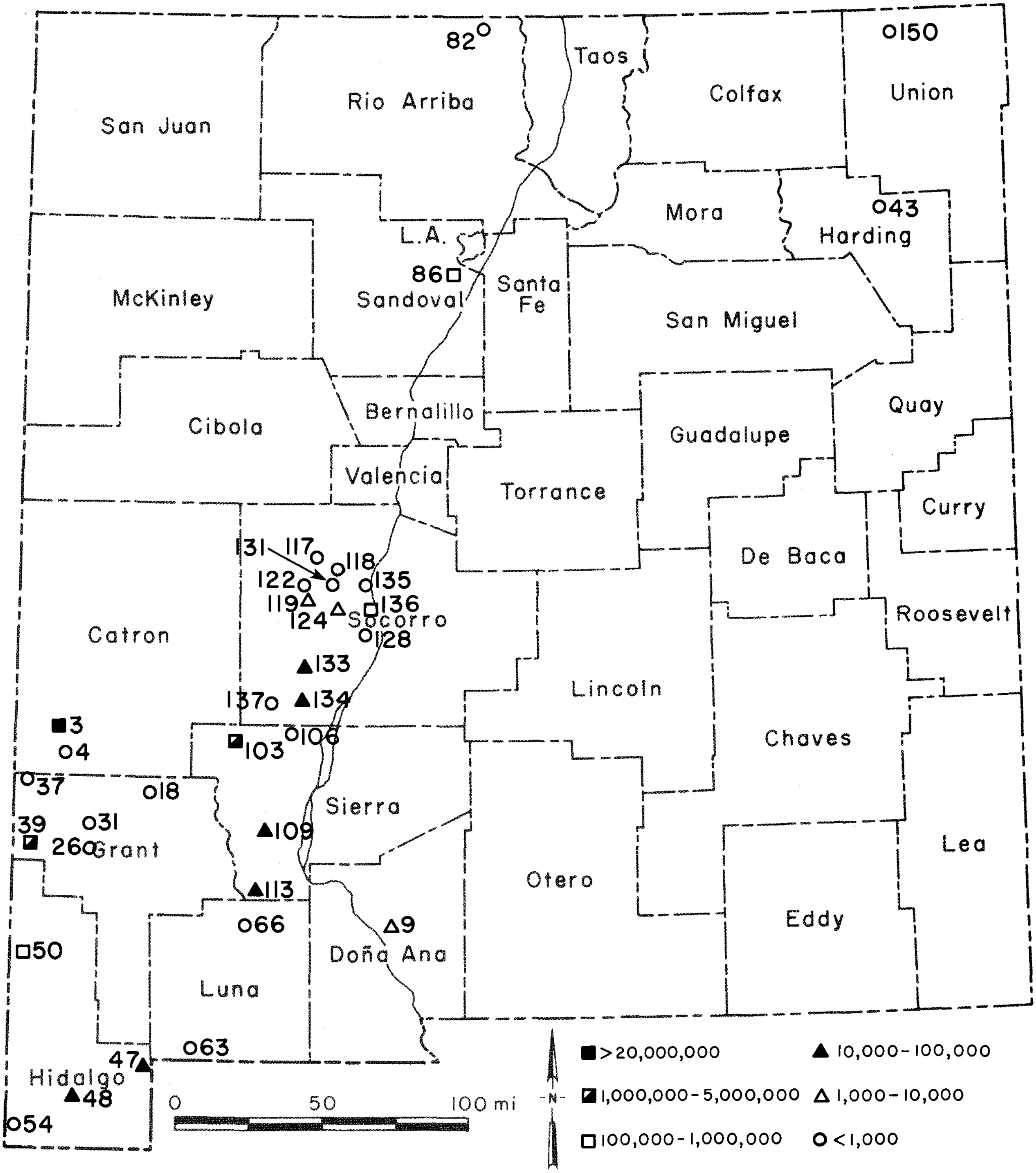

FIGURE 2—Volcanic-epithermal deposits in New Mexico showing estimated silver production in troy ounces. Numbers refer to Table 3.

These deposits are unlikely to be mined for their precious metals because of small size and low grade. Silver could be recovered only as a byproduct of uranium mining; however, the urnaium market is depressed and it is thus not likely that these deposits will be mined in the near future.

Great Plains Margin deposits

Several mining districts in New Mexico lie along, or near, the border of the Great Plains with the southern Rocky Mountains or Basin and Range Provinces. These deposits have some similar characteristics that, when compared with their tectonic setting, define a new class of ore deposits.

The Great Plains Margin deposits contain both base and precious metals, but precious metals are generally high compared to other metal deposits in the state. Alkalic rocks are found in most districts, but mineralization is usually associated with silica-saturated (monzonite) or oversaturated (quartz monzonite) rocks. The deposits are typically associated with Oligocene intrusives (stocks, laccoliths, sills), although the Orogrande district (#73) is associated with Eocene intrusive rocks (C. E. Chapin, pers. comm. 1985) and the Red River district (#141) with Miocene rocks. The Great Plains Margin deposits usually consist of four associated deposit types, including quartz veins, copper and/or lead–zinc skarns, iron skarns, and placer deposits. The veins have high gold/base metal ratios and commonly low silver/gold ratios. The breccia pipes found in the Old Placers (#100, Fig. 3, Table 3) and the Nogal (#60) districts may be a variation of the vein-type deposits.

Copper skarn deposits are common, and lead–zinc skarns are known from at least one district (New Placers, #99). Copper with by-product gold has been important in the Orogrande (#73) and New Placers (#99) districts. Copper skarns were also mined at the Elizabethtown–Baldy (#7) and Cimmaroncito districts (#6; Lindgren et al., 1910).

The relationship of iron skarns to precious-metal mineralization is uncertain. Districts with reported iron skarns include the Elizabethtown–Baldy (#7), Old Placers (#100), New Placers (#99), Gallinas (#58), White Oaks (#62), Jicarilla (#59), and Orogrande (#73; Kelley, 1949). These iron deposits do not contain recoverable gold or silver, but their occurrence in close proximity to the copper skarn and gold–silver vein deposits is interesting.

Placer deposits adjacent to the vein and skarn deposits are important in the Elizabethtown–Baldy (#7), Old Placers (#100), New Placers (#99), Jicarilla (#59), and Orogrande (#73) districts. Vein deposits probably supplied most of the gold concentrated in these placers.

The origin and association of the Great Plains Margin deposits is not clear. They coincide with a belt of alkalic rocks in New Mexico which mimics the margin from Texas to Colorado. This belt of alkalic rocks continues northward into Canada and southward into Mexico (Clark et al., 1982), and some of the ore deposits in other areas are similar. Other commodities found along this general trend are molybdenum, fluorite, and tungsten. It is likely that the co-occurrence of gold, copper, iron, molybdenum, fluorite, and tungsten is the result of several different events and tectonic environments which overlap near the Great Plains Margin.

Production of gold from Great Plains Margin deposits has been significant in New Mexico (Fig. 3). Districts producing over 100,000 ounces of gold include Elizabethtown–Baldy (#7), White Oaks (#62), New Placers (#99), and Old Placers (#100). This type of deposit may be a significant future target for precious-metal exploration. Since the ores are often low in base metals, they are good candidates for cyanide heap-leaching. However, further study of formation of these deposits is needed to identify reasonable exploration targets.

Sedimentary-hydrothermal deposits

Sedimentary-hydrothermal barite–fluorite–galena deposits are open-space fillings with little or no replacement and are not associated with magmatic activity. These deposits consist dominantly of barite and/or fluorite with subordinant to equal amounts of galena and minor quantities of silver, copper, and zinc. Gold and silver are rare in these deposits, although both have been recovered from a few deposits in New Mexico (Table 3). Gold rarely exceeds 0.02 oz/ton, whereas a few deposits may contain up to 0.8 oz/ton silver.

Mineralization occurs as veins, breccia cement, cavity fillings, and minor replacement bodies along faults, fractures, shear zones, bedding planes, solution cavities, and contact zones in Precambrian, Paleozoic, and Tertiary rocks. Sedimentary-hydrothermal deposits are widespread within or near the Rio Grande rift (McLemore and Barker, 1985).

The age of mineralization is not known, but is limited by the age of mineralized faults. Previous workers have attributed these deposits to the Tertiary (Allmendinger, 1974, 1975; Beane, 1974; Ewing, 1979; Putnam et al., 1983); however, recent work in north-central New Mexico indicates that these deposits could be as old as late Paleozoic or as young as Miocene (McLemore and Barker, 1985; North and McLemore, 1985).

The sedimentary-hydrothermal deposits in New Mexico are similar in emplacement, geology, mineralogy, and chemistry, and are in part analogous to Mississippi Valley-type deposits. The deposits are formed by water that is trapped within sediments during deposition and after burial (Hanor, 1979). The formational waters or basin brines accumulate in sedimentary basins and are heated by high heat flow, magmatic activity, or radiogenic heat from Precambrian plutons. The warm convecting water leaches barium, sulfate, and other ions including silver and gold, from source rocks such as arkosic sediments, evaporites, Precambrian rocks, and Precambrian mineral deposits. In central New Mexico these basins are

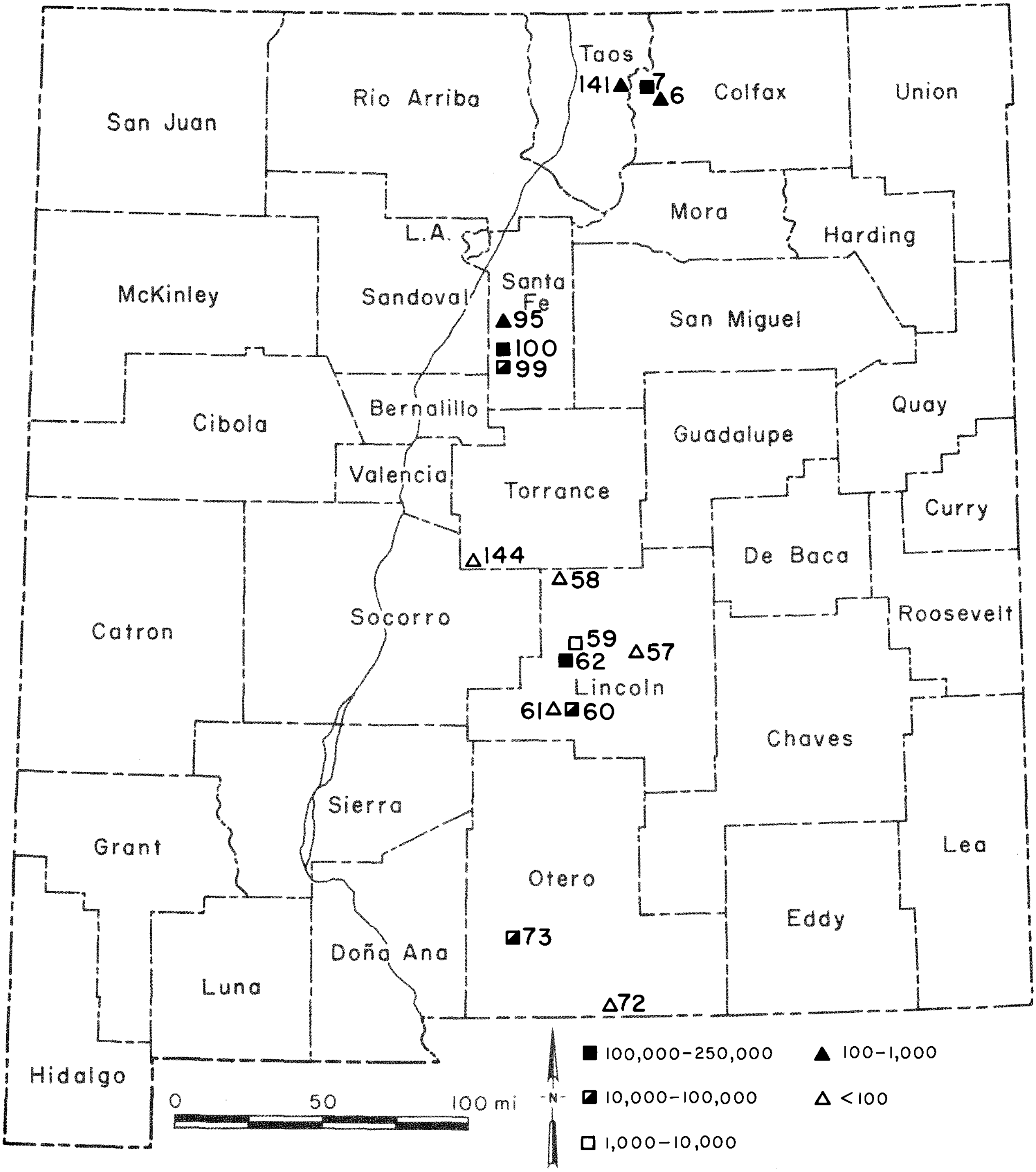

FIGURE 3—Great Plains Margin deposits in New Mexico showing estimated lode-gold production in troy ounces. Numbers refer to Table 3.

continental instead of marine as in the classic Mississippi Valley area.

The mineralized waters are ejected along open spaces such as faults, fractures, and contact zones, primarily by porosity reduction during burial and compaction and/or during tectonic activity. Precipitation occurs as a result of simple cooling of the fluids, decrease in pressure, or mixing of the mineralized hydrothermal fluids with reducing subsurface brines.

It is unlikely that any of these deposits will be mined solely for their silver or gold content; however, byproduct recovery of silver and gold from barite or fluorite production is possible. Barite production is heavily dependent upon the petroleum industry. As exploration for oil and gas increases, barite may once again be produced in New Mexico; silver and gold could then be recovered.

Carbonate-hosted lead–zinc (copper–silver) deposits

These deposits (including skarn) formed in the southwestern quarter of New Mexico during Eocene through mid-Oligocene, ca 50–28 m.y. ago. This was a tectonically quiet period following Paleocene compression (Laramide) and continuing into a period of widespread extension (Chapin, 1979). Volcanic-epithermal deposits are spatially and possibly temporally associated with carbonate-hosted lead–zinc deposits in some places. The deposits include skarns, replacements without evidence of calc-silicate minerals, and, in one area, veins cutting limestone (Carpenter district, #23, Fig. 4, Table 3). The most important silver and gold producers are the Magdalena (#129), Victorio (#68), and Organ (#11) districts.

The deposits are dominantly lead–zinc, with byproduct copper, silver, and gold. The primary mineralization is galena and sphalerite, with lesser amounts of chalcopyrite. Historically, the oxidized zones containing cerussite, anglesite, and smithsonite have been the most productive. Recognizable silver and gold minerals are rare, although both native elements have been found in the Magdalena district (#129).

The host rocks are mostly Paleozoic limestone and dolomite, with minor deposits in Cretaceous rocks (e.g. Apache No. 2 district, #45). Stratigraphy may be an important ore-controlling factor in many districts, as for example in the Cooke's Peak (#64) and Organ (#11) districts where the impermeable contact between Fusselman Dolomite and Percha Shale has in places localized ore. Other host-rock characteristics such as texture and possibly age may be important factors (Sullivan, 1973).

The position above the crystalline basement may be important in the localization of some deposits. The mineralized host in most carbonate-hosted districts in New Mexico is the first significant carbonate unit above crystalline basement, which, as observed by Titley and Megaw (1985) in many districts of the Cordillera, provides a pronounced contrast in chemical environment. Presumably, the ore-forming solutions moved upward and were deposited in response to a favorable chemical environment.

Intrusive igneous rocks crop out in all districts except the Big Hatchet Mountains district (#46). The intrusives are quartz monzonite, monzonite, and granodiorite, most of which have been dated at between 38 and 28 m.y. (Loring and Loring, 1980; Weber, 1971), although unpublished dates as old as mid-Eocene have been obtained for the Tres Hermanas stock (C. E. Chapin, pers. comm. 1985).

The carbonate-hosted lead–zinc deposits in New Mexico will not be important sources of silver or gold in the forseeable future. Although they have been significant producers of silver in the past (Fig. 4), this was during a time when zinc and lead mining was profitable. The deposits could only produce precious metals as a byproduct of zinc, or possibly of lead mining. Since lead and zinc mining in the Southwest is not presently economic, nor will be in the near future, it is doubtful that this type of deposit will produce siver.

Carbonate-hosted silver (lead, manganese) deposits

Carbonate-hosted ore deposits where silver was the major metal recovered have been important producers in New Mexico (Fig. 5). Over 20 million ounces of silver have been recovered from deposits of this type, much of it before 1895. Most of the silver was produced from oxidized ores, some of which were very rich (e.g. Lake Valley, #112, Fig. 5, Table 3).

The deposits are hosted by Paleozoic limestones and dolomites, usually the Silurian Fusselman Dolomite; the Mississippian Lake Valley Limestone is mineralized at the Lake Valley district (#112). The Devonian Percha Shale has acted as an impermeable cap in many districts, localizing ore in the underlying Fusselman Dolomite. Other Paleozoic rocks and Tertiary volcanics are mineralized in some districts, but in all cases carbonates are the most important host rocks. Jasperoid is commonly associated with these deposits.

The oxidation of this type of ore has been very important in forming high-grade deposits. The best example is the Lake Valley district (#112), where the "Bridal Chamber," an orebody of nearly pure chlorargyrite, was found in the early 1880's (Jicha, 1954). Other oxidized minerals commonly found in these districts include native silver, cerussite, vanadinite, wulfenite, and smithsonite. Primary minerals include argentite, argentiferous galena, polybasite, pyrargyrite, stephanite, sphalterite, and chalcopyrite. Manganese is abundant in some districts, and has posed metallurgical problems in recovering the silver. Manganese has been produced from the Chloride Flat (#24) (Boston Hill), Lone Mountain (#33), and Lake Valley (#112) districts.

The carbonate-hosted silver (lead, manganese) deposits of New Mexico have been in the past classified as epithermal silver–manganese deposits and epi-

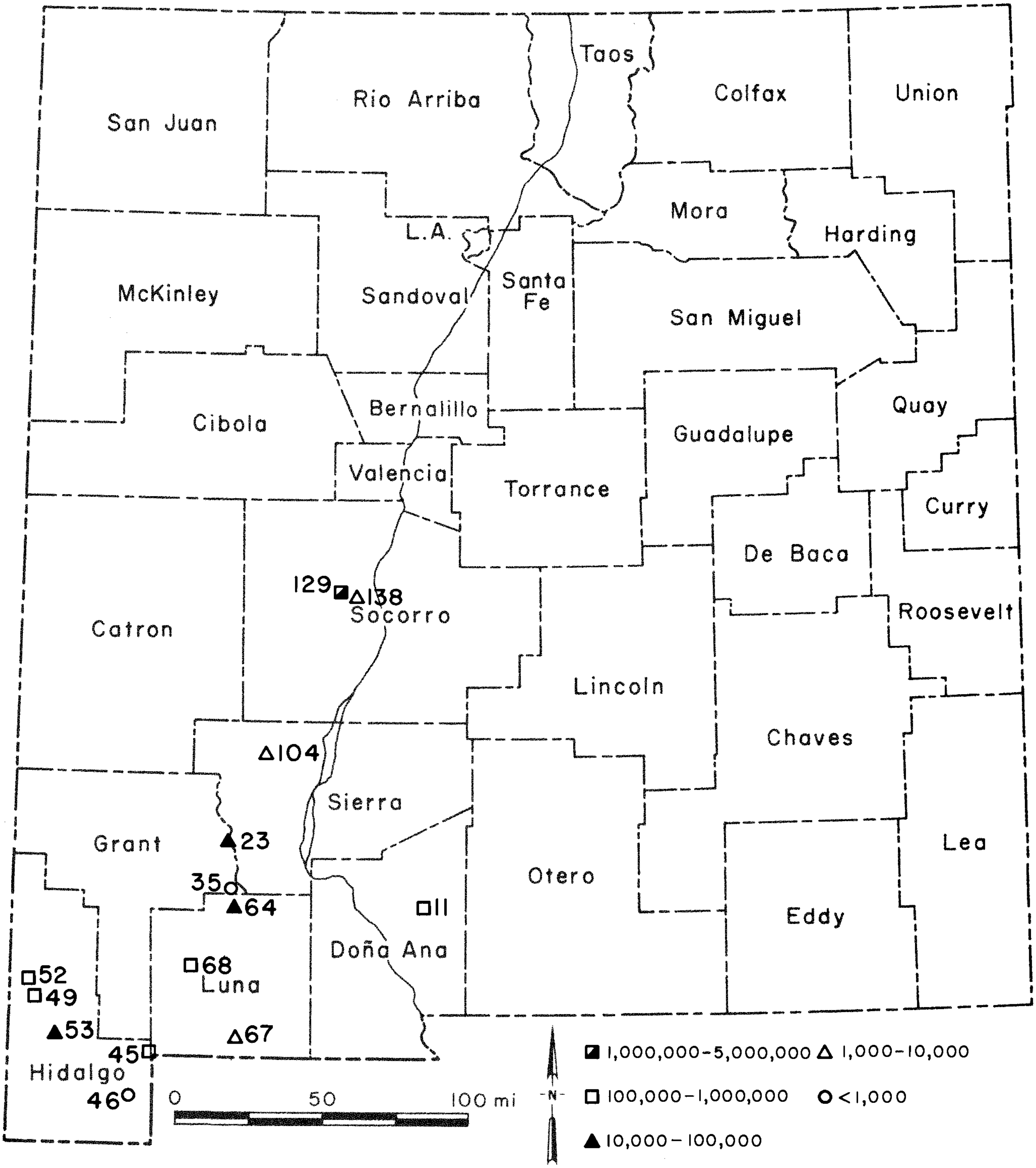

FIGURE 4—Carbonate-hosted lead–zinc (silver–copper) deposits in New Mexico showing estimated silver production in troy ounces. Numbers refer to Table 3.

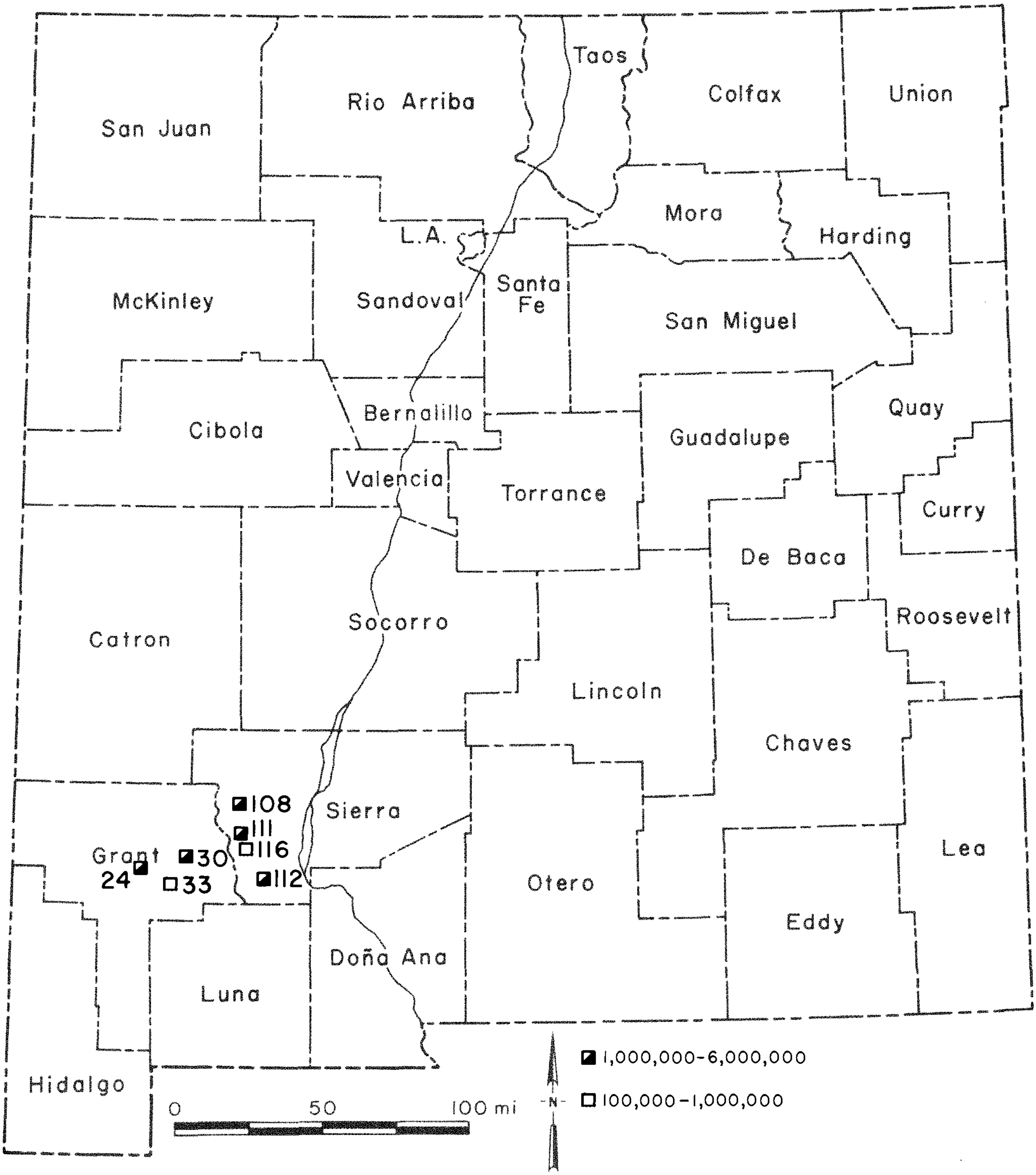

FIGURE 5—Carbonate-hosted silver (lead–manganese) deposits in New Mexico showing estimated silver production in troy ounces. Numbers refer to Table 3.

thermal silver–lead–zinc replacement deposits (Heyl et al., 1973). The deposits probably formed under temperature and pressure conditions overlapping those of the volcanic-epithermal deposits. However, since the host rock represents a very different chemical environment and stratigraphy is an important ore-controlling mechanism, the carbonate-hosted silver (lead, manganese) deposits are significantly different from the deposits considered epithermal in this classification.

These deposits all are spatially and probably genetically associated with Tertiary volcanic or plutonic activity. Age dates in the vicinity of the deposits are generally lacking, but they may represent two ages of mineralization based on general age trends. The Georgetown (#30), Lone Mountain (#33), and Chloride Flat (#24) districts of Grant County are in an area where dated plutons are Late Cretaceous to early Tertiary, suggesting the carbonate-hosted silver (lead, manganese) deposits of the area are of similar age. The Hermosa (#108), Kingston (#111), Tierra Blanca (#116), and Lake Valley (#112) districts of Sierra County are in an area where volcanic rocks have been dated as Oligocene (Loring and Loring, 1980), suggesting they are younger than their Grant County counterparts.

Carbonate-hosted silver deposits are good exploration targets for small mining operations. The deposits mined in the past have been high grade, but of small tonnage. Since the limestone is often silicified and quartz gangue is common, the deposits have potential as siliceous flux. Metallurgical problems with manganiferous silver ores have hampered production in the past. However, recent metallurgical research on silver associated with manganese has produced some promising results (Chase and Keane, 1985). A metallurgical breakthrough providing an inexpensive and efficient method of recovering silver from manganese-rich deposits would greatly improve the outlook for this type of deposit.

Copper and lead–zinc skarn deposits

These deposits were formed in New Mexico adjacent to plutonic rocks emplaced between the Late Cretaceous (ca 75 m.y.) and early Eocene (ca 55 m.y.). This interval is generally referred to as the Laramide or Laramide orogeny, although its exact age boundaries have been the subject of some controversy (see Damon et al., 1981, fig. 3). This was generally a time of compressional tectonics. The skarns are located in Paleozoic carbonates adjacent to porphyritic stocks and batholiths of granodiorite, monzonite, and quartz-monzonite composition. Although both zinc- and copper-rich skarns occur adjacent to the Fierro–Hanover (#28, Table 3) and Pinos Altos (#36) intrusions, they are clearly distinct. Late-stage veins carrying gold, silver, and base metals cut the intrusives at the Pinos Altos (#36), Eureka (#27), and Sylvanite (#55) districts, and may have contributed significantly to the placer deposits in those areas.

The most common ore minerals in these deposits are chalcopyrite, galena, and sphalerite. Common gangue minerals include garnet, diopside, wollastonite, calcite, quartz, epidote, hematite, ilvaite, and magnetite. The host rocks are Paleozoic and Lower Cretaceous carbonates.

The future exploitation of these deposits depends largely on the price of copper. Bolieden Minerals is currently examining a copper orebody in the Pinos Altos (#36) district; however, Sharon Steel's Continental mine (copper skarn) in the Fierro–Hanover (#28) district is shut down, on standby. With a favorable copper price (~$1.00/pound), these properties may produce copper with byproduct silver and gold. The lead–zinc skarns have a less favorable outlook. There are currently no smelters in the Southwest which recover zinc, so shipping costs would be prohibitive. The building of a new facility to recover zinc is not likely; thus, until there is a very good zinc market, production from the lead–zinc skarns is unlikely.

Laramide vein deposits

Vein deposits of Laramide age (Late Cretaceous–early Eocene, 75–55 m.y.) occur in a number of rock types in southwestern New Mexico. The veins show a variety of characteristics, but all are of similar age and probably formed under similar conditions. These deposits would have been classified as mesothermal in Lindgren's (1933) classification.

Precambrian rocks are the most common host for the veins, although Cretaceous volcanic and plutonic rocks host mineralization in the Lordsburg district (#51, Fig. 6, Table 3), Paleozoic sedimentary rocks host the ores of the Bayard district (#19), and Cretaceous sandstone hosts mineralization in the Fleming (#29) district. The veins were worked for both base and precious metals, and contain uranium at the White Signal (#41) and Black Hawk (#20) districts. The mineralogies and metal associations are diverse. Black Hawk (#20), for example, contains cobalt and nickel minerals with native silver; Lordsburg (#51) is an example of a copper–tourmaline deposit; and Bayard (#19) is primarily a lead–zinc producer. Despite these differences, the deposits are grouped together on the basis of their form, association with Laramide igneous activity, and perceived formation at moderate depth.

The ores from some Laramide vein deposits may have potential as siliceous flux for the copper smelters of the area. The smelters currently seek fluxing ores, and the close proximity of the veins to the smelters is a plus. Past production indicates these ores are of small to moderate tonnage; however, production, especially as a byproduct of copper and lead–zinc mining, has been significant (Fig. 6).

Porphyry-copper deposits

These are large, low-grade (~0.6–0.8%) copper deposits of disseminated and stockwork veinlets of sulfides. Mineralization typically occurs in and around prophyritic diorite, granodiorite, and quartz-mon-

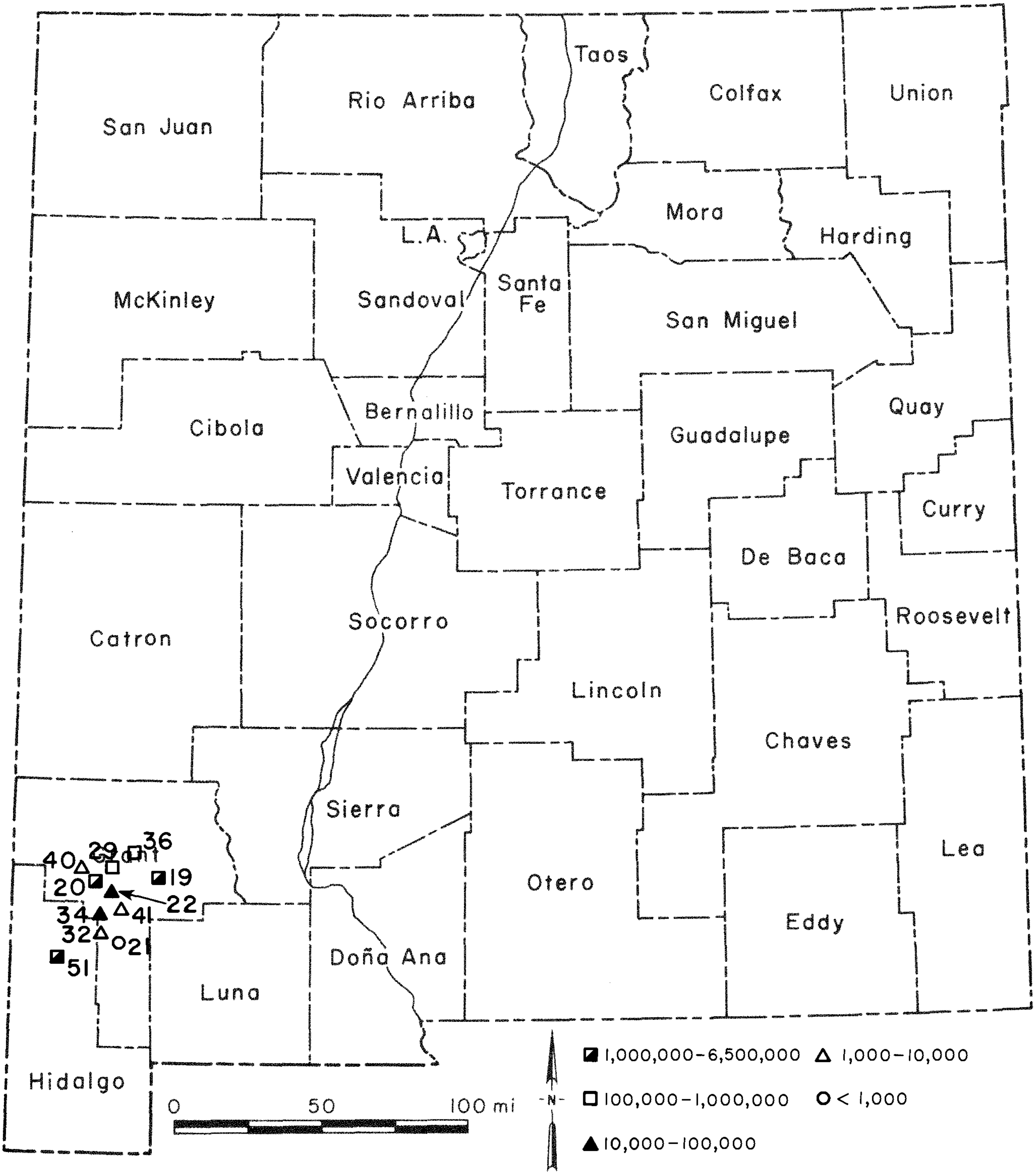

FIGURE 6—Laramide vein deposits in New Mexico showing silver production in troy ounces. Numbers refer to Table 3.

zonite intrusives and is surrounded by concentric zones of hydrothermal alteration (Lowell and Guilbert, 1970). Gold and silver are present in these deposits, but in low concentrations. They occur as particles of native metal; silver also occurs in solid solution in sulfide minerals (Kesler, 1973). Precious metals, including trace amounts of platinum-group metals (Eveleth and Bieberman, 1984), can be recovered from the anode slimes remaining after copper is refined. Since these deposits are so large, recoverable gold and silver can be significant. Silver production from the Tyrone porphyry deposit in the Burro Mountains district (#22, Table 3) ranked eleventh in the nation in 1982 (Eveleth and Bieberman, 1984).

Three porphyry-copper deposits in New Mexico, Santa Rita (#38), Tyrone (#22), and Copper Flat in the Hillsboro district (#109), are known to contain gold and silver. These deposits range in age from Late Cretaceous to Eocene.

The largest porphyry-copper deposit in New Mexico is the Santa Rita, where copper mineralization occurs in the upper, highly fractured part of a granodiorite intrusive and in the adjacent sedimentary rocks. Gold and silver are low in the primary ore; however, the enriched and oxidized zones may contain appreciable amounts of gold and silver (Koschmann and Bergendahl, 1968).

The Tyrone porphyry-copper deposit (#22) occurs within a quartz-monzonite laccolith and adjacent Precambrian granite (Kolessar, 1970, 1982). Small amounts of gold and silver are recovered from the primary ore. Gold and silver contents are higher in the enriched zones.

The Copper Flat deposit (#109) consists of copper, gold, and silver mineralization disseminated in a quartz-monzonite stock and in quartz veins (Kuellmer, 1955). Unlike Tyrone and Santa Rita, there is no supergene enrichment zone.

Additional porphyry-copper deposits occur in New Mexico; however, due to the depressed market conditions for copper it is unlikely that any of them will be mined. Gold and silver can be recovered only as byproducts of copper.

Mississippi Valley-type deposits

Deposits described as Mississippi Valley type have been recognized in the central United States and other parts of the world (Kisvarsanyi et al., 1983). These deposits have a wide variety of characteristics and may have as many differences as similarities (Sangster, 1979). A broad definition includes low-temperature, lead–zinc deposits generally in carbonate rocks formed near the margins of a marine sedimentary basin without any associated volcanic or intrusive activity (Ohle, 1980). Variations inclulde deposits that contain dominately fluorite or barite; these deposits are thought to have formed by connate basin brines expelled during compaction of sediments, similarly to sedimentary-hydrothermal barite–fluorite–galena deposits. Fluid-inclusion studies have shown that the ore-forming solutions have high salinities (>15%) and low temperatures (100–150°C; Roedder, 1984, p. 416).

Two deposits in New Mexico adjacent to the Permian Basin may be oxidized Mississippi Valley-type deposits. The deposits are restricted to collapse breccias in Permian dolomite and clastic sediments. The Two Ladies deposit (#17, Table 3) contains zinc and lead with some silver. The Red Lake deposit (#16) contains copper in addition to lead, zinc, and silver. Both deposits are small and highly oxidized, and no minerals suitable for fluid-inclusion studies have yet been found. However, their position in relation to the Permian Basin, the lack of obvious igneous activity, and the assemblage of metals indicate formation by the oxidation of Mississippi Valley-type deposits.

Production from Mississippi Valley-type deposits in New Mexico in the near future is unlikely. The known deposits are small, oxidized bodies of a few tens of tons of ore, at most. The area offers an interesting exploration target for lead–zinc orebodies. However, as discussed above, these commodities are not currently sought and it is doubtful that exploration programs aimed at lead–zinc orebodies will materialize in the near future.

Sedimentary-copper deposits

Local high concentrations of silver, and rarely of gold, occur in some stratabound sedimentary-copper deposits. These deposits occur within red-bed sequences deposited in intracratonic basins with a lack of volcanism or other magmatic activity. They have been called "sandstone" or "red-bed" copper deposits (Soulé, 1956; Phillips, 1960), even though mineralization is not restricted to sandstones and occurs in bleached gray, green, or tan sandstones, shales, siltstones, and limestones within red-bed sequences. Copper mineralization is dominant, but local high concentrations of silver, lead, zinc, uranium, and vanadium are common. Some deposits in the Sacramento district (#74, Table 3) are dominantly lead-bearing, with subordinant amounts of copper and silver. Other deposits, such as some deposits in the Coyote Creek (#69) and Sabinoso districts (#92), are dominantly uranium- and vanadium-bearing, with subordinant amounts of copper, silver, and gold. Other modifications are possible.

In New Mexico, stratabound sedimentary-copper deposits occur within specific intervals of Pennsylvanian, Permian, and Triassic fluvial to marginal-marine sedimentary rocks (LaPoint, 1979). Silver contents average about 0.5 oz/ton (17 ppm) and typically increase with increasing copper concentrations. Gold is rare in these deposits, although several have yielded small amounts as a byproduct.

Copper and associated metals were probably transported in low-temperature solutions through permeable sediments and along faults shortly after burial. Oxidizing waters could leach the metals from (1) Precambrian rocks enriched in these metals, (2) Precambrian base-metal deposits, and (3) clay minerals and detrital grains within the host rocks (LaPoint, 1976, 1979). Sources for chlorides or carbonates to form soluble cuprous-chloride or cuprous-carbonate complexes occur in older Paleozoic evaporite and carbonate sequences. Precipitation occurred at favorable oxidation–reduction interfaces in the presence of organic material or H_2S-rich waters. Subsequent ground water, igneous intrusives (such as at Sacramento), and structural events may modify, alter, or even destroy some deposits (LaPoint, 1979).

The mineral-resource potential for copper, silver, gold, and other associated elements in most stratabound sedimentary-copper deposits is low because of low grade, low tonnage, and poor accessibility to existing mills. Furthermore, economic conditions are unfavorable at present for development of these deposits. If in-situ leaching of these deposits becomes feasible and economical, then silver and gold might be recovered as byproducts from a few of the larger deposits. An in-situ project is underway at the Nacimiento district (#88), but the current plans are to recover only copper. It is also possible that a few deposits, such as at the Stauber mine, Pastura district (#42), may be mined for fluxing ores. In general, however, these deposits are considered a small, minor source of silver and, even more so, of gold.

Precambrian vein and replacement deposits

Vein and replacement deposits containing precious metals occur sporadically through most of the Precambrian terranes in New Mexico. The age of mineralization is uncertain in many districts. Many of these deposits are structurally controlled by schistosity or shear zones of Precambrian age and therefore are post-metamorphic. In the Hopewell (#85, Fig. 3) and Bromide No. 2 (#79) districts there is no evidence of Tertiary intrusive activity. Many precious-metal occurrences in Precambrian rocks are associated with quartz veins of presumably Precambrian age.

Precious metals occur in several types of deposits in Precambrian terranes in New Mexico. Volcanogenic massive-sulfide deposits contain precious metals and are described separately. Gold, silver, and some copper occur in lenticular quartz veins along shear zones in Precambrian greenstones in the Hell Canyon (#152) and Tijeras Canyon (#2) districts. Free gold occurs in many small quartz veins in several areas, notably the Hopewell district (#85). High silver concentrations have been found in quartz veins in the Zuni Mountains (#5). Copper minerals with subordinant amounts of silver and some gold occur in shear zones and as disseminations in many granitic and mafic terranes, such as the Zuni Mountains (#5), Pedernal Hills (#147), and Lemitar Mountains (#127). Other deposits contain varying amounts of chalcopyrite, malachite, pyrite, galena, and minor amounts of gold and silver. Fluorite, barite, and uranium may be present. Some of these deposits, such as in the Picuris district (#140), show evidence of metamorphism (Williams, 1982).

Most of the precious-metal deposits in Precambrian terranes are small and low-grade. High assays of silver and gold occur sporadically in these areas. A few districts have produced considerable quantities of gold and silver (Table 3) and warrant additional study. Some of the world's largest gold deposits occur in Precambrian greenstone terranes; similar areas in New Mexico should be examined for their silver and gold potential.

Precambrian massive-sulfide deposits

Volcanogenic massive-sulfide deposits contain varying amounts of precious metals and are associated with Precambrian greenstone terranes. These polymetallic, stratabound deposits formed contemporaneously with submarine volcanism by hot saline brines. Subsequent hydrothermal activity or metamorphism associated with younger granitic intrusives may have redistributed and reconcentrated some of these deposits. Immediate host rocks include mafic and felsic volcanic rocks, clastic sediments, and carbonate horizons (Robertson et al., in press). Primary sedimentary structures are preserved locally, although the majority of host rocks in New Mexico have been metamorphosed.

Ore deposits typically occur as several stratabound, lensoid bodies that are conformable with layering and metamorphic fabric (Robertson et al., in press). Variable amounts of pyrite and pyrrhotite occur with chalcopyrite, sphalerite, magnetite, and galena. Silver and gold are present. Chloritization and silicification may occur adjacent to the deposits, but widespread alteration is absent.

Many of the volcanogenic massive-sulfide deposits in New Mexico occur in wilderness areas and cannot be developed in the foreseeable future. Additional deposits occur in more favorable land status, and the potential for discovery of other deposits elsewhere in Precambrian greenstones in New Mexico is good.

Miscellaneous occurrences

Other types of deposits occur in New Mexico that may have potential for silver and/or gold in the future. These deposits have not been included on the map or in Table 3 because they are not conventional precious-metal deposits and are not economically feasible at the present time. For example, trace amounts of gold and silver occur in coals throughout New Mexico (F. Campbell, pers. comm. 1984). When coal is burned for electrical power, the resulting fly ash contains higher concentrations of precious metals that may be recovered. Many of the manganese and iron deposits in New Mexico have not been examined for their precious-metal content. Tertiary gravel deposits may have a potential for gold placers. All of these deposits need to be examined in the future for their precious-metal potential.

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