Barite in north-central New Mexico

Virginia T. McLemore and James M. Barker

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New Mexico Bureau of Geology & Mineral Resources
New Mexico Institute of Mining & Technology
801 Leroy Place
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Barite in north-central New Mexico

by *Virginia T. McLemore* and *James M. Barker*, New Mexico Bureau of Mines and Mineral Resources, Socorro, NM

Introduction

Barite is an industrial mineral with hundreds of commercial uses ranging from medicines to weighting materials, which is its most important use (Fields, 1983; Williams et al., 1964). Barite ($BaSO_4$), with a specific gravity up to 4.5 (commercial grade is 4.2), increases the weight of drilling muds to help control pressures in the drill hole. Consequently, the production of barite is heavily dependent upon the needs of the petroleum exploration industry.

Several economically promising barite occurrences are in north-central New Mexico in the Placitas and Tijeras Canyon districts (Sandia Mountains), in the Manzano Mountains near Edgewood, and at El Cuervo (Crow) Butte in southern Santa Fe County (Fig. 1; Table 1). Barite also occurs as a trace or gangue mineral at other localities in north-central New Mexico (Table 1). However, according to preliminary data, no significant barite deposits have been found in New Mexico north of the Sandia Mountains probably because sulphates are absent in the subsurface. Barite deposits are common in central and southern New Mexico in or near the Rio Grande rift (Smith, 1982; Williams et al., 1964).

Geology

Barite in north-central New Mexico occurs as veins, breccia cement, cavity fillings, and as minor replacement bodies along faults, fractures, shear zones, bedding planes, contact zones, and in solution cavities in Precambrian and Paleozoic rocks (Table 1). Some deposits pinch and swell along strike, which forms pods, lenses, and stringers of high-grade barite (Fig. 2). Some of these lenses are as much as 5 ft wide and several hundred feet long. Other deposits consist of steeply

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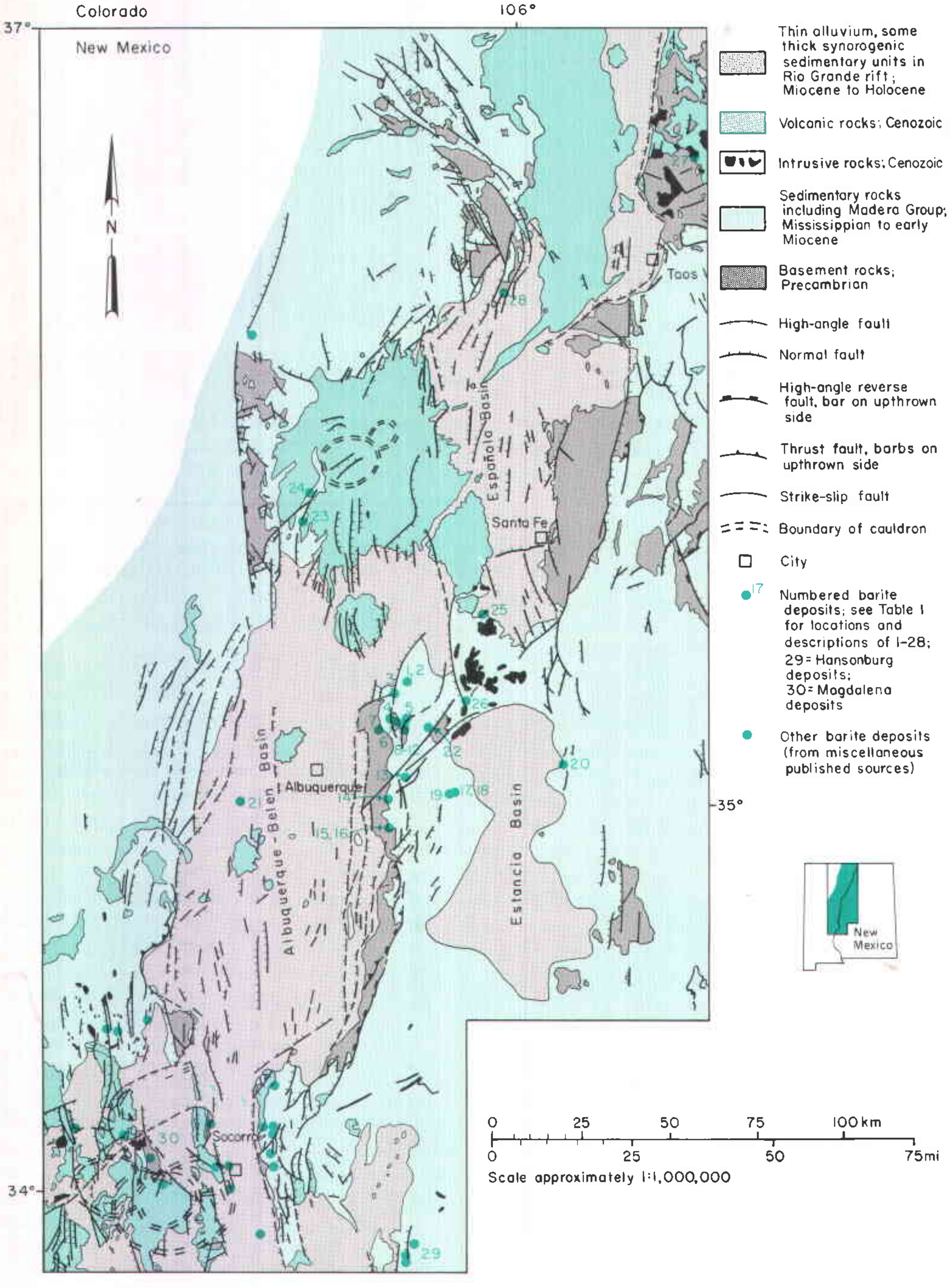

FIGURE 1—Barite occurrences in north-central New Mexico and their relationship to the regional geology and structures of the Rio Grande rift. Map compiled from Woodward et al. (1978), Seager (1982), Elston (1982), and Osburn and Chapin (1983a, b).

Also in this issue

Sediment sorting in gravelly megaripples from the Rio Grande p. 26
Taxes on natural resource production p. 31
Ground subsidence near Española p. 32
Oil and gas discovery wells drilled in 1984 p. 35
Service/News p. 40
1984 Mineral Symposium abstracts p. 41
Staff notes p. 44

Coming soon

Mechanical and chemical diagenesis in Miocene formations
Mineral-resource potential in NM
Kneeling Nun Tuff

dipping veins (Fig. 3) ranging in size from a few inches to 5 ft wide and 90 to 1,500 ft long. The El Cuervo Butte deposit has been traced southwest along strike for about 3 mi.

Most of the barite deposits occur in structurally and topographically high (up to 9,000 ft elevation) areas adjacent to the Albuquerque–Belen and Estancia Basins (Fig. 1). The barite deposits in the Placitas district occur along major north– and east–northeast-trending faults in the northern Sandia Mountains (Kelley and Northrop, 1975). The deposits in the Placitas district and in the Monte Largo Hills are in the Tijeras–Cañoncito fault system (Woodward, 1984). The deposits in the Manzano Mountains and at El Cuervo Butte also occur along major north-trending faults in elevated areas.

The most common host rock is limestone of the Madera Group (Pennsylvanian), although a few exceptions are noted (Table 1). The deposits at Montezuma and Las Huertas also occur in limestone, shale, and sandstone of the Arroyo Peñasco (Mississippian) and Sandia Formations (Pennsylvanian), whereas the El Cuervo Butte deposit occurs in limestone, siltstone, and sandstone of the Yeso Formation (Permian). Unlike some barite deposits in central and southern New Mexico, these deposits are not associated directly with Tertiary intrusive or volcanic rocks. However, the deposits in north-central New Mexico are similar to the Hansonburg deposits as described by Ewing (1979) and Putnam et al. (1983) and probably are characterized by

TABLE 1—Barite occurrences in north-central New Mexico. Notes: [1]**p€** = Precambrian, **Ma** = Arroyo Peñasco Formation, **ℙs** = Sandia, **ℙm** = Madera Group, **Pa** = Abo, **Py** = Yeso, **Tv** = Tertiary volcanics, **ls** = limestone, **ss** = sandstone, **gr** = granitic rock; [2]**1** = past producer, **2** = major occurrence, **3** = minor occurrence; [3]**1** = Williams et al. (1964), **2** = New Mexico State Inspector of Mines (1956), **3** = Clippinger (1949), **4** = Elston (1967), **5** = Kelley and Northrop (1975), **6** = Phillips (1964), **7** = Williams (1966), **8** = Northrop (1959), **9** = Rothrock et al. (1946), **10** = Ladoo (1927), **11** = Ross (1909), **12** = Wright (1943), **13** = Lambert (1961), **14** = Diana Normand (written comm. 1982), **15** = Lindgren (1933), **16** = Field notes (12/15/83), **17** = Field notes (12/14/83), **18** = Hedlund et al. (1984).

No. on Fig. 1	District, county deposit	Location	Host Rocks[1]	Status[2]	Minerals	Description	Sources[3]
	Placitas district, Bernalillo and Sandoval Counties						
1	Montezuma	S34 T13N R5E	p€, ℙm, Ma	3	Ba, Cu, Pb, Zn, Ag, F	Small pockets and veins along Las Huertas fault between Precambrian greenstone and Mississippian and Pennsylvanian limestone and shale	4, 5, 18
2	Las Huertas	S34 T13N R5E	ℙs, ls, ss	2	Ba, F, Pb	Lens of barite in overturned Sandia sandstone and limestone with minor green fluorite and galena	1, 5, 18
3	Victo–Roco–Novo Group	S7, 8 T12N R5E	ℙm	2	Cu, Pb, Zn, Ba, F	Numerous thin veins of copper, lead, zinc, and barite	17, 18
4	Unknown—Sec. 9	S9, 16 T12N R5E	ℙm, ls	2	Ba, F, Pb, Ag	Lenses of barite 3 ft wide along N10°W-trending fault zone in limestone	5, 17, 18
5	Blue Sky (Gold Star)	S29 T12N R5E	ℙm, ls p€	3	Ba, F, Pb, Cu, Zn, Ag, Au	Vein 4 ft wide and 90 ft long of barite, fluorite, galena, and chalcopyrite	5, 6, 18
6	Landsend (Lone Star)	S29 T12N R5E	ℙm, ls	2	Ba, F, Pb	Alternating bands of barite and silica; ore zone up to 4 ft thick; breccia cement and minor replacement; more than 400 ft long	1, 5, 18
7	Capulin Peak	S33 T12N R5E	ℙm, ls	3	F, Ba, Pb	Vein of fluorite 3 ft wide with minor barite (<5%), calcite, quartz, and galena along the Lagunita fault in limestone	1, 5, 7
8	Mohawk	S2 T11N R5E	p€, gr	3	F, Pb, Ba, Cu	North-trending veins of fluorite, barite, galena, and chalcopyrite along a fault in Precambrian granite	5, 6, 7
9	Schmidt	S5 T11N R5E	p€, gr	3	F, Ba, Pb	Fluorite veins with minor barite and galena	7
10	La Luz (Ruppe)	S6 T11N R5E	p€, gr	3	F, Ba, Pb, Ag, Au, Cu	Trace of barite in a 2–4-ft-wide vein	4, 5
11	La Madera	S11 T11N R5E	p€, gr	3	F, Ba, Pb	Small veins in Sandia granite	5
12	Tejano Canyon	S13, 14 T11N R5E	ℙm, ls	3	F, Ba	Barite and fluorite(?) in limestone near Doc Long picnic area	8
	Tijeras and Hell Canyon districts, Bernalillo County						
13	Shakespeare (P & G)	S26 T10N R5E	ℙm, ls	2	Ba, F, Ag, Cu, U	Vein of barite 3 inches wide, strikes N8°E, dips 70°W in limestone; other veins of barite, galena, and copper minerals	1, 5
14	Blackbird (Red Hill, Manzano)	S17 T9N R5E	p€	3	F, Pb, Ba	Fluorite veins with traces of barite and galena in fault zone striking N30°W in Sevilleta metarhyolite	4, 7, 9
15	Galena King	S8 T8N R5E	p€, gr, ℙm, ls	3	Pb, F, Cu, Ba, Ag, Au	Galena and fluorite veins up to 2 ft wide with minor barite along a fault zone trending due north	1, 7, 10
16	Swastika	S4 T8N R5E	p€, ℙm, ls	3	F, Ba, Pb, Au, Ag	Lead–fluorite veins along fault between greenstone and limestone	11
	Torrance County						
17	Tina	S5 T9N R7E	ℙm, ls	2	Ba, F, Pb, Ag	Vein 2 ft wide of coarsely crystalline barite along fractures	1
18	Shockley	S5 T9N R7E	ℙm, ls	1	Ba, F, Pb, Ag	Veins in fault up to 4 ft wide and 1,500 ft long; strike N80°W; produced 50 tons of barite in 1956	1, 2
19	Vincent Moore	S6 T9N R7E	ℙm	2	Ba, F	Extension of Shockley(?)	3
	Santa Fe County						
20	El Cuervo Butte (Crow Butte)	S16, 21, 22, 23, 27, 34 T10N R10E	Py, ls, ss	2	Ba, F, Pb, Ag	Veins up to 1 ft wide in a 3–5-ft-wide zone along a major fault in Yeso sedimentary rocks, extends for about 3 mi to the southwest	1, 16
	Miscellaneous occurrences, Bernalillo County						
21	Cerro Colorado	S1, 12 T9N R1W	Tv	3	U, Ba	Barite reported to occur in veins and cavities along faults in volcanic sequence	8, 12
22	Monte Largo area	S11, 16 T11N R6E	p€	3	Ba, F	Barite–fluorite veins, which may be related to a carbonatite, throughout Precambrian rocks	5, 13
	Sandoval County						
23	Spanish Queen	S3 T17N R2E	Pa	3	Cu, Ba, Ag, U	Trace of barite in stratabound sedimentary copper deposits in Abo sandstone	1
24	Jemez Springs	S13 T18N R2E	p€	3	Ba	Barite veins in Precambrian granite at Soda Dam	14, 15
	Santa Fe County						
25	Cerrillos district	T14N R8E	Tv	3	Cu, Pb, Zn, U	Veins filling shears and faults in Oligocene intrusions with barite as gangue	8
26	San Pedro mine (New Placers district)	S15, 27 T12N R7E	Tv	3	Cu, Pb, Zn, W	Barite occurs as a gangue mineral	8
	Taos County						
27	East of Wheeler Peak at head of Elm Creek	—		3	Ba	Minor occurrence of barite	8
	Rio Arriba County						
28	Ojo Caliente #1 district	—	active springs	3	Ba, F, Ca	Barite, fluorite, and calcite being deposited at springs and cementing Miocene sedimentary rocks	8, 15

FIGURE 2—Large barite pod along a fault at the Section 9 deposit in the Placitas district (looking south). The Section 9 deposit consists of several similar pods along a steeply dipping fault trending N. 30° E.

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FIGURE 3—Barite in thrust fault at El Cuervo Butte (looking north). The fault zone strikes N. 35° E. and occurs in sandstone, siltstone, and limestone of the Yeso Formation (Permian, Py). This vein reaches a maximum thickness of about 4 ft.

FIGURE 4—Bladed, opaque, white barite crystals at the Section 9 deposit in the Placitas district of the Sandia Mountains. Here barite occurs along bedding planes with little or no alteration of the Madera Group limestone.

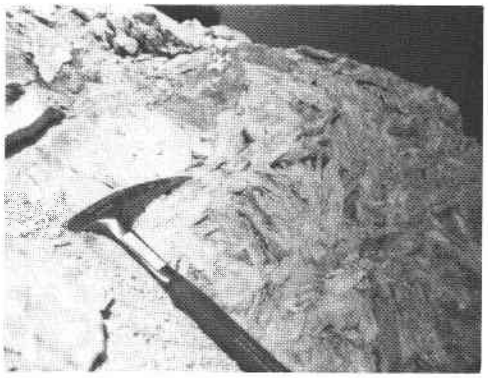

FIGURE 5—Massive bladed barite crystals at the Section 9 deposit in the Placitas district. This boulder is part of a pod of barite shown in Fig. 2. Very little fluorite or galena occurs within these pods.

similar high lead isotopic ratios (Ewing, 1979) and similar temperatures and salinities during deposition. At Hansonburg, fluid inclusion homogenization temperatures, pressure corrected, range from 148 to 218°C and salinities range from 7 to 15% (Putnam et al., 1983). The Hansonburg deposits were formed under low to moderate pressure (70 bars) at shallow depth (2,100 ft).

Although small veinlets and stringers of barite and calcite are common along fractures and bedding planes of the host rock, most contacts between mineralization and the host are sharp with little or no alteration (Fig. 4). Angular fragments of sedimentary rocks are abundant locally in some deposits. Dolomitization of the adjacent limestones, when present, probably resulted from diagenesis rather than from the barite mineralization process.

Many of the barite deposits in north-central New Mexico are stratigraphically close to Precambrian rocks. Numerous small, uneconomic veins of barite, fluorite, quartz, and sulfide minerals occur in the Precambrian terranes throughout the Sandia, Manzanita, and Manzano Mountains and the Monte Largo Hills (McLemore et al., 1984; Kelley and Northrop, 1975). These veins are controlled structurally and could be Precambrian in age. Some of these largely uneconomic veins consist mainly of barite or fluorite, whereas veins elsewhere contain varying amounts of barite, fluorite, galena, calcite, quartz, sphalerite, and copper oxides.

Composition

All barite deposits in north-central New Mexico are similar in mineralogy and chemistry. They consist of massive, bladed barite (Fig. 5) with small pockets, zones, or intergrowths of fluorite, calcite, quartz, and argentiferous galena. The barite in these deposits is typically white or pink and opaque, whereas fluorite is white, green, or purple and clear to translucent. Lead, copper, and zinc concentrations within the veins are typically less than 1% (Table 2). More than 4% lead was found in pods or lenses of the Section 9 deposit and more than 2% lead was found in zones at El Cuervo Butte. These pods (or lenses) and zones are rare and most of the deposits consist of 60–80% $BaSO_4$ (Table 3). Malachite and a trace of uranium were present at the Shakespeare deposit, and the samples yielded up to 16% copper and 0.005% U_3O_8 (Table 2). Precious metal contents of the deposits are low, although minor amounts of silver and gold have been recovered from other barite deposits in the state (North, 1983; North and McLemore, 1984). In the north-central New Mexico deposits, silver concentrations are typically less than 0.5 oz/ton and gold concentrations rarely attain 0.02 oz/ton.

Trace-element concentrations of relatively pure barite crystals are within narrow ranges (Table 3), even though some of the samples include accessory minerals (Table 4). Extreme differences in trace-element concentrations are a result of these contaminants. Strontium contents of 0.9–3.11% are relatively high but not unusual in barite vein deposits (Brobst, 1958; Clark, 1970; Barbieri et al., 1982, 1984). High-strontium barites are common because a continuous solid-solution series exists between barite ($BaSO_4$) and celestite ($SrSO_4$; Hanor, 1968). Calcium, magnesium, and manganese concentrations in barite of north-central New Mexico are similar to such concentrations in barites worldwide (Scull, 1958; Brobst, 1958; Clark, 1970). Chromium, copper, and lead levels are comparatively high in a few samples from north-central New Mexico and probably are a result of contamination by accessory minerals. Extensive data for zinc, potassium, sodium, and yttrium concentrations in barites are not available, but concentrations of these elements appear to be similar throughout north-central New Mexico barite deposits. The very low values of uranium and thorium are consistent with a continental deposition (Goldberg et al., 1969), although this does not necessarily imply a continental source of barium.

Age of mineralization

The age of the barite mineralization is not known, but it is limited by the age of the host rocks (Pennsylvanian through Permian) and the uplift of the Sandia, Manzanita, and

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TABLE 2—Chemical analyses of selected samples from barite–fluorite–galena veins in north-central New Mexico; numbers in parentheses refer to locations in Table 1 and Fig. 1; **tr** = trace (<0.02 oz/ton).

Sample number	Name	Percent $BaSO_4$	Percent $CaCO_3$	Percent CaF_2	Au oz/ton	Ag oz/ton	Percent Pb	Percent Zn	Percent Cu	Percent U_3O_8
4695	Victo–Roco (3)	52.51	9.36	10.99	0.00	0.20	0.21	0.006	0.01	—
4697	Section 9 (4)	18.3	0.40	38.88	0.00	0.46	4.99	0.65	0.007	—
4596	Section 9 (4)	38.07	—	—	tr	0.00	4.14	0.006	—	—
4700	La Luz (10)	~0.70	5.24	58.90	0.02	0.20	0.23	0.13	0.12	—
4728	La Luz (10)	0.27	—	—	—	—	0.62	0.13	0.07	—
4696	Shakespeare (13)	51.13	0.15	0.23	0.00	0.00	0.007	0.014	16.0	0.005
4694	Shockley (18)	67.72	0.97	16.46	0.00	0.20	0.74	0.01	0.002	—
4698	Shockley (18)	66.67	3.02	13.07	tr	0.08	0.34	0.11	0.012	—
4595	El Cuervo–sec. 23 (20)	27.28	—	—	tr	0.22	2.31	0.01	—	—

TABLE 3—Chemical analyses of barite crystals from north-central New Mexico; mineralogy of samples is given in Table 4; V, Nb, U, and Th were below detection limit of XRF for all samples (V, Nb = 3 ppm; U, Th = 1 ppm); numbers in brackets refer to locations in Table 1 and Fig. 1; assay methods: **calc.** = calculated, **grav.** = gravimetric, **AA** = atomic absorption, **XRF** = x-ray diffraction; **NA** = not analyzed; ( ) = XRF data, all others are AA data unless noted otherwise; [1]a sample from this deposit has a measurable content of uranium (*see* Table 2); [2]XRF, this report; [3]a mean of 20 samples analyzed by emission spectrography (±25%) from S. Sampattavanija (unpublished data, 1971).

Sample number	Deposit	$BaSO_4$ percent [calc.]	Ba percent [AA]	SO_4 percent [grav.]	Sr percent [AA]	Ca percent [AA]	Pb ppm [AA]	Cu ppm [AA]	Zn ppm [AA]	Cr ppm [AA]	Mg ppm [AA]	Mn ppm [AA]	K ppm [AA]	Na ppm [AA]	Y ppm [XRF]
4729	Section 9 [4]	87.96	51.76	41.14	2.07 (2.36)	0.11	135 (46)	<1	20	13	9	5	16	13	(33)
4732	Landsend [6]	83.37	49.06	41.43	3.11 (2.66)	0.07	91 (49)	38	6	<10	8	<4	25	3	(35)
4727	[1]Shakespeare [13] (P&G)	63.08	29.86	37.12	0.90 (0.92)	0.18	385 (38)	64,000	100	100	305	9	304	24	(15)
4730	Shakespeare [13] (P&G)	82.91	48.79	38.54	1.10	1.64	84 (33)	260	9	<10	272	290	135	20	(21)
4733	Shockley [18]	76.72	45.15	36.57	1.27 (1.27)	2.25	280 (35)	72	4	320	44	23	174	309	(26)
4734	El Cuervo Butte [20] (sec. 16 north)	85.93	50.57	41.85	1.45 (1.48)	1.12	328 (37)	6	4	<10	25	5	99	29	(19)
4731	El Cuervo Butte [20]	87.77	51.65	40.96	1.59 (1.64)	0.51	80 (39)	12	2	<10	244	5	34	29	(23)
—	[2]Hansonburg	NA	NA	NA	(1.49)	NA	(55)	NA	NA	NA	NA	NA	NA	NA	(66)
—	[3]Magdalena	NA	NA	NA	0.385	NA	218	582	390	NA	NA	360	565	NA	NA

TABLE 4—Mineralogy (x-ray diffraction) of barite crystals from north-central New Mexico; numbers in parentheses refer to locations in Table 1 and Fig. 1; chemical analyses are presented in Table 3; **M** = major **m** = minor, **tr** = trace, **0** = absent.

Sample number	Deposit	Mineral				
		Barite	Quartz	Fluorite	Calcite	Malachite
4729	Section 9 (4)	M	0	0	0	0
4732	Landsend (6)	M	0	0	0	0
4727	Shakespeare (13) (P&G)	M	m	0	tr	tr
4730	Shakespeare (13) (P&G)	M	0	0	tr	0
4733	Shockley (18)	M	M	m	0	0
4734	El Cuervo Butte (20) (north)	M	0	0	0	0
4731	El Cuervo Butte (2) (south)	M	0	0	tr	0

Manzano Mountains. Barite mineralization must have occurred before uplift of these mountains because barite deposits are now at high elevations. Fluid and hydrodynamic requirements necessary to form sedimentary hydrothermal deposits could not operate in these elevated terrains. At least three uplift episodes occurred in these mountains during the Cenozoic; the youngest event was 7–4 m.y. ago (Chapin, 1979). Although previous workers have attributed barite mineralization elsewhere in New Mexico to the Tertiary (Allmendinger, 1974, 1975; Beane, 1974; Ewing, 1979; Putnam et al., 1983), the sedimentary hydrothermal deposits in northeastern New Mexico could be as old as late Paleozoic or as young as Miocene.

Origin and genesis

The barite deposits in north-central New Mexico are similar in emplacement, geology, mineralogy, and chemistry to sedimentary hydrothermal deposits and are analogous in part to Mississippi Valley-type deposits (Ohle, 1959, 1980). Deposits of probable sedimentary hydrothermal origin are apparently widespread within or near the Rio Grande rift and include such deposits as those at Hansonburg, Palomas Gap, and Salinas Peak (Allmendinger, 1974, 1975; Beane, 1974; Ewing, 1979; Putnam et al., 1983). Sedimentary hydrothermal deposits are open-space-filling deposits with little or no replacement; they differ from magmatic hydrothermal deposits, such as the north Magdalena deposits, by the absence of a nearby volcanic or intrusive source of ions, fluids, and heat (Dunham and Hanor, 1967).

Sedimentary hydrothermal deposits are formed by water that is trapped within sediments during deposition and after burial by dehydration of minerals, chemical reactions, magmatic activity, and downward percolation of meteoric waters (Hanor, 1979). These formational waters or brines accumulate in sedimentary basins and are heated possibly during high-heat-flow episodes associated with rifting (Reiter et al., 1975, 1978, 1979), magmatic activity, or radiogenic heat from Precambrian granitic plutons (Cathles, 1981). The warm convecting water leaches barium, sulfate, and other molecules from source rocks such as arkosic sediments, evaporites, Precambrian rocks, and Precambrian mineral deposits. Mixing of formational waters with magmatic hydrothermal fluids originating from deep sources is also possible (Van Alstine, 1976; Lamarre and Hodder, 1978).

The mineralized waters are ejected along faults, fractures, and contact zones primarily by porosity reduction during burial and compaction of sediments (Noble, 1963) and/or during tectonic activity (Hanor, 1979). Precipitation occurs as a result of simple cooling of the fluids (Putnam et al., 1983), decrease in pressure (Noble, 1963), or mixing of mineralized hydrothermal fluids with reducing subsurface brines (Beales, 1975).

Economic potential

Although barite is relatively abundant in New Mexico south of the Sandia Mountains in or near the Rio Grande rift (Smith, 1982), commercial production of barite has been insignificant compared to national production and consumption (Fields, 1983; Williams et al., 1964). Only one deposit in north-central New Mexico yielded ore when, in 1956, 50 tons of barite worth $250 were shipped from the Shockley mine (Table 1, no. 18) near Edgewood (New Mexico State Inspector of Mines, 1956). Most of the barite production from New Mexico has come from Doña Ana, Sierra, and Socorro Counties (Williams et al., 1964).

The barite deposits in north-central New Mexico are economically promising. Numerous high-grade veins occur in the Tunnel Springs (Table 1, nos. 3 and 4) and Landsend (Table 1, no. 6) areas of the Sandia Mountains. These veins were classified as having probable mineral-resource potential by Hedlund and Kness (1984). However, the rugged terrain, high elevation, and wilderness designation will hamper development of these areas. Additional barite deposits are likely to occur along faults in Paleozoic limestones elsewhere in the Sandia, Manzanita, and Manzano Mountains where the terrain is less rugged and land acquisition is more favorable. The barite deposits at El Cuervo Butte (Table 1, no. 20) are also a possible mineral resource. These deposits are extensive and undeveloped except for a few trenches and prospect pits. Other fault zones in the vicinity should be examined for barite mineralization.

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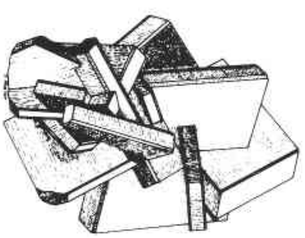

Barite, by artist Teresa Mueller.

New state geologic map

The 1965 *Geologic map of New Mexico* was compiled on a scale of 1:500,000 by Carle Dane and George Bachman, with cooperation from numerous other geologists. This map needs to be updated because of advances in stratigraphy throughout the geologic column and because of more recent geologic mapping in many parts of the state. The New Mexico Bureau of Mines and Mineral Resources and the U.S. Geological Survey are cooperatively compiling a revised geologic map of New Mexico, scale 1:500,000. Help is being solicited from geologists in locating original geologic maps that are not well known or generally available. These may be theses maps (particularly from distant universities), company files, or maps from the files of individual geologists. We would like to obtain copies of as many maps as possible to use during the compilation. We also would like to keep these maps in our Information, Resource, and Service Center files so they could be made available to the public eventually. However, we realize that some maps are proprietary; these maps would be designated confidential and not released except for the detail that shows on a 1:500,000 scale. Your help in our search for the latest and best mapping of all areas of New Mexico is appreciated. We welcome participation in reviews by geologists knowledgable about a particular part of the state or a segment of the stratigraphic column. If you would like to cooperate in providing primary data or help with the review process, please contact Glenn R. (Bob) Osburn, NMBMMR Compilation Coordinator, Socorro, NM (505/835–5147).