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PRECIOUS- AND BASE-METAL DISTRICTS IN RIO ARRIBA AND SANDOVAL COUNTIES, NEW MEXICO

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Abstract—Total production from Rio Arriba and Sandoval Counties is estimated at 8 million lbs of copper, 66,000 oz of gold, 284,000 oz of silver, 41,000 lbs of lead, and 1000 lbs of zinc. Five types of precious- and base-metal deposits occur in this area: placer gold, volcanic-epithermal veins, sedimentary-hydrothermal barite-fluorite-galena (± copper, silver) deposits, sedimentary-copper deposits, and Precambrian vein and replacement deposits. Of these deposits, volcanic-epithermal veins in the Cochiti district and sedimentary-copper deposits in the Nacimiento Mountains district have yielded significant production and continue as viable exploration targets. Furthermore, there may be additional potential for Precambrian precious-metal vein deposits in the Bromide and Hopewell districts in the Tusas Mountains.

INTRODUCTION

Precious (silver, gold) and base (copper, lead, zinc) metals have been important to the economy of New Mexico since the mid-1880s. These metals occur widely throughout New Mexico in a variety of deposit types (Lindgren et al., 1910; North and McLemore, 1986, 1988). The production of precious and base metals in Rio Arriba and Sandoval Counties has been of lesser importance compared to metal production elsewhere in the state, and especially when compared to production of oil, gas, uranium and coal from these counties. However, a few districts in this area have produced moderate amounts of one or more metals (relative to total New Mexico production). For example, over 7.6 million lbs of copper have been produced from the Nacimiento district; it ranks eleventh as a copper-producing district in New Mexico (V. T. McLemore, work in progress). An estimated 16,000 oz of placer gold were produced from the Hopewell district; it ranks seventh as a placer gold district in the state (Johnson, 1972; North and McLemore, 1988). Total production from these two counties is estimated at 8 million lbs of copper, 66,000 oz of gold, 284,000 oz of silver, 41,000 lbs of lead, and 1000 lbs of zinc (Table 1).

This paper provides precious- and base-metal production statistics, mining history, and brief description of the geology and mineral deposits of the metal-mining districts in Rio Arriba and Sandoval Counties.

PRODUCTION

Known and/or estimated production is given by district in Table 1 and each district is located in Fig. 1. Production data is derived from many sources of varying reliability; some of the production records for New Mexico are chaotic at best. Previous publications have incorrectly reported total production for various reasons; these have been resolved as well as possible. Because of the chaotic nature of some records I expect continuing updates and corrections will be necessary as work in specific districts progresses.

DESCRIPTION OF MINERAL DEPOSITS

Five types of precious- and base-metal deposits are found in Rio Arriba and Sandoval Counties (Fig. 1). The deposit types were described by North and McLemore (1986, 1988) and the reader is referred to these publications for more detail. Brief descriptions of types of mineral deposits, and some examples of mining districts in Rio Arriba and Sandoval Counties (Table 1) are presented here.

Placer deposits

Placer gold deposits are found in the Hopewell, Placitas and Chama placer districts (Fig. 1) in Rio Arriba and Sandoval Counties, but very little production is recorded and economic potential is minimal. Most

TABLE 1. Precious- and base-metal production from districts in Rio Arriba and Sandoval Counties, New Mexico. Values in parentheses are estimated figures. [1]Types of deposits: A = placer gold; B = volcanic-epithermal vein; C = sedimentary-hydrothermal barite-fluorite-galena; D = sedimentary-copper; E = Precambrian vein and replacement deposits. [2]Does not include production from 1971 to 1974 (confidential and withheld).

District	Years of Production	Ore (short tons)	Copper (pounds)	Gold (troy ozs)	Silver (troy ozs)	Lead (pounds)	Zinc (pounds)	Estimated Value	Type of Deposits[1]	References
Cruces Basin prospects	none	—	—	—	—	—	—	—	B(?)	North and McLemore (1986), Hannigan (1984)
Bromide district	1881-1940	—	—	(300)	(4,500)	—	—	—	E	North and McLemore (1986)
Hopewell district	1881-1919	—	some	(24,000)	(10,000)	some	—	400,000	E,A	Johnson (1972), Anderson (1957)
	1933-1940	1,445	400	94	734	7,100	—	—		USBM Mineral Yearbooks
Abiquiu district	none	—	—	—	—	—	—	—	D	
Chama placers	—	—	—	(<100)	—	—	—	<35,000	A	Johnson (1972)
Chama Canyon prospects	none	—	—	—	—	—	—	—	D	Light (1982, 1983)
Gallinas district	none	—	—	—	—	—	—	—	D	
Coyote district[2]	1956-1957	—	462,000	—	841	small	—	—	D	Bingler (1969)
Nacimiento district	1880-1964	—	7,561,567	0.4	75,068	1,783	463	1,100,000[2]	D,E	Elston (1967)
	1900-1964	26,786	1,261,567		12,068	—	—	—	D	
	1969-1975	Confidential-some copper produced								
Jemez Springs district	1928-1937	233	19,200	1	159	—	—	4,000	D	Elston (1967)
Cochiti district	1894-1963	205,000	2,500	42,000	210,000	22,457	—	1,400,000	B	Elston (1967); USBM Mineral Yearbooks, Lindgren et al. (1910)
Placitas district	1904-1961	39	2,441	49	48	10,357	580	3,000	A,C, D,E	USBM Mineral Yearbooks
TOTAL ESTIMATED PRODUCTION	1880-1975	—	8,000,000	66,000	284,000	41,000	1,000	2,900,000	—	These statistics probably reflect conservative totals

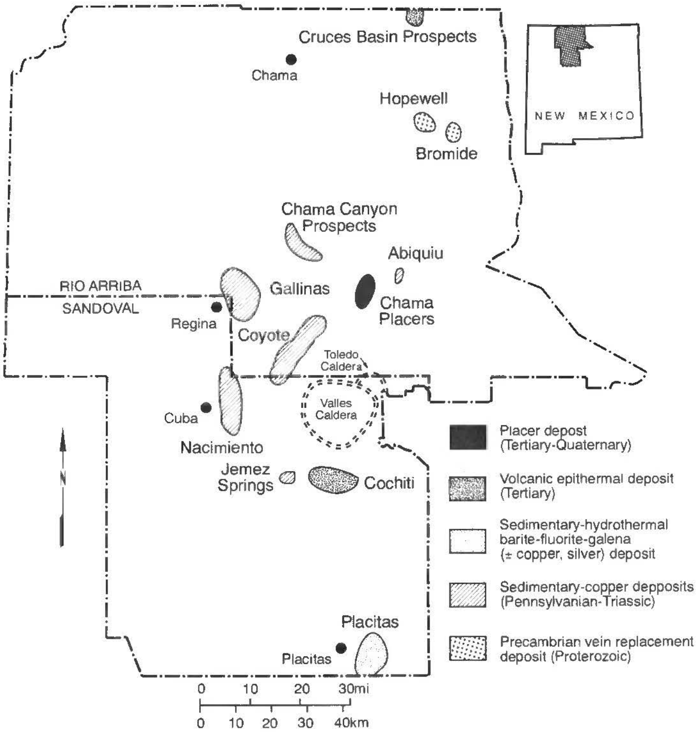

FIGURE 1. Location of base- and precious-metals districts in Sandoval and Rio Arriba Counties, New Mexico. Several districts contain more than one type of mineral deposit; the predominant type of mineral deposit is shown.

of the placer gold deposits were formed by late Tertiary through Recent erosion of older mineral deposits exposed by Tertiary uplift, although early Tertiary gravels were worked in the Hopewell district (Johnson, 1972; North and McLemore, 1986). The reader is referred to Johnson (1972) and Bingler (1968) for more details.

Volcanic-epithermal veins

The term epithermal refers to temperatures of formation between 50° and 300°C at low pressures. Volcanic-epithermal refers to epithermal deposits that are hosted by volcanic rocks. One of the most economically attractive exploration targets in Rio Arriba and Sandoval Counties are volcanic-epithermal veins in the Cochiti district in the Jemez Mountains (Fig. 1). Volcanic-epithermal veins may also occur in the Cruces Basin in north-central Rio Arriba County (Fig. 1). These hydrothermal vein deposits are formed primarily along faults in Oligocene or younger volcanic and volcaniclastic rocks.

Cochiti district

The earliest prospecting in the Cochiti district (Jemez Mountains) took place in the early 1890s, although earlier exploration by Spanish and Mexican explorers may have occurred. Production from the Cochiti district was credited to Bernalillo County until 1903, when Sandoval County was created. Production began in the district in 1896, when the R. W. Woodbury mill near Bland began operations. A 300-ton mill was built at the Albemarle mine in 1899, and was one of the first cyanide mills in the state, but it closed in 1904. Cossack Mining Co. built a mill in 1915 but it operated only until 1916 (Bundy, 1958). In 1943, another mill operated at the Iron King mine, but closed in 1947 (Elston, 1967).

Since 1948, very little production activity has been reported from the Cochiti district (Table 2), although several companies have conducted exploration programs. Total production is estimated at $1.4 million (Table 2; Lindgren et al., 1910; Elston, 1967). The Albemarle mine was the largest, and probably produced about 105,000 tons of ore grading 0.22 oz/t Au and 4.0 oz/t Ag. The Lone Star mine produced about 65,000 tons of ore grading 0.20 oz/t Au and 4.0 oz/t Ag. The

TABLE 2. Reported mineral production from the Cochiti district, Sandoval County (USBM mineral yearbooks; Lindgren et al., 1910; Elston, 1967). [a] = estimated production.

Year	Ore (short tons)	Copper (lbs)	Gold (oz)	Silver (oz)	Lead (lbs)	Zinc (lbs)	Total value ($)
1894–1904	170,000[a]	—	33,200[a]	W	—	—	1,040,000
1914	4,373	—	824	24,460	—	—	29,000
1915	18,701	—	4,021	93,314	14,657	—	133,006
1916	9,300	—	2,070	56,404	—	—	79,900
1932	659	—	364	13,440	—	—	11,336
*1933	465	—	158.33	7,940	W	—	6,052
*1934	580	200	110.47	7,060	—	—	8,441
*1935	159	—	20.20	1,575	7,800	—	2,151
*1938	276	—	164.2	1,700	—	—	6,846
*1939	514	100	66	2,310	—	—	3,766
1945	19	2000		28	—	—	290
1947	3	200	9	4	—	—	361
1948	9	—	9	451	—	—	723
1963	6	—	1	237	—	—	338
TOTAL	205,000[a]	2,500	42,000[a]	210,000[a]	22,457		1,400,000[a]

remainder of the production came from the Washington, Crownpoint, Laura, Iron King, Little Daisy and Tip Top mines (Elston, 1967; Wronkiewicz et al., 1984; NMBMMR files).

The Cochiti district is located on the southeast flank of the Jemez Mountains, which is formed by the Toledo and Valles calderas. Structural relationships and ages of various volcanic units suggest the mineralization at Cochiti occurred between 6.5 and 1.4 Ma (Wronkiewicz et al., 1984; Parkison et al., 1985); thus, this district is one of the youngest volcanic epithermal districts in New Mexico.

The mineralized veins in the Cochiti district occur in north-trending, steeply dipping faults and fractures that cut Miocene andesitic volcanic and felsic intrusive rocks. Multiple episodes of vein filling, stockwork zones and brecciation have occurred. Mineralized veins are up to 460 m long and 15 m wide (Bundy, 1958; Stein, 1983) and consist predominantly of quartz, with small amounts of sulfides and calcite. Sulfide minerals are sparse, rarely exceeding a few percent, and consist of pyrite, sphalerite, chalcopyrite, covellite, galena, argentite and proustite-pyrargyrite. Native gold and electrum also occur in the veins (Wronkiewicz et al., 1984). Fluid inclusion data indicates mineral deposition occurred at or above boiling, at temperatures between 240°C and 315°C, by low salinity fluids (less than 5 wt% eq. NaCl; Wronkiewicz et al., 1984). Alteration of the host rock is zoned from regional propylitization (farthest from veins) to advanced argillic alteration to silicification (nearest veins; Parkison et al., 1985). Clay minerals are zoned from chlorite-montmorillonite farthest from the vein to vermiculite-halloysite to illite-kaolinite to dickite nearest the vein (Bundy, 1958). An epithermal origin is proposed for these deposits, where episodic boiling of mineralized solutions resulted in deposition of vein minerals and alteration of the host rock (Wronkiewicz et al., 1984).

Cruces Basin prospects

Very little is known concerning the deposits in the Cruces Basin in northern Rio Arriba County (Fig. 1). Silver concentrations as high as 0.9 oz/ton (31 ppm) are reported and are associated with manganese mineralization along fractures and faults in the Conejos quartz latite (Tertiary) and underlying Precambrian gneiss and pegmatites (Hannigan, 1984). Additional investigation is required.

Sedimentary-hydrothermal barite-fluorite-galena deposits

The Placitas district in the northern Sandia Mountains (Fig. 1) is the only district known to contain sedimentary-hydrothermal barite-fluorite-galena deposits in Rio Arriba and Sandoval Counties. The lack of obvious magmatic activity in the Placitas district suggests these deposits were formed by sedimentary-hydrothermal processes. Sedimentary-hydrothermal deposits are common throughout the Rio Grande rift (Beane, 1974; Allmendinger, 1975, 1974; Putnam et al., 1983; McLemore and Barker, 1985). Water is trapped within basin sediments during deposition and after burial by dehydration of minerals, chemical reactions, magmatism and downward percolation of meteoric waters. These formation waters are heated by compression and compaction during burial and further warmed by convection from deeper sources, radiogenetic heat from the Sandia granite, and high heat flow associated with the Rio Grande rift. The heated formation waters leached metals and other ions from Precambrian rocks and Paleozoic sedimentary rocks. Precipitation occurred by cooling of hydrothermal waters, degassing and/or mixing of waters.

Placitas mining district

Little is known about the mining history of the Placitas district. A group of mines along the Cuchillo de San Francisco were mined for copper ores; potsherds found in one of these mines were dated at 1500–1550 A.D. (Warren and Weber, 1979). Metal mining did not begin until the arrival of the railroad in 1880. Production prior to 1904 is unknown, and production after 1904 is minor and amounts to less than $3000 (Table 3).

Numerous small deposits, only a few of which have been developed, occur throughout the district and include placer gold, sedimentary-hydrothermal barite-fluorite-galena, sedimentary copper, and base- and precious-metal veins and replacements in Precambrian rocks (Kelley and Northrop, 1975; McLemore et al., 1984). The most important deposits are sedimentary-hydrothermal deposits. Most of the veins in the Placitas district occur along or near faults in Pennsylvanian and Mississippian sedimentary units and in the Precambrian Sandia Granite. Typically the base- and precious-metal veins, with or without accessory barite and fluorite, occur in the vicinity of the sedimentary-hydrothermal barite-fluorite-galena veins. Base-metal veins consist of copper, lead and zinc minerals with minor silver, whereas precious-metal veins consist of silver and gold with minor copper and lead minerals. The barite-fluorite-galena veins consist primarily of barite with accessory fluorite and argentiferous galena. The veins are 0.6–0.9 m wide and up to several thousand meters long. The depth and age of the veins are unknown.

Chemical analyses from four barite-fluorite-galena deposits range from 0.10 to 0.46 oz/ton (3–16 ppm) silver, 0.19 to 4.99% lead, 0.001 to 0.65% zinc, and 0.001 to 0.12% copper (McLemore et al., 1984). Hedlund et al. (1984) reported 0.43 oz/ton (14 ppm) silver from the La Luz base-metal mine and Hendzel et al. (1983) reported 6 oz/ton (200 ppm) silver from a strip mine in sec. 1, T12N, R4E and >20,000 ppm Pb from the La Luz mine. Many of the prospects and mines have been reclaimed by the U.S. Forest Service.

The origin of mineralization in the Precambrian rocks in the Placitas district is unknown. The mineralization may be related to the base-metal and barite-fluorite-galena veins in Paleozoic sediments. However, a Precambrian age is also possible. Several periods of mineralization may have occurred, and very few data exist concerning these deposits.

Sedimentary-copper deposits

Stratabound sedimentary-copper deposits containing copper, silver, and locally gold, lead, zinc, uranium, vanadium and molybdenum occur throughout the Nacimiento and Jemez Mountains in Rio Arriba and Sandoval Counties (Fig. 1). These deposits are similar and are discussed by host rock instead of mining district. In Rio Arriba and Sandoval Counties stratabound sedimentary-copper deposits occur within specific intervals of Pennsylvanian, Permian and Triassic fluvial to marginal-marine sedimentary rocks (Table 1; LaPoint, 1979). Copper may have been mined in sedimentary-copper deposits by the Spanish and Indians prior to the 1800s; however, serious mining of these deposits did not occur until the 1880s through early 1900s (Elston, 1967). With the exception of the Nacimiento mine, very little development of these deposits has occurred since 1960. Production at the Nacimiento mine began in 1881. Between 1881 and 1960, 7.5 million lbs of copper worth over $1 million were produced (Elston, 1967). A few deposits were examined and some developed for uranium in the 1950s (McLemore and Chenoweth, this volume).

Most of the stratabound sedimentary-copper deposits in Sandoval and Rio Arriba Counties have similar characteristics (Gott and Erickson, 1952; Soulé, 1956; McLemore, 1983). They occur in fine- to coarse-grained, feldspathic to arkosic sandstone lenses containing organic plant debris. The majority of the deposits are in the lower part of the various formations. The sandstone lenses range in thickness from 1 to 20 m and in most places are pinkish gray to medium gray in color and are generally lighter in color than adjacent barren sandstones. Reddish-brown siltstone and mudstone surround the mineralized sandstone lenses. Copper content varies, with some deposits containing up to 40–50% copper. Silver averages about 0.5 oz/ton (17 ppm) and typically increases with increasing copper concentration. Gold is rare in these deposits.

The largest copper deposits occur in the Triassic Agua Zarca Sandstone (Chinle Group) in the Nacimiento Mountains (Woodward et al., 1974). Copper is associated with organic debris and other carbonaceous material; predominant minerals include chalcocite, covellite, and various copper carbonates and silicates. Silver is always present, ranging in concentration from 1 to 100 ppm (LaPoint, 1979) and occurs as native silver, silver sulfides or in chalcocite. Sphalerite is locally common, especially at the San Miguel mine. Copper mineralization is rare in the Poleo Sandstone Lentil, although uranium occurrences are present (McLemore and Chenoweth, this volume). Small copper orebodies occur in fluvial and adjacent sandstones in the Permian Abo (or Cutler) Formation in the Nacimiento Mountains, Jemez Springs, Gallinas, Coyote, and Placitas districts and Chama Canyon (Fig. 1).

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 Precambrian rocks enriched in these metals, Precambrian base-metal deposits, and from 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 of H_2S-rich waters. Subsequent ground water and structure 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 and tonnage. Furthermore, economic conditions are unfavorable at present for development of these deposits. If in-situ leaching of these deposits for copper becomes feasible and economical, then silver and gold might be recovered as by-products from a few of the larger deposits. An in-situ project was proposed at the Nacimiento district, but economic conditions were unfavorable for development.

TABLE 3. Reported mineral production from the Placitas district, Sandoval County (USBM mineral yearbooks; Elston, 1967; Wells and Wootton, 1932). [1]Wells and Wootton (1932) reported this placer production as probably from Placitas. [2]New Mexico Bureau of Mines and Mineral Resources files reported this production from a Montezuma mine, presumably from Placitas district.

Year	Ore (short tons)	Copper (lbs)	Gold (oz)	Silver (oz)	Lead (lbs)	Zinc (lbs)	Total value ($)
1904[1]	—	—	49	—	—	—	1,013
1920	21	—	—	11	5,262	—	433
1926	14	2,400	—	37	700	—	415
1961[2]	4	41	—	—	4,395	580	468
TOTAL	39	2,441	49	48	10,357	580	2,329

Precambrian vein and replacement deposits

Vein and replacement deposits containing precious and base metals occur sporadically through most of the Precambrian terranes in New Mexico, including those in Rio Arriba and Sandoval Counties. The two major districts are the Hopewell and Bromide in the Tusas Mountains (Fig. 1), although small veins also occur in the Nacimiento Mountains and Placitas district. The Hopewell and Bromide districts were once part of a single district, the Headstone mining district, but were separated in the late 1800s (Lindgren et al., 1910). The age of mineralization is uncertain in these districts, but data suggest a Precambrian age. The deposits are structurally controlled by schistosity or shear zones of Precambrian age and therefore are post-tectonic but probably synmetamorphic.

Most of the precious-metal vein and replacement deposits in Precambrian terranes are small and low-grade, although high assays for silver and gold occur sporadically. 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.

Hopewell mining district

Placer gold was discovered in the Hopewell district in the 1870s (Lindgren et al., 1910). Total production from the Fairview area in Placer Creek is estimated at $300,000 (Lindgren et al., 1910), with an estimated $175,000 of that in just three years (Bingler, 1968, 1974). By 1881, lode gold deposits were found in the Proterozoic rocks. Gold, silver, copper and lead were mined from the upper oxidized zone, but the amount of this early production is not known (Table 1). By 1890, mining was significantly diminished as the oxidized deposits were depleted. In 1903, a hydraulic operation was set up in Placer Creek to recover placer gold, but the operation was unsuccessful and lasted only a year (Bingler, 1968, 1974). Sporadic exploration and minor production have occurred since the early 1900s (Table 1), but with little success.

In 1935, the Amarillo Gold Co. acquired the Mineral Point claim and constructed a 30-ton mill. About 3500 tons of ore were processed; grades were reportedly 0.15 oz/t Au (5 ppm), 1–1.5 oz/t Ag (34–51 ppm), 0.5% Pb, 0.15% Cu and 0.5% Zn (Benjovsky, 1945). This operation also proved unsuccessful and closed in 1937.

Placer gold deposits occur along Placer Creek west of Hopewell Lake, where free gold is found in the alluvial stream gravels. The gold is probably derived from erosion of lode deposits in the Proterozoic rocks (Bingler, 1968, 1974).

The lode deposits in the Hopewell district consist of structurally controlled hydrothermal sulfide veins and replacement deposits, and quartz and quartz-carbonate veins in phyllite and schist of the Proterozoic Moppin metavolcanic series (Wobus and Manley, 1982; Robertson et al., 1986; Boadi, 1986). The replacement deposits consist of tabular stringer and veinlet zones within sheared, sericitic zones less than a meter thick in the Proterozoic rocks. The minerals include pyrite, chalcopyrite, galena, sphalerite, specular hematite and fluorite. Minor amounts of arsenopyrite and stibnite also occur (Boadi, 1986). Gold is associated with pyrite and chalcopyrite (Bingler, 1968, 1974; Boadi, 1986).

Hydrothermal veins up to a meter thick are associated with the replacement deposits and are mainly concordant to the foliations in the Proterozoic rocks. The veins consist of massive quartz, siderite, limonite after pyrite, native gold and tourmaline. Sixteen samples from the Croesus mine ranged as high as 2 oz/t Au (68 ppm) and 2 oz/t Ag (68 ppm) (Bingler, 1968). Seventy-three samples from throughout the district ranged as high as 33.8 oz/t Au (1160 ppm) and 0.4 oz/t Ag (13.7 ppm) (Boadi, 1986). Gold is strongly correlated with silver (Pearson correlation coefficient of 0.88), copper (0.95), and arsenic (1.00) (Boadi, 1986).

The age of these deposits is probably Precambrian (Bingler, 1968). Field observations, petrography, fluid inclusion data and isotopic geochemistry led Boadi (1986) to infer the age of mineralization to be 1467 Ma. The presence of tourmaline in the veins suggests mesothermal temperatures. However, fluid inclusion data indicate that gold deposition took place at temperatures ranging from 250° to 330°C and at pressures of approximately 1.5 kb. The fluids were rich in CO_2 (Boadi, 1986). The source of the fluid could have been magmatic hydrothermal or metamorphic (Boadi, 1986).

Bromide mining district

The first report of mining activity in the Bromide district was in 1884, with the location of the Bromide claim. The oxidized ore zones were mined until about 1910, but total production was small (Table 1). In 1977, U.S. Borax Inc. drilled seven holes in the district, the deepest of which was 293 m. Although zones containing magnetite and chalcopyrite were encountered, no significant precious-metal deposit was announced.

The mineral deposits in the Bromide district are grossly similar to those in the Hopewell district and consist of structurally controlled sulfide replacement deposits and thin pyrite-quartz veins in shear zones in the phyllite and schist of the Proterozoic Moppin series (Wobus and Manley, 1982; Robertson et al., 1986). The deposits in the Bromide district consist of chalcopyrite, pyrite, tetrahedrite, fluorite, molybdenite and tourmaline (Lindgren et al., 1910; Bingler, 1968). In 1957, a two-ton ore shipment from the Bromide mine to ASARCO, El Paso, contained 25.9 oz/t Ag (886 ppm) and 2.05% Cu (Bingler, 1968). There has been no subsequent production.

The age and origin of the deposits in the Bromide district are speculative. The gross similarity in mineralogy and emplacement of the deposits in both districts suggests a similar origin, but further work is needed.

POTENTIAL

The best exploration targets in Rio Arriba and Sandoval Counties are volcanic-epithermal veins in the Cochiti district and in situ leaching of sedimentary-copper deposits in the Nacimiento district. Possible additional targets are Precambrian precious-metal vein deposits in the Bromide and Hopewell districts in the Tusas Mountains. Environmental concerns will likely hinder development of these and other deposits in New Mexico in the near future. The deposits in the Cochiti, Nacimiento and Tusas Mountains occur in or near national forest lands administered by the U.S. Forest Service. Solution (or in situ leach) and other mining requires numerous permits; in addition, mining plans must be approved by several state and federal government agencies. Even if environmental problems are solved, grade and tonnage may be insufficient to develop and produce in these areas.

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