OKLAHOMA GEOLOGICAL SURVEY
Charles J. Mankin, *Director*

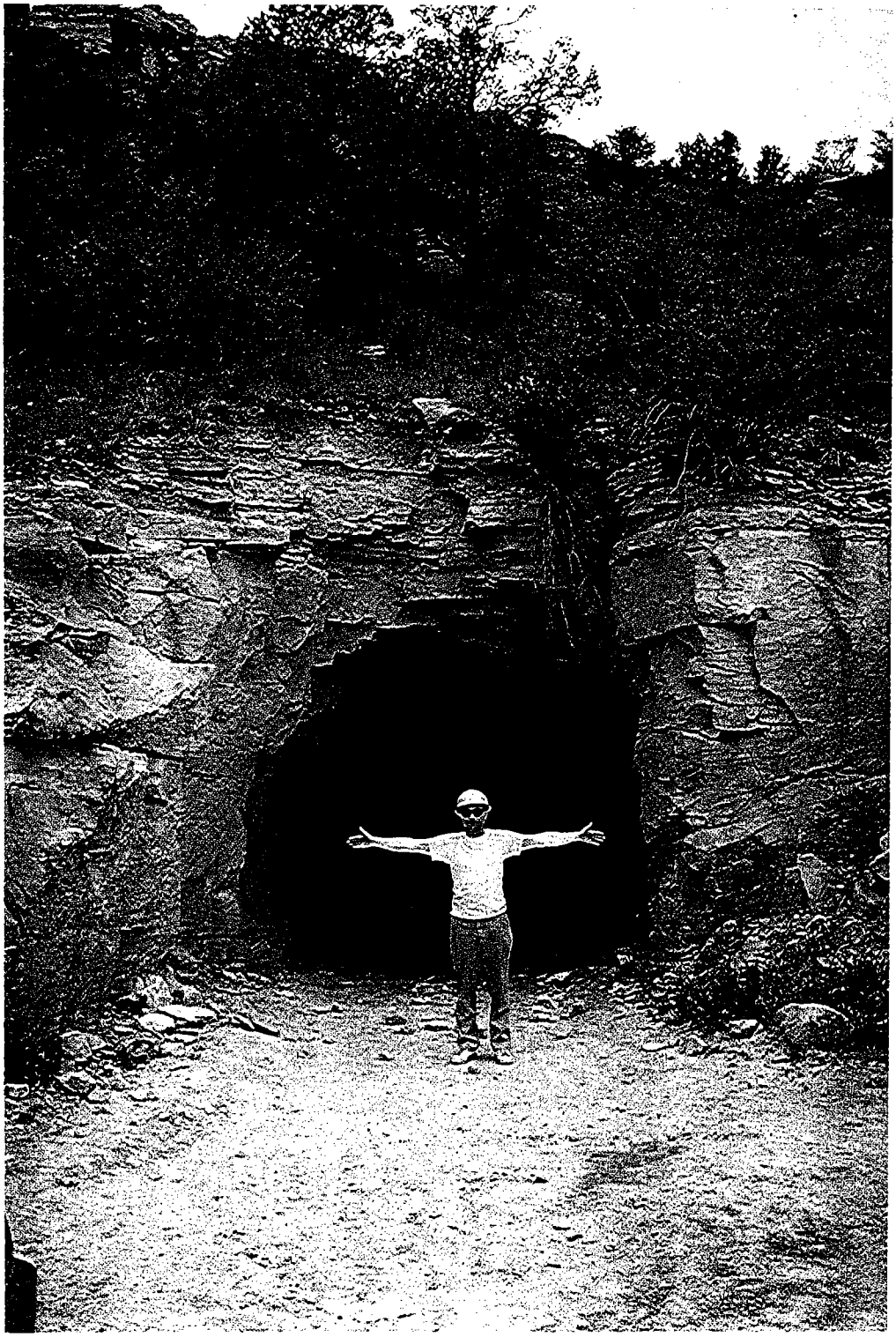
CIRCULAR 86

ISSN 0078-4397

COPPER DEPOSITS IN SHEEP PEN SANDSTONE (TRIASSIC) IN CIMARRON COUNTY, OKLAHOMA, AND ADJACENT PARTS OF COLORADO AND NEW MEXICO

ROBERT O. FAY

The University of Oklahoma
Norman
1983



Frontispiece. Independence Mine, looking south, in the Sheep Pen Sandstone, in the NE NW NW sec. 21, T. 34 S., R. 50 W., Baca County, Colorado. The mine was opened in 1889, and the adit is 524 feet long. Photo courtesy of Peter E. Price, Marathon Resources, Inc., Denver, Colorado.

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Title Page Illustration

Deep adit in the Sheep Pen Sandstone at Wiggins no. 4 prospect, sec. 30, T. 6 N., R. 1 ECM, Cimarron County, Oklahoma. (See figure 11.)

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COPPER DEPOSITS IN SHEEP PEN SANDSTONE (TRIASSIC) IN CIMARRON COUNTY, OKLAHOMA, AND ADJACENT PARTS OF COLORADO AND NEW MEXICO

ROBERT O. FAY[1]

Abstract—Approximately 14 copper prospects have been found in sections 19–20, 28–30, T. 6 N., 1 ECM, north of Black Mesa, Cimarron County, Oklahoma, near the northwestern corner of the Panhandle. The copper is in the Sheep Pen Sandstone (Late Triassic), a brown to light-gray, fine-grained, even-bedded, friable, micaceous quartzose sandstone less than 20 feet thick. The mineralization is lenticular and in places occurs in vertical clastic plugs that can be more than 200 feet deep. The brecciated sandstone in the plugs is Sheep Pen Sandstone, but the plugs probably fill holes in the underlying beds as well. The Sheep Pen is unconformable upon the underlying Sloan Canyon Shale and unconformable below the overlying Exeter Sandstone (Jurassic). The Sheep Pen probably was deposited as point bars by rivers draining westward. The copper probably was carried under oxidizing conditions and deposited under reducing conditions. Where much of the Sheep Pen has been eroded, the resistant plugs stand out in relief.

The ore is chalcocite, malachite, and azurite and is associated with hematite. It occurs in veins and pods and is distributed along bedding planes, joints, and fractures or in places is disseminated in the sandstone. Atomic-absorption analyses of hand samples show a copper content of 0.55 to 41.9 percent. Iron and titanium contents are greater than 2,000 parts per million (ppm); silver, lead, and zinc are less than 200 ppm; vanadium is less than 66 ppm; chromium, cobalt, molybdenum, and nickel are less than 20 ppm.

The prospects were opened before 1899, supposedly by the "Klondikers" from Woodward in northwestern Oklahoma. Approximately 200 mines and prospects in the Sheep Pen Sandstone were opened from 1884 to 1925 in adjacent Baca County, Colorado, and Union County, New Mexico. The total production is unknown, but probably less than 10,000 tons of ore was mined in Oklahoma. Some gold has been reported from the Colorado mines.

Introduction

Copper minerals were mined in northwestern Cimarron County, Oklahoma, more than 80 years ago, but the prospects had never been located or described until now. Previous to actual mining, it is possible that the Indians and the Spanish collected surface samples in the area for pigments or ornamental use and that the deposits were known to these people for hundreds of years.

Geologists began to look at the area about 1901, but it was not until the period from 1943 to 1959 that the stratigraphy of the area was understood. Several field trips to the area were conducted by Parker (1930), Stovall (Oklahoma City Geological Society, 1941), and Oborne and others (Oklahoma City Geological Society, 1956) for the Kansas Geological Society and the Oklahoma City Geological Society. Between 1968 and 1978, U.S. Geological Survey topographic-quadrangle maps (7½-minute series) were issued for this area, which includes adjacent parts of Baca County, Colorado, and Union County, New Mexico. The Triassic geology has been superimposed on these base maps (pl. 1, in pocket).

[1] Geologist, Oklahoma Geological Survey.

The copper mineralization consists of chalcocite, malachite, and azurite in the Sheep Pen Sandstone (Triassic) in the northwestern corner of Cimarron County and the adjacent areas in Colorado and New Mexico (fig. 1). The Sheep Pen is generally less than 20 feet thick in Oklahoma and dips about 60 feet per mile to the southeast. The minerals are concentrated in brecciated vertical plugs that can be more than 200 feet deep, extending down into underlying beds. They also are found in pods in the lower 10 feet of the Sheep Pen. Mineralization occurs along fractures, joints, and bedding planes but is also disseminated through the sandstone. The copper content runs as high as 41 percent in selected hand samples. The prospects consist of adits or holes or pits 6 to 8 feet wide and high and 20 feet or more into a hill or plug, following a high-grade vein or pod.

Shales of the Sloan Canyon Formation below the Sheep Pen, and the Exeter Sandstone (Jurassic) above the Sheep Pen, do not exhibit copper mineralization. Above the Exeter are the Morrison Formation (Jurassic), the Purgatoire Formation (Lower Cretaceous), and the Dakota Group (Lower and Upper Cretaceous), overlain by the Ogallala Formation (Pliocene). The Raton Basalt above the Ogallala caps Black Mesa. Copper

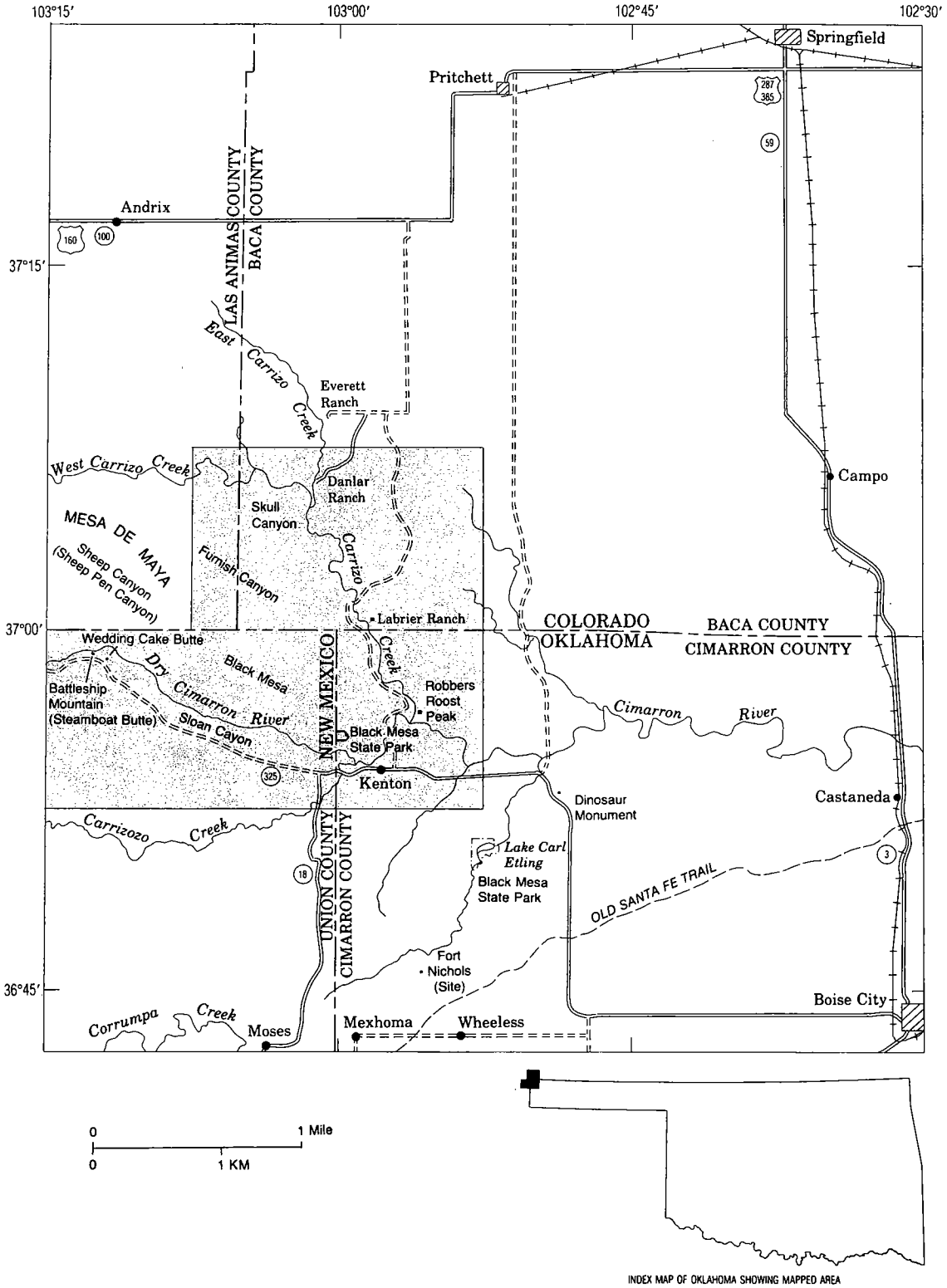


Figure 1. Map of northwestern Cimarron County, Oklahoma, and adjoining parts of Colorado and New Mexico; screened portion of map indicates area covered in report.

minerals have not been found above the Sheep Pen.

The Sheep Pen deposits are the youngest known red-bed chalcocite deposits in Oklahoma.

Sheep Pen Sandstone

Nomenclature.—The Sheep Pen Sandstone was named by Parker (1933, p. 41) from exposures in a butte in the SW NE sec. 35, T. 32 N., R. 35 E., Union County, New Mexico, about half a mile southeast of Sheep Pen Canyon, which is in sec. 26. At the type section, 68 feet of thin-bedded to massive, tan to buff sandstone caps the butte above the Sloan Canyon Formation. The Sloan Canyon is mostly a reddish-brown and greenish-gray mudstone and siltstone sequence about 150 feet thick. It is generally conformable with the Sheep Pen but may be tilted beneath the Sheep Pen unconformably in sec. 24, T. 31 N., R. 35 E., according to Baldwin and Muehlberger (1959, p. 40). The overlying Exeter Sandstone appears to grade into the Sheep Pen Sandstone at many places, but in selected areas of Triassic uplifts the Exeter may rest upon the underlying Sloan Canyon and Travesser Formations, as in the exposures in Wedding Cake Butte 1.6 miles west-northwest of the type Sheep Pen, in the SW SW sec. 27, T. 32 N., R. 35 E., or in Battleship Mountain (Steamboat Butte) and the bluff to the south in sec. 28, according to Baldwin and Muehlberger (1959, p. 41, fig. 10) (see figs. 2–4 of this report). Therefore, the Sheep Pen is considered to be more closely related to the Sloan Canyon (Triassic) than to the Exeter (Jurassic).

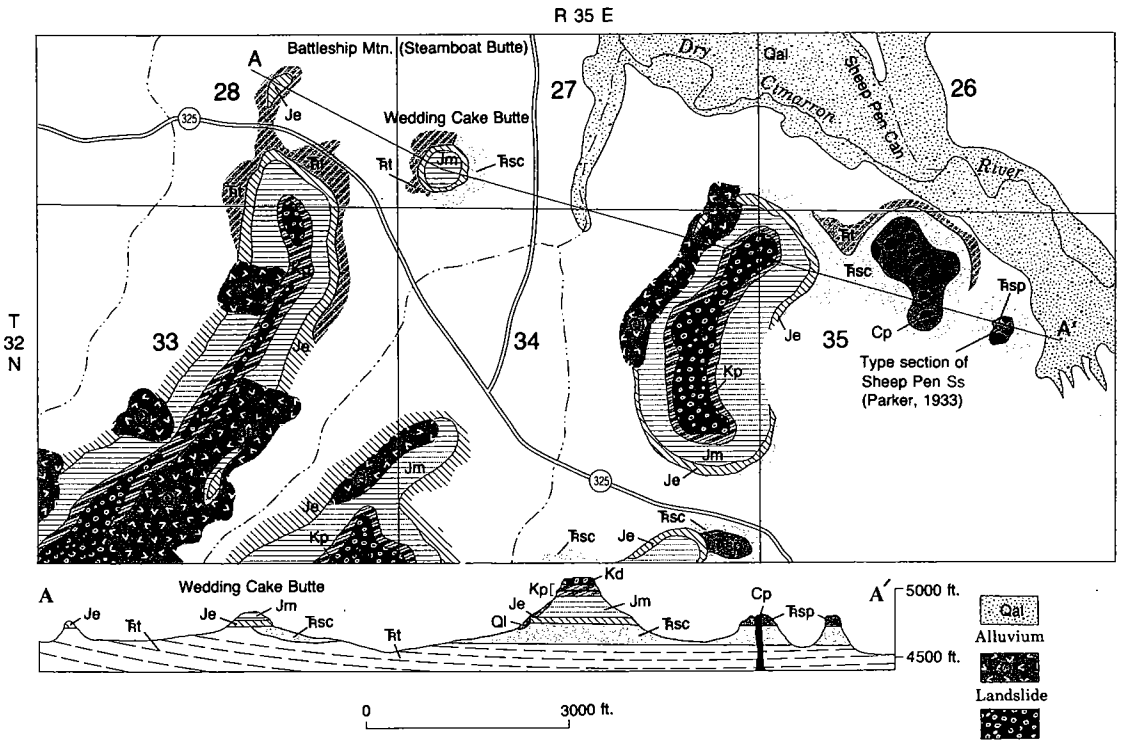
Parker (1930, p. 132) first used the name Sheep Pen Canyon Formation in a guidebook but did not formally publish the name Sheep Pen Sandstone until 1933. Lee (1902), DeFord (1927), Stovall and Savage (1939), and Stovall (1943) recognized the Exeter Sandstone beneath the Morrison Formation. Rothrock (1925), Sanders (1934a, 1934b), and Soulé (1956) placed the Sloan Canyon, Sheep Pen, and Exeter in the Morrison, thus leading to confusion in nomenclature and age of beds. Parker (1934), in a discussion of Sanders' paper (1934a), defended his own interpretation of the stratigraphy. Soulé (1956) misidentified the Sheep Pen as basal Purgatoire at places, adding further confusion. Baldwin and Muehlberger (1959) mapped Union County, New Mexico, and corrected the previous errors. McLaughlin (1954) mapped Baca County, Colorado, and corrected previous errors. Stovall (1943) mapped Cimarron County, Oklahoma, and corrected previous errors, but he failed to recognize the Sheep Pen Sandstone, although units 15–21 in his measured section 30 (p. 260) are probably Sheep Pen. Thus, previous to Parker (1930), the Sheep Pen was included as part of the Exeter or as part of the Morrison.

Description.—In Cimarron County, Oklahoma, the Sheep Pen Sandstone is an even-bedded, fine-grained, tan to brown, micaceous quartzose sandstone about 20 feet thick, above the Sloan Canyon Formation and below the Exeter Sandstone. It dips about 60 feet per mile southeastward, passing beneath the Cimarron River in sec. 7, T. 5 N., R. 1 ECM, about 1.5 miles northwest of Kenton, and passing beneath North Carrizo Creek in sec. 27, T. 6 N., R. 1 ECM.

Schoff and Stovall (1943, p. 260) described the following sequence in Labrier Butte in secs. 20 and 29, T. 6 N., R. 1 ECM, below the Morrison Formation (with the description slightly altered here and the range location and formation designation corrected):

	Feet
Exeter Sandstone (37 feet)	
Sandstone, white, coarse-grained, massive to crossbedded	37.0
Sheep Pen Sandstone (18.6 feet)	
Sandstone, brown, fine- to coarse-grained, moderately to well-indurated	1.2
Sandstone, brown to white, fine- to medium-grained, moderately to weakly indurated, with dark-brown and black specks	3.5
Sandstone, gray, fine-grained, friable, weakly indurated, eroding readily	2.0
Sandstone, brown, massive, with many brown and black specks	0.9
Sandstone, cream and gray, very fine-grained	0.5
Sandstone, gray and slightly purple, friable	1.0
Sandstone, white to greenish-gray, fine-grained, friable, thin-bedded	9.5
Unconformity?	
Sloan Canyon Formation (67.1 feet exposed to North Carrizo Creek)	
Sandstone, bluish-gray	1.5
Shale, purplish-red, mottled green	6.0
Sandstone, buff, flecked with iron stains	3.8
Clay, light-green, thin-bedded, with thin sandstone lenses near base	4.7
Shale, bright-green, platy, soapy, eroding into a recess	4.8
Shale, brown	6.5
Shale, gray	3.0
Shale, brick-red, closely jointed, conchoidal fractures	4.2
Marl, light-gray, stained purple along cracks	5.0
Marl, brick-red, with gray streaks	18.0
Marl, greenish-gray to purple, much jointed	2.3
Sandstone, gray, with some lime	2.8
Marl, gray, stained purple	1.0
Marl, pink, weathering into ¼- to ½-inch blocks	3.5

The Sheep Pen generally exhibits mineralization in the lower 9.5-foot bed, in the form of lenticular pods and clastic plugs, associated with hematite, chalcocite, malachite, and azurite. There is no association with the Black Mesa basalts, and there does not seem to be a relationship between mineralization and stratigraphic



JURASSIC	Exeter Sandstone	0–80	Massive white to pink fine-grained sandstone
	ANGULAR UNCONFORMITY		
TRIASSIC	†Clastic plugs		Vertical cylinders of sandstone surrounded by breccia of siltstone; some are mineralized
	Dockum Group		
	†Sheep Pen Sandstone	0–107	Thin-bedded light-brown sandstone
	†Sloan Canyon Formation	0–150	Light-green and red mudstone
	†Travesser Formation	245–550	Red-brown mudstone and sandstone
	†Baldy Hill Formation	100	Purple-mottled mudstone; base not exposed

† Recognized only in Dry Cimarron River valley.

Qal Alluvium
Landslide
Dakota Formation
Purgatoire Formation
Jm Morrison Formation
Je Exeter Sandstone
Cp Clastic plug
Sheep Pen Sandstone
Trsc Sloan Canyon Formation
Trt Travesser Formation

Figure 2. Geologic map and cross section of Wedding Cake Butte area, Union County, New Mexico. From Baldwin and Muehlberger (1959, fig. 10).

and structural controls other than brecciation. The pods and plugs are isolated and seem to be related to isolated areas of reducing environments that developed either during or after deposition of the Sheep Pen sand. The Exeter and higher units and the underlying Sloan Canyon beds lack copper mineralization.

Age.—The Sheep Pen Sandstone is considered Triassic in age because it seems to be related more closely to the Sloan Canyon Formation than to the Exeter, as has been discussed previously. The Sloan Canyon is Triassic in age, a determination based upon a phytosaur found in the type Sloan Canyon in sec. 12, T. 31 N., R. 35 E., Union County, New Mexico, by Stovall and Savage (1939). Fossils have not been found in the Sheep Pen and Exeter. The Exeter is considered Jurassic in age because it seems to be related more closely to the overlying Morrison Formation. Stovall (1938) described the Morrison dinosaurs in Oklahoma and considered them to be Jurassic in age. Lee (1901, 1902), Stanton (1905), and Rothrock (1925) first

Figure 3. View looking northeast at Battleship Mountain (Steamboat Butte), capped by Exeter Sandstone resting unconformably on southeast-dipping Travesser Formation in NW SE sec. 28, T. 32 N., R. 35 E., Union County, New Mexico. March 25, 1973.

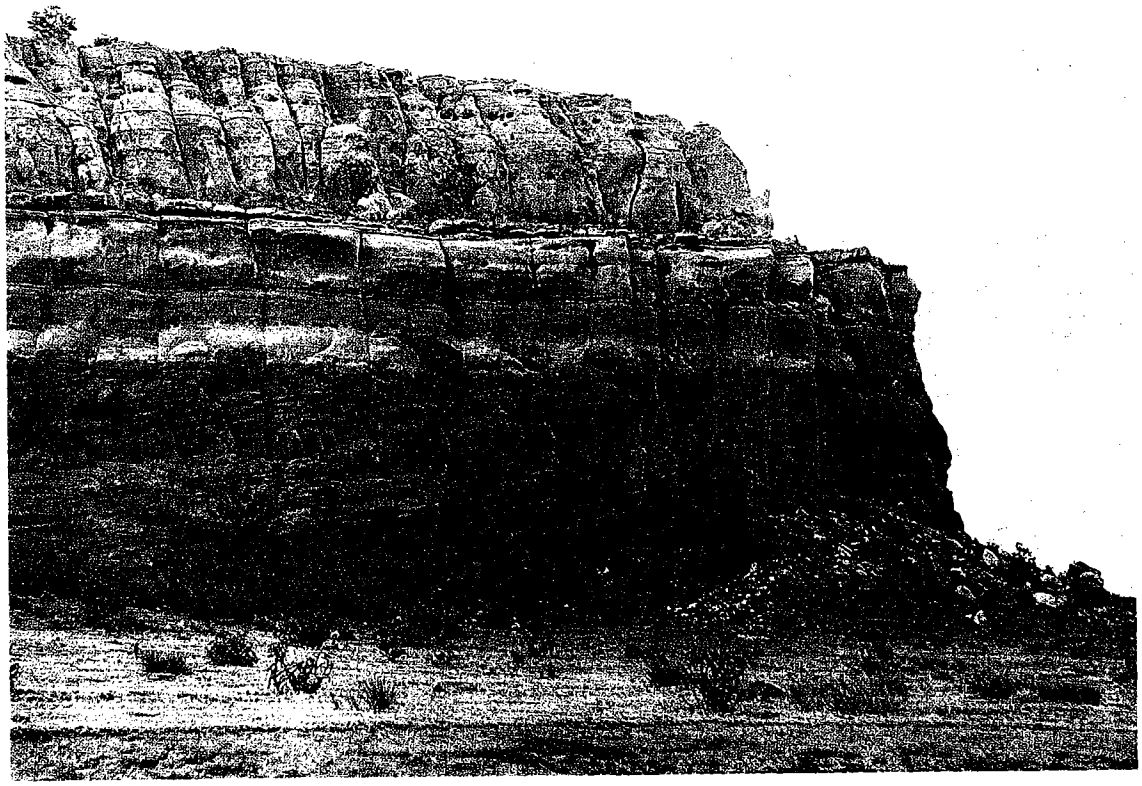


Figure 4. View looking south at type Exeter Sandstone resting unconformably on southeast-dipping Travesser Formation in bluff south of Battleship Mountain (Steamboat Butte) in SE sec. 28, T. 32 N., R. 35 E., Union County, New Mexico. March 25, 1973.

described the Morrison in the Cimarron River Valley but did not know the age of the beds until Stovall (1938) described the dinosaurs. Truman Tucker, who lives in the SE sec. 7, T. 6 N., R. 1 ECM, in the northwestern corner of Cimarron County, first discovered the Morrison dinosaur bones in 1931.

History of Mining

The Indians probably collected some copper ore for green and blue pigments, and later the Spanish may have mined a little ore; but the recorded history of mining in northeastern New Mexico and southeastern Colorado dates from 1884 to 1900, according to Soulé (1956, p. 1, 4, 7, 10, 16, 18). The Independence Mine, a 524-foot adit on the south side of Skull Canyon in the NE NW NW sec. 21, T. 34 S., R. 50 W., on the Furnish Canyon East topographic-quadrangle map, was opened in 1889, and this was probably the earliest mine in Baca County, Colorado (frontispiece). The mines in Union County, New Mexico, all were opened about 1899 and were closed before 1912. Everett (1953) located some prospects in the N½ sec. 27, T. 32 N., R. 35 E., just south of the Cimarron River, but these were not visited.

The earliest reference to mining in Cimarron County, Oklahoma, is that of Gov. Cassius McDonald Barnes (1899, p. 78), who stated: "In the mountainous country in the extreme western end of Beaver County [Oklahoma] are many indications of mineral deposits, and on Carisco [Carrizo] Creek, near Kenton, several rich deposits of copper have been located. Independence tunnel in North Cairo camp near there is over 200 feet into the sandstone mountain or butte, and 200 to 500 pounds of copper ore are being taken out per day. This ore assays from $75 to $250 per ton, and though it is necessary to freight it by wagon 90 miles to Lamar, Colo., and thence by rail to Pueblo for smelting, the mine is paying a handsome profit over and above all expenses. There are other deposits equally as rich in this section."

There are more than 210 known prospects and mines in Union County, New Mexico, Baca County, Colorado, and Cimarron County, Oklahoma, all in the Sheep Pen Sandstone. Most of the mines are less than 100 feet deep and less than 1 acre in lateral extent, most being in small clastic plugs or lenticular pods a few feet in diameter. Baldwin and Muehlberger (1959, p. 42) located 170 clastic plugs in Union County. The deepest mine was supposedly 380 feet deep, sunk by the Sater Copper Co. and later taken over by the Fort Pitt Copper Co., according to Harley (1940, p. 38). Harley mislocated the developed properties in secs. 33–34, T. 32 N., R. 35 E., but this was corrected by Baldwin and Muehlberger (1959, map). Parker (1933) stated that this was the Pittsburgh Copper Co. and located the mine correctly in sec. 7, T. 31 N., R. 36 E., Union County. Local residents locate the mine in the SE NE SE of sec. 7.

In 1901, four articles appeared in the *Cimarron News*, concerning mining and settlement in northwestern Cimarron County. These articles were reprinted in *The Boise City News* (1968, p. 4-F) as follows:

Woodward Colony Stakes Claims Near Kenton

In 1901, the growing Kenton community enthusiastically received a colony of settlers from Woodward, Okla. Editor Wikoff's account in the Cimarron News of these arrivals tells the story as it appeared in 1901:

January 18, 1901—Forty settlers from Woodward, O. T. The following letter explains itself: You will remember some ten days ago a party of Woodward people, myself among the number, called at your office after having spent some time in making observations in the extreme northwest corner of Beaver county.

On our return home our description of the beauties of the locality induced several of our citizens to unite in forming a colony to settle there. This colony has now been fully organized, and has elected officers, whose duties it will be to look after the general interests of all. Homesteads have been filed covering all the following sections in Township 6 north, Range 1 east, sections 17, 18, 19, 20, 29, 30, 31, 33 and part of 28 and 7, 8 and 9. We expect to move upon these lands in the spring. One of the first things to be done is to establish a good lumber yard, which has been arranged for. We are aware that some parties are prospecting for minerals (copper) on these lands but we presume they have about concluded that there is nothing there worth spending much more labor or money on. They will also learn that they have no protection under the mineral law. Oklahoma lands having been declared non-mineral and can only be disposed of under the homestead laws of the United States. The non-mineral affidavit not being required in making final proof as provided in Sec. 16 of the Act of March 3, 1891 (26 Stat., 989–1044). Our colony includes about 40 of our oldest and best citizens, including four lawyers, two doctors, and many business men. Kenton may expect to be somewhat benefited by this move. Respectfully, D. H. Patton.

Feb. 15, 1901—We are in receipt of a letter from Dr. Patton, of the Woodward colony, in which he says: Our colony will probably not get on the lands homesteaded before May or June. It is not our purpose to interfere in any way with the mineral prospectors on those lands. Speaking for myself, I will say prospectors are at liberty to dig all the holes that they wish on my claim. All that I ask is that when they are through that they will fill up these excavations so that our stock will not fall into them.

I have taken the trouble and expenses to have samples selected from each of the prospecting claims, assayed for minerals, none of which proved of any value, except the select pieces of copper glance, which we found in isolated particles and in insignificant quantities over the district in question. If the miners wish to prospect further there will be no objection by the homesteaders.

June 21, 1901—Quite a number of Woodward homesteaders have reached here this week. Among the number are Wm. Lowery, J. W. Holman, Dr. Ralph Workman and wife, Rev. Whaley, the surveyor, M. Everett, and two boys by the name of Douglas. They will be reinforced by a train of overland travelers some time next week, composed of some dozen wagons and vehicles, men, women and children. They are coming to stay, so they assert, and build up homes in this beautiful country. Among the number, a mining company is duly organized to prospect and develop mines over the line in Colorado. We gladly welcome all comers to this section of country, and hope every resource it possesses will be fully developed.

The emigrants that are daily arriving here remind one of the boom days in Western Kansas in 1885–87. It is to be hoped that the result will not be the same. Then the people verily believed they were landing in a country where farming would be a lucrative business. But the fallacy of that idea is long since made plain, and the great majority of those coming here know they cannot raise an ear of corn by the annual rainfall. They may raise some feed and some copper, but the copper crop up to date has been a failure, but it may be made profitable by thoroughly irrigating it with sweat. The country bids fair to yield something from the pick and shovel, or from the rod stroking drill an oil field may be opened up that will exceed the Beaumont strike in wealth. The future lies before us with all its opportunities.

June 28, 1901—The main Woodward colony of homesteaders arrived yesterday and with those who have been coming in for the past 30 days make a big neighborhood four or five miles from town. They are a first class lot of settlers and are coming with considerable means to develop the country they have taken land in. Among the number is Dr. Patton, an ex-congressman from Northern Indiana and the first receiver of the Woodward land office, and Hon. Temple Houston, one of the most noted attorneys in Oklahoma. In addition to these two prominent men the caravan crowd that passed up yesterday to the promised land embraces the following: L. I. Patton and brother, Standiford family, Henry Greer and wife, Ashley Greer, John Noble, Dad Nall, McDonald, John Pugh, wife and daughter, Mrs. Hopkins, Mrs. O'Bryan, Eugene Smith and family, Frank Amos, Miss Sallie Greer, Clifford Patton, and Will Healey.

Gould (1908, p. 79) mentioned: "There is a region along the valley of the Cimarron River and Carisso [Carrizo] Creek near Kenton, in the extreme northwestern corner of the state, where copper was mined for a number of years. Several hundred shafts have been sunk in this region. The rocks are the Redbeds similar to those which occur in central Oklahoma. These rocks are in many places vividly stained with copper. Some of the material obtained has been hauled to the railroad and shipped to smelters, but the investment did not prove profitable and at the present time all of these workings have been abandoned." He repeated the statement later (Gould, 1910, p. 59–60).

Rothrock (1925, p. 88–89) first mapped northwestern Cimarron County and commented:

There has been much prospecting for copper around the foot of the Mesa de Maya (Black Mesa) and the neighboring buttes, especially in a light green sandstone which forms the base of the Purgatoire formation. There are tiny pellets and stringers of black copper sulphide running through this rock, and the association of these with the green color has led to the belief that the green color is due to the presence of copper in quantity. Under the microscope, however, it can be seen that the color is due to an abundance of chloritic minerals, which contain no copper. A few miles up the Cimarron River in New Mexico there is a small copper mine from which copper can be produced, when its price is very high, and there is also a similar mine in Colorado on West Carrizo Creek, a few miles beyond the county line. Both of these and the copper found in Cimarron County are very near the mesa, and it is probable that the magmatic waters from the basalt flow, percolating through the underlying rocks, deposited the copper. The analysis of the basalt (p. 87), does not show copper, but special tests for small amounts of that element were not made. However, almost all basalts show small amounts of copper, and from the similarity in location and the absence of other igneous phenomena in the region, the natural conclusion is that this basalt furnished the copper of these veins. The prospecting has been confined to the white sands, because it is here that the black sulphides show most conspicuously, and also because, as stated above, the greenish color of much of this sand is mistaken for a copper color. Because of the nature of the source of the copper, large deposits are not to be expected. Though many analyses have been made of samples from prospects in the county, none have shown copper in workable amounts.

Rothrock did not show the location of the mines and did not publish the analyses. Also, he misidentified the Purgatoire as the host rock, as did Soulé (1956), who made the same mistake. DeFord (1927, p. 754) identified Rothrock's Purgatoire sandstone as the Exeter, following Lee (1902).

While doing a detailed study of the stratigraphy in the area for the Marland Oil Co. between 1927 and 1930, Parker (1933, p. 43–47) was the first to recognize the Sheep Pen Sandstone as a separate formation below the Exeter, and also the association of the copper mineralization with the Sheep Pen. Stovall (1943, p. 47) did not recognize the Sheep Pen in Cimarron County, but his measured section 30, units 15–21 (p. 259–260), which he designated Exeter Sandstone, is a description of the Sheep Pen in Labrier Butte in secs. 20 and 29, T. 6 N., R. 1 ECM. Stovall did not locate the copper mines, nor did he discuss them. He considered the brown sandstone at the base of the Exeter to be part of the Exeter (Stovall, 1943, p. 54).

The copper mines in Cimarron County had never been located or mapped until now.

Henderson (1926, p. 105) gave the following information on Baca County:

BACA COUNTY

The figures given in the table for Baca County for 1900 to 1902, inclusive, are those given by the Colorado Bureau of Mines and represent smelter and mint receipts. The report of the agent of the Director of the Mint upon the production of the precious metals in the United States during the calendar year 1900 gives $93 in gold as the output of Baca County.

The production for 1915 to 1917 is taken from Mineral Resources (mines reports). The total output is credited to the Carrizo Creek district, southwest of Springfield. The ore shipped in 1915–1917 was chalcocite, partly altered to malachite and azurite. The deposits, which are in white sandstone, lie principally in T. 34 N. (New Mexico base line), R. 50 W., in secs. 10, 15, 16, 21, 22, 23, 26, 28, and 35, although there are also indications of deposits to the east, west, and south, and in northwestern Oklahoma and northeastern New Mexico.

Henderson's map and many locations seem to be in error, and these should be checked in more detail.

Gold, silver, and copper produced in Baca County, 1900–1902 and 1915–1917

Year	Ore (short tons)	Lode gold (value)	Silver			Copper			Total value
			Fine ounces	Average price per ounce	Value	Pounds	Average price per pound	Value	
1900	----------	$103	102	$0.62	$ 63	8,900	$0.166	$1,477	$1,643
1901	----------	83	80	.60	48	590	.167	99	230
1902	----------	103	59	.53	31	1,929	.122	235	369
1915	----------	----------	8	.507	4	514	.175	90	94
1916	5	----------	50	.658	33	2,772	.246	682	715
1917	9	3	57	.824	47	6,806	.273	1,858	1,908
	----------	292	356	----------	226	21,511	----------	4,441	4,959

Descriptions of Prospects

The prospects are in sections 19–20, 28–30, T. 6 N., R. 1 ECM, north of Black Mesa on the Kenton topographic-quadrangle map, 7½-minute series, Cimarron County, Oklahoma; in sec. 7, T. 35 S., R. 49 W., and sec. 12, T. 35 S., R. 50 W., on the Big Hole Canyon topographic-quadrangle map, 7½-minute series, Baca County, Colorado; and in sec. 12, T. 31 N., R. 35 E., and sec. 7, T. 31 N., R. 36 E., on the Wedding Cake Butte topographic-quadrangle map, 7½-minute series, Union County, New Mexico (figs. 5–7).

Most of the copper prospects consist of adits or steeply inclined shafts and generally are about 6 to 8 feet wide and high, large enough for a person to enter. All prospects are in the Sheep Pen Sandstone, a brown to light-gray, fine-grained, even-bedded, micaceous quartzose sandstone generally less than 20 feet thick. The sandstone dips 60 feet per mile southeastward in Cimarron County. I named the Oklahoma prospects after the present landowners at the time of my visit on March 25, 1973. I also recorded two previously unpublished prospects in Baca County, Colorado.

Mr. Russell Labrier, son of Wesley Labrier (pronounced "Labree"), kindly showed the prospects to me. His grandfather homesteaded in the area in the late 1800's and knew about the prospects firsthand. The Labrier ranch house is in Baca County in the SE sec. 18, T. 35 S., R. 49 W., about half a mile north of the Cimarron County line and 2.25 miles east of the northwest corner of Cimarron County (figs. 5, 7).

Apparently many of the prospectors came from Woodward, in Woodward County, Oklahoma, about 1898 and were called the "Klondikers" because they had returned from the Klondike region of the Yukon Territory, according to Mr. Labrier. However, some of the prospects may have been opened as early as 1889.

The prospects are listed in the same order as the sample numbers. Approximately 14 prospects were found in Cimarron County.

Cimarron County, Oklahoma

Wiggins no. 1 prospect.—A small adit in the northwest side of the hill in the SW SE SW NW NW sec. 20, T. 6 N., R. 1 ECM, about 400 feet northeast of the Wiggins no. 2 prospect (fig. 8). No samples were taken. Jack Wiggins, the owner, lives in the SE SE NW sec. 20, T. 6 N., R. 1 ECM.

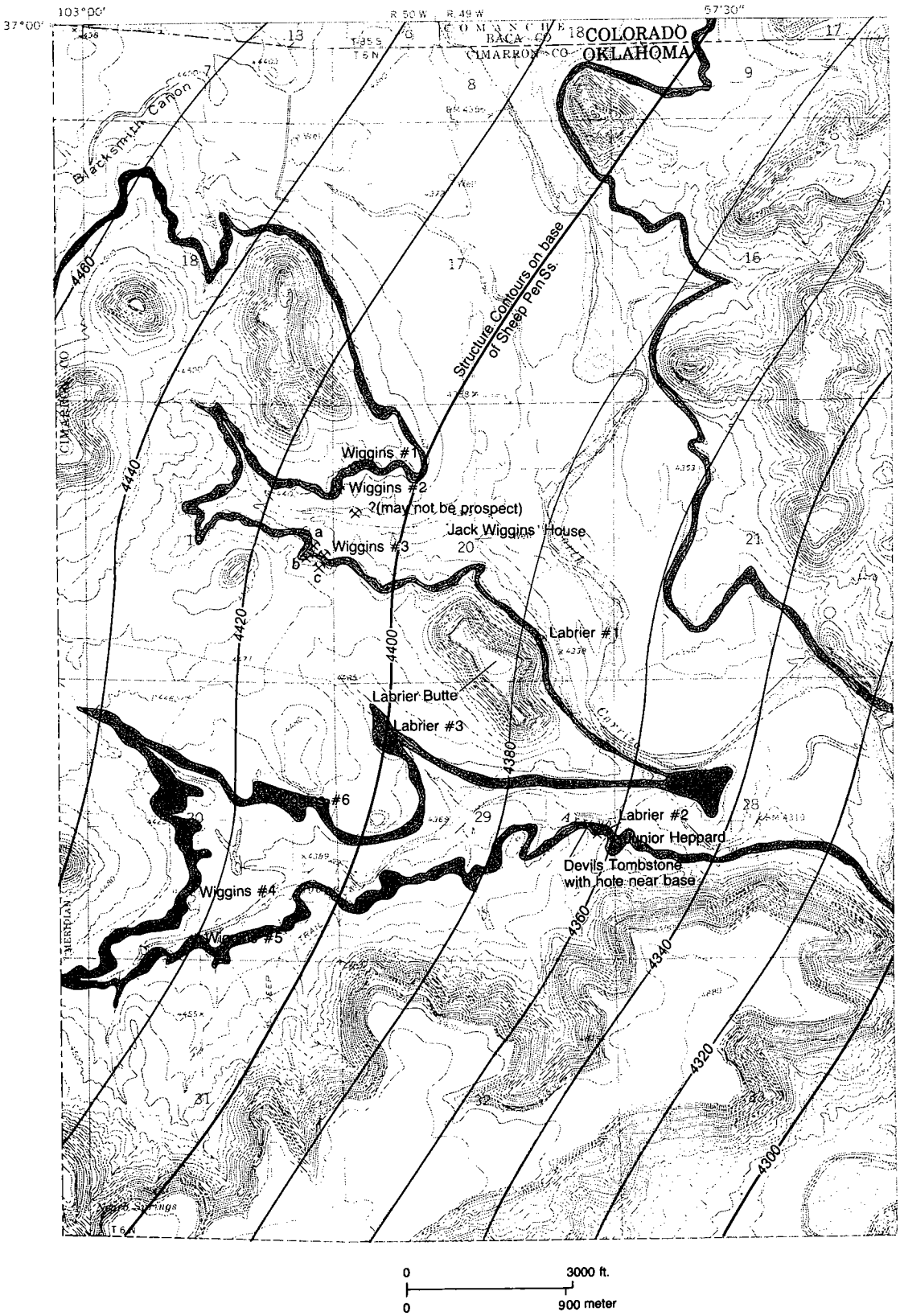


Figure 5. Map of northwestern Cimarron County, Oklahoma, showing locations of copper prospects. Structure contours depict base of Sheep Pen Sandstone; contour interval, 20 feet. Base from U.S. Geological Survey topographic quadrangles, 7½-minute series.

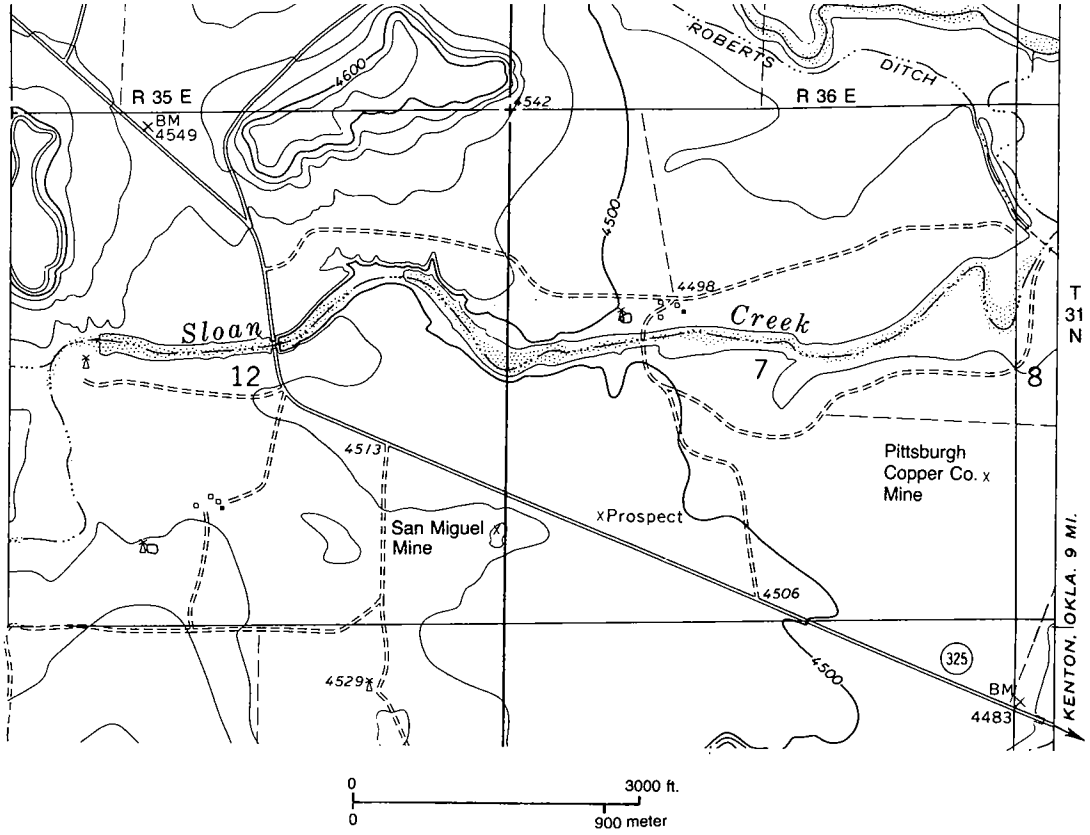


Figure 6. Map showing San Miguel Mine and Pittsburgh Copper Co. [Fort Pitt Copper Co.] mines in Union County, New Mexico. Base from U.S. Geological Survey topographic quadrangles, 7½-minute series.

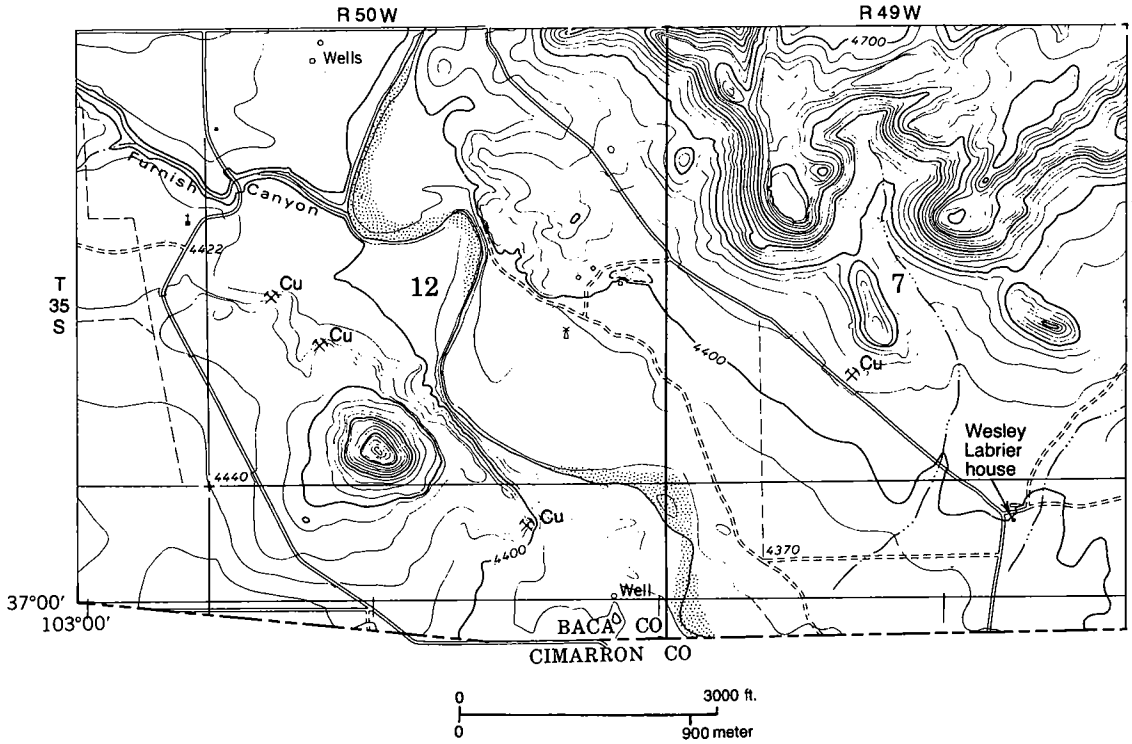


Figure 7. Map showing Baca County, Colorado, copper prospects. Base from U.S. Geological Survey topographic quadrangles, 7½-minute series.

Figure 8. Wiggins no. 1 prospect, looking west at adit in Sheep Pen Sandstone in SW SE SW NW NW sec. 20, T. 6 N., R. 1 ECM, Cimarron County, Oklahoma. March 25, 1973.

Wiggins no. 2 prospect.—A small adit in the west side of the hill near the C NW NW SW NW sec. 20, T. 6 N., R. 1 ECM, about 150 feet east of the north–south fence line (fig. 9). Sample 1 contains 1.64 percent copper. Sample 2 is higher grade ore, with 27.4 percent copper.

Wiggins unnumbered prospect.—A small pit north of an east–west creek north of an old road in the NE NW SW SW NW sec. 20, T. 6 N., R. 1 ECM. This may have been dug for water and may not be a copper prospect. Samples were not taken.

Wiggins no. 3 prospect.—Four prospect pits in the NE NE SE sec. 19, T. 6 N., R. 1 ECM: (a) near the north line of the SE¼ about 300 feet west of the east fence line of sec. 19; (b) about 200 feet southwest of (a) on the west side of a small creek; (c) about 300 feet southeast of (b) and 250 feet west of the east fence line of sec. 19; (d) about 100 feet north of (c) (fig. 10). Sample 3 is from (b), with 41.9 percent copper from a selected high-grade hand sample.

Wiggins no. 4 prospect.—A deep adit on the southwest side of a hill in the NE NW NE SE SW sec. 30, T. 6 N., R. 1 ECM (fig. 11). Sample 4 is a selected hand sample with 11.5 percent copper.

Wiggins no. 5 prospect.—A 40-foot hole steeply inclined southward on the south side of Cooper's Creek, near the C SE SE SW sec. 30, T. 6 N., R. 1 ECM, about 1,000 feet south of the Wiggins no. 4 prospect (fig. 12). Samples were not taken.

Wiggins no. 6 prospect.—A small pit in a 10-foot-high clastic plug near the C SE SW NE sec. 30, T. 6 N., R. 1 ECM, about 10 feet west of a fence line (fig. 13). Sample 5 is a selected hand sample with 29.2 percent copper.

Labrier no. 1 prospect.—A small adit on the east side of Labrier Butte in the SE SE NE SW SE sec. 20, T. 6 N., R. 1 ECM, about 200 feet west of road and 30 feet up hill (fig. 14). Sample 6 is a selected hand sample with 0.55 percent copper.

Labrier no. 2 prospect.—A low adit or cave in the north side of Black Mesa about 200 feet southeast of a prominent rock termed the Devil's Tombstone, in the NW NE NE NE SE sec. 29, T. 6 N., R. 1 ECM (fig. 15). Samples were not taken.

Labrier no. 3 prospect.—A small pit west of the C

Figure 9. Wiggins no. 2 prospect, looking west at adit in Sheep Pen Sandstone near C NW NW SW NW sec. 20, T. 6 N., R. 1 ECM, Cimarron County, Oklahoma. March 25, 1973.

Figure 10. Wiggins no. 3(d) prospect, looking east, on east side of small creek, in Sheep Pen Sandstone in NE NE SE sec. 19, T. 6 N., R. 1 ECM, Cimarron County, Oklahoma. March 25, 1973.

Figure 11. Wiggins no. 4 prospect, looking northeast, on southwest side of hill. Deep adit in Sheep Pen Sandstone, in NE NW NE SE SW sec. 30, T. 6 N., R. 1 ECM, Cimarron County, Oklahoma. March 25, 1973.

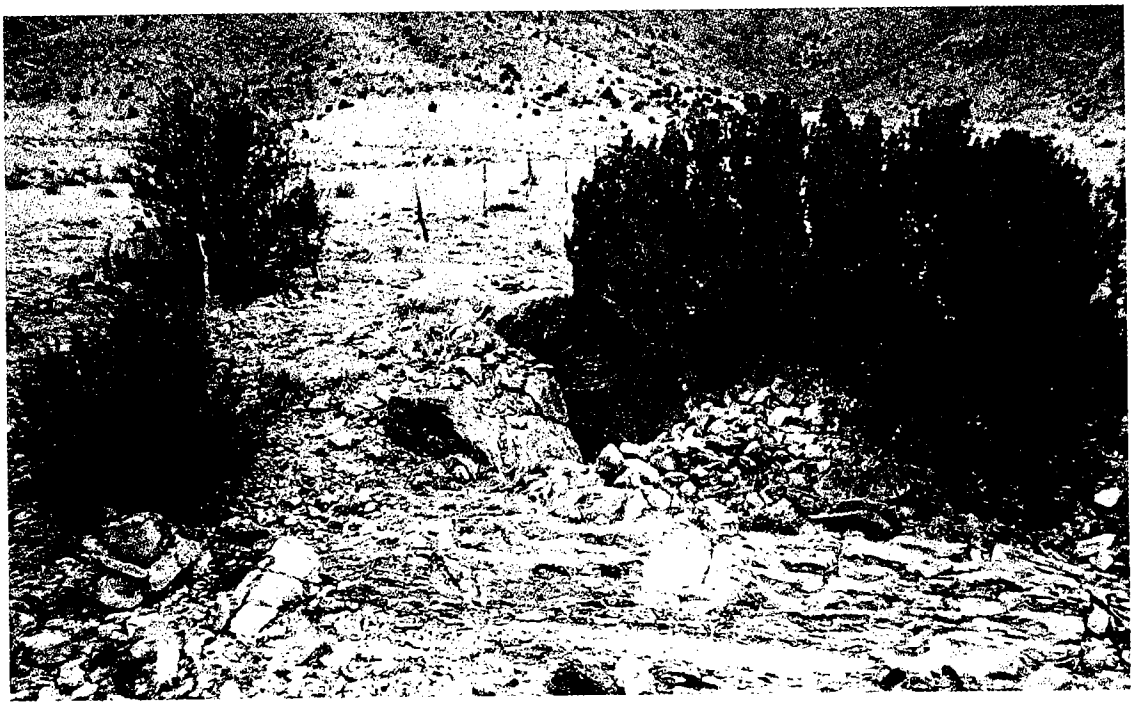


Figure 12. Wiggins no. 5 prospect, looking south, on south side of creek, west of fence. A 40-foot inclined adit in Sheep Pen Sandstone near C SE SE SW sec. 30, T. 6 N., R. 1 ECM, Cimarron County, Oklahoma. March 25, 1973.

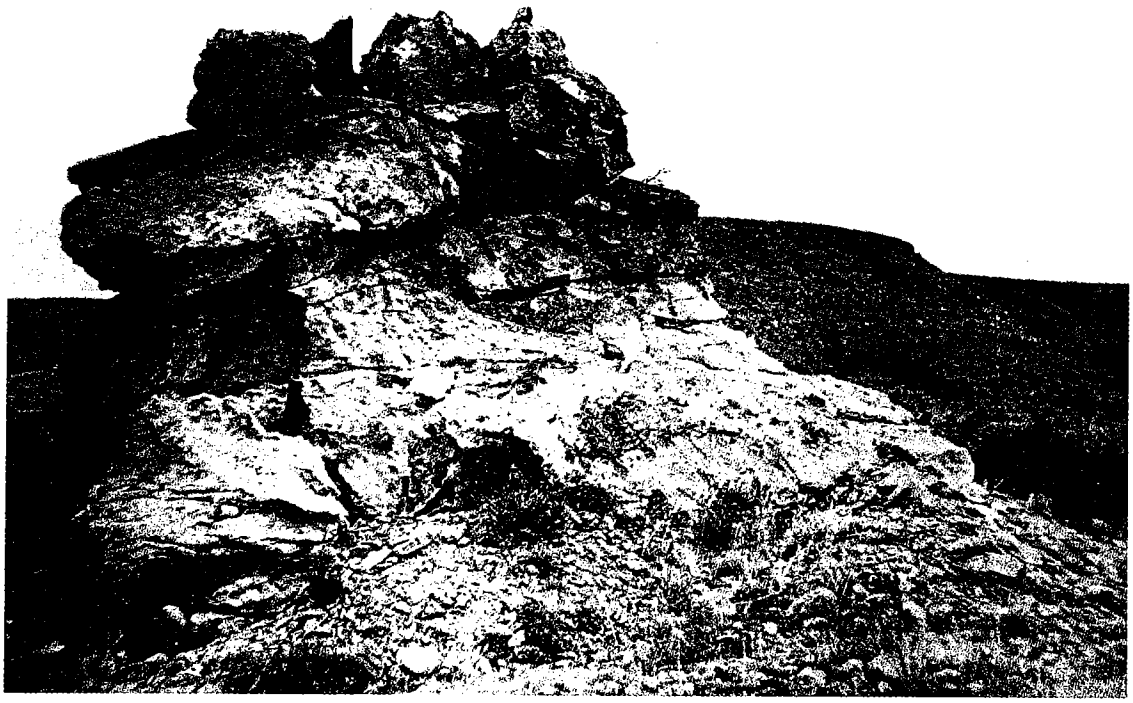


Figure 13. Wiggins no. 6 prospect, looking south at clastic plug, with malachite at base, in Sheep Pen Sandstone near C SE SW NE sec. 30, T. 6 N., R. 1 ECM, Cimarron County, Oklahoma. March 25, 1973.

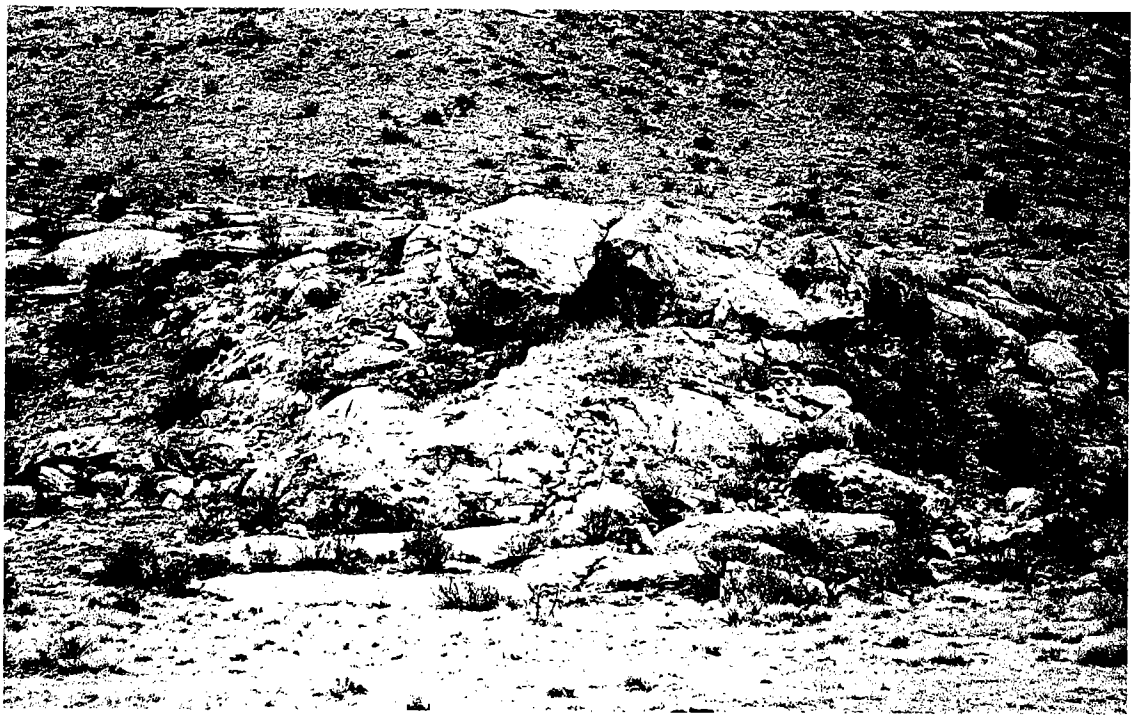


Figure 14. Labrier no. 1 prospect, looking west at adit in Sheep Pen Sandstone on east side of Labrier Butte, in SE SE NE SW SE sec. 20, T. 6 N., R. 1 ECM, Cimarron County, Oklahoma. March 25, 1973.

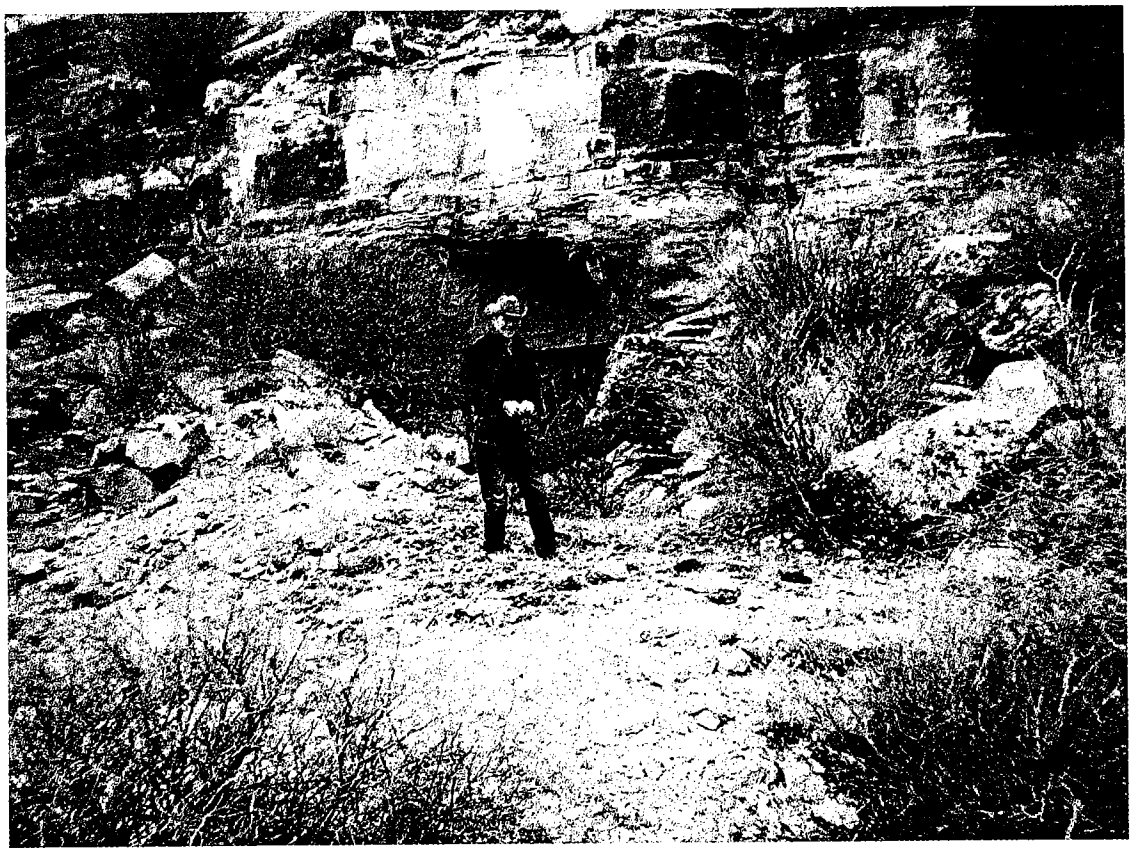


Figure 15. Labrier no. 2 prospect, looking south at entrance to adit in Sheep Pen Sandstone in NW NE NE NE SE sec. 29, T. 6 N., R. 1 ECM, Cimarron County, Oklahoma. Russell Labrier in photo. March 25, 1973.

SE NW NW sec. 29, T. 6 N., R. 1 ECM. No samples were taken.

Heppard prospect.—A small adit 30 to 50 feet long on the west side of a small creek in Black Mesa, in the NW NW NW SW sec. 28, T. 6 N., R. 1 ECM, at the base of the Sheep Pen Sandstone (fig. 16). No samples were taken. This is on Junior Heppard's property.

Baca County, Colorado

Baca County no. 1 prospect.—A 20-foot-deep shaft on the north side of a hill in the C SW NE NW SW sec. 12, T. 35 S., R. 50 W., in the Sheep Pen Sandstone (fig. 17). Sample 7 is a selected hand sample with 7.78 percent copper.

Baca County no. 2 prospect.—A small pit on the southwest side of a hill north of the road about half a mile northwest of the Wesley Labrier ranch house in the SE NE SW sec. 7, T. 35 S., R. 49 W. (fig. 18). Sample 8 is a selected hand sample with 200 to 666 parts per million copper.

Baca County no. 3 prospect.—A vertical hole 5 × 5 × 10 feet deep on a prominent point about 400 feet north of the C SW sec. 12, T. 35 S., R. 50 W. Samples were not analyzed.

Baca County no. 4 prospect.—A small hole 5 × 5 × 5 feet deep on the east side of a bluff in the NE NW NE sec. 13, T. 35 S., R. 50 W. No samples were taken.

Union County, New Mexico

San Miguel Mine.—A large strip pit of the Cimarron Copper Co. in operation until 1956, in the Sheep Pen Sandstone, in the NE SE SE sec. 12, T. 31 N., R. 35 E., on the south side of State Highway 325 (figs. 19, 20). Sample 9 is an average sandstone sample with 2.82 percent copper. Sample 10 is a selected sample with 24.3 percent copper.

Pittsburgh Copper Co. (Fort Pitt Copper Co.) mine.—A vertical shaft said to be 380 feet deep, in the SE NE SE sec. 7, T. 31 N., R. 36 E., in a plug in the Sheep Pen Sandstone (figs. 21, 22). Sample 11 is from the waste dump, with 1.78 percent copper.

Figure 16. Heppard prospect, looking south at 30- to 50-foot adit in Sheep Pen Sandstone in NW NW NW SW sec. 28, T. 6 N., R. 1 ECM, Cimarron County, Oklahoma. March 25, 1973.

Figure 17. Baca County no. 1 prospect, looking south, in north face of low hill, at 20-foot shaft in Sheep Pen Sandstone near C SW NE NW SW sec. 12, T. 35 S., R. 50 W., Baca County, Colorado. March 25, 1973.

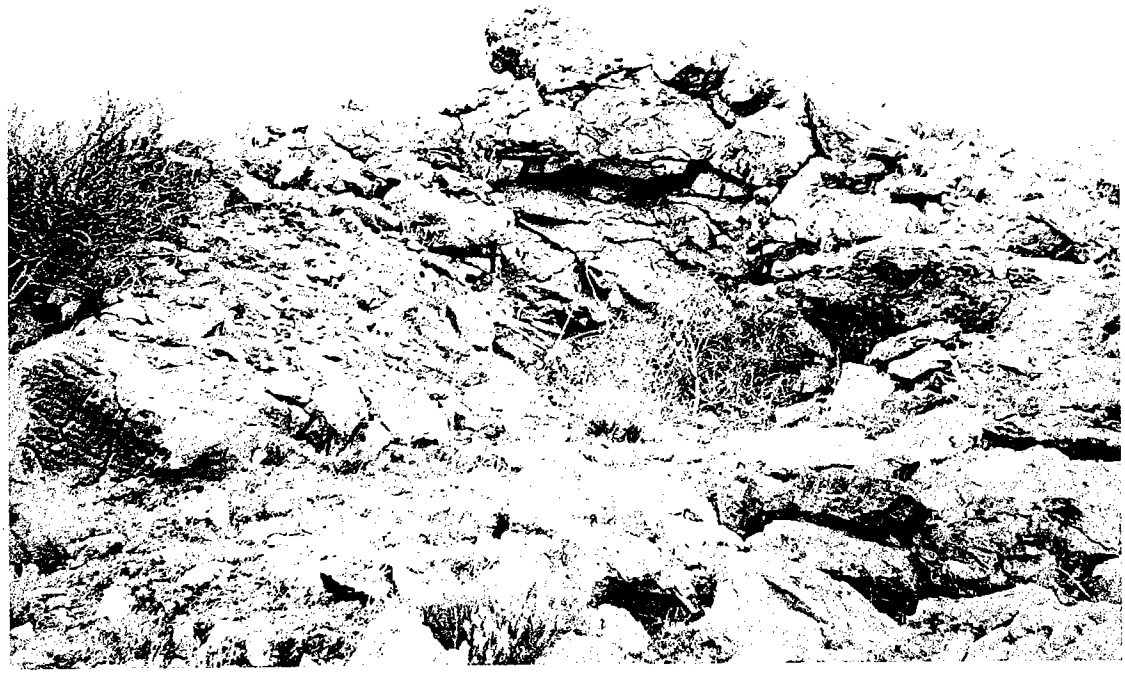


Figure 18. Baca County no. 2 prospect, looking northeast at pit in Sheep Pen Sandstone in SE NE SW sec. 7, T. 35 S., R. 49 W., Baca County, Colorado. March 25, 1973.

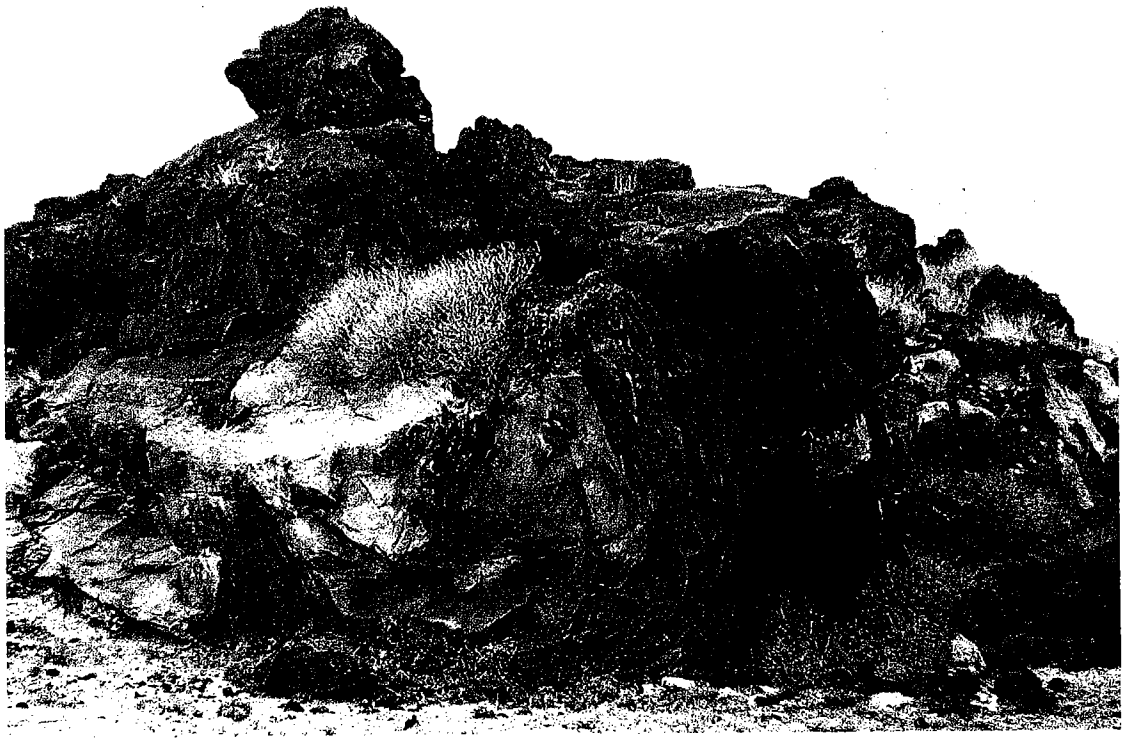


Figure 19. San Miguel Mine, looking southeast at clastic plug with hematite, with malachite in basal Sheep Pen Sandstone, in NE SE SE sec. 12, T. 31 N., R. 35 E., Union County, New Mexico. March 25, 1973.

Figure 20. San Miguel Mine, north side, looking southeast at east side of bulldozed trench, with basal Sheep Pen Sandstone overlying shale of Sloan Canyon Formation, in NE SE SE sec. 12, T. 31 N., R. 35 E., Union County, New Mexico. March 25, 1973.

Figure 21. Pittsburgh Copper Co. [Fort Pitt Copper Co.] mine (filled on right side of plug) and clastic plug with hematite and malachite, looking south, in SE NE SE sec. 7, T. 31 N., R. 36 E., Union County, New Mexico. March 25, 1973.

Figure 22. Closeup view of clastic plug shown in figure 21, looking south, in SE NE SE sec. 7, T. 31 N., R. 36 E., Union County, New Mexico. March 25, 1973.

Mineralogy and Analyses

The major copper minerals in the pods and plugs in the Sheep Pen Sandstone are chalcocite (Cu_2S), malachite ($Cu_2CO_3(OH)_2$), and azurite ($Cu_3(CO_3)_2(OH)_2$). The minerals occur either with cementing agents or along bedding planes and veins. The common cementing agents are hematite (Fe_2O_3), calcite ($CaCO_3$), dolomite ($CaMg(CO_3)_2$), and barite ($BaSO_4$). The major elements aluminum (Al), barium (Ba), calcium (Ca), iron (Fe), magnesium (Mg), and silicon (Si) are found in the clay minerals, sand grains, and cements. The titanium (Ti) content may be greater than 2,000 parts per million (ppm). The manganese (Mn) and strontium (Sr) contents may be as much as 2,000 ppm. Selected hand samples may contain as much as 41.9 percent copper. Silver (Ag), lead (Pb), and zinc (Zn) may run as high as 200 ppm. The molybdenum (Mo) and zirconium (Zr) contents may be as much as 666 ppm. The vanadium (V) content may be as much as 66 ppm. The cobalt (Co), chromium (Cr), and nickel (Ni) contents are less than 20 ppm. A summary of these analyses is given in table 1.

Chalcocite, the main copper mineral, probably formed under reducing conditions. Malachite and azurite are secondary minerals derived from alteration of the chalcocite. The main copper ions probably were carried in solution under oxidizing conditions from weathered Permian red beds that contained copper minerals. Before Exeter time, selected low areas or cracks in the Triassic red beds, or isolated areas of reducing environments, allowed the copper ions to precipitate below the ground-water table. With pre-Exeter subsidence and truncation, the Sheep Pen ground water or connate water probably moved into brecciated areas, and this helped to concentrate the copper mineralization.

TABLE 1.—SPECTROGRAPHIC AND ATOMIC-ABSORPTION ANALYSES OF SELECTED HAND SAMPLES FROM COPPER PROSPECTS IN SHEEP PEN SANDSTONE FROM CIMARRON COUNTY, OKLAHOMA (1–6), BACA COUNTY, COLORADO (7–8), AND UNION COUNTY, NEW MEXICO (9–11)

Sample Number	Ag	Al	Ba	Ca	Co	Cr	Cu	Fe	Mg	Mn	Mo	Ni	Pb	Si	Sr	Ti	V	Zn	Zr
1	<20	M	—	M	—	—	>2000 1.64%	>2000	>2000	66–200	<20	—	<.01%	M	200–666	>2000	<20	<200 <.01%	—
2	66–200	M	—	>2000	—	<20	M 27.4%	M	>2000	20–66	<20	—	—	M	B	666–2000	20–66	<200	—
3	<20	M	—	>2000	—	<20	M 41.9%	>2000	>2000	20–66	<20	—	—	M	B	>2000	<20	<200	—
4	<20	M	—	M	—	<20	M 11.5%	>2000	>2000	66–200	<20	<20	—	M	B	>2000	<20	<200	—
5	20–66	M	>2000	>2000	<20	—	M 29.2%	>2000	>2000	<20	<20	—	—	M	B	666–2000	<20	<200	—
6	—	M	—	666–2000	—	<20	>2000 0.55%	>2000	>2000	66–200	<20	—	66–200	M	B	666–2000	20–66	<200	—
7	<20	M	—	>2000	—	—	M 7.78%	>2000	>2000	<20	—	—	—	M	B	666–2000	<20	<200	—
8	—	M	—	M	—	<20	200–666	>2000	M	666–2000	—	<20	—	M	>2000	>2000	<20	<200	200–666
9	<20	M	—	666–2000	<20	<20	>2000 2.82%	>2000	>2000	20–66	—	<20	—	M	B	666–2000	<20	<200	<20
10	20–66	M	—	666–2000	<20	<20	M 24.3%	M	200–666	—	20–66	<20	—	M	B	>2000	<20	<200	20–66
11	<20	M	—	M	—	<20	>2000 1.78%	>2000	M	20–66	<20	<20	—	M	B	666–2000	<20	<200	20–66

B, background; *M*, major percentage. Analyses expressed in parts per million or percentage.

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(**Boldface** numbers indicate main references; parentheses indicate page numbers of figures; brackets indicate page number of table)