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GEOLOGICAL SURVEY

GEOLOGY AND ORE DEPOSITS

OF THE

ALLAMOORE-VAN HORN COPPER DISTRICT

HUDSPETH AND CULBERSON COUNTIES, TEXAS

BY

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By R. D. Sample and E. E. Gould

ABSTRACT

The Allamoore-Van Horn mining district is in southeastern Hudspeth and southwestern Culberson Counties, Tex. It is a part of an area of pre-Cambrian sedimentary formations along the southern and eastern flanks of the Sierra Diablo. It is from 5 to 10 miles northeast of Allamoore, which is on the Texas and Pacific Railroad. The average altitude is about 4,900 feet, and the semiarid climate is suitable for year-round operations.

The district has produced silver and copper ore sporadically since its discovery in 1880. The ore deposits are in fissure veins and in pinching and swelling lenses along altered and crushed fault zones. Silver and copper ore usually occur together. Copper sulfides and carbonates which impregnate favorable bands in the crushed zones are the principal copper minerals. There is only slight dissemination of the copper minerals into the surrounding sandstones. The average copper content of the ore shipped is from 2 to 4 percent. It is a siliceous ore, but commands no premium as a flux.

Approximately two cars per week are shipped from the Black Shaft and St. Elmo mines to the El Paso smelter. Other mines in the district are idle, and, in general, inaccessible.

No recommendations for further prospecting by drilling or trenching are made at this time. Future recommendations should be governed by additional data from the now inaccessible workings or from new prospects. Surface indications of ore are exceedingly meager and misleading.

INTRODUCTION

The Allamoore-Van Horn mining district occupies an irregular, northeast-southwest-trending area of about 30 square miles along the southern and eastern perimeters of the Sierra Diablo in Hudspeth and Culberson Counties of trans-Pecos, Texas. Most of the district is confined to the broad, rolling area between the Sierra Diablo proper and the Beach-Baylor Mountains (fig. 1). It is 15 to 20 miles northwest

of Van Horn, Texas and 5 to 15 miles northeast of Allamoore siding, Tex., both of which are on the Texas and Pacific Railroad and U. S. Highway No. 80. Good dirt and gravel roads connect the district with these shipping points. The smelter at El Paso is 110 miles west of Allamoore.

The north-south boundary line between Hudspeth and Culberson Counties divides the district into two parts: the northeastern area in Culberson County includes the Eureka, Pecos, Hazel, and Dallas mines; the southwestern area includes the Mohawk, Sancho Panza, St. Elmo, and Black Shaft mines, as well as numerous small workings and prospects.

Exploration for silver started in the district in the early 1880's, but there is very little reliable information for this period. The Hazel mine, one of the earliest discoveries, is supposed to have produced over a million dollars in silver and copper. Mining activity has been sporadic and the periods of activity coincide with favorable prices for silver and copper. According to Glen L. Evans, [1]

1/ Evans, G. L., Progress report on copper investigation: Texas University Bur. Econ. Geol. Mineral Resources Circ., No. 24, p. 1 1943.

"The district has been responsible for the only important production of copper in Texas to date, and has also produced substantial quantities of silver". W. H. von Steeruwitz, [2] who studied the district

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2/ Steeruwitz, W. H. von, Trans-Pecos, Texas: Tex. Geol. Survey, 3d Ann. Rep., 1891.

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in 1890, shows in his report that there was some mining activity at that time around the Hazel, Sancho Panza, and Black Shaft mine areas. Among others who have studied and reported on the district are G. B. Richardson 3/ and P. B. King. 4/

3/ Richardson, G. B., Description of the Van Horn quadrangle: U. S. Geol. Survey Geol. Atlas, Van Horn folio, (no. 194), 1914.

4/ King, P. B., Older rocks of the Van Horn region, Tex.: Am. Assoc. Petroleum Geologists Bull., vol. 24, 1940; Sierra Diablo region, Hudspeth and Culberson Counties, Tex.: U. S. Geol. Survey Oil and gas investigations Prelim. Map 2, 1944.

The average elevation of the district is about 4,900 feet; the semiarid climate is favorable for year-round operations. Because the annual rainfall is only 8 inches, there are no permanent streams and water must be obtained from deep wells, springs, or mine seeps. Vegetation is of the desert type; timber for mining and construction must be shipped in at considerable expense. The nearest electrical power is at Van Horn.

Field work upon which this report is based was done between April and June 1944 by R. D. Sample and E. E. Gould. Surface mapping was done by plane table, the underground mapping by compass and tape.

The purpose of this investigation was to determine the status of the submarginal copper deposits in the district, and to recommend favorable areas for detailed exploration by the U. S. Bureau of Mines.

Acknowledgment and thanks are here given to the operators and mine owners for their cooperation. Mr. M. F. Drunzer was especially

generous with past records and mining data on the Black Shaft and Sancho Panza mines.

GEOLOGY

Rock formations exposed in the district range in age from pre-Cambrian to Permian, and are covered in many places by recent alluvium. Most of the copper deposits are confined to the pre-Cambrian sedimentary and igneous rocks, which are exposed in the broad, rolling area between the mountain blocks of younger sedimentary rocks of the Sierra Diablo and the Beach-Baylor Mountains. The pre-Cambrian sedimentary formations are only slightly metamorphosed in spite of widespread diastrophic and igneous activity during pre-Cambrian and later periods. The pre-Cambrian complex was described by Richardson in 1914 as the Millican formation. Later, King subdivided the formation into the Allamoore limestone and the Hazel sandstone. The following table is a brief summary of the subdivisions of the older rocks in the district:

Richardson, G. B. Van Horn Folio 1914	King, P. B. Bull. Am. Assoc. Petroleum Geologists, 1940	Age of rocks
El Paso limestone	El Paso limestone	Lower Ordovician
Van Horn sandstone	Bliss sandstone	
	Van Horn sandstone	Cambrian or pre-Cambrian
Millican formation	Hazel sandstone	Pre-Cambrian
	Allamoore limestone	

The Allamoore limestone consists of relatively thin-bedded varicolored limestone with narrow streaks of chert, the chert appearing on weathered surfaces as angular nodules and fine ribbons. The limestone beds have been marmorized or replaced by silica, and are very resistant to erosion. Intercalated between the siliceous and limy layers are masses of intrusive and extrusive diabasic rocks. Some of these igneous masses are contemporaneous with the limestone, but others appear to be younger; all are highly silicified.

The Allamoore limestone predominates in the southwestern part of the district where the steeply dipping beds form high, narrow, ragged ridges. Large fragments of the limestone and the volcanic rocks are present in the conglomerate layers of the Hazel sandstone. The limestone and volcanic rocks are, therefore, older than the sandstones. In places, however, limestone masses now rest on top of the younger Hazel sandstone. This reversal of stratigraphic position indicates thrusting of older over younger rocks.

The Hazel sandstone is the most widespread formation in the mineralized belt. The maroon-colored sandstone is compact, well sorted, and fine-grained. Fracturing and jointing obscure bedding planes; dips and strikes are difficult to determine. Much of the outcrop area is covered with fine, weathered rock fragments. Near the contact with the Allamoore limestone, the Hazel sandstone is characterized by conglomerate beds as much as 20 feet thick across the outcrop; to the north and near the Hazel mine the conglomerates are absent.

In the southern part of the district, both the Allamoore limestone and the Hazel sandstone are greatly distorted by intense folding, faulting, and igneous activity; toward the north the folding in the Allamoore limestone fades out, and the dips in the Hazel sandstone finally disappears with a slight inclination to the north under the Permian escarpment. Along the distorted belt to the south, isoclinal folding and thrust faulting form complicated structures which are very difficult to interpret. The Sancho Panza, St. Elmo, and Black Shaft mines, which have produced most of the copper in the southern part of the district, lie in one of these distorted, faulted zones. This broadly curved, distorted, crushed, and partially mineralized zone may be traced by sporadic outcrops from the Sancho Panza No. 1 to the Black Shaft mine, a distance of about 1½ miles (see pl. 1). Apparently the thrust plate has been completely overturned in some places, as shown in section B-B', plate 1. The zone pinches and swells both along the strike and down dip, and the dip varies from nearly horizontal to vertical. The outcrop of this zone is about 5 feet wide at the Black Shaft mine, where the zone dips about 70° N. Because of the flattening and undulations of the zone near the Sancho Panza, scattered exposures can be traced for over 1,000 feet across the strike (see pl. 1). In this area the zone varies in dip from almost flat to 10° to 20° NE. In general, the undulating fault plane follows the bedding planes of the Hazel sandstone, but in places it cuts across it at various angles. Much of the flat-lying part of the fault zone between the St. Elmo and Sancho Panza

has been removed by erosion. A number of later cross sheers cut the zone, and at the Black Shaft mine the zone is offset to the north from 10 to 15 feet (pl. 2).

Mines and prospects in the northeastern part of the district are on nearly vertical faults and fractures which cut the gently dipping beds of the Hazel sandstone. The vertical fracture at the old Dallas prospect extends upward into the Van Horn, Bliss, and El Paso formations. Some of these mineralized structures converge to form richer ore bodies, as at the Hazel mine.

ORE DEPOSITS

The mineralized bodies in the southwestern area are associated with the crushed zones of intense folding and faulting. The principal zone is the one on which the Sancho Panza, St. Elmo, and Black Shaft mines are located. In this zone the richest copper ore is in black, coal-like gouge between the crushed, schistose layers. This black, shaly gouge varies in thickness from a thin seam to 10 feet or more in some of the lenses. In places it fills the zone from wall to wall, but thins rapidly within a few feet. This black layer is the one most sought for by the miners, as it is the richest in copper sulfides; values decrease gradually away from it into the enclosing schistose layers. The rich layers usually lie near the firm, smooth hanging wall of the slightly altered Hazel sandstone and the values decrease gradually towards the irregular and less definite footwall. Disseminated copper minerals are rare in the country rocks. The

lense-like shape of the ore bodies is probably due to movement along the undulating fault plane. Movement probably tended to open certain portions of the zone; the soft gouge was squeezed into the more open portions which in turn formed channels for the circulation of mineralizing solutions. Apparently, the soft gouge was more favorable for replacement and precipitation of copper minerals than the hard, compact sandstone country rock. Much of the gouge assays more than 6 percent copper, but in mining its grade is reduced by admixture with low-grade, crushed and schistose rock.

The ore bodies in the northeastern part of the district are in vertical fissure veins. These veins also pinch and swell from narrow seams to veins 20 feet in width. They carry copper and silver sulfides with considerable amounts of barite and some calcite gangue. According to some reports, the veins at the Hazel mine branch upward, and converge at depth (see pl. 3). A number of veins were found at depth that do not appear at the surface. At a few places in the Hazel mine, chalcocite (Cu_2S) is disseminated in the surrounding sandstones for a few feet, but these spots are not numerous and the mineralization is rather weak.

A memorandum report by S. G. Lasky states,[5/]

5/ Lasky, S. G., Memorandum for P. B. King: U. S. Geol. Survey, October 28, 1938.

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*The principal mineral at the Black Shaft mine is bornite.

"At the Hazel mine the principal mineral--the steely mineral so common as fine threads in the bleached rock--is tennantite, as determined by distinctive microchemical tests for arsenic and copper. Pyrite, galena, and traces of borrite are present."

However, chalcocite may in places be the principal ore mineral. Mrs. Medora H. Krieger of the Geological Survey, who examined thin and polished sections of a specimen of black gouge from the Black Shaft mine, states 6/ as follows:

6/ Personal communication.

"The sulfide mineral is chalcocite. This determination was made by means of etch tests. No other sulfides were found on the one polished surface examined. Most of the chalcocite occurs in veinlets cutting across the rock structure. Brief examination of a thin section showed quartz veinlets, many of which cut across the structure of the rock. Associated with the quartz veinlets are tiny grains of a mineral of lower index than the quartz which are probably feldspar..... Some of the chalcocite occurs in the center of quartz veinlets, but other veinlets are not associated with quartz..... The main mass of the rocks is a black fine aggregate of dust-like particles with occasional small angular quartz grains."

Several rock specimens from the Sancho Panza workings were examined petrographically by Clarence S. Ross of the U. S. Geological Survey.

Ross states that: "Specimens 1, 2, 3, and 5 all show evidence of closely spaced crushed zones. These rocks have been thoroughly replaced by quartz and calcite, and there is abundant apatite in No. 3 and possibly in the others. Replacement is so thorough that the nature of the original rock is somewhat problematical. However, there is no evidence of volcanic tuffs or other igenous rocks.....

"Specimen No. 4 is igneous, being a diabasic rock that has been very thoroughly altered to calcite and chlorite."

Specimen No. 4 was taken from a conspicuous outcrop of igneous rock in the faulted zone near the Sancho Panza workings (pl. 1). Whether this rock mass, which contains noticeable grains of specular hematite is of the same age as the igneous masses in the older Allamoore limestone is not clear. It may be an igneous injection along the fault zone and of Tertiary age. Tertiary intrusive rocks are known to occur 30 to 40 miles to the north and west, and the geologic map of Texas shows scattered patches of Tertiary rocks throughout the general region.

ORIGIN

The origin of the copper mineralization is problematical, but it seems to have been derived from deep seated solutions which rose along fracture and fault zones to the overlying sedimentary rocks. These zones of weakness probably formed in pre-Cambrian time but there

is evidence of late movement along the zones. Postmineral fault movement and ground water have slightly altered some of the deposits. Mineralized areas in the general region occur in formations of pre-Cambrian to Cretaceous age. Igneous activity in early Tertiary times may be the source of the copper in the district.

RESERVES

Structures which localize the ore bodies are usually poorly exposed. Many of the old workings in the district are inaccessible, and the numerous shallow prospects give very little evidence as to conditions at depth. From the accessible underground workings and available surface exposures, it is known that the structures change rapidly in attitude, and that the ore bodies change in thickness and mineral content. All evidence indicates that the ore bodies are in the form of lenses or pods along favorable structures and cannot be considered as blanket deposits over a wide area. The thinning and thickening of the ore bodies cannot be predicted; they cannot be projected for any distance. Therefore, an estimate of the ore reserves of the district as a whole must be based on the reserves estimated for the individual mines.

In the Black Shaft mine, the best ore was obtained from a zone extending 100 feet west and 300 feet east of the main inclined shaft. The west drift on the second level exposed about 10 feet of black gouge which extends along the bottom of the drift for almost 100 feet. The walls are firm and hard, and it seems probable that the structure and the ore body will continue downward for a short

distance. Assuming this downward extension, a reserve of 2,000 tons of 3 to 4 percent copper ore might be inferred west of the shaft for every 20 feet of depth. Recent extension of the main shaft shows that although the structure continues for about 50 feet, the ore body, at least along the shaft, pinches out at about 20 feet. The same condition might be inferred for the east drift on the second level, although the ore body here is not so thick on the bottom of the drift and may possibly pinch out against a cross fault (pl. 2).

Present production is from the area east of the main shaft, and between the first level and the surface where pillars are being robbed. Two small inclined shafts, east of the main shaft, have been started from the surface. Probably another 1,000 tons of 2 to 3 percent copper ore can be obtained from this area.

Operations at the St. Elmo are comparatively recent and only about 500 tons of ore with an average copper content of less than 2½ percent has been shipped. In mining, the operators have followed the best ore streaks along the distorted zone, working out the best ore pockets. The ore lens appears to be about worked out towards the southeast, and any great extension to the northwest is doubtful. An additional 500 tons of less than 2½ percent copper might be inferred from this mine.

The scattered, shallow pits in the Sancho Panza area show irregular patches of copper ore, but no indication of a continuous body. In the large open pit to the south, 4 or 5 feet of ore is

exposed along the north wall and appears to be taking a steep roll downward (sec. A-A', pl. 1). If this roll continues another 20 feet, about 1,000 tons of 2 to 3 percent copper could be inferred. Underground mining along the east wall of this pit was discontinued when the copper assays began to run less than 2½ percent. This lens of ore along the east wall will probably yield at least another 1,000 tons of 2½ percent ore before pinching out.

At the Hazel mine only a few tons of ore remains in the old pillars and stopes between the second level and the surface. According to reports, there is considerable stoping ground below the fifth level, and 10,000 tons of 2 or 3 percent copper ore is said to be already broken and ready for shipment. This report cannot be confirmed because of mine flooding, and the broken ore therefore can be considered only as an inferred reserve. Recent unwatering of the mine below the fourth level has revealed more stoping area between the fourth and second levels. A total of 1,000 tons of 2 to 3 percent copper ore is indicated in this unstoped area.

The other prospects and workings in the district reveal so little that estimates of present reserves are difficult. Perhaps not over 1,000 tons of unknown grade can be inferred from them at the present time.

A summary of the reserves in the district for present information is as follows:

Mine	Indicated ore (tons)	Inferred ore (tons)	Grade (percent)
Black Shaft	1,000	5,000	2½-3
St. Elmo		500	2½
Sancho Panza	100	2,000	2½-3
Hazel	1,000	10,000	2-3
Others		1,000	2-3
Total	2,100	18,500	2½

OUTLOOK

The present outlook for substantial copper production from the district is not promising. Investigations to April 1945 indicate that the ore is low in grade and occurs in lenticular bodies which cannot be predicted from surface exposures or underground workings. Following the mineralized zone underground seems to be the only sure method of staying in ore. Pinching, swelling, and cross-shearing in many places complicate exploration.

M. F. Drunzer, operator of the Black Shaft mine, is prospecting some small veins south of the Black Shaft, which, according to assays, show promise of producing considerable amounts of silver with a fair amount of copper. However, these veins are narrow and unless they widen downward, mining at depth will not be profitable. Assays from

the surface workings show 200 ounces per ton of silver and 8 to 10 percent copper from a 6-inch width of vein. Tom Suttlemeyer, owner of the Eureka mine, has begun exploration work on his property and expects to deepen the old shaft.

Small-scale production may be expected to continue for some time. It is unlikely that any bonus will be paid for the silica content. At the present time, the price of copper and cost of production are not in favorable balance, and until such a balance can be obtained, there will be very little of the lower grades of copper ore mined. From present information, the possibilities of finding any large deposits are unfavorable.

RECOMMENDATIONS

Unless the present and future workings in the district afford more geological data which would disprove the present conception that the copper ores occur as scattered, comparatively low grade lenses, no exploration program is recommended. There is no sound reason, from the geological information available, to believe that the district has any substantial copper reserves.

The most favorable areas for exploration seem to be: first, the vicinity of the Black Shaft mine to determine how deep the present mineralized zone continues below the lower workings; second, the areas around both the St. Elmo and Sancho Panza workings to determine the extensions of the several lenses. No recommendations can be made for the Hazel mine area until the mine is accessible and can be examined.

From the present information, the area between the east and west shafts at or below the fourth level might merit some consideration.

It would be desirable to keep informed of any new developments or activities within the region. Additional investigation by the Survey would be justified only if this information indicates substantial extensions of the known deposits.

MINES

Black Shaft mine.--The Black Shaft mine is in sec. 25, block 66, T. 7, of Hudspeth County, Tex. It lies near the eastern border of the county and on the principal mineralized and crushed zone in the district. The outcrop of the schistose zone is about 5 feet wide at the main shaft and strikes N. 70° E. with a dip of about 70° N. (pl. 2). From the surface an inclined shaft follows the zone for about 80 feet at a 70° dip to the first level, then flattens to 50° for 55 feet to the second level. The shaft then continues at about the same dip for 60 feet to the third level, which is the lowest level in the mine. Drifts have been run in the zone on both sides of the shaft for several hundred feet at the first and second levels, as is shown in plate 2. On the third level, drifting extends only 50 feet to the west. Between the first level and the surface, a few short drifts extend along the zone from the shaft. The hanging wall of the zone is a firm, strong, smooth plane in most places and forms the roof of the drifts. The richest ore, the black gouge, usually follows this firm wall, and most of the stoping is against the hanging wall. The

footwall is much less regular and less definite. In many places the footwall part of the vein contains large blocks of barren Hazel sandstone which are left as pillars in selective mining.

In the west drift on the second level, the fault zone is made up largely of black gouge to a thickness of more than 15 feet for a distance of 100 feet. Stoping in this part of the zone was from wall to wall, but 100 feet farther west the zone pinches to a few inches and the black gouge practically disappears. Along the east drift on the same level, the ore zone follows the hanging wall which is almost a smooth plane. The footwall in this area weaves in and out causing the crushed zone and gouge to thin and thicken from a few inches to more than 10 feet. At about 500 feet from the shaft the mineralization is very weak and drifting was discontinued. The mineralized zone might possibly open again if followed. The richest ore shoots have already been stoped from the second to the first level, and the available ore above the first level will soon be depleted unless the results of the new development work on the surface east of the shaft prove favorable.

The mineralized zone can be traced eastward from the Black Shaft incline for almost 800 feet; then it disappears in a dry wash and is not known to reappear. Near the eastern end of the mineralized zone an incline shaft follows the zone down dip for about 90 feet. The lower 20 feet is filled with water and the upper 70 feet shows only weak copper sulfide and carbonate mineralization in thin stringers in the schist. There are fair indications that some ore may be between this eastern incline and the main shaft.

West of the main Black Shaft incline, the crushed zone can be traced to the alluvium along Hackberry wash; beyond this point it appears only at scattered points until it reaches the vicinity of the St. Elmo mine. At one of these points there is a shallow incline which shows some very patchy and low-grade copper mineralization. Smaller prospects and pits are scattered between this incline and the St. Elmo but none shows promise of development.

The mine is operated by M. F. Drunzer of Van Horn, who has shipped about 60 carloads of sulfide ore to the El Paso smelter since the first of 1944. Shipments continue at the rate of about two carloads per week with an average copper content of 3 to 4 percent. Mr. Drunzer receives a special premium of 8 cents per pound of copper in addition to the regular premium of 5 cents per pound. Without these bonuses the mine would not be able to continue in operation.

An average analysis from the smelter sheets of ore shipped to the El Paso smelter shows the following:

Silver	0.2 oz. per ton	Lime	9.0 %
Copper	3.20 %	Zinc	.1 %
Insoluble	65.0 %	Sulfur	.5 %
Silica	54.2 %	Alumina	10.1 %
Iron	1.3 %	Arsenic	.10%

Although the ore is siliceous and is good smelting ore, it is not high enough in silica to command a premium. The smelting charges are $3.50 per ton; freight is slightly less than $1.00 per ton; and trucking cost from the mine to the shipping point at Allamoore is $1.75 per ton.

Hazel mine.--The Hazel mine is in sec. 14, block 66, T. 7, in Culberson County, Tex. It is owned by the Hazel Mine & Milling Co. of Dallas, Tex., as a patented section. The mine is one of the oldest and most productive mines in the district, although it has been idle for over a year. The present lessor, A. P. Williams of Van Horn, has started unwatering the mine and cleaning the drifts. A few tons of low-grade copper ore from some of the old pillars has been shipped.

The main workings are along an almost vertical, east-west fissure vein in the Hazel sandstone. This vein has a width of about 3 feet at the surface and cuts across the slightly northward-dipping beds of the Hazel sandstone. Several veins converge about 400 feet west of the main shaft to form most of the richer ore of the mine. This was mined by a large glory hole. Development of the main vein was from a vertical two-compartment shaft, which is reported to be over 700 feet in depth with levels about every 50 feet. Water now floods the mine to the fourth level, about 225 feet below the collar of the shaft (pl. 3). The main vein, and also a branching vein a short distance to the north, are stoped from the second level almost to the surface except for a few supporting pillars. The fourth, fifth, and sixth levels are apparently the only levels left with stoping ground. At these lower levels, according to reports and old maps, the main vein and branching north vein converge to form an ore body 25 feet wide, from which at least 10,000 tons of ore is said to remain broken in the stopes. The best ore seems to have come from the old glory hole to the west.

Copper occurs as sulfides and carbonates with appreciable amounts of silver. The minerals are confined almost entirely to the fracture zone; only in a few places have the mineralizing solutions penetrated into the surrounding Hazel sandstone. The principal gangue mineral is barite with some calcite.

The mine is said to have been in continuous operation from the time of its discovery in the early 1880's until 1895. 1/ During that

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1/ Information on early history from interviews with M. F. Drunzer, Tom Suttlemeyer, and A. P. Williams, all of Van Horn, Tex.

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time 80,000 tons of high-grade silver and copper ore was produced. Since 1895 intermittent operations have been carried on by several operators. A 100-ton mill was built in 1930, but closed down after a few months because of lack of water. M. F. Drunzer shipped 13,000 tons from the old dump in 1926-27; this material averaged 9 ounces of silver per ton and 0.5 percent copper. In 1938 A. P. Williams, the present lessor, produced from underground workings 5,000 tons of ore averaging 3½ to 4 percent copper. No premium was paid on the silica content.

The veins from which the ore was produced are not particularly conspicuous at the surface. They appear as narrow fractured bands of leached Hazel sandstone with tiny seams of barite and scattered particles of calcite. Apparently, these surface expressions are only the upward extensions of a much larger vein system below ground. Some of the veins which have considerable amounts of ore at depth do not show at the surface. This characteristic might be taken as a favorable

indication of increased ore deposition at depth. However, assay maps made by the World Exploration Co., a former lessee, show that the ore at depth is low in grade.

St. Elmo mine.--The St. Elmo mine is in sec. 13, block 67, in Hudspeth County, Tex. It is about half a mile west of the Black Shaft mine, and on the same crushed and contorted zone (pl. 1). It is operated by John Heath and Lewis Stumberg of Van Horn, who unwatered the 30-foot vertical shaft and the short crosscut leading to lenses of low-grade ore in the fault zone. The copper ore is similar to the Black Shaft ore but consistently lower in grade. The average copper content of the 10 cars shipped to date is less than 2½ percent. This is below the economic cut-off grade, and it is doubtful if the mine can continue operations long unless a better grade of ore is found.

Sancho Panza mine.--The old Sancho Panza workings are in sec. 13, block 67, in Hudspeth County, Tex. The numerous pits lie on the northwestern extremity of the fault zone which swings north from the St. Elmo and Black Shaft mines. It has been operated mostly by open pit methods, but is now idle. The beds in the crushed zone have a more gentle dip than those to the southwest. They vary in dip from almost horizontal to 30° NE. The mineralized areas are confined to irregular, distorted lenses of siliceous lime rocks with many large seams and stringers of calcite. Many large patches of igneous rocks occur in this area along the crushed zone. Most of the copper appears to be in the form of carbonates which coat and impregnate

the siliceous lime rocks. Considerable amounts of silver are also reported. M. F. Drunzer shipped several carloads from the old dumps which averaged 12 ounces per ton in silver but only 1 to 2 percent in copper. The average grade of copper from both the open pits and underground is said to be about 2½ percent.

The hanging wall in the underground workings is very pronounced and firm. The mineralized zone dips gently to the northeast where it appears to pinch out in the gully bank. The lens of low-grade ore under the hanging wall also appears to pinch out to the northeast.

FIGURE 1