STATE OF ARKANSAS

Arkansas Geological Commission

Norman F. Williams, State Geologist

INFORMATION CIRCULAR 24

ANTIMONY DISTRICT OF SOUTHWEST ARKANSAS

by

J. Michael Howard

Little Rock, Arkansas

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CONTENTS

ILLUSTRATIONS

Page

Figure

FIG. 1- PHYSIOGRAPHIC DIVISIONS AND EXTENT OF ANTIMONY DISTRICT IN SOUTHWEST ARKANSAS

ANTIMONY DISTRICT OF SOUTHWEST ARKANSAS

J. Michael Howard

ABSTRACT

The antimony district of southwest Arkansas is a belt 2.5 miles wide and 11 miles long extending east-northeast across northern Sevier County. Located within the district are ten abandoned mines and thirteen prospects. The antimony deposits occur wholly within the Stanley Shale (Late Mississippian) which in this area is largely shale with minor beds of siliceous shale and sandstone. The Stanley rocks are tightly folded and steeply dipping and the fissure veins of the deposits tend to follow rather than cross the bedding. Geologic mapping in the district led to the recognition of several previously unreported faults, including a major low angle thrust fault, designated as the Hurricane Creek Decollement. The rocks in the overriding sheet are units of the upper Stanley Shale and the rocks beneath the decollement are units of the middle and lower Stanley Shale. The orebodies are small, lenticular, and subject to pinching and swelling. The maximum length of the stibnite zone at any of the mines was 75 feet. Maximum width of stibnite zones was 52 inches, and one lens contained stibnite to a depth of at least 170 feet. The orebodies are essentially stibnite-bearing quartz veins in which crystals and crystal masses of stibnite are deposited in comb quartz. Other primary minerals are chalcopyrite, galena, pyrite, sphalerite, tetrahedrite, arsenopyrite, jamesonite, zinkenite, wurtzite, pyrrhotite, bournonite, fuloppite, semseyite and meneghinite(?). Of these, only galena, sphalerite and pyrite occur throughout the district. Secondary minerals are stibiconite, valentinite, cervantite, bindheimite, limonite-goethite, azurite, malachite, anglesite, cerussite and hydrozincite; of which, stibiconite is the most abundant. The antimony mineralization occurred during minor quartz deposition after the major volume of quartz veins in the district had been emplaced. Stibnite and other primary minerals were deposited from hypogene solutions which rose along thrust faults, and in sub-parallel fractures in adjacent fault blocks. It is thought that the mineralization is Permian-Triassic(?) in age and represents metamorphically mobilized constituents of Lower Paleozoic formation waters. Production of antimony ore from the district has been sporadic since it has generally coincided with periods of exceptionally high market metal prices. Although mining ranged over the period 1873-1947, the total estimated production of antimony ore from the district is only 5400 tons.

INTRODUCTION

The antimony district of southwest Arkansas occurs in a belt 2.5 miles wide and 11 miles long extending east-northeast across northern Sevier County (Fig. 1). Other minor occurrences of antimony mineralization have been noted to the east in Pike and Clark Counties (R. B. Stroud and others, 1969). Investigations of the antimony district have been from surface showings and trends of known veins. Since the decline in activity in the antimony district at the close of World War II, little information has been developed on the district. The writer appreciates the help of staff members of the Arkansas Geology Commission, particularly the guidance of Benjamin F. Clardy to mine locations and Charles G. Stone for many helpful discussions. Boyd R. Haley and C. G. Stone mapped the structure.

The purpose of this report is to publish a geologic map which would provide a basis for organized prospecting of the area, accurately locate the mines and prospects on the geologic map, and give a description of mines and prospects in the district.

HISTORY OF DISTRICT

Since the original discovery of stibnite (Sb_2S_3) by Robert Wolf in the winter of 1873-74, mining and exploration activity in the antimony district have been intermittent. Periods of activity include 1874-1888, 1902-1903, 1916 and 1937-47 (Fig. 2A). The major producing mines, the Otto and May, have been operated during nearly all these periods. Eight to ten mines have been opened and produced briefly. Production stopped abruptly in 1889 because of the declining price of antimony metal (Fig. 2B). In 1917 the price of metal increased sharply and the last major production in the district took place. Some activity at the May mine and the opening of the Harrell mines occurred since 1943, but there are no records of production. Although the price of antimony metal soared in 1969, no subsequent mining has been reported.

Mining has not reached depths greater than 170 feet in the district due to the unpredictability of ore prices (Fig. 2) and problems of drainage. From available data, the ore bodies have the potential of extending to some significant depth.

Descriptions of the mines, production data, and other information are taken from previous publications, Arkansas Geological Commission files, and unpublished master's theses.

F. L. Hess (1908), U. S. Geological Survey Bulletin 340-D, *The Arkansas Antimony Deposits* and R. B. Hall's thesis (1940), *Stibnite Deposits of Sevier County, Arkansas,* are the two most comprehensive works on the district. Other publications and reports on mines and prospects in the district are listed in the selected bibliography.

FIELD METHODS OF PRESENT INVESTIGATION

Previous literature was reviewed and a list of locations compiled. Examination of the mineralized area occupied the winter of 1974-1975 and spring of 1975 when vegetation cover was minimal. Search for the prospects began with the westernmost location, the Lignitz prospect, and proceeded northeastward across the district to northeast Sevier County. Recorded observations included a description of visible workings, type of mineralization, and county rock. At this time, hand samples were collected for microscopic examination.

Upon completion of field work on the mines and prospects, geographic boundaries for a geologic map were determined. Seven and one-half minute topographic quadrangle maps were available for the district. The geologic map included in this report was prepared initially from aerial photographs by Boyd R. Haley of the U. S. Geological Survey. Boyd R. Haley, Charles G. Stone, Benjamin F. Clardy and the author visited the area to field check the original mapping.

GEOGRAPHY

Location

The antimony district in southwest Arkansas lies in the Athens Plateau province of the Ouachita Mountain Region (Fig. 1). The westernmost occurrences of antimony known in the district are in section 26, T. 7 S., R. 32 W. and the easternmost occurrences are in section 4, T. 7 S., R. 30 W. Occurrences of stibnite have been recorded in Pike County in the mercury district and in Clark County; but since no production has been reported, these locations are not discussed in this report.

Culture

Gillham, population 200, is in the north center of the district. The small community of King is situated approximately 2 miles southeast of Gillham. Nine miles south of Gillham is DeQueen, population 4,083, the county seat of Sevier County.

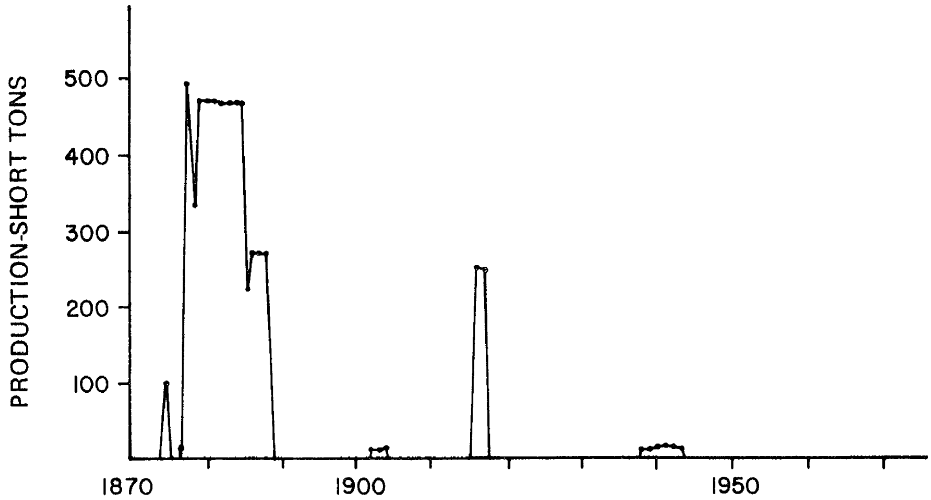

FIG. 2A- PRODUCTION-ARKANSAS ANTIMONY DISTRICT
(ARK. GEOL. COMM., ON FILE DATA)

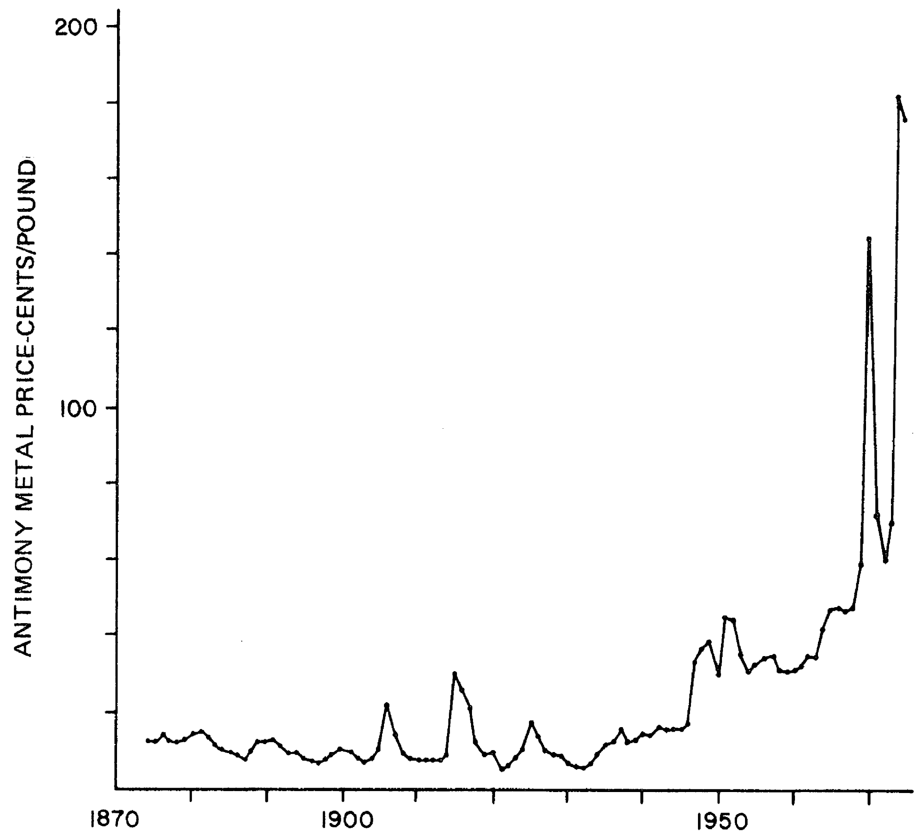

FIG. 2B- MARKET PRICE OF ANTIMONY METAL (U. S. B. M. DATA)

The Kansas City Southern Railway crosses the district through Gillham and King south to DeQueen and Texarkana. Most of the mines and prospects have some type of roads or trails leading to the old workings. Interstate Highway I-30 is sixty miles to the south. Arkansas Highway 390 trends east west across the district. U. S. Highway 71 crosses the district north-south. Dirt and gravel roads, both county and private, are plentiful throughout the district, and are generally passable both when wet and dry. Most creeks and streams are crossed by low water bridges.

The climate is moderate with little or no snow. Average yearly rainfall is about 50 inches. Tree farming and cattle ranches constitute the major industries.

Drainage

Ridges in the district trend east to east-northeast and are separated by narrow valleys in which a trellis drainage pattern is developed. The Cossatot River flows south across the district cutting gaps through the ridges. Tributary streams generally trend east-west (Plate 1).

GEOLOGY

General Features

Rocks exposed in the antimony district are all of sedimentary origin and include the Mississippian and Quaternary Systems. The Paleozoic rocks consist of steeply dipping beds of sandstone, siltstone, shale, and siliceous shale, which have been folded and faulted by compressive forces from the south during Pennsylvanian time (Miser and Purdue, 1929). Quaternary rocks occur as small patches of alluvium less than 15 feet thick.

Structure

Rock of the lower and middle Stanley Shale is folded and faulted into east-west trending structures. General orientation of folds indicates major pressure was in a northward direction. However, the rocks exposed in the undersheet of the decollement in section 9 and 10, T. 7 S., R. 30 W. are overturned to the south. Plunge directions of the folds trend from east or west to northeast or southwest respectively. East-west trending high-angle reverse faults cut the rocks and a number of relatively minor cross faults are present. A series of folded low-angle reverse faults separates the rocks in the upper part of the Stanley Shale from those in the middle and lower part. These low-angle thrust faults represent the Hurricane Creek decollement (Howard, 1979)*. Rocks in the upper part of the Stanley Shale are folded into a series of major east-west trending structures, predominately large synclines. High angle reverse faults and accompanying cross faults are present but they are not as common as they are in the lower and middle Stanley Shale rocks.

While there is the appearance of two separate structural episodes of deformation with the high angle faults representing an early stage and the decollement a later stage, it is most likely that these were concurrent and related events. The more competent (upper Stanley) strata enhanced one style of deformation and the less competent (lower and middle Stanley) expressed another style of deformation.

Stratigraphy

In the Gillham area the Stanley Shale consists of beds of shale intercalcated with subordinate beds of sandstone. The fresh shale is dark gray, almost black, has a shiny luster, and a platy fracture along the bedding. Some of the shale shows development of slaty cleavage. Certain shale samples are banded and consist of arenaceous light brown layers alternating with predominant beds of dark gray shale. The brown laminae are from a featheredge to about one-quarter inch thick and are always thinner than the dark laminae, which are ordinarily more than one inch thick. Locally the shale is cut by numerous quartz veins and veinlets. Many of the veinlets are joint fillings discordant with the bedding, but most of the veinlets are subparallel to bedding.

*Addenda: Howard, J. M., 1979, S.C. GSA Abst.

The sandstones in the Gillham area are so similar in ligthologic characteristics that no single bed has so far been usable as a key horizon. Typically, the fresh rock is dark gray, hard, tough, dense, very fine-grained, and quartzitic. Where slightly weathered it may assume a greenish-gray hue. The sandstone decomposes readily, altering to a gray, light-brown, chocolate, or buff and becomes soft, crumbly, and rather easily eroded. Individual beds are from a fraction of an inch to nearly 125 feet thick, usually being from 4 to 24 inches thick. Intervals of sandstone may be over 100 feet thick. Like the shale the sandstone beds are cut by quartz veinlets, which may form small stockworks in joints and fractures. H. D. Miser and A. H. Purdue (1929) present a detailed stratigraphic description of the Stanley rocks.

Using dark siliceous shales as mappable horizons in Oklahoma, Harlton (1938) elevated the Stanley rocks to group status and divided the group into three formations. The Ten Mile Creek Formation is overlain by the Moyers Formation which is in turn overlain by the Chickasaw Creek Shale. These formations are discussed in detail by Harlton (1938) and Cline and Shelburne (1959).

Dark siliceous shales are present in north Sevier County, but due to poor exposure and the complex structure of the rocks, no correlation has been made over any distance. It is possible that the siliceous shales of the Stanley Shale in the antimony district are equivalent to those siliceous shales of the lower to middle Stanley as described by Harlton (1938).

ORE DEPOSITS

Mineralogy

Deposits of antimony ore may contain a variety of antimony bearing minerals (Fig. 3). However, only stibnite and the antimony oxides are present in enough abundance to be economically important. The author examined hand specimens collected from the tailings piles of the mines and prospects. Mineral identification is complicated due to the small grain size and spotty distribution of many of the minor minerals. The similarity of the many possible sulfosalts and the admixture of the oxidation products do not allow adequate breakdown to mineral species in hand specimens. Detailed chemical and x-ray work is in progress on the mineralogy (Charles Milton, personal communication). Primary sulfides are dominant at depths 40 feet below the surface (Stroud, 1969). Minerals observed and identified by the author are presented in the section on prospects and mines descriptions. The paragenetic diagram (Fig. 3) is complex and complicated by the similarity and rarity of some of the sulfosalts discovered in the antimony district.

The majority of antimony mineralization appears to be deposited along with quartz in previously unmineralized fractures in the shales and sandstones of the Stanley Formation. Some of the copper-lead-zinc-bearing quartz veins in the district were reopened and received antimony mineralization.

Ore Minerals

Stibnite[1)] is the primary ore mineral in the district and occurs as coarse crystalline fillings varying from feather edge to 52 inches in thickness in quartz veins. Comby quartz is associated with the stibnite and quartz crystals have been observed enclosing blebs of stibnite (Stearn, 1935). Numerous doubly terminated quartz crystals are present in many of the stibnite vein fillings. Several hypogene antimony minerals are extremely difficult to distinguish from each other and in some cases from stibnite. These include bournonite, fuloppite, jamesonite, meneghinite(?), semseyite, tetrahedrite, and zinkenite. Of the sulfosalts, only jamesonite is relatively common. These minerals occur either as "feather ores" or as fine grained admixtures. Wait (1880) reported zinkenite at the Stewart mine.

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1) The reader is referred to Figure 3 for chemical composition of the minerals.

Figure 3 — PARAGENETIC DIAGRAM

(revised from Konig and Pittenger, in press)

Mineral	Hypogene	Supergene	*Abundance
Quartz — SiO_2			A
Dickite — $Al_2Si_2O_5(OH)_4$	—		C
Chlorite — $M_{5-6}(Al,Si)_4O_{10}(OH)_8$ where M=Mg, Fe^{+2},Ni,Mn, Fe^{+3},Al,Cr,Li	— — — — — — — — —		C
Cookeite — $LiAl_4(AlSi_3)O_{10}(OH)_8$	?——?		VR
Chalcopyrite — CuFeS	— — —		C
Siderite — $FeCO_3$	—		C
Sphalerite — (Zn,Fe)S	—		C
Galena — PbS	—		C
Pyrite — FeS_2	—		C
Tetrahedrite — $(Cu,Fe)_{12}Sb_4S_{13}$	—		R
Arsenopyrite — FeAsS	—		C
Ankerite — $Ca(Fe,Mg,Mn)(CO_3)_2$	- - —		C
Jamesonite — $Pb_4FeSb_6S_{14}$	—		C
Zinkenite — $Pb_6Sb_{14}S_{27}$	—		R
Stibnite — Sb_2S_3	—		C
Calcite — $CaCO_3$	— - —		C
Wurtzite — (Zn,Fe)S	—		VR
Pyrrhotite — $Fe_{1-x}S$	?---?		R
Bournonite — $PbCuSbS_3$	?---?		R
Fuloppite — $Pb_3Sb_8S_{15}$	—		VR
Meneghinite(?) — $Pb_{13}CuSb_7S_{24}$	—?		VR
Semseyite — $Pb_9Sb_8S_{21}$	?———?		VR
Azurite — $Cu(CO_3)_2(OH)_2$		—	C
Opal — $SiO_2.nH_2O$		—	R
Hydrozincite — $Zn_5(CO_3)_2(OH)_6$		—	R
Malachite — $Cu_2(CO_3)(OH)_2$		—	C
Anglesite — $PbSO_4$		—	R
Cerussite — $PbCO_3$		—	VR
Limonite-goethite — FeO(OH)		—	C
Stibiconite — $SbSb_2O_6(OH)$		—	C
Valentinite — Sb_2O_3		—	VR
Bindheimite — $Pb_2Sb_2O_6(O,OH)$		—	C
Cervantite — $Sb^{+3}Sb^{+5}O_4$		—	R
Smithsonite — $ZnCO_3$		—	R

*A-Abundant; C-Common; R-Rare; VR-Very Rare

Charles Milton (unpublished preliminary data) identified jamesonite at the Davis, Hawkins, Brewer, May, Stewart No. 3 shaft and Valley Mines. Bournonite also occurs at the Stewart and Valley Mines. Milton discovered fuloppite at the Valley, Stewart, and Unnamed No. 4 mines. Meneghenite(?) was reported in polished sections by Pittinger (1974) and occurs as minute grains along cleavage planes in galena (R. H. Konig, personal communication, 1975). Semseyite occurs at the Stewart mine (Milton, preliminary data, 1977).

The supergene alteration of the complex antimony sulfosalts and stibnite resulted in the formation of numerous antimony oxides including stibiconite, valentinite, bindheimite, cervantite and other presently unidentified antimony oxides and complex oxides. Stibiconite and cervantite are most common and occur as powdery, yellow to white, earthy fillings between comby quartz and as greasy yellow to reddish coatings on stibnite. Valentinite occurs as bright yellow orthorhombic plates in coarsely crystalline stibnite at the Antimony Bluff Mine. Other antimony oxides occur intimately intermixed with stibiconite and/or cervantite.

Other Sulphide Minerals

Arsenopyrite occurs as microscopic needles in shale adjacent to the ore-bearing veins. Sphalerite and galena are the most abundant accessory sulfides. Sphalerite usually occurs as highly fractured and internally cleaved grains. Wurtzite was discovered by Milton in stibconite vein material from the Antimony Bluff Mine. Barrel shaped crystals up to 1/16" in length of pyrrhotite were noted by the author in quartz veins at the Poor Boy Mine. Pyrrhotite, though rare, was usually within one-half inch of the wallrock contacts. Iron pyrite was seen at all mines except the May and Werner No. 2. Chalcopyrite was seen at the New Discovery and Valley Mines.

Carbonate Minerals

Carbonates include calcite, ankerite, and siderite. Calcite and ankerite veins occur at most mines, whereas siderite is restricted primarily to comby quartz vugs containing the "feather ores".

Silicate Minerals

Chlorite is the most abundant silicate accessory and was seen in dump material at every mine and prospect. At the May mine, chlorite occurs as green rosettes perched on jamesonite. Dickite, a white clay mineral, was seen in several quartz veins in the district. Milton (1976) has identified cookite associated with antimony ores.

Supergene Minerals

Common supergene alteration products formed from the previously noted minerals include anglesite and cerussite associated with galena, azurite, and malachite associated with chalcopyrite, goethite-limonite associated with siderite and pyrite and hydrozincite and smithsonite associated with sphalerite.

Size and Shape of Ore Shoots

Because the district has been inactive for some time little underground examination was possible. At the Antimony Bluff Mine, several quartz veins carrying stibnite were observed by the author. From the trend of the inclined shaft and Wait's (1880) description, these veins are only minor offshoots of the main mineralization. From published descriptions, Stroud (1969) concluded:

> "Ore bodies are lenticular and subject to pinching and swelling . . . Maximum length of the stibnite zone of any of the mines was 75 feet. Maximum width of stibnite zones was 52 inches, and one lens contained stibnite to a depth of at least 170 feet. The widest of the ore zones, including both quartz and stibnite, was approximately 6 feet."

Origin and Age of Deposits

To consider the origin of the antimony deposits in Arkansas, the relationship of the antimony-bearing quartz veins and other quartz veins must be discerned. Honess (1923) recognized two types of quartz veins in the Ouachita Mountains: "sulfide veins" and "large quartz veins." A. E. J. Engel (1951) discussed a number of problems involved with the origin and age of quartz in western Arkansas including: 1) depth of burial and vertical range of deposits; 2) possibility of composite source for composition of fluids; and 3) various alternatives consistent with his data responsible for the mineralizing solutions.

Miser (1959) stated:

> "Deposits of antimony, lead, copper, zinc and mercury are found at places in the Ouachita Mountains and are associated with a small amount of vein quartz. Some geologists have connected the origin of these deposits with the probable Cretaceous igneous rocks of Arkansas (Hess, 1908; Branner, 1932), but others, among whom I may be counted, believe that these metalliferous deposits and their associated minerals are related to the time of Pennsylvanian structural deformation (Honess, 1932; Stearn, 1935; Reed and Wells, 1938; Gallagher, 1942; Miser, 1943). This conclusion indicates that these metalliferous deposits were formed at the time of the extensive vein quartz deposition."

Williams (1890) in his study of the igneous rocks of Arkansas notes the presence of both primary and secondary quartz in miarolitic dike rocks west of Fourche Mountain (pp. 93-95) and quartz crystals developed in the novaculite contact rock on the east side of Magnet Cove (pp. 303-304). Zartman and others (1967) isotopically dated the Magnet Cove instrusion as Cretaceous (95-99 million years). Clardy and Bush (1976), in discussing the origin and age of mercury deposits in Arkansas, state: "In view of the conditions affecting the Mercury District, it seems probable that the cinnabar mineralization occurred during Lower Cretaceous time in connection with vein quartz and the major period of [Cretaceous] igneous activity in Arkansas." Stearn (1935) reported the discovery of stibnite at the west end of the Mercury District. Stearn found the crystallization sequence to be: stibnite, cinnabar, quartz, pyrite, dickite. In those known locations where antimony and cinnabar both occur, the antimony mineralization is older.

There exists the alternative that much of the quartz veining in the Ouachita Mountains is metamorphic in origin (Engels, 1951). Goldstein (1959) saw metamorphic effects in thin sections of sandstone from the Ouachita Mountains including secondary enlargement, granulation and partial recrystallization of quartz, chlorite, and sericite from original interstitial argillaceous material, and "augen" and "mortar" structures. Miser (1959) places the antimony district in an area of "J-111"metamorphism on the basis of thin sections of Jackfork sandstone, exposed to the south. Miser described the "111" category of metamorphism by the following characteristics: "angular sand grains, many grain boundaries modified and sutures developed on contacts between (a) adjacent original sand grains, (b) new grains of quartz formed by the partial recrystallization of the interstitial material, and (c) original and new grains." Bass and Ferrara (1969) obtained isotopic dates for adularia crystals from quartz veins in the Ouachita Mountains which place the time of adularia crystallization between 287 and 214 million years ago (Late Pennsylvanian to Middle Triassic). They concluded that formation of adularia represented a low grade regional metamorphic effect. Samples from the Viersen and Cochran, 25—1 Well (Sec. 25, T. 5 S., R. 23 E.) in McCurtain County, Oklahoma contained greenschist facies metamorphic rocks, both mineralogically and texturally. Material dated from this well by Denison and others (1977) ranged in age from 265 ± 5 to 307 ± 6 million years (Middle Pennsylvanian to Early Permian). In metamorphic reactions, the most common volatile component is water (Mason, 1966). The evolution of water during metamorphism is a progressive process resulting in the dehydration of the rock. This release of water most likely includes liberated ions which may ultimately result in metalliferous hypogene quartz veins. Included in minor mobile components of this "sweated out" material would be antimony and mercury. Pittenger (1974) from a study of polished ore sections and fluid inclusions in associated quartz found four stages of mineralization in quartz veins in the antimony district. Between each stage of mineralization, he saw fracturing. Stibnite, along with ankerite and calcite were deposited as the last stage of mineralization. Hand specimen samples indicate at least two distinct periods of mineralization: (1) quartz with copper-lead-sinc sulfides, and (2) quartz with stibnite and carbonates. Some stibnite is shattered and/or mylonized; this being indicative of minor structural adjustments after the major antimony deposition. Pittenger and Konig (1977) theorized a low temperature hydrothermal origin related to unknown deep seated sources during Pennsylvanian time for copper-lead-zinc deposits in the area. Then mobilization of formation waters of lower Paleozoic sediment during Late Pennsylvanian or Permian metamorphism to produce the antimony deposits.

From the previous discussion, it is apparent that quartz vein deposition in the Ouachita Mountains began in late Pennsylvanian time and continued sporadically into Permian and possibly even Triassic time. Lower Cretaceous igneous activity also resulted in quartz deposition, but apparently on a more localized and lesser scale. The antimony mineralization occurred during minor post Permian-pre-Late Cretaceous quartz deposition after the major volume of quartz veining in the district. Stibnite and other primary minerals were deposited from hypogene solutions which were mobilized by Permian-Triassic(?) metamorphism. The ore-bearing fluids rose along thrust faults and in sub parallel fractures in fault blocks adjacent to major thrust faults. These fractures most likely resulted from tensional release due to either structural relaxation along the Benton-Broken Bow uplift or minor hinge line flexure along a proto Cretaceous shoreline.

MINES AND PROSPECTS

During this investigation, data collected on the mines and prospects included a description of the excavations as of 1974-75, history of mining and production and hand specimen mineralogy of specimens collected from mine dumps. Certain mines were difficult to locate because the district has been idle many years and several prospects were improperly described in the literature. Numbers were assigned from east to west and the number following each name corresponds to location numbers on Plate 1.

Several prospects mentioned in previous literature were not located either because they have been filled or their locations are inaccurate. These include the Busby (T. 7 S., R. 29 W.), Blucher Bluff (N½ NW¼ Sec. 6, T. 7 S., R. 30 W.), Jordan workings (NW¼ NE¼ Sec. 11, T. 7 S., R. 31 W.), Luttrell lease (NE¼ SW¼ Sec. 3, T. 7 S., R. 31 W.), Clark (NW¼ SW¼ Sec. 3, T. 7 S., R. 31 W.), Daisy shaft (E½ SW¼ Sec. 19, T. 7 S., R. 31 W.), and the Gulch shaft (Sec. 8(?), T. 7 S., R. 30 W.).

May Mines (1)

The May mines are located in the NW¼ SE¼ Sec. 4, T. 7 S., R. 30 W., in Sevier County. The first mine was opened in 1877 by the United States Antimony Company (Shriver, 1917). The first shaft was initially opened to a depth of 60 feet. Paul Knod of Gillham worked the May in 1902 and shipped ore to New York.

In 1908, Hess reported:

"Mr. Paul Knod, of Gillham, one of the owners of the property, gave the following information concerning the mine:

The shaft is vertical, 8 by 9 feet, 125 feet deep, and solidly cribbed for 113 feet below the surface. At a depth of 45 feet a crosscut reached the vein at 27 feet, where only a little disseminated stibnite was carried in the quartz. At 80 feet in depth a crosscut reached the vein in 22 feet, at which point it carried a sheet of solid stibnite 6 inches thick. A drift was run 33 feet to the east, and a stope 10 feet wide was driven 18 feet high. From 16 to 18 tons of ore were taken out of this drift and stope. At 100 feet in depth the vein was reached by a crosscut 17 feet long. A drift was run 18 feet to the east, where the ore was about 10 inches thick in the face . . . Some years before the present shaft was dug, two other shafts, 300 and 600 feet west of it, were sunk simultaneously. The shaft 600 feet west reached a depth of 110 feet, and at one place had 22 inches of stibnite. The third shaft, sunk to 90 feet in depth, had a "feather-edge" of stibnite at the surface and but 5 inches at the thickest."

The vein was reported by Hess (1908) to strike N80°E with almost vertical south dip.

In January, 1916 C. M. Fenton leased the property under the name of the American Star Antimony Company. A fourth shaft was opened to 73 feet. Thoenen (1944) reported that the center May shaft was reopened in 1942 by Vernon Lewis and 3200 pounds of stibnite was mined from the 69 foot level east of the shaft. An adit was present about 50 feet below the collar.

In 1975 the workings consisted of 7 shafts and 2 prospect pits trending east-west and one north-south trench on the west end of the location. Some of these workings were opened since 1944 but little is known of any subsequent production. Specimens of ore and gangue minerals were collected from shafts 1, 2, 3, 4, and 7 (numbered from east to west). Presently all shafts are either brush or water-filled.

Minerals reported found in the May Mine by previous workers are stibnite, jamesonite, galena, pyrite, siderite, calcite and quartz.

Primary sulfides noted during this study are stibnite, sphalerite and pyrite. Jamesonite is present. Gangue minerals are chlorite, ankerite and quartz. Alteration products are yellow and white oxides of antimony and goethite-limonite.

Total production is estimated at 1510 tons (unpublished data, Arkansas Geology Commission).

Unnamed Prospect (2)

This prospect is located in the SE¼ NW¼ SW¼ Sec. 4, T. 7 S., R. 30 W., in Sevier County. No reference to the prospect was found in previous literature. The workings consist of two prospect pits on the same trend as the May mines and three shallow north-south trenches. Scattered quartz was seen on a shale dump of the west shaft, but no sulfide mineralization was noted.

Stewart Mine (3)

The Stewart mine is located in the SE¼ NE¼ SE¼ Sec. 5, T. 7 S., R. 30 W., in Sevier County. The Stewart "lode" was discovered in 1877. Wait (1880) reported that:

"The ore in large pieces was exposed to view in several places within the distance of a few hundred feet. In many places in this distance the ore and quartz seemed to be a solid mass projecting above the ground. The vein was attacked on the surface for several hundred feet, and was removed to the depth of twelve feet. Some fine pieces of ore were taken from this open cut, one piece of apparently solid stibnite, weighing 720 pounds, was shipped to Little Rock; other pieces even heavier were raised to the surface . . . At the eastern extremity of this excavation at a depth of 12 feet considerable quantities of very compact ore were found, consisting of granular galena and stibnite intimately associated . . . At the western extremity of this excavation was found an exceedingly interesting mineral of a lemon-yellow color, easily crumbling between the fingers, and giving upon charcoal the reactions for lead and antimony; it was pronounced bindheimite . . . In order to test the character and extent of ore in this lode, several holes were dug, and in each case satisfactory results were obtained, sufficient at least to warrant a moderate expenditure in sinking a shaft. This shaft, 8 feet by 5 feet, was commenced near the eastern extremity of the cut. Some very large and pure pieces of stibnite were taken from this shaft . . . The shaft was sunk to the depth of 32 feet, and at about 18 feet two drifts were started east and west on the vein, but were continued only a few feet. Some excellent ore was taken from these drifts. Little or no difficulty was experienced in sinking this shaft, as the formation was a black shale, easily removed with the pick, with an occasional blast. At the bottom of this shaft the vein of quartz which carried the mineral had assumed a thickness of one foot, the ore however occupying only 4 inches . . . Mining operations were stopped July, 1877, but previous to this time there was a general cleaning up, and the ore was selected and placed in casks for shipment. A large amount was necessarily lost, as this separation was effected by hand. On June 20th and July 5th, 45 casks and 10 casks respectively were gotten ready for shipment, and in all about 25 tons (2240 pounds) were shipped to Messrs. Hallet & Co., London, for which about sixty dollars per ton was paid. This mine was sold to parties in Memphis in March, 1878, and in the summer succeeding operations were again commenced."

Comstock (1888) noted that the vein had a strike of N 63°E and dipped 60° to 80° N. When Hess visited the Stewart in November of 1907 nothing remained but a caved trench and some tailing piles.

In the spring of 1975, the workings consisted of a caved trench trending along the strike of the vein, a filled shaft at the east end of the trench, and a filled shaft near the west end of the trench. A logging road crosses the workings from the southwest to the northeast. Just east of the west shaft on the west side of the logging road is an exposure of a quartz vein containing stibnite and stibiconite. The quartz vein is 18 inches thick and appears vertical. The stibnite occurs as unaltered cores in yellow powdery oxidation products and originally was multiple lens shaped fillings in vein quartz.

Minerals reported found in the Stewart Mine by previous workers are stibnite, jamesonite, zinkenite, bindheimite, galena, chalcopyrite and ankerite.

Primary sulfides noted from dump collections are stibnite, sphalerite, galena, chalcopyrite, iron pyrite and a mineral intergrown with galena, tentatively identified as fuloppite (C. Milton, personal communication, 1975). Jamesonite and arsenopyrite are present. Gangue minerals are thuringite (a variety of chlorite), ankerite, calcite and quartz. Secondary products present are yellow and white oxides of antimony, goethite-limonite, malachite, azurite, anglesite and chalcedony.

Total production is estimated at 1000 tons (unpublished data, Arkansas Geology Commission).

Unnamed Prospect (4)

This prospect is located in S½ NE¼ SE¼ Sec. 5, T. 7 S., R. 30 W., in Sevier County. About 200 feet southwest of the Stewart, the workings consisted of a single shaft and tailing pile. The shaft was back filled and part of the dump removed for road material. This prospect appears to be a western extension of the Stewart workings, but only quartz, calcite and ankerite with iron pyrite were noted in the tailings.

Unnamed Prospect (5)

This prospect is located in NW¼ SE¼ SE¼ Sec. 5, T. 7 S., R. 30 W., in Sevier County. Comstock (1888) apparently never located the Conboy workings, but visited this prospect thinking it was the Conboy. This prospect is a quarter mile west of the Stewart, whereas the Conboy as located by earlier reports, is slightly more than a half mile west of the Stewart. Hess (1908) reported on workings one half mile east of the Conboy which appears to be this prospect. He noted that:

> "About one-half mile farther east, in a general way along the strike of the vein, a couple of shafts have been sunk on a vein which may or may not be the same as that at the Conboy slope. Very little stibnite was to be seen in the fragments from the vein. There were small amounts of pyrite, sphalerite, and galena, with the usual quartz and considerable siderite. The vein seems to be not over a few inches wide."

In 1975 the workings consisted of two water-filled shafts and one prospect pit. Primary sulfide minerals noted are galena, sphalerite and iron pyrite. Arsenopyrite is present. Secondary minerals are yellow oxides of antimony and limonite-goethite.

Unnamed Prospect (6)

This prospect is located in NW¼ SW¼ SE¼ Sec. 5, T. 7 S., R. 30 W., in Sevier County. This prospect is a single water-filled shaft and tailings pile. Sparse quartz vein material containing iron oxides was present on the dump.

Conboy Mine (7)

The Conboy workings are located in NW¼ SE¼ SW¼ Sec. 5, T. 7 S., R. 30 W., in Sevier County. Hess (1908) visited the mine and stated:

> "An inclined shaft 90 feet deep was sunk along a quartz vein outcropping on the north side of a hill, about 100 feet above the base. The shaft follows the dip of the vein and is inclined about 45°. The stibnite in the shaft is said to have averaged 6 inches in thickness for 50 feet from the surface, below which it became thinner until it pinched out altogether. If there was any such amount of stibnite as this in the shaft the ore shoot must have been very narrow, for the sides were not mined. Mr. Conboy stated to the writer that some of the ore was so rich in silver that it was sold for 22 cents per pound. The fragments of ore found near the shaft show a distinct banded structure, with comby quartz one-half inch thick on each side of a central band of stibnite 1 to 2 inches thick, whose crystals lay roughly parallel to the walls. Scattered through the stibnite are small crystals of quartz and some particles of siderite. Outside of the comby vein there are several thin bands of siderite with some impurities, probably stibnite. No galena was seen. A tunnel 310 feet long cut the vein about 12 feet below the bottom of the shaft. At this depth the vein had pinched to almost nothing and no ore was

> in sight. A drift was run 75 feet eastward along the vein and although there was no ore in the roof of the drift, it is said that in the floor 6 or 7 inches of stibnite was found at the thickest part. The drift is now caved and could not be examined. The tunnel affords the best place to study the relations of the rocks and veins, as the walls are clean and there is no caving. The rocks strike N. 77° E., with a dip of N. 45°W. The vein follows the bedding and lies between dark sandy shales and a stiffer thin bed of sandstone. Slipping between the beds due to folding, is noticeable."

The Conboy mine in 1975 consisted of an inclined shaft just north of a filled shaft; the inclined shaft filled to about 15 feet of the entrance with water. The walls of the shaft were examined, but no mineralization was seen.

Samples from the dump contain stibnite, jamesonite, pyrite, arsenopyrite and sphalerite. Gangue minerals of quartz, ankerite and chlorite are present. Secondary minerals are limonite-goethite and yellow oxides of antimony.

Total production of stibnite ore amounts to 50 tons.

New Discovery Prospect (8)

This prospect is located in NW¼ SW¼ SE¼ Sec. 6, T. 7 S., R. 30 W., in Sevier County. No antimony has been reported from this prospect, but it was visited because it is on the same trend as the antimony mines east of the Cossatot River (Plate 1). Hess (1908) reported:

> "A shaft . . . between 100 and 125 feet deep was sunk in 1902, and a plant consisting of a shaft house, boiler, engines, ore crusher, and blacksmith shop was put up on a vein carrying some sphalerite and galena. This property is known as the New Discovery. When visited the vein was not visible at the surface and the shaft could not be entered, but to judge from a small amount of ore in the bin the deposit is evidently somewhat different from the others seen. The ore is a brecciated sandstone cemented with small veins containing sphalerite, galena, quartz, and siderite. There are also small amounts of pyrites, which may be copper bearing. Only one piece showing stibnite was found, and it was not certainly from this shaft. David Ziedler, who worked in the shaft until it reached a depth of 40 or 50 feet, stated to the writer that he saw no stibnite in the vein down to that depth. The ore bears little resemblance to the ores forming the antimony-bearing veins, and the amount of quartz present is very much less."

Pittenger (1974) examined material from this location and reported the presence of chalcopyrite, tetrahedrite, covellite, iron pyrite, calcite and ankerite.

In the spring of 1975 the New Discovery consisted of one shaft, two shallow trenches and a prospect pit. A vein containing galena and reddish brown gossan was exposed in the creek 50 feet southwest of the shaft. Samples collected from the vein and the shaft dump contained galena, sphalerite, chalcopyrite, calcite, ankerite, chlorite and quartz.

Antimony Bluff Mine (9)

This mine is located in the N½ SW¼ SW¼ Sec. 6, T. 7 S., R. 30 W., in Sevier County. Wait (1880) described the deposit:

> "The deposit was discovered by a man named Batson, but was not given prominence until taken hold of by D. C. Ladd. The claim was sold to the Little Rock Mining Company; and in October, 1876,

a shaft was commenced upon the vein, which has a strike N. 13°E., with a dip 70°N. At the surface the vein had a thickness of several inches, but soon increased to two feet, and retained that dimension for about nine feet in depth. The rock strata through which this vein passes transversely is a very compact siliceous sandstone, while the veinstone accompanying the ore is quartz. The ore obtained was antimony ochre-cervantite; some pieces were exceedingly pure, weighing as much as three hundred pounds . . . Below this depth, nine feet, the vein diminished in thickness, changed somewhat in direction, conforming more to the rock strata, and yielded ore of ochre and stibnite. At twenty feet in depth the vein was fourteen inches in thickness; below this the ochre had nearly disappeared, and at thirty feet it was replaced by solid glance, the vein here having a thickness of thirty inches. At this point large masses of stibnite, fibrous in structure, were taken out, weighing from one hundred to five hundred pounds . . . At thirty feet the ore on the north side of the shaft changed somewhat in appearance and indicated the presence of lead . . . At the depth of forty feet the vein began to decrease in thickness, but the mineral possessed no new or striking features. At fifty feet the ore became very fragile, breaking into small crystals and fragments. It was, however, of great purity . . . At fifty-five feet the mineral decreased in amount, and the vein was divided into several smaller ones, the character of the ore remaining about the same. At this depth blasting became expensive, and for reasons known only to the company, mining operations were stopped in June, 1877, and nothing has been done since that time . . . During the sinking of this shaft a siliceous slate was encountered in which were imbedded needlelike crystals of arsenopyrite."

Comstock (1888) noted that Wait's strike and dip were impossible and gave the dip as "79°, N. 27°W." (strike of N. 63°E, dip 79°N.).

Hall (1940) described a sandstone unit 30 feet northwest of the inclined shaft as striking N. 80°W. with a dip of 60°N. In 1944 Thoenen mentioned the presence of a barren prospect pit 30 feet down slope from the original inclined shaft. In 1975 the workings consisted of three shafts and three prospect pits. On the west end of the workings is the inclined shaft and prospect pit described by Wait and Thoenen; the inclined shaft being water filled to within about 25 feet of the surface. Benjamin Clardy, Raymond Stroud and the author entered the shaft and observed two stibnite veins, varying from knife-edge to 8 inches thick in the shaft wall. These veins strike N. 30°E. and N.40°E. From the inclined shaft quartz veins were sampled and were coated with yellow antimony oxides up to two and one-half inches thick. Primary sulfides collected from the dump pile are stibnite, sphalerite and pyrite. Arsenopyrite is present. Gangue minerals are ankerite, chlorite and quartz. Oxidation products are yellow and white antimony oxides and goethite-limonite. Thin clear coatings of opal are present on some of the oxidation products.

Up slope and east of the inclined shaft about 40 feet is a waterfilled shaft. About 125 feet east on the ridge is a fourth waterfilled shaft. Only quartz and shale were observed on the dump.

Two other prospect pits approximately 550 feet east of the inclined shaft are located on a shattered, slickensided quartz vein. In the easternmost pit the quartz vein is vertical with an east-west strike and varies in thickness from one and a half feet near the surface to approximately 3 feet at 15 feet in depth. The vein was examined, but only iron oxides and quartz were seen. These are all included with the original Antimony Bluff workings since they are on the same trend and are not listed in previous literature.

Total production is 10 tons of ore.

Harrell Prospect (10)

This prospect is located in NW¼ NE¼ SW¼ Sec. 1, T. 7 S., R. 31 W., in Sevier County. (The prospect was opened in 1938 by W. T. Harrell as a gold prospect. Hall (1940) observed pyrite in the specimens he obtained from the owner.) Hall (1940) described the prospect:

> "This vein is 7 feet wide, strikes N. 75°E., and dips 70° northward . . . exposed in a prospect hole 12 feet deep. It consists almost wholly of milky quartz and is badly fractured, with slickensides along the fractures. No stibnite is present."

In 1975, the author saw evidence of two prospect pits. Both had been backfilled by bulldozers during forest clearcutting operations. Quartz vein material was scattered about on the surface.

Harrell Mines (11)

The Harrell mines are located in S½ NE¼ Sec. 11, T. 7 S., R. 31 W., in Sevier County. The mines consist of a series of shafts, prospect pits and trenches which extend along strike of a vein for approximately 1500 feet. The westernmost end of the mines extend into the SE¼ NW¼ Sec. 11. The west end of this location was mistaken by Hall (1940) for the Wolfton Mine. Hall notes:

> "There are two shafts. The easternmost is seven by eight feet, and 115 feet deep. A second hole, presumably an air-shaft, was found about 40 feet farther west. This was six by eight feet and goes down to an unknown depth which, judging from the amount of dump, is probably not more than half as deep as the first shaft. Drifts are said to have been driven eastward. A massive sandstone bed was poorly exposed on the south wall of the shaft. The vein occurs adjacent to this wall. The rock on the north side of the vein is shale intercalated with a few thick sandy layers. The strike of beds and vein here is N. 85°W., with vertical dip."

Primary sulfides are stibnite and iron pyrite. Jamesonite is present. Gangue minerals are quartz, ankerite and chlorite. Secondary minerals seen include yellow antimony oxides, limonite-goethite and malachite.

Wolfton Mine (12)

The Wolfton Mine is located in SW½ NW¼ NW¼ Sec. 11, T. 7 S., R. 31 W., in Sevier County. Wait (1880) called this mine the Bob Wolf and reported:

> "There is a question of doubt as to the exact time of discovery, but it seems to have been in the early part of 1874. Large pieces of the sulphide of antimony were found on the surface, which were weatherworn, but when broken showed the bright metallic lustre peculiar for the freshly-fractured stibnite. Mining operations on a small scale were commenced without delay, and in a few days a hole was dug from which were taken several tons of very good ore. The ore is found in a vein nearly a foot in thickness at the surface, with strike N. 13° E., and dip approximately vertical. The veinstone accompanying the ore is quartz, stained with oxide of iron, and has received locally the name of "antimony quartz." The vein has been traced in an easterly direction for a distance of two miles, but at

this point the prospect seemed to be the most promising. The ore appeared in quantity, and several tons of selected ore were taken from the prospect shaft, but upon inquiry it was found that no use could be made of the ore, as there were no smelting works convenient for its reduction. Such being the case they deemed it advisable to cease operations, at least until a market could be found for the mineral . . . This mine was held by Mr. Wolf only a short time, and was then sold to Messrs. Green & Wells, of Missouri. They sank a small shaft fifty feet west of the original opening, and from it obtained some ore of excellent character . . . The vein to this depth (45 feet) had assumed a thickness varying from a few inches to one foot . . . Little or no work has been done on this claim, save the sinking of this small shaft, four feet square, to the depth of about sixty-five feet."

When Hess visited the mine in 1907, he noted:

"The dip of the country rock, which is considerably disturbed for about 2 feet on each side, could not be measured along the vein, nor could the exact relationship between the two be determined, but in the road about 200 feet north of the vein, the rocks have strike of N. 70°E., with a steep southerly dip. In a valley 200 or 300 feet north of the main shaft a smaller quartz vein also strikes N. 70°E. The rock in which the main vein is located is a soft, sandy, yellow to olive 'shelly' shale with thin drab intercalated sandstones. Where less weathered the sandstone is a very dark gray . . . As seen in the top of the shaft and in a prospect hole a short distance east of it, the vein runs about east and west with an almost vertical dip. It varies in width up to 10 or 12 inches, and may be traced by old excavations along its course for half a mile or more, swelling and thinning along both strike and dip. The vein is comby . . . Many pieces of shale form nuclei from which quartz crystals radiate, yet so soft that they crumble and fall out like clay . . . The vein is largely barren, and where stibnite occurs, it is found mostly between the combs of quartz . . . Fragments of ore lying on the dump show an antimony oxide, probably cervantite (Sb_2O_4). Here and there a small amount of calcite forms thin bands in the veins. The calcite is mixed with siderite, which in places is of a uniform reddish-brown color, from oxidations. No sphalerite, iron sulphides, or other accessory minerals were found in the pieces of ore picked up around the mine."

From Hall's (1940) range and township description and his account of the mine, it is apparent that he described the two west shafts of the Harrell Mines, instead of the Wolfton Mine.

Thoenen (1944) reported that some of the dump material was being excavated for road surfacing. In 1975 the dumps of the larger west shaft were gone and the shaft backfilled and covered with uprooted trees and top soil. No dump material was seen and the site of the shaft could not be located accurately. The east shaft was waterfilled, and the dump yielded quartz veins containing chalcopyrite. Gangue minerals are ankerite, calcite and chlorite.

Total production is estimated at 100 tons (unpublished data, Arkansas Geological Commission).

Werner No. 2 Prospect (13)

This prospect is located in SW¼ NE¼ NE¼ Sec. 10, T. 7 S., R. 31 W., in Sevier

County. Thoenen (1944) noted:

> "The Werner mine here designated as No. 2 was opened by George Werner in the fall of 1943 . . . This shaft is reported to be 45 feet in depth and to have cut a thin vein of stibnite. The shaft was full of water and could not be examined. The shaft house and headframe are in place and the necessary operations machinery are present . . . The dump is estimated to contain not more than 200 tons of shale which would indicate a 10-by-10-foot shaft depth of about 25 feet. Some stibnite specimens were observed as if ore had been cobbed on the dump."

When visited in the spring of 1975, the prospect consisted of a single waterfilled shaft and tailings pile.

Primary sulfides are iron pyrite and minor stibnite. Gangue minerals are quartz, chlorite and ankerite. Yellow antimony oxides and limonite-goethite are present.

Poor Boy Mine (14)

The mine is in the N½ SE¼ NW¼ Sec. 10, T. 7 S., R. 31 W., in Sevier County. Hall (1940) reported:

> "The shaft was opened in the spring of 1939 as a cooperative venture between several men in Gillham. In July, 1939, the shaft was four by four feet, and 40 feet deep, but filled with water. The hoisting apparatus and other machinery, although homemade, were in good condition. The work . . . was discontinued early in June, 1939. There is no surface outcrop of the vein in the vicinity. The gray quartzitic sandstone 'wallrock' is exposed just a few feet north of the shaft. This sandstone bed was nearly 15 feet thick and had an east-west strike and vertical dip. A dark, very fissile shale forms the south wall of the vein."

W. A. Field, Theo Davis, and A. D. Shope, all of Little Rock, formed the Stibnite Production Corporation and leased the Poor Boy in 1940.

When Thoenen visited the area in 1942, the Poor Boy was an active mine, but unfortunately he was unable to examine the working face.

All ore above the 170 foot level was stoped. At the 170 foot level, the shaft was making 15,000 gallons of water per hour. McCombs Hardy of Little Rock sold 40 tons of concentrates upon closing the mine (Thoenen, 1944). In 1947 two tons of concentrates were sold for $669 (U.S.B.M. Yearbook, 1949).

Thoenen (1944) noted a shaft 100 feet east of the original Poor Boy Shaft, which he named the Davis shaft. This shaft was 70 feet deep, but no ore was encountered.

In 1975 the Poor Boy Mine consisted of three shafts and numerous prospect pits and trenches trending east-west. Several buildings were still standing. The west shaft had the largest tailings dump and is presumed to be the main shaft described by Thoenen.

Primary sulfides are stibnite, iron pyrite and sphalerite. Jamesonite, pyrrhotite and arsenopyrite are also present. Gangue minerals are quartz, ankerite, calcite and chlorite. Secondary minerals are white antimony oxides and goethite-limonite.

Werner No. 1 Prospect (15)

This prospect is in the W½ NW¼ Sec. 10, T. 7 S., R. 31 W., in Sevier County. Hall (1940) reported:

> "The Werner mine was opened in August, 1938, by Mr. George Werner of Chicago, Illinois, who obtained a lease from Mr. E.A. Hiatt of Gillham, the owner of the property. The shaft is six by seven feet and 44 feet deep.

Just to the north ot the shaft is a low ridge of gray quartzitic sandstone, the same 'wall-rock' as that of the Poor Boy mine. The exposure is notably thicker here, however, approaching 100 feet. This is . . . indicative of the lenticular nature of these sandstone layers. The strike is N. 87°E. and the dip N. 70°, also a distinct change from the dip of the wall at the Poor Boy shaft. The vein lies in a fractured zone in the shale, immediately south of the quartzitic wall-rock. The mineralized zone is three and one-half to five feet wide, with three to six inches of good stibnite ore in the central part. The shaft was sunk on the vein, but the vein left the shaft at a depth of 20 feet, because of its northward dip . . . The shaft was deepened in the shale to 44 feet with the intention of cross-cutting northward to the vein, and drifting east and west. Work was discontinued at this point for unknown reasons. Very little ore has been removed, and to date none has been sold."

Thoenen (1944) designated this prospect as the "Werner Mine No. 1." He noted the headframe standing and about 100 pounds of antimony are apparently left from hand cobbing.

The prospect in 1975 consisted of three shafts, two being on the same east-west trend as the Poor Boy, and one shaft approximately 500 feet north of the trend. The south shaft has the largest dump and is presumed to be the shaft reported by Hall and by Thoenen. In the small creek adjacent to the main shaft is a limonitic alteration zone and a sandstone-shale contact, the beds strike N. 85°E. and dip 72°S. This strike and dip conflicts with Hall's dip, but conforms with the dip of the rocks at the Poor Boy and Werner No. 2.

Minerals previously reported are stibnite and quartz. Primary sulfides from the dumps of the south shaft are stibnite and sphalerite. Gangue minerals are quartz, ankerite, calcite and chlorite. Secondary minerals present are white and yellow oxides of antimony and limonite-goethite.

Valley Mines (16)

These mines are in the NW¼ SE¼ Sec. 20, T. 7 S., R. 31 W., in Sevier County. Ashley (1887) stated:

"A shaft at the Valley mines has been sunk 230 feet and still shows good ore . . ."

Comstock (1888) reported on the Valley:

"The workings, August 15, 1887, consisted of a shaft 82 feet in depth, with three drifts running off north and south, about 25 feet apart. Level No. 1 ran north 28 feet, and south 17½ feet. Levels Nos. 2 and 3 were not extended southward from the shaft, but ran north 33 feet and 16 feet, respectively. The country rocks dip from 70° to 80°, S. 27°E. There are traces of a vein structure, or of a bed of ore, in Level No. 1 in both directions from the shaft. The existence of feeders or strings of ore in crevices indicate that some better ore-body may occur in the neighborhood. It is stated that some good ore has been taken from pockets in the mine."

Hall (1940) noted that the Valley mines:

"consist of a series of shafts and pits . . . filled with water and debris so that little can be told about them. The workings are lined up east and west for a distance of nearly 800 feet. There are 8 holes, separated by distances varying from 10 to 250 feet. Shallow drifts between several of the holes were caved . . . In 1916, under stimulus of rising prices of antimony caused by the World War, the property was purchased by the American Star Antimony Company, and worked until September of that year. No work has been reported since that time. The strike of vein and country rock here is N. 85°E., dip 75° S. The vein zone is said to have been four to five feet thick, with four to eight inches of solid stibnite ore . . . Faulting has taken place . . . evidenced by clay gouge and slickensides. The wall-rock, or massive bed of quartzitic sandstone so common in the East District, is missing here, there being only a few thin, sandy beds intercalated with the shale."

The Valley Mines in 1975 consisted of two shafts and two prospect pits. The east shaft, locally called the Texarkana shaft, has been backfilled. The Texarkana shaft appears to have been the major producer of ore. Samples of quartz vein containing up to one inch thick fillings of stibnite were collected from scattered surface material. West of the Texarkana shaft approximately 100 feet is a second waterfilled shaft, apparently the original shaft as described by Comstock. The dump is depleted, some material being removed for road fill. Pittenger (1974) reported stibnite, jamesonite, zinkenite and arsenopyrite in samples from this shaft. The two prospect pits west of this shaft were shallow; both are backfilled by dump material. Several shallow trenches are present just west of the Valley prospect pits.

Primary sulfides from the Valley mines are stibnite, sphalerite, iron pyrite and chalcopyrite. Arsenopyrite and jamesonite are also present. Gangue minerals are quartz, ankerite, calcite (restricted to the westernmost prospect pit) and chlorite. Alteration products are yellow and white to gray antimony oxides, chalcedony(?), limonite-goethite and malachite.

Total production is estimated at 100 tons (unpublished data, Arkansas Geological Commission).

Otto Mine (17)

The Otto mine is located in SW¼ NE¼ SW¼ Sec. 20, T. 7 S., R. 31 W., in Sevier County.

Comstock (1888) noted four levels and good ore on the fourth level 41 feet east of the shaft. Hess (1908) stated:

> "The mine is now caved in and nearly filled with water, so that but little can be seen. However, the vein is fairly well exposed at the top of the shaft, where it is split into two branches, each 10 or 12 inches thick and about 3 feet apart. They evidently join at a depth of 20 or 25 feet. The strike is about N, 72° E., and the dip approximately vertical. The rocks are somewhat disturbed at the surface, probably from weathering so that the relation of the vein to the rocks is not certain. Half a mile farther west the rocks strike N. 80° E. . . . Pieces of ore picked up on the dump showed much zinc blende in small crystals. In some specimens quartz shows peculiar reentrant angles and is somewhat etched."

Shriver (1917) recorded the history of the Otto:

> "The United States Anitomy [sic] Co., of Philadelphia, obtained control of the properties known in 1877 and started work. The May, Valley, Otto, and East Wolfton shafts were sunk by this company . . . The old stopes at some of the mines, particularly the Otto, are quite large, and the orebody must have been on considerable size. Near the end of 1888, the United States Antimony Co., discouraged by want of transportation facilities and by their inability to smelt the ore, ceased operations. . . The majority of the old claims were leased by the American Antimony Co. in 1912.

> A small amount of work was done during the year but its capital was insufficient to continue . . . Early in January [1916], C. M. Fenton of Joplin acquired a large number of these properties [leasing] the May and Otto . . . The Otto Mining Co. was organized for the purpose of working the Otto mine, 75% of the stock being held by the American Star Antimony Co."

However, due to smelting problems and dropping antimony prices the mine was not reopened (Shriver, 1917).

In 1937 the Otto Mine was dewatered and cleaned out to a depth of 60 feet, but no mining took place. In 1941 A. J. Gold of Shreveport opened the mine and recovered a reported 7,000 pounds of ore from the 75 foot level (Thoenen, 1944).

In 1951 under a Defense Minerals Contract, Mr. Gold dewatered the Otto mine and R. B. McElwaine explored the safe areas of the mine. The shaft was found to be 173 feet deep with 3 drifts at 95, 115, and 173 feet. The vein was stull stoped above the 115 foot level. A small pillar was preserved in the stoped area at the 65 foot level which contained quartz and thin lenses of stibnite. A winze which followed the vein on the 173 foot level was seen and reportedly extended 40 feet in depth (McElwaine, unpublished report, Arkansas Geological Commission, 1951).

In the spring of 1975 the Otto mine consisted of a backfilled shaft and two dump piles. Some of the dump material had been hauled for road material. Approximately 200 feet north of the filled shaft is a second shaft and small prospect pit.

Primary sulfides from the dumps are stibnite, sphalerite and iron pyrite. Jamesonite and arsenopyrite are present. Gangue minerals are quartz, ankerite and chlorite. Secondary minerals are yellow antimony oxides and goethite-limonite.

Total production is estimated at 2500 tons (unpublished data, Arkansas Geological Commission).

Werner Prospect (18)

The Werner Prospect is located in SE¼ NW¼ SW¼ Sec. 20, T. 7 S., R. 31 W., in Sevier County.

When Hall visited the area in 1939, Mr. George Werner had recently opened several prospect pits with the hope of striking an ore shoot like that of the Otto mine. The country rock is shale with thin sandstone beds, striking N. 0°E., with a steep westward dip. Hall (1940) suspected local drag folding to account for the departure from regional strike. Only one small show of stibnite is reported (Hall, 1940).

Samples collected from the dumps of this prospect contained only a few thin veins of quartz.

Unnamed Prospect (19)

This prospect consists of a series of shallow pits and trenches extending from the Werner prospect in Section 20 to the Brewer Mine in Section 19. Thoenen (1944) reported:

> "There are six pits and trenches and one shaft estimated to be about 15 feet in depth . . . No information could be obtained concerning these workings, but all are caved and apparently are not of recent origin."

Brewer Mine (20)

The Brewer Mine is located in the NE¼ SE¼ SE¼ Sec. 19, T. 7 S., R. 31 W., in Sevier County. Hall (1940) described the mine:

> "The . . . shaft is 75 to 90 feet in depth. Drifts were driven in the vein 300 feet to the east and 200

> feet to the west. In the east drift, 60 feet from the shaft, a cross-cut 50 feet long was made toward the north . . . Although the mine is caved and nearly filled with water, good exposures of country rock and vein were visible on the west wall of the shaft. The weathered shale, intercalated with several sandstone layers, has a strike of N. 80°E., dipping about 60°S. The beds are badly crumpled and deformed, and are cut by a fault striking parallel to the strike of the shale, but dipping more steeply, about 84°S. . . . Several quartz veins varying from a feather-edge to six inches were found in this fault zone. No ore was visible. A stockwork of smaller veinlets criss-crosses the country rock, especially the sandstone, on each side of the fault."

Primary sulfides from the dump are stibnite, galena, sphalerite and iron pyrite. Arsenopyrite and jamesonite are also present. Gangue minerals are quartz, ankerite and chlorite. Secondary minerals are yellow and white antimony oxides, limonite-goethite and anglesite.

Total production is estimated at 75 tons (unpublished data, Arkansas Geological Commission).

Mickle Prospect (21)

The Mickle is located in the NE¼ SW¼ SE¼ Sec. 19, T. 7 S., R. 31 W., in Sevier County. Hall (1940) first described the prospect:

> "This shaft was sunk in 1936 by George Werner on the property of Sam Mickle . . . . The shaft is 30 feet deep. A massive bed of gray quartzitic sandstone lies against the south wall of the vein. Strike of vein and country rock here is N. 80°E., dip N. 78°. Four to 12 inches of clay selvage, or gouge, indicative of faulting, together with milky quartz material was found, but no ore."

The prospect in 1975 consisted of three shafts. The two shallow western shafts are in sandstone. Only thin vuggy quartz veins were observed in these shafts. The dump of the east shaft contains quartz veins with pyrite, arsenopyrite, ankerite and chlorite. Secondary minerals are limonite-goethite.

Hankins Prospect (22)

The Hankins Prospect is located in the SW¼ NE¼ NE¼ Sec. 26, T. 7 S., R. 32 W., in Sevier County.

In 1937 George Werner sank this 20 foot deep shaft on the property of Robert Hankins. Hall (1940) noted the hole was filled and reported seeing slickensided shale and quartz-ankerite veinlets in the dump pile. Specimens collected from the dump during this study contain stibnite, sphalerite and iron pyrite as primary sulfides. Jamesonite and arsenopyrite are also present. Gangue minerals are quartz, ankerite and chlorite. Secondary minerals are yellow and white antimony oxides and limonite-goethite.

Lignitz Prospect (23)

The Lignitz prospect is located in the NE¼ SW¼ NE¼ Sec. 26, T. 7 S., R. 32 W., in Sevier County. Hall (1940) reported:

> "This mine was opened by George Werner in 1937 . . . The headframe is still standing over the 40 foot shaft . . . The shaft was boarded up."

The shaft has since been filled and the dump leveled. The exact location of the shaft was not found, but the remaining dump material was located. Thin ankerite and quartz veinlets were present in the tailings. South of the dump a shallow north-south trench extends approximately 100 yards. Several small shallow pits are intermittently spaced alongside the trench. Iron pyrite is the only sulfide noted. Jamesonite and arsenopyrite are present. Gangue minerals are quartz, ankerite, calcite and chlorite. Secondary minerals are yellow oxides of antimony, limonite-goethite and malachite.

RESOURCES AND RESERVES

The stibnite deposits occur in fissure type veins as discussed by Bateman (1951). Stibnite occurs as lens in the quartz. Horizontally and vertically, the quartz veins may be rich to lean or barren of ore. Since the dips of the veins are near vertical, no assessment of reserves of the district can be made by available data. In the past the only reserve known at any given mine was the open ore face. To determine reserve potential for any of the known trends, close spaced drilling will be required. R. B. Stroud (1969) estimates that possibly as much ore remains in the district as what has previously been mined. This potential remains because the district was developed in a haphazard manner rather than systematically. Therefore, resources for the district to the depths that past mining has extended are 5400 tons of ore.

The potential of deeper deposits in the district is not known.

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INDEX