

METALLIC MINERALS IN ANHYDRITE CAP ROCK,
WINNFIELD SALT DOME, LOUISIANA

VIRGIL E. BARNES, *Bureau of Economic Geology, Austin, Texas.*

The Winnfield salt dome is located in Winn Parish, north-central Louisiana. A shaft sunk to the salt by the Carey Salt Company penetrates a zone containing metallic minerals. Specimens of these minerals collected from the mine dump were transferred to the writer by Mr. Paul Weaver, who has also contributed helpful suggestions in the preparation of this paper. Other specimens from the mine dump were collected later by the writer. Facilities for the study of these minerals were kindly furnished by the Bureau of Economic Geology, Austin, Texas, and by the Department of Geology, State College of Washington, Pullman, Washington.

Only a few metallic minerals have, heretofore, been recorded from American salt domes. A green copper mineral is recorded from the Hockley salt dome by Teas.¹ Hauerite (MnS_2) is reported by Wolf² and Hanna.³ Chalcopyrite, sphalerite, galena, and pyrite are mentioned from the Belle Isle salt dome, Louisiana, by Veatch⁴ and Vaughan.⁵ This completes the list, so far as the writer is aware, of metallic minerals described from salt domes. Of the minerals found during the present study only pyrite and chalcopyrite have been previously reported. Besides pyrite and chalcopyrite, native arsenic, chalcocite, enargite, and realgar are present.

These minerals are found at a place on the mine dump indicating that they are from the basal portion of the anhydrite. The same cap rock sequence, as found on many other American salt domes, is penetrated in the Carey Salt Company shaft. Thicknesses and depths of the materials penetrated are given in the following table.

¹ Teas, L. P., Hockley salt shaft, Harris County, Texas: *Am. Assoc. Pet. Geol. Bull.*, vol. 15, p. 465, 1931.

² Wolf, A. G., Hauerite in a salt dome cap rock: *Am. Assoc. Pet. Geol. Bull.*, vol. 10, pp. 531-532, 1926.

³ Hanna, M. A., A second record of hauerite associated with Gulf Coast salt domes: *Am. Assoc. Pet. Geol. Bull.*, vol. 13, p. 177, 1929.

⁴ Veatch, A. C., The Five Islands: *Geol. Sur. of Louisiana*, Rept. for 1899, pp. 223-226.

⁵ Vaughan, F. E., The Five Islands, Louisiana: Geology of salt dome oil fields, *Am. Assoc. Pet. Geol.*, pp. 386-388, 1926.

RECORD OF CAREY SALT COMPANY SHAFT, WINNFIELD, LA.

<i>Formations</i>	<i>Thickness Feet</i>	<i>Depth Feet</i>
Loam.....	2	0
Clay.....	33	2
Limestone—"Calcite cap".....	70	35
Gypsum—"Gypsum cap".....	25	105
Anhydrite—"Anhydrite cap".....	308	130
Salt	?	438

The metallic minerals have formed along parallel planes producing a distinct banding in the anhydrite. One mineralized layer is composed of native arsenic spheroids as much as a quarter of an inch in diameter. Other bands are composed predominantly of individual minerals, suggesting that selective replacement has taken place along lines of banding in the anhydrite, which in the mineralized zone shows no pronounced transverse breaks. This banding may correspond to flowage lines, rather than to bedding of a sedimentary type.

The native arsenic in the Winnfield specimens is a rather soft, brittle, light-gray, dull metallic mineral that tarnishes dark gray to nearly black, has a subconchoidal fracture, exhibits some evidence of colloform structure, and polishes to a white, smooth surface. A white arsenic trioxide sublimate and a garlic odor are given off if a specimen is placed on charcoal and touched by a blowpipe flame. Sublimation continues after the flame is removed until all the arsenic is consumed and leaves a very porous, magnetic ash containing copper. The iron and copper contained in the mineral probably cause the arsenic to oxidize in this peculiar manner.

Characteristic etch tests show that a bluish-gray mineral, associated with the native arsenic, is chalcocite. Chalcopyrite, a very abundant mineral in many specimens, is easily recognized by its characteristic color and softness. Pyrite is present in a few specimens. A mineral was encountered that stains black with potassium cyanide and is negative towards all other etching reagents. As this mineral is not separable from native arsenic and chalcocite, a qualitative analysis of material containing all three minerals was made. The analysis shows that arsenic, copper, and sulphur are abundant; also some antimony, as well as a trace of iron are present. The mineral is probably enargite (Cu_3AsS_4) containing some antimony.

A very soft, porous, dark-colored material surrounded by native arsenic, and a similiar brownish substance surrounded and veined by chalcopyrite, reacted briskly with nitric acid. These substances are probably residues of sooty chalcocite and limonite, which were formed by the leaching of impure native arsenic.

Realgar is rather abundant in some specimens, and some orpiment also is present. The orpiment appears to have formed since the specimens were exposed to light and air. This exposure, according to Winchell,⁶ permits a change to take place from realgar to orpiment and arsenolite (As_2O_3).

Green and blue copper minerals are prevalent on the surfaces of these specimens, but are not observed on fresh fractures. They probably formed while the specimens were on the mine dump in contact with chlorides, sulphates, and the damp Gulf Coast air. The rapidity of weathering may be judged, if the slightly weathered specimens, which were collected by Mr. Weaver, are compared with the highly weathered ones collected by the writer a few months later.

The non-metallic minerals were not especially studied. Anhydrite is the dominant mineral present. A few dolomite rhombs attached to the sides of gypsum filled tension cracks, and two very small druses of quartz in the anhydrite were exposed by polishing. Native sulphur was not seen.

The metallic minerals are located along anhydrite grain boundaries (Figs. 1-4) and show definitely that the anhydrite is replaced. Native arsenic was the first metallic mineral deposited. Replacement of native arsenic by chalcocite (Fig. 1), enargite (Fig. 2), and chalcopyrite has largely obscured the relationship of anhydrite to native arsenic. However, the scanty evidence present indicates that native arsenic replaces anhydrite. Corroded chalcocite fragments surrounded by enargite show that chalcocite preceded the enargite. Simultaneous deposition of enargite and chalcopyrite is indicated by the relationship shown in Fig. 4. Pyrite, which is younger than anhydrite, is not associated with the other metallic minerals, consequently its age relation to them is indeterminable. After deposition of metallic sulphides had entirely ceased tensional cracks formed across the mineralized bands. Realgar crystals and dolomite rhombs were deposited along the walls of these cracks,

⁶ Winchell, A. N., *Elements of Optical Mineralogy*, pt. II, p. 22, *New York*, 1927.



FIG. 1

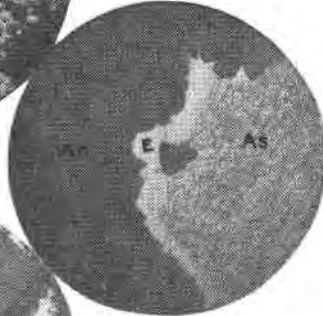


FIG. 2

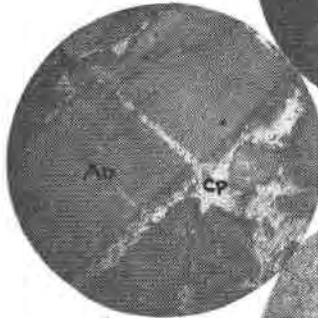


FIG. 3

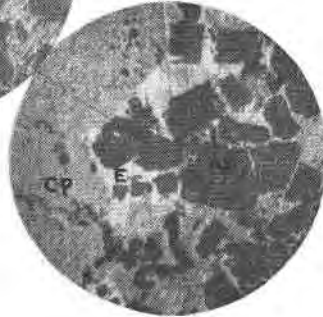


FIG. 4

PLATE I

The symbols on the photomicrographs are as follows: As—native arsenic; C—chalcocite; E—enargite; Cp—chalcopyrite; and An—anhydrite. The magnification is uniformly forty diameters.

FIG. 1. The edge of a native arsenic granule is replaced by chalcocite and enargite. Enargite is later than chalcocite, and all three minerals are later than anhydrite.

FIG. 2. The edge of a native arsenic granule is replaced by enargite. Both minerals are later than anhydrite.

FIG. 3. A chalcopyrite veinlet crosses a crystal of anhydrite, and chalcopyrite replaces other anhydrite grains along their boundaries.

FIG. 4. The chalcopyrite and enargite situated along anhydrite grain boundaries are related in such a manner that simultaneous deposition is indicated.

and the remaining space was filled by gypsum. Native arsenic was probably leached to form realgar, leaving the contained impurities as a residue of sooty chalcocite and limonite.

The source of these minerals is conjectural. Enargite is thought by American writers to be hypogene. European writers, however, have expressed the view that it may be supergene. Chalcopyrite is predominantly hypogene, and a few occurrences are undoubtedly supergene. Chalcocite in most deposits is supergene, but in a few it is hypogene. The evidence suggests a hypogene origin for this mineral assemblage; yet a supergene origin may be possible.

The orthorhombic variety of chalcocite, which forms at a temperature below 91°C., is indicated by the etched cleavage. The chalcocite, therefore, could not have crystallized at greater depths from the earth's surface than about seventy-five hundred feet, providing the present geothermal gradient observed in the salt-dome areas existed at the time these minerals were deposited. This depth is near that given by Lindgren⁷ for the central portion of the mesothermal zone. These minerals then, if hypogene, evidently belong to either the mesothermal zone or to the overlying surficial epithermal zone of ore deposition. Epithermal and mesothermal mineral deposits are probably largely derived from ascending mineralized solutions from magma basins or congealing batholithic masses.

The mineral paragenesis in a mesothermal deposit is usually pyrite, enargite, chalcopyrite, and chalcocite, deposited in the order named. The order for the Winnfield minerals is chalcocite and enargite-chalcopyrite. This change in order may be caused by the host rock, which is entirely different from that in any other deposit described.

In summarizing, it may be said that the metallic minerals of the Winnfield salt dome are *epigenetic*, and were deposited in the order: native arsenic, chalcocite, and enargite-chalcopyrite. Realgar crystals and dolomite rhombs, enclosed by gypsum, fill tensional cracks that formed across the brittle metallic mineral bands. The realgar is a secondary mineral crystallized from material nearby, probably from impure native arsenic, part of which was leached, leaving the contained impurities as a porous mass of sooty chalcocite and limonite.

⁷ Lindgren, Waldemar, Mineral Deposits, p. 598, *New York*, 1928.

The primary chalcocite probably is the orthorhombic variety which crystallizes below 91°C. If this be true, and the geothermal gradient at the time these minerals were deposited was the same as at present, the anhydrite was within seventy-five hundred feet from the surface at the time these minerals were introduced. These minerals belong probably to either the mesothermal or epithermal group of mineral deposits, which connotes an origin from some magmatic source.