A Memorandum Report on Barite-Fluorite Deposits
in the eastern belt of the Sweetwater Barite District
Monroe County, Tennessee.

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Areal geologic mapping in the eastern belt of the Sweetwater barite district has disclosed very small cross structures that appear to control the mineralization in this belt. This memorandum report, covering four mineralized areas related to the cross-structures, is submitted to guide a drilling project, proposed by the Bureau of Mines, for barite-fluorite ore which is in place in the rock, rather than prospecting for such ore in the residual soil. All of the commercial barite production in the district has been from residual deposits derived from weathering of the enclosing dolomite and limestone.

Areas 3 and 4, recommended for initial exploration, have been selected in the belief that they offer the best possibilities for large tonnange of ore rather than on the existence of better structural control of the mineralization. Specific suggestions are made for testing Area 3, the Ballard mine and vicinity, since the geologic mapping has been completed and the geology therefore more fully understood. No specific recommendations are made for testing Area 4, the Stephens mine and vicinity, as the geologic mapping is not yet completed. These two areas are believed to be about equal as potential sources of barite-fluorite ore.

Location of Areas Described

Three of the mineralized areas, numbered consecutively

northeast to southwest and shown on the attached map, are located in Monroe County, Tennessee. Area 4 is eight miles southwest of Area 3 and extends across the line into McMinn County. They are from seven miles east to five miles south of Sweetwater, Tennessee, and are easily accessible by good secondary roads. Sweetwater and Wood Station, two miles south of Sweetwater, are the nearest shipping points on the railroad.

Stratigraphy of the Ore Deposits

All of the deposits occur in the Beekmantown division of the Knox dolomite group of carbonate rocks of lower Ordovician age. These formations in ascending order are: the Chepultepec dolomite, the Longview dolomite, and the Newala dolomite and limestone. Where the bedrock of the Newala can be seen, as in diamond drill cores, it can be separated into two formations, the Kingsport limestone and the Mascot dolomite, to which it is the undifferentiated equivalent.

The Chepultepec dolomite, except for a few scattered outcrops, is not exposed anywhere in this region and has not been penetrated in core drilling so the detailed lithology is not known. The few outcrops are cherty dolomite, medium to light gray and fine grained. The two heavy sandstone beds, each with a maximum thickness of 2.5 feet, occur in the lower 15 feet of the formation, and blocks of these in the residual soil are used in drawing the base of the formation. Much of the light colored, brittle, slightly porous chert produced on weathering breaks down into small chips and covers the soils underlain by the formation rather

abundantly. Rounded, hollow nodules lined with quartz crystals, as well as aggregates of columnar quartz are common. The Chepultepec has been mapped together with the overlying Longview and the thickness of the two formations, computed from the breadth of outcrop at different points and the average dips of the overlying beds, is about 900 feet, of which the lower 600 to 700 feet is Chepultepec.

Only scattered outcrops of the Longview dolomite are found in the area, so the detailed lithology of this formation also is unknown except for the upper 100 feet which was cored at the Eve Mills zinc prospect, located in the same outcrop belt a few miles to the northeast. Here the upper 30 feet consists of light gray, very finely granular dolomite with a few beds of limestone followed by 60 feet of dense, dove-colored limestone. The fine grained dolomite contains abundant flattened nodules of blue and gray banded chert which appear on the surface but are subordinate to the large amounts of nearly white, very dense chert that is more typical of the formation. The thickness of the Longview in this area is probably 200-300 feet.

The lithology of the lower 300 feet of the Newals, the equivalent of the Kingsport formation, is accurately known at the Eve Mills prospect where it has been cored. The lower 50 feet consists of medium grained dolomite with beds of dense limestone up to 8 feet thick. Above this are 100 feet of dense dove-colored or brown limestone, in turn overlain by 130 feet of very light gray, very fine grained dolomite with a few thin beds of dark crystalline dolomite and limestone in the upper and lower portions. In the areas of zinc and barite mineralisation the thick limestone in the

lower Newala is partly altered to coarsely crystalline dolomite as are the limestones in the other Beekmantown formations.

The lithology of the upper 600 feet of the Newala, the equivalent of the Mascot formation, is known partly from cores and partly from outcrops. It consists of rather well bedded, light to dark gray, fine to medium grained dolomite. The lower 185 feet contains numerous sandy beds in which the cement is dolomite or calcite. The calcareous cement dissolves on weathering, the sand beds thus breaking down into separate grains no longer recognizable as beds in the residuum. The sand marking the base of the Mascot formation is of this character and is recognizable in so few places that the Kingsport and Mascot formations are mapped together as the Newala. The "A" sand, the upper sand in the cored section at the Eve Mills zinc prospect, 450 feet below the top of the Newala, has a siliceous matrix, is resistant to weathering, and can be mapped fairly accurately except in the southern end of the area where it too, has been broken down by weathering.

Chert is present in the residual soils of the Newala but generally occurs in much smaller amounts than in the soils produced by the other Beekmantown formations; in many places in the eastern belt it is almost entirely lacking. The Newala chert is chalky, porous, and often deeply stained with iron oxide in contrast to the dense, unstained chert of the Longview, and this difference is useful in drawing the contact between the two formations. In areas of structural disturbance and barite mineralization, the contact is often obscure because of the abnormally large amount of chert there developed, Longview types being found in the Newala, and Newala types in the Longview.

General Structure

The rock beds in the eastern belt have a regional strike of N 50° E; the dip average about 13° southeast at the northern end of the district and gradually increases to about 20° southeast at the southern end. This gradual increase in dip is shown on the map by the decreasing width in outcrop of the Beekmantown formations. Outcrops of the upper Newala are fairly numerous in the northern end of the area but become less common southward and because of this lack of outcrop the structural features in the southern end of the area are more difficult to determine. Folding or faulting, causing repetition of strata, may be present in the Newala in the southern end of the area as its outcrop width remains nearly constant throughout the belt while the outcrop of the other Beekmantown formations thins progressively. This is not believed to be caused by an increase in thickness.

Detailed Structures

Two types of detailed structures are known in the area and are believed to exercise much control over the mineralization; these are:

1. Gentle anticlinal cross folds shown by change of strike: Northeast across such structures the strike is first N 50° E, which is normal, then changes to N 55° or 60° E, then gradually shifts to about N 25°E, and finally returns to the regional strike.
2. Abrupt changes in strike forming a "kink" in the beds, but without appreciable horizontal displacement. Such changes in strike amount to about 30 and form a relat-

ively narrow fractured and brecciated zone.

The two types of minor structures described above have axes usually trending N 60 to 80° W, thus cutting across the regional structure. Their strike may actually vary through a still wider arc - between N 40° W and due east. The exact trend of a given cross structure cannot be learned from surface studies alone because of the sparseness of outcrops. Formational boundaries drawn on residual material are not accurate enough to show such small features. It must be emphasized that the cross-folds and changes in strike of the above types are very inconspicuous and can only be found where outcrops occur. It is not likely that all have been located, and this applies particularly to the southern end of the area where outcrops are least common.

In addition to the above types, minor folds and faults may well occur but have defied detection because of the heavy cover of residual soil. Their presence is suspected, particularly in and near the thick limestone near the base of the Newala, because a few outcrops do not agree with the regional strike.

Occurrence and Type of Mineralization

The known stratigraphic range of the barite mineralization is from a stratigraphic position about 375 feet below the top of the Newala through the Longview and into the Chepultepec dolomite, an interval representing more than 1,100 feet of strata.

A study of rock pinnacles exposed in the barite mines has shown that the barite, pyrite, fluorite, sphalerite, and galena occur

primarily as banded veins in coarse breccia. Occasionally the above minerals are found along bedding planes and disseminated in coarsely crystalline dolomite that has replaced limestone. Roughly, these minerals were deposited in the following order of abundance: (1) barite, (2) pyrite, (3) fluorite, (4) sphalerite, and (5) galena. Only traces of sphalerite and galena have been seen; locally fluorite is more abundant than pyrite.

Discussion of Individual Mines and Areas

Area 1: Barnes (Simpson) and McCallie Mines and vicinty.-

These two small mines are now idle though considerable barite, mixed with pyrite and limonite, occur in the walls. The Barnes Mine is above the "A" sand, higher stratigraphically than any other mine known in the district. In order, (1) wall rock, (2) pyrite and marcasite, (3) sphalerite, and (4) barite occur in veins surrounding breccia blocks. More sphalerite was seen here than in any other mine examined, but the quantity is very small as compared with barite and pyrite. A small amount of galena was observed on the dump but none was found in the rock pinnacles in the mine.

The McCallie Mine is just above the contact between the Longview and Newala formations. Only a small amount of barite has been mined here and no bedrock is exposed. Barite, fluorite, pyrite, and much chert, considered to be a secondary type, occur in the walls.

The broken line shown on the map, A-A', marks a very abrupt change in strike from N 55° E to N 20° E. This change is well shown at the contact between the Newala formation and the overlying Lenoir limestone. No horizontal displacement is evident at the point of change, but the limestone is considerably sheared. The direction

of the line of change is fairly well controlled by outcrops and it is near N 78° W. There can be little doubt that this structure controls the mineralization at these two mines.

While the structural control is more precise here than at any of the other mines, the area is not recommended for drilling at present as the mineralization does not appear to be as strong as at the Ballard and Stephens Mines and the mineralized area is likely to be narrow. Should drilling be done here, the first holes should be located along the line of change in strike.

Area 2: Guthrie, Readley, and Jones Mines and vicinity.-

The three mines in this group are now idle and the amount of barite produced from them is not known. Pinnacles exposed in the pits show the bedrock to be coarsely crystalline dolomite; the type resulting from dolomitization of limestone. The Longview-Newala contact is very difficult to locate accurately here because of the development of non-typical types of chert, but the mines are believed to be in the thick limestone unit of the lower Newala. Barite, fluorite, and pyrite occur as veins 2 and 3 inches thick between blocks of coarse breccia. The proportion of fluorite is large in respect to barite. Pyrite and limonite are intimately mixed with the berite making separation difficult. The mineralization at Mine #2 is stronger than at the other two, but is much weaker than at the Ballard Mine described beyond.

The mineralization in this area appears to be related to a very abrupt change in strike, marked by a line B-B', that trends about N 70° W. Its direction is not known with certainty because outcrops are lacking.

This area is not recommended for testing at the present time because the mineralization appears weaker than at the Ballard and

Stephens Mines and because the mineralized area is probably not as wide, particularly down-dip. Should drilling for barite and fluorite in rock ever be done here, the first holes should be near the line marking the change in strike.

Area 3: Ballard (Krebs) Mine and vicinity.-

The Ballard Mine and other adjacent pits are, together, reported to have produced the second largest quantity of barite in the Sweetwater District. Gordon 1/ states that this mine had

1/ Gordon, C. H., Barite deposits of the Sweetwater district, East Tennessee: Resources of Tenn., vol. 8, pp. 62-63, 1918.

produced a total of 20,000 tons to January 1918 and that the Hudson Mine(more commonly called the Bertha Mine), 650 feet to the east, had produced 2,000 tons. It is estimated that the total production from these mines to the present time is near 100,000 tons.

Both mines have been idle for many years and the Bertha Mine is now filled with tailings. Mr. L. A. Wood has recently opened a new mine, showing good ore, about 800 feet south of the Ballard. More pinnacles of bedrock are exposed in the Ballard than in any other mine in the district and these show the rock to be mineralized along a strike distance of 800 feet. Barite and fluorite are the principal minerals, pyrite is common and traces of sphalerite and galena have been found. These minerals occur primarily as banded veins in coarse breccia. It is estimated that the rock exposed contains about 8 percent barite, 2.50 percent fluorite, and 1.5 percent pyrite. The irregular pinnacles do provide satisfactory faces for making grade estimates and this figure may be considerably in error, particularly since it is bases on about 15 feet of a mineralized zone that may be as

much as 200 feet thick. Pinnacles showing similar mineralization are reported to occur in the Bertha Mine but are no longer visible. The rock exposed consists of light gray finely granular dolomite, coarsely crystalline dolomite, and limestone. The surface data are meagre but indicate that the ore occurs in the thick limestone dolomite above this unit.

The mineralization here is believed to be related to a gentle anticline shown in outcrops one mile due east of the mine. Outcrops are not sufficiently numerous to indicate the exact position of the axis of this fold but the Ballard Mine is believed to be near its center. The approximate position of the axis is shown on the map by line C-C'.

Because of the good showings of barite and fluorite and because of the favorable conditions caused by the anticline for finding ore down-dip, this area is recommended for the first exploration. It is suggested that the first testing be by a line of holes spaced 300 feet apart along the strike; the line should be located far enough down the dip to penetrate the full thickness of the indicated mineralized zone. The eight hole locations shown on the map southeast of the Ballard pit are recommended. Each hole would have to be about 200 feet deep to penetrate the full thickness of the thick limestone of the Newala, and, if ore is found in the thick limestone in the upper Longview formation, would have to be about 300 feet deep. It is recommended that the locations designated #1 and #2 be drilled first as they are thought to be nearest the crest of the anticline. The first hole should be continued through the thick limestone in the upper Longview formation.

The eight locations shown represent a minimum of about 1700 feet and a maximum of about 2500 feet of drilling. In seeking down-dip extensions of mineralized ground, additional holes should be located due east of holes on this line that encounter barite. The estimated position of the thick limestone in the Newala has been computed from the position of the "A" sand and the top of the Longview formation and may be considerably in error as neither of these horizons can be very accurately located in this area and the average dip is not known with certainty. After the first hole has been drilled it may be necessary to shift the entire line of holes either up or down the dip.

The overburden in the vicinty of the proposed locations can be expected to vary greatly, probably from 10 to 70 feet, and it would be well to make some provision for detecting the presence of barite in it since the mineralization may extend higher stratigraphically than is now known and the residual deposits represent the most readily available source of the mineral.

Area 4: Stephens and Roy Mines and vicinty(not shown on map).-

The Stephens Mine, now in operation, is the largest in the district and is reported to have produced to date about 500,000 tons of barite. The Roy Mine also produced a large quantity but the total production is not known.

The geologic mapping has not been completed and no recommendations for testing the area are made at this time. The studies completed to date indicate the presence of an anticline, but the information at hand is not sufficient to establish the position of the mines with respect to the axis of the fold. The stratigraphic range of the mineralization

here seems to be from above the thick limestone unit of the lower Newala down into the Chepultepec formation. The large production of residual barite, taken together with the previously mentioned fold, make this area equal with the Ballard Mine area as a favorable locality for finding a large tonnage of barite in the rock. Areal mapping is being continued; if a a later date exploration here proves desirable, geologic data will be available for guiding the prospecting.