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VERMICULITE DEPOSITS
OF THE
ENCAMPMENT DISTRICT, WYOMING

by
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THE GEOLOGICAL SURVEY OF WYOMING
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ABSTRACT

Vermiculite of the Encampment District, Carbon County, Wyoming, occurs in pre-Cambrian metamorphic and igneous rocks along contacts of granite pegmatite and aplite with hornblende schist, biotite schist, and hornblende-quartz diorite. Formation of vermiculite is associated with intrusions of pegmatite and aplite. These intrusions were apparently sufficiently aqueous to alter hornblende and biotite to vermiculite.

There are three deposits located in the foothills of the east flank of the Sierra Madre range at altitudes between 7000 and 7500 feet. The metamorphic rocks are steeply dipping roof pendants not entirely digested by the early granites of the region. Later granites, pegmatites, and aplites intruded the earlier rocks principally as lit-par-lit injections although injections cutting across schistosity are common.

Individual vermiculite bodies vary in size from those a few feet in length and width to one about 40 feet by 40 feet. Most of the vermiculite occurs in bands and lenses along the contacts referred to above. The maximum depth at which it has been mined is 105 feet. Below this depth bodies are, for the most part, too narrow to work profitably.

Accurate estimates of reserves from surface evidence are not possible because of the extremely irregular distribution of the vermiculite and the tendency of bodies to pinch and swell in depth. Further exploratory work is recommended to block out a sufficient reserve so operations may continue uninterrupted when the body now being worked is depleted.

INTRODUCTION

The three deposits described in this report are located in Carbon County, Wyoming, in secs. 9 and 15, T. 15 N., R. 83 W., and in sec. 3, T. 13 N., R. 82 W. Two properties are situated near the Encampment River about 5 miles northeast of Encampment; the third is about 15 miles southeast of Encampment on the Ralph Platt ranch. Each deposit is accessible by dirt road connecting with a paved highway leading into Encampment. The railroad at Encampment is the nearest shipping point except for a spur about a mile from the deposit in sec. 3, T. 13 N., R. 82 W.

The elevation of the deposits is between 7000 and 7500 feet. Winters are severe enough to interfere somewhat with surface mining and transportation from October through May. Sufficient water is available a short distance from all three deposits for their operation.

One of the properties, on the south side of the Encampment River, in sec. 15, T. 15 N., R. 83 W., was formerly operated by the Mikolite Company of Kansas City, Kansas. The other deposit, across the river in sec. 9, T. 15 N., R. 83 W., is owned principally by Earl Paine of Casper, Wyoming. The

deposit southeast of Encampment, on the Platt ranch, is now being worked by the Mikolite Company.

The writer's study of the Encampment deposits was part of the State Geological Survey's investigation of Wyoming mineral resources. About ten days were spent in the area in the summer of 1940 and one day in 1942. Geologic maps were made of both deposits along the Encampment River and of the principal workings on the Platt ranch.

The writer wishes to thank Dr. Knight of the University of Wyoming Geology Department and Dr. Thomas, State Geologist of Wyoming, for critically reading the manuscript. The Geological Survey of Wyoming has generously financed the studies. Messrs. Milan Maravich and Eldon House acted as instrument men during the geologic mapping. Consent to map the deposits was obtained from Mr. Earl Paine, Mr. Ralph Platt, and Mr. R. W. Rice. The writer is also indebted to Mr. Frank Huston, of Encampment, for his many courtesies.

TOPOGRAPHY

The relief in the immediate vicinity of the vermiculite deposits is not great. The topography is subdued and slopes are relatively gentle. Erosion has locally produced divides which are essentially foothills of the Sierra Madre range. The principal stream draining the region is the Encampment River. Pre-Cambrian metamorphic and igneous rocks comprise the hills in which

all the vermiculite is found.

Because of the character of the topography it has been relatively easy and inexpensive to construct roads in the region.

GEOLOGY

General--The vermiculite deposits of the Encampment District are all associated with pre-Cambrian metamorphic and igneous rocks. The rock types include biotite schist, hornblende schist, meta-diorite and meta-basalt, granite gneiss, granite, granite pegmatite, aplite, and quartz veins.

It is believed that the rocks, with the possible exception of biotite schist, represent original igneous material in various stages of metamorphism. The hornblende schist, for example, exhibits all gradations from a coarse-grained hornblende-quartz diorite to a fine-grained quartz-hornblende schist with well developed schistosity. The granite gneiss also shows transitions from a pink, coarse-grained granite to a highly contorted gneissoid granite. Biotite schist may represent a metamorphosed sediment. None of the Paleozoic and Mesozoic formations found along the west flank of the Sierra Madre Mountains crops out in the vicinity of the vermiculite deposits.

Hornblende Schist and Meta-diorite--The hornblende schists and meta-diorites are black, fine to medium-grained rocks containing white specks and streaks of quartz. The principal mineral is hornblende with lesser amounts of quartz. Minor constituents are epidote, zoisite, sphene, feldspar, and magnetite.

This rock shows all gradations from a hornblende-quartz diorite with no schistosity to a rock with well-developed parallel orientation of mineral grains. It seems probable that the hornblende schist was originally either a quartz diorite where it occurs as dikes, or a dacite where it appears to have been a flow rock. Although most of the rock is now hornblende, it is quite possible that originally the hornblende schist was basaltic in composition.

Hydrothermal alteration of hornblende schist and hornblende-quartz diorite has produced most of the commercial vermiculite in the Encampment District. The hot aqueous pegmatitic solutions acted on the hornblende to give vermiculite, apparently without an intermediate chlorite and amphibole stage except locally. Where chlorite has formed the rock is mottled green and brown. Other alteration products include small quantities of sericite and kaolin.

Biotite Schist--The biotite schists are brown and white, fine-grained rocks consisting almost entirely of biotite and quartz. Minor amounts of apatite, zircon, and an appreciable amount of magnetite are present. Schist-

osity is usually well-developed.

Near pegmatite contacts biotite schist may be partly or entirely altered to vermiculite. The schist has been soaked with granitic material producing, in places, a speckled brown and white rock composed of vermiculite and pegmatitic feldspar and quartz. The only other alteration product is kaolin which is present in very small quantities.

Granites, Pegmatites, and Aplites--The most abundant granite is a white, coarse-grained rock consisting chiefly of quartz, orthoclase, and albite-oligoclase. Locally it contains appreciable amounts of biotite and /or muscovite. In places the rock exhibits a parallel arrangement of mineral grains. Principal alteration products are sericite, kaolin, carbonate, and chlorite.

Granite is intrusive into the older schists and meta-diorites and has largely assimilated these rocks. Somewhat later than the granite, intrusion of granite pegmatite, aplite, and quartz veins took place.

In the general vicinity of the vermiculite deposits a red coarse-grained granite is found. The color varies somewhat with the feldspar content. Locally the rock is gneissoid. No alteration products were noticed in hand specimens.

Since the red granite is outside the immediate vermiculite area, no attempt was made to determine in detail its relation to the rocks of the region. It appears to be younger than the quartz diorites and schists and older than the pegmatite, aplite, and quartz veins.

STRUCTURE

All the metamorphic rocks in the vermiculite areas have been strongly folded. The schists dip steeply; the dip frequently changing considerably in a short distance. The general trend of the schists in secs. 9 and 15, T. 15 N., R. 83 W. is N. 20° W. In sec. 34, T. 14 N., R. 82 W. the trend is in general NE-SW.

Invasion of the hornblende and biotite schists is largely lit-par-lit but small stringers of pegmatite and aplite cut across schistosity. Minor offsets of the metamorphic and igneous rocks are numerous and, along with the number and irregularity of the schist bands, make it impractical to map each occurrence in detail.

The metamorphic rocks in the Encampment area appear to be roof pendants not entirely digested by the younger pre-Cambrian granites of the region. Xenolithes are common and frequently exhibit lit-par-lit injection and considerable assimilation by the granites.

OCCURRENCE

The Encampment vermiculite of commercial quality and quantity is found

at the contact of granite and hornblende schist, granite and biotite schist, and of granite and hornblende-quartz diorite. Occasionally it occurs as specks or patches within granite but never in sufficient quantity or purity to constitute commercial material.

The Encampment vermiculite may be bronze, dark brown, or brownish green depending principally upon which mineral altered to vermiculite. Biotite has altered to the bronze variety, hornblende to the dark brown, and the green variety is produced by intermixed chlorite. The color is fairly uniform throughout any one vermiculite body except locally where alteration has been incomplete or where considerable impurities occur.

The distribution of vermiculite is extremely irregular. Individual bodies pinch and swell. In depth vermiculite may open up to a fair-sized body or end abruptly. This is typical of Wyoming vermiculite; the formation and size of the deposits depends upon the location and size of the schists or hornblende-quartz diorites and the granites. This irregularity makes it virtually impossible to arrive at an accurate estimate of vermiculite reserves from surface evidence.

Another unfortunate characteristic of relatively small vermiculite bodies is the variability in capacity of the mineral to expand. Vermiculite in different deposits and even in parts of the same body may not expand uniformly. In general, however, the larger bodies will react essentially the same throughout. It is this variability, however, that makes it difficult to standardize the product for the market.

The Encampment vermiculite bodies vary considerably in size and quality. Many are only a few feet long and wide. One is as much as 40 feet wide and 40 feet long and has been worked in a shaft to a depth of 95 feet. None of the bodies extends to great depth; the deepest shaft is about 105 feet and little vermiculite lies below this depth.

The vermiculite flakes vary somewhat in size. In the preparation of expanded material the larger flakes must be crushed and sized. Undersized flakes which are of no value in the preparation of the expanded product may be used in the manufacture of paints. There is at present no equipment at the Encampment deposits for sizing and expanding the mineral. All the vermiculite is shipped as crude material to be treated elsewhere.

ORIGIN

Vermiculite in the Encampment District was apparently formed by the action of hot pegmatitic and aplitic solutions on biotite and hornblende. The alteration has taken place along contacts of granite with biotite schist,

hornblende schist, and hornblende-quartz diorite. Locally chlorite has been produced along with the vermiculite. It seems probable that a small amount of vermiculite was formed where pegmatites cut earlier biotite granites. Here the biotite was altered to vermiculite.

Apparently the end-stage magmatic solutions contained sufficient volatile matter to change hornblende and biotite to vermiculite. The largest vermiculite bodies in the Encampment District are those which occur adjacent to granite and hornblende schist and granite and hornblende-quartz diorite contacts. This is probably due to the fact that hornblende schist and hornblende-quartz diorite form more massive, thicker, bodies than does biotite schist.

MIKOLITE DEPOSIT NEAR ENCAMPMENT RIVER

The Mikolite property in sec. 15, T. 15 N., R. 83 W. is at an elevation of about 7300 feet. It is reached by a dirt road about 2 miles long which connects with Wyoming State Highway 130 at a point about 3 miles northeast of Encampment.

In 1940 the deposit was owned by the Mikolite Company but is not being worked at present. The main workings include 3 shafts, a drift, and a number of pits which vary in size from a few feet in width and length to one about 40 feet by 40 feet. One shaft is 65 feet deep and is connected by a 112 foot drift with another farther up the hill, which is 95 feet deep. The third shaft on the hill is about 105 feet deep.

The principal workings are along contacts of hornblende schist and granite though some of the smaller pits are at the contacts of biotite schist and granite.

The granite which has produced the vermiculite by alteration of hornblende and biotite is of two kinds. One is a coarse-grained pegmatite composed essentially of quartz and feldspar. The other is a fine-grained granite containing much the same minerals.

The largest hornblende schist mass in the area is the one in the immediate vicinity of the shafts and drift. This mass contains numerous smaller bands and lenses, some of which have been partly altered to vermiculite. The biotite schist bands are narrower than the largest hornblende schist bodies and consequently have given rise to correspondingly narrower vermiculite bands.

When the deposit was visited by the writer in the summer of 1940, one shaft and part of the drift to the shaft on the hill was accessible. This second shaft had caved badly and could not be explored. The east wall of the drift shows the general geologic conditions of the principal workings.

The geological relations are more readily understood from the accompanying cross-section than from a map.

Most of the commercial vermiculite appears to have been removed from the property. Small amounts occur as relatively narrow bands in the walls of the shafts and drifts, and in some of the pits. To remove what vermiculite remains in the walls of the shafts and drifts would necessitate the installation of hoisting equipment. The cost of such an installation would almost certainly prove to be prohibitive.

PATNE DEPOSIT NEAR ENCAMPMENT RIVER

The Paine property is in sec. 9, T. 15 N., R. 83 W. and is across the Encampment River just north of the Mikolite deposit. It appears to be a continuation of the Mikolite occurrence interrupted by the channel of the Encampment River. The property is reached by a private road about a mile long connecting with Wyoming State Highway 130 at a point 3 miles northeast of Encampment. The distance to Encampment is about 4 miles. There is a railroad spur about 1 mile from the property at which vermiculite can be loaded.

The general geologic conditions and character of the vermiculite are similar to those at the Mikolite deposit referred to above. Vermiculite has formed at the contacts of granite with hornblende schist and biotite schist. The granite is pegmatitic and aplitic and is younger than the other rocks of the region.

There is not as much vermiculite here as at the Mikolite property across the Encampment River. Most of the commercial material has apparently been removed, judging from pits and surface showings. Numerous small pits containing vermiculite have been dug but the bands of vermiculite are narrow and interrupted.

MIKOLITE DEPOSIT ON PLATT RANCH

The Mikolite property now being worked is located on the Platt Ranch in

sec. 3, T. 13 N., R. 82 W. The deposit is accessible by a dirt road about 1 mile from Wyoming State Highway 230. The distance to Encampment is 15 miles.

The property was examined on June 14, 1942. The rocks in the vicinity of the principal workings consist of a hornblende-quartz diorite and granite. Vermiculite has formed along the contact of these two rocks.

The workings consist of a tunnel about 100 feet long near the granite and hornblende-quartz diorite contact. The geologic relations are not well shown in the tunnel, which is in vermiculite cut by pegmatite dikes. In one of the drifts, however, the relation of vermiculite to granite and hornblende-quartz diorite can be seen and is shown in the following cross-section.

The hornblende-quartz diorite mass is relatively large and is mappable on the surface for a distance of 275 feet. When examined in June, the southwest part of the tunnel was still in vermiculite and, judging by surface exposures, there remained about 125 feet of vermiculite. Several small (4' to 15') drifts to the northwest and southeast were in vermiculite.

In addition to the principal tunnel there are surface indications and pits sunk in vermiculite in the general vicinity now under lease to the Mikolite Company. These were not visited by the writer but according to Mr. Platt could furnish additional vermiculite if opened up.

Production figures of vermiculite from the Mikolite-Platt property are as follows:

1941	544.8 tons
1942	479.5 tons (to Nov. 1)

FUTURE POSSIBILITIES OF ENCAMPMENT DISTRICT

It is believed that the best opportunities for further development of vermiculite in the Encampment district are in the area now under operation. This is indicated by underground workings, surface showings, and the essential depletion of the other Encampment deposits.

Vermiculite surface indications have been reported from many places in

the Encampment district but most of these are too limited to be of value, or have never been explored. It is possible that exploratory work may prove sufficient commercial vermiculite for increased production. Such work should be done before the vermiculite now being mined gives out so that operations may continue elsewhere with no interruption in production.

It seems probable that vermiculite production could be increased somewhat if necessary by development of some of the surface indications and by the employment of additional men. Mr. Frank Huston has done essentially all the work in the area for the Mikolite Company. Some additional equipment would also facilitate and speed up production.