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Geology and Mineral Deposits of Lincoln and Flathead Counties, Montana

by

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QUARTZ LATITE PORPHYRY AND DIORITE DIKES

Several quartz latite porphyry dikes north and southwest of the Rainy Creek intrusive are exposed for distances as great as half a mile, and they range in width from 50 to 75 feet. Specimens are characterized by light-gray to white phenocrysts in a dark-yellowish-green to brown or black groundmass, which weathers dark gray to rusty orange brown. The phenocrysts range from 3 to 25 mm in length; rectangular phenocrysts attain a width of 7 mm.

In thin section most of the phenocrysts can be identified as plagioclase, but a few are quartz. Feldspar phenocrysts exhibit Carlsbad, albite, and pericline twinning, and most are strongly sericitized. The most abundant feldspar is albite, which occurs in grains 0.35 to 0.7 mm in width and 1.0 to 2.35 mm in length. The very fine grained groundmass contains slightly more plagioclase than orthoclase; ferromagnesian minerals are also abundant, and iron oxides and moderately abundant quartz are disseminated throughout. Iron oxide grains (hematite and limonite) range from 0.10 to 0.42 mm; angular to subrounded quartz grains range from 0.05 to 0.43 mm.

Two diorite dikes south and southwest of the Rainy Creek pluton strike eastward (Beer, 1960). In surface exposure the rocks are light yellowish orange to light gray, are medium grained, and weather bright yellowish orange. Needles and grains of pyroxene are disseminated unevenly throughout the groundmass.

The most abundant mineral seen in thin sections is plagioclase; the grains range from 0.80 to 2.25 mm. Next most abundant are crystals and grains of pyroxene (probably diopside) ranging from 0.05 to 1.45 mm. Quartz is minor, and the grains range from 0.12 to 0.15 mm. Magnetite is also sparse; the grains range from 0.10 to slightly more than 2 mm.

AGE OF DIKES

Granitic dikes are closely related to acidic stocks, and it seems reasonable to assume that the ages of the two kinds of rock are similar, that is, late Mesozoic.

BASIC STOCKS

RAINY CREEK STOCK

The Rainy Creek stock is west of the Kootenai River about 8 miles northeast of Libby. This large complex stock of pyroxenite and syenite underlies part of the valley of Rainy Creek and extends east beneath Vermiculite Mountain. The irregular outcrop area of the stock is about 7½ square miles.

Aegirite pyroxenite and aegirite-diopside pyroxenite, syenite, and some pegmatite have intruded strata of the Wallace Formation. Pyroxenite is probably the oldest intrusive rock in the stock and constitutes about two-thirds of the stock. Almost all of the other one-third is syenite. Quartz veins containing small amounts of chalcopyrite, sphalerite, and galena are postsyenite in age, as they intrude pyroxenite and syenite. A small amount of opaline material associated with quartz veins was observed locally in the Zonolite Company's open pit. The border phase of the pyroxenite intrusive mass is rich in magnetite. An analysis of a magnetic concentrate of this material gave 63.80 percent iron, 0.60 percent titanium oxide, 2.40 percent silica, and 0.50 percent phosphorus.

Pyroxenite within the Zonolite pit is light-gray to yellowish-green coarse-grained friable rock composed of vermiculite, aegirite, aegirite-diopside, soft fibrous tremolite, apatite, magnetite, garnet, biotite, and hydrobiotite. Fluorine-rich apatite makes up 7 to 10 percent of the rock. Aegirite and aegirite-diopside both are locally vanadiferous. Boettcher (1963) described two major types of pyroxenite; the more abundant type (common pyroxenite) consists of pyroxene, vermiculite, and apatite. Another, finer grained type of pyroxenite consists of pyroxene and contains smaller proportions of vermiculite, apatite, garnet, magnetite, and sphene.

Near the center of the pyroxenite mass is a biotite-rich (biotitite) area consisting of 90 percent biotite, the rest being feldspar, pyrite, and calcite. Tremolite (amphibole asbestos) forms at the expense of pyroxenite in altered zones bordering syenite apophyses and quartz veins that cut the pyroxenite mass (Boettcher, 1963).

Aegirite-diopside and vermiculite crystals within the pyroxenite are as large as 4 cm. Some pale-green prismatic crystals of apatite are as much as 10 cm in length but average crystals are 1 or 2 cm long. The rest of the rock comprises about 5 percent orthoclase, less than 5 percent quartz, less than 1 percent plagioclase, and smaller amounts of sphene, carbonate, zircon, garnet, and biotite.

The southwestern part of the Rainy Creek stock consists of medium- and coarse-grained yellowish-green and gray syenite containing muscovite and iron oxides. Composition of the syenite is diverse; the main body is composed of potash feldspar and mica, whereas a small body of nepheline syenite southwest of the main syenite intrusive body is composed of nepheline, microcline, albite, and aegirine.

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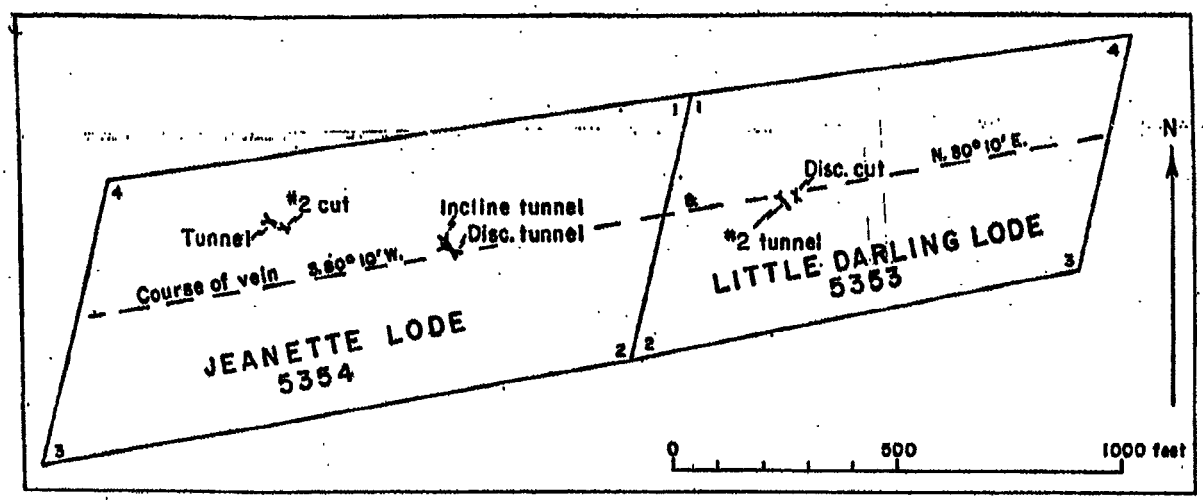


Figure 52.—Claim map of Little Darling (5353) and Jeanette (5354) lodes, southeastern Flathead County.

it is not known whether this work was ever completed.

An open cut adjacent to the Forest Service trail to Baptiste Lookout and a mile northwest of Mt. Baptiste exposes a 3-inch vertical quartz vein striking N. 84° E. The vein contains milky quartz and small masses of chalcocite and hematite. The cut is in the Grinnell Formation, which strikes N. 5° W. and dips 10° E.

At the head of Silver basin (upper South Fork Logan Creek) between Baptiste Lookout and Mt. Baptiste, a 20-foot timbered shaft was sunk in the basal unit of the Piegan Group. No ore was found on the dump, and no veins were visible from the collar of the caved shaft.

On the Truman Creek-Blacktail Mountain road 0.4 mile south of Kerr Mountain, a 4 by 6-foot pit at the base of a cliff exposes a 17-inch quartz vein striking east and dipping 74° S. The massive white quartz vein contains vugs filled with hematite. Specular hematite is found as unaltered masses in quartz. A fault, indicated by 2 inches of shattered rock and gouge, parallels the hanging wall of the vein. Country rock is purple-gray finely banded quartzite of the Ravalli Group, which strikes N. 47° W. and dips 25° NE.

Three intersecting(?) quartz veins are exposed in a road cut at the head of Truman Creek 3 miles north of Lake Mary Ronan. Small limonite-filled vugs in shattered quartz were noted in 3½- and 1½-inch veins striking northeast and east respectively. White massive vuggy quartz, containing siderite and iron oxides, is poorly exposed in a plus 6-inch vein believed to strike northwest. Traces of copper and silver are associated with the quartz veins. Two claims, Old Dominion No. 1 and 2, were located by Gary L. Vollmer of Kalispell on October 8, 1960.

In a highway cut near Swan Lake 1 mile northwest of Swan Lake campground, a ¼-inch veinlet of earthy malachite follows bedding in Grinnell argillite. A sample of the mineral zone assayed 1.16 percent copper and 0.55 ounce silver a ton. Locally at other outcrops east of Swan Lake, malachite was found as blebs, many of which have a chalcopyrite nucleus.

A piece of lead-zinc float was reported found in 1926 during trail construction on the Helen Creek trail about 1 mile southwest of Helen Mountain, at a point where the trail turns from a northeasterly to a southerly direction. The float may have come from the divide south of Helen Mountain.

U. S. Forest Service personnel report that a sluice box was observed about 1925 near the mouth of Hodag Creek, about a mile north of Blackbear Guard Station. The sluices have now disappeared, and no tailings were noted there.

Barren quartz veins and veinlets striking about N. 75° W. and dipping 11° NE are exposed by three or more shallow pits on the north side of Soldier Creek north of Soldier Lake about 6½ miles northwest of Spotted Bear Ranger Station.

NONMETALLIC DEPOSITS

VERMICULITE

Rainy Creek mineral deposits were first prospected in the 1880's when base metals in quartz veins were discovered at the north end of the Rainy Creek pluton, but the presence of vermiculite was first determined by E. N. Alley of Libby while prospecting for vanadium in 1915. Small-scale vermiculite production commenced in 1925, and in 1939 several independent operations were

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combined under the name Universal Zonolite Insulation Company; the name was changed to Zonolite Company in 1948. In 1964 the company became the Zonolite Division of the W. R. Grace Company.

A 1,000-ton mill erected in 1948 produced 350 to 400 tons of concentrate a day. Production has been increased to 500 tons a day, and the present facilities are to be expanded. Since the middle 1920's, about 35,000,000 tons of ore and waste have been moved, at an ore-to-waste ratio of 1:1.4 (Boettcher, 1963, p. 7).

Open-pit mining methods are used, and the ore is selectively mined and loaded by power

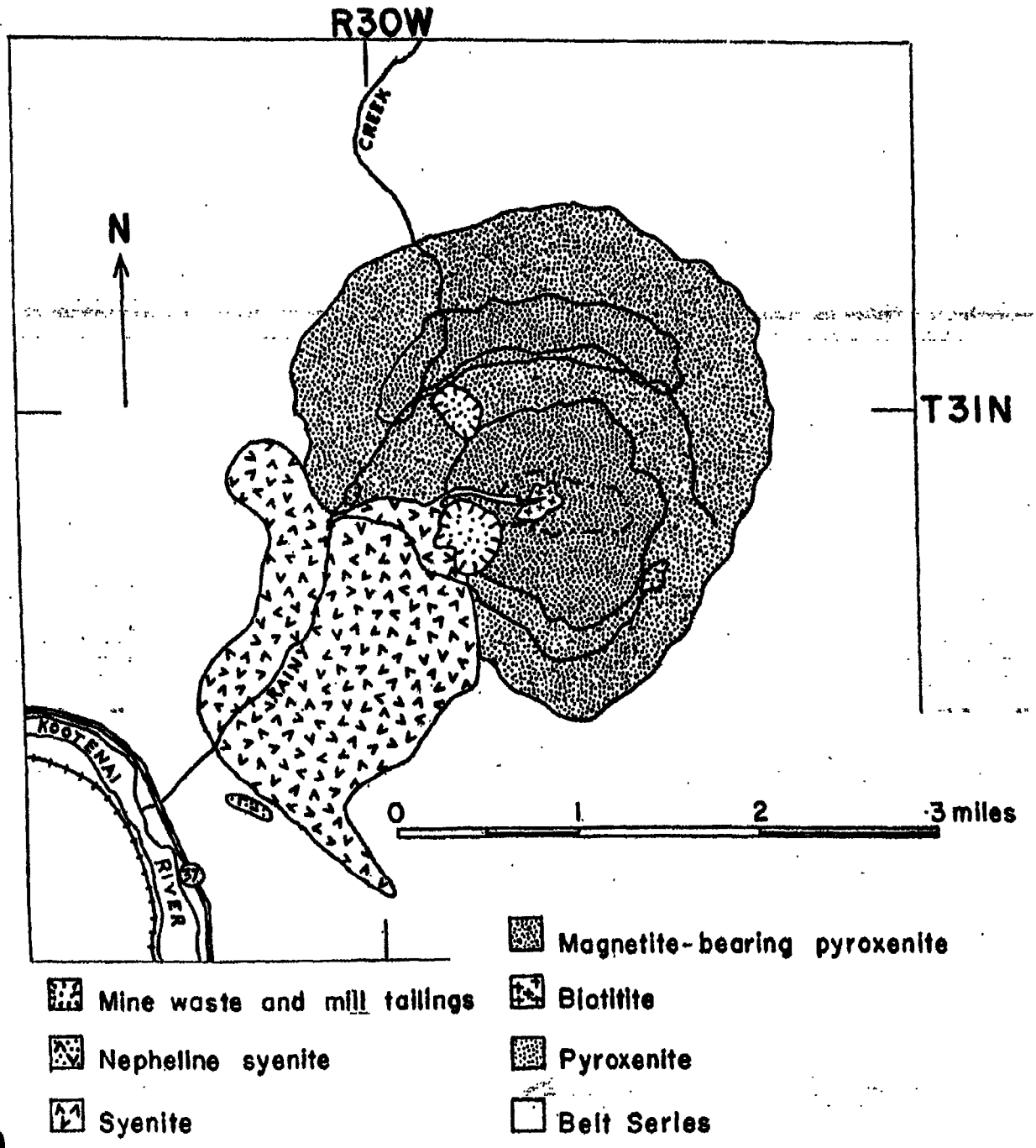


Figure 53.—Geologic map of Rainy Creek pluton, Rainy Creek district, Lincoln County (A. L. Boettcher, 1963).

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shovels. Waste is trucked to a dump at the southwest end of the mine area. Milling is done by a combination of wet and dry processes, including gravity methods, flotation, and screening. The vermiculite concentrate is dried and screened to various size ranges.

The Rainy Creek intrusive body is an elongate composite stock of biotite-magnetite-pyroxenite and syenite (Fig. 53) intruding strata of the Wallace Formation within the trough of a northwest-trending syncline. An alteration halo reported to be 300 feet wide (Boettcher, 1963) consists of recrystallized and sericitized metasedimentary rocks surounding the magnetite pyroxenite; the intensity of alteration decreases outward from the contact of magnetite pyroxenite with sedimentary rocks. A border phase of the magnetite pyroxenite is magnetite rich, a grab sample of the material assaying about 16 percent magnetite.

Boettcher (1963, p. 12) described two major pyroxenite rock types; the more abundant type is very coarse grained pyroxenite composed of pyroxene (probably diopside), mixed vermiculite and hydrobiotite, and accessory fluorapatite; it contains all of the economic vermiculite in the stock. The grain size of the pyroxenite ranges from 1 cm to 2 meters or more in length, the average grain size being about 5 cm. The second, finer grained type described by Boettcher forms zones within the coarse-grained pyroxenite. It consists almost entirely of pyroxene and contains only small quantities of mixed vermiculite and hydrobiotite, apatite, garnet, magnetite, ilmenite, and sphene.

A mass of biotite, 600 by 1,000 feet, near the center of the biotite-magnetite pyroxenite intrusive body was described by Boettcher (1963, p. 13) as consisting of 90 percent biotite and the other 10 percent feldspar, pyrite, and calcite. The contact between biotite and pyroxenite is sharp. Syenitic pegmatite bodies as much as 10 feet wide intrude both biotite pyroxenite and biotite.

Bordering the biotite-magnetite pyroxenite intrusive body on the southwest (Fig. 53) is a syenite body, from which an apophysis extends into the pyroxenite. The main syenite body is coarse-grained microcline microperthite containing 20 to 30 percent muscovite. Bordering the syenite apophysis and related syenite dikes in the pyroxenite are alteration halos of tremolite after pyroxenite, which are of potential economic importance as a source of brittle asbestos. Southwest of the syenite mass is a coarse-grained nepheline syenite intrusive body containing nepheline, albite, aegirine, and microcline-perthite (Boettcher, 1963).

Post-syenite quartz veins contain uneconomic amounts of chalcopyrite, bornite, sphalerite, fluorite, pyrite, aegirine, rutile, and accessory calcite. Some opalized rock was uncovered at the west end of a lower bench in 1964.

The Rainy Creek pluton has many minerals of potential value, besides the vermiculite, which is being marketed at present. Amphibole asbestos (tremolite), the nearly pure feldspar in the syenite dikes, biotite in the biotite mass, and apatite, associated with vermiculite, pyroxene, and the magnetite-rich border phase of the biotite-magnetite pyroxenite intrusive body, may be profitable byproducts if separation can be achieved economically and if markets can be developed for these minerals.

Origin of the vermiculite is still debatable, although some investigators have concluded that it is derived from biotite through hydrothermal alteration or alteration by weathering and surface water. Boettcher (1963, p. 59) stated:

> "There is no evidence in the field or in thin section to indicate that the vermiculite (or biotite if the vermiculite was originally biotite) or the biotitite* core are alteration products of the pyroxene. Furthermore, field relationships suggest that the vermiculite (or biotite) and biotitite are older than the veins, syenite dikes, and pegmatites, and could not be alteration products associated with their emplacement . . . It is concluded that biotite is a primary constituent of the pyroxenite. The problem is to determine if the vermiculite is an alteration product

*Biotitite is a term used by Gruner (1934) and Boettcher to describe a rock composed mainly of biotite, but containing feldspar, pyrite, and calcite.

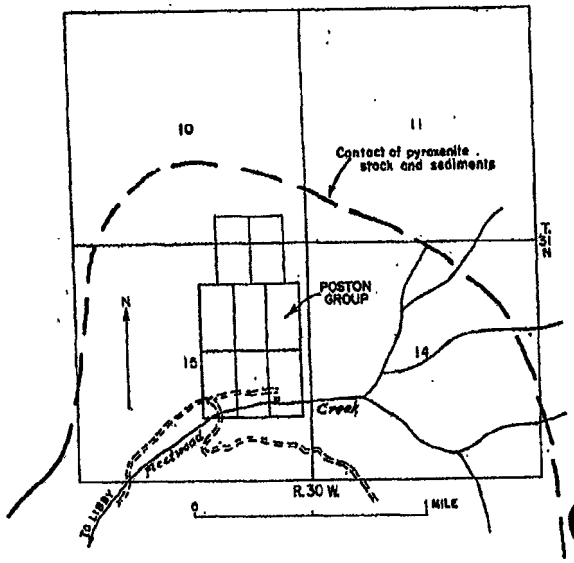


Figure 54.—Claim map of Poston property, Rainy Creek district.

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> of biotite and, if so, to determine the nature of the alteration . . . the writer favors the hypothesis that the vermiculite has been derived from biotite by the action of fluids of magmatic origin."

Another vermiculite deposit of undetermined extent is north of Fleetwood Creek toward the northern part of the Rainy Creek stock. (Fig. 54). Eight unpatented claims, the Last Chance and Last Chance No. 1 to 7, were staked by George Ottoway and Mr. Fleetwood in 1925. The property was acquired by H. J., H. L., and U. L. Poston of Kalispell in 1932. During the 1950's the property was leased and optioned by the F. &. S. Construction Company of Butte. Prior to 1964, H. J. Poston assumed complete ownership of the group.

A small irregular stock composed of porphyritic syenite and some pyroxenite intrudes the Wallace Formation east of Bobtail Creek about 10 miles north of Libby. The stock crops out on private land and National Forest land. At the southwest end of the stock, an exposure in a cut on the east side of the road exposes tremolite, biotite, magnetite, and pyroxene minerals. Some vermiculite has been reported in the cut. Development work consists of some pits in soil-covered areas near the south end of the stock.

BARITE

KOTSCHEVAR

The Kotschevar or Copper Mountain group is on Copper Mountain 5 miles south of Troy in the Troy district. The property consists of nine unpatented lode claims and three millsites (Fig. 55). The group was purchased in 1958 from James B. Robinson of Spokane, Washington, by Donald and Lendal Kotschevar of Sandpoint, Idaho, and Missoula, Montana. No production has been reported.

The property is developed by an 80-foot adit (accessible) on Vein No. 1, a 35-foot adit on Vein No. 3, and several pits and cuts on the other veins.

Three branching fracture-filling veins and one cross vein ranging from 1 to 5 feet in width strike northwest to northeast (DeMunck and Ackerman, 1958). The three branch veins dip east and the cross vein dips southwest. The barite vein on the Julia K. claim (No. 1 on map, Fig. 55) strikes about N. 20° W. and dips 44° NE, but swings to strike about N. 30° E. on the Tungsten King, Rising Sun, and Nina K. claims. It is well exposed in an 80-foot adit, where it is 30 to 40 inches wide and is composed of dense white barite, which assays 92.1 percent barium sulfate and 0.35 percent silica. A split from this vein (No. 2 on map) strikes N. 15° W. and dips 60° NE, crossing the Windjammer claim. The cross vein at the southwest ends of the Windjammer and Tungsten King claims (No. 3 on map) is 4½ feet wide, strikes N. 60° W., and dips 47° SW. It is well exposed in a 35-foot drift, where its width averages 30 inches. Some sulfides occur in this vein. The Tungsten King vein (No. 4 on map) trends N. 50° E. and dips 40° SE. It is a split off vein No. 1 and is 2 to 5 feet wide. Other veins crop out on the Buckskin and Windy Pass claims. The Buckskin vein is 3½ feet wide, strikes N. 80° W., and dips 85° N. On the Rising Sun fraction, the vertical vein (No. 1) is about 3 feet wide. All veins are in the Wallace Formation, which trends about N. 30° W. and dips 60° to 65° S.

Tom Schessler (personal communication) reported that a 3½-foot vein on the Buckskin claim contains 8 inches of quartz and barite on the hanging wall, 14 inches of yellow crystalline barite in the center, and 20 inches of brecciated barite, ankerite, and siderite on the footwall. Schessler estimated the barite content of sections of veins as ranging from 40 to 60 percent. High-grade parts of the veins may assay 85 to 95 percent barium sulfate.

KENELTY BARITE

The Kenelty barite lease is about 2 miles south of Loon Lake on the south side of a tributary of the Fisher River, in Lincoln County. Gerald Kenelty of Libby discovered the vein during logging operations in 1960 and leased the property from The Anaconda Company in 1961. The property has been inactive for several years.

Three trenches and a strip pit 175 by 18 by 5½ feet expose a barite vein along a probable strike length of about 600 feet. Width of the vein ranges from 10 to 18 feet. The vein strikes N. 65° to 75° W. and is vertical or nearly vertical at the center cut. The massive white and reddish-white barite contains minor white quartz, hematite, and sericite. South of the stripped area (Fig. 56) is a fourth cut exposing a 2½- to 3-foot vein, which strikes N. 30° E. and is vertical. The barite contains some quartz and small masses of purplish-maroon hematite and sericite. Country rock is sericitic light-gray, yellow-gray, and yellow-brown noncalcareous siltstone and argillite of the Libby Formation. Samples of barite from surface cuts have specific gravities of 4.15 to 4.20.

In 1962 about 400 tons of barite was mined and shipped by Great Northern Railway to Cal-Bar at Clear Lake, Washington. Most of the ore was broken by jackhammer and loaded by front-end loader from the northwest trench. Chunks of high-

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and green-gray sericitic talc containing disseminated pyrite, iron oxides, and some quartz.

The deposit may have been formed by hydrothermal alteration of favorable Striped Peak strata.

TREMOLITE

In the Rainy Creek stock, mass-fiber tremolite of contact-metamorphic origin borders syenite dikes and quartz veins. The tremolite has formed from pyroxenite. Tremolite asbestos has economic potential for use in many applications, such as roofing, where the spinning qualities of the higher grade chrysotile is not needed. The deposit has been discussed under Vermiculite. Asbestos (tremolite, a cross-fiber variety) also occurs at the Esther May and Larue-Cripe prospects in the Yaak River area, Lincoln County.

ESTHER MAY

The Esther May claims, about half a mile northwest of Yaak in the northwest corner of Lincoln County, were staked by Romeo and Virginia Garrison in 1946. The group comprises two unpatented claims, the Esther May No. 1 and 2. In 1948 the claims were leased to Hough and Loveland of Spokane, Washington, for a period of 10 years. The lessees drilled twelve to fifteen holes near a small asbestos vein exposed on a bluff. All holes were reported to have intersected tremolite at depths of 20 to 30 feet. In 1958, H. P. Reinshagen, Sr., and H. P. Reinshagen, Jr., of Libby, leased the property for one year, with option to buy, but dropped the option.

A vertical vein of tremolite about 3 inches wide, trending N. 10° W., is exposed at the base of a bluff. Wallace country rock also strikes N. 10° W. and dips 75° NE. A second vein, 6 inches wide, has been explored by a shallow pit, in which the vein trends N. 70° W. and dips 60° SW. Autunite, a calcium-uranium phosphate mineral, was reported found associated with a 3-inch syenite dikelet in a small pit at the face of a bluff. The dikelet strikes N. 70° E. and dips 70° SE. Wallace argillite has been hydrothermally altered; silica has been introduced into the surrounding country rock. A metadiorite body whose trend was not determined crops out in the area.

LARUE-CRIPE

The Larue-Cripe prospect, about 1 mile south of Roderick Butte, consists of a narrow tremolite asbestos vein exposed in two small surface pits. The vein is 3 to 6 inches thick, strikes N. 70° E., and dips 55° NW. The country rock is ripple-marked and mud-cracked Wallace argillite.

WOLLASTONITE

Two bodies of wollastonite ($CaSiO_3$) on the south side of Kennedy Gulch, 5½ miles east of Libby, strike N. 30° W. They are poorly exposed and unexplored, but each is at least 2 feet wide, and they are about a quarter of a mile apart. Country rock is the Wallace Formation.

A sample from the outcrop assayed 42 percent CaO, 45.80 percent silica, 3.90 percent Al_2O_3, 5 percent CO_2, 1.20 percent ferric oxide, and 0.50 percent ferrous oxide. Magnesium oxide was nil.

Wollastonite is used in the ceramic industry, the chemical industry, in high-grade electrical insulators, and as a nonmetalic filler.

CLAY

Clay is widespread in Lincoln and Flathead Counties; varieties include laminated glacial-lake clay, alluvial clay, and clay formed by hydrothermal alteration of igneous rock. No special study of clays was made for this report, but samples of clay from the area have been included in a continuing Bureau study of all Montana clay and shale. Samples from selected areas have been examined for their suitability as ceramic raw materials, as a source of alumina for aluminum recovery, and as possible expandable material for lightweight aggregate. Clays that have been examined are tabulated (p. 154). The results of testing are given in the publications listed, to which the reader is referred for details.

STONE

TUFA

A deposit of calcareous tufa on the D. A. Sheffler ranch near the mouth of a small tributary of the Kootenai River, about 2 miles southeast of Leonia, is approximately half a mile from the Great Northern railroad. It is estimated to be 1,200 feet long, 50 feet wide, and +12 feet deep, and assays show 85 to 90 percent $CaCO_3$. Three other deposits of tufa are on the Marion Fisher ranch 3½ miles southeast of Leonia.

Another body of calcareous tufa is poorly exposed 3 miles northeast of Loon Lake, along the road on the east side of Pipe Creek in Lincoln County. It contains about 88 percent calcium carbonate and was deposited by a spring.

Calcareous tufa near the Jack Garrison ranch on the J. Neil haul road on Callahan Creek south of Troy assayed about 90 percent calcium carbonate.

These deposits of tufa are possible sources of rock for the manufacture of quicklime.

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