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Nonmetallic Mineral Resources of Montana (Except Fuels)

F. L. Rytlewski

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GEOLOGY 72
Second Semester
Senior Year

GEOLOGY THESIS

NONMETALLIC MINERAL RESOURCES OF MONTANA
(EXCEPT FUELS)

By
F. L. Rytlewski

A Thesis
Submitted to the Department of Geology
in Partial Fulfillment of the
Requirements for the Degree of
Bachelor of Science in Geological Engineering

Montana School of Mines
Butte, Montana
June, 1953
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NONMETALLIC MINERAL RESOURCES OF MONTANA (EXCEPT FUELS)

By

F. L. Rytlewski

INTRODUCTION

This paper is being written in partial fulfillment of the requirements for a Bachelor of Science degree in Geological Engineering at the Montana School of Mines. An endeavor has been made to compile a brief specific inventory of Montana nonmetallic mineral resources (except fuels). Naturally, such a list is bound to be incomplete, but every attempt has been made to present as accurately as possible the known facts.

Essentially, the paper is composed of seven parts, each of which concerns a group of related nonmetallic minerals such as ceramic materials, gemstones, or abrasives. Following the data pertaining to the minerals of each group are index maps locating the major mineral deposits which are known to date. Production and reserve figures are listed by tables in cases where such information is available.
It is difficult to devise a simple classification for nonmetallic products as one substance will have many uses or be formed by more than one process. The purpose for which they are used often determines their value and is consequently their outstanding feature. For this reason, the writer has grouped the nonmetallic minerals according to their chief uses.
## PRODUCTION DATA—NONMETALLIC MINERALS OF MONTANA (2; 11)

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<td>value</td>
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<tr>
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<td>value</td>
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<tr>
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<tr>
<td>Pumice &amp; Pumicite</td>
<td>short tons</td>
<td>*</td>
<td>-</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>value</td>
<td>*</td>
<td>-</td>
<td>*</td>
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<tr>
<td>Sand &amp; Gravel</td>
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</tr>
<tr>
<td></td>
<td>value</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

* Undistributed: cement, gem stones, gypsum, lime, pyrites, stone (basalt and unclassified), talc, vermiculite, and minerals whose value must be concealed for particular years.

Figure 1
GEMSTONES

Agate

In Montana, moss agates are found along the bed and sometimes on gravel bars of the Yellowstone River from Livingston to North Dakota. The agate compares favorably with any found in the world, and a minor industry in the sorting, cutting, and polishing of these stones exists in the area. (1; 36)

Sapphires

Sapphire is the blue transparent variety of corundum, the blue color being attributed to traces of titanium.

The development of the synthetic sapphire industry during the war has seriously undercut the natural sapphire market and consequently most Montana sapphires are now recovered chiefly as a by-product in placer and dredging operations. It is doubtful that large scale operations will again be conducted for the recovery of placer sapphires alone even though there is extensive unworked sapphire-bearing placer ground in the Missouri River, Rock Creek, Cottonwood Creek, and other localities. Sapphires of high gem quality were once produced from the Yogo deposit southwest of Lewistown, but the property has not been worked for many years although the reserves of gem-bearing dike rock is very large. (9; 18)
ABRASIVES AND ABRASIVE MATERIALS

Corundum

Corundum is found as a primary constituent in many types of igneous, metamorphic and contact metamorphic rocks. Most of the production has come from coarsely crystalline syenetic or monzonitic pegmatites, sometimes called "desilicated pegmatites". (16) Deposits of abrasive corundum are found as lenticular to tabular bodies or corundum-bearing gneiss in the metamorphic rocks southwest of Bozeman. The corundum differs greatly from that in the dikes and placer deposits elsewhere in Montana and its physical characteristics render it suitable only for abrasive use. The Camp Creek corundum deposit, southeast of Dillon, is of high grade, but limited in quantity. The Bear Trap deposit, in the same general area, is of commercial grade. Further exploration in these areas may disclose new corundum deposits, but it is not likely that any will be appreciably larger and richer than those already known. (9; 10; 15; 16)

Garnet

Many deposits of garnet-bearing rocks are found in southwestern Montana. Garnet is usually found in metamorphic rocks or placer deposits and is formed by metamorphism in shists and by contact metasomatism in calcareous rocks. Some garnet has been cut and polished.
as semi-precious stones, but its principal use is an abrasive. The total quantity present is enormous but the deposits are not of commercial significance because of their distance from markets and competition of artificial abrasives. (18; 36)
Asbestos

There are at least three known deposits of asbestos in Montana, none of which has proved to be entirely successful. Short fiber amphibole asbestos has been produced on a commercial scale from the Karst mine, 35 miles south of Bozeman. Short fiber serpentine asbestos occurs near Cliff Lake, 50 miles south of Ennis in Madison County, and a small amount was milled, but none has been produced on a commercial scale. Large quantities of amphibole asbestos in altered pyroxenite are known to exist in the Rainy Creek area, 7 miles northwest of Libby in Lincoln County, but none has been produced commercially. (25; 36)

Serpentine asbestos is a hydrous silicate of magnesium while the amphibole variety is a magnesium silicate containing some calcium, aluminum, or iron. Both types originate by deep-seated alteration of pre-existing rocks. Considering the large amount of igneous intrusion and metamorphism in Montana, it seems feasible to assume that other commercial bodies of asbestos are present. However, in view of the intensive prospecting this area has undergone, it is unlikely that a mineral so conspicuous as asbestos could be overlooked. (25)
Barite

Minor occurrences of barite have been reported near Bernice, Ekalaka, Red Lodge, and Libby. Little is known of the quality or extent of these deposits although some barite has reportedly been shipped from near Libby and a deposit of possible economic importance has been recently discovered north of Missoula. (18; 36)

Bentonite

Bentonite, an altered volcanic ash which occurs intercalated with lake and marine shales and sandstones, is a mineral of rapidly expanding industrial use and is found extensively throughout the state. At many stratigraphic horizons in the marine Cretaceous rock formations of Montana are bentonite beds which contain large resources of commercial grade foundry sand, bonding bentonite, and and bentonite that can satisfactorily be used for drilling purposes. In general, the relationship of these deposits to the geologic structure and topographic features is such as to offer few attractive mining sites. However, large deposits of bentonite which contain clay that may be suitable for industrial uses are present in the Yellowstone district of Big Horn County at many sites where mining may be feasible. In many areas, bentonite is not mined commercially but is used locally for lining irrigation ditches and reservoirs. (19; 20)
Calcite

Deposits near Clyde Park, Park County, were a source of supply for optical grade calcite during the war, but this operation has since been discontinued. Other calcite deposits run in a general line for a distance of nearly 50 miles, from Wilsall, Park County to Greycliff, Sweet Grass County. The nearly pure calcium carbonate veins, a small part of which may be of optical grade, are from 5 to 7 feet wide and miles in length. There are similar deposits in Lincoln County near Eureka and in Granite County 7 miles east of Drummond. Some Calcite has been marketed for use in sugar refining and stock feeds. (27)

Diatomaceous Earth

Diatomaceous earth, sometimes called diatomite, is composed of the siliceous shells of diatoms, microscopic aquatic plants. Because of its lightness and porosity it serves a variety of uses as a filler, insulator, filter, and mild abrasive. The only deposit of any significance is in Broadwater County, about 15 miles southeast of Townsend. At present, the property has not been developed sufficiently for evaluation, but it may prove to be of commercial significance in the future. Other deposits of diatomite have been found in Granite, Gallatin, and Broadwater Counties. (18; 28)
Glass Sand

A sand of 98 per cent silica content is located at Daly's Spur, south of Dillon in Beaverhead County, but the small grain size is said to be objectionable to consumers. In Fergus County, 3 miles southwest of Hilger, there is a silica-sand deposit suitable for molding and foundry uses or in the manufacture of green or amber glass. (31; 36)

Mica

The number of known mica deposits in Montana is small and virtually all previous production has come from the Tobacco Root Mountains area in Madison County. These pegmatite deposits have been formed from magmatic solutions and are considered to be igneo-aqueous. Most of the pegmatites are of low grade and cannot be worked at a profit at ordinary mica prices. Although the area is geologically favorable for the occurrence of mica, it has not been thoroughly prospected and workable deposits may possibly be found sometime in the future. (25; 39)

Talc

Deposits of talc are known in several localities in southwestern Montana and several thousand tons have been shipped in recent years, primarily from the Axes Creek deposit southeast of Dillon and the Johnny Gulch deposit south of Ennis. These deposits, which occur
only in the Pilgrim and Cherry Creek formations, are believed to have originated by the action of hydrothermal solutions upon magnesium-bearing rocks during deep burial.

Ceramic, cosmetic and lava talc have all been mined and marketed in Montana and the lava talc found here is said to be superior to imported material which has supplied most of the market. The volume of easily available talc gives promise of a permanent moderate size industry. (25; 36)
Fluorspar

Most of the fluorspar produced is obtained as a by-product from base-metal and precious-metal operations; however, occurrences of fluorite of considerable size and purity are fairly numerous and widely distributed. It is normally a hydrothermal mineral which occurs in fissure veins and as replacement beds in limestone. (35)

Shipments have been made from a property 12 miles southwest of Superior in Mineral County and the Crystal Mountain prospect in Ravalli County seems to be of commercial grade and extent. A fluorite deposit has recently been found south of Missoula. Exploration up to now has been too meager and insufficient to permit close calculation of reserves. Until further information is obtained, the fluorspar deposits of Montana should be regarded as resources for further exploration and development rather than deposits of demonstrated importance. (28; 36; 40)

Graphite

Crystalline graphite, equal in quality to that imported into the United States from Ceylon, occurs in commercial quantities in the area southeast of Dillon. It has been estimated that 100,000 to 200,000 tons of the graphite occurs here in irregular seams, bunches, pockets, and stringers. The mineral is believed to have
formed at depth through the action of hot solutions or vapors given off by deep-seated igneous bodies. As a result of chemical reactions, carbon was liberated and precipitated in crystalline form. (6; 25)

Numerous other graphite deposits are known but none appear to be of great commercial importance. Due to intensive prospecting of all the mountain areas, it is unlikely that any large commercial bodies of graphite have been overlooked. (16; 18)

Lime

The reserves of good limestone in Montana are limitless and the production is controlled more or less by local demands. There are many deposits close to railroads, but they are restricted to western and central Montana where mountain uplift has resulted in exposure of the Paleozoic strata in which they lie. (24) Some of the limestone is of remarkable purity and is quarried for use in sugar refining. A quarry near Warren in Carbon County is the source of most of the sugar refinery lime, and limestone has at various times been quarried near Sappington for this purpose. Local needs in the construction and other industries are supplied with quicklime and hydrated lime by lime kilns at Elliston and elsewhere. (24; 36)
Sillimanite, Kyanite, and Andalusite

These minerals are all aluminum silicates of the same composition and are used for high temperature refractory products. The major deposits, located southwest of Ennis in Madison County, are found associated with pegmatite and gneiss. An accurate estimate of tonnage and grade cannot be made because of the irregular nature of the deposit. The Bozeman and Gallatin deposits, southwest of Bozeman, are of variable grade, the amount of high grade being small. The Beartrap deposit, southeast of Norris in Madison County, is somewhat similar, containing a small amount of high grade and some corundum. Recent investigations in the Dillon area have disclosed widespread and abundant deposits which constitute a potential source of high grade sillimanite. (14; 18; 36)

Zircon

Small amounts of zircon have been found in southwestern Montana. Zirconium oxide is used primarily as a refractory material and in opaque white enamels. Some zircon has been cut for semi-precious stones. (36)
Building Stone

The outstanding deposit of building stone in the state at the present time is near Gardiner in Park County where a beautiful travertine has been quarried and used in many parts of the country for interior trim. The Library Building at the Montana School of Mines is finished with this stone which is far superior to Italian travertine in appearance. For many years "black and gold" marble was produced from a quarry near Radarsburg. Limestone, marble, granite, gneiss, or sandstone are found near all the large cities, but at the present nearly all stone of this type is imported from the eastern states where extensive quarries and cutting plants can easily supply orders at short notice. (18; 28)

Cement

Limestone, clay, and calcareous shales, the ingredients of portland cement, exist in vast quantities in the mountainous counties of the state. The only cement plant operating at present is at Trident, but its production capacity is being greatly increased. Five miles south of Havre, vast amounts of limestone and sufficient suitable shale, warrant the building of a cement plant should it prove feasible. The White River, Arikaree, and Niobrara formations near Ekalaka are reported to contain large amounts of natural cement rock. (23; 26; 31)
Gypsum

Gypsum occurs in sedimentary beds and is usually associated with grey, green, or red shales. The bedded deposits are believed to have originated through the evaporation of sea water in restricted bays. (24)

Gypsum was mined, processed, and marketed in Montana over 50 years ago, and two plants, at Heath and Hanover, have been in continuous operation for the past 25 years. Gypsum is also found near Bridger in Carbon County, at Limespur in Jefferson County, and on Little Sheep Creek south of Lima in Beaverhead County. With an ever increasing demand for this important building material, expansion of the industry in Montana may be feasible, considering the extent of the gypsum deposits. (22; 24)

Pumicite

To date, true pumice (which refers to light, spongy pieces of lava) has not been found in the state. However, pumicite (which refers to volcanic ash) occurs in many counties. This material is hardly pure enough for abrasive purposes but could possibly be found suitable for use as a lightweight aggregate. A deposit of fairly pure pumicite is found 9 miles south of Hathaway in Rosebud County. (18; 34)
Vermiculite

Vermiculite is known to occur in several localities, the most important of which are near Libby in Lincoln County, Hamilton in Ravalli County, Pony in Madison County, and in the Bearpaw Mountains near Box Elder in Hill County. The quantity of material in all of these deposits is large although the quality is variable. (16; 25)

With the exception of the deposits near Pony, all of the known occurrences are of direct igneous origin with the vermiculite being found in large intrusive masses or dikes. The Pony deposits occur in pre-Cambrian biotite or hornblende shists and in many cases pegmatite dikes cut the deposits in the immediate vicinity of the vermiculite. (25)

Vermiculite is likely to be found only in the mountainous areas of Montana, for it is only in these areas that conditions suitable for its formation existed. (16)
CERAMIC MATERIALS

Clay

All clays have essentially the same origin; that is, chemical disintegration of aluminous rocks. Clays derive their usefulness from their ability to become plastic when wet and stonelike under fire. (33; 37)

Common clay deposits suitable for making red bricks are used locally and found throughout the state. Missoula and Flathead Counties have large deposits of higher quality clays suitable for manufacture of terra cotta and other ceramic wares. Dickite, a high grade pottery clay, is found near Lewistown and in the Moccasin Mountains northeast of Hanover. (21; 37; 38)

Feldspar

Feldspar is used primarily in making glass and as a fluxing agent in the production of chinaware. Most of the feldspar mined in previous years has come from rich concentrations of very coarse crystals which are found along the margins or within the cores of pegmatites. (16) The pegmatite dikes in the western part of the state contain large tonnages of feldspar, but at the present time freight rates and market conditions do not justify production. (36)
CHEMICAL MATERIALS

Phosphate

The lower part of the Phosphoria formation in Montana contains enormous reserves of phosphate rock. This vast deposit occurs as a result of marine chemical depositions in large enclosed basins.

Mines are operating in Powell, Granite, Beaverhead, Madison, and Silver Bow Counties. In the Elliston and Garrison fields of Powell County and the Maxville area of Granite County there is over 300,000,000 tons of available phosphate rock which assays more than 60 per cent tricalcium phosphate. The actual reserve throughout the state may run into hundreds of millions of tons. (4; 17)

Sodium Sulphate

The intermittent lakes of southern Choteau County and eastern Sheridan County contain large amounts of muds and slimes rich in sodium sulphate. These deposits might possibly prove to be a source of sodium sulphate if an economically feasible method of extraction could be devised. (36; 42)

All of the deposits in the Sheridan County area are found in depressions in the glacial drift which appear to be kettle holes. Analysis of ground waters indicates that either the Fort Union formation or the glacial drift of this area contain enough sodium sulphate to be the source of the Glauber salt. (8)
Sulphur

There are no deposits of native sulphur in the state, but large amounts are contained in the sulphide ores. Some of the sulphur in the Butte ores is converted to sulphuric acid at Anaconda for use in manufacturing phosphate fertilizers. (12)
BIBLIOGRAPHY


