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A POSSIBLE ASBESTOS SUBSTITUTE

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BY

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A Possible Asbestos Substitute[1]

By Robert B. Fisher[2], Robert L. Thorne[3],
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INTRODUCTION

The purpose of this paper is to acquaint manufacturers of various types of asbestos products, particularly those that specialize in materials used for sound deadening, vibration damping, and filtration, with a recently investigated deposit of paligorskite, a type of asbestos usually called mountain leather. In the past this mineral has been only a museum curiosity, but it possesses characteristics that may adapt it to industrial uses.

The deposit is on Lemesurier Island, near the entrance to Glacier Bay, in the northern portion of southeastern Alaska, at approximately latitude 58° 17' N., longitude 136° 05' W. The island is about 4-1/2 miles in east-west length and 3 miles in width. The property on which the deposit occurs is owned by the locator, Joe Ibach, and it was brought to the attention of the Bureau of Mines by Col. George B. Norris. A Bureau of Mines engineer, accompanied by the owner and Chris Ellingen, visited the property and examined the open-cuts from May 7 to 10 in 1944. The purpose of the examination was to determine the approximate extent of the occurrence and to obtain samples of the material for identification and study of its utilization.

DESCRIPTION OF DEPOSIT

Some geological information regarding the area was obtained by the reconnaissance of the Bureau of Mines engineer and supplemented by the owner of the property. The western portion of the island is composed of granitic rocks and the eastern portion largely of white and blue limestones. One small area of greenstone is reported in the limestone section of the north shore. Paligorskite is found in the blue limestone. The contact of the granitic rock and the limestone roughly divides the island on a north-south line.

1/ The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Information Circular 7313."
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Paligorskite has been found in three places on Lemesurier Island. An open-cut from which 1,000 pounds has thus far been obtained is on the steep slope of a mountain at an elevation of 1,100 feet. At this point, lenses of material as thick as 18 inches had been reported in surface cuts, and widths of 6 to 8 inches were observed during the examination. There was evidence that similar material had been mined in the past. The limestone has a strike of N. 30° E. and dips roughly 30° to the southeast. The strike of the limestone bed and the fracturing pass into a saddle to the south where covering is likely to be heavy. The main outcrop of paligorskite is in a fracture parallel to the limestone bedding. Erosion appears to have cut out the down-dip extension here, and the mineral hangs down from the underside of a remnant deposit. A cross fracture carrying a deposit 8 inches in width was found in the same exposure but could not be traced down the bare rock slope below. If the lower extension of the deposit has been eroded away directly below the outcrop, it should be present below the talus about 200 feet downslope. In this outcrop the paligorskite was found in widths up to 10 inches and in lengths of slightly over 4 feet. Blue clay was found with the paligorskite; and calcite, in places 6 inches in width, occurs on both sides of it. Slightly less than a mile south of the main occurrence another very similar exposure was found. Only small pieces of the material had been reported, but a deposit only slightly smaller than the main discovery was uncovered by digging into the overburden. This showing is about 300 yards from tidewater at an elevation of about 30 feet on the west bank of a stream and about 20 feet from a large spring. A small seam of paligorskite also occurs in cross fractures in the back of a cave along the shoreline about a quarter of a mile farther south.

All three exposures roughly parallel the strike and dip of the limestone bedding. The mineral occurs in fractures running both parallel and normal to the bedding of the blue limestone. In addition to the calcite usually present, layers of sandy material, high in iron oxide, are found near the paligorskite. All exposures are on the surface, and the size and the nature of the deposits may have been altered by the action of surface water. It is reasonable to expect that, if the material is found at depth, it will be in a drier and more compact form than that found on the surface.

IDENTIFICATION OF PALIGORSKITE

A large sample of the paligorskite and adjacent rocks, from the deposits on Lemesurier Island, Alaska, was examined at the Rolla laboratory of the Bureau of Mines. The sample as received was very wet, and the paligorskite was in fairly large, flabby, flat chunks, somewhat stained by iron oxide and organic matter and smeared in some instances with a blue claylike material. A bluish limestone was associated with the paligorskite, and some clear calcite was also present.

After the sample had been dried at approximately 85° C. the paligorskite was rather tough and tore somewhat like a piece of heavy cardboard. It was light in weight and resembled buckskin. Upon wetting, it apparently absorbed considerable water, swelled and again became soft, could be torn easily, resembled paper pulp, and was slimy to the touch. The wet material was weak enough to suggest that in a paper beater it might be reduced to a smooth pulp and re-formed on the paper machine into a paligorskite paper or cardboard.

Before the blowpipe, thin shreds of the paligorskite fused rather readily to a white enamel. Qualitative tests showed that it was only slightly decomposed, if at all, by hot 1:1 hydrochloric acid but that the acid treatment removed a considerable quantity of the extraneous material. After washing and drying, the acid-treated material was nearly white, bordering on gray, except for some small areas lightly stained by organic matter. This gray-white color was similar to that of the crude mineral when torn open. The resistance toward acid suggests its use in competition with the acid-resisting grades of amphibole asbestos. Under the petrographic microscope in immersion oil, shreds of the crude mineral showed a fibrolamellar structure. Only an average index of refraction, approximating 1.53, in the chrysotile (serpentine) range, was discernible.

A chemical analysis was made on a sample selected from various specimens of the paligorskite. This sample was obtained by sawing through various pieces of the dried mineral with a hacksaw and collecting the sawdust. The chemical analysis of this material is given below.

Analysis of paligorskite sample, percent

MgO	Al_2O_3	SiO_2	Fe_2O_3	TiO_2	CaO	K_2O	Na_2O	Ig. Loss	H_2O-	H_2O+
8.11	14.27	49.50	2.62	0.32	3.34	0.06	0.34	21.43	7.05	10.85

Results of the examination indicated that the mineral was neither a serpentine nor a tremolite-actinolite variety of asbestos. In fact, the test data showed that this material was not a member of the serpentine or of the amphibole group of minerals. The presence of the alumina and the apparent insolubility of the mineral in hydrochloric acid excluded it from the first group; and because its apparent index of refraction was considerably lower than that listed5/ for the lowest index of refraction of amphibole (tremolite, alpha 1.599; anthophyllite, alpha 1.598), it could not very well be placed in the amphibole group under the present classification of this group. Dana6/ classifies mountain leather, mountain cork, and mountain wood as amphiboles, under actinolite, containing little or no aluminum.

Samples of the Lemesurier Island paligorskite were submitted to G. A. Muilenburg7/ and to O. R. Grawe8/ for their views as to the identity of

5/ Larson, E. S., and Berman, H., The Microscopic Determination of the Nonopaque Minerals: Geol. Survey Bull. 848, 2d ed., 1934, pp. 219-227.

6/ Dana, J. D., A System of Mineralogy: John Wiley & Sons, New York, 6th ed., 1892, p. 389.

7/ Professor of Geology, School of Mines and Metallurgy, University of Missouri, Rolla, Mo.

8/ Associate Professor of Mineralogy, School of Mines and Metallurgy, University of Missouri, Rolla, Mo.

the mineral. A specimen of mountain leather from China in Muilenburg's private collection was examined megascopically and compared with the Alaskan specimen. The Chinese specimen had a finer and softer texture than the Alaskan specimen. It was in a relatively thin, pliable piece and resembled kid. Grawe had previously identified the Chinese specimen as an amphibole by X-ray examination. It was concluded that an X-ray study of the Alaskan mineral would be necessary to establish its identity definitely. Attention of the Bureau of Mines was called to an abstract by Micheal Fleischer of an article by Krajicek[9] describing the occurrence of a mountain leather near St. Lorenzen ob Eibiswald, a market town in Austria. The abstract read in part: "The material occurs in sand-filled cavities in limestone. Analysis gave SiO_2 54.16, Al_2O_3 13.08, Fe_2O_3 3.71, FeO 0.35, MgO 7.34, H_2O- 9.05, H_2O+ 12.23, sum 99.92 percent, corresponding to beta-paligorskite. The specific gravity was 1.582, which was raised to 1.97 by pumping out under vacuum." The analysis of this mineral compared closely with that of the Alaskan mineral.

Specimens of the mountain leather were then submitted to the regional offices of the Bureau of Mines at Salt Lake City, Utah, and at College Park, Md., for identification by the X-ray method. Results of the study at Salt Lake City showed that the mineral gave a distinct X-ray diffraction pattern but that the pattern did not coincide with any of the 4,000 which are listed in the catalog of the American Society for Testing Materials. A large lattice-parameter value and a complex crystal structure were indicated. The College Park laboratory, through the courtesy of the National Museum, was able to obtain specimens labeled "paligorskite" from Russia, Moravia, Washington, and Alaska. Optical data on all the samples, including those which the Rolla laboratory submitted, were essentially identical. Also, the X-ray pattern of the Alaskan sample and that of the Russian were identical. In consideration of the examination it was concluded that the mineral from Lemesurier Island, Alaska, was paligorskite. Dana[10] lists paligorskite under aluminous varieties of amphibole and states that it is probably an altered asbestos.

There is no evidence to indicate whether this mineral is a secondary product formed in a near-surface zone or a mineral which may be found at some depth. According to B. B. Polynov,[11] "Paligorskites are hydrated aluminosilicates of magnesium in which the latter is replaced to some little extent by Ca, Fe, Mn, etc. Exceptions to this are calciopaligorskites in which Ca predominates among the bases. In analogy to the paligorskites the magnesian ferrosilicates form a special subgroup called xylotiles .....

9/ Krajicek, Egon, (An Occurrence of Mountain Leather near St. Lorenzen ob Eibiswald): Berg. -u. huttenmann, Monatsh montan. Hochschule Leoben, vol. 90, 1942, pp. 175-177; Chem. Abs., vol. 38, 1944, p. 3930.

10/ Dana, J. D., Work cited in footnote 6, p. 398.

11/ Polynov, B. B., The Cycle of Weathering: Thos. Murby & Co., London, 1937, p. 111, (Translated from the Russian by Alexander Muir.)

These vadose minerals have a fibrous crystalline structure, although in outward appearance they are corky, filmy and otherwise colloid-like. According to a detailed investigation of paligorskites and related magnesium silicates, 'They are formed under the normal conditions of the crust of weathering from either hot or cold aqueous solutions.'[12] This is an extremely important conclusion and indicates that we are dealing not with residual but with synthetic products of weathering, with the results of the interaction of solutions. It should be added that in addition to the paligorskites and xylotiles found in large masses, they also occur as soil formations,[13] a fact which can thus be satisfactorily explained."

CONCLUSION

The undeveloped property on Lemesurier Island offers some possibilities of developing the mineral in quantity. Other deposits may be found by further prospecting. This report has been prepared and published in the hope that the existence of a deposit of paligorskite - probably a variety of asbestos and usually classified mineralogically as a type of mountain leather - will be brought to the attention of consumers of normetallic industrial minerals and that its physical properties will be investigated from a commercial standpoint to ascertain if it has any strategic uses in the war program. The mineral's unusual characteristics would probably permit it to be readily converted to a pulp in conventional paper-mill beaters, from which form innumerable, lightweight, acid- and fire-proof products could be formed. Wide application of the material either in a rough-granulated or in a processed form for use as an insulating, a sound-proofing, or a shock-absorbing medium would depend upon establishing the existence of extensive reserves; but specialized uses might be considered on the basis of present disclosures.

12/ Forsman, A., Trans. Acad. Sci. (Russia), vol. 32, 1913, p. 311.
13/ Polynov, B. B., Ortstein Horizon of Soils: Ann. Dokuchaiev Soil. Com., 1914.