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X-RAY INVESTIGATION OF "MOUNTAIN LEATHER"

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ABSTRACT

A powder X-ray-diffraction study (Gandolfi technique) of 52 samples having the "mountain leather" habit, a fibrous, matted intergrowth of asbestiform crystals, shows that 41 are either sepiolite or palygorskite; seven are actinolite–tremolite, and four are chrysotile.

Keywords: "mountain leather", X-ray diffraction, sepiolite, palygorskite, actinolite–tremolite, chrysotile.

SOMMAIRE

Une étude par diffraction X (chambre de Gandolfi, méthode des poudres) de 52 échantillons d'asbeste, contenant une intercroissance de cristaux asbestiformes fibreux et nattés, montre que 41 sont faits de sépiolite ou de palygorskite; sept contiennent actinote–trémolite, et quatre contiennent de la chrysotile.

(Traduit par la Rédaction)

Mots-clés: asbeste, diffraction X, sépiolite, palygorskite, actinote–trémolite, chrysotile.

INTRODUCTION

"Mountain leather" as a textural term is currently applied to various minerals that occur in a fibrous, flexible, matted intergrowth of leather-like, asbestiform habit. The term is based on fabric elements of hand specimens, as described by Jameson (1820), Phillips (1844) and Heddle (1879). Heddle (1879) described mountain leather as "quite flexible, but tough, leather-like in appearance, colour light buff, composed of fine threads felted like a hat . . imbibes water like a sponge and then puts on the appearance of wet leather". Texturally similar materials have been called "mountain cork", "mountain wood", and "mountain paper". Heddle suggested that texturally unique mountain leather constitutes a single mineral species, which he named "pilolite". Fersman (1913) identified pilolite as palygorskite on chemical grounds. The term "mountain leather" has been applied to textures developed by many minerals; although it is descriptively accurate, the term does not refer to a specific mineral species.

Individual occurrences having a worldwide distribution have been described by Stephen (1954), Brauner & Preisinger (1958), Watts (1976), Nakai (1984), Galan & Castillo (1984), Imai & Otsuka (1984), Ovcharenko & Kukovsky (1984), Subbanna *et al.* (1986). These and other studies show that the mineralogy and texture of mountain leather vary with locality, or even within a single deposit (Stephen 1954, Subbanna *et al.* 1986).

The purpose of this paper is to identify the mineralogy of a large suite of "mountain leather" samples, evaluate morphological variations as a function of mineralogy, and characterize the mineralogy of "mountain leather". An X-ray-diffraction study was undertaken, and comparisons made with textural characteristics.

SAMPLE SELECTION AND CLASSIFICATION

Fifty-two samples initially identified as "mountain leather", *etc.*, and adhering to the historical definition of "mountain leather", "mountain cork", "mountain wood" or "mountain paper" based on characteristics described by the authors cited above, as well as Smith & Norem (1986), were chosen from The American Museum of Natural History collection. Five of the samples were from Heddle's (1879) type localities (see Table 1). The samples may be classified in accord with early references: *Mountain Leather* is thinly matted (usually 4 to 12 mm), flexible and fibrous, and commonly has a weathered surface. It generally contains small inclusions of calcite, dolomite, gypsum and montmorillonite. The fibers form a cross-matted matrix that absorbs water readily and exhibits a greasy feel similar to that of wet chamois. Separation (parting) into layers is common. *Mountain Paper* is a thinner (usually <4 mm) variant of mountain leather, with similar mineral associations. *Mountain Wood* is irregular in form, and has a distinctive wood- or bark-like appearance. Its surface is smooth, with fibers in an elongate and parallel orientation, typically light brown, with a brittle texture, commonly breaking into tabular pieces, and occasionally coated or stained by birnessite or iron oxide. Some examples show slickensides. "Mountain wood" also is denser than other morphological variants of "mountain leather". *Mountain Cork* is blocky (usually 12 to 30 mm), white, light grey, or light brown, and has a fibrous cross-matted texture that readily absorbs water. The surface is occasionally vuggy and contains accessory minerals similar to those found in "mountain paper" and "leather".

TABLE 1. HEDDLE'S (1879) TYPE MATERIAL

AMNH #	Initial Identification	Location	X-ray Id
C57080	Pilolite/Palygorskite Mountain Leather	Porsoy, Scotland Type 1 material	Sepiolite
C57086	Pilolite/Palygorskite	Boyne Burn, Scotland Type 2 material	Palygorskite
C57078	Pilolite/Palygorskite Mountain Leather	Tod Head, Scotland Type 5 material	Palygorskite
C57082	Pilolite/Palygorskite Mountain Leather	Strontian,Scotland Type ? material	Palygorskite
C57083	Pilolite/Palygorskite Mountain Cork	Tod Head, Scotland Type 5 material	Palygorskite

* Note: The C prefix is used to designate Columbia Collection.
Type materials refer to location and sample description given by Heddle (1879).

Analytical Method

X-ray-diffraction patterns of all samples were obtained using 114 mm Gandolfi cameras, Cu$K\alpha$ radiation with a Ni filter and exposure times of 5-7 hours. Samples were hand-picked clean, disaggregated using a scalpel and probe, then mounted as a ball on a glass spindle using a 50/50 mixture of "Ambroid" glue and amyl acetate. Samples were prepared in this manner for the following reasons: (1) A disaggregated sample mounted on a spindle closely approximates that of an unoriented mount. Moreover, the samples are difficult to prepare as smears or suspensions. (2) Some of the "mountain leather" samples consist of thin coatings on matrix; the removal of larger samples would destroy most of the specimen and adversely affect the overall aesthetics of the original museum specimen.

Analytical Results

All fifty-two samples of the "mountain leather" habit investigated in this study fall into three mineralogical groups: 1) asbestiform clay: sepiolite or palygorskite, 41 samples; 2) asbestiform amphiboles: actinolite or tremolite, 7 samples, and 3) asbestiform serpentine: chrysotile, 4 samples. X-ray peaks not related to the major phases identified were observed in some samples; in most cases it was not possible to attribute diffraction maxima to specific phases. Their presence probably indicates minor clay phases present as mixtures or intergrowths, or inclusions of non-clay associated minerals.

Table 1 compares Heddle's descriptions with the data obtained in this study for the five type-locality specimens. Label identification, sample localities and X-ray identification of the other 47 samples are given in Tables 2 to 5. Descriptions for all samples are given in "Mountain Leather" sample descriptions and locations and are available from The Depository of Unpublished Data, CISTI, National Research Council of Canada, Ottawa, Ontario K1A 0S2.

TABLE 2. LOCATION OF CHRYSOTILE SAMPLES

AMNH #	Initial Identification	Location
C27381	Chrysotile, M. Leather	Serbia, Yugoslavia
C34990	Chrysotile	Dissentis, Switzerland
C57039	Asbestos, M. Cork	St. Gothard, Switzerland
C57064	Amphibole, Amianthus	Switzerland

TABLE 3. LOCATIONS OF ACTINOLITE AND TREMOLITE SAMPLES

AMNH #	Initial Id.	X-ray Id.	Location
3316	Quartz + ?	A	Rothane, Switzerland
9101	Orthoclase + ?	A	Maderaner Thal, Switzerland
38681	Actinolite, M.L.	A	Patterson, New Jersey
C57035	Tremolite, M.L.	A,T	Arlin Quarry, Tuckahoe, New York
C57050	Amphibole, M.C.	A	Buckingham, Connecticut
C57054	Actinolite	A	French Creek, Pennsylvania
C57125	Amphibole,M.C.	A	Buckingham, Quebec

Note: X-ray identification of C57035 is intermediate composition between actinolite and tremolite.

TABLE 4. SEPIOLITE SAMPLES AND LOCATION

AMNH #	Initial Identification	Location
25415	Tremolite, M.Leather	Patterson Quarry, New York
31277	Tremolite, M.Leather	Quebec, Canada
C57037	Amphibole, M.Wood	Tyrol (Austria)
C57041	Amphibole, M.Wood	Mt. Holly, Vermont
C57042	Amphibole, M.Leather	Kutna Hora, Czechoslovakia
C57045	Amphibole, M.Wood	Tyrol (Austria)
C57051	Amphibole, M.Leather	King's Bridge, New York
C57067	Sepiolite	Little Cottonwood, Utah
C57070	Sepiolite	Inner Mongolia, China
C57072	Sepiolite, Meerschaum	Moravia, Czechoslovakia
C57076	Palygorskite, M.Leather	Zermatt, Switzerland
C57089	Sepiolite	Chester County, Pennsylvania
C57095	Sepiolite	Dorsey mine, New Mexico
C57097	M.Wood	Schneeburg, (E. Germany)
C57099	Sepiolite	Little Cottonwood, Utah
C57100	Sepiolite	Beto County, Maryland
C57101	Amphibole, M. Paper	Tyrol (Austria)
C57102	Amphibole, M. Paper	Chester County, Pennsylvania

TABLE 5. PALYGORSKITE SAMPLES AND LOCATION

AMNH#	Initial Identification	Location
9995	Tremolite	Guerreo, Mexico
C57040	Amphibole, Mountain Cork	Swanton, Vermont
C57044	Amphibole, Mountain Cork	Holland, Vermont
C57048	Mountain Leather	Santa Eulalia, Mexico
C57049	Mountain Leather	Michoacan, Mexico
C57068	Amphibole, Mountain Leather	St. Lawrence Co., New York
C57074	Sepiolite	Howard Co., Maryland
C57077	Palygorskite	Raskovska, (USSR)
C57084	Palygorskite,Mountain Paper	Metaline Falls, Washington
C57085	Palygorskite	York Region, Alaska
C57087	Palygorskite	Zacatecas, Mexico
C57088	Palygorskite	Mt. Cook, Venezuela
C57090	Palygorskite	Lancaster Co., Pennsylvania
C57091	Palygorskite	Metaline, Washington
C57093	Palygorskite	Texas, Pennsylvania
C57094	Sepiolite	Inyo Co., California
C57103	Pilolite, Meerschaum	Sappillo mine, New Mexico
C57104	Pilolite, Mordenite	Grant Co., New Mexico

Discussion

The four samples labeled as "mountain wood" proved to be sepiolite. They had previously been identified as amphibole. Therefore field identification of a specimen a "mountain wood" may correlate with mineralogy. However, Subbanna *et al.* (1986) reported that the "mountain wood" of

Holenarasipur, in southern India, is composed of brucite–anthopyllite intergrowths. It appears that other mineral species not identified in the AMNH study may exhibit the "mountain wood" texture. The remaining forty-eight samples fit into the three mineralogical groups: 1) asbestiform serpentine: chrysotile; 2) asbestiform amphibole: actinolite and tremolite, and 3) asbestiform clays: palygorskite and sepiolite. The majority of samples fall into the asbestiform clay category. The absolute X-ray identification of chrysotile *versus* lizardite was found to be difficult because diffraction lines commonly are diffuse and some are too weak to be observed in these experiments. Likewise, distinctions are not made between orthochrysotile and clinochrysotile. Mixtures of the above are possible.

Matrix mineral associations may be helpful in the determination of the mineralogy of morphologically similar species. Calcite usually is absent in the actinolite–tremolite samples; pyrite and iron staining is more prevalent in the actinolite–tremolite than in sepiolite or palygorskite. However, associated minerals are of little use when attempting to distinguish palygorskite from sepiolite other than "mountain wood". X-ray techniques are necessary for definitive identification.

Conclusion

Fibrous or felted morphology and limited array of possible minerals are the unifying characteristics of the "mountain leathers", from the cross-matted texture of "mountain leather", "mountain paper" and "mountain cork" to the more parallel arrangement of fibers in "mountain wood". Distinctions between groups based on variations in texture, as with "mountain wood" or as inferred by associated minerals, offer limited but nonunique information about mineralogy. The majority of "mountain leather" samples appear to be sepiolite or palygorskite, but X-ray-diffraction determination is ultimately required to definitively separate texturally similar rocks.

"Mountain leather" remains a valid field term much like "limonite"; its relationship to other asbestiform minerals requires further study.

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