The formulae assigned to the two minerals are:

ludlamite—$2Fe_3P_2O_8.Fe(OH)_2+8H_2O$.

"lehnerite"—$2R_3P_2O_8.R(OH)_2+5H_2O$

where $R=(Fe,Mn,Mg)$

While the crystallographic data for "lehnerite" do not seem to agree with those given for ludlamite, in Dana, it is probable that the differences are due to another orientation and a different unit form. There is, however, a similarity in the following interfacial relations:

"lehnerite"	$c(001)\wedge d(101)=52°57'$
ludlamite	$c(001)\wedge t(201)=52°37\frac{1}{2}'$

It is therefore believed that "lehnerite" is identical with ludlamite.

VEINS WITH FIBROUS QUARTZ AND CHLORITE FROM THE VICINITY OF PROVIDENCE, RHODE ISLAND

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INTRODUCTION

Two of the localities visited on the New England Intercollegiate Geological Field Excursion in the vicinity of Providence, Rhode Island, in October, 1924, showed veins of fibrous quartz cutting graphitic schists. A study of specimens of these veins, collected by representatives from the Division of Geology, Harvard University, and by Professor A. C. Lane of Tufts College and kindly placed at the disposal of the writer, led to the conclusions reached in this paper. The study was carried out under the direction of Professor E. S. Larsen of Harvard University, to whom the writer is indebted both for a knowledge of the methods used and for many helpful suggestions during the course of the work.

Hawkins[1] described veins of fibrous quartz from the vicinity of Providence, Rhode Island, and concluded that the quartz, grading from fibrous material into massive white vein quartz, is of primary origin and that the greenish color is due to an admixture of actinolite in varying proportion. The determination of actinolite was based on color and extinction angle.

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[1] Hawkins, A. C.; Fibrous Quartz from Rhode Island; *Am. Min.*, **3**, 149-151, 1918.

Perry and Emerson[2] describe similar veins of fibrous quartz in the vicinity of Worcester, Massachusetts, and mention occurrences in the Naragansett Basin, concluding that the vein filling was originally chloritic, possibly made fibrous by pressure and changed in part to silica by acid from the oxidation of pyrite. They state that analyses by L. G. Eakins, U. S. Geological Survey, show the green fibers to be a fibrous form of prochlorite, without including the chemical data.

DESCRIPTION

The veins range in width from 1 mm. to 60 mm. with the individual veins of fairly constant width. The fibers, in general, are arranged nearly normal to the walls but where several veins intersect there may be no agreement in direction between the various bundles of fibers. The vein matter varies in color from pure white to yellowish green or pale brown and, in the latter cases, frequently shows a silky luster. In places the vein matter grades into massive white quartz and irregular grains of quartz may also occur among the fine fibers. The white fibers are brittle, though generally somewhat elastic and are nearly pure quartz while the colored fibers are tough and flexible have a decidedly greasy feel and contain a considerable proportion of chlorite. The proportion of quartz to chlorite varies from place to place from nearly pure quartz to a mixture of quartz and chlorite containing only a few per cent of quartz. Aside from small inclusions of wall rock, the only other constituents of the veins are subordinate flakes and fibers of muscovite and occasional small grains of pyrite.

The chlorite is in long, flat laths with a thickness of but 0.002-0.005 mm., a width of 0.015-0.060 mm., and a length up to 10 mm. These laths appear nearly isotropic and have the plane of the optic axis normal to the direction of elongation and the acute bisectrix normal to the flat face. They have a very small optic angle and,as indicated by rather uncertain interference figures, have a negative sign. The elongation of crystals lying on the flat face is apparently negative while that for crystals lying on the long narrow edge is weakly but definitely positive, thus confirming the negative character of the crystals. The value for β as determined by

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[2] Perry, J. H., and Emerson, B. K.; The Geology of Worcester, Mass., pp. 17-18, **1903**. Emerson, B. K.; Geology of Massachusetts and Rhode Island; *U. S. Geol. Surv., Bull.* **597**, 63, 1917.

immersion liquids is 1.633±.003; γ is estimated to be less than 0.001 higher than β; and α perhaps 0.002 lower.

A portion of the mineral was obtained nearly free from quartz by repeated use of the electromagnet, discarding the less magnetic portions and by the use of heavy solutions with a gravity higher than quartz. This material, though of limited amount, was submitted to Miss Helen E. Vassar, of the Department of Mineralogy and Petrography, who has furnished the partial chemical analysis given in Column 1 of the following table. As there was a notable sublimate of sulphur on heating, the sulphur is apparently largely present as pyrite and, in Column 1a the analysis has been recalculated free from pyrite. Allowing for some quartz still remaining, this gives an approximate formula of $6(Mg,Fe)O.2(Al,Fe)_2O_3.4SiO_2.5H_2O$. In Column 2 an analysis of an aphrosiderite from Striegau, studied by Websky and to which he assigns the probable formula of $6FeO.2Al_2O_3.4SiO_2.5H_2O$ is given for comparison. Larsen and Steiger describe aphrosiderite from near Field, British Columbia, which is very similar to the chlorite described in this paper. It has a very faint birefringence and an index of refraction of 1.625. Steiger's analysis is quoted in Column 3.

	1	1a	2	3
SiO_2	23.3 per cent	23.8 per cent	24.78 per cent	24.97 per cent
Al_2O_3	21.4	21.8	18.69	23.76
Fe_2O_3	2.0	2.0	6.45	1.55
FeO	28.6	28.2	36.17	26.86
MgO	10.7	10.9	4.52	10.81
CaO	none			trace
Na_2O	n.d.			0.26
K_2O	n.d.			0.97
H_2O	10.5	10.7	9.09	10.71
TiO_2	trace			0.11
S	0.9			
MnO	0.3	0.3		
	97.7	97.7	99.70	100.00

1. Analysis of aphrosiderite from Rhode Island. Helen E. Vassar, analyst.

1a. Analysis of same computed free from pyrite.

2. Aphrosiderite from Striegau, Websky. Quoted by Dana, System of Mineralogy, 6th edition, p. 660, analysis 6.

3. Aphrosiderite from near Field, British Columbia, Larson and Steiger; Mineralogic Notes; *Jour. Wash. Acad. Sci.*, 7, 6-8, 1917, analysis 3a.

Muscovite, partly in very slender laths, flattened parallel to the base, is a minor constituent of the veins. Some of the muscovite laths have a length of over 50 times their width. The plane of the optic axis makes an angle of 60° with the elongation of the laths.

The quartz varies in form from long, slender fibers to irregular grains with little or no elongation. The fibers are somewhat coarser than those of the chlorite and are markedly less regular in outline. Examination under the microscope shows no relation between external form and crystallographic directions, as by rolling various fibers and elongated grains, individuals were found with the elongation varying from nearly parallel to *c* to normal to *c*. The elongation of the quartz, whether in irregular grains or fibers, corresponds in general direction with the chloritic fibers and, in places, the latter are replaced irregularly along the edges by quartz. A cross-section in which the quartz grains are interlocked so as to form a solid mass, with the boundaries between individual grains but faintly distinguishable except in polarized light, shows that these grains are separated by remnants of chlorite fibers.

Fibers are locally bent, due to movement after formation, as is common in asbestos veins of similar structure and, in one such case, the quartz fibers, though of random orientation, show a wavy extinction along the bent portion, showing, in this case at least, that if the quartz fibers are a replacement of chlorite, the movement causing the bending was subsequent.

A variation from the occurrences described is shown in a specimen from the coal mine at Cranston, Rhode Island, in the Collection of the Department of Mineralogy and Petrography. This shows a vein, 10 mm. wide, of fibrous quartz, chlorite and minor muscovite in graphitic schist. In this specimen the chloritic fibers are markedly wider, reaching 0.15 mm. but show similar optic properties. Those of pale yellowish green color are shot through with darker green rutile needles, as individuals or in sheaves, while the brownish fibers, generally the narrower, are nearly or quite free from rutile.

CONCLUSIONS

Both the chlorite and muscovite of these veins show a definite relation between outward form and crystallographic development as well as to the plane of the vein, indicating original vein filling. Quartz can be seen as a replacement of chlorite, in all stages, either fiber by fiber or in mass with complete loss of the earlier fibrous structure. As any relation between form and crystallographic directions is lacking, the quartz has been introduced at a period subsequent to vein filling as a replacement of chlorite. No indication that muscovite has also been replaced by quartz has been noted and as the proportions of quartz and chlorite are variable within wide limits, quartz is entirely a replacement of chlorite. Pyrite, where present, either in veins or in the country rock is fresh, except for surface weathering, and its oxidation is not believed to have been a factor in the replacement of chlorite by quartz.

ABSTRACTS

THE "TOADSTONE-CLAYS" OF DERBYSHIRE. C. S. GARNETT. *Mineralog. Mag.*, **20,** (103), 151-157 (1923).

The igneous rocks yielding the clays are mainly olivine-dolerites (diabases) and basalts. Near the surface, due to oxidation, limonitic staining may be observed. Then follow almost white clay, "green earth," "green stone rock" and slightly altered dolerite. The white clay, when analyzed and deductions made for $CaCO_3$ and $CaSO_4.2H_2O$, yields a compound having the formula $2\ Al_2O_3.6SiO_2.3H_2O$. The changes are due to the leaching action of percolating meteoric waters. W. F. H.

AN ASSOCIATION OF KAOLINITE WITH MIAROLITIC STRUCTURE. A. F. BUDDINGTON. *J. Geology,* **30,** 149-151 (1923).

The kaolinite occurs as fillings in druses in rhyolite porphyry and as an alteration of the plagioclase feldspars in a granite porphyry in the Wrangel district of S. E. Alaska. It is believed that the kaolonite and calcite have been derived through the alteration and leaching of the plagioclases by thermal carbonated waters of relatively low temperatures. W. F. H.

THE METEORIC STONE WHICH FELL AT ASHDON, ESSEX, ON MARCH 9, 1923. G. T. PRIOR. *Mineralog. Mag.*, **20,** (103), 131-133 (1923).

This stone is a white hypersthene-chondrite, containing 8.26% of nickeliferous Fe, in which the ratio of Fe:Ni is 6. An analysis of the attracted portion showed: insol. silicate 8.05; sol. silicate 5.29; troilite 1.09; Ni 12.46; Fe(+Co) 73.11. W. F. H.

THE METEORIC IRON OF KAREE KLOOF, AND THE METEORIC STONES OF LEEUWFONTEIN AND SINAI PENINSULA. G. T. PRIOR. *Mineralog. Mag.*, **20,** (103), 134-139 (1923).

KAREE KLOOF, CAPE PROVINCE, S. AFRICA: This iron is a coarse octahedrite with a ratio of Fe : Ni about 11. Fe 90.79; Ni 8.27; Co 0.68; Cu 0.03; P 0.24; S trace; insol. 0.03. LEEUWFONTEIN, TRANSVAAL: An intermediate hypersthene chondrite containing 10.09% nickeliferous Fe, in which the ratio of Fe : Ni is 7. The attracted portion gave: Insol. silicate 8.94; sol. silicate 6.54; troilite 1.81; Ni 10.72; Fe(+Co) 71.99. SINAI PENINSULA: An intermediate hypersthene chondrite containing 8.60%