THE AMERICAN MINERALOGIST

JOURNAL OF THE MINERALOGICAL SOCIETY OF AMERICA

VOL. 10 FEBRUARY, 1925 No. 2

THE IDENTITY OF VARISCITE AND PEGANITE AND THE DIMORPHOUS FORM, METAVARISCITE[1]

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Some years ago while collecting data for a set of mineral tables[2] the very close similarity of the optical properties of peganite and lucinite was noticed and the authors of this paper discussed the similarity but decided that the difference in composition between the two seemed too great to justify the conclusion that they were identical. Attention was called to the optical similarity[3] in the hope that further work would be done.

In 1918, Moschetti[4] published a new analysis of peganite on material that appeared to be identical with the original peganite described by Breithaupt, and showed that it had a composition identical with that assigned to variscite, and concluded that peganite and variscite are identical. Optically, peganite had been shown to be identical with lucinite while the "variscite" from Lucin, Utah is optically different. It therefore seemed desirable to study this group of minerals further.

A large number of specimens of these minerals was accordingly secured, attempting in particular to get reliably labelled material from the type localities. Specimens were kindly furnished us by Harvard University, Yale University, Johns Hopkins University,

[1] Published with the permission of the Director of the United States Geological Survey.

[2] Larsen, E. S. Microscopic determination of the non-opaque minerals. *U. S Geol. Survey Bull.* **679**, 1921.

[3] Larsen, E. S. *Loc. cit.* p. 102.

[4] Moschetti, Lorenzo. Sulla probabile identità della peganite con la variscite. *Reale Accademia delle Scienze di Torino*, **LIII**, 1918.

The University of California, The United States National Museum, The American Museum of Natural History, The Academy of Natural Science of Philadelphia, and Colonel Roebling, to all of whom we express our thanks.

In all, thirty specimens were obtained and their optical properties determined. Seven were labelled peganite, Striegis, Saxony, the original locality for peganite; two were labelled peganite from Arkansas; two were type specimens of lucinite from Utah of somewhat different texture; two were "variscite" from Lucin, Utah (now called metavariscite); and seventeen were labelled variscite from various localities, including four specimens from Messbach, the original locality.

The optical data are shown in tables I to III. All the material labelled peganite, the lucinite, and all specimens labelled variscite, except those from Lucin, Utah, are optically negative, and have a moderately large (50-60°) axial angle. The birefringence measurements vary from 0.020 to 0.030 but the two extreme measurements

TABLE I

OPTICAL PROPERTIES OF VARISCITE
(Coarsely crystalline varieties)

All are optically −; $2V$ moderately large; Elongation +; Extinction ||.

	Striegis, Saxony	Striegis, Saxony	Striegis, Saxony	Striegis, Saxony	Arkansas[1]	Striegis, Saxony	Messbach,[2] Saxony	Lucinite[3] Lucin, Utah	Striegis, Saxony
α	1.554	1.556	1.555	1.562	1.562	1.562	1.564	1.563	1.568
β	1.571	1.573	1.576	1.580	1.583	1.583	1.584	1.585	1.588
γ	1.576	1.580	1.583	1.586	1.590	1.587	1.592	1.592	1.594

Note: The Arkansas mineral appears to be very uniform while specimens from Striegis vary.

[1] Average for 7 specimens from different sources. Maximum divergence ±0.001. Five labelled variscite, two labelled peganite.

[2] Looks like "peganite" from Striegis.

[3] Type lucinite.

Table II

Optical Properties of Variscite
(Finely crystalline varieties)

All are optically −; $2V$ moderately large.

	Messbach, Saxony	Columbus, Nevada	Lewistown[1] Utah	Mercur, Utah	Striegis,[2] Saxony	Messbach, Saxony	Messbach,[3] Saxony	Tooele, Utah	Manhattan, Nevada	near Tonopah Nevada	Lucin,[4] Utah	Lehigh, Utah	Arkansas
α	1.550	1.555	1.569	1.570									
β	1.565	1.580	1.585	1.589	1.555[a]	1.554[a]	1.565[a]	1.565[a]	1.569[a]	1.570[a]	1.580[a]	1.582[a]	
γ	1.570	1.585	1.593	1.595									1.594

[a] Mean index of refraction.
[1] Rhombic plates with Z bisecting the acute angle.
[2] Coarser part has a higher index of refraction.
[3] Coarser fibers have $\gamma = 1.580$.
[4] Type lucinite appears to be derived from metavariscite.

Table III

Optical Properties of Metavariscite

Only material from Lucin, Utah agreed with this.
Optically +; $2V = 55°$; $\rho < \nu$ perceptible.
Y is normal to the flat face, X is parallel to the length.

	Coarsely crystalline	Small grains
α	1.551	1.551
β	1.558	1.561
γ	1.582	1.585

were made on very finely crystalline material and the probable error is ± 0.005. For the better measurements $\gamma - \alpha$ is about 0.026, nearly within the limit of probable error. The indices of refraction vary considerably as measurements of β ranged from 1.565 to

1.589, with a probable error of ± 0.003. However, this is no greater than is common in minerals with some variation in composition and it may be due to replacement of a part of the aluminum by iron, chromium, or vanadium, or by a variation in the water content. The large amount of water lost by the Arkansas mineral below 110° makes a variable water content probable. As explained below this mineral will now be called variscite.

The mineral hitherto called variscite from Lucin, Utah, is optically different from all other variscites, peganites, and lucinite, and having the same chemical composition is now called *metavariscite.* It is optically positive, has an axial angle of 55°, and a birefringence of about 0.032. Its index of refraction (β) is 1.558, somewhat lower than that of the variscites, but the mean index of refraction is near that of the lowest values for variscite.

These data confirm the conclusion of Moschetti that peganite and variscite are identical and they show that lucinite is also identical with these but that the mineral from Lucin, Utah, previously described as variscite by Schaller, is a different species. Crystallographical measurements verify these relationships, the values of the interfacial angles of metavariscite (formerly called variscite) from Lucin, Utah, and of variscite (formerly called lucinite) from the same locality, being definitely shown to be different.[5]

Breithaupt proposed the name peganite for the Striegis mineral in 1830 but the analysis on which the description was based was so poor that in 1837 he proposed the name variscite on the basis of a better analysis for the Messbach mineral. The latter analysis and description were much better hence nearly all later finds of the mineral have been called variscite and that name is well established both in scientific mineralogy and in the gem trade. We believe that less confusion will result from retaining the name variscite for the much more common and abundant species and discarding the names peganite and lucinite, and such nomenclature is therefore proposed.

The following new analysis of variscite from Arkansas, made by Earl V. Shannon, shows a close similarity to the theoretical composition.

[5] Schaller, W. T. Mineralogic Notes, Series 3, *Bull.* **610,** *U. S. Geological Survey,* p. 65, (1916).

ARKANSAS VARISCITE

	Analysis	Recalc.		Theory ($Al_2O_3.P_2O_5.4H_2O$)
Insoluble SiO_2	6.40			
Insoluble Fe_2O_3, etc.	.10			
Al_2O_3	27.34	29.16	32.88	32.30
Fe_2O_3	2.20	2.33		
CaO	0.43	0.46		
MgO	0.87	0.93		
P_2O_5	41.20	43.79	43.79	44.90
H_2O-110	7.00	7.44	23.33	22.80
H_2O+110	14.95	15.89		
	100.49	100.00	100.00	100.00

CONCLUSION. The tabular and prismatic crystals from Lucin, Utah, originally described[6] as variscite, are different from all other specimens labelled variscite or peganite, and are now called *metavariscite.*

The crystallographical constants of metavariscite are: Orthorhombic, $a:b:c=0.8944:1:1.0919$. $p_0=1.2208$. Thirteen forms known: *b* (010), *a* (100), *l* (130), *j* (250), *d* (120), *h* (340), *m* (110), *q* (210), *f* (520), *e* (012), *g* (032), *t* (102), *p* (111). The form *c* (001) formerly added, has to be left out as the material from Arkansas on which it was determined is not metavariscite.

Optically metavariscite is positive, has an axial angle of about 55°, $\rho<\nu$ is perceptible. Y is normal to the flat face and X is parallel to the length. $\alpha=1.551, \beta=1.558, \gamma=1.582; \gamma-\alpha=0.031$. Metavariscite has been found only at Lucin, Utah, where it appears to alter to finely crystalline variscite. It has the same composition as variscite (=peganite), namely $Al_2O_3.P_2O_5.4H_2O$. An analysis on pure material is given in the literature cited (p. 64). Density 2.54.

All other minerals of this same composition belong to the species variscite, as now defined, and includes all minerals formerly called variscite (with the one exception from Lucin, Utah), peganite, and lucinite (which name is now to be discarded). The data given[7] for lucinite are therefore to be applied to the mineral, now to be called variscite.

[6] Schaller, W. T. Crystallized variscite from Utah, Mineralogical Notes, Series 2, *Bull.* **509,** *U. S. Geological Survey,* 1912, pp. 48-65; and The crystallography of variscite, Mineralogic Notes, Series 3, **1916,** pp. 69-80.

[7] Schaller, W. T. Lucinite, a new mineral; a dimorphous form of variscite, Mineralogic Notes, Series 3, *Bull.* **610,** *U. S. Geological Survey,* pp. 56-68, (1916).

The crystallographical constants of variscite are then: Orthorhombic, $a:b:c = 0.8729:1:0.9788$. $p_0 = 1.1225$. Habit octahedral. Eight forms: *c* (001), *a* (100), *d* (120), *e* (012), *r* (113), *i* (112), *p* (111), *s* (121).

The optical properties of variscite from Arkansas are: optically negative, $2V$ moderately large, Z is parallel to the elongation. $\alpha = 1.562$, $\beta = 1.583$, $\gamma = 1.590$, $\gamma - \alpha = 0.028$. The intermediate index of refraction, β, of specimens from other localities varies from 1.560 to 1.588 and the birefringence from 0.020 to 0.030. The axial angle of the variscite from Striegis is 53°, that from Lucin is 57°. The dispersion of the optic axis is perceptible and $\rho < \nu$.

Variscite has the same composition as metavariscite, $Al_2O_3.P_2O_5.4H_2O$, as evidenced by analyses of material from Utah (lucinite), Arkansas, Messbach, Striegis, Sardinia, etc. Its density is nearly the same as that of metavariscite.

RADIO-DETECTOR MINERALS

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In the paper by Roberts and Adams[1] on radio-detector minerals only thirteen species were listed. The writer has tested a considerable number of additional ones, using a copper "cat's whisker" and a simple crystal set, and has found about 75 to possess detector properties. These are listed in table 1, arranged in the order of their chief metallic constituents in the periodic system. As is well known, radio-detector properties are not constant for a given mineral, but vary from one specimen to another, and even from one form to another on a single crystal; in general, the maximum effect obtained with each mineral is here recorded.

The relation of detector properties to the composition of the minerals is very interesting. In most cases sulfides detect better than oxides, but occasionally the oxides may be superior, as with manganese and zinc. Replacement of sulfur by selenium may improve the detector properties, as in argentite-aguilarite-naumannite, but the reverse holds in stromeyerite-eucairite. The effects of introducing tellurium or arsenic are likewise variable.

On comparing the list of detecting minerals with the table of low-voltage conductors prepared by Davy and Farnham,[2] a certain

[1] *Am. Min.*, **7**, 131-136, (1922).

[2] Microscopic examination of the ore minerals. N. Y., 1920, p. 123.