ADDITIONAL NOTES ON PSEUDOBROOKITE

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Since the publication of my paper on this mineral[1] a number of new facts concerning it have come to my attention, which seem to be worthy of record.

In a paper which I overlooked, Dr. P. Ramdohr[2] has described minute crystals of pseudobrookite from a bore hole in altered basalt at Hessenbrücker Hammers, Hesse. The crystals show the forms: *b, a, n, m, μ, e, l, q,* and *s* of my list as well as two new forms, (212) described as common and (412) as rare. No measurements of these forms are given but they are stated to have been established by zonal relations. The position chosen is that of Groth-Dana, and the symbols as written above have been transformed to the new position adopted in my paper. Ramdohr also describes parallel growths of pseudobrookite on magnetite with *a*(100) of the former parallel to a face of (111) of the latter and the *c*-axis (of our position) parallel to an edge of the octahedron.

Pseudobrookite has long been known from the nepheline rock (shonkinite) of the Katzenbuckel in Baden. In a highly altered zone in one of the newer quarries there, minute crystals of pseudobrookite are numerous associated with secondary phosphate minerals. One of these crystals, not more than 0.1 mm. in length but very brilliant, was measured by Dr. Pough and showed the forms: *b*(010), *a*(100), *m*(110), *μ*(210), *e*(101), *q*(111), *s*(121), and *r*(212). The last-named form, first found by Ramdohr as noted above, is thus confirmed.

Mr. Lazard Cahn has drawn my attention to parallel growths which were found in the lot of pseudobrookite described in my first paper. One of the specimens which he sent me consisted of pseudobrookite needles attached to the surface of the basal plane of a hematite crystal. The *c*-axes of the needles were inclined about 41° to the vertical axis of the hematite and attached in such a manner that the plane of contact with the hematite is approximately the pyramid (121) of pseudobrookite. Furthermore, the *c*-axis of the latter is normal to a face of $(11\bar{2}3)$ of hematite.

In the fall of 1934 a new and remarkable occurrence of pseudobrookite crystals of hitherto unknown perfection was discovered

[1] *Am. Mineral.*, vol. **19**, p. 16, 1934.

[2] *Notizblatt des Vereins f. Erdkunde, Hessische Geolog. Landesanstalt*, **1923.**

in the Thomas Range, Utah, by Messrs. E. Over, Jr., and A. Montgomery. The new locality is on the east side of the range near Joy, Juab County. The specimens acquired by the Harvard Mineralogical Museum are in the usual white lithophysal rhyolite, some of the flattened cavities being as much as 4 cm. in diameter. The pseudobrookite needles are implanted on the walls as radiating groups or in sheaflike bundles. The longest needle is $2\frac{1}{2}$ cm. long with a flat cross-section of about $.1\times.25$ mm. Others are much more slender, like millerite needles. Unless the needles span the cavity from wall to wall their free ends are sharply terminated. In the sheafs the crystals are short and much stouter, with diameters reaching .5 to .75 mm. They are sometimes doubly terminated. Excellent measurements were obtained which were in substantial agreement with the angles based on the elements of the earlier paper. Three new forms were found in addition to all those earlier observed. The position angles for these forms measured and calculated, as well as those calculated for the two found by Ramdohr, are given in the following table, which may be regarded as a supplement to that already published.

PSEUDOBROOKITE. ANGLE-TABLE

		Measured		No. of	Calculated	
		ϕ	ρ	faces	ϕ	ρ
x	021	0°05′	36°56′	2	0°00′	36°42′
w	252	22 08	45 08	3	22 15	45 $11\frac{1}{2}$
v	141	14 25	57 09	3	14 $20\frac{1}{2}$	56 59
r	212	—	—	—	63 57	22 $59\frac{1}{2}$
t	412	—	—	—	76 16	38 $07\frac{1}{2}$

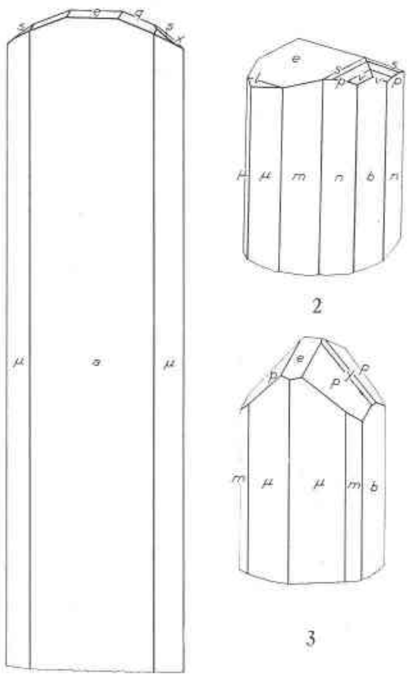
The crystals of pseudobrookite are always deeply striated longitudinally. They have a brilliant metallic lustre and the groups of shining needles make very attractive micromounts. The drawings show the new forms and the wide range of habit. They were made by Mr. C. W. Wolfe.

CHEMICAL COMPOSITION: No positive conclusion as to the correct formula of pseudobrookite has been hitherto reached. The simplest formula proposed is Fe_2TiO_5 first derived by Doss[3] for an artificial product. Pauling's[4] structure study led to the same result. The excess of TiO_2, found in most analyses, over that called for by

[3] *Zeit. f. Kryst.*, vol. **20,** p. 574, 1892.
[4] *Zeit. f. Kryst.*, vol. **73,** p. 102, 1930.

this formula was explained by Pauling as due to the presence of rutile in minute intergrown particles. He found in his powder photographs lines which did not belong to the pseudobrookite structure but which were completely explained by reference to rutile.

To check this interpretation, Messrs. Berman and Dane polished a crystal of pseudobrookite and examined the surface by reflected light with high magnification. They could perceive a small amount of foreign material as vague bands in the crystal but were not able to determine its nature.



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Figs. 1–3. Crystals of pseudobrookite from Thomas Mts., Utah, showing the forms: *a*(100), *b*(010), *n*(120), *m*(110), *μ*(210), *e*(101), *l*(301), *y*(031), *x*(021)*, *q*(111), *s*(121), *p*(131), and *v*(141)*.

The following analysis, made on 0.28 grams of the Thomas Mts. pseudobrookite, shows a much nearer approach to the formula Fe_2TiO_5 than any yet made of the naturally occurring mineral. It was made on crystal fragments quite free from any visible impurity. The figures indicate an excess of TiO_2 (rutile ?) of approximately 4%. It seems a satisfactory confirmation of the simple formula for pseudobrookite and of the explanation of the common high content of TiO_2 as due to enclosed rutile.

Composition of Pseudobrookite

	1.	2.
Fe_2O_3	60.57	66.64
TiO_2	38.12	33.36
MgO	1.26	—
	99.95	100.00

1. Thomas Mts. F. A. Gonyer, analyst.
2. Theoretical values for Fe_2TiO_5.