Friedel himself! The old master wanted to mark his disapproval of the abuse of bibliography in teaching, which he thought was carrying us back to the medieval practice of rehashing bookish gossips.

The greatest lesson which emanates from his text as well as from his life work is the importance of meticulous observation and scrupulous acceptance of duly observed facts.

Even from this incomplete survey of Friedel's scientific contributions, one cannot fail to be impressed by the magnitude of his work as well as the fundamental nature of the problems he solved. None of the important questions of crystallography at issue during the past half-century escaped his inquisitive attention and his name remains attached to several natural laws.

The indomitable energy with which he carried on his work during his long illness gave the measure of his moral fortitude. In Georges Friedel, the man was equal to the scientist.

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See also: *Ann. Soc. géol. Belgique*, vol. **29,** Mém. 237, 1902; vol. **45,** Bull. 284, 1923; Livre jubilaire 1924 (geology, diamond). *Bull Soc. Ind. Min.*, Saint-Etienne (4) vols. **3–4,** 485 pp., 1904 (twins). *Bull. Soc. géol. France* (4) vol. **6,** p. 240, 1906; vol. **7,** p. 191, 1907; vol. **23,** p. 488, 1923; *Bull. Serv. Carte géol. France*, vol. **20,** 1910 (geology). *Jour. Chimie phys.*, vol. **11,** p. 478, 1913 (Curie theory). *Annales Phys.*, vol. **18,** p. 274, 1922; *Bull. Soc. fr. Phys.*, 1922, 1924, 1926; *Revue gén. Sc. pures et appl.* vol. **36,** p. 162, 1925; *Jour. Phys. et Radium*, (6) vol. **3,** (12); (7) **2** (5); *Z. Krist.*, vols. **72, 73, 79, 83** (liquid crystals). C. R. Congrès Soc. savantes, Strasbourg, 1920 (twinning).

NOTES AND NEWS

NOTES ON STAUROLITE AND ASSOCIATED MINERALS FROM SCHIST AT GASSETTS, VERMONT

L. W. Currier*

A certain garnetiferous mica schist in south-central Vermont has been named Gassetts schist by C. H. Richardson[1] from the excellent exposures near Gassetts station in Chester township. For the

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[1] Richardson, C. H., The geology and petrography of Reading, Cavendish, Baltimore and Chester, Vermont: *Report of the Vermont State Geologist*, 1927–28, p. 225.

greater part, as mapped, the highly mineralized portion appears to be a relatively narrow border facies of his Cavendish schist at its contact with what he believes to be an orthogneiss intrusive into the regional schists. Furthermore, these schists are considered to be of Middle or Upper Cambrian age because of their stratigraphic relationships to the Lower Ordovician (Beekmantown) beds as traced from areas where fossil evidence has been obtained. Intrusives of granite, pegmatite, aplite, and basic rocks are numerous in the region in which these Cambrian (?) schists are exposed.

Because of its impressive appearance and its mineral content, the mica schist at Gassetts should be of considerable interest to amateur mineralogists as well as to professional geologists. The brief description given here is intended chiefly to indicate its interesting mineralogic character, especially as regards the staurolites of rather unusual habit. The list of minerals is doubtless not complete but should serve to stimulate search for showy material and for other mineral species in the formation.

At the type locality, near Gassett's station, the rock is a silvery white garnetiferous mica schist of very striking appearance. Fresh cuts, when bathed in sunlight, present a brilliant and dazzling effect. Old cuts and exposures are duller, but the material is still distinctive. The rock is highly schistose because of the predominance of parallel plates of mica. Interfoliated with the layers of mica are more or less lenticular and discontinuous layers of clear granular quartz.

The following minerals are common in the schist: Muscovite-paragonite, quartz, staurolite, garnet (almandite), kyanite, tourmaline, chlorite, biotite, magnetite, rutile, and zircon.

The metamorphism of the schist is not closely restricted to igneous contacts, but igneous rocks are abundant in the region and the highly metamorphosed portion of the schist follows in general the contact of a somewhat less metamorphosed schist with a granitic gneiss that may be of intrusive character. Although staurolite, garnet, and kyanite are generally indicative of so-called regional or dynamic metamorphism, the presence of abundant tourmaline, in places, suggests that igneous influences may have been prominently active. Possibly, too, the uncommon habit of the staurolite is related to such conditions of metamorphism. At any rate it appears that the process of metamorphism may not have been as simple as is commonly understood by the term "dynamic

metamorphism," even though the mineralogic character of the rock is, except for the tourmaline, characteristic of many regional schists.

The staurolite presents an interesting crystallographic feature which seems worthy of special emphasis. The crystals display an uncommon habit, being thin tabular parallel to the brachypinacoid which is the dominating form. Other forms are the unit macrodome, forming sharp terminations, and the unit prism, developed as narrow faces (Fig. 1). Although this habit, in which the crystals are tabular parallel to $b\{010\}$, is not unknown elsewhere, it is apparently rare and is markedly different from the usual habit of staurolite in regional schists, such as are known in Virginia, Georgia, and elsewhere. Some staurolite crystals of the familiar stout prismatic habit with basal pinacoidal terminations are also to be found. Very few staurolite twins are present, and these are not of the common cruciform type, but apparently have a pyramidal twinning plane. The staurolites are mostly less than one centimeter in greatest dimension, fresh, sub-transparent to transparent and of dark reddish-brown color. They lie roughly parallel to the planes of foliation. A number of crystals were examined by W. T. Schaller of the U. S. Geological Survey, who has reported the following data:

"The average of the measured angles compared with those calculated from the axial ratio[2] $a:b:c: = 0.4725:1:0.6806$, $p_0 = 1.4404$, are as follows:

MEASURED AND CALCULATED ANGLES FOR STAUROLITE FROM VERMONT

Forms	Measured				Calculated			
	ϕ		ρ		ϕ		ρ	
	°	′	°	′	°	′	°	′
$b\{010\}$	0	01	90	00	0	00	90	00
$m\{110\}$	64	40	90	00	64	43	90	00
$r\{101\}$	90	06	55	11	90	00	55	14

"There is a good cleavage parallel to $b\{010\}$. Some faces of $r\{101\}$ are faintly striated parallel to the intersection edges $r\{101\}:b\{010\}$.

"Crystals of staurolite flattened parallel to $b\{010\}$ are not com-

[2] Goldschmidt, V., *Atlas d. Krystallformen*, Text, vol. 8, 1923, p. 76.

mon. They were described by Weiss[3] who illustrates a crystal tabular to $b\{010\}$ with the additional forms: $\{001\}$, $\{110\}$, $\{1.0.10\}$, $\{106\}$, $\{101\}$, and $\{201\}$. Weiss also states that staurolite crystals from the Tirol have been described as tabular after $\{010\}$ by others."

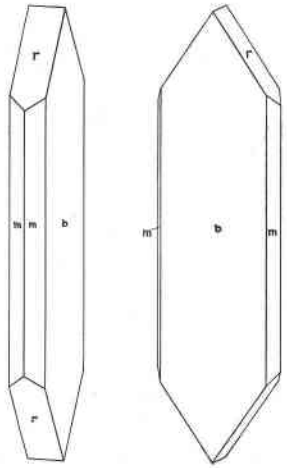

FIG. 1. Tabular habit of staurolite in the schist at Gassetts.

The muscovite is worthy of particular mention because of its content of soda. Two samples of carefully separated material were analyzed in the chemical laboratories of the United States Geological Survey for alkalis and silica with the following results:

	I	II
Na_2O	4.65	3.24
K_2O	2.49	6.01
SiO_2	44.25	47.16

Analyses were checked on each sample. The excess silica chiefly represents quartz. Sample No. I was slightly less pure than No. II. A very small amount of chlorite was present. The two samples were taken from different parts of the same outcrop. It is clear that the paragonite molecule enters largely into the composition of the mica, which varies within the isomorphous series muscovite-paragonite and in part is dominantly paragonite. The refractive

[3] Weiss, Karl, Der Staurolith in den Alpen: *Zeitschr. Ferdinandeums für Tirol u. Vorarlberg*, vol. **45**, p. 134, 1901.

indices are doubtless variable. Two samples examined by Jewel Glass gave (1) $\gamma = 1.602 \pm 0.001$ and $\beta = 1.598 \pm 0.001$; (2) $\gamma = 1.605$ and $\beta = 1.600$. Further study of the mica in field and laboratory, with complete chemical and optical analyses is planned, but it seems appropriate to present the preliminary results at this time.

The garnet porphyroblasts are commonly less than one centimeter in diameter, but have been reported several times as large. They display the common unmodified dodecahedral habit, and, with care, well-formed crystals may be obtained. The deep red color and index of refraction of 1.80 ± 0.01 indicate the almandite species in which the pyrope molecule is present in minor quantity. For the most part the crystals are fresh and free of shearing effects. A very subordinate number show association with peripheral chlorite which may be an alteration product. The mineral is of general distribution in the formation.

Kyanite is present as greenish-gray, stout, lath-shaped or bladed crystals up to 2 or 3 centimeters in length. It is not well distributed but rather of localized development.

Tourmaline crystals are abundant in parts of the formation, but its distribution is spotty. The mineral is the black variety with characteristic crystal development. The individuals are generally less than one centimeter in length; many of them are of microscopic size. Under the microscope the color of the ordinary ray is deep green, of the extraordinary ray, pale brown. The indices determined were as follows: $\omega = 1.652 \pm 0.002$, $\epsilon = 1.621 \pm 0.002$. The variety is probably dravite.

Green chlorite is distributed in the rock as small, rather inconspicuous foliae, in part peripheral to the garnet crystals of which it may constitute an alteration product. It is optically (+), $\beta = 1.613 \pm .002$, and the birefringence is very low, probably about 0.002. The variety is rapidolite according to Winchell's classification. Greenish-brown biotite is generally inconspicuous and not abundant.

Magnetite is distributed as very small black anhedral grains, and not conspicuous; the rutile and zircon are entirely microscopic and rare.

At Gassetts a mill has been constructed for the crushing of the schist and the separation of mica and garnet. The mill was not in operation at the time of the writer's visit but good concentrates of garnet, mica, and staurolite were seen.