NOTES AND NEWS

IDIOMORPHIC CORDIERITE FROM SAFE HARBOR, PENNSYLVANIA

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In the examination of altered schists from the quarry at Safe Harbor, Pa., the author found small idiomorphic crystals of cordierite in association with other aureolitic minerals. These cordierite crystals are quite abundant forming in some instances as much as 25% of the rock. As far as the author is aware, idiomorphic cordierite has not been reported from Pennsylvania, and it is the purpose of this note to place this locality on record.

A distinction should be drawn between occurrences of cordierite of this type and occurrences of coarse, granular cordierite as found in granitic gneisses. The latter are a feature of deep seated alteration, usually extending over wide areas. The former are the result of thermal conditions which affect the stability of the micas and other aluminum minerals and are usually confined to narrow contact aureoles.

The cordierite at Safe Harbor occurs in a brecciated zone in a highly micaceous schist. This schist lies on the opposite side of the Antietam quartzite from the Vintage dolomite, and according to the recorded series should be the Harpers formation. The brecciated zone crosses the quarry in a N.E.–S.W. direction, roughly parallel to the structure of the schist. As the thickness of the Cambrian sediments varies greatly in this area it is quite possible that this brecciated zone is near the unconformity at the base of the Cambrian. This zone was intruded presumably during Paleozoic time by a granitic derivative which enveloped fragments of the schist. There does not appear to be any direct connection between this granitic intrusive and the aureolitic minerals although some of the fragments contained in the granite show aureolitic alteration. During Triassic time the area was fissured in a N.–S. direction. These fissures were intruded by a basaltic magma which formed the main diabase dike 50 ft. wide and many smaller parallel dikes of diabase and basaltic glass. These Triassic dikes cut directly across both the brecciated zone and the schists. The aureolitic minerals are found at the intersection of the dike and the brecciated zone.

The presence of numerous dikelets of basaltic glass suggests that a large body of basaltic magma has been intruded somewhere in the vicinity of the intersection causing the thermal conditions that developed the aureolitic minerals.

Since the schistose structure is retained in much of the aureolitic rock, it is evident that the stress minerals were formed before either the brecciation or thermal alteration took place. The development and metamorphism of the schists of this area have been very carefully traced and described as far as the almandine-staurolite-cyanite stage, both by Dr. Eleanor B. Knopf and Dr. Anna I. Jonas in *U.S.G.S. Bull.* **799** (1929), and by Dr. Ernst Cloos and Dr. Anna Hietanan in *G.S.A. Special Paper* **35** (1941). The aureolitic stage of alteration, however, has not been described or reported from the area.

Following the formation of the schist minerals, as described in these papers, the relations of the igneous rocks to each other and to the schist inclusions would indicate the following sequence. Subsequent to the formation of the schist minerals and relief of stress conditions, came the E.–W. brecciation with accompanying granitic intrusion and tourmalinization of the schist. All the minerals formed during this period are characteristically coarse grained. The minerals formed at this time appear to have remained stable until the Triassic period.

During Triassic time came the N.–S. fissuring accompanied by the intrusion of a mass of basaltic magma. This intrusion created thermal conditions which altered both the schist and the granite in the brecciated zone. The micas of the schist were unstable under the conditions imposed and broke down forming the aureolitic minerals, orthoclase, cordierite, a second generation of biotite, hercynite, rutile and sillimanite. This alteration of the micas can be seen in all stages from slightly altered schist to the aureolitic rock. The minerals formed during this period are characteristically very fine grained. They represent an adjustment to changed thermal conditions without change in the chemical composition of the rock.

As the basaltic magma cooled there came a period of hydrothermal activity. Solutions from the intrusive following channels through the brecciated zone and along the structure of the schists formed albitic veinlets. These hydrothermal solutions dissolved and reacted with the minerals of the rocks they passed through forming crystal-lined vugs. The characteristic minerals are albite, albite-quartz intergrowths, chlorite, calcite, sphene and pyrite. The minerals of this period are moderately coarse grained. This final hydrothermal alteration is distinctly superimposed on the aureolitic alterations although in places it blends into the aureolitic rock.

The cordierite crystals with which this note is concerned are small in size, generally ranging between .002 and .004 mm. across the prism face. A few are a little larger. Untwinned crystals are of simple form bounded by pinacoids, the prism and the *d* faces. Pseudohexagonal crystals with the prism face as the twinning plane are common (Fig. 1), and some crystals show polysynthetic twinning with pseudohexagonal outline (Fig. 2). The crystals are very unstable and alter readily, some to pinnite, some to chlorophyllite. The pinnite alteration produces a fine grained matte of mica. The chlorophyllite alteration is a pseudomorphous alteration, a pseudohexagonal twin of chlorophyllite replacing a pseudohexagonal twin of cordierite.

Most of the material available is in an advanced stage of alteration so that it was impossible to separate fresh material for index determination

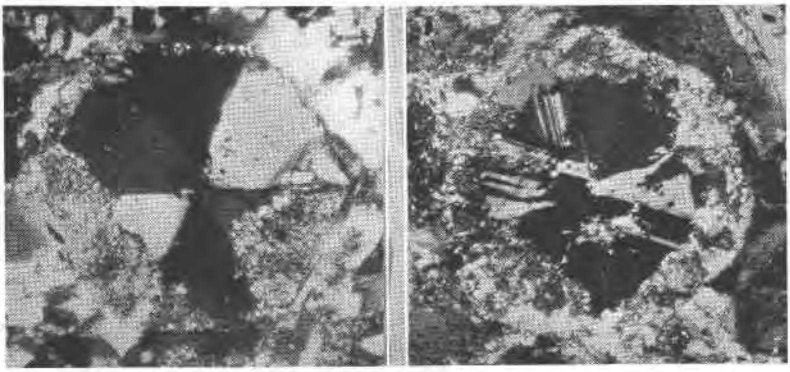

Fig. 1. Basal section of pseudohexagonal crystal due to penetration twins. Bounded by six brachypinacoids. Twin-plane is {110}. Alteration to pinnite starting along outer edge. Crossed nicols. × about 140 diameters.

Fig. 2. Polysynthetic twinning with pseudohexagonal outline. Alteration as in Fig. 1. Crossed nicols. ×about 140 diameters.

or for a chemical analysis. However, a minute fragment from a thin section gave 1.552 for γ and 1.545 for α. Basal sections of unaltered crystals give a poor interference figure showing the emergence of a negative bisectrix with an optic angle between 60 and 65°.

These idiomorphic crystals have formed in contact with orthoclase which according to Harker is the only mineral with weaker crystal assertiveness than cordierite, and the only mineral against which cordierite will assume its own crystal form.

Much work still remains to be done in this area before the extent of this aureole can be established or the source of the thermal conditions definitely established.