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Tacharanite in an amygdaloidal basalt, Highland County, Virginia

SINCE its original discovery on the Isle of Skye, Scotland, by Sweet *et al.* (1961), tacharanite has been observed at other places in Scotland (Walker, 1971; Livingstone, 1974), Northern Ireland (Sabine and Young, 1972), West Germany (Koritnig, 1972; Hentschel, 1978), Italy (Lucchetti and Penco, 1978), France (Boutry, 1983), Tasmania (Sutherland, 1978), and Japan (Sutherland, 1976). Cliff *et al.* (1975) have summarized data for several of these earlier reported localities. The purpose of this note is to report a new locality in Highland County, Virginia, apparently the first in the Americas, where tacharanite occurs as common amygdale fillings in a black to dark grey basalt sill emplaced between limestone and dolostone strata.

The tacharanite, identified by X-ray powder diffraction, is white, cryptocrystalline, and porcellaneous. It fills ellipsoidal amygdales that range up to 1 cm long. Rarely there are larger masses of the mineral over 5 cm across, presumably deposited in fractures within the intrusion. Thomsonite, as clear to white short fibres, is commonly attached to the amygdale walls and radiates into the tacharanite. Also small equidimensional to elongated scalenohedral vitreous calcite crystals are sometimes attached to the amygdale walls that are otherwise filled with tacharanite. Infrequently, thomsonite or calcite completely fill small amygdales. There is no evidence for the rapid alteration of tacharanite in the laboratory as reported by Sweet *et al.* (1961); however, material collected in the field showed that rarely tobermorite fills an amygdale and apparently is secondary after tacharanite. Also X-ray powder patterns of tacharanite often show a very weak extra reflection at 11.4 Å, corresponding to an intense tobermorite reflection. Some of the larger masses of tacharanite that have been exposed to weathering are amorphous and now contain traces of a smectite-group clay. Occasionally in these weathered masses there are small zones of light pink colour. Studies showed this is a smectite clay whose X-ray data are close to saponite, a mineral also observed by Sweet *et al.* (1961) in their study.

Secondary minerals likewise occur on abundant planar fracture surfaces that commonly cut across some portions of the igneous intrusion. White crusts composed predominantly of fine-grained calcite are very conspicuous. X-ray studies of these, and the insoluble residues from them, showed subordinate granular chabazite. Less frequently thaumasite also occurs on these fracture planes. Thin, brassy films of pyrite sometimes lie on these surfaces and tiny pyrite crystals embedded in thomsonite are occasionally observed in amygdales.

The igneous sill is an aphanitic, dark grey to black, mafic-poor basalt that shows extremely rare phenocrysts of plagioclase and black amphibole as well as zones rich in amygdales. The amygdales are especially abundant along the northwestern edge of the sill. That portion of the basalt containing amygdaloidal-rich zones is considerably altered, and the plagioclase is almost completely replaced by thomsonite or calcite. The replacement of plagioclase by thomsonite in rocks of this nature has been discussed by Sabine (1975). From evidence based on the secondary minerals and the replacement of the basalt, it appears that the sill was affected by later hydrothermal or deuteric alteration. Similar alteration, involving a different suite of minerals, has been reported for a dike in another part of the county (Mitchell and Freeland, 1986).

The sill, which is possibly Eocene in age (Fullagar and Bottino, 1969), was intruded between carbonate sediments that here are part of the Keyser Formation (apparently the Upper Silurian portion). The igneous body, striking approximately N 50° E, can be traced intermittently in-place and by float material for about 215 metres. Its maximum width, observed in a roadcut, is 6 m, but it diminishes to about 3 m near the northeastern end.

The best exposure of the sill and its secondary minerals is where State Road 620 intersects it. The site is 4.26 km (straight line) east, northeast of Doe Hill, Highland County, Virginia, or 3.38 km northwest of the intersection of State Road 620 with State Road 614.

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Churchite from the Mt Weld carbonatite laterite, Western Australia

CHURCHITE, the hydrous yttrium phosphate, has been reported from weathered chert, shale and limestone sequences and weathered granite pegmatite and vein deposits (e.g. Claringbull and Hey, 1953; Barstow and Cooper, 1982). This note documents the occurrence of secondary, supergene churchite formed during laterization of the Proterozoic Mt Weld carbonatite, Western Australia (Willett *et al.*, 1986). Long-term, deep weathering processes during the Mesozoic–Cainozoic caused pseudomorphic replacement and decomposition of primary igneous carbonatite minerals and subsequent recrystallisation of secondary, supergene minerals. The leaching and reprecipitation processes created a thick overburden overlying unweathered carbonatite rocks. Churchite occurs within the laterite in association with other *REE*- and P-bearing, secondary, supergene minerals including goyazite, gorceixite, florencite, crandallite, monazite, apatite and cerianite. Similar parageneses have been reported from numerous weathered carbonatite products (e.g. Rose *et al.*, 1958; Coetzee and Edwards, 1959; Frondel and Marwin, 1959; Deans, 1966; Bloomfield, 1973; Sandvik and Erdosh, 1977; McNeil, 1979).

Churchite is a minor secondary mineral in the weathered carbonatite residuum. The mineral occurs mainly as acicular radiating crystals in a microcrystalline form (Fig. 1) which readily breaks up into slime-sized particles. It is present as void fillings in crandallite-group minerals and as crustifications on 'limonite' aggregates, weathered magnetite and crandallite-group mineral grains. Fine-grained intergrowth with 'limonite' has been observed in places.

X-ray identification of the churchite was undertaken with a Gandolfi camera. Electron microprobe analyses of churchite revealed major amounts of Y and P and minor levels of *HREE*, *LREE* and Ca.

The observed textures, the present paragenesis of other secondary, supergene minerals and the friable nature of the reported churchite preclude a residual origin and so far no primary igneous xenotime has been observed. Furthermore, the associated monazite occurs as friable, earthy material and commonly replaces secondary hexagonal apatite. Such earthy monazite has been reported from deeply-weathered carbonatites and granite pegmatites and was interpreted as a mineral of secondary, supergene origin (Rose *et al.*, 1958; Deans, 1966; Mitchell *et al.*, 1976).

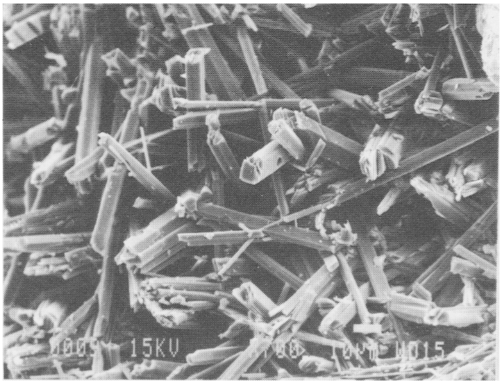

FIG. 1. SEM picture showing microcrystalline supergene churchite crystals.

The genesis of supergene churchite at Mt Weld is related to the extensive laterization, whereby numerous elements including Y and *REE* experienced extreme mobility and subsequently formed a variety of secondary, supergene minerals including churchite.

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