

Ta-Nb borates and other rare accessory phases in granitic pegmatites of the Itremo region, central Madagascar

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In the last decade, in pegmatite fields of the metasedimentary upper unit of the Itremo Group, Central Madagascar (Fernandez et al., 2001), local mining cooperatives made a series of new artisanal mining activities for the production of gemstones (mainly red and polychrome tourmaline and pink beryl) and mineral specimens. A restricted number of pegmatite veins hosted in the dolomitic marbles of the Itremo Formation, reported as "Danburite Subtype" pegmatites in Pezzotta (2001), are characterized by exceptionally abundant boron-rich minerals (tourmaline-group minerals, danburite, dumortierite, rhodizite-londonite, hambergite) and by the presence of very rare accessory phases including Ta-Nb borates (behierite and schiavinatoite) and a number of Ta-Nb oxides.

Four areas are of main interest for Ta-Nb borates: 1) central Sahatany valley, south of Antsirabe (pegmatites of *Manjaka*, *Ilontsa* and *Marirana*); 2) Manandona valley, south of the Sahatany (pegmatite of *Antandrokomby*); 3) Manapa-Antsetsindrano, south-east of Betafo (pegmatite of *Antsongombato*); 4) Tetezantsio, south-east of Manapa (pegmatites of *Ampasagona*, *Ampanodiana North*, *Ampanodiana South*).

"Danburite-Subtype" pegmatites, normally occurring in swarms of dikes emplaced along metamorphic foliation, or crosscutting it, are mainly thin (a few centimeters up to a few meters width) but can be rather long (up to many hundred meters in length). The mineralogy of the border zone and of the core zone is rather similar; relatively primitive minerals in the border zones (blackish tourmaline, dark-red garnet, milky white to greenish spodumene, ferrocolumbite, betafite) correspond to relatively primitive minerals in the core zone. When high evolved minerals are present in the border zone (polychrome to red tourmaline, green to pink beryl, deep green to deep blue apatite, pink spodumene, rhodizite-londonite, Mn-rich apatite, fergussonite-(Y), microlite, etc.), high evolved (to very high evolved) minerals characterize the core zone. Danburite is present in variable quantity (up to over 15% of the volume of the rock) in both zones. Micas are absent or they are very rare and confined to small portions of the dikes in the core-zone. A bluish thin layer (0.5 to 3 millimeters width) of crystals and fibers disposed perpendicular to the walls, constituted by Mn-rich apatite and a mixture of tourmaline and dumortierite, mark the contacts with the hosting rock. From this layer, large crystals of elbaite (or elbaite/liddicoatite) mainly of red color project to the center of the dike disposed in "comb"-texture, associated with elongated crystals of danburite, K-feldspar, green to pink spodumene, with minor quartz. Such "comb"-texture develops symmetrically on both walls of the dike. At the center, large crystals of albite, K-feldspar, spodumene and danburite with minor quartz are randomly distributed. In this volume, at the center of the core zone, rhodizite crystals can be abundant, together with Nb-Ta oxides, apatite, pollucite, native bismuth, etc.

True miarolitic cavities are rare and in many dikes they are absent. When they occur, even if large spaces are exceptionally rare, elbaite/liddicoatite can form wonderful crystals and gemstones. Much of the cavities are of secondary origin, formed because of the leaching of primary minerals. Crystals of Ta-Nb borates have been found mainly in the core-zones of the dikes, but occasionally also in the border zones. Such minerals are mainly concentrated in small miarolitic cavities, but they are also present hosted between the contacts of rhodizite with quartz and feldspars with quartz.

A series of representative behierite-schiavinatoite crystals and accessory phases from the pegmatites of Manjaka, Ilontsa, Ampasagona, Ampanodiana-North and Ampanodiana-South (see below), have been recently characterized and are the object of a study in progress.

Manjaka (Sahatany valley) - Behierite crystals with rather end member composition have been found at this locality. The size of the crystals ranges from submillimetric to exceptionally one centimeter. Some of the largest crystals are partially replaced by microlite. Tiny manganocolumbite crystals are frequently associated.

Ilontsa (also known as Ilotsa, Sahatany valley) – Behierite crystals with a moderate Nb content have been found here. A few crystals with grayish to blackish color displayed an unusual pseudo-prismatic morphology formed by parallel growth of small crystals. Associated (and partially included) minerals are huebnerite and “wolframixiolite”. Partial alteration of Nb-rich behierite into Nb-rich microlite plus behierite end-member are common.

Ampasagona (Tetezantsio area) – A few tens of crystals of behierite with little to moderate Nb content have been found in this locality. The presence of a strong color zoning, with a dark gray phantom in pale gray-pinkish behierite, is a typical feature of samples of this locality. The size of the crystals ranges from millimetric to 1 centimeter. Much of the crystals are fresh and well preserved while a few ones are altered into microlite plus behierite end-member plus manganocolumbite.

Ampanodiana North (Tetezantsio area) – Many tens of crystals of behierite with little to moderate Nb content have been discovered here. The size of the crystals can exceptionally exceed 2 centimeters. Much of the crystals are partially altered into behierite end-member plus microlite plus manganocolumbite, or into microlite plus manganocolumbite, or into behierite end-member plus Nb-rich microlite. Stibiotantalite can be present in abundance together with the other accessories.

Ampanodiana Suth (Tetezantsio area) – Many tens of crystals of Nb-rich behierite and schiavinatoite have been discovered here. The size of the crystals (or crystals aggregates) can exceptionally exceed 2 centimeters. Much of the crystals are partially altered into behierite end-member plus vigezzite or rynersonite, occasionally with stibiotantalite.