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Accessory Thorianite from the Massifs of Alkaline Rocks and Carbonatites of the Turja Peninsula (Kola Peninsula)

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Abstract

Thorianite has been discovered in altered melilite rocks of the Turja peninsula (White Sea). Physical properties ($n = 2.14$; $d = 8.4$; $a = 5.603$ Å) indicate that this mineral belongs to the thorian end member of the isomorphous group of UO_2-ThO_2-CeO_2 minerals.

Introduction

Thorianite is a comparatively rare mineral of the CeO_2 structural type. It occurs mainly in placer deposits, accompanied by zircon, ilmenite, and thorite. It has been found in pegmatites in bedrock and is also observed as an accessory mineral in some granites, syenites, carbonatites, and marbles. This present occurrence, in altered melilite rocks of the Turja peninsula (northern coast of the White Sea), represents a rather peculiar association.

Occurrence

The alkalic massifs of the Turja peninsula belong to the Caledonian alkalic-ultrabasic formation of the Baltic shield (Dmitriev, Shatilov, and Bulakh, 1970; Kukharenko, Bulakh, and Ilyinsky, 1971). Two large massifs and a number of small satellites are known within the limits of the Turja peninsula and occupy a total area of about 40 km². The Central massif which is the largest one, has a zonal structure. Its border zone is formed by alkalic rocks of the ijolite-melteigite series. The inner zone, however, contains not only ijolites and melteigites but also alkalic pyroxenites, turjaites, uncompahgrites, okaites, and melilitholites. Where these rocks predominate, they alternate with each other in a complicated manner. Veins and vertical, stock-shaped bodies of carbonatite and of apatite-forsterite-magnetite and apatite-calcite-magnetite rocks have also been reported from the core of the massif (Bulakh *et al*, 1972, 1973a). The proterozoic sandstones and granodiorites surrounding the massifs are strongly fenitized (Yevdokimov and Bulakh, 1972).

Thorianite occurs with pyrochlore as an accessory in the original calcite-diopside-hornblende and calcite-garnet-vesuvianite rocks which are genetically related to carbonatites in alkalic-ultrabasic massifs, being generally formed from the alteration of melilite rocks (Kranck, 1928; Orlova, 1959; Epshtein, Anikejeva, and Michajlova, 1961). In the Central massif of the Turja peninsula, these rocks are developed in turjaites and uncompahgrites, their form being that of pockets and irregular bodies and their thickness fluctuating from 1 to 100 m. As a rule, the calcite-diopside-hornblende rocks are medium- to fine-grained aggregates of zeolites, calcite, and apatite, including short prismatic and xenomorphic grains of diopside ($c \wedge \gamma = 38°$; $2V = 62°$). Perovskite occurs as an accessory mineral. Evenly scattered in this polymineralic aggregate are rounded grains of magnetite and large (1–3 cm) poikilitic crystals of hornblende. The hornblende has the following optical characteristics: $(-)2V = 69–74°$; $c \wedge \gamma = 21–23°$, $\gamma = 1.670$; $\beta = 1.662$; $\alpha = 1.651$. The average composition of the rock (in volume percent) is: hastingsitic hornblende, 50; magnetite, 10; diopside, 10; fine-grained aggregate of zeolites, calcite, and apatite, 30.

The calcite-garnet-vesuvianite rocks are dense and massive. They are composed of a fined-grained (0.2–0.3 mm) garnet-vesuvianite-phlogopite-calcite aggregate in which megacrysts (1–2 cm) of garnet and magnetite are uniformly distributed. Calcite also occurs in separate pockets. Perovskite is an accessory mineral. The average composition of the rock (in volume percent) is: vesuvianite, 30; garnet (andradite and melanite-andradite), 30; magnetite, 10; calcite, 20; phlogopite, 10.

Morphology and Physical Properties

Thorianite usually occurs in areas of calcite segregation as an impregnation of fine (0.2–0.3 mm and

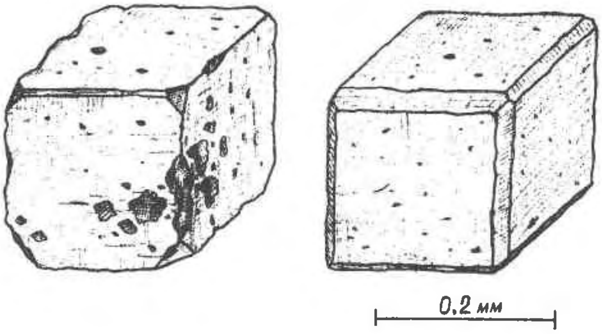

FIG. 1. Crystal habits of thorianite from the Turja peninsula. USSR.

smaller) round grains or as idiomorphic crystals. The latter are cubes modified by very narrow rhombic-dodecahedral and sometimes octahedral faces (Fig. 1).

The thorianite is light orange in color, is translucent in small grains, and has a slightly greasy lustre. In thin section it is transparent and light brown or gray. It is optically isotropic, $n = 2.14 \pm 0.01$. The specific gravity is 8.4 ± 0.4.

X-ray diffraction study shows the thorianite to be slightly metamict. The mineral powder gave the following reflections in the range 27–55°2θ (DRON-1 diffractometer, Cu radiation, recording rate of 0.5°/min., NaCl standard for *d*-spacings): 111-**80**-3.234; 200-**22**-2.804; 220-**41**-1.9807; 113-**30**-1.690 (*hkl*-**relative intensity**-*d*-spacing in Å). The cell edge *a* is 5.603 ± 0.005 Å.

All the data obtained—namely, index of refraction, specific gravity, and unit cell size—indicate that this mineral corresponds to the thorian end member of the isomorphous group of UO_2-ThO_2-CeO_2.

Conclusions

Prior to its discovery in apomelilite rocks from the Turja peninsula, thorianite had been observed at the Kola peninsula only in the Kovdor massif, in phlogopite-bearing rocks (Krasnova *et al,* 1967), and in carbonatites (Kapustin, 1964). The thorianite in the altered melilite rocks of the Turja peninsula resembles that from the phlogopite-bearing rocks of the Kovdor massif. In both cases the mineral is essentially the thorian end member. This peculiarity of composition of thorianite from the phlogopite-bearing and calcite-garnet-vesuvianite rocks distinguishes it from thorianite in carbonatites from a number of other massifs. In these latter the mineral is usually enriched in uranium, sometimes to such degree that it forms varieties intermediate in composition between ThO_2 and UO_2 (*e.g.,* in carbonatites from the Lulecope massif, Africa). Evidently, such a change from essentially pure thorianite in the phlogopite-bearing, calcite-garnet-vesuvianite and other early metasomatites to the uraniferous varieties in the later carbonatites is in complete agreement with the general geochemical characteristic of thorium and uranium—a gradual decrease in the ratio Th/U with time in natural evolutionary series of rocks and minerals. This tendency of thorium and uranium has been clearly recognized in the formation of the alkalic massifs of the Turja peninsula (Bulakh *et al,* 1973b).

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Photograph Identification Contest

Photographer	Identification
No. 1. Richard I. Gibson	Human kidney stone; carbonate-apatite, $Ca_{10}(PO_4,CO_3OH)_6(OH)_2$; whewellite, $CaC_2O_4 \cdot H_2O$; and weddellite, $CaC_2O_4 \cdot 2\,H_2O$.
No. 2. J. H. Berg[1]	Snowflake troctolite, Labrador. Spheroids of radially grown plagioclase in granular layered dunite plus anorthosite, from the unmetamorphosed Hettasch layered intrusion.
No. 3. S. A. Morse[1]	Snowflake troctolite, Labrador. Spheroids of radially grown plagioclase set in olivine (here hornblendized by a later granite) plus plagioclase.
No. 4. Peter R. Buseck and Sumio Iijima	Electron microphotograph of clinoenstatite.
No. 5. P. R. Buseck and S. Iijima	Electron microphotograph of idocrase.
No. 6. P. R. Buseck and S. Iijima	Electron microphotograph of beryl and cordierite.
No. 7. P. R. Buseck and S. Iijima	Electron microphotograph of orthoenstatite: a-b and a-c sections.
No. 8. Hans Nissen	Scanning electron microphotograph of opal.

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