

Geochemical (LA-ICP-MS) investigations of baddeleyite from the Palaeoproterozoic mafic and Palaeozoic alkaline intrusions in the Arctic part of the Baltic shield

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Baddeleyite is a zirconium dioxide mineral, which is very important, but less common as zircon. While the zircon microelementary composition study is widely applicable, the baddeleyite geochemical features are poorly known. The first data on REE concentrations and distribution in baddeleyite were published in the past century. Baddeleyite is used as a geochronometer for dating mafic and alkaline rocks. It may be noted that the data on its geochemical composition are quite contradictory with a strongly varying Ce anomaly value and absent Eu anomaly in some samples. The new data on the elementary composition of baddeleyite (REE, Hf, U, Th, Y, and Ti) from the Monchegorsk pluton mafic rocks (2.5 Ga) and Kovdor and Vuoriyarvi deposits (380 Ma) was obtained.

The sample morphology was studied using an electronic spectroscopy method (Hitachi S-430), and the position of local analysis on baddeleyite crystals was chosen based on analyzed optic images of minerals. The content of REE and other elements was measured using LA-ICP-MS technique on quadrupole mass-spectrometer ELAN 9000 DRC-e (Perkin Elmer) with laser evaporator UP-266 MARO (New Wave Research) with a wave length of 266 nm for sampling. The laser ablation was made in argon atmosphere in a 35 and 70 μm diameter spot or when scanning to a line with a pulse repetition rate of 10 Hz and pulse energy of 14–15 J/cm². The device was calibrated using the NIST SRM 612 standard with a REE, U, and Th concentration of about 40 ppm.

The baddeleyite from reference rocks of mafic intrusions are characterized by medium concentrations of Hf (0.69-1.9 %), Th (7.6-21.1), REE (50.3-162), U (164-357), Y (5.0-149) ppm for the sample M-2 from Monchegorsk. Another rocks of alkaline intrusions are depleted in Th (0.25-5.9), REE (9.2-103), U (1.8-48.1), Y(2.9-65.9) ppm and Hf (0.20-1.9%) for the sample Bd-400 from Vuoriyarvi and Hf (0.18-1.3 %), Th (0.4-5.2), REE (2.1-17.7), U (4.2-32.6), Y(2.2-68.4) ppm for the samples Bd-300 and Bd-300 prism. from Kovdor.

The titanium content in the samples widely varies being 10-37 ppm for sample Bd-300 and 28-72 ppm for Bd-300 prism., 47-150 ppm for sample Bd-400 and 0.31-0.79% for older baddeleyite M-2. The average baddeleyite crystallization and U-Pb system closure temperature calculated using a zircon-applied method is 804-888°C (Kovdor) and 984°C (Vuoriyarvi). The baddeleyite from the Monchegorsk pluton has shown high crystallization temperatures of about 1,000 degrees centigrade.

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