Hydrothermal zircon from Proterozoic carbonatite massif

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Zircon from Tiksheozero (Northern Karelia) carbonatite massif forms pseudo octahedral-dipyramidal crystals, typical for zircon from carbonatites and alkaline rocks. Facets of (111) sharp dipyramid prevail over (110) prism, but often they are asymmetric. Zircons are semitransparent, pale-pink or pinkish-grey. SEM study reveals heterogeneity of zircon inner structure: cracks, gas-liquid inclusions, caverns. Apatite, magnetite and alk.amphibole are found as inclusions in zircon grains. Size of zircon grains is up to 5 mm. Zircons are cracked, with rough surfaces and often with corroded 10 mkm-thick rims of secondary baddeleyite. Baddeleyite met in central parts of zircon and is considered as primary baddeleyite. Based on CL images zircons were divided into three groups: a) dark CL images with traces of zoning in BSE images; b) dark crystals with CL lighting in a thin irregular rim; c) “whirlwind” CL images, without any coincidence with the inner structure. All studied zircons has unusually low Hf (up to 0.52%).

SIMS SHRIMP U-Th-Pb zircon dating revealed extreme variations in U (2-3100 ppm) and Th (1-4400 ppm) and Th/U 0.6-137, and disturbance of isotope system at the analytical level. Such characteristics are not typical for the carbonatite zircon and may be explained by the influence of low-temperature alkaline fluids, resulted in reaction rims in zircon saturated with water, alkalis, REEs and phosphorus. REE patterns vary from typical magmatic (carbonatite) to “hydrothermal” with 10 times-enrichment in LIL and greater enrichment in LREE. Positive Eu anomaly is occasionally observed. Growth of outer zones was emphasized by Pb and U redistribution due to intensive metamictization (primary Th+U up to 5000-7000 ppm). The best estimation of zircon crystallization age in Tiksheozero carbonatites could be 2070±70 Ma by $^{208}Pb/^{232}Th$ ratios. It is similar to the age of primary baddeleyite (2100 Ma), which marks crystallization of the carbonatite complex. Zircon and baddeleyite relationships in this case refer to the later zircon crystallization. Hydrothermal recrystallization of metamict zircon took place much later, at Caledonian orogenesis 450-410 Ma, but some zircon transformation (dissolution-reprecipitation) at Proterozoic postmagmatic stages could not be excluded.

The genesis of I- and S-type granitoid rocks of the Early Ordovician Oledo pluton, Central Iberian Zone (Central Portugal)

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The Early Ordovician Oledo pluton intruded a Cambrian schist-metagraywacke complex and consists of four distinct granodioritic to granitic phases, G1-G4. ID-TIMS U-Pb ages for zircon and monazite from these granitic rocks indicate emplacements within a short period of time at 479 - 480 Ma. Granodiorite G1 is the most deformed rock with shear zones and deformation at the border. G1 and G3 contain fine-grained biotite tonalite and biotite granodiorite microgranular enclaves, showing rounded or ovoid shapes, some of them irregular and having sharp, occasionally crenulated and diffuse contacts. Microgranular enclaves (ME) and granitic rocks are peraluminous (A/CNK=1.0 to 1.2), and contain quartz, albite-labradorite, K-feldspar, biotite, zircon, apatite, monazite and ilmenite. Muscovite was found in most rocks and amphibole, titanite, allanite and magnetite also occur in ME and host G1. ME are darker and richer in mafic minerals than the host granodiorites. The geological, mineralogical, geochemical and Sr, Nd and O isotopic data show that tonalitic and granodioritic enclaves and host G1 are of I-type and were related predominantly by a fractional crystallization process. Least-square analysis of major elements and modelling of trace elements indicate that granodioritic enclaves and host G1 could be derived from the tonalitic enclave magma by fractional crystallization of plagioclase, grunerite, biotite and ilmenite. Granodiorite G2 is of hybrid origin. Most variation diagrams for granodioritic enclaves and host G3 granodiorite and their biotites show linear trends. Modelling of major and trace elements of granodioritic enclaves indicate that they result from mixing of a relatively primitive granodiorite magma with a magma derived from crustal melting. Tonalitic enclaves correspond to globules of a more mafic relatively primitive magma. Granite G4 has the most pronounced crustal signature and is of S-type.