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U-Pb (CA-ID-TIMS) geochronological studies of the metamict zircons

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Our research demonstrates an example of using the chemical abrasion technique (U-Pb CA-ID-TIMS) [1] for U-Pb dating of the metamict zircons with a high self-irradiation α-dose ($D_\alpha > 6\times10^{18}$ α-events/g, amorphous domains >80%). Annealing at 850–900°C for 48 hours followed by leaching in HF + HNO_3 for 2–4 hours at 180–230°C resulted in effective removal of the metamict phase and an improvement in crystallinity. However, only a fine-crystalline (5-20 µm) undisturbed zircon residue remains in this case.

For this study, the zircon from rare-metal granites of the Turga massif [2] has been chosen. Zircons from granite with Li-siderophyllite (1) have metamict cores ($D_\alpha = 6.0\times10^{18}$–$1.1\times10^{19}$ α-events/g); zircons from amazonite granite (2) demonstrate a porous structure and are highly metamictized ($D_\alpha = 7.0\times10^{18}$–$2.3\times10^{19}$ α-events/g).

Annealing improves crystallinity as seen by the increasing of the Raman shift and reduction of the full-width at half maximum (FWHM) of the ν3(SiO_4) anti-symmetrical stretching mode of the B_{1g} Raman band at ~1008 cm^{-1}. Zircon-1: the Raman shift increases from 997.4±4.0 cm^{-1} to 1004.4±1.6 cm^{-1}, FWHM reduces from 34.1±29.6 cm^{-1} to 15.0±5.7 cm^{-1}. Zircon-2: the Raman shift increases from 993.4±3.5 cm^{-1} to 1002.2±1.7 cm^{-1}, FWHM reduces from 57.0±24.8 cm^{-1} to 18.2±3.8 cm^{-1}. These zircons are highly damaged but they demonstrate the improvement of crystallinity up to values similar to the moderately damaged zircon [3]. The optimal conditions of the one step partial dissolution treatment for studied zircons are: 2 h at 230°C for zircon-1 and 4 h at 180°C for zircon-2. These conditions provide the best ratio between the suitable amount of residual material and effective removal of the metamict phase. The estimated U-Pb ages are: 146±4 Ma (MSWD=0.074) for zircon-1 and 141±1 Ma (MSWD = 0.014) for zircon-2.

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[1] Mattinson (2005) *Chemical Geology* **220**, 47-66. [2] Ivanova *et al.* (2019) *Geology of Ore Deposits* **61(8)**, 707-721. [3] Widmann *et al.* (2019) *Chemical Geology* **511**, 1-10.