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Megacrystic zircon with planar fractures in miaskite-type nepheline pegmatites formed at high pressures in the lower crust (Ivrea Zone, southern Alps, Switzerland)

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Abstract

Trace element, Hf, and O isotopic composition and U-Pb geochronological data are reported for zircon megacrysts found in miaskitic (zircon, biotite, plagioclase-bearing) nepheline syenite pegmatites from the Finero complex in the Northeastern part of the Ivrea-Verbano Zone, southern Alps. Zircon from these pegmatites was reported to reach up to 9 cm in length and is characterized by ~100 μm spaced planar fractures in different directions. Small volumes of these highly evolved alkaline melts intruded into the lower crust and were emplaced within amphibole peridotites and gabbros between 212.5 and 190 Ma. A zircon crystal of 1.5 cm size records a systematic core-to-rim younging of 4.5 Ma found by high-precision CA-ID-TIMS $^{206}Pb/^{238}U$ dating of fragments, and of 8.7 Ma detected by laser ablation ICP-MS spot dating. Volume diffusion at high temperatures was found to be insufficient to explain the observed within-grain scatter in dates, despite the fact that the planar fractures would act as fast diffusion pathways and thus reduce effective diffusion radii to 50 μm. The U-Pb system of zircon is therefore interpreted to reflect an episodic protracted growth history.

These high-pressure miaskites probably formed by episodic, low-degree decompression melting of a metasomatically enriched mantle source and subsequent crystallization in the lower crust at volatile saturation with explosive volatile release, evidenced by their brecciated texture in the field and by the occurrence of planar fractures in zircon. They point to the existence of a long-lived period of heat advection in the deep crust by highly differentiated melts from enriched, lithospheric mantle.

Keywords: Miaskitic pegmatite, zircon megacrysts, U-Pb, planar fractures, southern Alps, diffusion modeling, volatile explosions