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High-grade metamorphic alteration processes on zircon grains: a combined LA-ICPMS isotopic and trace element study of a composite mafic-ultramafic layered complex in Central Brazil

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ABSTRACT

Zircon recrystallization is a common processes operating throughout high-grade metamorphism and promotes partially to totally reset of the primary isotopic and chemical record, which may lead to misunderstanding of the U-Pb information.

In Central Brazil, such scenario is illustrated by three composite mafic-ultramafic intrusions metamorphosed under amphibolite-to-granulite conditions, whose geochronological framework has been matter of controversy for the last 30 years. The Serra da Malacacheta and Barro Alto complexes compose the southernmost layered body and four samples from distinct rock types within both units are investigated in order to verify the consequences of zircon alteration during metamorphism for U-Pb dating.

Cathodoluminescence imaging reveal internal features typical of concomitant dissolution-reprecipitation process, such as convolute zoning and inward-moving recrystallization fronts, even in samples in which partially preserved igneous textures are observed. Due to this extensively alteration, LA-ICPMS U-Pb dating was inconclusive. Nevertheless, in situ Hf isotopic and trace-element analyses allow clarifying the real meaning of geochronological data. Low Lu/Hf (<0.004) and homogeneous 176Hf/177Hf values imply that zircon population (within individual samples) have crystallized in a single episode.

Trace element signature of zircon from garnet-bearing samples reveals that it was generally unreactive to the development of the peak assemblage and, thus, the main chemical feature in such grains is attributed to a coupled dissolution-reprecipitation. However, in the Cafelândia amphibolite a further alteration process is identified and is probably related to the influx of late-stage fluids.

Ti-in-zircon thermometer renders constant values at ca. 700°C which are interpreted as representative of neither igneous nor metamorphic conditions. The consistent temperatures more likely reproduce a crystallographic control and, thus, Ti-in-zircon data from recrystallized grains shall be cautiously evaluated.

Therefore, combined isotopic and geochemical investigation on zircon grains allow the undoubtedly distinction of two magmatic events. The first corresponds to the Serra da Malacacheta Complex and characterizes a juvenile magmatism that occurred at ~1.3 Ga. The latter episode, recognized in the Barro Alto Complex, is dated around 800 Ma and has a strongly contaminated signature, implying that the emplacement took place in a continental crust, probably in a back-arc setting. Zircon altered domains and titanite grains dates the metamorphic imprint at ca. 760-750 Ma. The roughly coeval voluminous mafic magmatism and high-temperature metamorphism in the Neoproterozoic, thus, requires an additional heat source, which is coherent with the hypothesis of a hot-orogen and, accordingly, suggests an accretionary nature for the orogenic setting.