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Zircon and garnet compositional constraints on the nature of extension-related peraluminous silicic magmas in the Northern Pannonian Basin.

SZABOLCS HARANGI[1,2], RÉKA LUKÁCS[1,3], MARCEL GUILLONG[4], OLIVIER BACHMANN[4], MAXIM V. PORTNYAGIN[5], SAMUEL MÜLLER[6] AND ZOLTÁN KOVÁCS[1]

[1]MTA-ELTE Volcanology Research Group
[2]Department of Petrology and Geochemistry, Eötvös Loránd University
[3]Institute for Geological and Geochemical Research Research Center for Astronomy and Earth Sciences, ELKH
[4]ETH Zürich
[5]GEOMAR Helmholtz Centre for Ocean Research Kiel
[6]Institute for Earth Sciences, Christian-Albrecht University of Kiel

Presenting Author: harangi.szabolcs@ttk.elte.hu

The Mid-Miocene volcanism in the northern Pannonian basin has a peculiar nature. The first volcanic products (metaluminous andesite to peraluminous dacite-rhyodacite) are unique since the dacites and rhyodacites contain almandine garnet, which rarely occurs in volcanic rocks. The primary almandine crystals have a moderate Ca content (CaO=4.5–8.1 wt%), although low-Ca (CaO<3 wt%) almandine derived from lower crustal metapelites is also found. Trace element variations in garnet are consistent with progressive crystal fractionation at high-pressure (>700 MPa). Zircon U-Pb geochronology results suggest eruption ages between 15.6 and 15.0 Ma. Remarkably, this volcanism has no relationship with coeval subduction, but it occurred in response to continental rifting.

The nature of these magmas was further explored with the help of trace element and Hf-isotope composition of zircon. Zircon in the peraluminous rhyodacites has a unique compositional feature, an elevated Al content (Al=10–15 ppm) not found in other silicic volcanic rocks in this region. Notably, zircon in the coeval metaluminous volcanic rocks has also relatively high Al-content (5–10 ppm). Zircon crystals in the peraluminous rocks have relatively high Dy/Yb and low Th/U ratios consistent with early garnet crystallization. Strong depletion of heavy rare earth elements is observed also in the glass shards.

The epsilon Hf values of zircon crystals show a variation from -4 to +2, transitional values compared to the Miocene volcanic rocks of the region and suggest mixing of mantle-derived and crustal-derived magmas. This is consistent with petrogenetic modelling calculations based on bulk rock isotope and trace element data, implying interaction between mafic magmas derived from enriched lithospheric mantle and metasedimentary lower crust. Thus, the peraluminous garnet-bearing magmas in the northern Pannonian basin are hybrids, and are not of pure anatectic origin, as being proposed for compositionally similar magmas, such as in SE Spain. Preservation of high-pressure garnet can be explained by fast magma ascent enhanced by crustal extension. In contrast, some magmas stalled at shallow crust. They also contain Al-bearing zircon crystals suggesting peraluminous character of their parental magmas, whereas garnet phenocrysts were likely dissolved at low pressure (as also reflected in the glass composition).