Plio-Quaternary Volcanism in Italy: Petrology, Geochemistry, Geodynamics

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Invited review

Early to Mid-Miocene syn-extensional massive silicic volcanism in the Pannonian Basin (East-Central Europe): Eruption chronology, correlation potential and geodynamic implications

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ABSTRACT

Formation and evolution of the Pannonian Basin as part of the Mediterranean region was accompanied by eruptions of compositionally diverse magmas during the Neogene to Quaternary. The long-lasting magmatic activity began with some of the most voluminous silicic eruptions in Europe for the last 20 Myr. This paper describes the eruption chronology of this volcanic activity using new, high-quality zircon U-Pb dates, and provides the first estimates on the volume and areal distribution of the volcanic products, characterizes the magma composition and discusses the silicic magmatism in a region, where the continental lithosphere underwent significant extension. A thorough zircon geochronological study was conducted on samples collected from ignimbrites and pyroclastic fall deposits exposed in the Bükkalja Volcanic Field. In-situ LA-ICP-MS analysis on zircon grains provided a fast, cheap and accurate method for such detailed geochronological work, where the volcanic products occur in scattered outcrops that often have poor stratigraphic constraints. The interpreted eruption ages were determined from the youngest zircon age population within the samples and this methodology was validated by new single zircon CA-ID-TIMS dates and sanidine Ar-Ar ages. The volcanism covers about 4 Myrs, from 18.2 Ma to 14.4 Ma and involved at least eight eruptive phases. Within this, four large eruption events were recognized at 14.358 ± 0.015 Ma (Harsány ignimbrite), 14.880 ± 0.014 Ma (Demjén ignimbrite), 16.816 ± 0.059 Ma (Bogács unit) and 17.055 ± 0.024 Ma (Mangó ignimbrite), which are found in areas across the Pannonian Basin and elsewhere in central Europe. Considering all the potential sources of silicic ash found in the Paratethys sub-basins around the Pannonian Basin and along the northern Alps and in central Italy, we suggest that they were probably derived almost exclusively from the Pannonian Basin as shown by zircon U-Pb dates presented in this paper and published comparable age data from several localities. The new eruption ages considerably refine the Early to Mid-Miocene chronostratigraphy of the Pannonian basin, where the extensive volcanoclastic horizons are used as important marker layers.

The cumulative volume of the volcanic material formed during this 4 Myr long silicic volcanism is estimated to be > 4000 km^3, consistent with a significant ignimbrite flare-up event. Zircon crystallization ages indicate magma intrusions and formations of magma reservoirs in the continental crust for prolonged period, likely > 1 Myr prior to the onset of the silicic volcanism accompanied with sporadic andesitic to dacitic volcanic activities. Mafic magmas were formed by melting of the thinned lithospheric mantle metasomatized previously by subduction-related fluids and emplaced at the crust-mantle boundary. They evolved further by assimilation and fractional crystallization to generate silicic magmas, which ascended into the pre-warmed upper crust and formed extended magma storage regions. Zircon Hf isotope and bulk rock Sr-Nd isotopic data indicate a sharp decrease of crustal and/or increase of asthenospheric mantle input after 16.2 Ma, suggesting that by this time the crust, and the lithospheric mantle was considerably thinned. This magmatism appears to have had a structural

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