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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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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 started with some of the most voluminous silicic eruptions in Europe for the last 20 Myr. We present the eruption chronology of this volcanic activity using new, high-quality zircon U-Pb ages, provide 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 dating (LA-ICP-MS and CA-ID-TIMS) was conducted on samples collected from ignimbrites and pyroclastic fall deposits exposed in the Bükkalja volcanic field. 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 affected 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 the new zircon U-Pb ages and the 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 as up to 4000 km3, consistent with a significant ignimbrite flare-up event. Zircon crystallization ages indicate magma intrusions and formations of magma reservoirs in the continental crust for about 2 Myr prior to the onset of the silicic volcanism and during this period there were also 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. Zircon Hf isotope and bulk rock Sr-Nd isotope 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 could have been considerably thinned.

This magmatism appears to have a structural relationship to tectonic movements characterized by strike-slip and normal faults as well as vertical axis block rotations, where two microplates are juxtaposed along the Mid-Hungarian Shear Zone. Our new zircon ages helped to refine the time of the two major block-rotation phases. This volcanism shows many similarities with other rift-related silicic volcanic activities such as the Taupo Volcanic Zone (New Zealand) and the Basin and Range province (USA).

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