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Post-collisional interaction of lamproite mantle and dacite crustal magmas: a case study from the Neogene Volcanic Province, southeast Spain

Aitor Cambeses and Jane H. Scarrow

Department of Mineralogy and Petrology, Faculty of Sciences, University of Granada, Campus Fuentenueva, 18002 Granada, Spain (jscarrow@ugr.es)

Orogenic igneous rocks are important tectonomagmatic markers. The Neogene Volcanic Province of southeast Spain is located in the Betic Cordillera which is part of the Alboran Domain of the Betic-Rif orogen of the western Mediterranean. The province comprises four types of volcanic rocks: calc-alkaline, high-K calc-alkaline and shoshonitic, potassic and alkali basaltic.

Many of the potassic volcanic centres, the focus of this study, are situated close to, and elongated along, basin margins faults. Detailed field mapping of two such coeval, but geographically separate, volcanic centres (Zeneta and La Aljorra), and comparison of peperite sediment facies and volcanic radiometric ages with similar rocks at nearby Fortuna, suggests that all three centres formed at approximately the same time, late Tortonian, by the same tectonomagmatic process, strike-slip, and in the same, shallow marine, paleogeographical context. Movement of basin margin faults that closed the Miocene sedimentary basins causing drying out leading to the Tortonian salinity crisis seemingly also facilitated contemporaneous ascent of mantle-derived potassic magma.

In this work we use field, petrographic and compositional evidence to study the petrogenesis of the potassic volcanic rocks from Zeneta and La Aljorra. Here we show that the former are 'atypical lamproites', in fact being calc-alkaline lamprophyre minettes, that apparently formed as a result of post-collisional interaction of alkaline lamproite mantle magma and peraluminous dacite crustal magma.

Recent U-Pb zircon ion microprobe analyses of new-formed zircons and overgrowths on inherited zircons give an age of 8.71 ± 0.14 Ma for the Zeneta volcanic rocks. This age, which is older than previously thought, reveals that a mantle melting event was coeval with a well documented regional crustal anatexis event at 9 Ma.

The mixing hypothesis sheds light on the anomalous nature of the Zeneta minettes when compared with other contemporaneous potassic rocks of the Neogene Volcanic Province. In particular, the addition of a dacitic component can explain their more SiO_2-rich and MgO-poor whole-rock compositions, less enriched Sr and Nd isotope values and their varied mineralogy that, in addition to olivine, phlogopite and sanidine also includes orthopyroxene and biotite.

Independent of age or setting late-orogenic magmatism is typically K-rich and associated with strike-slip movement. It has been suggested that regional strain is localized by heterogeneities in the mantle that serve as nucleation points for the development of strike-slip faults which may then act as channels for magma ascent. The close spatial and temporal association of the peraluminous intermediate-acid dacites and alkaline basic lamproites provides the opportunity to investigate the interaction between crustal and mantle melt generation during late orogenesis.