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Xenoliths as constraints on crustal architecture and melting levels in southern Spain and northern Morocco

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Xenoliths in volcanoes can, under suitable conditions, provide key constraints on the architecture of both the underlying crustal segments and magma conduits/chambers. Using thermobarometry to calculate the depth of the provenance level and geochronology to trace known or unknown crustal units, main crustal boundaries, e.g. detachment zones known from surface geology and geophysics, can potentially be mapped. Alternatively, if all xenoliths are derived from the same level, information can be gained on crustal melting or other processes operating at that level. Here we give examples from SE Spain and northern Morocco.

Crustal xenolith suites in the Neogene Volcanic Province of SE Spain originated by high-T (c. 900 degrees C) partial melting at different crustal depths, decreasing from 20-25 km in the SW to 9-12 km in the NE. The xenolith source levels are equated with the wall-rock of basaltic magma chambers at the base of a felsic crust. This level matches a thin, intracrustal low-velocity zone underneath the Miocene El Hoyazo volcano that increases in thickness towards NE. A model of increasing upper crustal thinning from SW to NE in the NVP, accompanied by mafic underplating, is consistent with the 9 Ma petrological data, with current heat flow, seismic data and gravimetry, as well as with the triggering event for the eruption episode. It is concluded that significant crustal extension occurred in the NVP in the late Miocene, i.e. after the main phase of widespread extension, exhumation of high-pressure rocks and formation of the Alboran Sea.

In Morocco, crustal domains are well characterized at the surface, ranging in age from Proterozoic in the south to Plio-quaternary in the north. Exploration wells in northern lowlands and offshore have extended surface information down to several km depth, but at larger depths, only geophysical data have been used for downward extrapolation. We will demonstrate how crustal xenoliths in Neogene and Quaternary volcanoes can complement geophysical data in northern Morocco.