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Crustal processes cause adakitic chemical signatures in syn-collision magmatism from SE Iran

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We report new elemental and Nd-Sr isotopic analyses for Late Cenozoic intrusive and extrusive rocks emplaced in SE Iran as part of the wider syn-collision magmatic province within the Turkish-Iranian Plateau. The sample sites are near the town of Dehaj in Kerman Province. Most of the rocks are from stocks and batholiths, interpreted as the roots of central volcanoes. Age controls are not precise, but the rocks are likely to be Late Miocene-Quaternary in age. Basaltic to andesitic lavas crop out nearby; their relationships to the intrusive rocks are uncertain.

Geochemically, the entire range of rocks from basalt lavas through to rhyolitic intrusives ranges from 51-71 wt.% silica and isotopic signatures are similar to Bulk Earth, without any clear evidence for large-scale crustal contamination. The basaltic to andesitic lavas appear to have variable and often high La/Yb and Sr/Y such that they range from calc-alkaline arc-like rocks to adakitic compositions depending on the degree of fractionation. The intrusive rocks seem to form a separate suite, with clear indications of increasing Sr/Y and Dy/Yb with fractionation.

Previous interpretations relate adakitic magmatism to Tethyan oceanic slab break-off and slab melting beneath the collision zone. However, as the 'adakitic signature' is increasingly apparent in more evolved magmas, at least in the intrusives, adakite generation is more likely to have occurred during melt evolution from an initial low Sr/Y and low La/Yb parent. This parental melt may have been similar in starting composition to proposed non-adakitic basaltic melts from elsewhere in the collision zone.

The high Sr/Yb and La/Yb signatures are best explained by the suppression of plagioclase fractionation by high magmatic water contents, promoting incompatible behaviour of Sr. Conversely, Y and Yb are compatible during amphibole and garnet fractionation at crustal or uppermost mantle levels.

Rather than a localised slab break-off or melting effect, the Dehaj magmatism may have developed its geochemical signature during deep fractionation as the ascent of the magmas was impeded by thick orogenic crust. The rocks may be seen as just another part of the widespread syn-collision magmatism that has affected widespread areas of Turkey, Iran, Armenia and neighbouring countries in the last $\sim$10-15 Ma, and need not be used as markers for debateable geodynamic events such as break-off. Adakites are also present in NE Iran without any obvious association with subduction processes.

We argue that magmatism across much of the plateau is linked at least in part to mantle upwelling following Miocene slab break-off, but also to small-scale convection beneath the collision zone, as predicted by numerical modelling. Particular compositions such as those at Dehaj are influenced by local sources and differentiation processes, but there is no need for independent triggers for initial melting across disparate locations.