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"Dirty" subduction during the closure of Tethyan Ocean(s)-evidence from K-rich postcollisional magmatism within Alpine-Himalayan belt

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The Alpine-Himalayan accretionary orogen occurs at a diffuse and long lived convergent zone between Eurasia and Gondwana that has been active since Permian-Mesozoic times, resulting in the consumption of major Tethyan ocean(s) along the Alpine-Himalayan system. The convergence involved accretion of small continental slivers, and numerous oceanic island arcs, which eventually resulted in a complex collage enclosing numerous continental crustal blocks intercalated with ophiolitic terrains of various sizes and ages forming superimposed orogenic belts. While the origin and development of the crustal segments of the lithosphere involved in the convergence along the Alpine-Himalayan system is better constrained being more accessible, the “destiny” of the lithospheric mantle beneath this accretionary orogen, the type and the timing of its metasomatic preconditioning is enigmatic.

In this contribution I will draw conclusions about the nature of orogenic lithospheric mantle within the Alpine–Himalayan belt by using the geochemical and mineral data of K-rich post-collisional mantle-derived lavas from Spain, Italy, Balkans, Turkey and Iran. The volcanism is activated mostly after subduction ceased. It is diachronous with the most voluminous and widely distributed episode(s) beginning from the late Cretaceous, representing a magmatic response to the post-accretionary orogenesis. These volcanic rocks can be used as geochemical proxies to elucidate mantle geochemistry because they are derived from freshly metasomatized lithospheric mantle that is strongly enriched in radiogenic isotopes and trace elements.

The whole rock and mineral chemistry of K-rich postcollisional lavas suggests that the orogenic mantle underwent much more intense and complex material recycling than anticipated only by fluid- or melt- dominated transport. This is based on several fundamental constraints: i) The lavas are strongly incompatible-element enriched with elevated 87Sr/86Sr (both in the whole rock and clinopyroxene), 207Pb/204Pb, 187Os/188Os and low 143Nd/144Nd and 176Hf/177Hf ratios. This isotopic enrichment complements trace element enrichment indicated by high LILE/HFSE, exceptionally high Th/Nb, predominantly high Hf/Sm and low Ce/Pb and Nb/U ratios. These tracers represent a hallmark for continental crust, pointing to a component within the mantle source similar to terrigeneous sediments; ii) The presence of an ultra-depleted component in the source of the K-rich lavas is identified by usual presence of very refractory Cr-spinel, high Fo olivine and relatively low whole-rock FeO abundances; iii) Finally, extremely high Th/La is coupled with high Sm/La of potassic mantle-derived lavas, and it is even higher than in the upper crust or crust derived melts. The extreme fractionation of these conservative trace elements points to a genetic relationship with the melange.

The above observations suggest that neither fluids nor melts alone are able to precondition orogenic mantle using known mechanisms that are active during material recycling within subduction zones, thus a new model is required. I will present a hypothesis that the orogenic mantle along the Alpine-Himalayan system is preconditioned during previous episode(s) of “dirty” subduction. This process involves formation of a new mantle lithosphere formed by accretion of suprasubduction fore-arc oceanic lithosphere plus trench sediments beneath older lithosphere during convergence within the Alpine-Himalayan system. The model demands conversion of principally oceanic lithosphere (including melange) into the phlogopite-bearing continental lithospheric mantle and production of K-rich post-collisional lavas, which is a multi-component and multi-episodic process.