Analytical and experimental study of post-collisional volcanism in the Alpine-Himalayan belt

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Post-collisional mantle-derived magmatism in the Alpine–Himalayan belt is geochemically extremely heterogeneous, but dominantly enriched in potassium. Its origin is controversial, particularly the role of recycled continental crust. In our contribution, we combine the field and geochemical data on the lavas with high-pressure experiments on different mantle and crustal materials to form a comprehensive model for the origin of this magmatism and its geodynamic significance.

Three major geochemical components are recognized: (i) the lavas are strongly incompatible-element enriched with elevated $^{87}Sr/^{86}Sr$, $^{207}Pb/^{204}Pb$, $^{187}Os/^{188}Os$ and low $^{143}Nd/^{144}Nd$ and $^{176}Hf/^{177}Hf$ ratios. All these tracers represent a hallmark for continental crust; (ii) an ultra-depleted component, which is identified by the presence of refractory Cr-spinel, high Fo olivine and relatively low whole-rock FeO abundances; (iii) extremely high Th/La coupled with high Sm/La of potassic mantle-derived lavas, which indicates a genetic relationship with melange. We performed several series of fluid-absent near-solidus phase equilibria studies at 1-3 GPa. Experimental capsules juxtaposed peridotites with different fertility against phlogopite-clinopyroxenites in different proportions. Additional melting experiments were performed at 1-3 GPa and 900-950°C on a quartz-phyllite to investigate the behaviour of Th, Sm and La during melting of the crust. Results were compared with phase relations and compositions of natural Alpine-Himalayan ultrapotassic lavas.

We hypothesize that the orogenic mantle along the Alpine-Himalayan system is preconditioned by previous subduction episodes. This involves formation of new mantle lithosphere by accretion of supra-subduction 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 phlogopite-bearing continental lithospheric mantle. The later production of K-rich post-collisional lavas thus requires a multi-component and multi-episodic process.