Mantle origin of andesites in the central Mexican Volcanic Belt

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While the significance of orogenic andesites in the solid Earth geochemical cycle is undisputed, consensus still does not exist as to their petrogenesis. Here we present new constraints on andesite formation in the central Mexican Volcanic Belt (MVB), which is constructed on 40-47 km thick Proterozoic crust. Mafic melts range from high-magnesium calc-alkaline andesites with depleted HFSE (Nb ~5 ppm) and strongly fractionated LILE/HFSE (Nb/La ~0.4), to Fe-rich alkaline basaltic andesites rich in HFSE (Nb ~25-35 ppm) and nearly flat LIL-element patterns (Nb/La ~0.8-1). Ubiquituous olivine phenocrysts are Ni-rich with maxima of 0.53 wt% Ni at Fo_{90} and 0.35 wt% Ni at Fo_{83}, in excess of oceanic basaltic or even Ni-rich Hawaiian olivines [1]. Olivine is in equilibrium with bulk rock of ~3.5-8 wt% MgO and ~51-63 wt% SiO_2, and thus the Ni-rich olivine simply reflects the high Kd_{Ni} (oliv/melt) at low MgO contents. Equilibrium melts can be inferred to have 50-250 ppm Ni and Mg# =53-75, similar to partial melts from peridotite. However, peridotite melts have much higher MgO (>10 wt%). We suggest formation of the low-MgO central MVB andesites by mixing of Mg- and Fe-rich peridotite melts (Ni=250-550 ppm, Mg#=71-77) from variably depleted mantle sources with low-Mg, low Fe component melts. In the simplest case, such low-Mg, low Fe components melts are earlier melt batches of the same volcano system that have fractionated 15-20% olivine. Additional low-MgO, low FeO components melts may be added from either the slab or the crust. Correlations of mantle source Mg# with slab (Pb/Ce, U/Nb) and mantle (Nb/Yb, Zr/Hf and Nb/Ta) tracers suggest that trace elements systematics of MVB andesites reflect mixing of a variably depleted mantle with a few percent of highly enriched slab components. These results support models that advocate andesite formation primarily through differentiation of a metasomatized upper mantle with a neglible role of crustal additions.

References

[1] Sobolev AV, Hofmann AW, Sobolev SV, Nikogosian IK (2005) *Nature* **434,** 590-597.