Crustal recycling by subduction erosion in central Mexico

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In recent years, the recycling of the upper plate crust in subduction zones, or 'subduction erosion', has been recognized as important mechanism of crustal destruction at convergent margins [e.g. von Huene et al. 2004]. Obtaining evidence of the recycling of eroded crust from arc magmas, however, is challenging owing to the compositional similarities between eroded crust, subducted trench sediment and arc crustal basement that all can contribute to arc magma formation. We addressed this problem by a Hf-O-Pb isotope study of a previously well-characterized series of olivine-phyric high-Mg# basalts to andesites in the central Mexican Volcanic Belt (MVB). These magmas are hybrids of primary basaltic to dacitic mantle melts from olivine-free, secondary pyroxenite lithologies which escaped crustal contamination during ascent [Straub et al. 2011, ESPL]. The olivine phenocrysts combine high-Ni (up to 0.67 wt% Ni) with high $^{3}He/^{4}He$ = 7-8 R_a and high $\delta^{18}O$ = +5.3-6.6‰ (of $\delta^{18}O$ = +6.3-8.5‰ of host melt) which attests to the presence of a crustal component in the mantle melts that must derive from slab. However, Hf-Nd isotope and trace element systematics rule out the pelagic trench sediment as crustal component and imply a major contribution from eroded crust that became entrained in the subduction channel either via the trench following landward surface erosion, or by abrasion of the underside of the upper plate. The model agrees with new high-precision Pb isotope ratios of central MVB magmas that identify the arc Pb to be dominated by the radiogenic Pb from the eroded and recycled Mexican continental basement with only a lesser contribution of unradiogenic Pb from MORB-type crust produced at the Pacific East Pacific Rise. Overall, the mass of the eroded continental crust dwarfs the mass of the recycled pelagic sediment, emphasizing the importance of subduction erosion in the recycling of continental crust.