Aleutian primitive andesites: From the mantle, but how?

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Primitive andesites (Mg#>0.6) are an important end-member in forming high Mg# (>0.5) andesites virtually identical to continental crust. In the western Aleutians, high Mg# andesites contain little or no older, recycled continental material, so unless the chemical similarity is a coincidence, they are juvenile continental crust, and are crucial to understanding continental genesis.

The most primitive Aleutian andesites have the highest La/Yb, Dy/Yb, and Sr/Y in the arc, and the most depleted Pb, Sr and Nd isotopes in global arc magmas. High Ni, Cr and Mg# indicate mantle-derived liquids. High H_2O and alkalies stabilize high SiO_2 melts with olivine. In the Aleutians, there is no evidence for evolved components which, mixed with basalt, could form primitive andesite. Thus, Aleutian primitive andesite passes into arc crust from the mantle.

This said, the ultimate origin of primitive andesite remains uncertain. Hydrous melt of subducting oceanic crust in eclogite facies may react with peridotite to form primitive andesite, but then how can primitive andesite erupt in close proximity with primitive basalts recording higher mantle temperature? Also, why are Sr isotopes in Aleutian primitive andesites so low?

Alternative and supplementary hypotheses abound (e.g., Kelemen *et al.* ToG 2003, Fig. 16). Cold diapirs may rise into the mantle, but why would mafic eclogites be buoyant? Basalt may react with cold, shallow mantle at ~ 1.5 GPa to yield andesites but why would they be isotopically different from basalt? Dense lower crustal cumulates may founder into underlying mantle, but then what is the source for the abundant H_2O, K_2O, etc? Subduction erosion, or imbrication of the subduction zone, may cycle oceanic fragments into the mantle wedge where they are heated by conduction, but again low Sr isotopes pose a puzzle.

Decoupling of plant-driven weathering from leaching in the critical zone

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The root systems of vascular plants acquire mineral-derived nutrients by chemical weathering. These processes have been assumed to load soil and ground waters with leachable weathering products. We isolated the effects of red-pine root systems on concentrations of mineral-derived Ca and Mg in shallow soil waters of the 60 m^3 Hubbard Brook “sandbox” mesocosms growing 15-20 yr old trees, and in replicated 0.0002 m^3 columns growing 6-12 month old seedlings. At both scales, tree-system soil waters had 20-60% lower concentrations than controls without trees, and the tree systems showed correspondingly smaller leaching losses. Increased mineral weathering fluxes in these systems were largely diverted into soil and biomass pools (Figure 1), perhaps by localization of mass transfers within the biofilms observed to blanket and attach rootlets and microbes to mineral surfaces. This may maximize return on resources devoted to weathering by vascular plants, and decouple nutrient uptake from leaching losses under certain conditions in nature.

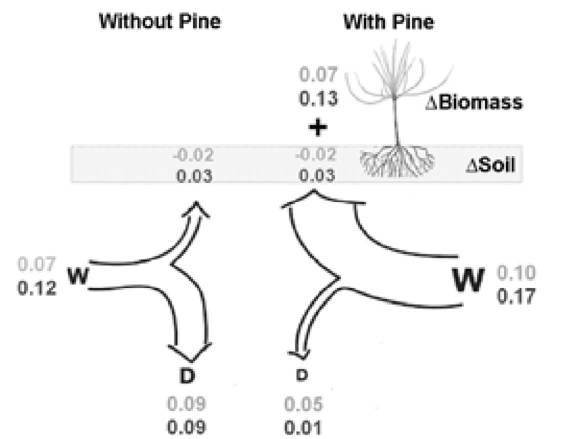

Figure 1: Partitioning of weathered (W) Ca and Mg mass in experimental ecosystems, in mol m^{-2} y^{-1} [1]. Upper (green) values are sandbox fluxes over 15 yr; lower (blue) values are column fluxes over 6 to 12 months.

[1] Balogh-Brunstad *et al.* (2008) *Global Biogeochemical Cycles* **22**, GB1007.