Geophysical Research Abstracts
Vol. 16, EGU2014-8491, 2014
EGU General Assembly 2014

Subduction of Fracture Zones control mantle melting and geochemical signature above slabs

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The geochemistry of arc volcanics proximal to oceanic fracture zones (FZs) is consistent with higher than normal fluid inputs to arc magma sources. Here, enrichment of boron (B/Zr) in volcanic arc lavas is used to evaluate relative along-strike inputs of slab-derived fluids in the Aleutian, Andean, Cascades, and Trans-Mexican arcs. Significant B/Zr spikes coincide with subduction of prominent FZs in the relatively cool Aleutian and Andean subduction zones, but not in the relatively warm Cascadia and Mexican subduction zones, suggesting that FZ subduction locally enhances fluid introduction beneath volcanic arcs, and retention of fluids to sub-arc depths diminishes with subduction zone thermal gradient. Geodynamic treatments of lateral inhomogeneities in subducting plates have not previously considered how FZs may influence the melt and fluid distribution above the slab. Using high-resolution three-dimensional coupled petrological-thermomechanical numerical simulations of subduction, we show that fluids, including melts and water, concentrate in areas where fracture zones are subducted, resulting in along-arc variability in magma source compositions and processes.