



Slab induced return flow as a driving supply for off-arc alkaline volcanism and atypical magmatism in convergent settings

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A variety of atypical plume-like structures and focused upwellings that are not rooted in the lower mantle have recently been discussed, and seismological imaging has shown ubiquitous small scale convection in the uppermost mantle. We argue that subduction induced three-dimensional return flow and slab fragmentation within the upper mantle can generate focused upwellings, and that these may play a significant role in regional tectonics. The testable surface expressions of this process are off-arc alkaline volcanism, a topographic swell, and shallow, low-velocity seismic anomalies associated with partial melt. Using three-dimensional, simplified numerical and laboratory subduction models, we show that focused upwellings can be generated both ahead of the slab, in the back-arc region, and around the lateral edges of the slab. To understand the mechanism responsible for such slab-related volcanism, we analyze in detail case histories from Mt. Etna (Italy), the western US, and the western Pacific.