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Subduction-triggered magmatic pulses: A new class of plumes?

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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 in regions such as the Mediterranean region, the western US, and around the western Pacific. We argue that the three-dimensional return flow and slab fragmentation associated with complex oceanic subduction trajectories 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 the outsidearc alkaline volcanism, topographic swell, and low-velocity seismic anomalies associated with partial melt. Using three-dimensional, simplified numerical subduction models, we show that focused upwellings can be generated both ahead of the slab in the back-arc region (though ∼five times further inward from the trench than arc-volcanism) and around the lateral edges of the slab (in the order of 100 km away from slab edges). Vertical mass transport, and by inference the associated decompression melting, in these regions appears strongly correlated with the interplay between relative trench motion and subduction velocities. The upward
flux of material from the depths is expected to be most pronounced during the first phase of slab descent into the upper mantle or during slab fragmentation. We discuss representative case histories from the Pacific and the Mediterranean where we find possible evidence for such slab-related volcanism.