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Delamination, upper plate extension, and plate margin complexity

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We investigate the syn- and post-subduction margin evolution with respect to extension, lithospheric removal, and magmatic and topographic consequences by employing 3D geodynamic models. In all experiments, regions of extended partial melting are overlain by up to 3 km high plateaus. There is complex geometric entanglement between upper mantle, partially molten rocks, and lithosphere, which is thermally eroded, over hundreds of kilometers across the plate contact. A complex lithosphere-asthenosphere-boundary features elongated anomalies at scales of few tens to hundred kilometers. First-order, synthetic seismic anomaly patterns, based on thermodynamic velocities which are tabulated for model p,T conditions, are accordingly complex.

Passive margin geometry variations in the lower plate effect consistent and inherited differences in dynamic evolution. Promontories along the margin tend to trigger three stages of evolution: 1) a magmatic arc; 2) a lower plate, eduction-like exhumation of buried continental crust in domal patterns of few tens of km wavelength; and subsequently, 3) the formation of extended zones on the upper plate which lack a lithospheric mantle, undergo partial extension, and feature lower crustal melting. Slab break-off is consistently favoured in locations where the lower plate margin is relatively recessed. Concerning the classical removal mechanisms, transitions and co-evolution between delamination, convective thinning, and upper-plate extension are gradual and these modes are not mutually exclusive. Almost complete mixed-mode removal and extension can be compared to the Aegean. Slab window formation by margin geometry variation produces characteristic uplift patterns that are comparable to the Apennines, where higher uplift rates could be a consequence of incipient necking of the slab below central Calabria.