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Divergent plate motion drives rapid exhumation of (ultra)high pressure rocks: thermo-mechanical models vs geologic constraints

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Exhumation of (ultra)high pressure [(U)HP] rocks by upper-plate divergent motion, recently proposed for the Western Alps (Malusà et al. 2011, 2015), has never been tested by numerical methods. Here we present 2D thermo-mechanical models incorporating subduction of a thinned continental margin beneath either a continental or oceanic upper plate, followed by upper-plate divergent motion away from the lower plate. Results demonstrates how divergent plate motion may trigger rapid exhumation of large volumes of (U)HP rocks directly to the Earth's surface, without the need for overburden removal by erosion. Model exhumation paths are fully consistent for a wide range of upper-plate divergence rates, and exhumation rates are systematically higher than the divergent rate imposed to the upper plate. The modeled size of exhumed (U)HP domes is invariant for different rates of upper-plate divergence. Major variations are instead predicted at depth, as larger amounts of divergent motion may allow mantle-wedge exhumation at shallow depth under the exhuming domes. The transient temperature increase determined by the ascent of mantle-wedge material in the subduction channel barely affects continental (U)HP rocks exhumed at Earth's surface. Models were designed to test two natural examples, the Cenozoic (U)HP terranes of the Western Alps (continental upper plate) and eastern Papua New Guinea (oceanic upper plate). The good fit between model predictions and the geologic record in these (U)HP terranes encourages the application of these models to (U)HP terranes where the geologic record of exhumation is only partly preserved.

Malusà M.G., Faccenna C., Garzanti E., Polino R. (2011) Divergence in subduction zones and exhumation of high pressure rocks (Eocene Western Alps). Earth Planet Sci Lett 310(1):21-32

Malusà M.G., Faccenna C., Baldwin S.L., Fitzgerald P.G., et al. (2015) Contrasting styles of (U)HP rock exhumation along the Cenozoic Adria-Europe plate boundary (Western Alps, Calabria, Corsica). Geochem Geophys Geosyst 16(6):1786-1824