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Burial and exhumation rates for (U)HP rocks: insight from numerical modeling

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(Ultra)-High-Pressure metamorphic rocks provide evidence that in subduction zones material can return from depths of more than 100 km to the surface. The pressure-temperature paths recorded by these rocks are variable, mostly revealing cooling during decompression, while the time constraints are generally narrow and indicate that the exhumation rates can be on the order of plate velocities. As such, subduction cannot be considered as a single pass process; instead, return flow of a considerable portion of crustal and upper mantle material must be accounted for. The evolution of three subduction-related settings (an oceanic arc, an active continental margin and an incipient collision zone) is simulated in 2D (Gerya et al., 2002, 2004; Gerya & Yuen 2003; Gerya & Stoeckhert, 2005), using a finite difference thermomechanical code with staggered grid and marker-in-cell technique. For each model, representative P-T-paths are studied for selected markers. Our numerical simulations provide insight into the self-organizing large scale flow patterns and temperature field of subduction zones, primarily controlled by rheology, phase transformations, fluid budget, and heat transfer, which are all interrelated. They show the development of a subduction channel with return flow of low viscosity material and progressive widening by hydration of the mantle wedge. The exhumation rates for (U)HP rocks can exceed subduction and burial rates by a factor of 1.5 to 3, when return flow in the hanging wall portion of the subduction channel is focused. Exhumation rates on the order of centimeters to meters per year are modeled for buoyant finger-like and wave-like structures (cold plumes and cold waves) formed along the slab at asthenospheric depths and composed of partially molten hydrated crustal and mantle rocks. The large scale structures and

the array of pressure-temperature paths obtained by these simulations favorably compare to the record of natural rocks and the structure of (U)HP metamorphic areas.

References:

Gerya, T.V., Stoeckhert, B., Perchuk, A.L. (2002) Exhumation of high-pressure metamorphic rocks in a subduction channel - a numerical simulation. Tectonics, 21(6), 6-1 - 6-19.

Gerya, T.V., Yuen, D.A. (2003) Rayleigh-Taylor instabilities from hydration and melting propel "cold plumes" at subduction zones. EPSL, 212, 47-62.

Gerya, T.V., Yuen, D.A., Sevre, E.O.D. (2004) Dynamical causes for incipient magma chambers above slabs. Geology, 32, 89-92

Gerya, T.V., Stoeckhert, B., (2005) 2-D numerical modeling of tectonic and metamorphic histories at active continental margins. Int. J. Earth Sci, DOI 10.1007/s00531-005-0035-9.