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Eclogitization processes and consequences for high-pressure rocks exhumation

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The granulite-facies anorthositic unit on northwestern Holsnøy, within the Bergen Arcs, Norway, was buried and partially eclogitized at depth during the caledonian orogenesis (Austheim, Chemical Geology, 1985). Eclogite-facies deformation is very consistent at the scale of the studied zone (5*5 km), and results therefore from the action of large-scale tectonic stresses, rather than local stresses related to metamorphic reactions. When the unit is restored to its original position at depth within the caledonian slab, the top-to-the-east sense of shear is interpreted as resulting from the thrusting of kilometer-scale crustal slivers. The eclogite-facies shear zones, which enable the mechanical decoupling between the light crustal slivers and the dense underlying mantle, play therefore a crucial role in the initiation of exhumation.

The relevance of such a conceptual model is assessed through the unidimensional channel-flow model. Within this model, all material properties are integrated into a single adimensional parameter, the exhumation number, which describes the competition between eclogitization-related density increase (impeding exhumation) and viscosity decrease (promoting exhumation). The evolution of the exhumation number with progressive eclogitization shows a peak, corresponding to partially eclogitized crust which is still much lighter than the surrounding mantle, but already much weakened by large-scale eclogite-facies shear zones cutting through it, similarly to Holsnøy unit. Such high-exhumation number crust prevents a large downward flow of crust and act as a bottleneck for the circulation, forcing the formation of a backward flow of crust and therefore controlling the onset of exhumation.