UHP P-T-TIME LOOPS: A RECORD OF ULTRADEEP SUBDUCTION OR TECTONIC OVERPRESSURE?

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Ultra high pressures are reported from more and more places, and with increasingly high pressures around the world. Assuming lithostatic pressure, these extreme pressures are generally presented as evidence for subduction of continental crust deep into the mantle. However, as the recorded pressures in continental roots grow, they become an increasing challenge to the basic assumption of a simple correlation between pressure and depth. For example: 1) why was the pressure highly heterogeneous within UHP terrains; 2) why are UHP minerals (e.g. coesite) typically found inside hard minerals or bodies potentially acting as pressure vessels during compression and decompression; 3) why is there no evidence for huge erosional products resulting from exhumation of UHP rocks; 4) how can both sides of an orogen like the Caledonides subduct to extreme depths; and 5) what are the driving forces behind such super-deep subduction and near instant exhumation?

Models of tectonic overpressure (TO) basically suggest that P(total) locally is higher (e.g. 2x) as the lithostatic P(load), depending on several variables, including strength of rocks, pressure deviations around lenses of variable viscosity (i.e. mafic bodies, garnets with coesite inclusions, diamonds in a peridotite) or in the hinges of or between flexed strong layers.

Arguments against tectonic overpressure usually are based on the assumption that rocks are too weak to sustain substantial differential pressures. Such arguments can be disproved by the fact that big mountain chains need an integrated lithospheric strength on the order of 10^{13} Pa•m, in order to sustain its surface and moho-topography. Secondly the strength argument can be met on its own turf. Tectonic overpressure in its simplest form is proportional to differential stress (strength) that for creep is a function of rheological parameters, temperature and strainrate. When strength is calculated it is typically the temperature that is varied through the crust, while strainrate is kept constant. There is no doubt that the temperature has a major influence on strength, but heat diffuses, and thus does not vary that much within region over long periods of time. Strain, in contrast, tend to localize, and therefore can vary > 10 orders of magnitude within a handsample. In the models presented here we 'free' the strainrate parameter, in order to investigate its effect on P-T loops in 'dynamic P-T-time diagrams, which takes shear heating, overpressure and strainrate into account. Clearly low strain lenses in UHP regions like the Flatraket granulites in Norway, the Hurry Inlet granite in Greenland, or the Dora Maira Massif in the Alps, will not record large overpressure, whereas the highly strained surrounding rocks will. It is of course interesting to speculate why some rocks are strained and others not, but it remains a first order observation that strain and thus strainrate was low in these 'low' P lenses.

Implementing this type of structural information in the 'strength Christmas three' (Brace-Goetze Lithosphere), it can be illustrated how different and complex P-T-time loops can form in neighboring rocks as a result of tectonic overpressure and shear-heating. Implementing the strain record into P-T-time data, thus suggest that high pressures are 'tectonometers' rather than altimeters.