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Tectonic and reaction overpressures: Theoretical models and natural examples.

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Generally pressure estimates based on equilibrium thermodynamics have been treated as equivalent to depth estimates. The concept of tectonic overpressure– challenge this view, suggesting that horizontal tectonic stresses add to the vertical gravitational stresses, in some cases doubling pressures compared to conventional gravitational (load) pressure. Here we first review the concepts of tectonic overpressure and associated shearheating, and then analyze their effects on the PT record. Such calculations depend on rock rheologies but can be tested against rheology-independent force balanced models, as well as natural rocks. We focus on the processes in the Norwegian and Greenland Caledonides given the abundance of previous research (in the case of Norway) and near-100% rock exposures.

Secondly, we introduce the theoretical concept of 'reaction overpressure', which relates differential volume expansion of inclusions inside a stronger container to extreme and rapid PT excursions; similar to a pressure cooker. Reaction overpressure may act on any scale and differs from tectonic overpressure in that it does not require high rock strength (differential stress). Pressure builds as the rocks heats and expands, particularly as melt conditions is approached. Eventually the pressure may exceed the 'container' strength, which will break, leading to a catastrophic drop in (over)pressure, and subsequent pervasive decompression melting. The process is self-propagating, and results in a PT path similar to the melt lines on a PT diagram. Such dramatic and rapid PTtime loops are common in the literature and have typically been explained by rapid and deep subduction-exhumation cycles. However, considered 'reaction overpressure' extreme pressure records are perhaps not diagnostic of extreme depths. In support of our model, we illustrate that the PTtime excursion recorded in the UHP eclogites of Liverpool Land, East Greenland, fit this model. These rocks appear

to have been positioned in the overriding plate of the Caledonian collision, and therefore need a nontraditional explanation for their calculated PT excursion, subsequent pervasive melting, and rapid cooling.