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Impact of weak zone geometry on pressure variations and potential implications for variation of mineral assemblages

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The formation of eclogites and high-pressure rocks has been routinely related to the depth of recrystallization during metamorphism. Although this is a good approximation for a non-deforming lithosphere, significant stress and pressure variations that develop during deformation may provide more complex relationships between mineral assemblages developing in deforming rocks and their burial depth.
Results from mechanical modeling demonstrate that the stress distribution in natural deforming rocks is mainly function of the general stress level in the system and the spatial distribution of weak and strong lithologies. The general stress level depends on the boundary conditions and material properties such as effective viscosity and yield stress. However, the spatial distribution of strong and weak lithologies impose a non-trivial stress pattern, which can be responsible for significant pressure deviations from the lithostatic. In general, weak layers and shear zones will develop stress and pressure variations according to their orientation to the far-field tectonic stress and their strength contrast with the surrounding lithologies.
To estimate the effect of weak-zone geometry on the stress and pressure distribution we developed numerical models based on continuum mechanics that take into account the natural geometry of the interconnected eclogite shear zones as they have been mapped on Holsnøy, Bergen Arcs, Norway.
Our results demonstrate that pressure and stresses in the shear zones can strongly vary from the surrounding pressure and stresses. We perform a series of simulations with different viscosity ratios between shear zones and adjacent country rocks in order to calculate representative pressure values for both the shear zones and their country rock system. We finally compare our results with different models which have been recently proposed for the relationship between differential stress, tectonic pressure and metamorphic reactions and calculate the expected mineral assemblages using Perplex. Comparison of synthetic mineral assemblages with those actually documented in the natural shear zones from Holsnøy are discussed.