Up-scaling eclogitization: from experimental and natural aggregates behaviours to seismological signatures


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Eclogite formation in the subducting crust was the first metamorphic transformation to be acknowledged as important in the dynamics of convergent plate boundaries. It is indeed expected to affect the mass distribution via density change, but it also influence the fluid content of crustal and possibly lithospheric wedges; both density and fluids being first order in values measured by passive geophysical imaging such as tomography of receiver functions. Recent high accuracy focal mechanism solutions showing singular signatures in deep orogens actually imply that eclogitization could also have a signature in the seismological source signals, and hence have an impact at much shorter time-scales. This presentation aims at bridging what we know from the field and the lab at smaller time and space scales, to what we observe at larger scales in collision zones. Field-based studies show the ways a pristine rock can evolve from metastable to fully eclogitized from the thin section to the kilometre scale. More than the contrast between eclogitized and non-eclogitized domains, the eclogitization front itself is expected to be detected in the geophysics, especially when driven by strain. Indeed strain-assisted eclogitization develops a characteristic shear zone network pattern with a significant anisotropy. This network itself evolves with the eclogitization progress. The observed progressive widening and increasing connectivity of eclogite-facies shear zones with increasing fluid availability could actually be controlled by the transient properties of the newly formed assemblages, inducing fluid pressure gradients for instance. In this context it appears that the competition between reaction kinetics and strain-rate is a key factor. This is also the case at shorter time scales. Experimental studies show that strain of metastable assemblages in the eclogite facies is more likely to lead to mechanical instabilities for intermediate reaction kinetics, implying again that not the eclogite but the eclogitization rate is the smoking gun. Eclogitization of plagioclase-bearing rocks is the finite result of a large set of reactions involving different chemical subsystem (Na or Ca end-members, with or without fluid available), not reacting at the same pace. Further work is therefore needed on the kinetics of the
different reactions and their interactions to distinguish the one(s) that controls the eclogitization front signature, and hence improve the seismological imaging acuity.