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Breaking the Crust: Intermediate-depth Subduction Earthquakes Recorded by Eclogite Breccias

S. Angiboust (1), P. Agard (1), P. Yamato (2), and H. Raimbourg (3)

(1) University Pierre et Marie Curie, Institut des Sciences de la Terre, France (samuel.angiboust@upmc.fr), (2) Geosciences Rennes, France, (3) ISTO, Université d'Orléans, France

Understanding processes acting along the subduction interface is crucial to assess lithospheric scale coupling between tectonic plates and mechanisms causing intermediate-depth seismicity. Despite a wealth of geophysical studies aimed at better characterizing the subduction interface, we still lack critical data constraining processes responsible for seismicity within oceanic subduction zones. We herein present new field data from an almost intact, km-scale fragment of oceanic lithosphere (Monviso ophiolite, W. Alps) crosscut by 30 to 150 m wide eclogite-facies shear zones formed at ∼80 km depth during subduction. One of them shows spectacular m-sized blocks of eclogite facies breccias made of 2-10 cm fragments of eclogite mylonite cemented by omphacite, lawsonite and garnet, and later embedded in serpentinite. At the mineral-scale, omphacite crack-seal veins and garnet zoning patterns also show evidence for polyphased fracturing-healing events. Our observations suggest that brecciation was seismic, accompanied by the input of externally-derived fluids and occurred in the middle part of the oceanic crust. We conclude that these eclogite breccias mark the locus of an ancient fault zone associated with intraslab, intermediate-depth earthquakes at ∼80 km depth.