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H_2O release in cold subduction zones: eclogitization vs. lawsonite stability

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Transition from blueschist to eclogite facies is considered as a major step of dehydration during subduction of oceanic crust. In cold subduction zones, this critical transitional field is characterized by the stability of lawsonite, which represents the major H_2O carrier in HP basaltic rocks. Lawsonite-bearing eclogites are commonly associated with lawsonite-blueschist [1]. This association is commonly referred to prograde (i.e. from blueschist- to eclogite-facies conditions) or retrograde (i.e. from eclogite- to blueschist-facies conditions) incomplete re-equilibration. However, field, microstructural and petrological data indicate that the two assemblages can coexist over a wide PT field. In Alpine Corsica (France), deeply subducted metabasalts are well preserved as lawsonite-bearing eclogite (Law-Ecl) and lawsonite-bearing blueschist (Law-Bs), providing a unique access to these rocks rarely preserved elsewhere. The Corsican Law-Ecl, consisting of omphacite + lawsonite + garnet + phengite + titanite, commonly occur as single undeformed metabasaltic pillows surrounded by Law-Bs. Law-Bs are found as variably deformed metabasaltic pillows locally cross-cut by eclogitic veins and consist of glaucophane + actinolite + lawsonite + garnet + phengite + titanite. Field evidence and microstructures reveal that both Law-Ecl and Law-Bs are stable at the metamorphic peak in the lawsonite-eclogite stability field. Isochemical phase diagrams (pseudosections) calculated in the system MnNKCFMASH for representative Law-Ecl and Law-Bs samples indicate that both lithologies equilibrated at the same conditions of 520 $\pm$ 20 °C and 2.3 $\pm$ 0.1 GPa, in response of primary differences in the bulk rock compositions, probably acquired during igneous or seafloor metasomatic processes [2]. These PT estimates are comparable with and therefore representative of common PT values registered and preserved by exhumed rocks in HP orogenic belts. Despite the two rocks are omphacite-free (i.e. Law-Bs) and amphibole-free (i.e. Law-Ecl), respectively, PT pseudosections indicate that the water content of the two coexisting rocks is very similar (difference $\sim$ 1% wt). On the contrary, a much more significant water release ($\sim$ 3-4%) is observed by crossing the lawsonite-epidote boundary independently from the occurrence of eclogite, blueschist or both coexisting assemblages. This feature indicates that significant water release in cold subduction zones occurs i) at greater depth with respect to eclogitization in rocks that will be incorporated into the mantle, or ii) at lower depth, during the retrograde path in rocks detached from the subducting slab and exhumed.

[1] Tsujimori, T., Sisson, V.B., Liou, J.G., Harlow, G.E. & Sorensen, S.S., 2006. Very-low temperature record of the subduction process: a review of worldwide lawsonite eclogites. Lithos, 92, 609–624.

[2] Vitale Brovarone, A., Groppo, C., Hetenyi, G., Compagnoni, R. & Malavieille, J., 2011b. Coexistence of lawsonite-eclogite and blueschist: phase diagram calculations from Alpine Corsica metabasalts. J. Metamorph. Geol., doi:10.1111/j.1525-1314.2011.00931.x.