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Olivine enrichment in dehydration veins in serpentinites by reactive fluid flow

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Serpentinite dehydration in subduction zones plays an important role in Earth's deep water cycle. In order to keep this water cycle in balance, an efficient rock dehydration mechanism at depth is needed to keep pace with loss of ocean water due to subduction of hydrated oceanic lithosphere. Field observations in non-deformed meta-serpentinites in Erro Tobbio, Ligurian Alps, show that serpentinite dehydration at depth occurs by a channelized vein network rather than pervasive flow. The mineral assemblage in the veins is characterized by a high abundance of metamorphic olivine. Plümper et al. (2017) showed that on small scales (µm-mm) the formation of these veins is controlled by intrinsic chemical heterogeneities in the rock. Field observations suggest that on larger scales the fluid escape is governed by mechanical processes such as hydraulic fracturing. On small scales, where dehydration is chemically controlled, reactive fluid flow is an important process because changes in the fluid chemistry may trigger or hinder further dehydration reactions in the rock. Because of its high solubility and high abundance as a rock forming component, Si might be a key metasomatic agent for first-order effects on the dehydration process.

Following the approach of Beinlich et al. (2020) we extended the model of Plümper et al. (2017) to a reactive fluid flow model for serpentinite dehydration that accounts for the Si content of the fluid. As input for our model we use mineral chemical data of non-dehydrated serpentinites from the Mirdita ophiolite in Albania that are representative for serpentinized oceanic lithosphere that enters a subduction zone, hence has not experienced any subduction-related metamorphic processes. The results of our model suggest that the high abundance of metamorphic olivine observed in the Erro Tobbio meta-serpentinites hence the purification towards a olivine-dominated assemblage is the result of interaction with an external fluid in the veins after they have been formed from the intrinsic chemical heterogeneities.

References

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