The intrinsic nature of antigorite breakdown at 3 GPa: Experimental constrains on redox conditions of serpentinite dehydration in subduction zones

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Antigorite is considered as the most important source of water in the subduction system, playing a key role during arc magma genesis. Although, these magmas seem more oxidized than mid-oceanic ridge basalts (MORB), the possible inherent link between the oxidation state of arc magmas and serpentinite-derived hydrous fluids is still not well established. We report dehydration experiments of natural antigorite-rich serpentinite containing 5 wt% magnetite at 3 GPa and at temperature from 600 to 900 °C using a multi-anvil apparatus. These experiments aim to reproduce the different stages of H_2O release, forming secondary antigorite, chlorite, olivine and orthopyroxene plus water as observed in natural outcrops. Our experimental set up permits for the first time to preserve the intrinsic high oxygen fugacity (fO_2) of serpentinites, and allow highlighting the crystallization of hematite over the pre-existing magnetite. This result indicates that the fluid released during the dehydration of antigorite is in equilibrium with both magnetite and hematite, hence constraining log(fO_2) between -10 and -12, which is equivalent to FMQ+5 (fayalite-magnetite-quartz oxygen buffer). The occurrence of hematite in both experimental and natural samples such as the dehydrated serpentinites in meta-ophiolites from the Western Alps and the Cerro Del Almirez massif (Spain) demonstrates that hematite is by no means a retrograde product in natural samples. This is the first experimental report constraining the oxidation state of fluids released during subduction. Thus, at high pressure and high temperature conditions, fO_2-sensitive elements such as carbon and sulfur are expected to be mobilized under their oxidized form, providing an oxidizing context for arc magmas genesis and assuming that they are not reduced by their percolation through meta-gabbro, meta-basalts and meta-sediments.