Redox transfer by iron- and sulfur-bearing serpentinite dehydration in subduction zones

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Dehydration of antigorite in subduction zones releases a large amount of aqueous fluid and volatile elements which can potentially oxidize the mantle wedge. In order to evaluate the redox capacity of subducted serpentinites experimental approach and thermochemical modeling were combined in the present study. Three synthetic serpentinites with variable Fe_{total}, Fe^{3+} and S contents were investigated at the conditions close to those in subduction zones. Experimental results show a decrease in Fe^{3+}/Fe_{total} ratios from 0.9 of serpentinites to ~0.2 in anhydrous assemblages through magnetite and Fe^{3+}-bearing antigorite breakdown. Part of the sulfur, initially present as pyrite is transformed into pyrrhotite at temperatures below 450°C, and the excess sulfur is released as a volatile phase. The experimental results demonstrate that the presence of both Fe^{3+}-rich serpentines and magnetite make serpentinite an O_2 reservoir of remarkable capacity for fO_2 at QFM and below.

The evolution of mineral modes and Fe^{3+}/Fe_{total} with temperature in our synthetic samples show very similar trends to what has been reported in serpentinites of the metamorphic suite in the western Alps [1]. A tremendous amount of O_2 can be released from antigorite serpentinites, however, the question whether the released fluid reaches the mantle wedge remains open.

[1]Debret et al. (2014) ESPL 400, 206-218.