Mineral dehydration as a source of water for some natural portlandite formation

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The usual artificial portlandite [$Ca(OH)_2$],wich is widely used in a variety of industries, results by hydration of lime (CaO). However, natural portlandite, scarcely found in contact metamorphism areas and other low pressure geological settings, could not be formed by this mechanism. One possible mechanism that we propose here is calcite hydration:

$CaCO_3 + H_2O \rightarrow Ca(OH)_2 + CO_2$

We have designed and performed high temperature and low pressure experiments in which the source of water are other commonly hydrated minerals which may be naturally associated whith calcite. Limonite and kaolinite were chosen as two examples for their representativity and their different dehydration temperature ranges. Binary mixtures of limonite or kaolinite with calcite crystals were studied. We have investigated a temperature range of 100ºC ÷ 900ºC, at different rates of heating. We also observed the kinetics of the reaction by maintaining each mixture at a target temperature for various intervals.

Limonite-calcite mixtures lead to no portlandite formation up to temperatures where limonite was completely dehydrated. We interpret this result as an effect of the too low dehydration temperature of limonite. Instead, kaolinite-calcite mixtures yelded psedomorphoses of portlandite on calcite above 600ºC, which is the starting dehydration temperature of kaolinite. Totally pseudomorphic replacement of calcite by portlandite was only observed at high temperature (800ºC).

We find that the formation of portlandite requires a small and constant water vapour pressure. The availability of water is not the only factor driving the reaction, temperatures must also be high enough to drive the hydration of calcite.

Our results indicate that vapor water and not liquid is a prerequisite to the formation of portlandite and help constrain temperatures for portlandite pseudomorphic formation.

Even though portlandite is scarce in the upper crust, the formation mechanism proposed here can be seen as another possible way of water transport in the mantle by subducting carbonatic sediments.

Key words: experiment, portlandite formation, calcite hydration, high temperature, pseudomorphic replacement