



Experimental dehydration kinetics of intact lizardite serpentinite specimens under effective stress

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The onset of metamorphic changes in rock materials under tectonic stress determines significantly their mechanical behaviour during deformation and adequate knowledge of reaction kinetics is fundamental in establishing the effects on rheology. Petrologists have traditionally undertaken experiments with powdered specimens and when fluids are involved these have been kept at the same pressure conditions as the solids, i.e. tests are run under no effective pressure. This has the advantage of speeding up the reactions by providing a fluid interphase favouring diffusive transport. However, if these samples were deformed during the progress of the reaction it would be expected that the material would behave in a brittle manner or compact until failure occurs by hydrofracturing (related to pore overpressure as a consequence of pore collapse).

In active tectonic settings such as subduction zones, the low porosity in rocks and the conditions of burial, which imply effective pressure, are likely to have an important control on reaction kinetics and mechanical strength of rocks. To explore some of these effects on reaction kinetics, we have carried out a series of dehydration experiments on intact samples of serpentinite. These have been compared with dehydration in powdered synthetic samples. Our experimental setting incorporates a servo-controlled volumeter that keeps pore pressure constant throughout the experiments, allowing us a continuous readout of the excess of water added to the system, and thus to the progress of the dehydration.

The curves showing water expulsion over time in tests using intact specimens have three clear stages, regardless of the effective pressure applied: two exponentially decreasing stages at the beginning and at the end, and a linear stage in the middle that

accounts for more than 50 % of the dehydration. This linear segment in intact rocks and found right from the start in powdered samples, can be described by a rate equation of zeroth order, i.e. with a constant reaction rate. The temperature dependences of rate constants obtained in this way in three test series (powdered and intact under no effective pressure, and intact under effective pressure) are consistent with an empirical activation energy for the dehydration reaction of the order of 84-91 kJ/mol.

The relatively low porosity throughout dehydration in intact specimens, with respect to powdered synthetic samples, extends substantially reaction times to completion, by about one order of magnitude for similar experimental temperatures. The application of effective pressure reduces further the speed of the reaction, despite the limited compaction expected in the experimental conditions.