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Kinetics of antigorite dehydration: Rapid dehydration as a trigger for lower-plane seismicity in subduction zones

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Abstract

Antigorite dehydration experiments were performed under ambient pressure using a non-isothermal thermogravimetric analysis. Antigorite, with a grain size of 5−10 μm, was analyzed using heating rates of 10, 15, 20, and 25 K/min at temperatures of up to 1260 K. The results show that the progress of the dehydration reaction varies with the heating rate, and the dehydration reaction of antigorite occurs within a temperature range of 800–1050 K. Several models were used to fit the dehydration results, and the double-Gaussian distribution activation energy model (2-DAEM) yielded the best fit to the experimental data. The dehydration kinetics of antigorite follow 2-DAEM, and there is a compensation effect between the pre-exponential factor and the average activation energy. The activation energy of the first step of antigorite dehydration stretches over a wide interval; the second step has a significantly higher activation energy, distributed over a narrower interval. We determined that the release rate of H_2O is 8.0×10^{-5} and 2.1×10^{-3} $m^3_{fluid}m^3_{rock}s^{-1}$ at 893 and 973 K, respectively, which are near the onset temperature for the isothermal dehydration reaction. Our results indicate that antigorite dehydration is fast enough to induce mechanical instabilities that may trigger seismicity in the lower plane of the double seismic zone.

Keywords: Antigorite, dehydration kinetics, non-isothermal thermogravimetric analysis, 2-DAEM, seismicity