

## **Influence of the liquid-liquid phase transition of water on mineral solubility and solution chemistry**

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The pressure–temperature characteristics of water are unusual: for example, one familiar oddity is the fact that ice ( $I_h$ ) is less dense than water. Very recent findings, reported in the physics literature, indicate that further exotic behaviour occurs in water itself. A liquid–liquid transition, from a low- to high-density structure, occurs in water upon compression. The pressure- and temperature-dependence of this transition is uncertain, but our preliminary results indicate that it coincides with the conditions experienced by pore fluids in sediments, hydrothermal fluids in the crust, and may also take place at depth within subduction zones. Yet the existence of this liquid–liquid transition in geofluids has not yet been assimilated, or even considered, by the geoscience community. Here, we explore how the liquid-liquid phase transition (LLPT) of water influences water-mineral interactions in the near- and sub-surface of Earth. Our results indicate that it prevents simple extrapolation of thermodynamic properties such as mineral solubility (which determines fluid chemistry) from low- to high-pressure and temperature conditions, a commonly adopted approach. Using diamond anvil cell techniques coupled with Raman spectroscopy, we have made the first quantitative in situ observations of mineral–aqueous solution systems through the pressures and temperatures of the LLPT to reveal the influence of this transition on geofluids and the consequent stability of minerals in Earth’s interior. Extending this approach would enable the LLPT to be incorporated into thermodynamic models of geofluids and mineral solubility in diagenetic and metamorphic processes within sediments and subduction zones. Our results also bear on mineral-fluid interactions during oil/gas extraction and carbon capture and storage.