Preliminary Thermodynamic Modeling of Carbon-Enriched Mineral Phases and Fluid Composition in Icy Bodies of the Outer Solar System

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Abstract

In my master's research at the University of Milan, I conducted high-pressure experimental petrology, volatile analysis in experimental capsules, thermodynamic modeling with Perple_X, and advanced characterization techniques including micro-Raman spectroscopy, electron microprobe, and scanning electron microscopy. My doctoral research focuses on thermodynamic modeling of the composition and evolution of outer solar system bodies, including moons like Titan and Ganymede. These bodies, composed of silicates, sulfides, ices, and carbonaceous materials, undergo low-temperature/pressure reactions that influence fluid compositions as they warm via radiogenic heating and tidal deformation. Using Perple_X, a software package used for thermodynamic modeling in geology and petrology, I modeled a preliminary compositional evolution of icy objects with variable XCO2, showing that changes in the C/Si ratio and oxygen fugacity govern the stability of mineral phases, particularly carbonates and graphite. The thermodynamic calculations also reveal the coexistence of CO2, CH4, and H2O in equilibrium with these phases, providing insights into the geochemical environments of icy moons and their internal evolution.

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