Abstract

Title: Experimentally Probing the High Pressure Behavior of Szomolnokite ($FeSO_4$•H_2O)

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Szomolnokite ($FeSO_4$•H_2O) is a monohydrated iron-bearing sulfate and is generally discussed in conjunction with other hydrated sulfates including jarosite, goethite, kieserite, and meridianite in addition to pyrite. This group of minerals is discussed in relation to several planetary processes in a variety of environments on Earth and other bodies in the solar system. On Earth these minerals are discussed in regard to volatile cycling within the mantle and the high-pressure stability of the mineral phases and their role as oxidizing agents upon volatile release. Szomolnokite and other hydrated sulfates have been identified on Mars' surface and are important in understanding the hydrological activity and history on the surface of Mars with potential importance to subsurface sulfur cycling. Additionally, it has been proposed that hydrated sulfates may exist as abundant constituents of icy satellite mantles, such as Ganymede.

Given this wide range of attention and the varying compositions of monohydrated sulfates, it is important to characterize the end-members of this class of minerals. Szomolnokite allows for an investigation of an iron-end member hydrous sulfate and its behavior at a range of pressures relevant from surface conditions to planetary interiors. This work presents the results of diamond anvil cell experiments conducted at beamline 12.2.2 at the Advanced Light Source of Lawrence Berkeley National Laboratory (ALS) and sector 3 at the Advanced Photon Source of Argonne National Laboratory (APS). We conducted high-pressure X-ray diffraction experiments at the ALS on a powdered sample of synthetic szomolnokite using a helium pressure transmitting medium. Synchrotron Mössbauer spectroscopy and nuclear resonant inelastic X-ray spectroscopy experiments were performed at the APS up to 15 GPa. X-ray diffraction analysis indicates a structural phase transition at ~7 GPa that is corroborated by the synchrotron Mössbauer and nuclear resonant inelastic X-ray spectroscopic data.

This suite of measurements serves as a comprehensive study of the structural, electronic, and vibrational dynamics of szomolnokite up to pressures of 15 GPa. Synthesis of these results will allow for a comprehensive description of iron within a hydrous environment under compression, which will ultimately allow discussion of the role that szomolnokite may play in planetary interiors.