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How the synchrotron light can prove planetological knowledge: the case of icy planetary bodies

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Finding signs of ancient and present life, in the solar system and beyond, is and has been one of the most intriguing challenges in scientific research. Water is one of the essential components for life and interest in 'ocean worlds', such as Jupiter's Europa or Saturn's Enceladus, is particularly vibrant. The recent decision by ESA and NASA to push ahead with plans for a new mission to Europa offers strong incentives to learn more about the surface composition through analysis of current spacecraft data.
Recent satellite inferences about the non-ice component of the world's oceanic crust imply the presence of Na sulphates, other salt hydrates and trapped gases, which could imply that, for example, Europa's ocean should probably contain sulphates, Mg, Na and Cl as major solutes and promising candidate minerals for deep icy mantle rock formation.
Knowledge of the behaviour of sulphate hydrates at pressures and temperatures similar to those of planetary bodies is particularly important to answer questions such as the thickness of the ice shell, its rheology and the radial density of these bodies. In addition, relevant information could be obtained on the potential for geological activity and material exchange between the different layers.

Today, the diamond anvil cell with integrated cryostats and heaters can sample most of the P-T range expected for the interior of the Earth and other planetary bodies. The high brightness and high collimation of the synchrotron radiation (SR) allow X-ray beams to be focused down to micrometre-sized spots to probe minute samples under extreme conditions.
This makes it possible to precisely study the mineral physics of planetary materials.

Results of recent studies using synchrotron data to analyse the behaviour and stability of sulphate mineral groups, particularly phase transitions and transformations, as well as dehydration reactions occurring under non-environmental conditions, and implications for planetary models will be presented.

The Commission on Mineral Physics of the International Mineralogical Association (CMP-IMA) encourages the use of synchrotron radiation because, as the case studies presented show, it offers unique potential for studying the interior and dynamics of planetary bodies.

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