New applications of *in situ* synchrotron x-ray techniques for studies of earth and planetary materials at high pressure and temperature

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The field of high-pressure earth and planetary sciences has changed dramatically over the last two decades, primarily owing to the increasingly sophisticated tools that are constantly being developed. Capabilities of modern synchrotron and neutron sources provide enormous opportunities for new types of experimentation at high pressure (P) and temperature (T). Accordingly, many new high-pressure devices have been developed to take advantage of these advances. This presentation will focus on a range of new developments for characterizing physical and chemical properties of minerals and rocks at simultaneous high P and T: (1) structures of crystals and liquids, (2) Elasticity of solids and potential applications for liquids, (3) rheological properties of minerals (poly- and single crystals) and melts. In addition, a high-pressure 3D tomographic imaging technique will be introduced, which has been used to study various phenomena, including (1) texture development in multi-phase materials under shear deformation, (2) segregation of Fe-rich melts from silicate, and (3) equations of state of melts. Future prospects will be discussed base on a few new initiatives.

Nonlinear dynamics of Banded Iron Formation precipitation

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Banded iron formations (BIFs) carry important information on the early evolution of the Earth. The actual mechanisms for their formation remain controversial. We have shown that the passage from predominant occurrence of BIFs in the Archaean-Early Proterozoic to their absence thereafter may have reflected compositional changes in the oceanic crust [1]. Fe-Si-rich geologic fluids can be generated only from Al-poor oceanic crust through hydrothermal leaching by seawater. Al enrichment in the oceanic crust after ~ 1.7 Ga ago tends to prevent BIF formation. We have further shown that periodic precipitation of iron and silica minerals in alternating bands can be induced by positive feedbacks among relevant chemical reactions as a Fe-Si-rich hydrothermal fluid mixes with ambient seawater [1]. Complexation of dissolved Fe (II) with silicic acid plays a crucial role in the self-organized process. Small-scale (< 1 cm) BIF bandings are thus attributed to the internal dynamics of the chemical system, rather than to an outside force such as surface temperature variations. In this presentation, we provide a detailed stability analysis of the model we developed to clarify the physical and chemical conditions for oscillatory precipitation of BIFs.

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