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Commentary

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Importance of Chemical Reactions on Earth's Core

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ABOUT THE STUDY

The evolutionary processes of chemistry and physics of the Earth's core can be observed by understanding the geochemical signals preserved in minerals and rocks. Deep interiors of the Earth and other rocky planets experience severe pressure and temperature, ranging from 360 Gigapascals (GPa) to 7000K at the Earth's core. Many questions about Earth's interiors remain unanswered, including the compositions and mineralogy of the mantle and core, the causes of chemical and physical heterogeneities in the mantle, the origins of magma and petroleum, the role of fluid-rock interaction in crustal evolution and earthquake generation, the behaviour and partitioning of elements and chemical species, and the behaviour and partitioning of elements and chemical species.

Chemical dynamics of the degassing process, and other processes that have caught the interest of scientists. The materials in Earth's and other planets' interior domains are subjected to severe processes of high pressure and high temperature (high P-T). High pressure, as well as high temperature, has a significant impact on the behaviour of atoms and molecules, the chemical kinetics of processes, and the existing states of materials. Traditional studies, on the other hand, frequently overlook the chemical reactions that occur at high P-T values.

As a result, high P-T chemical reactions and processes are among the most important factors in Earth's evolution, as they are involved in a variety of geological processes such as mantle metasomatism, element differentiation, isotopic fractionation, magma evolution, ore formation, rock alteration, earthquake generation, and so on. As a result, research into the geochemical behaviour of materials under high P-T values is critical for understanding the physicochemical qualities of the Earth's interior. In addition to geophysical approaches, natural sample analysis, and meteorite analysis, high-pressure experiments and theoretical models are essential tools for exploring the Earth's interiors.

Chemical interactions between melts and minerals, as well as partial melting of rocks, provide additional evidence for magma formation. The experimental study on amphibolite dehydration and partial melting at 1.5 GPa and 800-950ºC indicated that the melt was geochemically comparable to adakite, confirming the origin of adakite, which is extensively dispersed in the eastern North China Craton. The trace element data of the experiment reaction products under high P-T circumstances suggested that high-SiO_2 OIB type basalts with varying chemical compositions might be formed by the reaction of basaltic melt with ortho-pyroxenite.

Chemical compositions, hydration and dehydration of minerals all contributed significantly to the mantle's heterogeneity. The behaviour of gases in minerals under high P-T settings provided insight into gas migration in minerals and the mantle degassing process. The calculations for high P-T adsorption behaviours of supercritical CO_2 in magnetite pores revealed that the excess CO_2 adsorption quantities dropped with rising temperature but grew with increasing pressure and pore size. The incorporation and diffusion behaviour of He in quartz and site for instance were studied using the DFT and CI-NEB techniques at pressures up to 12 GPa, indicating that the diffusivity of He was anisotropic in the crystals and decreased with pressure in the coesite. He was first ejected from those minerals, which greatly contributes to mantle degassing.