Liquid immiscibility in the Fe-S-H system at high pressure

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Light elements in the Earth's core is key to understanding its formation, evolution, and present state. Hydrogen is considered to be one of important core light elements, but there have been little experimental studies on hydrogen-bearing iron alloys. While liquid-liquid immiscibility has been observed in several iron alloy systems such as Fe-FeO and Fe-S-Si, it tends to disappear with increasing pressure and has not been reported above 30 GPa.

Here we performed melting experiments on the Fe-S-H and Fe-S-Si-H systems using laser-heated diamond-anvil cell techniques from ~50 to ~135 GPa. Hydrogen contents were obtained from X-ray diffraction data at high pressures. Chemical and textural characterizations were made on recovered samples using FIB, FE-SEM/EDS, and FE-EPMA. Microprobe observations of sample cross sections revealed the liquid-liquid immiscibility in the Fe-S-H and Fe-S-Si-H systems. The liquid was separated into S-rich (or S-Si-rich) and H-rich ones.

These findings suggest that the Earth's liquid core is depleted in either sulfur or hydrogen. It is also possible that the liquid-liquid immiscibility is the cause of the compositional layering observed at the top 300 km of the outer core.