Bottom-up solidification versus top-down solidification of the liquid core of the relatively small planetary bodies

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Some planetary bodies, such as Mercury and Ganymede, have their own magnetic fields and other bodies, such as the Moon and Mars, once had a magnetic field. These magnetic fields of the relatively small bodies are thought to be originated from core dynamo driven by compositional convection. Compositional convection is related to the density fluctuation due to partial crystallization of liquid core. The phenomenon that iron solidified at the upper part of the core settles is called ‘Fe snowing’ and it is considered as the main cause of compositional convection in the core of the small planetary bodies. However, crystallization of iron occurs from the top of the core in some cases and from the bottom of the core in another case, due to the complexity of melting relationships of iron-light element system under pressure. Whether the top-down freezing occurs or the bottom-up freezing occurs depends on the adiabat in the liquid core and the melting slope of the constituent substance of the core. We have investigated the adiabatic temperature gradient of the Fe-S liquid core based on the thermal expansivity which is determined by X-ray absorption density measurements at high pressures. Then, we divided the pressure-composition space for the Fe-FeS system into the bottom-up solidification field and the top-down solidification field at the pressures up to 10 GPa. These would contribute to understand the generation of magnetic field in the relatively small bodies.

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