Subduction barrier for argon

*Shigeaki Ono[1]

1. Japan Agency for Marine-Earth Science and Technology

It is known that volatile components contained in subducted slab are released by dehydration of hydrous minerals and back to the Earth's surface under subduction zones, which is known as "subduction barrier". In contrast, volatiles might be carried into the deep mantle, because volcanic gases from the mid-oceanic ridge or hotpots contains significant amount of volatiles. In the case of argon (Ar), geochemical data indicate Ar from the mantle is the recycled component that is derived from Earth's atmosphere. However, the mechanism of recycle of Ar at the deep mantle is still an open question.

We perform density functional theory to investigate the melting temperature and thermal pressure of Ar. We also use high-pressure experiments to determine the room temperature EOS (equation of state) of Ar. The combination of first-principles molecular dynamics calculations and high-pressure experiments allows us to determine reliable physical properties, such as the EOS and melting temperature, over a wide range of pressures and temperatures.

The results show that the estimated density of Ar is smaller that of the PREM mantle, which indicates that the density crossover does not occur at the bottom of the lower mantle. The calculation data indicate that a melting temperature has a significant pressure dependence. If the pressure-temperature path of the subducted slab is lower than the critical condition, ~750 K and ~7.5 GPa, solid Ar can be carried down into the deep mantle. Melting of solid Ar in the upwelling mantle plume occurs at the bottom of the transition zone. Thus, solid Ar plays an important role in Ar recycling in the Earth's interior.

[1] Ono, S. Fate of subducted argon in the deep mantle. *Sci Rep* **10**, 1393 (2020). https://doi.org/10.1038/s41598-020-58252-8

Keywords: Argon, Mantle, Phase diagram

