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下部マントル上部に沈み込んだスラブ内でのフェロペリクレースの連結とそれに伴う粘性降下とスラブの形態
Interconnection of ferro-periclase reduces viscosity of the subducted slab at the top of lower mantle

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Subduction of cold slab is one of the most important phenomena for dynamics of the Earth and hence many studies have been performed based on geophysical observation, geodynamical simulation and mineral physics. Seismic tomography revealed that the subducting slab classified in two types from the view of shape of slab around 660 km depth discontinuity: one is the continuous penetration into the deep lower mantle and the other is stagnation around 660 km discontinuity forming horizontal layer at this depth (e.g., 1, 2). However, recent tomographic images show the trapped slabs around 1000 km depth, for example, Tonga, Java, Kermadic, Mariana and so on (3, 4). The slab shape around 660 km depth can be explained by the viscosity structure after phase transformation in which relatively low (high) viscosity with colder (warmer) slab because of small (large) grain size (5). However, for understanding the whole mantle convection, the mechanism to trap the subducting slab around 1000 km depth, related to the rheology of lower mantle rock, should be clarified.

The mineral assembly of the subducting slab in the lower mantle is approximately 80 volume % of silicate perovskite and 20 volume % of ferro-periclase. Therefore, we often approximate the bulk rheology of slab by that of silicate perovskite. This approach works well when dominant phase is weaker than secondary phase, for example, a case of the upper mantle (6). However, in the case of the lower mantle, this approximation does not work because silicate perovskite is much stronger than ferro-periclase (7). A presence of ferro-periclase may significantly reduce bulk viscosity when the interconnected layer of ferro-periclase is formed in the bulk rock (8). To estimate the bulk viscosity, we need to understand not only individual viscosities of silicate perovskite and ferro-periclase but also the connectivity of ferro-periclase in the lower mantle rock.

In the present study, we observed the electrical conductivity change of post-spinel phase just after phase transformation from ringwoodite with time at the uppermost lower mantle conditions to detect the interconnectivity of ferro-periclase. The electrical conductivity is very sensitive for the interconnection of high conductive phase of ferro-periclase in mantle composition. Based on the results of the electrical conductivity measurements by means of high pressure experiments, ferro-periclase forms the interconnected layer in the aggregates of sillicate perovskite and ferro-periclase. The interconnected microstructure can be maintained for a geological time scale (~10 My) under the condition of the cold subuducted slab (~800 oC), indicating the low viscous slab even at lower temperature than the surrounding mantle, because of lower viscosity of ferro-periclase than that of silicate perovskite. The low viscous slab may be prevented the penetration into the deeper lower mantle against the high viscous region at ~1000 km depth, named "viscosity hill"(9, 10), and therefore causes the stagnation at this depth observed in seismic tomography.

references

1. Y. Fukao, M. Obayashi, H. Inoue, M. Nenbai, J. Geophys. Res. 97, 4809 (1992).
2. J. Lei, D. Zhao, Phys. Earth Planet. Inter. 154, 44 (2006).
3. S. Widiyantoro, A. Gorbatov, B. L. N. Kennett, Y. Fukao, Geophys. J. Inter. 141, 747 (2000).
4. Y. Fukao, M. Obayashi, DI23C-01, 2010 Fall meeting.
5. S.-i. Karato, M. R. Riedel, D. A. Yuen, Phys. Earth Planet. Inter. 127, 83 (2001).
6. S.-I. Karato, P. Wu, Science 260, 771 (1993).
7. D. Yamazaki, S.-i. Karato, American Mineralogist 86, 385 (2001).
8. M. Handy, J. Struct. Geol. 16, 287 (1994).
9. J.X. Mitrovica, A.M. Forte, Earth and Planetary Science Letters 255, 177 (2004).
10. R.M. Wentzcovitch, J.F. Justo, Z. Wu, C.R.S. da Silva, D.A. Yuen, D. Kohlstedt, Proceedings of the National Academy of Sciences of the United States of America 106, 8447 (2009).