スラブ直上の薄い低粘性層によるスラブ・マントル間カップリングの弧に沿った方向の変化
Along-arc variation in the slab-mantle coupling due to a thin, low viscosity layer just above the slab

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In order to understand how seismic and volcanic activities occur in the subduction zone, it is critical to better understand the thermal structure there. Previous studies have shown that many factors affect the thermal structure including slab velocity, plate age, temperature dependence of viscosity, viscous anisotropy, complex slab geometry, and slab-mantle coupling. Among these factors, I focus on slab-mantle coupling in this presentation. It is well known mainly based on the observed low surface heat flow and low seismic attenuation that the forearc mantle is cold and rigid. To explain such a “cold corner”, the movement of slab and mantle need to be decoupled down to a certain depth by a thin, low viscosity layer (LVL) just above the slab so that hot material does not reach the corner of the mantle wedge. Many numerical studies have investigated the effects of slab-mantle coupling so far, although very few of them focus on its along-arc change. In this presentation, I will show how LVL at the plate interface affects the along-arc change in the degree of slab-mantle coupling.

I construct 3D finite element models to investigate a possible role of LVL in the subduction zone. The model domain is divided into crust, slab, and mantle wedge that includes LVL just above the slab. The flow is computed only in the mantle wedge and temperature is computed for the whole model domain. Buoyancy force is not considered and viscosity is assumed to be temperature and strain rate dependent except for LVL where it is constant. The model setting is exactly the same in the along-arc direction.

I find that when the viscosity of LVL is sufficiently low, the degree of slab-mantle coupling starts to change in the along-arc direction at some point and 3D flow and thermal structure develop. Temperature dependence of viscosity may be a key factor in producing such a feature. I also find that a thicker LVL leads to a longer wavelength of the 3D flow, and a deeper down-dip limit of LVL leads to a delayed onset of the 3D flow. In order to explain the spatial distribution of Quaternary volcanoes in Northeast Japan with this model, the viscosity and thickness of LVL need to be $<5\times10^{18}$ Pa.s and ~6 km, respectively. These results show that a detailed understanding of LVL including its formation process and spatial extent is essential to constrain the thermal structure in the subduction zone.

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