Impact of anisotropic thermal conductivity due to crystallographic-preferred orientation on the thermal structure of subduction zones

*Manabu Morishige[1], Miki Tasaka[2]

1. Earthquake Research Institute, the University of Tokyo, 2. Shizuoka University

It has been known that rocks deformed by dislocation creep have anisotropic material properties due to crystallographic-preferred orientation (CPO). For example, the anisotropy of elastic constants has been detected as seismic wave anisotropy in various tectonic settings, including subduction zones, lithosphere, and asthenosphere. However, little is known about how the anisotropic material properties of rocks change the dynamics of Earth's interior. In this presentation, we report the impact of anisotropic thermal conductivity due to olivine CPO on the thermal structure of subduction zones.
The Tohoku subduction zone, Northeast Japan, is chosen as the target region. For simplicity, anisotropy is taken into account only in the mantle wedge beneath the volcanic front and back arc. The model domain is two dimensional and steady state is assumed. We consider diffusion creep (with constant grain size) and dislocation creep as the deformation mechanisms of the mantle wedge. Thermal conductivity of olivine single crystal is assumed to be 4.0, 2.0, and 3.3 W/m/K for a-, b-, and c-axis, respectively. Three types of olivine CPOs are tested, including [100](010) slip system (corresponding to A-type olivine), [001](100) slip system (C-type olivine), and [100](001) slip system (E-type olivine). The CPO development was predicted with a code D-Rex.
Our results show that the thermal conductivity is highly anisotropic near the bottom of the overriding plate and the region just above the slab. In these regions the strain due to slab subduction is very large and the dominant deformation mechanism is dislocation creep. We also observe the maximum temperature difference of ~100℃ in these regions compared to the case with isotropic thermal conductivity. The temperature difference can be understood by considering thermal conduction in the vertical direction (for the bottom of the overriding plate) and in the direction perpendicular to the slab surface (for the region just above the slab), respectively. In A-type olivine case the temperature difference from the isotropic case has opposite sign compared to that in C-type olivine case, whereas the thermal structure obtained in E-type olivine case is very similar to that in the isotropic case. It is possible that including anisotropic thermal conductivity within the slab can further modify the thermal structure of subduction zones.

Keywords: thermal conductivity, crystallographic-preferred orientation, anisotropy, subduction zone, thermal structure

