Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

SIT02-P05 Room:Convention Hall Time:May 22 17:15-18:30

The mantle flow and the deformation of subducting slab at the plate junction

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Recent seismological studies suggest the importance of the plate junction on the mantle flow and the deformation of subducting slab. As an example of this, we consider the junction of the southwestern Kurile arc and the northeastern Japan arc in this presentation. The observations of S-wave splitting in this region show that the fast polarization direction in the mantle wedge is approximately the same as the maximum dip direction of the subducting slab, which suggests 3D mantle flow. The angle of subduction shows some variation along the strike of the trench. It is smallest at the plate junction and it becomes larger beneath the southwestern Kurile arc where oblique subduction occurs. We shall explore the origin of these features by numerical modeling.

In numerical simulation, we use the previously-developed numerical model of subduction zone in a spherical coordinate system with a minor modification to include the non-linear rheology (i.e., dislocation creep). The numerical model is set so that it is similar to the geometry of the plate boundaries in the region considered. We estimate seismic anisotropy based on the theory of LPO development.

Our results show that the flow in the mantle wedge is 3D, whereas that in the subslab mantle (i.e., the mantle below the subducting slab) is almost 2D. Our results also show that the geometry of the subducting slab is qualitatively the same as the observations. It may be explained by considering the torque balance acting on subducting slab, that is, the torque due to the dynamic pressure and that due to the gravity of the subducting slab. We find that the pattern of seismic anisotropy obtained in the numerical simulation and the observations are similar in the mantle wedge, which suggests that the 3D mantle flow as seen in our results may exist in this region.

Keywords: plate junction, subduction zone, mantle flow, deformation of subducting slab, seismic anisotropy