Migration of aqueous fluid in a subducting slab with implications for intermediate-depth seismicity

*森重 学[1]、van Keken Peter[2]
*Manabu Morishige[1], Peter E Van Keken[2]

1. 国立研究開発法人海洋研究開発機構、2. カーネギー研究所
1. Japan Agency for Marine-Earth Science and Technology, 2. Carnegie Institution for Science

So far many previous studies have discussed the relationship between aqueous fluid and intermediate-depth seismicity, although they have mainly focused on where fluid is released based on the predicted thermal structure and the maximum water capacity in the slab. However, recent numerical studies have demonstrated that aqueous fluid does not simply go up vertically but shows a wide range of behaviors. Therefore, it is critical to understand the migration of aqueous fluid in a subducting slab in detail (Morishige & van Keken, 2018).

We construct 2D and 3D finite element models for viscoelastic slab based on a theory of two-phase flow, which allows us to treat the movement of rock and aqueous fluid simultaneously. We solve the equations for porosity (volume fraction of aqueous fluid) and compaction pressure (pressure difference in between rock and aqueous fluid). The slab is assumed to subduct at a uniform velocity and the source of the fluid is fixed in time and space.

We find that when fluid mobility (which is defined as the ratio of permeability to fluid viscosity) is relatively low, porosity increases not only in the shallower part but also in the deeper part of the fluid source. It is the result of the resistance of rock to volume change, that is, when the rock has a high resistance the fluid released from the source cannot be localized there and hence spreads away from the source over some distance. With this mechanism the fluid can migrate toward the inner part of the slab, which may help explain the occurrence of the lower plane of double seismic zones.

We also find that in 3D fluid focusing occurs in along-arc direction and it leads to the increase in porosity and compaction pressure where the slab bends away from the trench. At the junction of northeast Japan and Kurile arcs we observe a deepening of seismic belt in the upper plane of double seismic zones. Our results suggest that 3D fluid migration may be a key to understand this observation in addition to a low temperature there caused by 3D slab geometry and/or subducted fore-arc sliver.

Reference

Morishige, M., & van Keken, P. E. (2018). Fluid migration in a subducting viscoelastic slab. Geochemistry, Geophysics, Geosystems, 19. https://doi.org/10.1002/2017GC007236

キーワード：沈み込み帯、スラブ内地震、水流体の移動
Keywords: subduction zone, intermediate-depth seismicity, migration of aqueous fluid