SMP43-P06 Room:Convention Hall Time:May 24 16:15-17:30

Modeling shear wave anisotropy in forearc regions: implications for distribution of antigorite and olivine CPO fabrics

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In the upper mantle it is generally thought that the crystal preferred orientation (CPO) of olivine forms by plastic deformation related to solid-state mantle flow. The presence of olivine CPO is one of the main causes of the seismic azimuthal and polarization anisotropy observed in the upper mantle. This link means seismic anisotropy can be used to investigate the flow patterns in the mantle. An important proviso is that there has to be good knowledge of the distribution and type of olivine CPO.

Thermodynamic modeling combined with results of deformation experiments can be used to predict the distribution of different types of CPO patterns in the forearc mantle (e.g. Kneller et al 2008). However, it has also been proposed that topotactic growth of olivine on aligned antigorite may also be an important process in the formation of B-type olivine CPO (Nagaya et al., 2012). This mechanism predicts B-type Ol CPO may be much more widespread in the wedge mantle than CPO formed by deformation alone.

Many forearc regions show an unusual pattern of seismic anisotropy with the fast direction perpendicular to the plate movement direction. One explanation of this observed seismic anisotropy is that the wedge mantle of these regions is characterized by a B-type olivine CPO patterns that characteristically have an a-axis concentration parallel to the intermediate principle axis of strain. The anisotropy observed in NE Japan (s-wave splitting with a time delay of ˜0.1 sec) can be explained by the presence of B-type olivine CPO (Katayama and Karato, 2006).

Olivine is the dominant mineral in the mantle, but forearc mantle of subduction zones also consists of significant amounts of hydrous minerals, in particular antigorite, that have much high anisotropy (for olivine Vp=24%, Vs=18%; for antigorite Vp=46%, Vs=66%). Relatively thin layers of antigorite-rich rock may therefore also have a strong influence on the seismic anisotropy. S-wave splitting with large-time delays greater than 1 second seen in the Ryukyu arc may be due to the presence of antigorite with a CPO that has a strong alignment of the c-axes perpendicular to a steeply dipping subduction zone (Katayama et al., 2009).

Modeling seismic anisotropy is a potentially useful way to place constraints on the types and distribution of different CPO patterns in the forearc mantle. We develop an approach used by Kneller et al. (2008) including a 3D analysis of ray paths and apply it to investigate proposed models of antigorite and olivine CPO distribution in the wedge mantle of NE Japan and the Ryukyu arc. The anisotropy of antigorite has only recently been determined and it has not yet been incorporated in such models. Our model combines two recently developed Matlab toolkits: MTEX (Hielscher & Schaeben, 2008; Mainprice, 2011) and MSAT (Walker & Wookey, 2012). We apply this model to the Ryukyu and NE Japan subduction zones and examine its potential to constrain the distribution region and type of olivine and antigorite CPO in these two wedge mantle.

[References]

(1)Kneller, E.A. et al., 2008. Earth Planet. Sci. Lett. 268, 268-282.
(2)Nagaya, T. et al., 2012. Eos Trans. AGU 93(52) Fall Meet. Suppl., Abstract MR11A-2473.
(3)Katayama, I., Karato, S., 2006. Phys. Earth Planet. Inter. 157, 33-45.
(4)Katayama, I. et al., 2009. Nature 461, 1114-1117.
(5)Hielscher, R., Schaeben, H., 2008. J. Appl. Cryst. 41, 1024-1037.
(6)Mainprice, D., 2011. Geol. Soc. Lond. Spec. Publ. 360, 175-192.
(7)Walker, A.M., Wookey, J.M., 2012. Comput. Geosci. 49, 81-90.

Keywords: antigorite, olivine, crystal preferred orientation (CPO), topotaxy, MTEX & MSAT, seismic anisotropy