Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)

SIT042-16 会場: 101 時間: 5月25日14:45-15:00

D”不連続面直上の地震波速度異方性の発見とその物質学的解釈

Detection of the seismic anisotropy above D" discontinuity and its mineral physics interpretation

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Many studies have reported V_{SV}< V_{SH}anisotropy in various places of the D" layer. However the depth distribution of the anisotropy is still unclear due to the lack of the seismic data set, and the anisotropy could not be investigated above the D" layer. To get a large number of data sets, we use seismic data recorded by new five broad-band stations at East Antarctica, and then we analyze the shear wave splitting focusing on the whole lowermost mantle beneath the Antarctic Ocean. We observe 2.0 % V_{SV}< V_{SH}anisotropy and it is consistent with previous work (Usui et al., 2008). However, we detect the anisotropy even above D" discontinuity unlike the previous analysis. Although the lattice preferred orientation (LPO) of post-perovskite (PPv) phase is now thought to be a major source of D" anisotropy in many studies, this strongly suggests that the anisotropy is not caused only by the PPv phase.
Since perovskite (Pv) and MgO are expected as the primary lower mantle phases and also anisotropic (Kendall, 2000; Wentzcovitch et al., 2006), they could be a source of the anisotropy. However deformation mechanisms of the minerals under high-P,T condition are still under debate. In order to clarify the origin of the anisotropy, we analyze the elastic anisotropy of polycrystalline aggregates (Pv + MgO) and (PPv + MgO) using the elastic tensor of each phase determined from ab initio calculations (Karki et al., 1997; Tsuchiya et al., 2004). We model the anisotropy in several different LPO directions with different degree, where the pyrolitic volume fraction is set to be PPv (Pv) : MgO = 7 : 3.
We find three likely LPO directions to produce the anisotropy. Transversely isotropic aggregate (TIA) of PPv with [001] vertical direction is likely cause of the anisotropy in the D" layer. The degree of LPO is the smallest in this analysis. This is consistent with the results of single phase analysis (Tsuchiya et al., 2004). The secondary likely source of the anisotropy is TIA of MgO with [100] vertical direction. Though the amount of MgO is much smaller than that of PPv and Pv, significantly small LPO reproduces the anisotropy because MgO is much anisotropic. MgO could be the origin of the anisotropy even above the D" layer. TIA of Pv with [100] vertical directions also produce the anisotropy. Although most previous works suggest Pv phase cannot reproduce large positive transverse anisotropy (V_{SV}< V_{SH}), our result shows that this phase with unexpected small LPO can explain the observed anisotropy. Pv could also be a source of the anisotropy above the D" layer. We will report the details of the difference in the anisotropy above/below D" discontinuity.

Research supported by JSPS Grant-in-Aid for Scientific Research Grants 21740330 and the Ehime Univ G-COE program "Deep Earth Mineralogy".

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キーワード:異方性,最下部マントル, S波スプリッティング,数値モデリング,南極海

Keywords: Anisotropy, The Lowermost Mantle, Shear Wave Splitting, Numerical Modeling, Antarctic ocean