Two anisotropic layers constrained from split SKS phases beneath the Lutzow-Holm Bay region, East Antarctica

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The analysis of seismic anisotropy has developed into a powerful tool to know deformations in the Earth's interior. Upper mantle anisotropy is mainly produced by lattice preferred orientation of highly anisotropic mantle peridotites. Seismic investigations suggest that most of the anisotropy is restricted to the olivine stability field, i.e. above 410km depth, in the lithosphere and/or asthenosphere. The origin of such anisotropy is generally attributed to the deformations of present plate motion reflected the mantle flow and paleo tectonic events of collision and/or break-up of craton. In this study, we investigate the upper mantle anisotropy using broad-band seismic data recorded at a few seismic stations in Lutzow-Holm Bay (LHB), East Antarctica, and discuss the origin of the anisotropy, the history of the Antarctic plate motion and the effects of continental collision and/or break-up.

We use broadband seismographs from 1996 to 2004 in LHB. We selected the events located within the epicentral distances of 85-130(deg.) from each station. We chose the data of the good signal to noise ratio, and simple and impulsive source time function which we could easily found SKS arrivals. We calculate the splitting parameter (f, dt) for teleseismic SKS waves using Silver and Chan [1991]. f is fast direction of split shear wave and dt is the delay time of two split waves. The splitting parameters are determined by minimizing the energy of the transverse component by net grid search technique with intervals of 1(deg.) and 0.1s, respectively. The error estimate of each combination of splitting parameters can be given by 95% confidence level of F test. Additionally, we assume more complex models as a two-layer model with four independent parameters [Silver and Savage, 1994]. The apparent splitting parameters are fitted by the four parameters (f1, dt1, f2, dt2), with index 1 corresponding to the lower layer and index 2 to the upper layer.

The delay times at all stations are the same degree in comparison to the average value of the results in global continental studies, and the fast polarization directions are systematically parallel to near coast line in the LHB. For 6 stations except PAD and STR, azimuthal variations of the splitting parameters do exists. In this case, we modeled two-layer model of azimuthal anisotropy. From a geodynamic point of view, since two layers may correspond to anisotropy in the lithosphere and asthenosphere, such a model is reasonable.

The results of four parameters are AKR (131, 0.7s, 43, 1.7s), LNG (124, 0.9s, 35, 1.5s), SKL (6, 0.6s, 39, 0.8s), SKV (49, 0.1s, 40, 1.1s), SYO (145, 0.4s, 57, 1.3s), and TOT (133, 0.9s, 47, 1.9s). Investigations of seismic anisotropy may contribute to ideas about influence of recent or fossil mantle flows and/or the tectonic evolution of the study regions. Fast polarizations directions of the lower layer are generally parallel to the directions of Absolute Plate Motion (APM) based on the HS3-NUVEL1 [Gripp and Gordon, 2002]. The directions are about N120E and the velocity is about 1cm/yr in this study region. The APM velocities are slow for East Antarctica and the delay time is small relative to upper layer. We consider that it is reasonable that the structures of lower layers anisotropy might have been produced asthenospheric mantle flow.

The upper layers don't coincide with the APM direction (the difference is about 70-90). We should consider the anisotropic structure which is past tectonic events of East Antarctica. The direction of Gondwana continent break up was NW-SE [Nogi et al., 1995]. This is perpendicular to the observed direction. In general, the fast polarization directions are consistent with NE-SW paleo-compressional stress [Board et al., 2005]. We consider that the anisotropy of upper layers is caused by lithospheric deformation during Pan-African orogen event (~500Ma).