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Lattice preferred orientation of amphibole in amphibolites from Jenner Headland and Ring Mt. in California and implications for seismic anisotropy

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Seismic anisotropy in the crust which is observed throughout the world can be attributed to lattice preferred orientation (LPO) of elastically anisotropic minerals. Although amphibole has smaller elastic anisotropy than that of mica, it takes a large proportion of deep crust and sufficiently anisotropic. Therefore, to understand the seismic anisotropy of lower crust, we studied amphibolites from Jenner Headland and Ring Mt. in California. All samples are well-foliated amphibolites constituting dominantly amphibole, plagioclase and other minor minerals such as garnet, epidote, biotite, and titanite. Chemical compositions of these minerals were analyzed by EPMA, and LPO of minerals was determined by using SEM/EBSD technique at the Tectonophysics Laboratory in Seoul National University. Almost all samples showed that [100] axes of amphibole are aligned normal to the foliation and [001] axes are subparallel to the lineation, which is called Type-I LPO of amphibole (Ko & Jung, 2015). All axes of plagioclase showed almost random distributions. Seismic anisotropy was calculated from the LPOs of minerals. P-wave velocity anisotropy of amphibole was in the range of 15.9–20.9% and maximum S-wave anisotropy was in the range of 13.1–19.7%. For horizontal flow, seismic velocity of P-wave is slowest in the direction subnormal to foliation and fastest subparallel to lineation. Polarization direction of vertically propagating fast S-wave is subnormal to lineation. Shear wave anisotropy (AVs) is also lowest subnormal to lineation. When we consider dipping angle of flow at 45° assuming 2D corner flow model, polarization direction of fast S-wave is normal to lineation. Seismic anisotropies of whole rock were weaker than those of amphibole. Our results suggest that LPO of amphibole can strongly induce low-velocity and anisotropic layers in the deep crust causing a large seismic anisotropy depending on the direction of seismic wave propagation.

Ko, B. and Jung, H., 2015, Crystal preferred orientation of an amphibole experimentally deformed by simple shear, Nature Communications, 6:6586.