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Crystal preferred orientation of amphibole and implications for seismic anisotropy in the crust

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Strong seismic anisotropy is often observed in the middle to lower crust and it has been considered to be originated from the crystal preferred orientation (CPO) of anisotropic minerals such as amphibole. Amphibolite is one of the dominant rocks in the middle to lower crust. In this study, crystal preferred orientations of hornblende in amphibolites at Yeoncheon and Chuncheon areas in South Korea were determined by using the electron backscattered diffraction (EBSD)/SEM with HKL Channel 5 software. In Yeoncheon area, hornblende showed two types of CPOs. Type-I CPO is characterized as (100) poles of hornblende aligned subnormal to foliation and [001] axes aligned subparallel to lineation. Type-II CPO is characterized as (100) poles of hornblende aligned subnormal to foliation and (010) poles aligned subparallel to lineation (refer to Ko and Jung, 2015, Nature Communications). In Chuncheon area, three types of CPOs of hornblende were observed. In addition to the type-I and –II CPOs described above, type-III CPO of hornblende was observed in Chuncheon area and it is characterized as (100) poles of hornblende aligned subnormal to foliation and both [001] axes and (010) poles aligned as a girdle subparallel to foliation. Using the observed CPO and the single crystal elastic constant of hornblende, seismic anisotropy of hornblende was calculated. Seismic anisotropy of P-wave was strong in the range of 10.2 – 13.5 %. Seismic anisotropy of S-wave was also strong in the range of 6.9 – 11.2 %. These results show that hornblende deformed in nature can produce a strong CPO, resulting in a strong seismic anisotropy in the middle to lower crust. Taking into account of the CPO of plagioclase in the rock, seismic anisotropies of whole rock turned out to be maximum P-wave anisotropy (Vp) of 9.8% and maximum S-wave anisotropy (Vs) of 8.2%. Therefore, strong seismic anisotropy found in the middle to lower crust in nature can be attributed to the CPO of hornblende in amphibolite.