Geophysical Research Abstracts
Vol. 17, EGU2015-7557, 2015
EGU General Assembly 2015
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Seismic evidence for a sub-lithosphere origin of anisotropy beneath the Pamir

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The Pamir and Hindu Kush region, located north of the western Himalayan syntaxis, feature submerged high velocity slabs and intermediate depth (up to 250 km) seismicity, probably testifying to continental subduction. Our main motivation in the current study is to map lateral variations of seismic anisotropy parameters for a better understanding of a possible link between surface and internal deformation in the context of crust and mantle structure. Using data recorded by several temporary (TIPAGE, FERGANA, TIPTIMON) and permanent passive seismic networks in the region, we performed shear wave splitting analysis of SKS phases of teleseismic earthquakes as well as S-wave signals of mostly deep-focus local earthquakes. We have measured splitting parameters from 932 high-quality SKS waveforms extracted from 193 teleseismic events (Mw>5.5) recorded at 104 broadband stations and obtained time delays ranging from 1.0 to 1.5 s. A coherent dominant pattern of ENE-WSW oriented fast polarization directions (FPD) is observed at most of the stations, which is perpendicular to the convergence direction within the Pamir.

Analysis of local shear wave splitting yields much smaller delay times (∼0.025-0.5s) with a complicated pattern of anisotropic directions. Considering that our local event database mostly contains deep-focus (>120 km) events in the subducting slab, small time delays imply that the crust and shallow part of the mantle only have a minor contribution to the observed SKS splitting. The coherent pattern of rather large SKS splitting parameters thus most likely represents sub-lithospheric anisotropy, which could be diagnostic of asthenospheric return flow in response to the ongoing indentation of Indian lithosphere into Eurasia.