8th International Conference on Seismology & Earthquake Engineering
11-13 Nov. 2019, Tehran, Iran

SEISMIC ANISOTROPY IN WESTERN MAKRAN SUBDUCTION ZONE

Saeid RAHIMZADEH
Ph.D Student, Institute of Geophysics, University of Tehran, Tehran, Iran
saeid.rahimzadeh@ut.ac.ir
Ali MORADI
Assistant Professor, Institute of Geophysics, University of Tehran, Tehran, Iran
asmoradi@ut.ac.ir
Ayoub KAVIANI
Research Associate, Institute of Geosciences, Goethe University Frankfurt, Frankfurt, Germany
kaviani@geophysik.uni-frankfurt.de

Keywords: Anisotropy, Shear wave splitting, Makran subduction zone, Trench-perpendicular

We performed shear wave splitting (SWS) of SKS, SKKS and PKS (XKS) phases from six broad-band stations across the western makran subduction zone (WMSZ) to investigate seismic anisotropy in the region (Figure 1). For each waveform, the energy minimization method of Silver and Chan (1991) is used to find the SWS parameters. An example of such analysis is shown in Figure 2. For stations located on the Oman Sea coastline, the fast directions are oriented approximately trench-perpendicular and for stations JASK and JSK1 the fast directions are oriented trench-oblique (Figure 1). It seems that the main source of the anisotropy is residing in the upper mantle. As the lithosphere of the WMSZ is thin (about ~ 20 km) (Entezar-Saadat et al., 2017), therefore we expect the splitting contribution from the continental lithosphere to be negligible. The location of these stations provides several advantages that ameliorate some of the challenges inherent in interpreting XKS analysis in a subduction zone like the study done by Eakin et al. (2015) on Peruvian subduction zone. In west Makran, first, in the subduction regime, the slab starts with a very shallow gentle dip (~ 8°) and increases to about 55°, where it plunges into the asthenosphere beneath the volcanic arc (Shad Manaman et al., 2010). So in this subduction region, dipping anisotropy is less likely (Eakin et al., 2015).

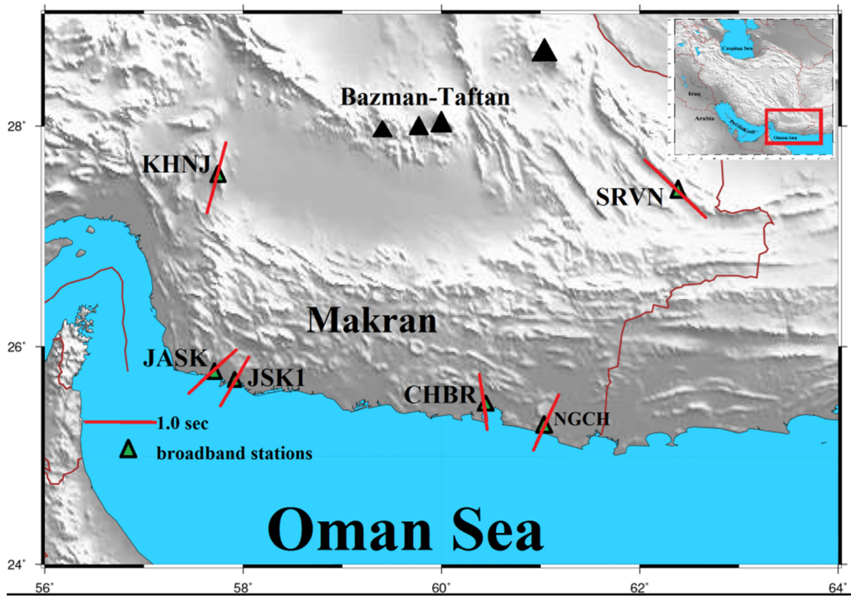

Figure 1. Stacked shear wave splitting parameters at each station. Orientation of bar indicates fast direction; bar length is proportional to delay time.

Second, because at these stations place, the slab dips angle is very small, likely there is no substantial mantle wedge to consider (at most only a thin layer of mantle remains between the flat slab and overlying continental crust (Eakin et al., 2015)). Therefore, mantle wedge cannot be contribution at splitting parameters. Recent Pn velocity tomography (Lazki et al., 2014) show very low velocities (S^{-1}<7.7 km) beneath the WMSZ, which imply a hot upper mantle with the likely presence of partial melt. Thus, we attribute the majority of the observed teleseismic shear wave (XKS) splitting to anisotropy within the mantle beneath the coastline stations. Therefore, the direction of mantle flow under these stations (NGCH and CHBR) is most likely trench-perpendicular. Long and Silver (2009) reported a similar behavior for the Cascadia subduction zone, where trench-perpendicular directions of anisotropy were observed, dissimilar to most subduction zones with trench-parallel sub-slab anisotropy. The different fast directions under stations JASK and JSK1 are likely due to the complexity of the crust beneath these stations. Further north, at station SRVN the fast direction is approximately parallel to the strike of Saravan fault. At these stations (SRVN and KHNJ) is delay times average grate than 1 s.

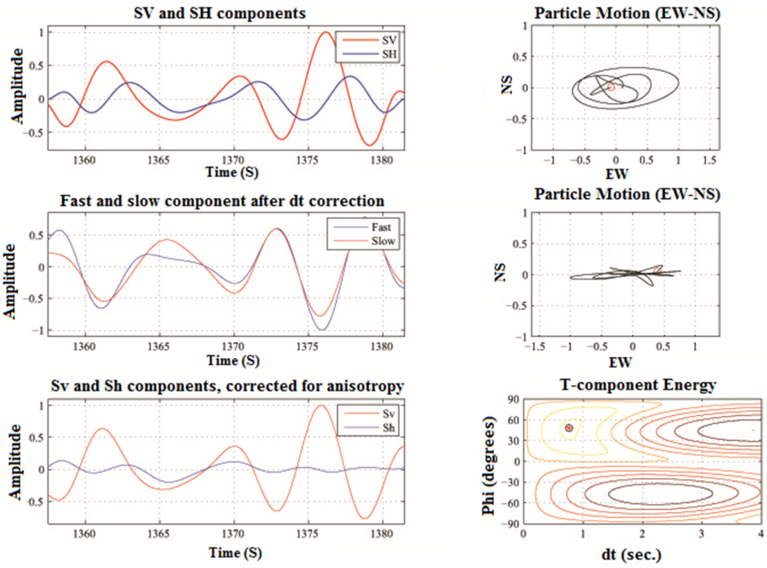

Figure 2. Example of shear wave splitting measurement (fast direction N48ºE, delay time 0.76 s) on a PKS phase using the method of Silver and Chan (1991). Data is from JSK1 station.

REFERENCES

Eakin, C.M., Long, M.D., Wagner, L.S., and Beck, S.L. (2015). Upper mantle anisotropy beneath Peru from SKS splitting: Constraints on flat slab dynamics and interaction with the Nazca Ridge. *Earth and Planetary Science Letters*, *412*, 152-162.

Entezar-Saadat, V., Motavalli-Anbaran, S.H., and Zeyen, H. (2017). Lithospheric structure of the Eastern Iranian plateau from integrated geophysical modeling: A transect from Makran to the Turan platform. *Journal of Asian Earth Sciences*, *138*, 357-366.

Lazki, A.A., Damegh, KH.A., Hadidy, S.E., Ghods, A., and Tatar, A. (2014). Pn-velocity structure beneath Arabia-Eurasia Zagros collision and Makran subduction zones. *Geological Society*, London, v.392, p 45-60.

Long, M.D. and Silver, P.G. (2009). Mantle flow in subduction systems: The sub-slab flow field and implications for mantle dynamics. *J. Geophys. Res.*, *114*, B10312, doi:10.1029/2008JB006200.

Shad Manaman, N., Shomali, Z.H., and Mirzaei, N. (2010). 3-D S-velocity structure of upper mantle and Moho depth variations in the Makran subduction zone. *Iranian Journal of Geophysics*, 153-169.

Silver, P.G. and Chan, W.W. (1991). Shear wave splitting and subcontinental mantle deformation. *J. Geophys. Res.*, *96*, 16429-15454.