THE STUDY OF CRUSTAL SEISMIC ANISOTROPY IN NORTHWEST IRAN BY SHEAR WAVE SPLITTING OF CRUSTAL PHASES

Zahra ESKANDARI
Institude of Advance Studies in Basic Sciences, Zanjan, Iran
z.eskandari@iasbs.ac.ir

Farhad SOBOUTI
Institude of Advance Studies in Basic Sciences, Zanjan, Iran
farhads@iasbs.ac.ir

Gholamreza MORTEZANEJAD
Isntitude of Geophysices University of Tehran, Tehran, Iran

Abdolreza GHODS
Institude of Advance Studies in Basic Sciences, Zanjan, Iran

Esmaeil SHABANIAN
Institude of Advance Studies in Basic Sciences, Zanjan, Iran

Ahmad SADIDKHOUY
Isntitude of Geophysices University of Tehran, Tehran, Iran

Keywords: Seismic Anisotropy, Shear Wave Splitting, Fast Polarization Direction, Crust, Northwestern Iran

In this study we have investigated crustal anisotropy in northwestern Iran by determining fast polarization directions and delay times of the crustal Sg and the mohoP to S converted phases. For the Sg measurements we used aftershocks of the 10 August 2013 Ahar-Varzaqan earthquake. We used data from 468 aftershocks recorded by 3 temporary broadband instruments installed by the Institute for Advanced Studies in Basic Sciences, Zanjan (IASBS), as well as some 403 main and aftershock records from four nearby stations of the BHRC strong motion network. These events have accurate epicenters and focal depths calculated from cluster location methods. For the moho Ps converted phases we used P-wave receiver functions calculated for 23 stations of the IASBS temporary network across northwestern Iran that operated from 2008 to 2013 and ran from Astara on the Caspian coast to Lake Uroumieh. The fast directions and delay times were calculated using the minimum energy method, and the software SPLIT developed by Teanby (2009) was used for this purpose.

The Ahar aftershocks have all occurred in the upper crust (6 to 20 km focal depths). The fast polarization direction in all of the 7 recording stations is oriented NW-SE, with an average azimuth of 150 degree (Figure 1). Delay times vary between 0.03 to 0.08 second with an average of 0.038 sec. Since all of the Sg phases used here originate in the upper crust, these results describe the anisotropic field of the shallow crust. The focal mechanism of the two main shocks of the Ahar event and many of the aftershocks indicate right-lateral slip on roughly E-W planes with a reverse component. The seismic fault responsible for the event is also has a E-W strike. All of this indicates that the regional maximum compressional stress is oriented NW-SE. Stress inversions of nodal plane of focal mechanism in the Ahar region gives a direction of max compressional stress of N132^{0}E ± 2. This stress direction is very much parallel to the direction of fast polarizations in the region. Since the only phenomenon common to all rocks where such symmetry is observed is stress aligned cracks, this observation strongly suggests that the shear wave splitting observed in the shallow crust in the Azarbaijan region is caused by stress-aligned microcracks.

Figure 2 shows the fast polarization directions and delay times calculated from moho Ps phase in the 23 stations across northwestern Iran. The average delay time over all of the stations is 0.44 sec. This delay time is an order of magnitude greater than the delay times obtained from the Sg phase in the upper crust. Therefore, it seems that the lower crust in northwestern Iran has a pronounced anisotropic fabric. There is considerable scatter in the fast directions in many of the stations and a large degree of variation is seen between different tectonic regions. In the region of Sahand and Sabalan volcanoes, fast directions show pronounce variations over short distances. This could reflect complex crustal structure and crack orientations as a result of magmatic and geothermal activities in the deeper crust underneath the volcanic structures. Towards the Talesh Mountains and the Caspian coast the fast directions gradually rotate from N-S to NE-SW direction. In the western margin of the South Caspian Basin the maximum horizontal compression is acting in NE-SW direction as inferred from the westward underthrusting of the South Caspian basement and the right-lateral motion along the Talesh region. This stress direction is sub-parallel with the fast polarization direction in the Talesh. We suggest that the ductile flow field in the lower crust in the Talesh and Caspian region has produced a NE-SW anisotropic fabric.

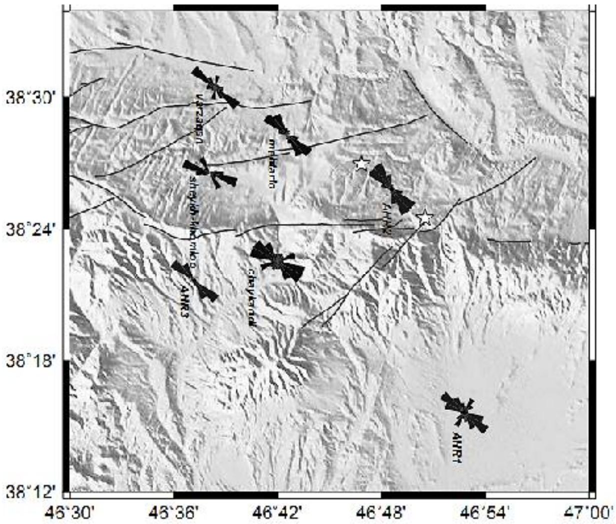

Figure 1. Rose diagrams of fast polarization directions determined in 7 stations in Ahar region

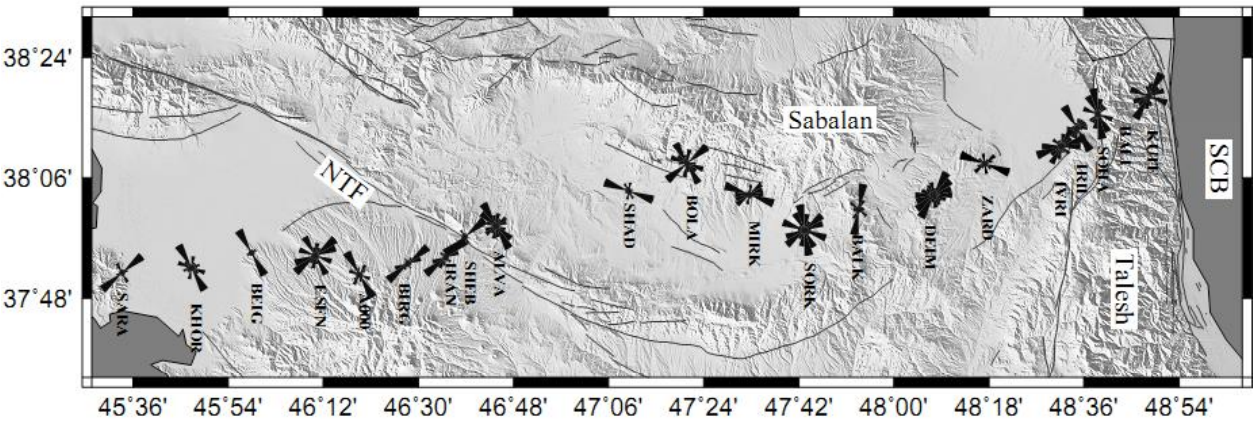

Figure 2. Rose diagrams of fast polarization direction for Ps converted phases in 21 stations in IASBS network

REFERENCES

Ghods A, Shabanian E, Faridi, Bergman E, Aziz Zanjani A and Mortezanejad G (2013) The Ahar-Varzaghan earthquake doublet (Mw 6.4, 6.2, Iran), *International Geoscience Congress, Tabriz, Iran*

Teanby NA, Kendall JM and van der Baam M (2004) Automation of shear wave splitting measurements using cluster analysis, *Bull. Seismol. Soc. Am.* 94: 453-463