TEMPORAL VARIATION OF VP / VS AS A PRECURSORY FOR 11 AUGUST 2012 AHAR – VARZEQAN EARTHQUAKE

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Japanese Seismologist, Wadati, has invented Wadati method in 1928 for direct calculation of Vp/Vs wave velocities from seismic source to seismic stations by using a linear relationship between P wave and time difference S-P wave arrivals. The ratio Vp/Vs indicates the nature of wave propagation in the environment that variations may be indicative of changes in the crust (Reyners et al., 2006). These changes in the parameters can be modified by the amount of tension in the region before an earthquake arises. Zou and Hannan (2004) showed that fracture creation caused changes in Vp/Vs. Wang et al. (2008) studied the ratio variations before and after the China Van- en earthquake 4 July 2006, at the four stations. Changes in this ratio have been reported about one year before the earthquake. Normal value range (1.73) decreases before the earthquake and then returned to the normal value after the earthquake occurs in all 4 stations.

Li in 1981 has considered the Vp/Vs ratio as an important physical parameters that reflects the characteristics of the upper crust in the studied area. For ideal homogeneous elastic media, P and S-wave velocities are related to Poisson's ratio of media σ, Young's modulus E, elastic constant of media μ and medium density ρ as follows.

$$V_P = \sqrt{\frac{E}{\rho}\left[1 + \frac{2\sigma^2}{1-\sigma-2\sigma^2}\right]}, \qquad V_S = \sqrt{\frac{E}{\rho}\,\frac{1}{2(1+\sigma)}} \qquad \frac{V_P}{V_S} = \sqrt{\frac{2(1-\sigma)}{1-2\sigma}}$$

Temporal variations of this parameter were studied as a tool in earthquake precursory researches in part of the Western Alborz seismotectonic province, before and after 11 August 2012 Ahar-Varzaqhan (Mn = 6.5) earthquake. Earthquakes occured in the studied area from 01 01 2006 to 22 09 2014 with Mn ≥ 3, were recorded by IrSC (Iranian Seismological Center, Institute of Geophysics, University of Tehran). In this time 419 events with Mn ≥ 3 has recorded that 53 of them occurred before the main shock (Figure 1).

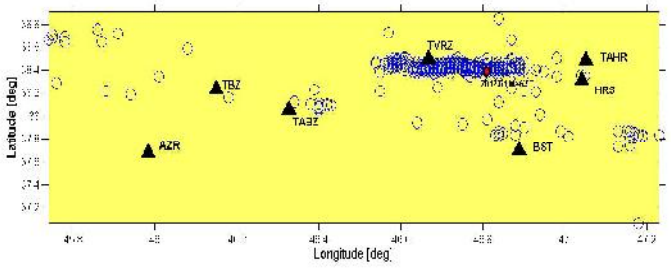

Figure 1. Earthquakes and stations in the studied area

The diagram of the Vp/Vs variations plotted and show the specific variation from 1 to less than 2 (figure 2). This figure shows temporal variations of this ratio and a decrease of the values to 1.57 before the earthquake. Figure 2 shows normal-low-normal process in earthquake occurrence time and around it. Vp/Vs show normal value 1.73 a few months before earthquake occurrence. This value turns to 1.57 or less than 1.73 (normal value) ranging from a few days before earthquake happening to earthquake incidence time. This value gradually increases and return to 1.75 after the event time.

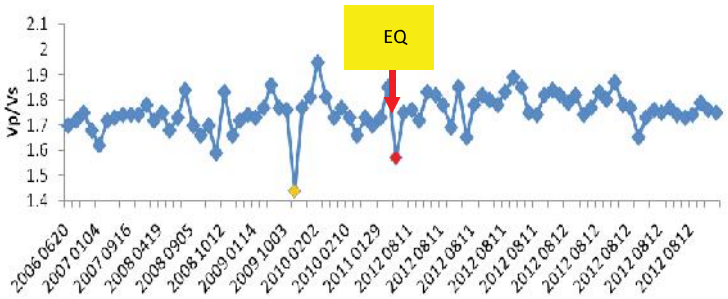

Figure 2. Temporal variations of Vp/Vs ratio, Mn ≥ 3, 2006-2012

The mean difference of Vp/Vs is 0.16 a few months before main shock occurrence to near days of earthquake occurrence. Figure 3 shows temporal variation of this parameter in the 2010 to 2012 time window. Vp/Vs in the beginning of 2012 had returned to background level (about 1.73).

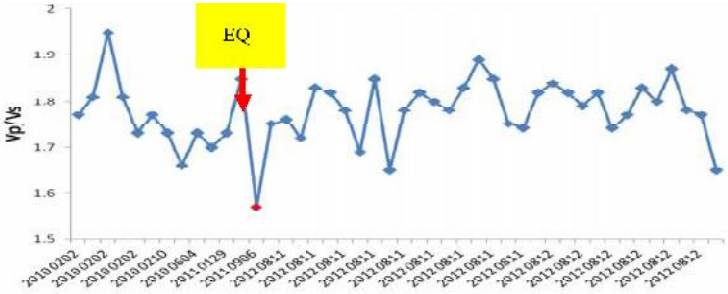

Figure 3. Temporal variations of Vp/Vs ratio, Mn ≥ 3, 2010-2012
Note decreasing just before the earthquake occurs

According to seismicity of this region continues monitoring of this wave velocity ratio by dense local stations and appropriate azimuthally cover in recording earthquake events, changing in this ratio before and after earthquake occurrence can act as a precursor in region and may help for earthquake prediction. By accurate data possessing in this manner (well spatially and temporally located events M ≥ 2 by well distributed and sufficient stations) more certainty short time windows before and after earthquake happenings may be achieved, the fact that is hardly possible in our case studies.

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