SHEAR WAVE VELOCITY TOMOGRAPHY IN IRAN

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To investigate the state of deformation in Iranian plateau, the geometry of different crustal pieces and knowledge of lateral undulations of crustal thickness are required. Quality of Lg wave propagation is very sensitive to lateral changes of crustal thickness. Lg propagation efficiency in continents strongly reduces while crossing any strong lateral crustal thickness variations (e.g., Kennett, 1986; Furumura and Kennett, 1997). Finding regions of passing or blocking Lg wave in Iran can give important information about geometry of different crustal pieces and any lateral crustal structure variations within them.

Maximum amplitude of shear wave in one Hz is being used routinely for calculation local magnitude (i.e., M_L magnitude). In normal continental crust, M_L amplitudes belong to Lg wave. However, if a ray crosses an Lg blocking region, Lg wave leaks into mantle and thus allowing for efficient Sn propagation instead. So by performing a mixed phase shear wave tomography we map regions of passing and blocking Lg waves in Iran using velocity of M_L amplitude rays.

We have picked arrival time of M_L amplitudes from seismic waveforms collected from permanent Iranian networks and temporary seismic networks of Department of Earth Sciences of Institute for Advanced Studies in Basic Sciences (IASBS). The arrival time of 65152 M_L amplitudes are read manually from waveforms of 2943 events. The selected events belong to 63 seismic clusters for the period of 1996-2012. The events happened within the crust, have depth shallower than 45 km, and local magnitudes in the range of about 3 to 6 with maximum readings from events having magnitudes around 3. Except for Makran region, the selected amplitude readings provides a very satisfactory ray coverage for the study area (Figure 1a).

Using a tomography method and the arrival time of M_L amplitudes from Iranian stations, we calculate shear wave velocity map of Iran. The shear wave velocity map is derived from a mixture of crustal Lg and mantle lid Sn seismic phases, therefore the shear wave velocity map can only be used to differentiate Lg blocking and passing regions.

Figure 1b shows the map of M_L shear wave velocity which is superimposed upon shaded topography of the region. The calculated shear velocity varies between 2.5 to 4.5 km/s. Our results show that Zagros and South Caspian Basin (SCB) have shear wave velocity in the range of Sn phase, and thus are Lg blocking regions. We also noted that the border between Zagros and Central Iran is considerably deviating from Zagros suture line indicating the partial underplating of the cold Arabian plate beneath Central Iran. The low velocity zones running normal to the dominantly Lg blocking region of Zagros suggests segmentation of crustal deformation along the Zagros trend. The Kura basin in the west of Caspian Sea and low plains of Gorgan in East of Caspian Sea shows high shear velocities likewise that of SCB, implying the low plains are underlined by oceanic type crust of SCB. Extension of the high velocity SCB south of the Khazar fault put serious doubt about the presence of the fault. Our M_L shear wave velocity map implies a continental nature for the aseismic Lut block. Alborz, most of the Central Iran and especially the northwestern Iran show low shear velocity in the range of Lg velocity, suggesting a warm crust.

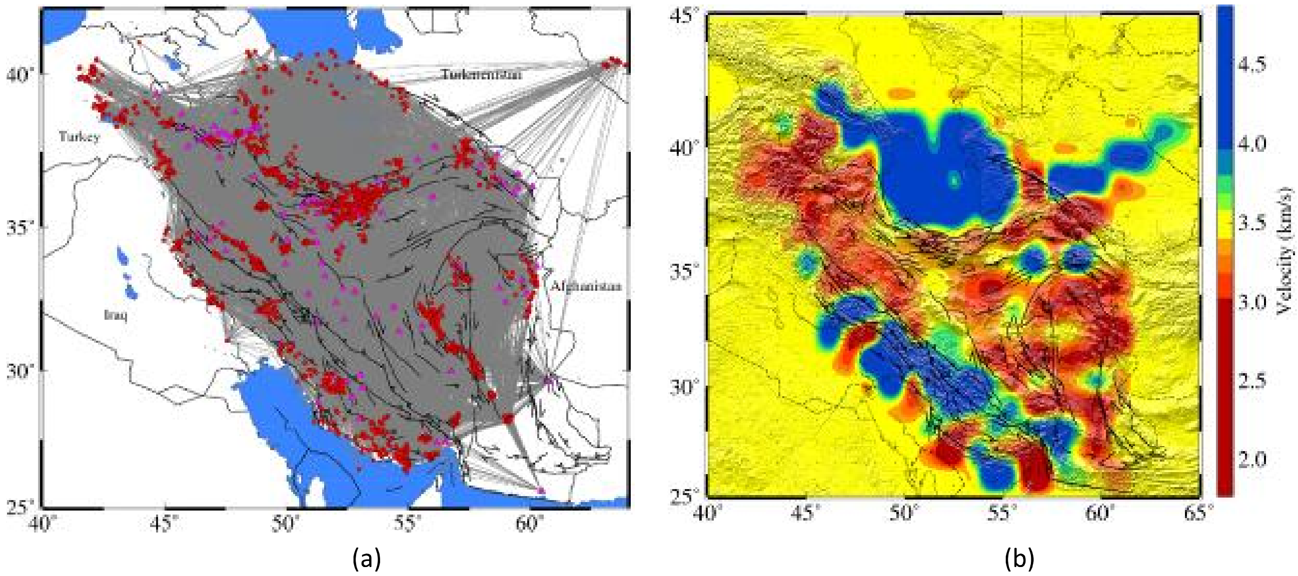

Figure 1. a) Ray coverage of used M_L amplitude readings used in this study. The gray lines are the surface trace of the event-station paths; red circles are epicenters of the selected events; triangles are seismic stations.
b) Map of M_L shear wave velocity superimposed upon shaded topography of the region; the black curves are trace of active faults and the thick gray lines are political borders

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