Abstract

The Northern Iraq Seismic Network (NISN) has operated 10 broadband stations in north-eastern Iraq since late 2005. In the Fall of 2008, an array with five-station broadband stations (KSIRS) was added to the capabilities in north-eastern Iraq. These installations are currently expanded by the Iraq Seismic Array (ISN), which adds six broadband stations in western central and southern Iraq to improve the seismic coverage throughout the country. In this paper, we present the latest results of our crustal studies obtained with seismic data recorded by NISN and surrounding networks. At present, over 85 GB of NSN seismic waveform data have been recorded and analyzed.

The aim of the present study is to derive models of the local and regional crustal structure of north and north-eastern Iraq, including the northern extension of the Zagros collision zone. This goal is achieved by estimating local and regional seismic velocity models using 3-D joint inversion for hypocenter locations and velocity structure, receiver-function and surface wave dispersion analyses and to use these velocity models to obtain accurate event focal mechanisms. Our analysis of phase arrival times yielded over 27,000 phase picks, comprised of 9,000 Pg, 5,000 Pn, 10,000 Sg/Lg and 3,000 Sn arrivals. Our analysis of hypocenter locations presents a clear picture of the seismotectonics associated with the tectonics of the region. The large seismicity is confined to the northwestern section of the Zagros thrust zone, while it decreases towards the southern end, before the intensity increases in the Bandar Abbas region again.

Our analysis of waveform data indicates clear propagation paths from the west or south-west across the Arabian shield as well as from the north and east into NSN. Phases including P, Pn, Pg, Sg, and Sn are clearly observed on these seismograms. In contrast, no blockage or attenuation of Pg and Sg-wave energy is observed for propagation paths along the axis of the Zagros-Biflin zone from the south, while Pn and Sn phases are not affected. These findings are in support of earlier tectonic models that suggested the existence of multiple parallel linear faults splitting off the main Zagros fault zone in east-west direction. These faults appear to attenuate the crustal phases while the refracted phases, propagating across the mantle lid, remain unaffected. We will present surface wave analysis in support of these findings, indicating multi-pathing for surface waves from events located to the south-east of NSN, indicating the complex structure of the Zagros fault zone. In combination with receiver function analysis, our preliminary structural models indicate velocities in the upper crustal model of 60 km for the foothills, which increases to 45-55 km below the core of the Zagros-Biflin zone.

Data for RF Analysis

Receiver Function Inversions

Figure 3: Global distribution of events (Mb > 5.5) used during receiver function analysis. Green wave: upcoming red triangle center of NSN.

Figure 4: Receiver functions for 20 teleseismic events recorded at station KSSW. The observed RFs are shown in blue and estimated from the inversion process in red. The best fit for these RFs ranges from 60% to 95%.

Figure 5: Locations of NSN stations (blue triangles) and associated S-wave velocity models obtained from RF inversion. Moho depths beneath the stations in the foothills appear shallower than those beneath the stations in the Zagros mountains. Similarly, a mid-crustal velocity increase appears shallower depth below the foothills (~15 km depth) compared to the Zagros mountains (~20 km depth). Station ERIL and KESM (aquamarine triangles) were temporary stations. Station SLY (red triangle) belongs to ISN.

Summary

Since 2005, the seismic capabilities in Iraq have been expanded to 16 broadband stations within the Northern Iraq Seismic Network (NISN) and the Iraq Seismic Network (ISN). These networks are supported by the five-station Iraq Seismic Array (KSIRS). Current improvements of telemetry will enable real-time data flow with a few months. Thus far, over 850 GB of data have been collected and analyzed. The results of the receiver function analysis reflect lower-than-average velocities, as previously observed for the region (Thakur et al., 2006). A mid-crustal velocity increase in velocity at depths of 30-40 km is observed below the network. The depth of this mid-crustal velocity jump and the Moho depth appear to increase from the foothills towards the Zagros mountains. The results of the surface wave analysis reflect strong variability of dispersion characteristics as a function of azimuth while indicating multipathing even from clustered events close to the seismic network. The Rayleigh waves propagating along Arabian Shield develop strong fundamental modes over broad frequency bands as previously observed by Pasyanos (2005) and Bianco et al. (2008). The Moisand reflector is not always observed even for clustered events close to the seismic network. The Rayleigh waves propagating along Arabian Shield develop strong fundamental modes over broad frequency bands as previously observed by Pasyanos (2005) and Bianco et al. (2008). The Moisand reflector is not always observed.