PATTERNS OF SEISMICITY IN THE COASTAL REGIONS OF THE SOUTH CASPIAN BASIN

Abdolreza GHODS
Institute for Advanced Studies in Basic Sciences, Zanjan, Iran
aghods@iasbs.ac.ir

Farhad SOBOUTI
Institute for Advanced Studies in Basic Sciences, Zanjan, Iran
farhads@iasbs.ac

Minoosh BIJARI
Institute for Advanced Studies in Basic Sciences, Zanjan, Iran
m.bijari@iasbs.ac.ir

Majid NEMATI
Dept. of Geology, Kerman University, Kerman, Iran
majid1974@uk.ac.ir

Mehdi MAHERI-PEYROV
Institute for Advanced Studies in Basic Sciences, Zanjan, Iran
maheri@iasbs.ac.ir

Keywords: South Caspian Basin, Seismicity, Earthquake Relocation, Receiver Functions

The South Caspian Basin (SCB) is a rigid basement block that has highly affected the deformation history and seismotectonics of the surrounding Caucasus, Talesh, Alborz and Kopeh Dagh mountain ranges (e.g. Berberian, 1983; Jackson et al., 2002). The basin is most probably of oceanic origin and is underthrusting beneath the neighbouring continental regions to the west and south and north of it. The position of its borders with the surrounding continental curst and the degree of its underthrusting, however, still remain unknown.

Correlating the existing seismicity pattern with active structures in SCB is seriously compromised by location biases inherent in single-event location techniques using only regional and teleseismic arrival time observations. The purpose of this study is to unravel the details of patterns of seismicity along the Iranian coasts of SCB and the bordering Talesh and Alborz ranges and to understand them in the context of crustal structure and active deformation of the region. To achieve these goals we have relocated as many events as possible using the the hypocentroidal decomposition multiple-event location technique. Data from national and regional networks along with data gathered from several temporary seismic networks were combined to make an accurate assessment of seismicity in the region. We have also extensively used S-P phase readings from the dense accelerometer network of Iran. The relative phases from very near accelerometer stations are critical for our accurate depth determination.

We have relocated 446 events belonging to six clusters covering mostly the Iranian coastal regions of SCB. Most of the events are relocated with epicentral errors of less than 5km. For 164 events we have been able to estimate a reliable focal depth using very close seismic and/or accelerometer stations.

Significant offshore seismicity is only observed in a 50-km wide margin along the western margin of the Caspian Sea. East of the Talesh Fault along the Caspian coastline, the depth of seismicity varies from 20 to 47 km. This pattern extends no more than about 5 km inland. The pattern of seismicity indicates that the basement slab of the South Caspian is undergoing intense seismic deformation as it is underthrusting beneath the northern Talesh. In the southern Talesh the amount of underthrusting inferred from deep seismicity is much less than in the North. The sedimentary cover of the basin deforms aseismically. The seismicity, depths, and previous focal mechanisms of the larger offshore events are consistent with low-angle underthrusting of the South Caspian floor.

The depth of all offshore events and those close to coastal lines are usually larger than 15 km. The largest focal depths (i.e., ~ 45-50 km) are observed in the eastern margin of SCB in the low plain of Gorgan. Other large focal depths are observed in the Baladeh region where focal depths as large as 30 km are observed. Focal depths in the range of 15 to 20 km are observed south of Babol, and Amol cities in Mazandaran. The large focal depths have a strong implication for seismic hazard studies in the coastal Caspian region. The lack of earthquakes with focal depths less than 15 km along the coastal region of the Caspian Sea would reduce the seismic hazard estimates made already for the region.

Focal depths of the accurately located events show a systematic sudden jump to depths shallower than 15 km while moving from sea to inland regions. The location of the jump coincides approximately with the peak of the mountain ranges and thus has different distances from the coast. Crustal seismic images obtained from receiver function studies across the western and SW of SCB indicate that the change in focal depth of events is coincident with the transition from oceanic-type SCB to continental type of rust in the Talesh and Alborz. From these observations, we conclude that the presence of deep events everywhere offshore or along the coastal region of the Caspian Sea indicates that these regions are underlined by the SCB crust. Lack of seismicity above the depth of 15 km is related to thick sedimentary cover of SCB.

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