Seismic Observations at the Marmara Sea, Turkey Using Ocean Bottom Seismometers

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Introduction

The sea of Marmara is located in the western end of the North Anatolian Fault (NAF) system. This region is a transition zone between the strike slip regime of the NAF and the extension regime of the Aegean Sea. The Marmara Sea is located immediately west of the first bifurcation of the NAF, and another bifurcation (Main Marmara Fault and South Boundary Fault) occurs in the Sea. The 17 August 1999, Izmit earthquake ruptured the NAF at the east margin of the Marmara Sea. The westward migration of the series of large earthquakes along the NAF suggests that the possibility of occurrence of large earthquakes is high at the Marmara region. To investigate detailed micro seismicity in the Marmara region, we have conducted seismic observations using ocean bottom seismometers (OBSs).

Observations and data acquisition

The observations consisted of two stages. In the first leg, we deployed ten pop-up type OBSs at the eastern Marmara Sea from 28 April to 2 June, 2000, and in the second leg, the ten OBSs were deployed at the western Marmara Sea from 14 June to 17 July, 2000. The total observation period is 70 days. All OBSs were equipped with a digital recording system and recorded continuous data.

To detect seismic events, we used an event detection method using the ratio between a short-term average and a long-term average, and duration time of events. Then we extracted events recorded at four or more stations, and made a common event list. Number of common events is over 1000 for each Leg.

Results

During the observation period, we could determine hypocenters of more than 450 events whose error estimates were less than 5 km using the HYPOMH algorithm (Hirata and Matsu'ura, PEPI, 1987). The hypocenter distribution shows that many micro earthquakes occurred just beneath the western Main Marmara Fault and between the eastern Main Marmara Fault and Inner Boundary Fault (located at south edge of Cinarcik basin). There are few events along the South Boundary Fault. A cluster was observed at the north part of Armutlu Peninsula (southeast of the Marmara Sea). The focal depth distribution shows that all events occurred shallower than 20 km. The depth of events in the eastern part of the Sea is up to 15 km, and that in the western part is up to 20 km.

Many earthquakes occurred between the eastern Main Marmara Fault and Inner Boundary Fault. From the cross section analyses, we can see that the eastern Main Marmara Fault dips south, and Inner Boundary Fault dips north. Both faults may merge at depth. This result is consistent with the results from a seismic reflection study (Okey et al. Tectonophys, 2000).

Most earthquakes were too small to determine focal mechanism of each event. We try to make composite focal mechanisms for some area. The results show that most mechanisms are dextral (right-handed) strike-slip type. One (or two) reverse type mechanism was determined, but compression axis is the same as that of the strike-slip type.

Conclusions

We conducted seismic observations at the Marmara Sea, and got the following results;

-Seismic activity was high at the Main Marmara Fault. The activity at the South Boundary Fault was relatively low, and a cluster was observed at the north part of Armutlu Peninsula.

-Events were occurred just beneath the western Main Marmara Fault. This suggests that the dip of this fault is almost vertical.

-Events were occurred between the eastern Main Marmara Fault and Inner Boundary Fault. Cross section analyses suggest that two faults may merge at depth.

-Focal depth is up to 20km at the western part, and up to 15km at the eastern part.

-Composite focal mechanisms show strike-slip regime.

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