An outline of the Turkish – Japanese post-1999 İzmit earthquake research in the Gulf of İzmit: Offshore faults, submarine mass movements, seafloor gas seeps and offshore paleoseismology

İsmail Kuşçu[a], Makoto Okamura[b], Hiromi Matsuoka[b], Kunio Yamamori[b], Yasuo Awata[c] and Selim Özalp[a]

[a] *Department of Geological Research, General Directorate of Mineral Research and Exploration (MTA)*

[b] *Department of Natural Environmental Science, Faculty of Science, Kochi University*

[c] *Active Fault Research Center, Geological Survey of Japan*

High resolution shallow seismic data (along 133 lines, approximately 1200 km) collected during the post-August 17, 1999 earthquake cruise were interpreted to locate and map the active faults in the Gulf of İzmit in light of bottom topography provided by the bathymetry chart obtained from the cruise data. Considering the neotectonic features around the gulf in general, two sets of faults were recognized: an earlier and mostly now-inactive set of faults responsible for the formation of a large depressional area by the pull-apart mechanism in which the Gulf of İzmit is located; and a younger, second set of throughgoing active strike-slip faults in the gulf cutting the former set. The active faults in the gulf were further divided into two groups, the main fault and the secondary faults. The main fault is made up of longer and mostly continuous, roughly E-W striking segments. The secondary faults are shorter, lying in left-stepping or in en echelon pattern on both sides of the main fault especially in the Central Basin. Along the profiles in the Eastern and Central Basins there are evidence of recent rupturing during the August 17, 1999 earthquake which are supported also by on-land data.

High-resolution shallow seismic profiles were taken across the Gulf of İzmit, in the eastern Sea of Marmara, both before and after the İzmit earthquake on August 17, 1999. The seismic profiles were collected in July 1995 and March 2000 and revealed gas-charged sediments, gas seepage into the water column. In addition to gas seeping, a large number of sediment failures occurred in the offshore and coastal zones of the study area as a result of the İzmit earthquake.

Examination of the high-resolution shallow seismic data acquired during the March 2000 cruise revealed that a large offshore area had failed on the southern margin of the Eastern Basin due to seafloor instability from the earthquake. Five major zones of slumping are present in the area of this study. These areas are: north of Başiskele, east of Batak Point, north of Batak Point, Gölcük area, and Değirmendere. The large slump zones in the former areas are composed of a continuous series of translated sediment units. The slump zone Değirmendere area is rather small. The slumps in all areas generally start from the coastline and extend out onto the deeper parts of the basin.

Anomalous acoustic signatures on the March 2000 seismic profiles provide evidence for widespread gas-charged sediments and gas seeps. Seismic profiles from 1995 also show the presence of gas in the area before the earthquake. Comparing the pre- and post-earthquake data we found that the apparent amount of the gas in the sediment and water columns increased after the earthquake. We conclude that it is this change in apparent gas level, rather than simply the presence of gas, that indicates a causative relationship between the increase and the 1999 earthquake. The presence of gas in sediments and gas seeps in and around failed sediments, in fact, has often been observed in relation with seismic activity elsewhere.

Besides the offshore mass failure, excessive sea floor gas seeps the earthquake generated tsunami waves and caused subsequent damage and subsidence mainly along the southern shores of the gulf. We retrieved three piston corer samples in the area in order to

detect signs of historical earthquakes recorded in the sediments of the Central Basin of the Gulf of İzmit. Based on the visual and laboratory investigations, magnetic susceptibility measurements, grain fraction and water contents, five turbidite layers were identified in the study area. We suggest that these turbidites were generated by submarine slides and slumps triggered by the August 17, 1999 İzmit earthquake and by major historical earthquakes previously occurred in the region. These turbidites are characterized by amalgamated beds, irregular or incomplete structure sequences, grain-size breaks/fluctuations, abrupt changes in composition within bed and variable composition among beds. These characteristic features of the seismoturbidites contrast with "normal" turbidite characteristics for identifying turbidites and seismoturbidites. With a precise dating of shell fragments in the cores it is expected to correlate the major on land and offshore earthquakes in the region.