FINAL TECHNICAL REPORT

PALEOEARTHQUAKE HISTORY OF THE NORTH ANATOLIAN FAULT, WESTERN TURKEY – AN INVESTIGATION INTO THE NATURE OF EARTHQUAKE RECURRENCE AS REVEALED BY A LONG STRATIGRAPHIC AND HISTORICAL RECORD

U.S.G.S. Grant No. 98-HQ-GR-1014

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Abstract

We excavated four trenches across the North Anatolia fault zone (NAFZ) along the Gazikoy-Saros segment, which last produced surface rupture in 1912, near Kavakkoy where the fault enters the Gulf of Saros. The trenches exposed faulted sediments in a flood plain environment with abundant detrital charcoal and scattered land snail shells. Twenty two radiocarbon dates place constraints on the ages of the exposed sediments, which range from less than a few hundred years to about 6000 years in age. In one trench, we identified five discrete earthquake event horizons in the upper 2.5 m of stratigraphy based on abrupt upward termination of shear zones, folding, fissuring, and abrupt stratigraphic thickening, four of which may corresponded to historically recorded large regional earthquakes. The earliest of the identified events occurs below an unconformity and dates to about 4 ka B.P. The more recent four events all occurred within the past 1300 years and may be the large earthquakes of A.D. 824, ca 1354, 1766 and 1912 (Ambraseys and Finkel, 1987). In another trench, we identified two events that have occurred during the past 500 years and almost certainly correspond to the large events of 1766 and 1912. These observations support an average return period of about 350 years for the Gazikoy-Saros segment of the NAFZ. They also suggest that this segment, which is bound both to the east and west by large releasing stepovers, behaves in a quasi-periodic fashion (σ_n ~150 years), at least for the past several surface ruptures.

Most of the 20 mm/yr of dextral shear between Anatolia and Europe observed by GPS occurs on the North Anatolian fault. We use 15 mm/yr and the ~350 year recurrence rate, as determined from our trenching and the historical record, to suggest that each of the earthquakes observed in our trenches produced several meters of slip, consistent with their inferred sizes from the extent of historical damage. Considering that Istanbul has not suffered a large nearby event in the Marmara Sea since 1766 and possibly 1509, we suggest that at least 3.6 m and possibly as much as 7.3 m of strain has accumulated across faults in the Marmara during these past centuries. If released seismically, this could result in an earthquake in the M7-M7.5 range