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Undersea acoustic telemetry across the North Anatolian Fault, Marmara Sea: results from 3 years of continuous monitoring of the fault displacement

Heidrun Kopp (1,8), Dietrich Lange (1), Florian Petersen (1), Jean-Yves Royer (2), Pierre Sakic (3,9), Valérie Ballu (3), Ziyadin Çakir (4), Sinan Ozeren (4), Pierre Henry (5), Semih Ergintav (6), and Louis Géli (7)

(1) GEOMAR Helmholtz Centre for Ocean Research Kiel, Germany (hkopp@geomar.de), (2) Laboratoire Ge´osciences Oce´an, Universite´ de Brest and CNRS, Plouzane´, France, (3) Laboratoire Littoral Environnement et Sociétés, Université de La Rochelle and CNRS, La Rochelle, France, (4) Eurasian Institute of Earth Sciences, Istanbul Teknik U¨niversitesi, Istanbul, Turkey, (5) Aix-Marseille Univ., CNRS, IRD, Coll. France, CEREGE, Aix-en-Provence, France, (6) Kandilli Observatory and Earthquake Research Institute, Department of Geodesy, Bogazici University, Istanbul, Turkey, (7) Laboratoire Ale´as ge´ologiques et Dynamique se´dimentaire, UR Géosciences Marines, IFREMER, Institut Carnot EDROME, Plouzane´, France, (8) University Kiel, Germany, (9) GFZ Helmholtz-Zentrum Potsdam, Germany

Located in the Marmara Sea, the Istanbul-Silivri segment of the North Anatolian Fault (NAF) is known to be a seismic gap since 1766, although, in the last century, the NAF has caused major devastating strike-slip earthquakes over most of its extent. This fault segment, characterized by sparse seismicity, was suggested to be either creeping aseismically or blocked and accumulating enough strain to produce an earthquake of magnitude 7 or greater. This section of the NAF may thus represent a major seismic and tsunamigenic hazard for the Istanbul megalopolis, located only 40 km away.

Under the auspices of EMSO and of the MARSITE project funded by the European Union an array of 10 acoustic transponders has been deployed in the eastern part of the Kumburgaz Basin on the Istanbul-Silivri segment on either side of the fault, in order to measure at the seafloor the relative displacements across the fault over a period of 3 to 5 years. The telemetric beacons (4 from the University of Brest and 6 from GEOMAR in Kiel) form two arrays fitted in one another.

The principle of the experiment is to repeatedly measure the distance (ie two-way-travel time of acoustic pings) between pairs of beacons and thus to monitor the deformation of an array of 20 baselines, 500m to 3000m long, of which 12 cross obliquely the assumed fault trace. The French and German arrays are independent but ensure a redundancy of rangings along parallel baselines. Each acoustic transponder also monitors the temperature, pressure, sound-velocity and attitude (tiltmeters), every one or two hours. Data are stored in each beacon and can be downloaded from the surface using an acoustic modem. We present the results of more than 3 years of continuous recording by this undersea geodetic array, from November 1st, 2014 to January 10, 2018.

All acoustic transponders worked nominally and appear to have remained stable on the seafloor. Recorded sea-bottom temperatures provide evidence for transient changes likely due to episodic flows of colder water across the Kumburgaz Basin. Pressure records display diurnal variations related to the tides and storms. Both parameters affect the sound-velocity and thus the acoustic ranges, and are used to correct the baselines. The data acquired up to May 2017 did not detect strike-slip movement above the resolution of 6 mm/yr, suggesting that the Istanbul seismic gap is not a significantly creeping segment.