Creep rate measurement and fault modeling at the North Anatolian Fault, beneath the Sea of Marmara, Turkey, by means of acoustic ranging

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The North Anatolian Fault (NAF) is the strike-slip fault that passes 1200 km length through the Northern Turkey having about 20 mm/yr of right-lateral motion in average. In the past 100 years, the fault sequentially ruptured from east to west. In 1999, two earthquakes occurred at Izmit (M7.4) and Duzce (M7.2) adjacent to the Sea of Marmara, the south of Istanbul, where it remains unruptured. Because NAF is under the sea, we cannot directly observe its motion by using GNSS or other space geodetic tools. To reveal the strain rate and fault structure of NAF in the Sea of Marmara, we use “direct path acoustic ranging” in this study.
The acoustic ranging can detect relative motion across the fault with millimeter-level precision for 1 km baseline. We installed five instruments at so-called the Western High across the NAF. Round trip time is recorded every 6-hours. At the same time, in-situ temperature, pressure (for sound speed), and tilt (for attitudes) were also recorded. These data can be recovered on-demand through acoustic modem from a ship.
In this talk, we present the ranging data from September 2014 to July 2015. At first, we evaluate sound velocity. Observed temperature variation was quite small (~0.007℃) close to the instrumental resolution, so we applied a polynomial fitting to get smooth variation. Pressure correction was applied only during the first half period, because it was not available due to instrumental failure in the second half. Without pressure correction, small scatter remains in the apparent range, which does not much affect the creep rate determination, though. After correcting instrumental attitude and baseline angle to the fault line, we obtained 4-8 mm/yr of right-lateral motion. Because such extremely large strain rate is unlikely, we consider the observed 4-8 mm/yr movement at the Western High along the NAF is “creep” in the shallow crust out of 20 mm/yr of regional block motion. We will also talk about the fault structure modeled using additional onshore GNSS data.

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Keywords: direct path acoustic ranging, the North Anatolian Fault, GNSS, fault modeling, seafloor geodesy

