Earthquake locations within the Western Sea of Marmara

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Abstract

A detailed study, based on Ocean Bottom Seismometers (OBS) recordings from two recording periods (3.5 months in 2011 and 2 months in 2014) and on a high-resolution, 3D-velocity model, is presented here, that provides an alternative view of the microseismicity along the submerged section of the North Anatolian Fault (NAF), within the western Sea of Marmara (SoM). The non-linear probabilistic software packages of NonLinLoc and NLDiffLoc were used. Only those earthquakes that comply with the following location criteria (e.g., representing 20% of the total amount of events) were considered for analysis: i) number of stations ≥ 5; ii) number of phases ≥ 6 including both P and S; (iii) RMS location error ≤ 0.5 sec, (iv) azimuthal gap $\leq 180\circ$. P- and S- travel times, suggest that there are very strong velocity anomalies along the Western High, with low VP, low VS and ultra-high VP/VS in areas where mud volcanoes and gas-prone sediment layers are known to be present. The location results indicate that not all earthquakes occurred as strike-slip events at crustal depths ($>$ 8 km) along the axis of the Main Marmara Fault (MMF). In contrast, the following features were observed: 1) A significant number of earthquakes occurred off-axis, with a predominantly normal focal mechanism, at depths between 2 and 6 km, along tectonically active, structural trends oriented E-W or SW-NE.; 2) A great number of earthquakes were also found to occur within the upper sediment layers (at depths $<$ 2 km), particularly in the areas where free gas is suspected to exist, based on high-resolution 3D seismics. Part of this "ultra-shallow" seismicity appears to occur in response to deep earthquakes of intermediate (ML ¯ 4 – 5) magnitude. Resolving the depth of the shallow seismicity requires adequate experimental design ensuring source-receiver distances of the same order as hypocentral depths. To reach this objective, deep-seafloor observatories with a sufficient number of geophone sensors near the fault trace are needed.

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