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Fluid activity within the North Anatolian Fault Zone according to 3D marine seismic data on the Sea of Marmara Western High

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Along the northern branch of the North Anatolian Fault Zone (NAFZ) within the Sea of Marmara, numerous gas seeps occur. A large part of the gas origin is biogenic but on the Western High, gas bubbles and gas hydrate with a thermogenic signature have been sampled. The expulsion of deep fluids opened new perspective about the permeability, the mechanical properties and the monitoring of the NAFZ.

Consequently, the Western High was selected for the deployment of a 3D seismic acquisition layout during the MARMESONET cruise (2009). Thirty-three km^2 of high resolution seismic data (with a frequency content of 50-180 Hz) have been collected within the shear band of the fault. The SIMRAD EM-302 was also operated to detect acoustic anomalies related to the presence of gas bubbles in the water column.

Within the upper sedimentary cover (seismic penetration ranges from 100 to 500 m bsf), high seismic amplitude variations of the reflectors allow to identify gas traps and gas pathways. Local high amplitude of negative polarity, such as flat spots and bright spots, are observed. Amplitude anomalies are located above and within anticlines and along normal faults. They often correlate with seafloor manifestations of fluid outflow and gas plumes in the water column. This suggests that gas migrates from depth towards the seafloor along normal faults and permeable strata, and part of it is trapped in anticlines.

North of the NAF, seabed mounds, corresponding to active hydrocarbon gas seeps, are aligned along a NE-SW direction. They are linked in depth to buried mud volcanoes with an episodic activity. The last mud eruption activity apparently just before or during the Red-H1 horizon deposition which is a prominent reflector of high amplitude and negative polarity occurring all over the Sea of Marmara. It has been interpreted as a stratigraphic horizon, corresponding to slow sedimentation and high sea-level interglacial period.