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Observations of seafloor deformations and fluid emissions from AUV and submersible surveys in the Sea of Marmara.

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Ifremer AUV AsterX (Autonomous Underwater Vehicle) surveys were performed during the Marmesonet cruise of Ifremer RV Suroît in November 2009, at sites considered for the deployment of long-term seafloor observatories on coupled fluid and deformation processes in the Sea of Marmara. The AUV carried a Simrad EM 2000 multi-beam sounder (operating at 200 kHz) 70 m above the seafloor. About 70 km2 of very high resolution (metric) bathymetry and reflectivity data were collected, primarily along main active fault of the North Anatolian Fault (NAF) system on the Central and Western highs, and along the edges of the Tekirdag and Cinarcik Basins.

Fluid emission sites are seen as high backscatter patches, presumably from the presence of authigenic carbonates at or immediately beneath the seafloor and from disturbed gas-saturated sediments. From the bathymetric data, gas emission sites are often associated with small depressions (pockmarks of 10-50 m in diameter, exceptionally up to 150 m). Visual observations of cold seeps with ROV (Remote Operated Vehicle) (Armijo et al., 2005; Zitter et al., 2008) and Nautile submersible (Marnaut cruise) and acoustic anomalies detected in the water column in 2000, 2007 (Geli et al., 2008) and during the Marmesonet cruise in 2009 with the EM302 multibeam sounder are well correlated with the AUV observations. The seafloor expression of active faults and landslides is well seen in the AUV bathymetric data, in basins as well as on topographic highs. Various structural contexts were surveyed: Strike-slip localized on a single linear fault (e.g. Western High), releasing and compressive jogs on the main strike-slip fault (e.g. Kumburgaz and Central High), fault segment with combined strike-slip and normal slip (N Cinarcik scarp), en-echelon normal fault system (Southern Cinarcik basin), and a basin edge with minor transpressive deformation (NW Tekirdag). In most areas where it is observed, the main strike-slip fault trace presents reflectivity anomalies indicative of fluid outflows. However, secondary extensional (normal faults) and compressional structures (anticline axes), and, in some occurrences, Riedel shears also influence the distribution of seepage sites. Some of the emission sites are not obviously correlated with active faults. In particular, gas emissions are generally present at the base of the slopes along the edges of the basins, but these do not systematically correspond to an active fault trace. Furthermore, slope instabilities of moderate size (100m - 1 km) appear common and are often associated with seepage. AUV and submersible surveys permitted to observe fluid outflows and relate them with geomorphologic and tectonic features. The AsterX AUV provided high-resolution data over wider swaths than the Victor ROV, which, during the 2002 Marmarascarps cruise, surveyed the main fault scarps. The main outcome is that the gas emissions not only occur along the major faults of the NAF system but also along secondary structures, and, at some locations, follow patterns that more likely relate with the underlying sedimentary structure and may only be indirectly influenced by fault activity. As the primary objective of the long-term observatory is to monitor the consequences on fluid processes at the seafloor of small variations of crustal stress and strain, considering the context of the fluid emissions to be monitored is essential. We propose a selection of sites more promising for this approach.