Cold seeps along the Main Marmara Fault: context and perspectives for monitoring.

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Seafloor manifestations of fluid expulsion are common on sedimented margins worldwide and are designated as cold seeps. Observations at cold seeps sites typically include dark patches of reduced sediment, mats of sulfide oxidizing bacteria, chemosynthetic benthic communities and authigenic carbonates. These manifestations result from combined methane oxidation and sulfide reduction at a shallow depth (0-50 cm) in the sediment. Cold seeps are primarily the consequence of a locally increased methane flux, which may either be dissolved in the pore fluid or migrate as a separate phase.

In the Sea of Marmara, cold seeps were observed with towed cameras (Halbach et al., 2004) and ROV (Armijo et al., 2005) along the seafloor trace of active faults. We compiled video observations from MARMARASCARPS cruise and show that many fault segments have no or very limited cold seep activity. Most cold seep observations were done at few sites, suggesting very focused flow in the fault zone. Among the main active sites, a distinction is made between gas seeps and water seeps. At gas seeps, bubble emissions at the seafloor or disturbed echofacies on echosounder profiles (3.5 kHz band) demonstrate the presence of free methane gas at a shallow depth within the sediment. On the other hand, authigenic carbonate chimneys characterize the water seeps and visible water outflow was observed at two sites (in the Tekirdag and Central basins). This observation is rare at deep-water cold seep sites and may relate with the paleoceanography of the Sea of Marmara. The transition from lacustrine (or brackish) to marine conditions near the end of the last glaciation causes a salinity gradient in the sediment (between 5 and 40 m deep), which may trigger buoyancy driven convection if high permeability conduits are present. The chimney site in the Tekirdag basin is located at the outlet of a canyon feeding a buried fan with coarse sandy turbidites in the lacustrine sequence. Pore fluid composition profiles indicate that the sand layers channel brackish pore fluid laterally from the basin into the fault zone at less than 20 m deep. This suggests water seeps correspond to local flow cells. While a contribution from a deeper fluid source cannot be excluded, and still needs to be examined for gas seeps, the distribution of venting activity appears controlled by shallow, rather than deep, structures.

One motivation for monitoring cold seeps in the Marmara Sea is a possible relationship between seepage activity and processes occurring in the seismogenic zone. Because of the complexity of near seafloor processes, there may not be a simple relationship between fluid pressure in the seismogenic zone and cold seep flow rates. However, experiments performed above subduction zones (Brown et al., 2005; Davis et al., 2006) indicate that shallow flow cells are affected by silent slip events originating at depth. The mechanism proposed is the propagation of a silent slip wave from the seismogenic zone to the seafloor where it affects local stress and permeability conditions. We propose to perform an experiment in the Marmara Sea, combining shallow pore fluid and flow rate measurements with seismological monitoring.

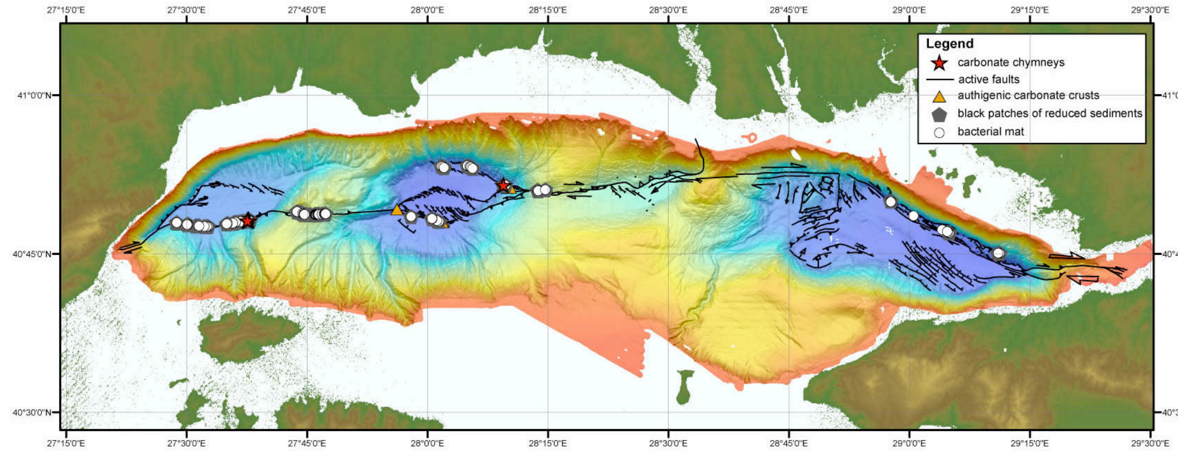

Figure1: Observations of cold seeps in the Sea of Marmara from Ifremer ROV cruise Marmarascarps. Active sites are systematically found in association with active fault scarps but their distribution along the faults is very heterogeneous. Note, however, that several segments of the Main Marmara fault have not been systematically explored.

References

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