Cold seeps in the Sea of Marmara: a refuge for “extremophile” foraminifera?

*Christophe Fontanier[1], Delphine Dissard[2], Livio Ruffine[3], Emmanuel Ponzevera[3], Ewan Pelleter[3], François Baudin[4], Angélique Roubi[3], Sandrine Chéron[3], Audrey Boissier[3], Nicolas Gayet[5], Sylvain Bermell-Fleury[3], Vivien Guyader[3], Françoise Lesongeur[5], Florence Savignac[4]

1. EPOC Laboratory (University of Bordeaux, France), Ifremer Géosciences Marines (Plouzané, France), FORAM Study Group (Villevêque, France) & University of Angers (France), 2. IRD-Sorbonne Universités, UPMC, Univ Paris 06-CNRS-MNHN, LOCEAN Laboratory (Paris, France), 3. Ifremer Géosciences Marines (Plouzané, France), 4. ISTeP-Sorbonne Universités, UPMC, Univ Paris 06, UMR 7193 (Paris France), 5. Ifremer Etude des Ecosystèmes Profonds (Plouzané, France)

In this study, we investigate living (stained) deep-sea foraminifera from the Sea of Marmara. We focus on faunal composition and geochemical signatures (trace elements and stable isotopes) in foraminiferal tests at two cold-seep sites, which are located at 329 and ~1240 m depth. Both study areas are bathed by dysoxic water mass ($O_2 < 20$ μmol/L). They present extreme conditions characterized by a remarkable spatial heterogeneity. This variability is expressed through (1) contrasted geochemical process (e.g., free methane gas seepages provoking sulfate reduction, authigenic carbonate precipitation), (2) various sedimentary facies (e.g., coarse facies related to gravity flow, Mn-carbonates-enriched sediments, sapropel layers) and (3) an obvious biozonation of benthic life (e.g. microbial mat observed at 329 m depth). Overall dysoxia prevailing at both study areas restricts foraminiferal diversity to very low values ($S < 9$, $H' < 0.97$). Stress-tolerant species *Bolivina vadescens* and *Globobulimina affinis* dominate living faunas in both environments, with the highest standing stock recorded in shallower site where bacterial mat spreads. We assume that filamentous bacterial mat consists in a refuge for “extremophile” foraminifera, which can thereby survive and proliferate in dysoxic and sulfidic ecosystems. Moreover, our biogeochemical results show that the interpretation of the foraminiferal Mn/Ca ratio as a reliable proxy for bottom water oxygenation is neither straightforward nor equivoque, and depends strongly on basin physiography, sedimentary process and water column structure in modern and past periods.

Keywords: Living (stained) benthic foraminifera, Sea of Marmara, Cold seeps, Extreme ecosystems, Trace elements, Stable isotopes

