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Biogeochemical dynamics in superficial sediments collected from the new anoxic hypersaline lake Thetis

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Anoxic sediments were sampled from a new discovered hypersaline basin, Thetis Lake, explored during an Italian oceanographic in September-October 2008. The Thetis Basin is a narrow depression of elliptical shape at the depth of 3300-3400m below sea level (22°07'E 2 34°41'N – 22°10'E 34°40'N). The seawater-brine interface is located at a depth of 3,258 m below sea level with a thickness of ∼157 meters. That seawater-brine interface represents a steep pycno- and chemocline with evident gradients of salinity and Eh. Brine composition was found to be saturated by halite with a total salinity of 348‰The predominant processes driving the ecosystem of the Thetis Lake are likely sulphate reduction, methanogenesis and anaerobic methane oxidation.
Here, we present the geochemical results of sediments from a box-core collected in the central part of the basin. The 52 cm thick grey/dark homogeneous sediment core is characterized by non-bioturbated, structureless mud with evident sandy fractions in the upper part.
Variation of Mn and Ba contents versus depth are characterized by increasing values toward the upper part of core while the Fe depth profile shows an opposite trend with higher concentrations in the lower part of the core. Enrichment factors estimated for the measured trace elements showed high values for Co, Cu, Mo and Ni.
The Eh values measured on-board during sampling activity were nearly constant along the core (about -350 V), while the Mn and Ba geochemical behavior evidence a clear redox zonation along the core. Particularly more reducing conditions occur in the lower part of the core as also suggested by relative Fe enrichments.
The upper brine induce and maintain permanent anoxic conditions in the bottom sediments of Tethys and favor organic matter accumulation and consequent Co, Cu, Mo and Ni enrichments.
The geochemistry of redox-sensitive trace elements suggests a progressive mobilization front from the base of the core where very reducing conditions favored upward shifting of more soluble elements (Ba, Mn, etc). Molybdenum geochemical behaviour suggests that the last ∼10 cm of the core are characterised by an strong raise of H2S activity probably due to an increase of sulphate reduction activity and/or to an heavy (additional) supply of H2S activity deriving from the brine. A redox three step-like redox sensitive front represents the geochemical dynamics of the studied extreme environment, where predominant sulphur and sulphate microbial reduction processes regulate the biogeochemical behaviour of trace metals.
The studied record represents a best-analogue for past ocean anoxic events and a great chance to explore geomicrobiological activity and dynamics in extreme deep environments.