Postdoctoral Position (M/F) in Marine Geochemistry:

Integrated Molecular and Microbial Biogeochemistry of Dissolved Organic Matter and Organometallic Complexes in the Paleochori Bay Hydrothermal System (Milos)

Project Description

Context and Objective:

Marine hydrothermal systems play a major role in the transfer of trace elements (strategic metals and radionuclides) from the lithosphere to the water column, particularly via shallow plumes, which act as a key vector for the transport, transformation and retention of these elements. This biogeochemical coupling is shaped as much by the abiotic chemistry of the subsurface as by the activity of the microbial communities colonizing the fluid/seawater interface.

Dissolved organic matter (DOM), particularly its functionalized, sulfur-bearing fraction, largely governs the speciation, complexation and mobility of metals and radionuclides by controlling their solubility, reactivity and residence time.

Part of this sulfurized DOM is produced abiotically (thermochemical sulfurization), and another part by the activity of chemolithotrophic microbial mats proliferating at the vent sites — two sources whose relative contribution remains to be quantified.

Milos Island (Cyclades, Aegean Sea) hosts an extensive shallow-to-moderate-depth hydrothermal system (< 15 m). Paleochori Bay, the project's focal site, concentrates fluids rich in reduced sulfur, metals and sulfurized DOM, as well as dense microbial mats (Sulfurimonas, Arcobacter) whose role in sulfur cycling remains debated — an ideal natural laboratory for studying the integrated coupling between molecular chemistry, metal/radionuclide complexation and microbial metabolism, from the hydrothermal source to the diluted plumes.

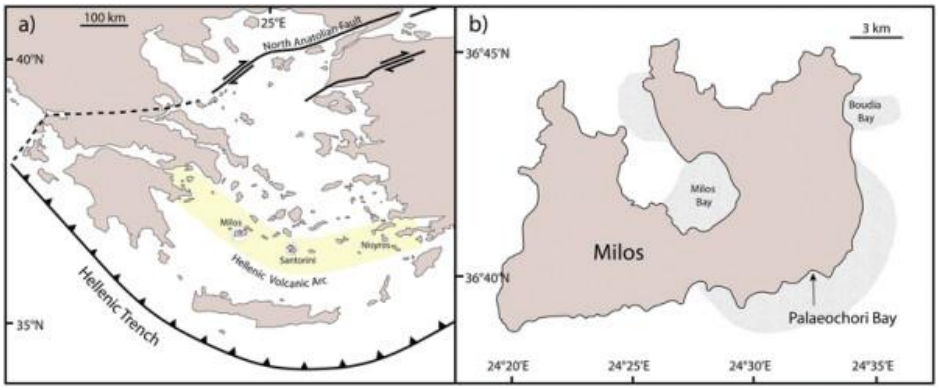

Figure 1. *Map of shallow-water hydrothermal vents. The hydrothermally active islands of Milos, Santorini and Nisyros are located along the Hellenic volcanic arc. Shaded areas represent the spatial extent of hydrothermal activity (34 km²) observed around Milos. Map from Gilhooly et al. (2014).*

The main objective of the postdoctoral position is to **characterize and quantify the integrated biogeochemical coupling between the molecular chemistry of DOM, the complexation of trace**

metals/radionuclides, and the metabolism of microbial mats in the shallow hydrothermal system of Paleochori Bay (Milos), with particular attention to the abiotic or biotic origin of DOS and to the strategic issues surrounding critical metals.

Key Instrumentation:

Ultrahigh-resolution mass spectrometry is the central analytical tool of the project. The laboratory has two latest-generation Orbitrap Tribrid mass spectrometers:

Orbitrap Fusion Lumos 1M and **Orbitrap IQ-X 1M** (with or without chromatographic coupling): for ultrahigh-resolution analysis (1,000,000 at m/z 200) and high sensitivity, with multistage fragmentation capability enabling detailed molecular speciation of DOM and its sulfur compounds. Both platforms are equipped with various ionization sources (ESI/APCI/APPI), which will make it possible to (i) target different pools of organic matter and organometallic complexes, and (ii) track the stable isotopes of organosulfur biomarkers ($\delta^{34}S$) to trace the origin and transformation of organic sulfur compounds (alkylthiophenes, sulfur-containing amino acids) from the hydrothermal source to the diluted plumes. This multi-parameter approach will combine high-resolution molecular speciation (Orbitrap) with stable isotope analysis (($\delta^{34}S$) of specific compounds by Orbitrap).

Figure 2. *Ultrahigh-resolution Orbitrap Fusion Lumos 1M and Orbitrap IQ-X 1M mass spectrometers for the molecular and isotopic analysis of DOM.*

Main Activities:

- Characterization of the molecular composition (chemodiversity) of DOM by direct infusion and LC/Orbitrap coupling, along the source→plume gradients in Paleochori Bay
- Physicochemical mapping of the site (temperature, pH, sulfide, trace metals) coupled with paired sampling of microbial mats and mat-free fluid
- Detection of intact metal/metalloid-DOM complexes (Cu, Cd, Ni, As) by ESI(+) Orbitrap, with stoichiometric screening
- Metagenomic and metatranscriptomic analyses of the microbial mats
- Dissemination: publication of scientific articles and presentation at international conferences

Candidate Profile:

PhD in analytical chemistry, marine geochemistry, biogeochemistry or a related discipline.

Strong skills in:

- Separation techniques and high-resolution mass spectrometry (Orbitrap / FT-ICR MS)
- Trace element geochemistry and/or analytical chemistry
- Sampling and fieldwork in the marine environment
- Familiarity with microbial ecology and metagenomic data will be appreciated

Experience**:** Less than 2 years after obtaining the PhD

Host Laboratories

This work will be carried out within the Yves-Rocard joint research laboratory (https://www.geosciences.ens.fr/lrc-yves-rocard), co-supervised between the **Institut de Géologie de l'École Normale Supérieure (ENS)**, under the supervision of **Javier Escartin**, and the **Département d'Analyse et Surveillance de l'Environnement du CEA (DAM/DIF)**, under the supervision of **Maxime Bridoux**.

ENS - Institut de Géologie

The oceanology and marine geology team has recognized expertise in shallow Mediterranean hydrothermal systems. It has in-depth knowledge of the Milos site, access to data from previous campaigns, and detailed vent mapping (drone, AUV).

CEA/DAM/DIF

The team has major expertise in the molecular characterization of complex environmental mixtures. It has state-of-the-art analytical platforms including two Orbitrap Tribrid mass spectrometers (Fusion Lumos 1M and IQ-X) for high-resolution mass spectrometry, ICP-MS, and chromatography coupled to mass spectrometry, offering cutting-edge molecular analysis capability. The team has significant experience in the molecular speciation and complexation of metals and radionuclides. The metagenomic and metatranscriptomic analysis of the microbial mats will be carried out in collaboration with the company Qualtech.

Contract Terms

Contract type:	Fixed-term contract, 24 months
Expected start date:	During 2027 (to be discussed)
Salary:	According to the CEA/ENS postdoctoral researcher salary scale
Workplace:	CEA/DAM/DIF (Bruyères-le-Châtel) and ENS (Paris)
Field access:	2–3 marine campaigns planned in the Mediterranean
Application deadline:	During 2027

Contact and Application

For any questions:

- Javier Escartin (ENS): escartin@geologie.ens.fr
- Maxime Bridoux (CEA): maxime.bridoux@cea.fr

To apply:

Send a CV, cover letter and two recommendations to: escartin@geologie.ens.fr and maxime.bridoux@cea.fr