

Paleoenvironments and climate-society dynamics in the Sindh Region (Pakistan)

A combined sedimentary geochemistry and molecular organic biomarker approach applied to the sediment core from lake Manchar

Project Name: ERC- AGROCHRONO - Development of agropastoralism in southwest Asia in the indo-iranian border region: Chronological reconstructions and economic, cultural and environmental models

Contract: 5- to 6-month paid internship (starting in January/February 2027)

Workplace: Laboratoire des Sciences du Climat et de l'Environnement, Orme des Merisiers, Bat 714, 91190 Saint-Aubin

Supervision: Manon Sabourdy (LSCE, CEA), Emmanuelle Casanova (LSCE, CEA), Elodie Brisset (CEREGE, CNRS)

Submission of applications: Please send your application to the contact listed below by October 5, 2026. Send Resume a resume, a cover letter, grades from previous academic years, and referents contacts (with a recommendation letter if possible).

Contact : manon.sabourdy@lsce.ipsl.fr, emmanuelle.casanova@lsce.ipsl.fr, brisset@cerege.fr

Context and scientific objectives of the internship

This internship is part of the "paleoenvironmental changes" research theme of the ERC AGROCHRONO project, whose objective is to explore the development of agropastoral activities in the Indo-Iranian zone since the Holocene. The evolution of the environmental context, particularly changes in vegetation and hydrology, may have played a decisive role in the settlement of societies in this region. To assess this influence, the project relies on the study of lacustrine sedimentary archives collected from several lakes in the area.

In 2025, during a field mission to Pakistan, the project team collected a sediment core from Lake Manchar (Sindh, Pakistan), located on the western margin of the Indus Valley. The aim of this coring is to build a new sedimentary record documenting the hydroclimatic and environmental variations that occurred at the regional scale.

The internship aims to initiate the geochemical study of this archive (MAN25-01, 260 cm), following two complementary lines: (1) characterizing the sedimentary sources and sedimentation rate through analysis of the mineralogical and geochemical composition of the sediments (for example: continuous high-resolution XRF core scanner analysis; discrete samples: sieving, X-ray diffraction, C and N analyses) and (2) reconstructing regional paleoenvironmental conditions through the analysis of molecular biomarkers.

First, for a short-term period at CEREGE (Aix-en-Provence), the student will be trained in sediment core study methods: lithostratigraphic description, construction of a composite core, subsampling, and preparation of discrete samples. He/she will take part in the continuous analysis of elemental composition by XRF, which makes it possible to identify geochemical ratios reflecting variations in detrital input, hydrodynamics, and sedimentary sources, and to characterize contrasting depositional episodes (*e.g.*, floods, droughts, reworking). He/she will also carry out sampling of the core for the analyses planned on this archive by the whole team (^{14}C dating, palynology, molecular biomarkers), including those they will not be directly responsible for.

Then, at LSCE, the student will be trained in molecular organic geochemistry: protocols for the extraction, separation, and analysis of biomarkers by chromatography and mass spectrometry (GC-FID, GC-MS, GC-IRMS). The work will focus on the distribution of *n*-alkyl lipids and fatty acids, whose chain lengths allow different plant sources and their temporal evolution to be distinguished. The $\delta^{13}\text{C}$ isotopic compositions of these compounds may also be studied to distinguish the contribution of C_3 and C_4 photosynthetic plants. Depending on their presence and state of preservation in the samples, complementary biomarkers may also be analyzed, such as pentacyclic triterpene methyl ethers (indicators of *Poaceae*) and acetates (indicators of *Asteraceae*), which are of particular interest with regard to the composition of the herbaceous vegetation present in this region.

Description of the desired profile

The student is enrolled at a university in a Master's 2 or equivalent, in Earth Sciences, Environmental Sciences, Chemistry, or a related discipline. Experience in or an aptitude for laboratory work is highly recommended. An interest in paleoenvironmental topics and human-environment interactions will be appreciated.

The student is expected to carry out a literature review, laboratory work, data interpretation and the writing of a Master's 2 thesis.