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Assessment of analytical procedures for elemental ratio calibration of benthic and planktonic foraminifera from the Arctic Ocean for paleoceanographic studies

SOPHIE SEPULCRE[1], RUIFANG MA[1,2], SOLÈNE POURTOUT[1], YU WANG[1], MERYEM MOJTAHID[3], ROSELLA PINNA-JAMME[1], FRÉDÉRIC HAURINE[1], ALEXIS DERYCKE[1], ANDRE POIRIER[4], LILA-EVE SABATIER[4], TIFFANY AUDET[4], JOSHUA H.F.L. DAVIES[5], MATTHIEU MOINGT[6] AND ANNE DE VERNAL[4]

[1]Université Paris Saclay, GEOPS, CNRS, UMR 8148
[2]State Key Laboratory of Cryospheric Science and Frozen Soil Engineering, Northwest Institute of Eco-Environment and Resources
[3]University of Angers
[4]Geotop - Université du Québec à Montréal
[5]Université du Québec à Montréal
[6]LAE-ISE, Université du Québec à Montréal

A key component of the climate system is the Atlantic Meridional Overturning Circulation (AMOC), which regulates heat redistribution and ocean–atmosphere gas exchange. Its northern branch connects the Arctic Ocean, Nordic Seas, and North Atlantic, where warm Atlantic waters flow northward, become denser, and return southward as deep waters. Despite extensive research, the evolution of this circulation, past Arctic Ocean chemical properties, and their implications for climate dynamics and atmospheric pCO_2 variability over glacial–interglacial timescales remain poorly constrained. Major limitations include scarce sediment archives, challenging chronologies, low sedimentation rates, and analytical difficulties linked to rare microfossils and poorly documented endemic species.

This project aims to establish new calibrations between elemental ratios (e.g., Mg/Ca, Sr/Ca, Cd/Ca, ...) measured in benthic and planktonic foraminifera from Arctic surface sediments and various environmental parameters (e.g., temperature, nutrient concentration, carbonate ion content, ...). These calibrations will then be applied to sediment cores for paleoceanographic reconstructions. In order to assess potential methodological biases, modern specimens of benthic foraminifer *Ammonia tepida* from the Bay of Biscay are analyzed using three techniques: (i) solution ICP-MS-HR (Thermo Element XR, GEOPS), (ii) laser ablation LA-HR-ICP-MS (Photon-Machines G2 coupled to a Nu AttoM, Geotop) and (iii) solution triple quadrupole ICP-MS (ICP-QQQ Agilent 8900, LAE-ISE).

Mg/Ca ratios obtained by methods (i) and (ii) are ~1.95 (±0.4, 1σ, n=48) and ~2.59 (±0.6, 1σ, n=115) $mmol \cdot mol^{-1}$, respectively, while Sr/Ca ratios are ~1.12 (±0.19, 1σ, n=48) and ~1.56 (±0.3, 1σ, n=115) $mmol \cdot mol^{-1}$. The ~0.5 $mmol \cdot mol^{-1}$ offset likely reflects the Cd-cleaning procedure applied prior to method (i), whereas no cleaning was conducted before LA. These results indicate that LA yields measurements comparable to solution analyses, enabling mono-specimen analyses in sedimentary archives. Additional analyses of *A. tepida* using method (iii) will validate measurements by ICP-QQQ.

The project will then focus on Arctic species, including planktonic *Neogloboquadrina pachyderma* and benthic *Oridorsalis tener* from a surface sediment core collected on the Lomonosov Ridge (PS87/030-3, 88°39.39'N, 61°25.55'W, 1278m). Calibrations will be applied to sediment cores E25 (78.573°N, 179.26°E, 1200m) and PS2185 (87.529°N, 144.166°E, 1073m) to reconstruct past Arctic environmental changes and improve the understanding of AMOC variability through time.