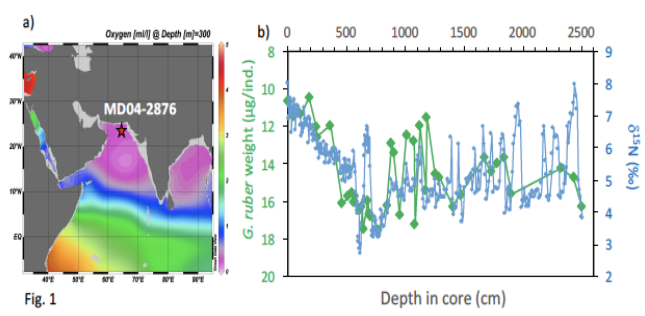
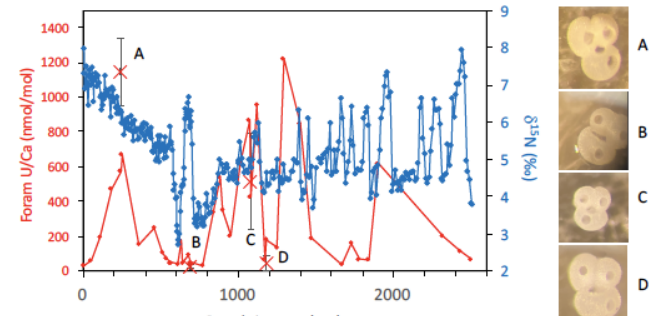


## FINAL REPORT PROGRAM LEFE

Program LEFE/ CYBER	Project Title	Years 2019-2021
	Authigenic uranium precipitates on foraminiferal tests to reconstruct water oxygenation conditions: studies on proxy behaviour (AURORE)	
PI: Kazuyo Tachikawa, Kazuyo@cerege.fr, CEREGE Participating Laboratories: IPGP, LSCE	Contribution to <i>IMAGES, CLIMOZA, ANR MedSens</i>	Other funding sources:
<p><u>Context:</u> Dissolved oxygen concentration (<math>O_2</math>) in the ocean reflects both biological productivity and ocean ventilation. On-going global warming has been leading to the extension of oxygen minimum zone (OMZ). Foraminiferal U/Ca has been proposed to trace past oxygenation state of bottom water, but the influence on test (shell) preservation state and the ability of the ratio to serve as a quantitative tracer should be examined.</p> <p><u>Objectives / scientific questions:</u> The objective of the AURORE project is to evaluate authigenic foraminiferal U/Ca as a proxy of bottom water oxygenation by applying bulk and single foraminiferal elemental analyses as well as individual test weighing to samples collected at a site characterised by strong bottom water <math>O_2</math> variations.</p> <p><u>Main results:</u> Planktonic foraminifer (<i>Globigerinoides ruber</i>) U/Ca ratio was analysed for core MD04-2876 inside of the present-day Oxygen Minimum Zone (OMZ) in the Arabian Sea (Fig. 1a). To monitor the influence of test preservation state on U/Ca ratio, individual foraminiferal weight (250-355 <math>\mu\text{m}</math> size fraction) was determined (Fig. 1b). The U/Ca ratio was measured with a conventional bulk calcite test analysis and laser ablation (LA)-ICP-MS technique on single foraminifer (three ablation spots/individual, Fig 2). Our results indicate that the U/Ca ratio obtained by bulk analysis ranged between 30 and 1200 nmol/mol with higher values when OMZ intensified as shown by higher bulk sediment <math>\delta^{15}\text{N}</math> values (Pichevin et al., 2008) (Fig. 2). This strong change cannot be explained by changes in test weight, of which the amplitude is much smaller (10 to 18 <math>\mu\text{g}/\text{ind.}</math>, Fig. 1). The general tendency of U/Ca values obtained by LA-ICP-MS is consistent with the bulk measurements (Fig. 2). All the results support the use of foraminiferal U/Ca as an indicator of bottom water oxygenation although its capacity as a quantitative indicator is questioned due to the large heterogeneity of intra- and inter-individuals (Fig. 2)</p>		
<div style="display: flex; justify-content: space-between;"> <div style="width: 48%;">  <p>Fig. 1</p> </div> <div style="width: 48%;">  <p>Fig. 2</p> </div> </div>		
<p>Fig.1 (a) Present-day <math>O_2</math> concentration at 300 m water depth in the Arabian Sea and the core location of MD04-2876 (24°50'57N, 64°00'49E, 828m water depth). The map created using Ocean Data View (Schlitzer,2015). (b) <i>G. ruber</i> individual test weight (green, this study) together with bulk sediment <math>\delta^{15}\text{N}</math> as an indicator of OMZ strength (Pichevin et al., 2007). Fig. 2. Comparison of bulk foraminiferal U/Ca (red dots with red solid line, this study) with U/Ca obtained by LA-ICP-MS (red crosses) and pictures of some analysed <i>G. ruber</i> with ablation spots (this study).</p>		
<p><u>Future of the project:</u> AURORE project allowed optimising bulk foraminiferal U/Ca analysis. The method has been used for CLIMOZA (IMAGO/LEFE, PI. L. Vidal) and ANR MedSens projects (PI. K. Tachikawa). The marked heterogeneity of foraminiferal U/Ca calls caution to use this proxy as a quantitative bottom water <math>O_2</math> indicator. Considering this point, foraminiferal U/Ca ratio should be better used by combining with other oxygenation</p>		

*indicators. I have been conducting combined measurements of foraminiferal U/Ca and I/Ca from the same samples benefitting the experiences acquired during AURORE project.*

*Number of publications, communications and theses (2 coming communications, 3 master internships)*

- Guarinos V., Tachikawa K., Vidal L., Garcia M., Minon N., Sonzogni C., Revel M., Schulz H., Sierro F J., 2023. Subsurface/intermediate and deep-water oxygenation states in Mediterranean Sea during the Holocene sapropel deposition inferred from planktonic foraminiferal I/Ca and U/Ca ratios, Goldschmidt 2023, Lyon, 9-14 July.
- Vidal L., Tachikawa K., Rossignol L., Pérez-Asensio, J., Caley T., Gerbaud O., Sonzogni C., Jorry S., Vazquez Riveiros N., Menviel L., 2023. Hydrological variability in the Agulhas current across Terminations I and II as inferred from geochemical multi-foraminiferal species in the Mozambique Channel: link with transient simulations, XXI INQUA Congress 2023, Roma, 14-20 July.
- Guarinos V., 2023. Perturbation hydrologique et oxygénation en Méditerranée durant les périodes chaudes du passé : cas du sapropèle S1. M2 STPE Géosciences de l'Environnement Aix-Marseille Université.
- Guarinos V., 2022. Perturbation hydrologique et sensibilité de la ventilation en Méditerranée orientale durant les périodes chaudes dans le passé : étude du dépôt de sapropèle S5. M1 STPE Géosciences de l'Environnement Aix-Marseille Université.
- Minon, N., 2022. Perturbation hydrologique et sensibilité de la ventilation en Méditerranée orientale durant le dépôt S1 de sapropel, M1 STPE Géosciences de l'Environnement Aix-Marseille Université.

*Data availability*

*Once the data are published, they will be deposited in open access repositories such as SEANOE.*

