ECOLE LEMANIQUE DES SCIENCES DE LA TERRE
DES UNIVERSITES DE GENEVE ET DE LAUSANNE

Master ès Sciences in Earth sciences

# Constraining formation conditions of cherts by coupling Cl and O isotope compositions

## Contact persons

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## Context

The reconstruction of past paleoenvironmental conditions at the Earth's surface is based on geochemical proxies, applied to sedimentary records. For nearly 50 years, the origin of the increase in oxygen isotope compositions ($\delta^{18}O$) observed in most of these archives since the Archean has been interpreted as resulting from either: (1) very high ocean temperatures (>60°C), (2) an increase in ocean $\delta^{18}O$ value, or (3) various degrees of re-crystallization during geological time. Siliceous cherts are considered less affected by diagenetic and metamorphic changes and thus one of the best-preserved records of past conditions. However, their formation in the sedimentary pile, at the interface between seawater and the underlying oceanic crust (e.g., Marin et al., 2010), remains poorly constrained and represents a caveat in the reconstruction of remote environments.

## Aims and Methods

This project proposes to better constrain the formation conditions (e.g., temperature, water/rock ratio, fluid composition) of present and ancient cherts by coupling, for the first time, the stable isotopes of oxygen and chlorine (major anion of seawater and sediment pore fluids). Investigations on rocks will be done at macroscopic (bulk analyses, with $\delta^{37}Cl$ measured at IPGP in Paris on gas-source mass spectrometry, e.g., Bonifacie et al., 2007) and microscopic (in-situ analyses by SIMS in Lausanne; e.g., Zakharov et al., 2023) scales on recent IODP oceanic drilling samples and some Archean cherts from our collection. Isotopic characterization of parent fluids will be done in pore fluids from recent oceanic sediments (recovered via IODP) and by analyzing fluid inclusions from ancient cherts. All these approaches will allow us to better decipher the origin of the macroscopic and microscopic variations of the $\delta^{18}O$ of cherts, by specifying what is the impact of the various lithologies on the diagenesis and the evolution of $\delta^{37}Cl$ and $\delta^{18}O$. After a bibliographic review of IODP sites with various lithologies, a sample request will be made to IODP. Potential measurements of Cl isotopes with the SwissSIMS are also possible.

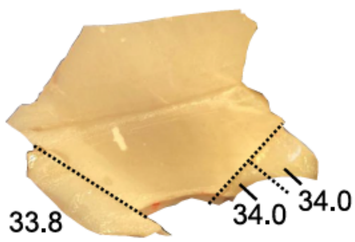
## References

**Bonifacie, M.**, C. Monnin, N. Jendrzejewski, P. Agrinier, M. Javoy (2007) Chlorine stable isotopic composition of basement fluids of the Eastern flank of the Juan de Fuca ridge (ODP Leg 168), *EPSL. 260, 1-2; 10-22*.

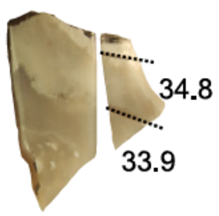
**Marin, J.,** Chaussidon, M., & Robert, F. (2010). Microscale oxygen isotope variations in 1.9 Ga Gunflint cherts: Assessments of diagenesis effects and implications for oceanic paleotemperature reconstructions. *Geochimica et Cosmochimica Acta*, *74*(1), 116–130. https://doi.org/10.1016/ j.gca.2009.09.016

Zakharov D. O, **Marin-Carbonne J.**, Pack A., , Di Rocco T., Robyr M., Vennemann T. (2023) In-Situ and Triple Oxygen Isotope Characterization of Seafloor Drilled Cherts: Marine Diagenesis and Its Bearing on Seawater Reconstructions, *Geochemistry, Geophysics, Geosystems*, *24*, e2022GC010741. https://doi. org/10.1029/2022GC010741

## Exemple of oceanic cherts




167-17-33-147-149
43 Ma, 605 mbsf
34.0‰ (KC04)




167-17-33-127-129
42.5 Ma, 605 mbsf
36.0‰ (KC04)

## Site web

https://www.researchgate.net/profile/Magali-Bonifacie

## Prerequiste

It will be important to have followed the following courses: Method of isotope analysis, Fluid in the crust, chemical analyse and imaging technics for major and trace elements

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