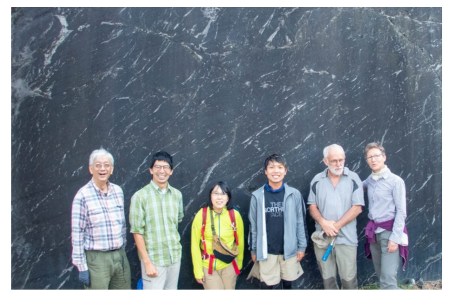
Fluid inclusions of ophicarbonate at the Piemont Zone, Western Alps, as a case of paleo oceanic core complex at slow-spreading ridges

OSPA Entry
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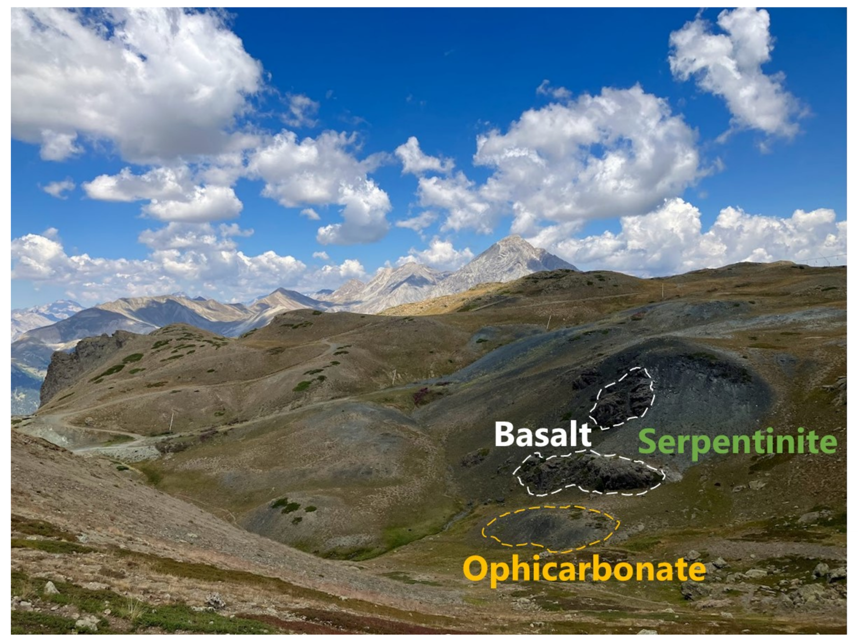
1. Introduction

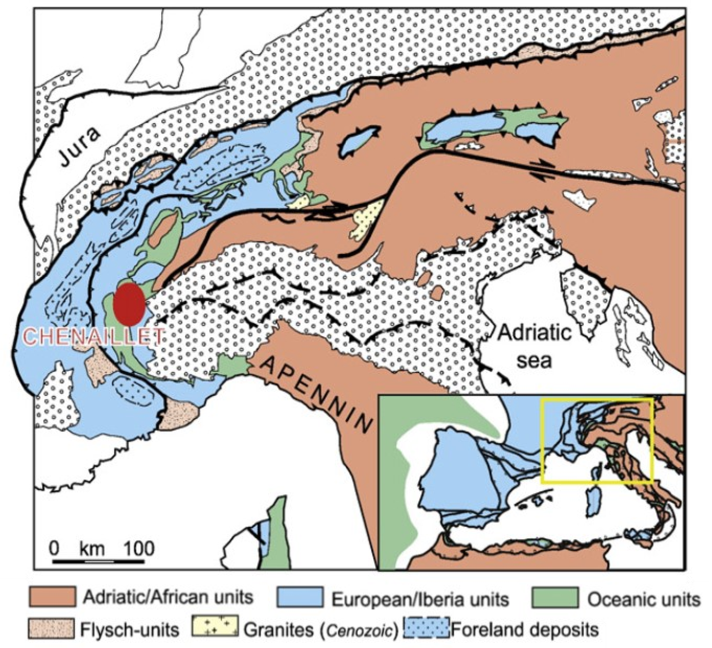
Carbonation of serpentinite
Contribution to the global carbon cycle (e. g. Alt et al., 2013, Lithos)
Relation to slow earthquakes (e. g. Okamoto et al., 2021, Commun. Earth Environ.)
Carbon capture and storage (e. g. Kelemen et al., 2011, Annu. Rev. Earth Planet. Sci.)

The oceanic core complex, where the mantle is exhumed at the seafloor, forms **carbonated serpentinite (ophicarbonate)**.

This study
Clarifies the chemical species, salinity and temperature of the fluid that forms ophicarbonate at the oceanic core complex

2. Sampling locality





Mantschal et al. (2010, Lithos)

The Piemont Zone is an oceanic unit containing **a paleo oceanic core complex** (Manatschal et al., 2010, Lithos). With a series of metamorphic grades, this unit is well suited to study chemical evolution in subduction zones. We sampled from two ophiolites; **Chenaillet** (**almost free of subduction metamorphism**) and **Lago Nero** (**metamorphism of green-schist facies**).

3. Methods

Field emission-scanning electron microscopy (FE-SEM)
microstructure observation and chemical analysis of thin sections

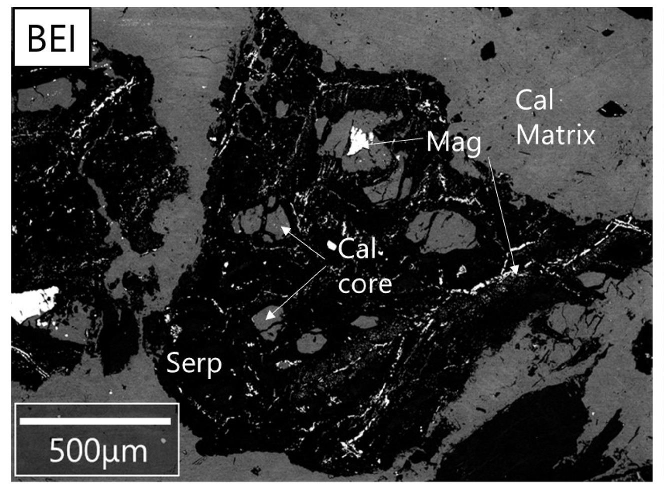
Raman microscopy
identification of mineral and chemical species in fluid inclusions

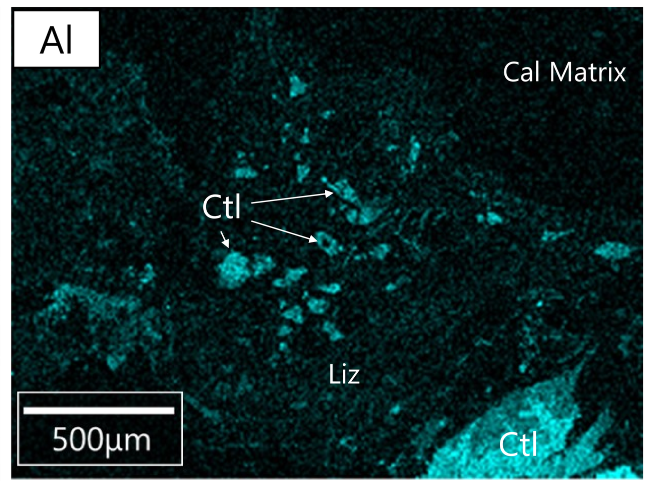
Heating and cooling stage
measuring salinity and homogenization temperature of fluid inclusions

4. Texture of ophicarbonate

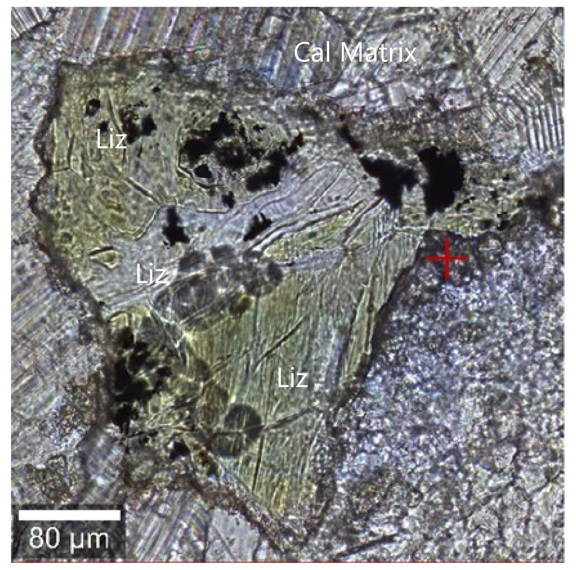
Chenaillet ophicarbonate

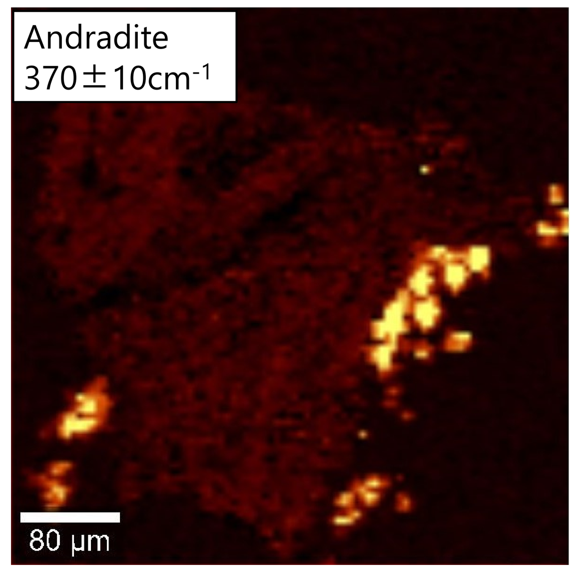
Serpentinite breccias are filled with calcite **matrix** and **veins**. Serpentinite is locally replaced by calcite **cores**.



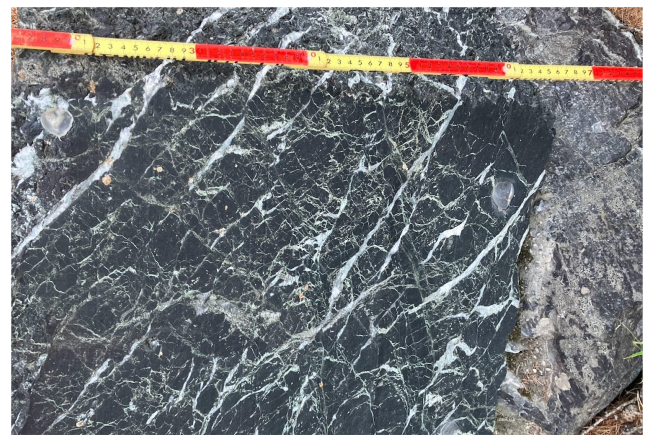


Lizardite contains **lower** concentrations of **Al** than **chrysotile**.





Andradite ($Ca_3(Fe^{3+},Ti)_2SiO_3O_{12}$) was locally observed in the calcite matrix. The presence of **Fe^{3+}** in andradite suggests that the fluids were **highly oxidized** (Cannaò et al., 2020 Chem. Geol.).

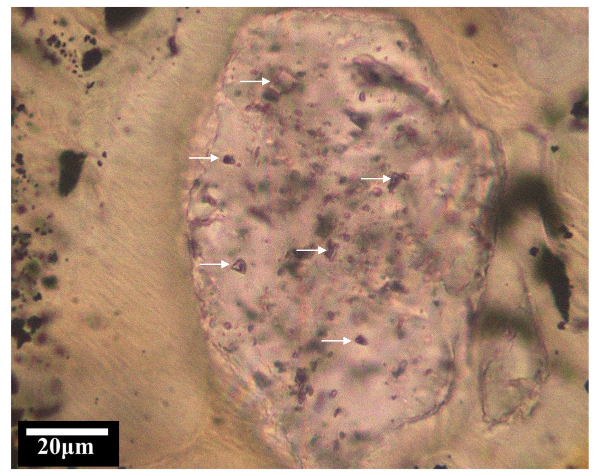


Lago Nero ophicarbonate

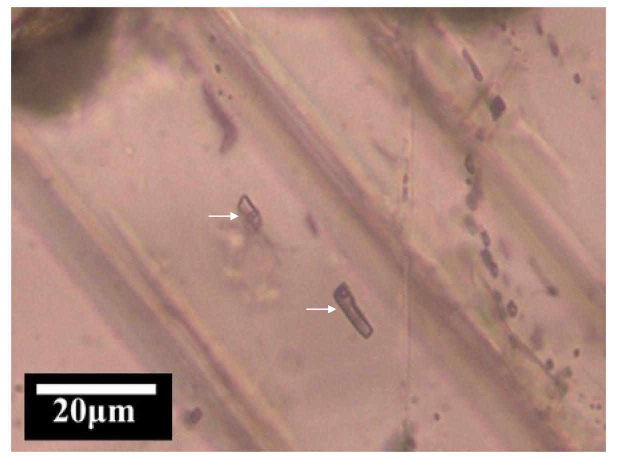
Branching calcite **veins** develop in the serpentinite.

5. Fluid inclusions analysis

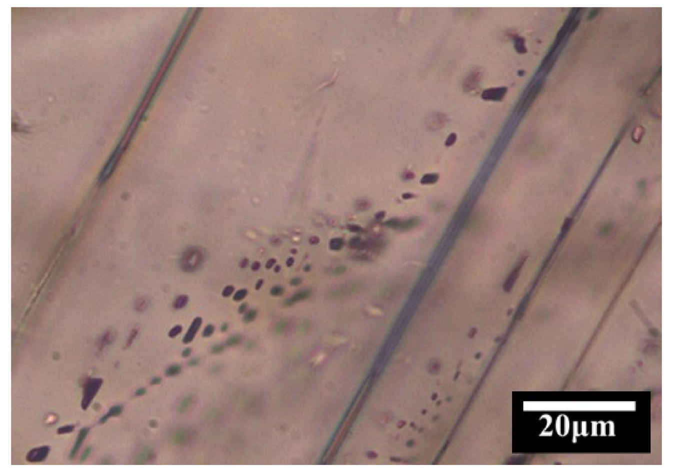
Calcite core (Chenaillet)



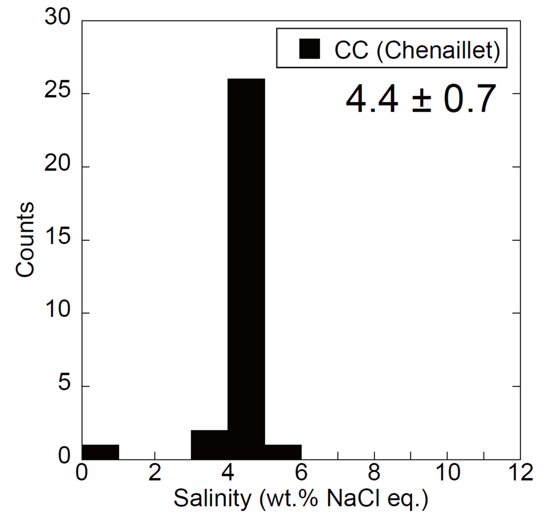
Matrix calcite (Chenaillet)

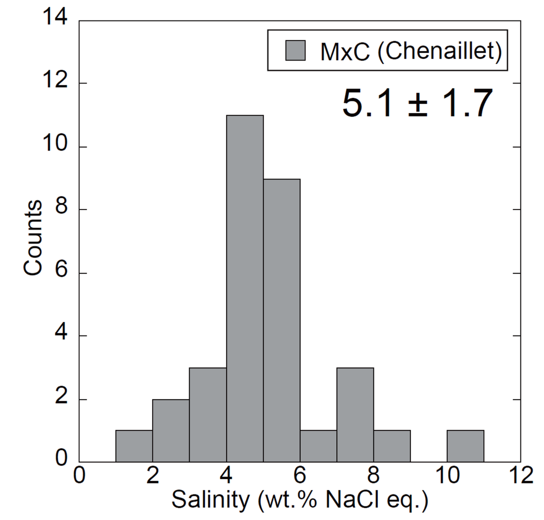


Calcite vein (Lago Nero)

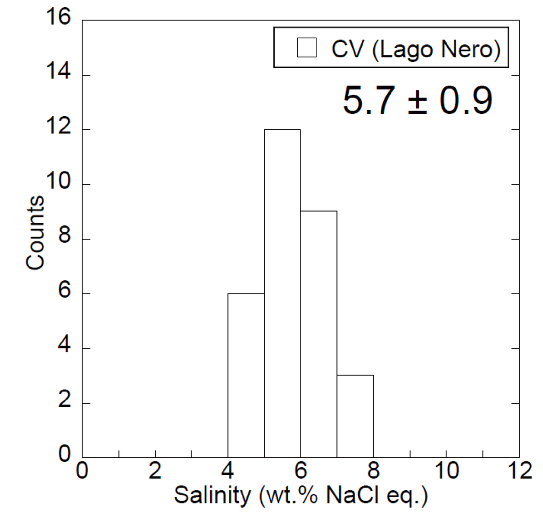


Salinity



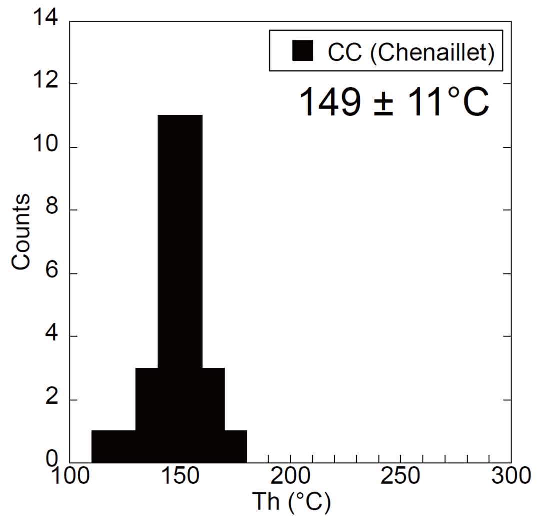


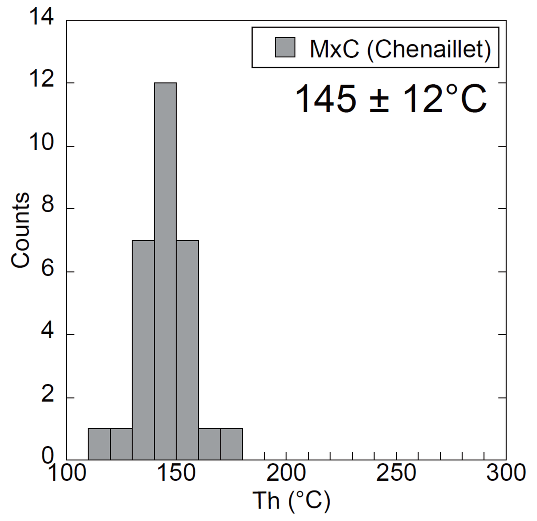
a wide range of 1-11wt.% NaCl eq.

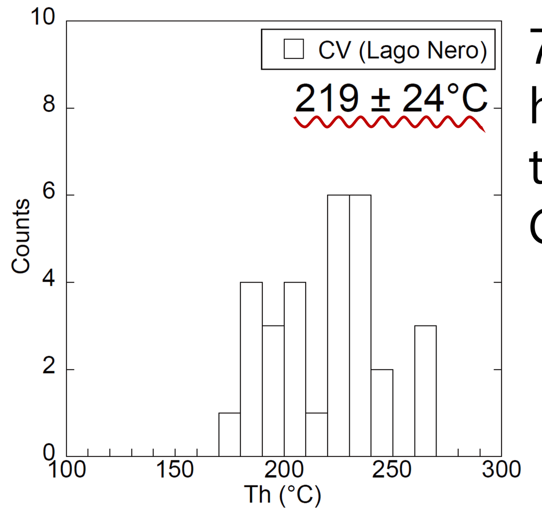


Higher than seawater

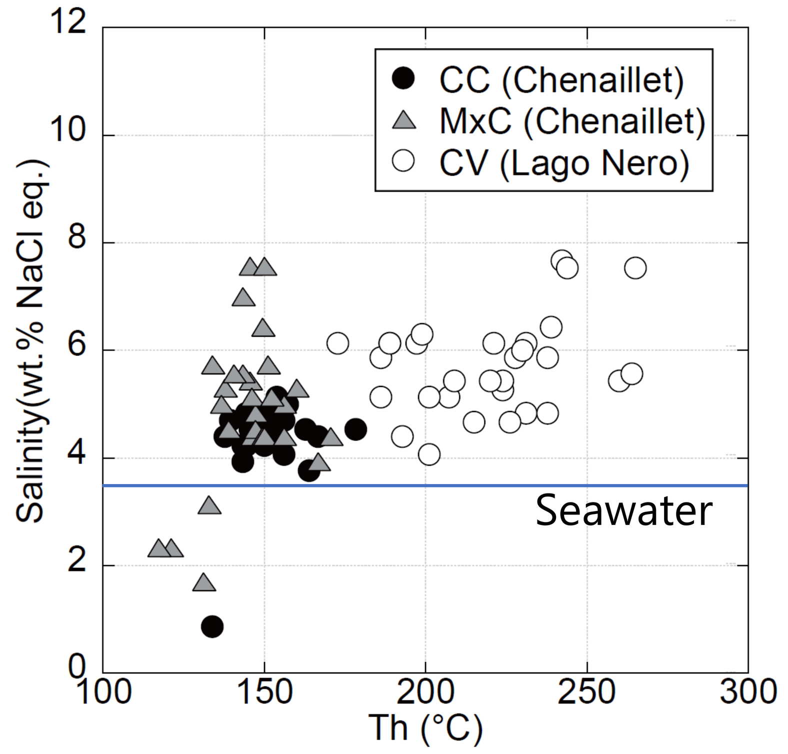
Homogenization temperature







70℃ higher than in Chenaillet



Chenaillet

Oxygen isotope thermometry assuming **seawater** as the fluid estimated **calcite cores at 130-160℃** and **matrix calcites at 155-170 ℃** (Lafay et al., 2017, Lithos). **Similar homogenization temperatures** indicate that these calcites were formed from **seawater.**

Carbon isotope results suggested that **calcite cores** were **formed with serpentinite** (Lafay et al., 2017). Fluid inclusions with **higher salinity** suggest that the calcite cores were formed by **fluids associated with serpentinization** (Debure et al., 2019, Sci. Rep.).

Matrix calcite was precipitated from seawater in the **hydrothermal circulation of the seafloor** (Lafay et al., 2017). **Depression and boiling** of seawater resulted in a **wide range of salinities** (Kelly & Delaney, 1987, Earth Planet. Sci. Lett.; Lafay et al., 2017).

Lago Nero

Differences in the homogenization temperatures of fluid inclusions between **Chenaillet and Lago Nero** samples may represent differences in **the subduction depths.**

6. Conclusion

Fluid inclusions suggest that the calcite core and matrix were formed during seawater interaction.

The temperature of carbonate formation can be related to subduction depths.

We will analyze samples from ophicarbonate associated with higher-grade metamorphic rocks.