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LiCORNE

# Geochemical characterization of geothermal reservoir rocks in the Upper Rhine Graben

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és géothermie

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# LiCORNE project

Lithium (Li) is a high-value metal which is fundamental to develop lithium-ion batteries used in electric vehicles and in general for the European energy transition…

**which is not currently industrially produced in Europe**

www.licorne-project.eu

**The LiCORNE project** → 15 companies and institutes that aims to establish the first-ever lithium (Li) supply chain in Europe


A variety of materials were sent to lab partners for technology investigation :

- Material from ore and concentrate
- Material from brines → és géothermie
- Material from off-specification cathodes

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# ÉS-Géothermie (ESG) operator of two geothermal plants in the Alsace region

## Soultz-sous-Forêts

1.7 MW electricity production
3 wells at ~5000 m
Discharge > 30 L/s ; Temperature ~ 150°C

## Rittershoffen

24 MW heat production capacity
2 wells at ~2600 m
Discharge > 70 L/s ; Temperature ~ 168°C


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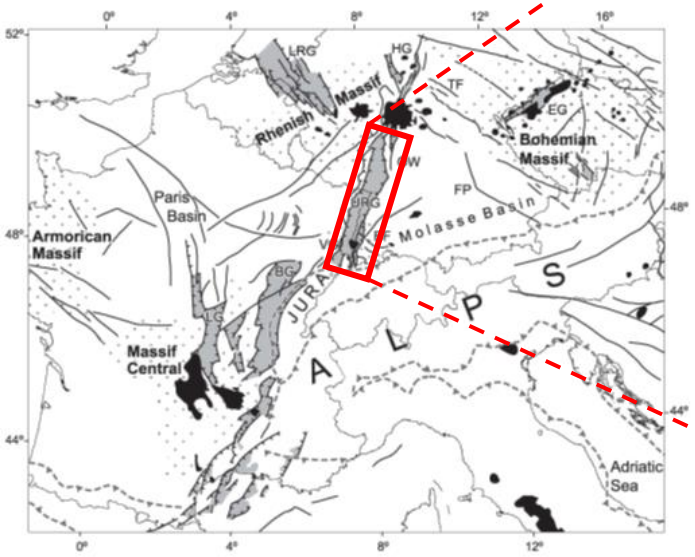
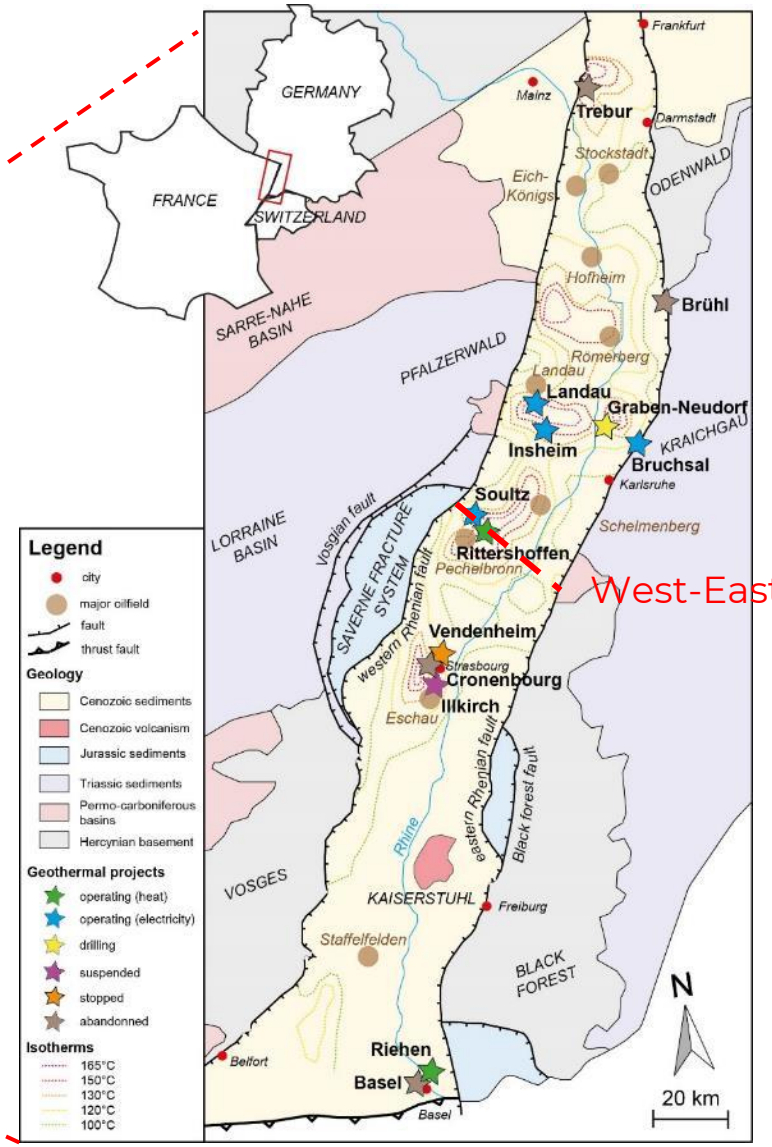
# Geological context of the Upper Rhine Graben

- 300 km long and 30-40 km wide
- From Basel (Switzerland) to Frankfurt (Germany)
- Formation started 35 M years ago
- Belongs to the European Cenozoic Rift System
- A series of geothermal anomalies with high geothermal gradients >100°C/km




**European Cenozoic Rift System (Dèzes et al., 2004)**




West-East Cross section

**Glaas, 2021**

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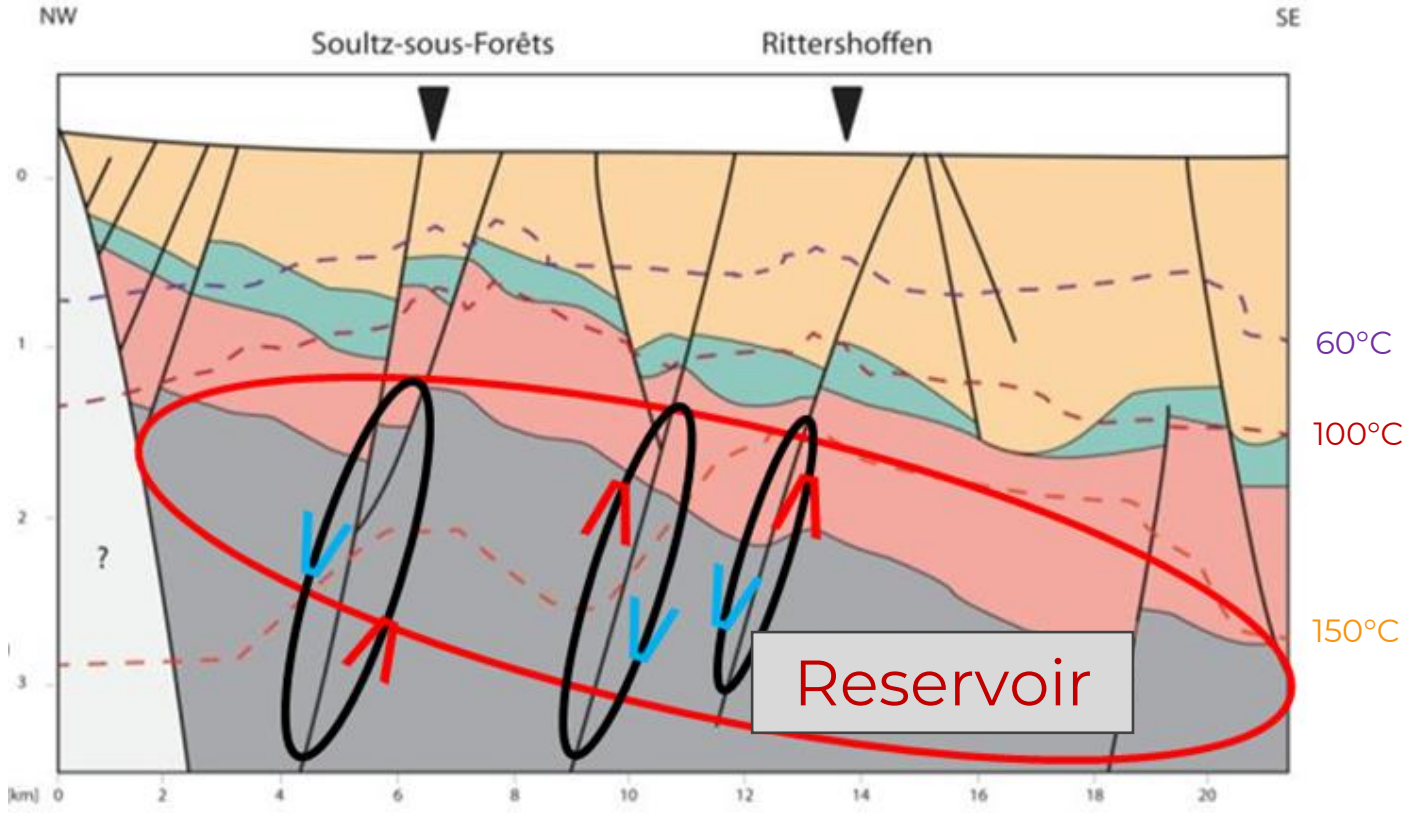
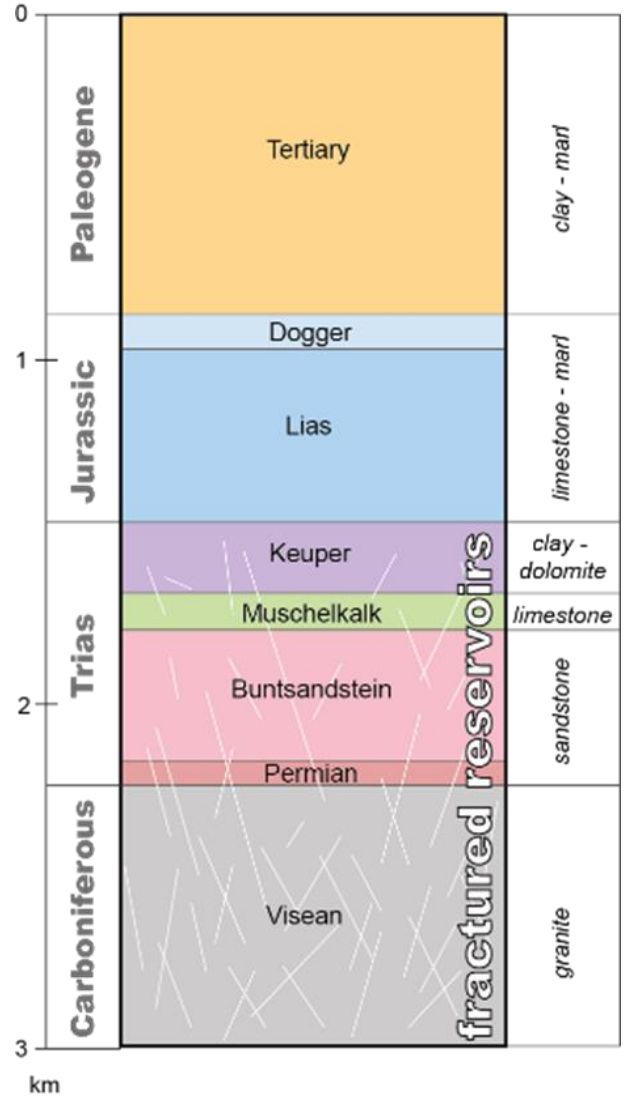
# Geological context of the Upper Rhine Graben

Fluid circulation in subvertical faults and fractures




Geothermal reservoir is mainly composed of limestone (Muschelkalk), sandstone and granite

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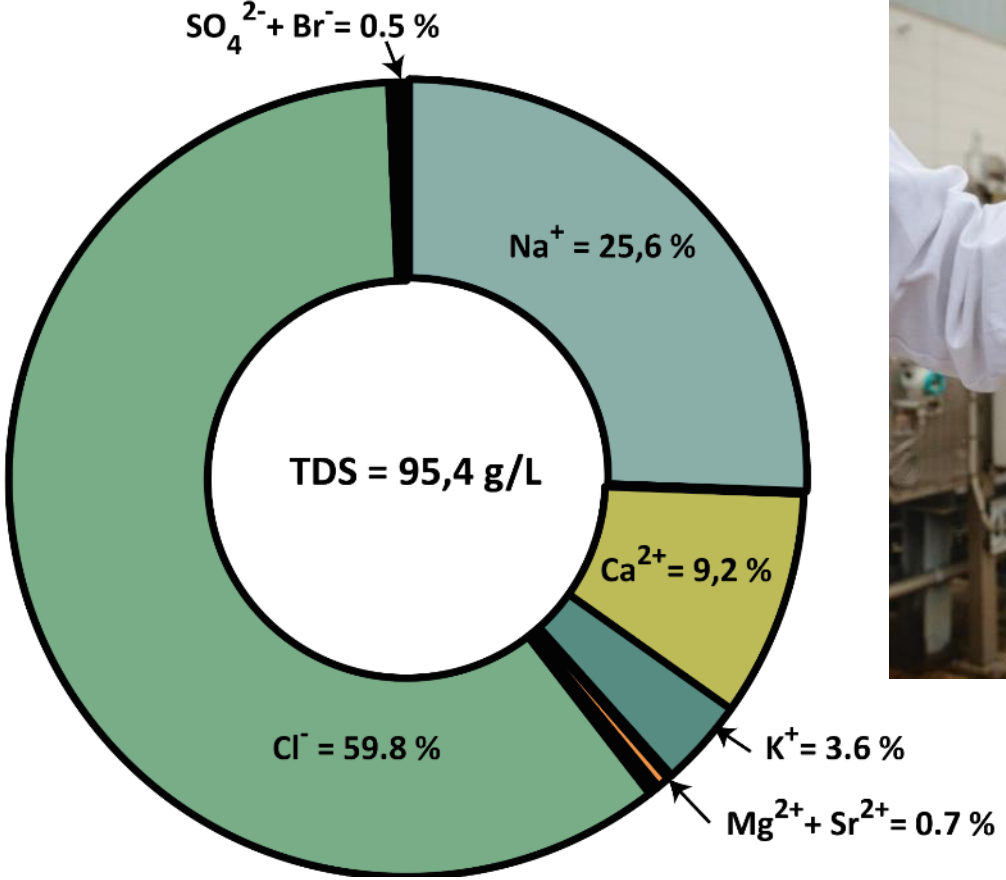
# Geothermal brine in the Upper Rhine Graben




Geothermal brine measurements at Soultz-sous-Forêts in 2024


Na-Ca-K-Cl brine, with minor and trace elements

Main dissolved gas: $CO_2$ and $N_2$

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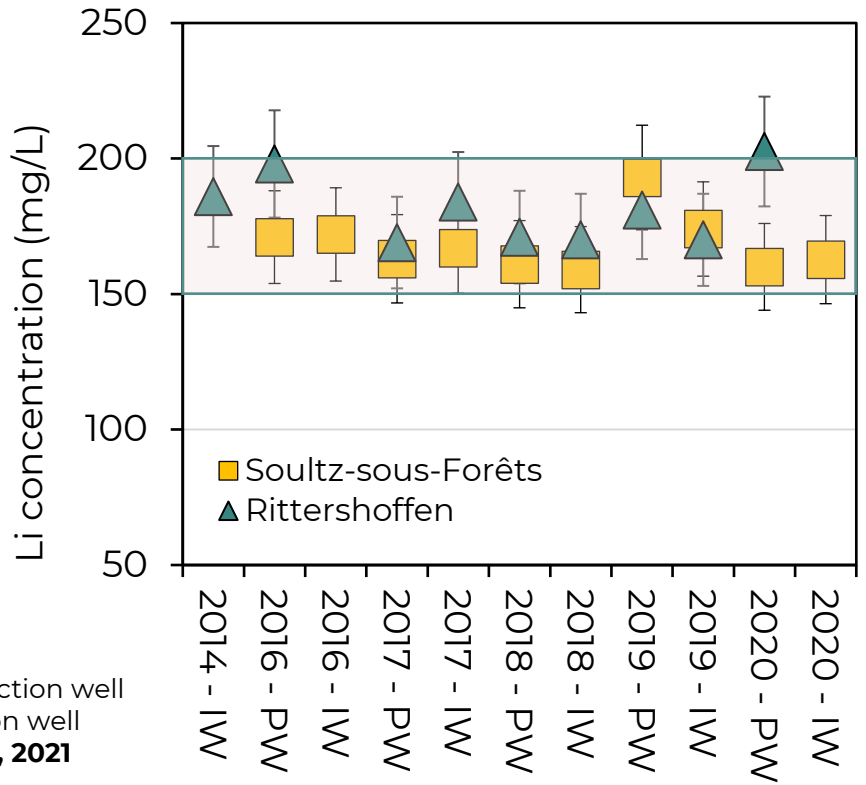
# Lithium: a potential co-product of geothermal energy in the Upper Rhine Graben ?

The Upper Rhine Graben (URG) has a great potential for a lithium (Li) production from geothermal brines due to its high concentration and the significant water flows exploited by the geothermal power plants in this area :




PW : Production well
IW : Injection well
**Bosia et al., 2021**

Between **150 et 200 mg/L** of Li in geothermal brine at Soultz-sous-Forêts and Rittershoffen (geothermal plants operated by ESG) with a discharge of **30 to 75 L/s**

Li extraction from geothermal brine during production is feasible (EuGeLi, Fries et al., 2022)

**What is the origin of these concentration in the geothermal water?**
**From which geological formation Li in the brine comes from ?**

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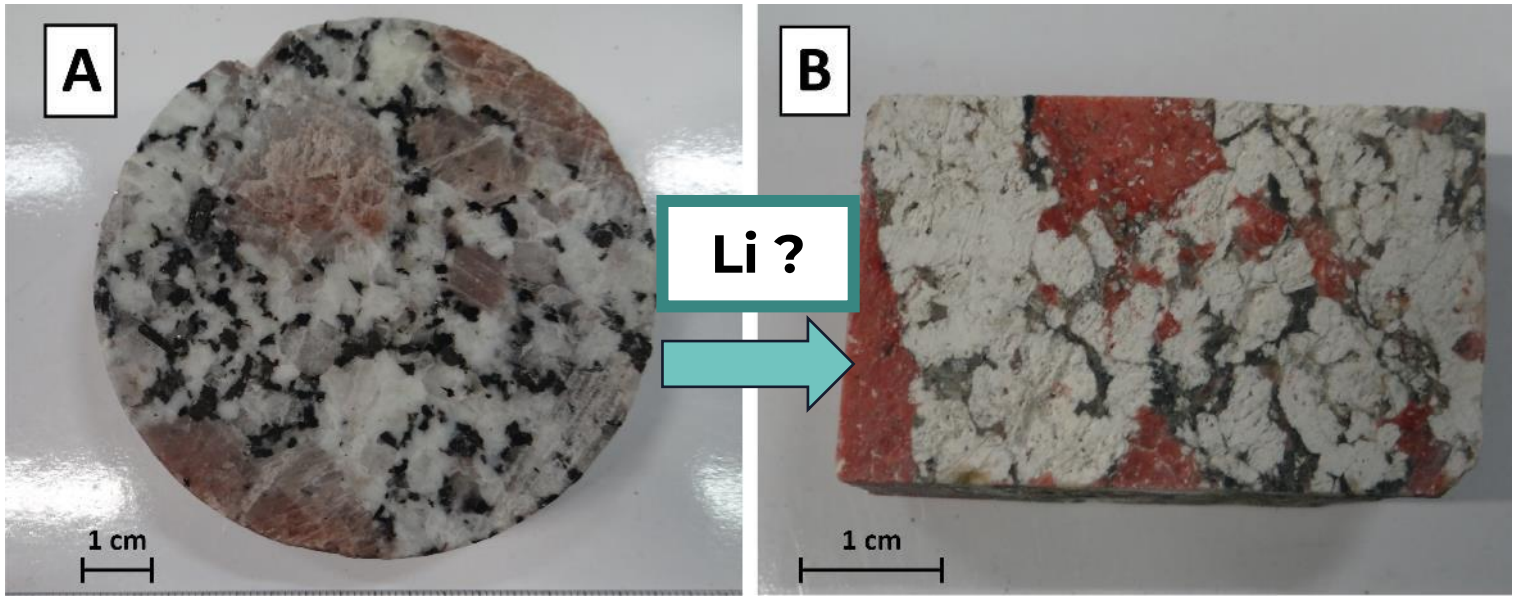
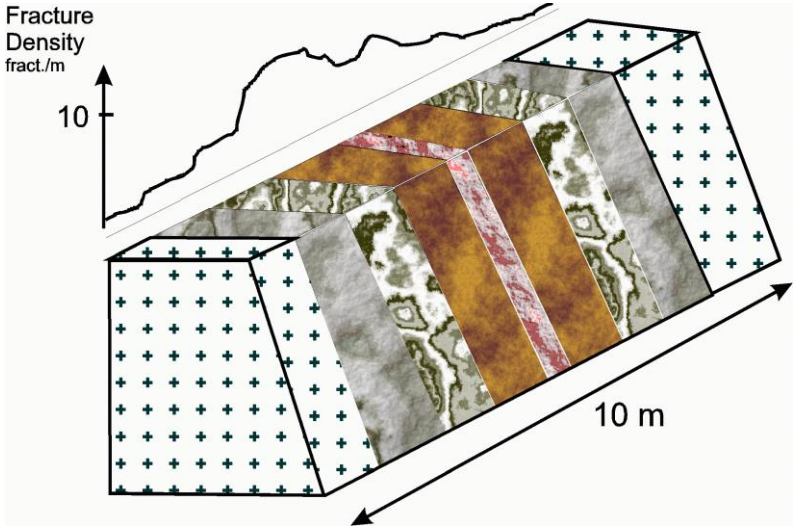
# Hydrothermally altered granite

## Focus on 34 granite samples




***Genter et al., 2000***

**<u>Primary Minerals</u>**
Quartz
Potassic Feldspar
Biotite
Plagioclase

**<u>Secondary Minerals</u>**
Chlorite
Illite
Carbonates
Secondary Quartz

What is happening during fluid/rock interactions?

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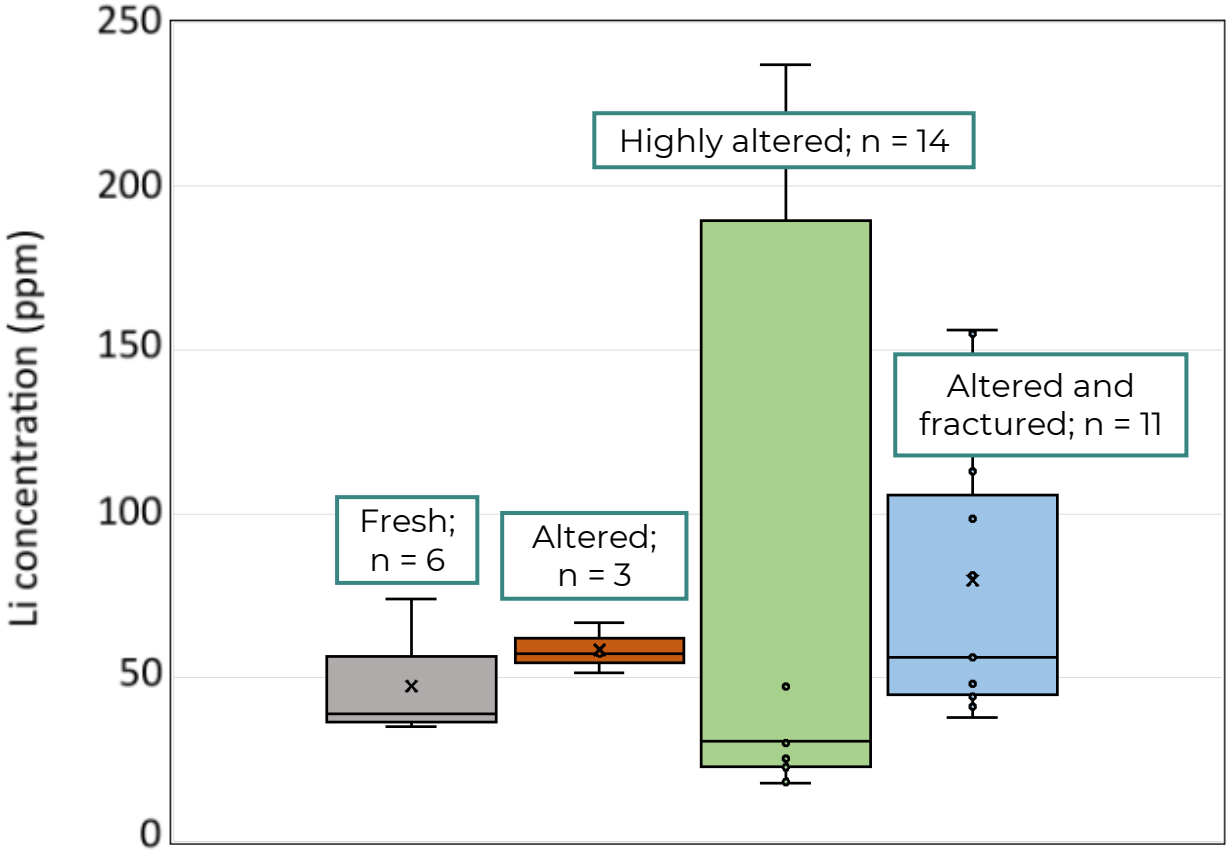
# Lithium in the granite

Li concentrations of the total rocks range from 18 to 1938 ppm.

1. Fresh (average 47 ppm)
2. Altered (average 58 ppm)
3. Altered and fractured (80 ppm)
4. Highly altered (318 ppm)

**In average, Li concentration increases in altered rocks**

**However, this is not representative of most of the highly altered samples that have a lower median compared to the fresh granite samples**

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# Conclusions

- Measurements of Li in deep rocks are rare but necessary to understand the origin of Li in the brine
- Granite chemical composition at Soultz-sous-Forêts is strongly dependent of the alteration facies
- Leaching of Li during hydrothermal alteration is also associated with precipitation of Li in secondary quartz veins and rare tosudite minerals

# Future works

- Sedimentary rocks are also part of the reservoir of Soultz-sous-Forêts. Their chemical composition will be investigated together with Li concentration
- Li and Sr isotope analyses are on-going to provide additional clues of the Li origin in the brine

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# Geochemical analyses of deep rocks from geothermal wells in the Upper Rhine Graben

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## Thank you

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