

Exam format and important dates

26 November 2025, 14h:

Groups of 3, picked at random.

Each group will be given 1 scientific article (approx. 15 pages long) on one of the key topics of the course.

3 December 2025:

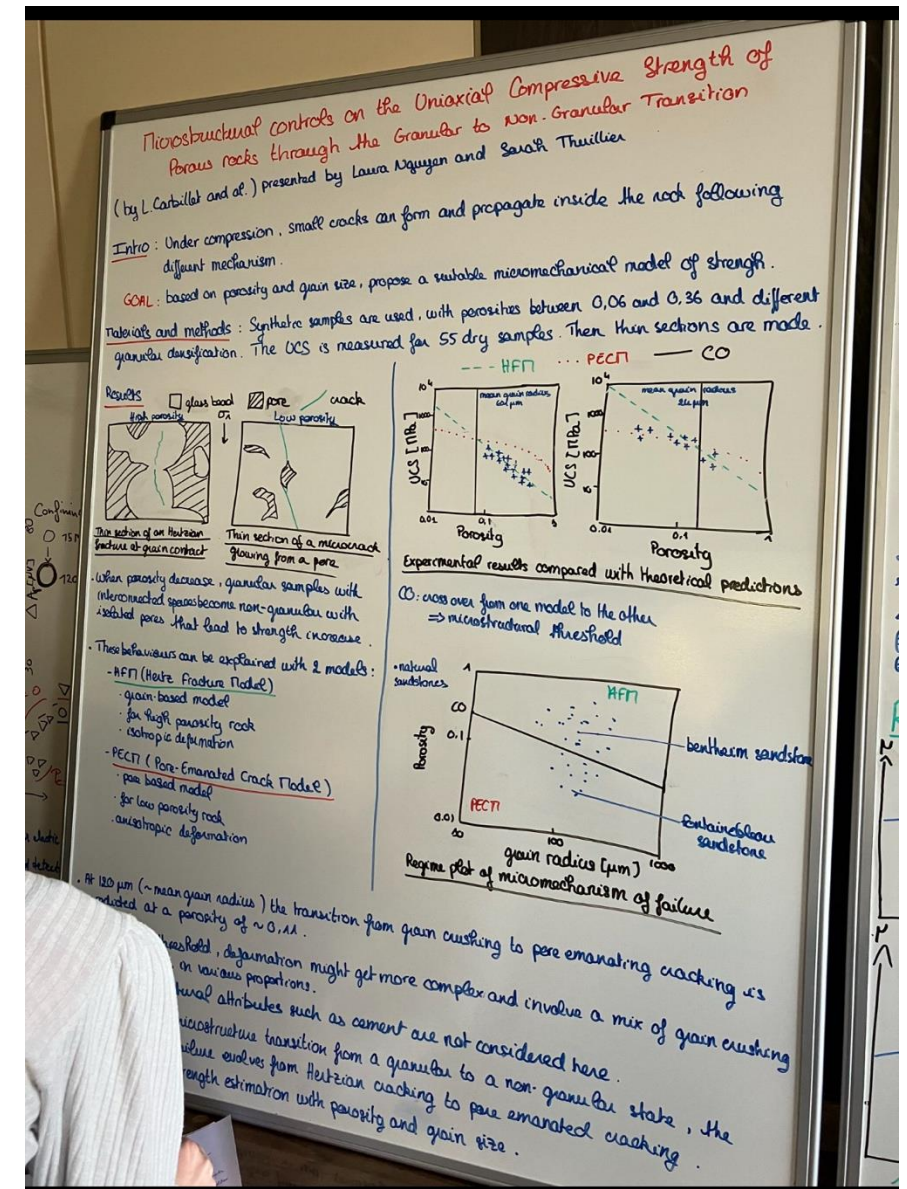
Group preparation.

10 December 2025:

Each group will make a poster summary of the article on a whiteboard.

17 December 2025:

Each group presents their poster to the whole class: 10 minutes presentation, 5-10 minutes questions.



Evaluation

Part 1: Whiteboard poster

The poster must adequately summarise the scientific article, without needing someone to explain it to the reader.

Your poster must include:

Title

Study authors' names

Introduction

Methods

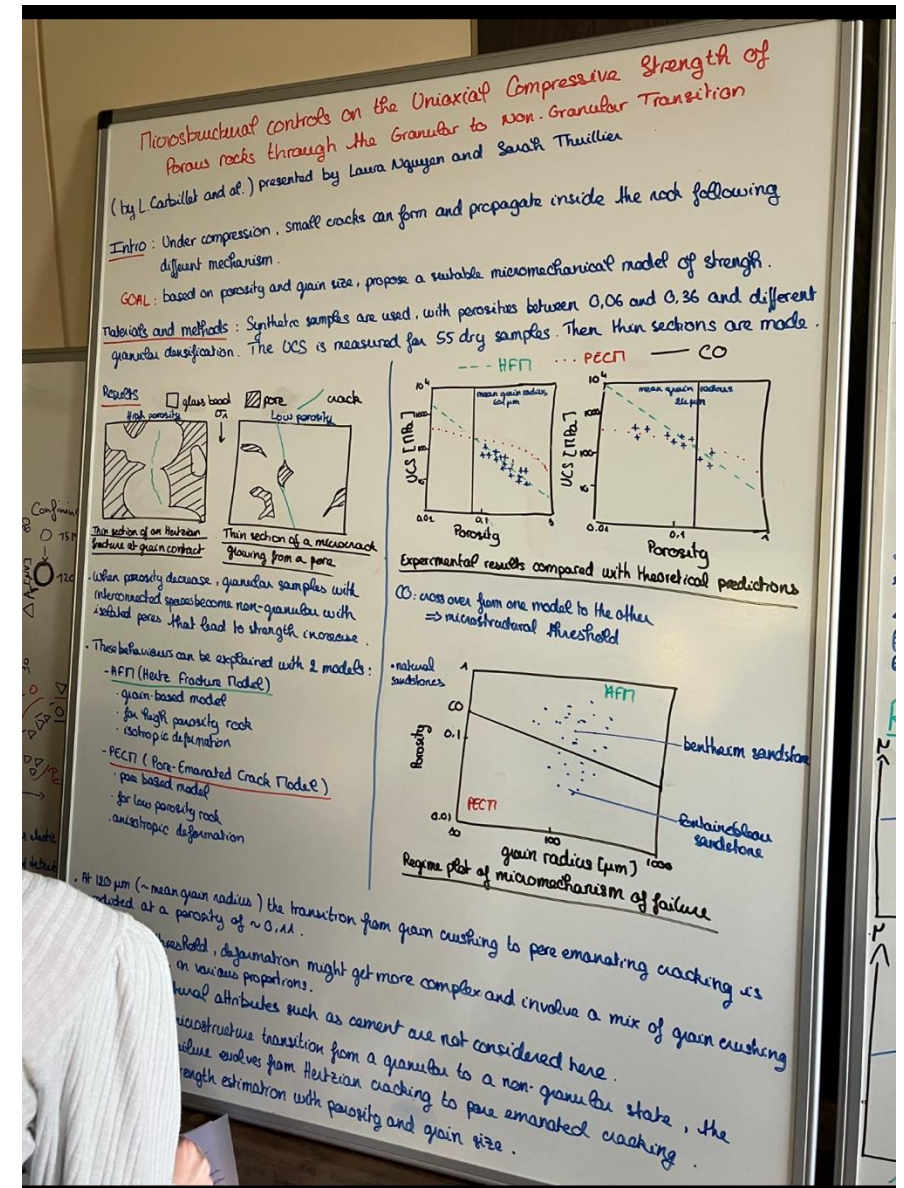
Results

Discussion

Conclusions

Visual elements (the poster cannot just be words!)

You will need to make decisions about what elements to talk about!



Reading scientific articles

Abstract: Summary of paper, presenting: motivation, methods used, key results, and conclusions.

Introduction: Context and motivation for the study.

Methods: Complete description of the methodological approach used by the study.

Results: Scientific observations, without interpretation.

Discussion: Interpretation of results and framing within the larger context of the literature.

Conclusions: Summary of the main study findings.

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CHEMICAL GEOLOGY

Major geochemical characteristics of geothermal brines from the Upper Rhine Graben granitic basement with constraints on temperature and circulation

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Triassic
Oligocene
Fluid circulation

ABSTRACT

This paper is the first to present the main geochemical characteristics of the native brines collected from all the geothermal wells penetrating the granite basement underlying the sedimentary cover, in the Upper Rhine Graben. These deep wells (from 2580 to 5000 m) were only drilled in four geothermal sites (Soutz-sous-Forêts and Rittershoffen in France; Landau and Inenheim in Germany). The Na-Cl geothermal brine samples collected from the granite returned TDS values ranging from 99 to 107 g/l with pH values close to 5, along with Cl and Br concentrations and δD , $\delta^{18}\text{O}$ and $\delta^{34}\text{S}$ values that indicate a multiple origin with mixing between primary brine formed by advanced evaporation of seawater (probably until the stage of halite precipitation) and dilute meteoric water, plus contributions from halite dissolution following successive marine transgression-regression cycles from the Triassic to the Oligocene. Chemical, isotopic and gas geothermometers indicate concordant reservoir temperatures close to $225 \pm 25^\circ\text{C}$ for all the fluids, even though the maximum temperature so far measured on site is 200°C . An exhaustive literature review has indicated that only the geothermal brine from the deep Cronenberg well (2870 m) ending in the Buntsandstein has similar chemical and isotopic compositions (apart from Br and Ca) to the fluids from the granite, with an identical estimation of reservoir temperature from geothermometry. Geothermal brine from the deep Bruchsal well (2540 m), drilled down to the junction of the Buntsandstein and the Saxo-Thuringian formations, has a higher TDS value ($120\text{--}125\text{ g/l}$) with its chemical and isotopic compositions giving a lower estimation of reservoir temperature ($190 \pm 25^\circ\text{C}$). By contrast, geothermal brine from the Bühl well (2655 m) ending in the Buntsandstein has an even higher TDS value of about 201 g/l and a lower temperature-at-depth estimation of $110 \pm 25^\circ\text{C}$, close to the temperature measured on site (115°C). The above results indicate that the geothermal fluids collected from the granite probably originate from Triassic sedimentary formations located at great depth ($\geq 4\text{ km}$) with temperatures close to $225 \pm 25^\circ\text{C}$ in the centre of the Rhine Graben, but that their different TDS and Cl/Br values reflect the presence of several distinct geothermal reservoirs. Many discrepancies due to high-temperature water-rock interactions are revealed on comparing the chemical and isotopic compositions of the hot brines with those of cooler brines from Bühl and the Landau Eocene-Oligocene oilfield wells, among others. The hottest brines are much enriched in K, Ca, SiO_2 , Li, Rb, Cs, As, Sr, Ba, Mn, Nd, U and in metals such as Zn, Pb, Cu, Co, Cd, Sb, but are depleted mainly in Mg, SO_4 and B and have much lower isotopic Li and B signatures. The He isotopic signatures of the gases associated with these fluids ($R/R_{\text{atm}} = 0.128$ at Bruchsal and 0.252 at Inenheim) confirm that the thermal anomalies are mainly crustal and not mantle-derived (1.46% and 2.88% of mantle He, respectively, for the two sites). Thus it is concluded that the thermal anomalies are associated mainly with the convective circulation of hot fluids along probable NE-SW faults between the graben's deep sedimentary centre and the fractured granite basement at its edges. Moreover, the western part of the Upper Rhine Graben (the Landau, Inenheim, Soutz, Rittershoffen and Cronenberg sites) seems to be hotter than the eastern part (Bruchsal and Bühl). According to the U-Th isotope system, the minimum transit time of these deep geothermal brines would be about 1000 years.

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1. Introduction

Several geothermal projects are in hand in the Upper Rhine Graben to develop the hot fluids ($>160^\circ\text{C}$) circulating in the deep parts of the

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Reading scientific articles

One way to read a scientific article for the first time:

Abstract: Overview of the study

Introduction: Context for the study.

Conclusions: Main take-home points

Results: Scientific data produced by the study

Discussion: Importance of the study

Methods: How the study was conducted


All parts of the study are important, but how you read an article depends on what information you need to glean from it.

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