



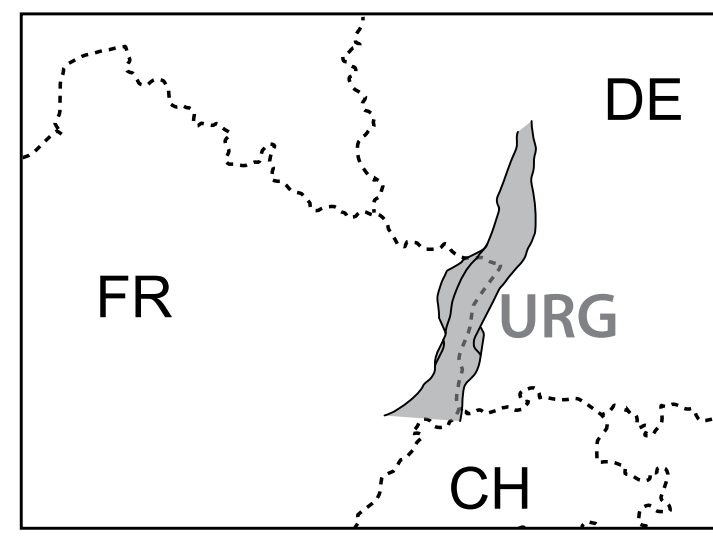
# PETROLEUM SYSTEM STRATEGY APPLIED TO GEOTHERMAL FIELDS: THE CASE OF THE PECHELBRONN SUB-BASIN (FRANCE)

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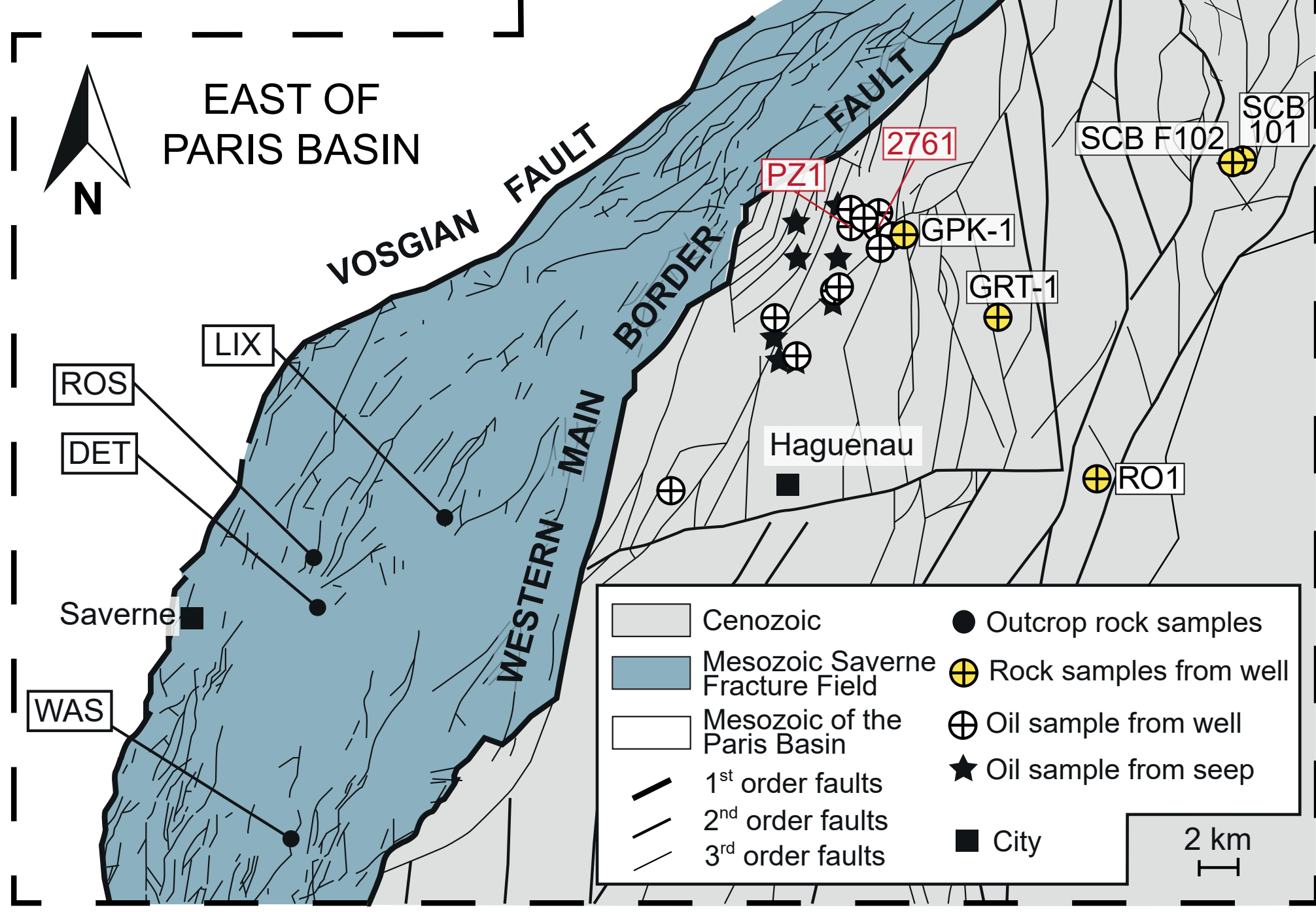
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Climate change has become a major global concern. To address this issue, it is essential to adopt an integrated approach to the exploration, exploitation and usage of geological reservoirs as energy sources and underground storage. In this context, the Upper Rhine Graben (URG) is a prime target in Europe for geothermal energy projects and the co-exploitation of lithium bearing geothermal brines, due to its high geothermal gradients and reservoirs with favorable hydraulic properties. However, exploring the Upper Rhine Graben raises challenges due to its geological complexity and coexisting petroleum and geothermal systems. Reservoir characterization and fluid dynamics are governed by basin thermal and burial histories which also influence organic matter evolution. Integrating organic geochemistry into basin reconstruction enhances understanding of burial, thermal, fluid generation and migration histories. This study aims to reconstruct the evolution of the Pechelbronn sub-basin by considering hydrocarbon fluids, their sources, genetic relationships, alterations and key moments in their evolution. Integrating organic geochemistry into 1D and 2D basin thermal modeling constrained by the geological history of the URG allows to reconstruct thermal and burial histories and propose an evolving scenario for hydrothermal and hydrocarbon fluid circulation by conceptual 3D blocks.

## Geological background and sampling

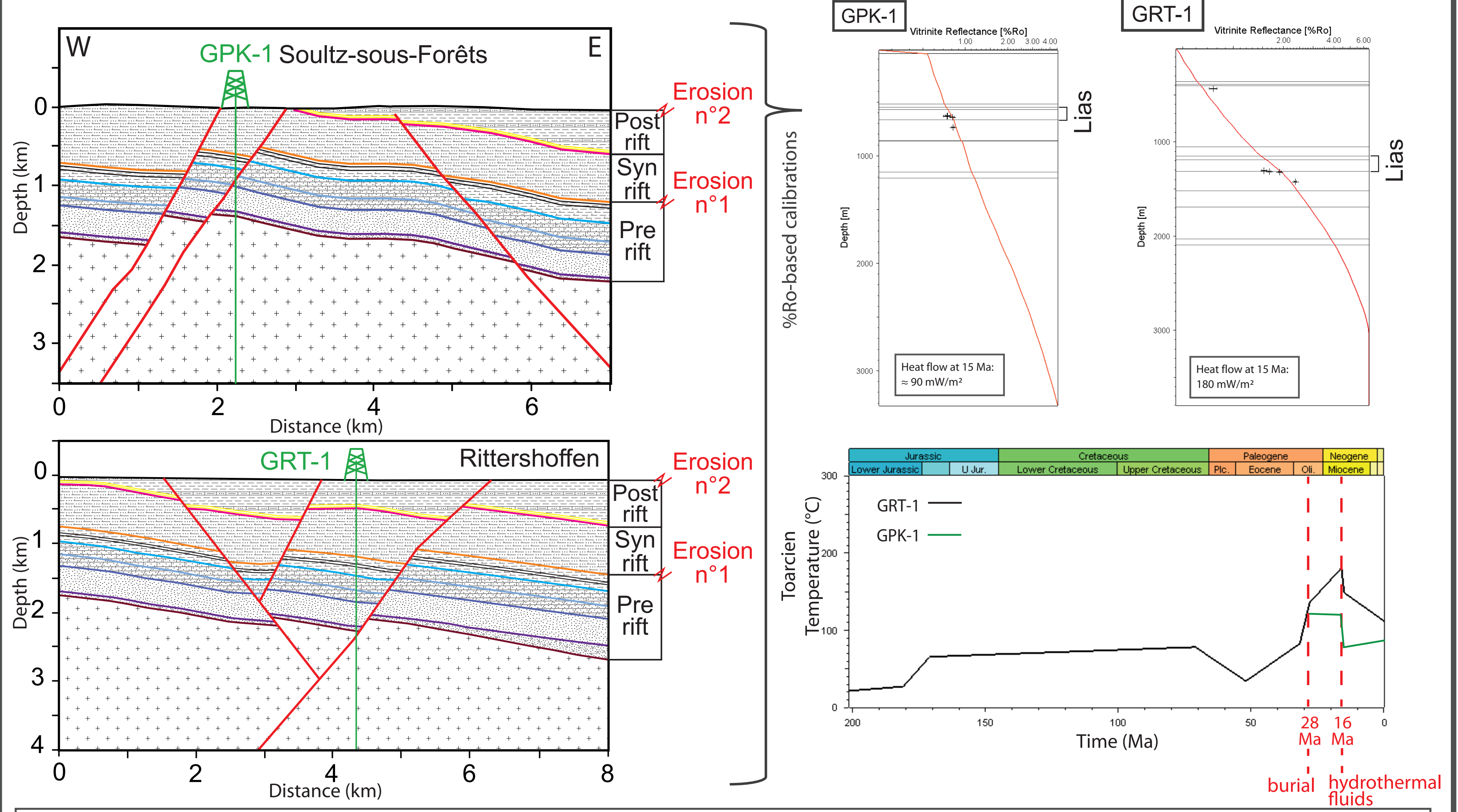


The Upper Rhine Graben (URG) is a Cenozoic intra-continental rift, partly located in France (FR), Germany (DE) and Switzerland (CH). The Pechelbronn sub-basin (central western part of the URG) hosts oil and geothermal fields (e.g. at geothermal wells GPK-1 and GRT-1). The Saverne Fracture Field corresponds to the URG's pre-rift analogue.

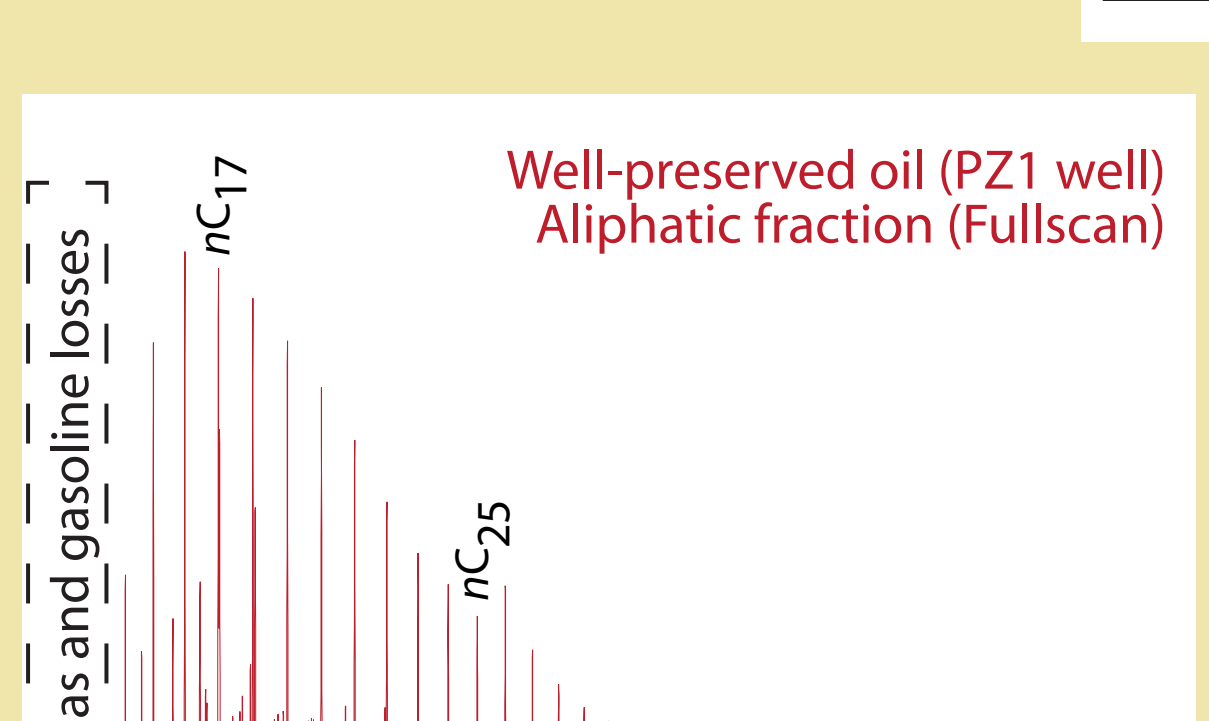
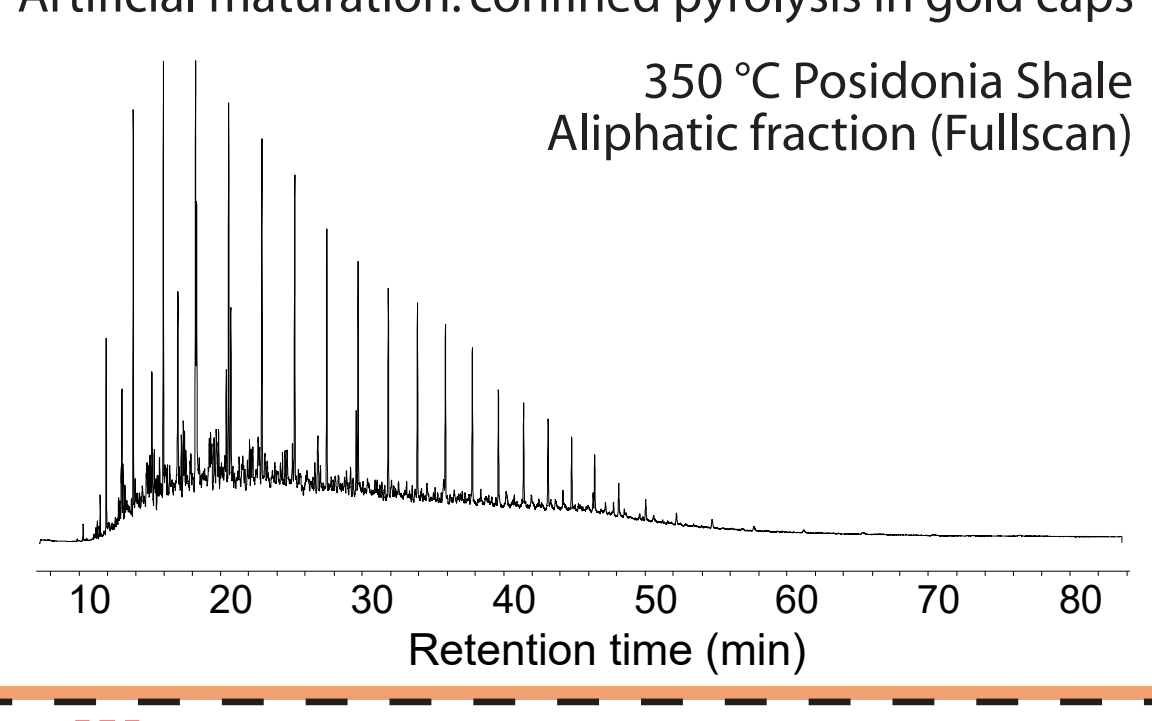
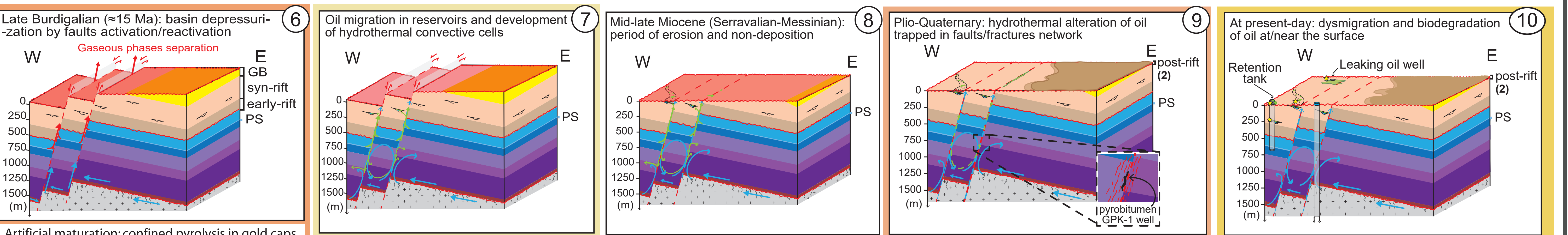
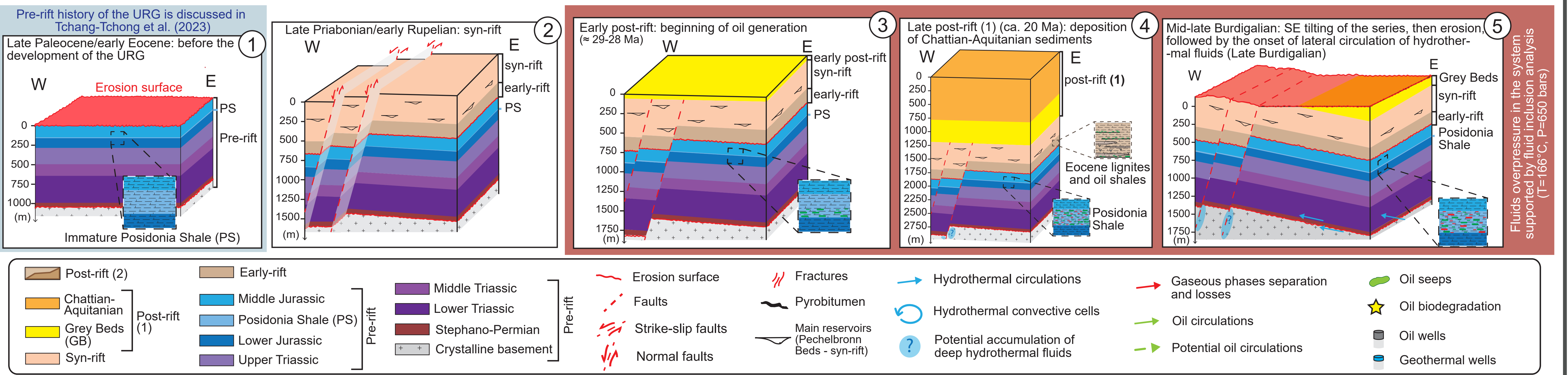


The quarries of: LIX: Lixhausen; ROS: Rosenwiller; DET: Dettwiller; WAS: Wasselonne.

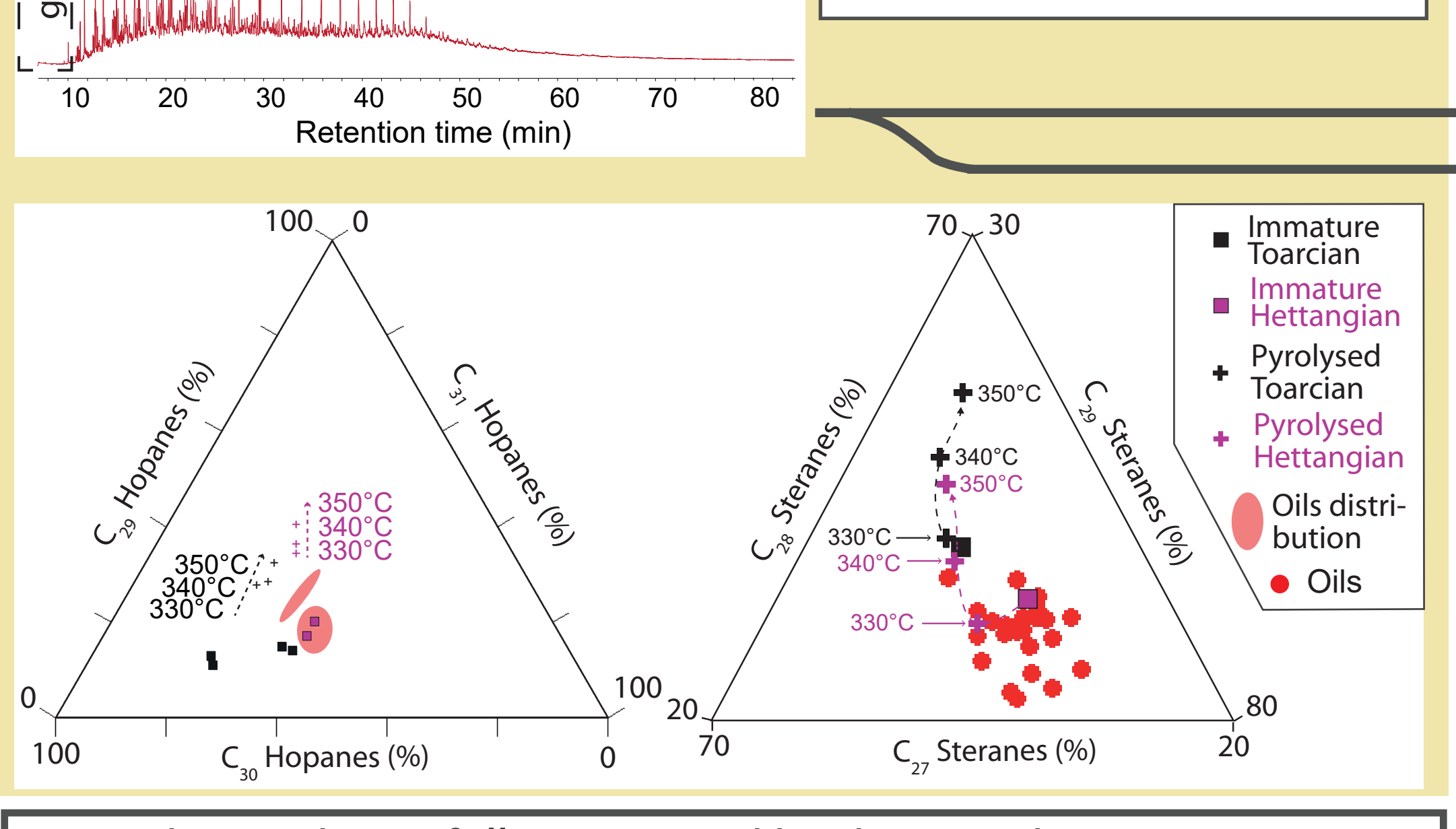
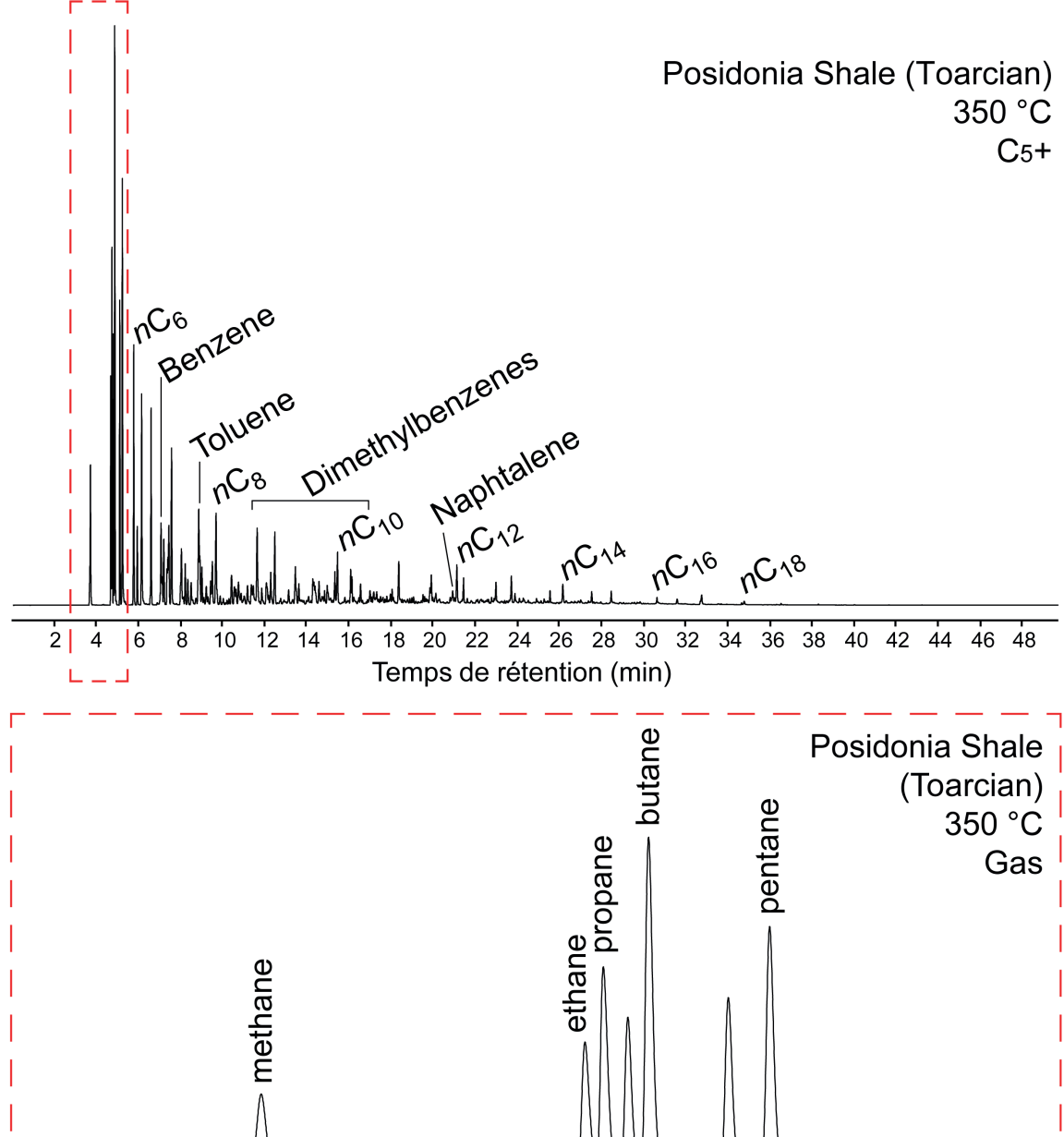
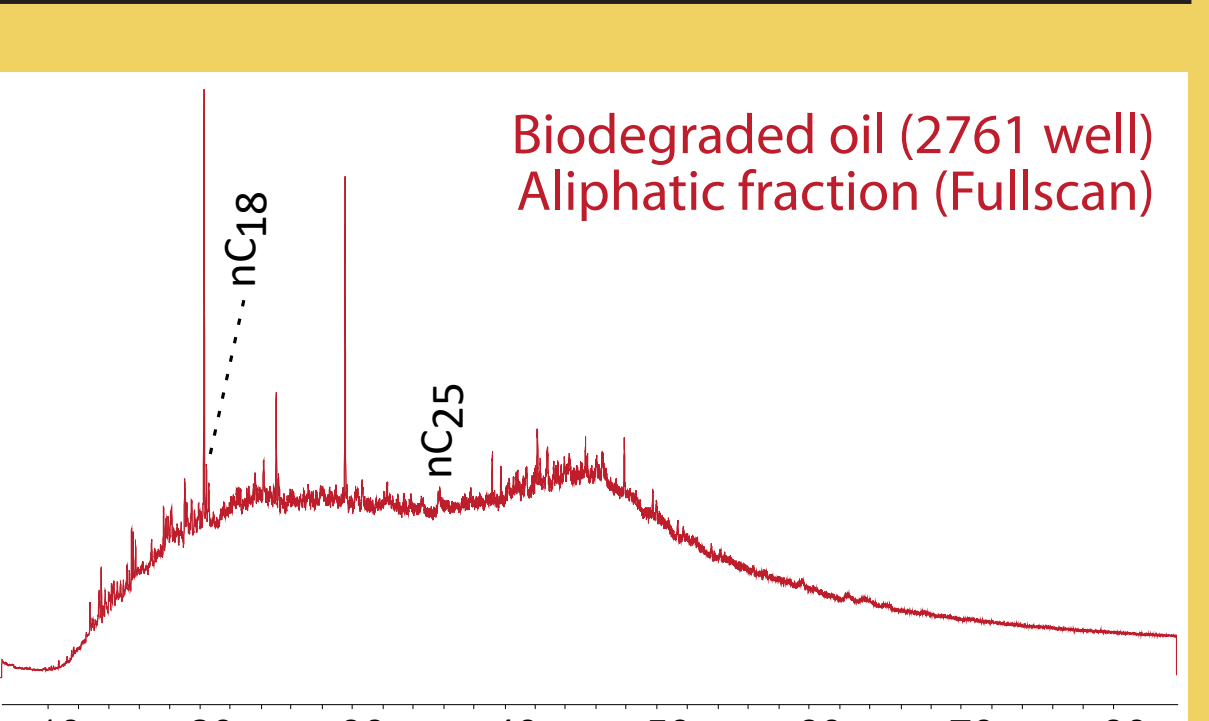
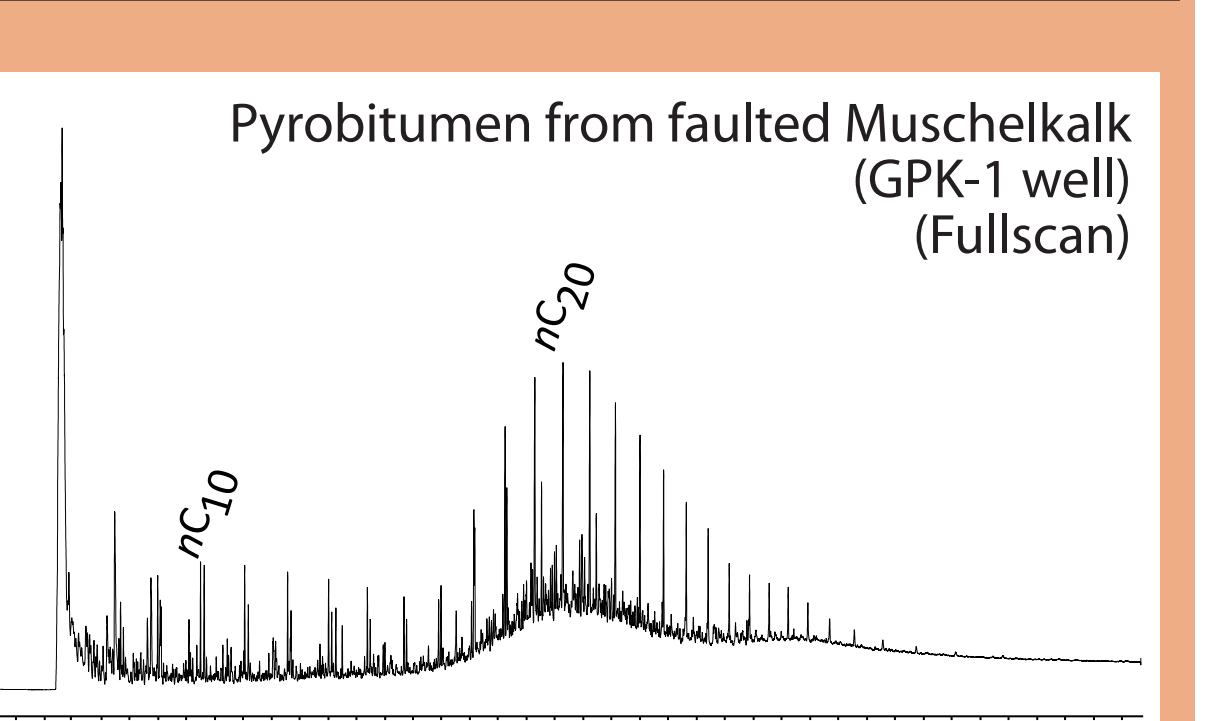
## Integrating organic geochemistry with basin thermal modelling:



**Main conclusions:** 1) Thermal maturities are higher in Rittershoffen than in Sultz; 2) In Sultz, the thermal peak is linked to the syn-rift burial; 3) In Rittershoffen, the thermal peak is linked to a high heat flow from the activation/reactivation of the faults in the Miocene (15 Ma; post-rift); and 4) The heat flow at Rittershoffen 15 Ma ago was higher (probably  $\approx 180 \text{ mW/m}^2$ ) than the current heat flows measured in the URG.



**All oils from the Pechelbronn sub-basin:**  
• are derived from Liassic source rocks;  
• lost their light fraction;  
• have reached the same level of thermal maturity, suggesting an homogeneous oil kitchen.



**Conclusion:**  
1) Additional burial during Upper Jurassic/Cretaceous was limited to approximately 300 m in the URG area; 2) Main source rocks were immature when the graben formed; 3) Hydrocarbon generation in the Pechelbronn sub-basin started during its isolation (end of Lower Oligocene); 4) Fluid overpressure is recorded in the basin during Oligocene (fluid inclusions analysis) and is associated with hydrocarbon accumulation in the source rocks and potential accumulation of deep hydrothermal fluids at the vicinity of faults in the basement; 5) Gas and gasoline were lost during the activation/reactivation of faults during the Miocene (around 15 Ma); 6) Residual oils along fault systems underwent thermal alteration due to hydrothermal fluids circulation; 7) Oils collected in the sub-basin are biodegraded, probably in relation to their residence time at the surface (present-day).

**Reference:** Tchang-Tchong, L., Michels, R., Beccaletto, L., Bossennec, C., Lorgeoux, C., Faure, P. (2023). Pre- to early-rift thermal conditions of the Upper Rhine Graben using geological and organic geochemical controls. *Marine and Petroleum Geology*, 151, 106202.

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