Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.37221

Mineralogical controls on lithium distribution in the Upper Rhine Graben geothermal system

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In Europe, significant lithium concentrations have been identified in geothermal brines, particularly in the Upper Rhine Graben (URG), a high-temperature rift system with fluids reaching up to 250 °C and about 200 mg/L Li (Sanjuan et al., 2022). Elevated lithium concentrations have been linked to the alteration of Li-rich micas, especially biotite, within the granitic basement (Drüppel et al., 2020; Dugamin et al., 2024; Jungmann et al., 2025).

This study investigates the mineralogical controls on lithium distribution within the granitic basement and the overlying sedimentary formations of the URG. Samples were collected at different depths from the GPK-2 and GPK-3 Électricité de Strasbourg wells at Soultz-sous-Forêts (Alsace). Mineralogical characterization was conducted using X-ray diffraction, scanning electron microscopy, electron probe microanalysis, and laser ablation mass spectrometry.

Biotite and chlorite are the main lithium-bearing minerals in the granitic basement, with biotite reaching up to 500 ppm Li and chlorite up to 600 ppm. Illitization affecting both biotite and feldspars leads to lower lithium concentrations, generally below 200 ppm. The overlying sedimentary formation is dominated by illite with similar lithium contents, indicating redistribution during alteration. The mineralogical facies and lithium content was correlated with the degree of alteration of rocks, providing a better understanding of the lithium partitioning during basin evolution.

References

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