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## **First identification of fluvial channels by advanced spectral decomposition in Chattian syn-rift successions of the central Upper Rhine Graben: Implications for subsurface energy storage**

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The Chattian-Oligocene interval of the Northern Upper Rhine Graben (URG) is characterized by a complex stratigraphic and structural framework influenced by several phases of tectonic activity and variations of crustal stress fields. The deposition of the fluvatile-lacustrine Niederrödern Formation coincides with the major Chattian regression phase overlaying unconformably the brackish-marine uniform Grey Bed Series (Froidefontaine Formation). The Niederrödern Formation is characterized by colorful marls hosting sand layers and lenses that were partly exploited for hydrocarbons more than 40 years ago. Detailed investigations of 3D seismic data were conducted due to the direct link between channel geometry and the depositional regime with the storage potential of the sandstone layers for heat, CO<sub>2</sub>, or hydrogen.

A subset of a 3D seismic survey carried out in 2012, covering an area of 10 km × 4 km close to the Karlsruhe Institute of Technology (KIT) Campus North and including more than 20 in-field wells, was used for structural-stratigraphic analysis and advanced spectral decomposition analysis. Advanced spectral decomposition techniques could enhance seismic resolution and enable – for the first time in the Upper Rhine Graben – the delineation of meandering fluvial channels of up to 25 m width, providing constraints for the depositional system of the Niederrödern Formation. The delineation of meandering fluvial channels provides not only a better sedimentological understanding of the graben filling development but also geometric constraints for the thermo-hydraulic modeling of HT-ATES (High Temperature Aquifer Thermal Energy Storage) of former hydrocarbon reservoirs. This work highlights the potential of the Northern URG as a key region for geothermal energy utilization and subsurface storage, paving the way for future research and applications in renewable energy technologies.