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# Characterization and permanent monitoring of the hydraulically active zones of a deep geothermal reservoir using a fiber-optic monitoring system in a production well in the Bavarian Molasse Basin

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Interpretation and monitoring of hydraulically active zones in hydro-geothermal wells is critical for assessing the hydraulics of a reservoir and for understanding sustainable reservoir management. For this purpose, flowmeter runs are often performed during injection at the end of short-term pumping tests after the well is completed. Because conventional well designs do not allow direct monitoring in the reservoir once the well is in operation, it is often not clear whether the flowmeter's interpreted injection zones reflect subsequent production zones.

To gain insight into the long-term hydraulic and thermal behavior of geothermal wells in operation, a fiber-optic monitoring system was installed down to 3683 m MD of a geothermal production well in 2019 and below the electric submersible pump into the reservoir in 2021. The well is part of the Schäftlarnstraße geothermal site in Munich, Southern Germany, where six doublets develop the deep hydrothermal Upper Jurassic “Malm” reservoir of the Northern Alpine Foreland Basin. The fiber-optic monitoring system is the first of its kind installed permanently in a geothermal production well. It allows monitoring of temperature (distributed temperature sensing, DTS) and acoustic/strain (distributed acoustic sensing, DAS) continuously in space and time and of pressure and temperature at a fiber-optic gauge located at top of the reservoir at 2748 m MD.

Using DTS technology, the temperature inside the borehole was monitored when the wells at the geothermal site started production. The recorded data were used to analyze the temperature signature at the hydraulically active zones known from previous hydraulically injection tests (flowmeter and temperature monitoring during cold-water injection).

The results show that both hydraulics and production temperature are dominated by an active, karstified zone in the uppermost part of the reservoir of the monitored well. The production of another well of the three doublets geothermal site also strongly affects the temperature distribution in the monitored well. We highlight the importance of continuous monitoring and show the benefit of the permanent fiber-optic monitoring system for sustainable reservoir management.