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地震メカニズムトモグラフィー法によるバーゼル地熱貯留層での間隙流体圧分布の推定
High fluid pressure and triggered earthquakes in the enhanced geothermal system in Basel, Switzerland

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We analysed 118 well-constrained focal mechanisms to estimate the pore fluid pressure field of the stimulated region during the fluid injection experiment in Basel, Switzerland. This technique, termed focal mechanism tomography (FMT), uses the orientations of slip planes within the prevailing regional stress field as indicator of the fluid pressure along the plane at the time of slip. The maximum value and temporal change of excess pore fluid pressures are consistent with the known history of the wellhead pressure applied at the borehole. Elevated pore fluid pressures were concentrated within 500 m of the open hole section, which are consistent with the spatio-temporal evolution of the induced microseismicity. Our results demonstrate that FMT is a robust approach, being validated at the meso-scale of the Basel stimulation experiment. We found average earthquake triggering excess pore fluid pressures of about 10MPa above hydrostatic. Over-pressurized fluids induced many small events ($M < 3$) along faults unfavourably-oriented relative to the tectonic stress pattern, while the larger events tended to occur along optimally-oriented faults. This suggests that small-scale hydraulic networks, developed from the high pressure stimulation, interact to load (hydraulically isolated) high strength bridges that produce the larger events. The triggering pore fluid pressures are substantially higher than that predicted from a linear pressure diffusion process from the source boundary, and shows that the system is highly permeable along flow paths that allow fast pressure diffusion to the boundaries of the stimulated region.

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