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High injection rates decrease the probability of creating undesired, far-reaching fluid migration pathways at Cooper Basin geothermal field

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Enhanced Geothermal Systems apply the pressurized fluid injection to fracture impermeable rocks to form pathways in which water circulates. The cold water under high pressure is pumped into the hot subsoil, where it heats up and returns to the surface. However, the induced fractures may coalesce into unwanted paths that allow the fluids to reach pre-existing faults, triggering major seismic events.

This work investigates the relationship between injection and a degree of disordering of sources, ZZ, at Cooper Basin geothermal field in Australia, following the methodology developed and applied to study The Geysers geothermal field case (Lasocki & Orlecka-Sikora, 2020). The parameter ZZ quantifies the potential of seismicity to build pathways for fluid migration. It is the average distance between the seismic events in the eight-dimensional parameter space consisting of three hypocentral coordinates, T- and P-axis plunges, T-axis trend, and polar and azimuthal angles in the spherical system of coordinates beginning at the open hole of an injection well. A decrease of ZZ indicates an increasing hazard of forming far-reaching migration pathways. In The Geysers case, ZZ turned out to be highly correlated with the injection rate.

Here we focus on the case of Habanero 4 well stimulation from 17 - November 30, 2012 (data access, see: IS EPOS, 2020). We processed 489 seismic events with known focal mechanisms. The events moment magnitude varies between 0.8 and 3.1.

Our analysis shows that ZZ is significantly correlated with both the injection rate and the wellhead pressure. The higher the injection rate / the wellhead pressure was, the less probable was the creation of undesired fluid migration pathways. The Cooper Basin's and The Geyser's reservoir rocks are vastly different, the former – granite, the latter – greywacke sandstone, likewise the stimulation techniques applied in these two reservoirs. However, in both cases, ZZ was positively correlated with injection rate; thus, the potential to build unwanted paths for fluids was negatively correlated. These results suggest that such correlation may be a global feature of rock fracturing caused by pressurized fluid injections.

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