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Analysis and interpretation of stress indicators in deviated wells of the Coso Geothermal Field

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Characterizing the tectonic stress field is an integral part for the development of hydrothermal systems, especially enhanced geothermal systems (EGS). With a known stress field, critically stressed faults can be identified. Faults that are critically oriented with respect to the in-situ stress field exhibit a high tendency for slip, and thus are likely candidates for reactivation during the creation of an EGS. Reactivated faults are known to serve as dominant fluid pathways during hydrothermal circulation and the characteristics of this process determine the potential for damaging earthquakes; should extensive portions of well-oriented, large features be reactivated.

As part of the FORGE initiative at the West Flank of the Coso Geothermal Field, we analyze a large set of image logs obtained from wells distributed across the geothermal field for details about the stress state revealed by indicators such as borehole breakouts and drilling-induced tensile fractures. Previous stress analyses at Coso have ignored deviated well sections, since their interpretation for the orientation of the stress tensor is non-unique with respect to varying stress magnitudes. Using interpreted borehole-induced structures, we perform a grid search over all possible Andersonian stress states and find a best fitting vertical stress tensor for each stress state characterized by principal stress magnitudes. By including deviated well sections and recently drilled wells, we considerably expand the suite of stress measurements in the Coso Geothermal Field.

Along individual wells, this analysis also reveals local meter length-scale deviations from the best-fitting mean stress orientation. While most wells show consistent horizontal principal stress orientations with standard deviations of about 10°, other wells show large standard deviations on the order of 25°. Several regions have logged well trajectories with lateral spacing below 1 km. This enables us to trace changes of the stress orientation along the well paths over multiple wells and quantify variations of the stress field on a reservoir scale. The resulting analysis provides a characterization of stress spanning from meters to kilometers that fills the gap left by regional scale stress measurements resolved from inversion of earthquake focal mechanisms.