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PSP08

Stress Tensor Changes Related to Fluid Injection at The Geysers Geothermal Field, California

P. Martinez-Garzon* (Helmholtz-Centre GFZ German Research Centre), G. Kwiatek (GFZ German Research Centre for Geosciences), M. Bohnhoff (Free University Berlin) & G. Dresen (GFZ German Research Centre for Geosciences)

SUMMARY

Studying variations of the stress field caused by fluid injection is relevant towards an improved understanding of geomechanical reservoirs processes. We present a software package performing stress tensor inversion based on SATSI algorithm (Hardebeck and Michael, 2006, J. Geophys. Res.) with overall performance and stability improvements, versatile graphical output allowing visualization of 0 to 3D stress inversion results, and user friendly interface. The MSATSI package is composed of two elements: one for performing the stress inversion and uncertainty assessment, and second providing the graphical visualization of the results. The package is GPL-licensed and freely available.

In this study, we estimated potential spatiotemporal variations of the local stress field orientation at The Geysers geothermal site by using fault plane solutions of local events provided by the Northern California Earthquake Data Center. First, we investigated the stress field orientation at different depths using high quality focal mechanisms of induced seismicity over the whole reservoir. The results point out a clear variation of the stress field orientation at reservoir depth (normal regime) with respect to above and below (strike-slip regime). These observations were interpreted as an effect of the reduction of horizontal stresses due to the depletion of reservoirs. Second, we look at the temporal changes of the stress tensor at a particular seismicity cluster in the northwestern part of the field. Results show a clear correlation between detected stress field orientation changes and injection rates. We interpreted these observations either as the reactivation of pre-existing cracks oriented in the direction NE-SW, or as the opening of new fractures.