Geophysical Research Abstracts
Vol. 12, EGU2010-11695, 2010
EGU General Assembly 2010

Analysis of fracture patterns and local stress field variations in fractured reservoirs

Hagen Deckert (1,2), Michael Drews (3), Dominik Fremgen (2), J.Florian Wellmann (4,1)

(1) Institute for geothermal resource management, University of Applied Sciences Bingen, Germany (deckert@uni-mainz.de), (2) Institut für Geowissenschaften, Universität Mainz, Becherweg 21, 55099 Mainz, (3) School of Civil Engineering and Geosciences, Newcastle University, UK, (4) Western Australian Geothermal Centre of Excellence, University of Western Australia, School of Earth and Environment, Crawley, Australia

A meaningful qualitative evaluation of permeabilities in fractured reservoirs in geothermal or hydrocarbon industry requires the spatial description of the existing discontinuity pattern within the area of interest and an analysis how these fractures might behave under given stress fields. This combined information can then be used for better estimating preferred fluid pathway directions within the reservoir, which is of particular interest for defining potential drilling sites.

A description of the spatial fracture pattern mainly includes the orientation of rock discontinuities, spacing relationships between single fractures and their lateral extent. We have examined and quantified fracture patterns in several outcrops of granite at the Costa Brava, Spain, and in the Black Forest, Germany, for describing reservoir characteristics. For our analysis of fracture patterns we have used photogrammetric methods to create high-resolution georeferenced digital 3D images of outcrop walls. The advantage of this approach, compared to conventional methods for fracture analysis, is that it provides a better 3D description of the fracture geometry as the entity of position, extent and orientation of single fractures with respect to their surrounding neighbors is conserved. Hence for instance, the method allows generating fracture density maps, which can be used for a better description of the spatial distribution of discontinuities in a given outcrop. Using photogrammetric techniques also has the advantage to acquire very large data sets providing statistically sound results.

To assess whether the recorded discontinuities might act as fluid pathways information on the stress field is needed. A 3D model of the regional tectonic structure was created and the geometry of the faults was put into a mechanical 3D Boundary Element (BE) Model. The model takes into account the elastic material properties of the geological units and the orientation of single fault segments. The independently estimated regional stress tensor is put as a boundary condition into the BE Model. The computed BE model allows to recognize local 3D stress tensor perturbations caused by the larger faults that act as mechanical inhomogeneities.

The geometry of the fracture network from field work together with the local stress tensors derived from the 3D BE models allows examining normal and shear stresses on single fractures in different domains of the investigated area. This in turn is used to evaluate, which of the fractures might preferably act as fluid conduits by describing the dilation potential of single fractures. The combination of an improved understanding of the fracture network along with local stress tensors variations from mechanical models will provide a sound evaluation of fluid pathways in fractured reservoirs. In future applications the accurate investigation of large discontinuity pattern in outcrops might be used for a better mathematical definition of fracture networks which could be implemented into numerical simulations of fluid flow.