Geophysical Research Abstracts
Vol. 21, EGU2019-5370, 2019
EGU General Assembly 2019

Wellbore Stability and Scientific Basis for Geomechanical Modeling on the Example of the Los Humeros Geothermal Field, Mexico

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Obtaining qualitative information about the stress state in the Earth's crust is a challenging task. Typically, direct measurements of crustal stresses are not included in logging programs of geothermal wells, especially while drilling in high enthalpy reservoirs in which temperature conditions often exceed operational limits of the conventional logging equipment. There are a number of methods for assessing stress state of the reservoir, all of which adhered to the petroleum industry, and include sonic logging, hydraulic fracturing, leak-off tests, borehole breakouts analysis and stress indications from core samples studies. Unfortunately, only in a few geothermal wells, these methods are being applied. This is often due to either high investment costs, challenges during core recovery or extremely high reservoir temperatures. Obtaining reliable estimates of parameters such as minimum and maximum horizontal, vertical stresses and pore pressure is vital for ensuring safe drilling operations and increasing the learning curve for the future drilling operations. This study proposes a method for the assessment of crustal stresses using non-direct stress measurements such as circulation losses, multi-arm mechanical caliper logs, and analysis of continuously measured drilling parameters. A MATLAB-based software for assessing minimum and maximum horizontal stresses and breakout orientation from multi-arm mechanical caliper recordings was developed. The proposed methods do not require additional equipment or costs and can be simply extracted from already recorded parameters during drilling. The analysis carried out in this study was based on the results from deep drilling in the Los Humeros Geothermal Field, the third largest field in Mexico, located at the border of Veracruz and Puebla states in the central-eastern part of the country, where the highest recorded temperature recorded was 395°C and hostile reservoir fluids were produced. Throughout almost 40 years of drilling operations in the field, issues related to wellbore instability have been observed. Such complications might be prevented or mitigated in future operations once solid knowledge about reservoir geomechanics is assessed prior to the drilling activity. Additionally, this study proposes an approach for computing the base data needed for the geomechanical modeling on the example of the central part of the Los Humeros Geothermal Field.