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Thermo- and petrophysical rock properties of the Los Humeros geothermal field (Mexico): comparison of outcrop analogues and reservoir formations

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The Los Humeros geothermal system is an operating steam dominated field with 65 wells (23 producing). With temperatures above 380 °C, the system is characterized as a super-hot geothermal system (SHGS). The development of such systems is still challenging due to the high temperatures and aggressive reservoir fluids, which lead to corrosion and scaling problems.

For better reservoir understanding and prospective modeling of the Los Humeros caldera complex, extensive geological, geochemical, geophysical and technical investigations are performed within the scope of the GEMex project (EU-H2020, GA Nr. 727550). Relatively little is known about the petro- and thermophysical rock properties in the study area. This data is critical for i) processing and interpreting geophysical data and ii) for parameterizing reservoir models. Therefore, outcrop analogue and reservoir sample studies have been carried out in order to define and characterize all key units from the basement to the cap rock. Thus to identify geological heterogeneities on different scales (outcrop analysis, representative rock samples, thin sections and chemical analysis) enabling reservoir property prediction.

More than 200 rock samples were taken from representative outcrops inside of the Los Humeros caldera, the surrounding area and from the exhumed 'fossil' system Las Minas. Additionally, 64 core samples covering 14 wells of the Los Humeros geothermal field were obtained. The samples were analyzed for petrophysical (e.g. density, porosity, permeability) and thermophysical properties (thermal conductivity, thermal diffusivity, heat capacity) as well as ultra-sonic wave velocities and magnetic susceptibility.

Based on the outcrops and petrological analysis, the unit's geological heterogeneity, which controls the rock properties, can be addressed. Hydrothermal alteration of different intensities was observed on borehole core samples resulting in high heterogeneity in terms of sample appearance, chemical composition and rock properties. Likewise, hydrothermal alteration can be observed in outcrops in the vicinity of dykes, igneous bodies and fault zones. An extensive rock property database was created comprising more than 20 parameters analyzed on more than 1200 plugs altogether. The results enable the classification of different lithofacies types with distinct properties, which is essential to define geothermal model units within a 3D geological model. Based on statistical analysis, 19 lithostratigraphic units were defined for the Los Humeros geothermal field.

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