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Geological structures in the Acoculco geothermal area, Mexico: a background for EGS development

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In the surroundings of Acoculco village in the eastern Trans-Mexican Volcanic Belt, two 2-km-deep geothermal exploration boreholes, 500 m apart, demonstrate a temperature gradient of nearly 150°C per km and a tight reservoir. In this context, the GEMex project considered the Acoculco area as a study area for applying methodologies of analysis for Enhanced Geothermal Systems. The stratigraphy indicated by the boreholes consists of about 700 m thickness of volcanic deposits underlain by about 1000 m thickness of limestone and skarn, in turn underlain by granite.

One of the first approaches for predicting the natural fracture properties of the reservoir is to define the structural setting, highlighting the main regional trends and the intra-caldera characteristics in terms of fracture network and connectivity. Toward this goal, a new structural map was constructed and two main fault systems recognized, striking NNW-SSE and SW-NE respectively. Kinematic analysis of the outcropping fault slip-surfaces was carried out by structural stations located along the regional faults. The results indicate that the NNW-SSE striking faults are characterized by early dextral to oblique-normal movement characteristically overprinted by predominantly normal movement. In contrast, the SW-NE striking faults are characterized by normal movement. The fault activity is encompassed between late Pleistocene and Present, based on paleontological and stratigraphic evidence. Detailed fieldwork carried out in the area surrounding the boreholes confirms this structural framework and highlights northward migration of the deformation, indicated by stratigraphic relations, thermal springs and gas effusions. Outcropping fractures are typically mineralized.

The objective of these detailed outcrop studies is to assist the forecasting of existing fracture systems in the predominantly granitic reservoir. In the vicinity of the boreholes small fault-bounded sedimentary basins 200 to 500 m wide contain late Pleistocene sediments and are delimited by NE-trending normal faults and NNW-trending oblique-slip transfer faults. The fault exposures are typically in lava and highly-compact welded tuff and characterized by damage zones estimated to be three to 10 meters wide with fracture frequencies of up to 10/m. Several of the steep NNW-striking faults trend between or near the boreholes. Whereas the fault spacing and damage zone width is expected to change with depth and location in the fault network, the fault geometry and displacement indicates that the fault system cuts through the volcanic and underlying carbonate strata into the granite. The mineral sealing observed in outcrop is consistent with the lack of fluid loss when the wells were tested. However, for EGS purposes, the mineralized fractures can be expected to be weaker than non-fractured rock volumes and to open under pressure stimulation.

In conclusion, fieldwork produced geometrical and strength parameters, both at local and regional scale, to assist the simulation of EGS in a rock volume affected by a known fracture system.

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