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Reservoir quality assessment by means Discrete Fracture Network reconstruction of the geothermal system of Rosario de La Frontera, NW Argentina

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ABSTRACT

Discrete fracture network (DFN) models are three-dimensional stochastic or combined stochastic/deterministic representations of fractures network that characterizes natural fracture systems. They represent an important tool to investigate pathways for fluid flow in geothermal reservoirs in order to predict their behavior in prospect evaluation and reservoir management.

In this project a DFN model is applied to the geothermal system of *Rosario de La Frontera*, in the *Salta* province, with the aim to assess the effective permeability of its reservoir and to obtain input parameters for dynamic reservoir modeling.

This active geothermal system is marked by several hot springs, with surface temperatures ranging between 23°C and 93.7°C that occur in the suburbs of the town of *Rosario de La Frontera* located at the northern edge of *La Candelaria* mountain ridge.

La Candelaria Ridge represents one of the positively inverted structure cropping out in the foothills of the Central Andean retro-wedge. It consists of an anticline structure elongated in N-S direction for ca.60 km and strongly plunging (up to 25°) both to the north and to south. This anticline is uplifted by high-angle reverse fault planes dipping both to the west and to the east with top-to-the-east and top-to-the west sense of transport, respectively. Low-grade metasedimentary Precambrian rocks widely crop out at its core and are unconformably overlain by a thick sequence of predominantly continental Cretaceous to Paleogene strata (Salta Group) related to the Cretaceous rift stage (Salfity and Marquillas, 1982, 1994). Fractured sandstones strata belonging to the syn-rift deposits of the Salta Group (Pirgua subgroup) represent the reservoir of the geothermal fluids (Moreno Espelta et al., 1975). Instead, the post-rift (Balbuena and Santa Barbara subgroups) and syn-orogenic impermeable strata (Metán subgroup), that are related to an inversion tectonic phase (Gebhard et al., 1974; Bianucci et al., 1982; Cominguez and Ramos, 1995), provide the cap rock to the geothermal system (Seggiaro et al., 1997).

In correspondence of the northern plunge, where syn-orogenic clastic sediments extensively crop out, the well-known hot springs and the thermal spa of *Las Termas* are located. One further hot spring with temperature of about 20°C occurs a few tens of kilometers along the southwestern flank of the ridge, in correspondence of the *El Ceibal* area and along a kilometric strike slip fault cross cutting the regional anticline.

With the aid of dedicated software (e.g. Move by Midland Valley Ldt.), a 3-D geological model of the *La Candelaria* anticline was built in order to extract a 3-D geocellular volume of the deep reservoir and to constrain the fracture network model.

Structural studies performed on the outcropping portion of the reservoir, allowed us to define the main fracture system occurring in the structure and to calculate the input parameters for the generation of the DFN in the 3-D volume of the buried geothermal reservoir.

Faults and fractures have been analyzed and quantified by means of scan-lines and scan-area surveys defining diagnostic parameters such as fracture type, orientation, dimension, surface texture and numerical parameters (e.g., density and spacing, length, aperture, etc.). According to the orientation data, the observed discontinuities have been classified in different sets, interpreted with respect to the regional structural setting, and their density distribution was assessed in different sectors of the reservoir.

In conclusion, several DFN models were generated, one for each fracture set. Furthermore, comparison among the different models provided a preliminary qualitative assessment of reservoir permeability with special regard to the anisotropy due to the secondary permeability.

KEY WORDS: DFN modeling, faults and fractures, geothermal system, La Candelaria Ridge, NW Argentina.