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Characterization and evolution of the paleo-fluids circulating in the exhumed geothermal system of Las Minas (Mexico)

The evolution and origin of the hydrothermal fluids circulating in the exhumed geothermal system of Las Minas area (Central Mexico) were investigated by i) structural and mineralogical studies and, ii) fluid inclusion and isotope analyses carried out on skarn and hydrothermal alteration minerals. Different stages of fluid flow in the system related to the emplacement of intrusive rocks and their interaction with the andesitic and carbonatic reservoir in the Las Minas area were recognized from fluid inclusions found in mineral assemblages (e.g. quartz, calcite, garnet) associated with skarn deposits. Fluid inclusions recorded the circulation of: 1) high-temperature (up to 650°C), high-salinity (up to 60 wt.% NaCl equiv.) fluid of magmatic origin; 2) high-temperature (470-650°C) aqueous-carbonic fluid produced during fluid-rock interaction with carbonate basement rocks and 3) relatively low-salinity (up to 2 wt.% NaCl equiv.) fluid of meteoric origin. A general evolution from high- to low-temperature fluid circulation characterized the geothermal system. Stable and radiogenic isotopes analyses also showed that fluids with different origins interacted in the system. The circulation of these geothermal fluids was strictly dependent from two main fault systems NNW- and SW-trending, recognised in the study area. Indeed, the fault zones played the role of main conduits favouring the uprising of the fluids from deep to shallower structural levels. Furthermore, fracture networks characterising the fault zones enhanced the geothermal fluid circulation as shown by hydrothermal veins localised in the damage zones.

The integration of structural, geochemical and fluid inclusion analyses allowed to i) characterize the physical-chemical properties of the paleo-fluids stored in the exhumed reservoir of Las Minas; ii) define the fluid-rock interaction processes promoted by the geothermal fluids circulating through the reservoir rocks; iii) characterize the structural control on the fluids circulation. Finally, the information obtained from the paleo-fluids in Las Minas,

were used to better characterize and predict the P-T conditions of the deep fluids circulation in the analogue active geothermal field located in Los Humeros (Central Mexico).

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