Multi-isotopic study of the fluid circulation at Los Azufres geothermal field, Mexico

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Los Azufres, the second most important geothermal field in Mexico, is located in a Miocene-Pliocene andesitic volcanic complex covered by Quaternary rhyolitic-dacitic domes and affected by E-W normal faults. It consists of two productive zones, SPZ in the south and NPZ in the north. The focus of this study is understanding the evolution of fluid circulation after nearly 30 years of extensive exploitation.

A multi-isotopic survey was carried out to constrain the fluid evolution. Major and trace elements, noble gas isotopes (He, Ne, Ar, Kr and Xe) and stable isotopes (δ^2H and $\delta^{18}O$, $\delta^{81}Br$ and $\delta^{37}Cl$, $^{87}Sr/^{86}Sr$ as well as $\delta^{13}C$ and $\delta^{18}O$ of CO_2 were obtained from 36 selected wells and 10 springs. The δ^2H and $\delta^{18}O$ values indicates mixing with fresh meteoric Generally, the NPZ is isotopically heterogeneous, while the SPZ show a narrower range of variations. In particular, $^3He/^4He$ ratios corrected for air contamination range between 4.3 and 7.9Ra in the NPZ while the SPZ shows a narrower range centred on 7.2Ra (where Ra is the helium atmospheric ratio of 1.382×10^{-6}). The $^{40}Ar/^{36}Ar$ ratios are higher in the SPZ up to 600 and correlated with helium ratios, suggesting the addition of mantle Ar. In the NPZ, argon is close to the atmospheric ratio of 295.5. Similar characteristcs are also observed from the $\delta^{81}Br$ and $\delta^{37}Cl$ signatures, where the SPZ samples are isotopically homogeneous compared to those collected from the NPZ.

The dichotomy between NPZ and SPZ seems to suggest a sustained recharge in the north and an isolated reservoir in the south, with more mantle He, Ne and Ar values measured in the SE area. A few wells, located closer to the western re-injection areas show clear evidences from heavier noble gases and stables isotopes that are contaminated by reused brines.