Using Noble Gases to Trace Fluid Circulation in the Los Humeros Geothermal Field, Mexico

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The Los Humeros geothermal field is located in the eastern portion of the Mexican Volcanic Belt, in a caldera complex resulting from ignimbrite eruptions which took place between 0.5 and 6.4 ka. According to the latest data measured in the producing wells, it is considered that there is one single reservoir, with several feeding zones defined by local structural conditions. The Paleozoic basement is mainly metamorphosed limestone. Since first exploration of the field was carried out in 1968 and production wells drilled in the beginning of the 90s, some conceptual models of the fluid circulation were done, although a recent actualization was not performed. With this in mind, an extended noble gas (He, Ne, Ar, Kr and Xe) survey was carried out in January 2015 in 22 productive wells in order to obtain new information on the fluid circulation. Additional data such as stable isotope δ^2H, $\delta^{18}O$, $\delta^{37}Cl$ and $^{87}Sr/^{86}Sr$ data were also obtained.

The δ^2H and $\delta^{18}O$ point to mixing between freshwater and andesitic water. $^{87}Sr/^{86}Sr$ ratios vary from 0.70406 to 0.70885 suggesting that besides the basalt-andesitic reservoir, the water also circulated in the limestone basement. $^3He/^4He$ ratios are relatively homogeneous, ranging between 6.25 and 7.62 Ra with a mean value of 7.03±0.40 Ra (where Ra is the atmospheric ratio of 1.384×10-6). This value is between that of sub-continental lithospheric mantle He (~6.5Ra) and the upper mantle He (8Ra). In the middle and southern part of the field, $^{21}Ne/^{22}Ne$ and $^{40}Ar/^{36}Ar$ ratios range from 0.0319 to 0.0517 and from 507 to 865, respectively. These point to low impact in this area by recharge water. Homogeneous $^4He/^{40}Ar$ ratios (~7.1) in the entire region points to relatively low K/U value (~7000) of a single magma source. The ratios of heavier noble gases Kr/Ar and Xe/Ar are fractionated compared to those expected in the liquid phase due to boiling and simultaneous phase separation throughout the field.