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# Geochemical exploration of a promissory Enhanced Geothermal System (EGS): the Acoculco caldera, Mexico.

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The Acoculco caldera (Puebla, Mexico) has been identified by the Mexican Federal Electricity Company (in Spanish "Comisión Federal de Electricidad", CFE) as a potential Enhanced Geothermal System (EGS) candidate. Two exploration wells were drilled and promising temperatures of $\sim$300˚C have been measured at a depth of 2000 m with a geothermal gradient of $11^{o}$C/100m, which is three times higher than the baseline gradient measured within the Trans-Mexican Volcanic Belt. As usually observed in Hot Dry Rock systems, thermal manifestations in surface are scarce and consist in low-temperature bubbling springs and soil degassing. The goals of this study were to identify the origin of these fluids, to estimate the soil degassing rate and to explore new areas for a future detailed exploration and drilling activities. Water and gas samples were collected for chemical and isotopic analysis ($\delta^{18}$O, $\delta$D, $^{3}$He/$^{4}$He, $^{13}$C, $^{15}$N) and a multi-gas ($CO_2$, $CH_4$, $H_2S$) soil survey was carried out using the accumulation chamber method. Springs' compositions indicate a meteoric origin and the dissolution of $CO_2$ and $H_2S$-rich gases, while gas compositions reveal a MORB-type origin mixed with some arc-type contribution. Gas geothermometry results are similar to temperatures measured during well drilling (260˚C-300˚C). Amongst all measured $CO_2$ fluxes, only 5% (mean: 5543 g m$^{-2}$ day$^{-1}$) show typical geothermal values, while the remaining fluxes are low and correspond to biogenic degassing (mean: 18 g m$^{-2}$ day$^{-1}$). The low degassing rate of the geothermal system is a consequence of the intense hydrothermal alteration observed in the upper 800 m of the system which acts as an impermeable caprock. Highest measured $CO_2$ fluxes (above $>$ 600 g m$^{-2}$ day$^{-1}$) have corresponding $CH_4$/$CO_2$ flux ratios similar to mass ratios of sampled gases, which suggest an advective fluid transport. To represent field conditions, a numerical model was also applied to simulate the migration of $CO_2$ towards the surface through a shallow aquifer under fully saturated conditions. By changing some of the aquifer properties (i.e., depth, permeability and porosity), it was found how geothermal $CO_2$ fluxes can show values similar to a biogenic background flux. Future field work at Acoculco will include $\delta^{13}$C analysis together with soil flux measurements for a better discrimination of the degassing origin, and a thinner flux measurement grid will be defined for a better detection of any possible gas flux anomaly.