Water- and gas-based geochemical prospecting of geothermal reservoirs in the Tarapacà and Antofagasta regions of northern Chile

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Studied area

The Andean Central Volcanic Zone, which runs parallel the Central Andean Cordillera crossing from North to South the Tarapacà and Antofagasta regions of northern Chile, consists of several volcanoes that have shown historical and present activity (e.g. Tacora, Guallatiri, Isluga, Ollague, Putana, Lascar, Lastarria). Such an intense volcanism is produced by the subduction process thrusting the oceanic Nazca Plate beneath the South America Plate. The anomalous geothermal gradient related to the geodynamic assessment of this extended area gives also rise to intense geothermal activity not necessarily associated with the volcanic structures.

This study is mainly focused on the geochemical characteristics of water and gas phases of thermal fluids discharging in several geothermal areas of northern Chile (Fig. 1):

El Tatio, Apacheta, Surire, Puchuldiza-Tuya

Main aims

This study was aimed to provide a complete database of chemical and isotopic composition of thermal fluid discharges seeping out in the areas of interest to obtain conceptual models able to describe the main mechanisms regulating the underground fluid circulation for geothermal purposes.

Fig. 1

Chemistry of waters

Water discharges are characterized by a Na-Cl composition, acidic pH (between 1.7 and 6.9) and medium-to-high TDS values (up to 10,600 mg/L). These chemical features are typical of springs seeping out in geothermal areas. In Fig. 2 is reported the composition of the main anions.

Chemistry of gases

Water vapour is the dominant gas component only in fumarolic emissions (up to 99% by vol), while its contents in gases bubbling in pools, where it is partly condensed, is highly variable (0.2-75 % by vol.). Carbon dioxide is the main component of the dry gas phase (67-99 % by vol.), followed by N_2 (up to 25 % by vol.), H_2S (up to 2.5 % by vol.), H_2 (up to 0.42 % by vol.) and CH_4 (up to 0.4 % by vol.). In Figg. 3 and 4 the main sources of fluid discharges are shown.

Fig. 2

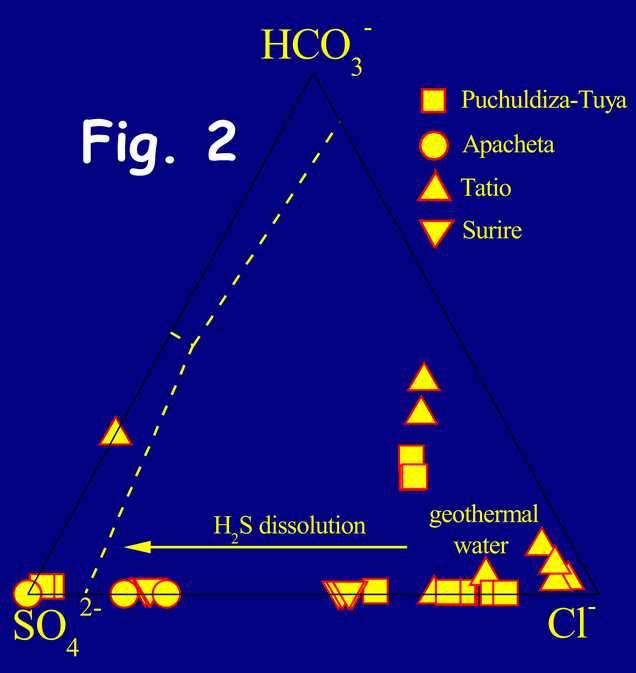


Fig. 3

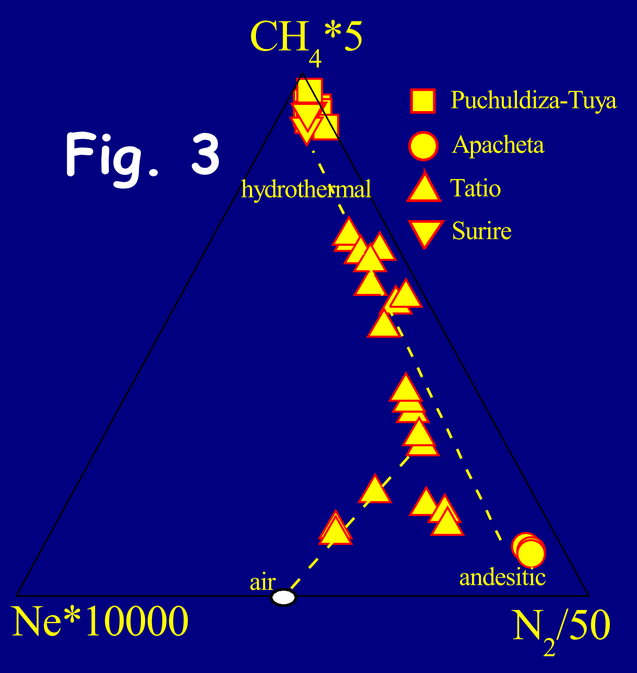
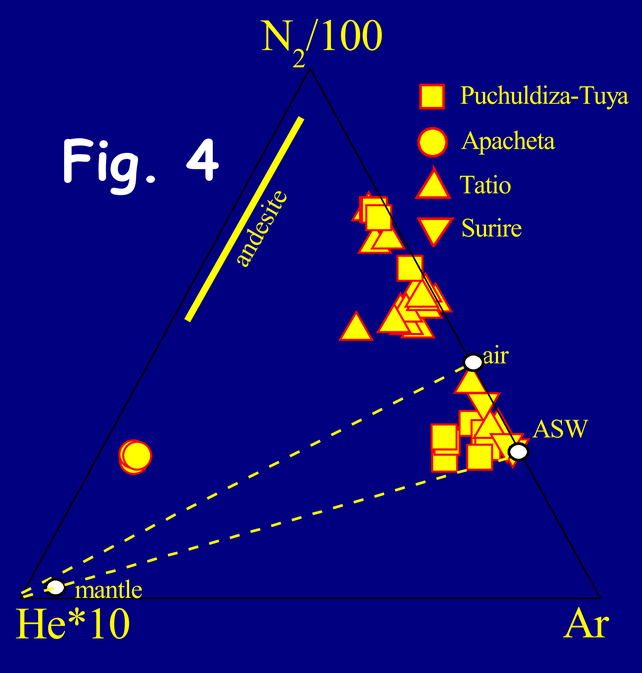


Fig. 4



Isotopic compositions

The values of $\delta^{18}O$ and δD in waters indicates that the fluid discharges are mainly fed by meteoric water. The values of $\delta^{13}C$-CO_2 and R/Ra are consistent with those of MORB, suggesting that CO_2 and Helium have a mantle origin

Concluding remarks

The results of this preliminar geochemical investigation suggest that the thermal discharges of the four investigated areas have the typical chemical and isotopic characteristics of geothermal fluids. Although further studies are needed to evaluate the real geothermal potential, El Tatio, Puchuldiza-Tuya, Surire and Apacheta represent promising systems for geothermal energy exploitation.

El Tatio

Puchuldiza

Apacheta

La Torta de Tocorpuri