

Arsenic in wells at the Guayabo Caldera in Northwest Costa Rica

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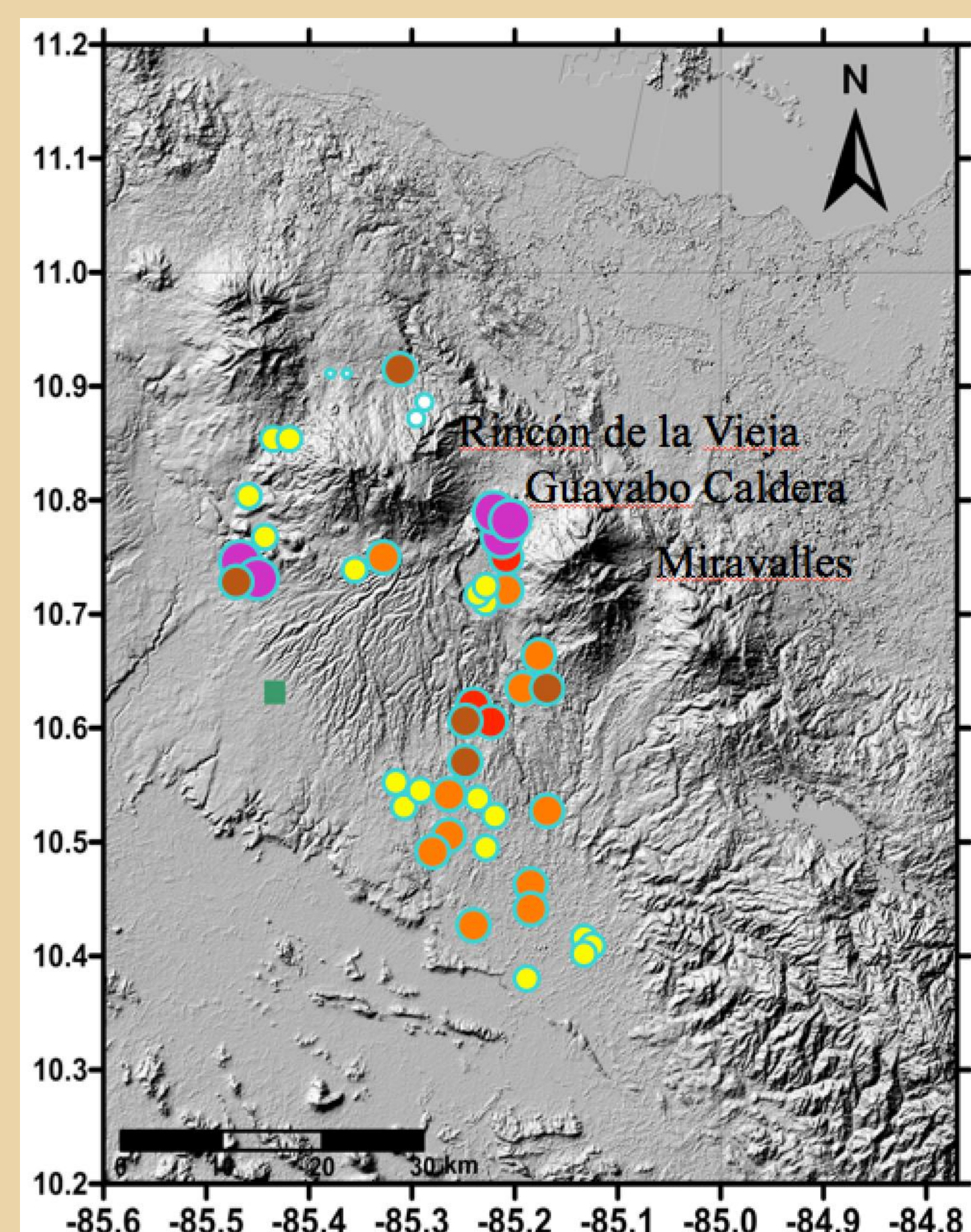
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Introduction

The Guayabo Caldera, a 14 km diameter volcanic depression with Miravalles volcano rising 2028 m a.s.l. in the northeastern side of so called, formed by repeated eruptions and multiple collapses which dismembered earlier volcanoes between 1.5 to 0.6 m.y. ago. The pyroclastic-flow sheets represent more than 30 km³ of dacitic to rhyolitic magma associated to crystal fractionation processes. Microprobe and geobarometric analyses of amphibole suggest that the level of the magma chamber was shallow, 5 km or less (Gigolini et al., 2018).

A number of deep wells (400 to 700m) have been drilled at the southwest-south flanks of Miravalles volcano leading to the development of a geothermal field with an installed capacity of 163 MWe that has been running for ca. 25 years.

The wells are from a liquid-dominated reservoir characterized by sodium chloride waters and near neutral pH in the SW flank of Miravalles volcano, however in the NE flank, wells produce sulphate rich acid fluids. The permeability of the geothermal system is mainly fracture controlled.



Guayabo Caldera based on Vega et al. (2005). Green square Liberia town. Circles: Concentrations of As in ground and surface waters: Púrpura 10,000-11,000 ppb; Red 2000-5000 ppb (62-72° C); Brown 40-300 ppb; Orange 10-28 ppb; Yellow 5-9 ppb; White 2-3 ppb springs; tiny white circles b.d.l. As.

Methodology

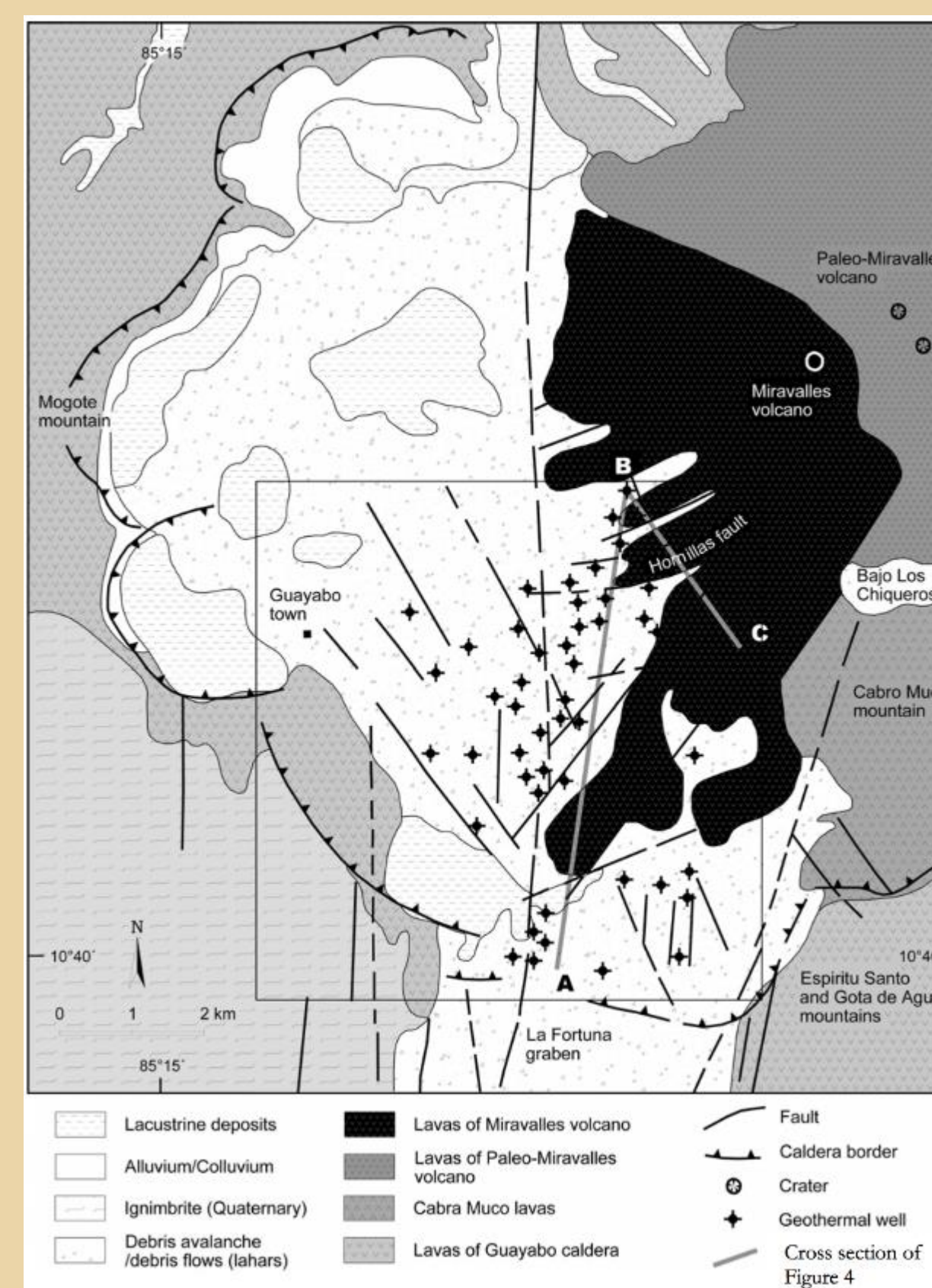
- Field observations, sampling, measures and inhabitants' knowledge
- ICP-MS instrumental
- Data comparison

Results



Water samples from 30m deep wells located in Termales Salitral in Bagaces, outside the SW edge of the Guayabo Caldera, were collected in Feb 2017 and April 2018 for As analysis by ICP-MS. The As concentrations found in the samples from both campaigns yielded similar average values of 3980 ± 500 ug/L and 4320 ± 510 ug/L of total As. A sample from a family house nearby measured 63 ug/L As. These values exceed by far the normative for As in drinking water (OMS limit 10 ug/L).

A system of structural features oriented N-S and NE-SW that enhance the permeability of fluids from a high enthalpy reservoir originates the geothermal system of Guayabo Caldera-Miravalles volcano (230-255° C) and possibly the presence of As in ground and surface waters at the SW of the caldera.



Key Points

Arsenic concentrations in wells at the SW border of the Guayabo Caldera such as Termales Salitral, exceed by far the normative with values up to 2000 to 5000 ppb As. Nonetheless, As concentrations in some of the wells within the Guayabo Caldera are even one order of magnitude higher (10,000 to 11,000 ppb As) (Hammarlund, L. et Piñones, J., 2009; this study).

These results are of a great concern due to the high toxicity of As and the risks that this element represent for humans, animals and the quality and integrity of ecosystems in general (CRHoy, 2017).

The pollution of drainages with As is one of the most significant environmental issues at the surroundings of geothermal plants (Welch, A.H et Stollenwerk, K.G., 2003).

Further studies must be carried out in the near future to determine the transfer of As beyond the borders of the geothermal field, its presence in a extensive distribution network, the As speciation, and recognition of other sites with such a high As concentrations and to learn about the uses of water resources in the area.

It is urgent and crucial that Costa Rica and its governmental entities and universities research about the causes of pollution of ground and surface waters with As, through a revision process of methods and results developed by several certified laboratories and the establishment of remediation strategies for As pollution.

Acknowledgements

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