

Geochemical survey of volcanic gases at touristic areas of El Salvador

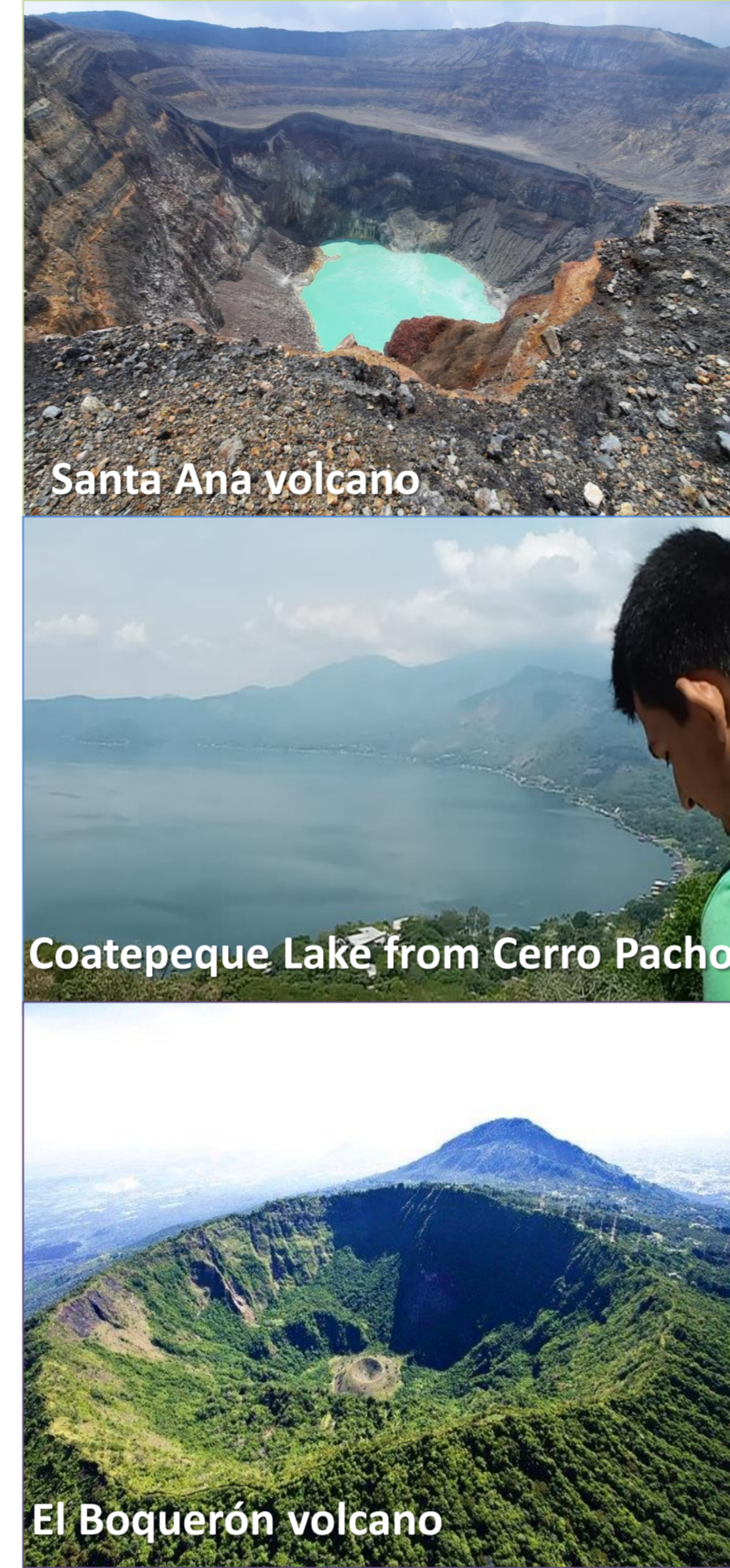
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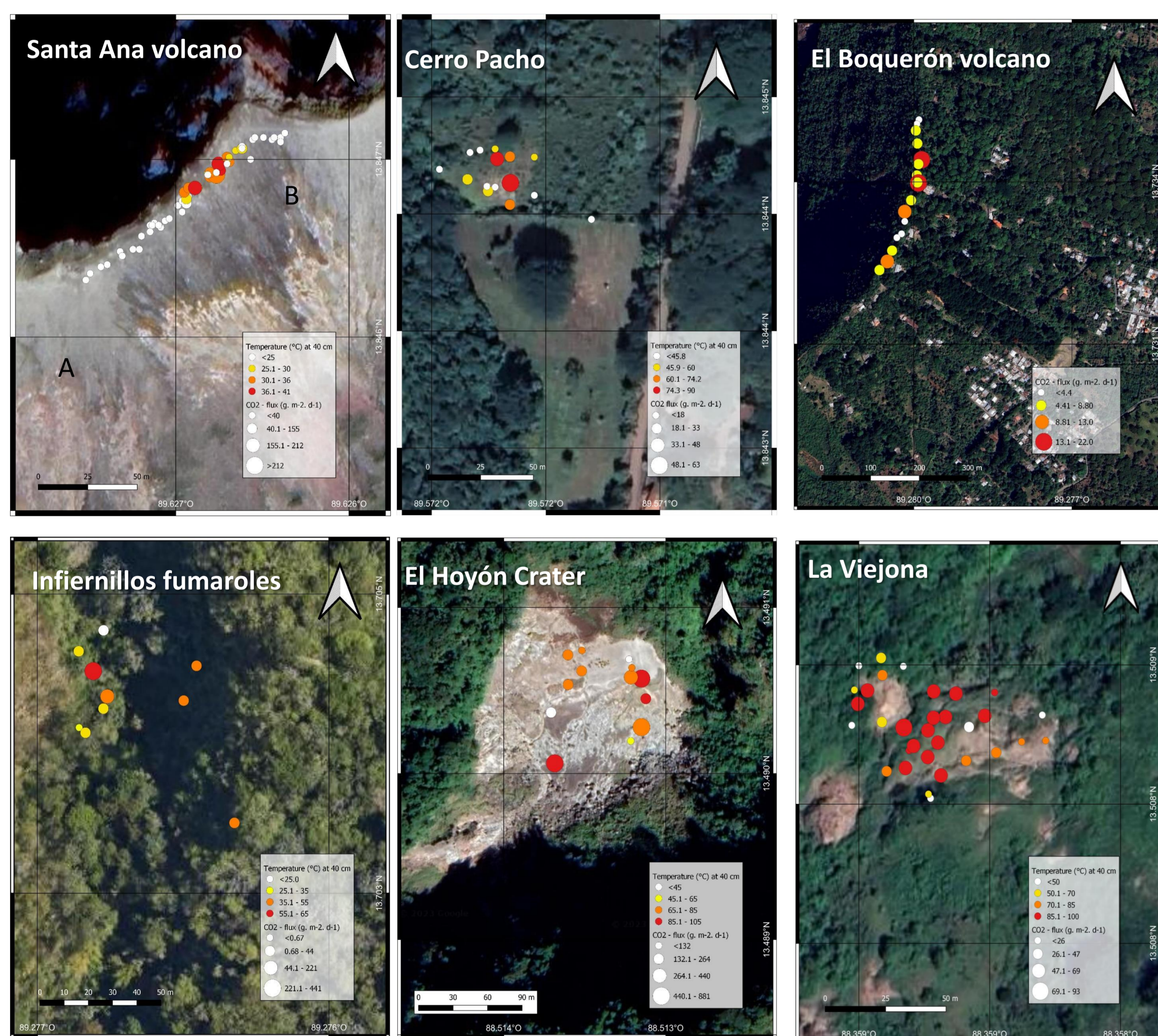
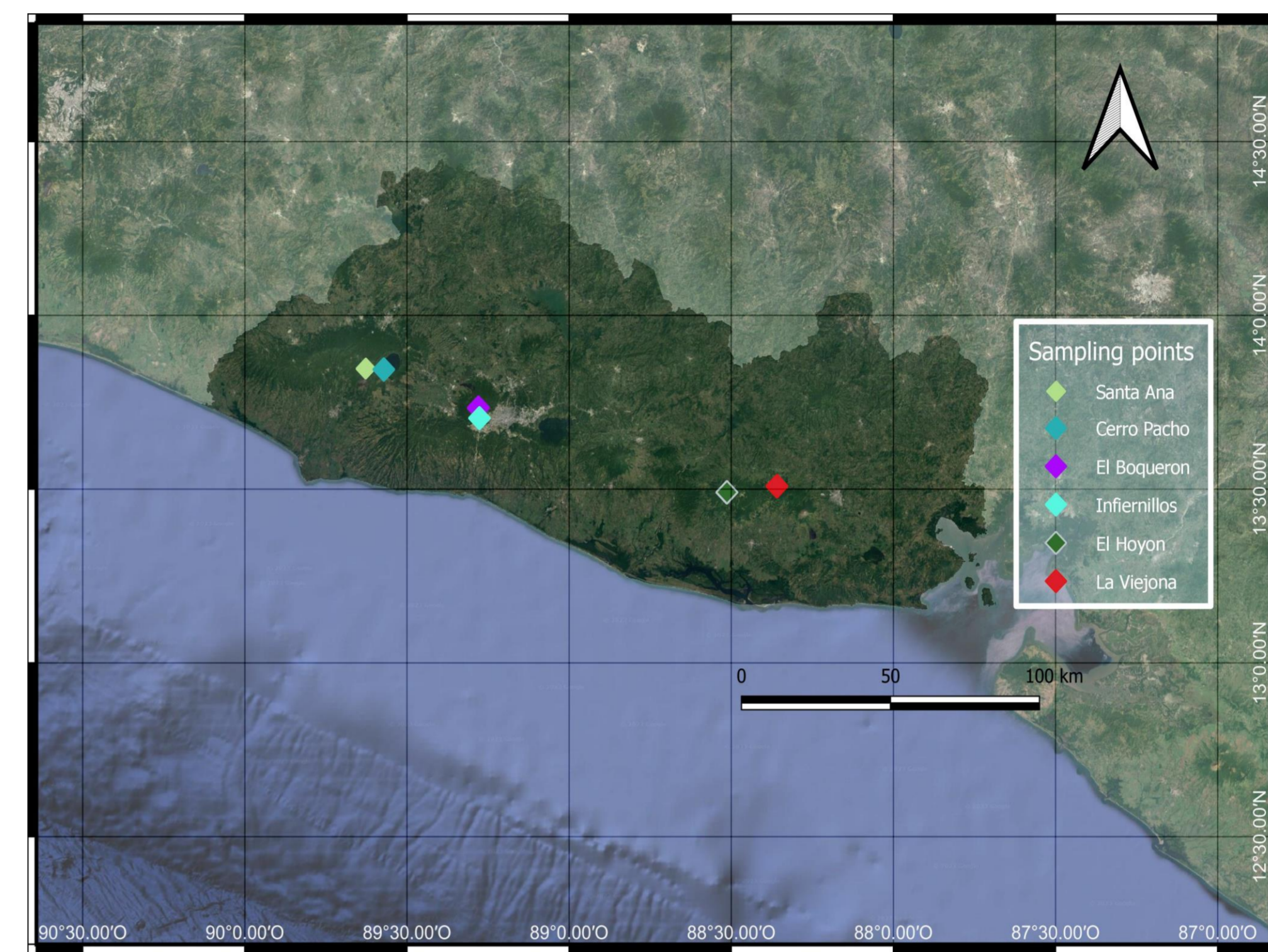
Introduction

El Salvador's volcanoes are one of the country's main touristic attractions. Every year, thousands of local and foreign tourists visit these active volcanic areas, notwithstanding numerous associated dangers. These areas often have potential risks, and a robust and systematic geochemical monitoring of volcanic activity is absent. A preliminary geochemical survey was carried out at the most visited volcanic sites: Santa Ana volcano, Cerro Pacho, El Boquerón volcano, Infiernillos fumaroles, El Hoyón Crater and La Viejona. It included diffuse soil CO₂ flux measurements and gas samples, collected in May 2023 to determinate their chemical and isotopic compositions.

In this study the CO₂ soil flux measurement technique was applied using the Accumulation Chamber Method (ACM) (Chiodini et al., 1996). The criteria used to select the sampling sites were obvious hydrothermal activity and volcanic areas that suppose a risk to the tourists. In addition, 11 gas samples were collected from fumaroles and bubbling hot springs to determine their chemical and isotopic composition and analyzed by gas chromatography and stable isotope mass spectrometry.



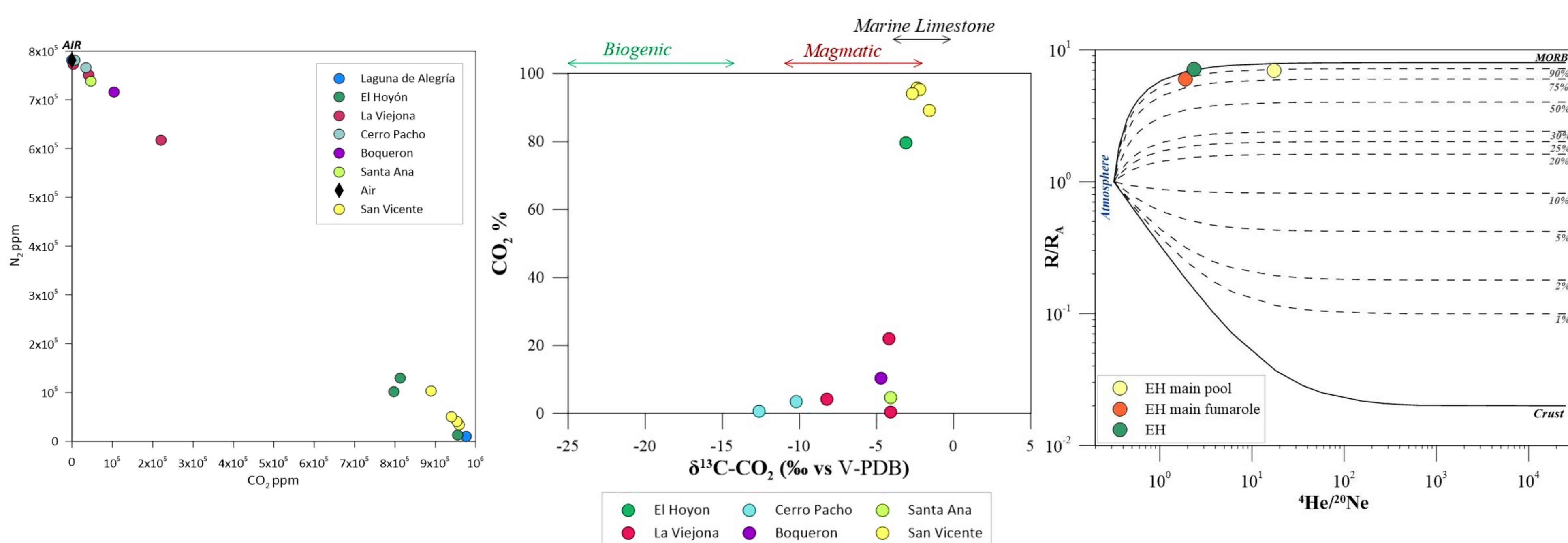
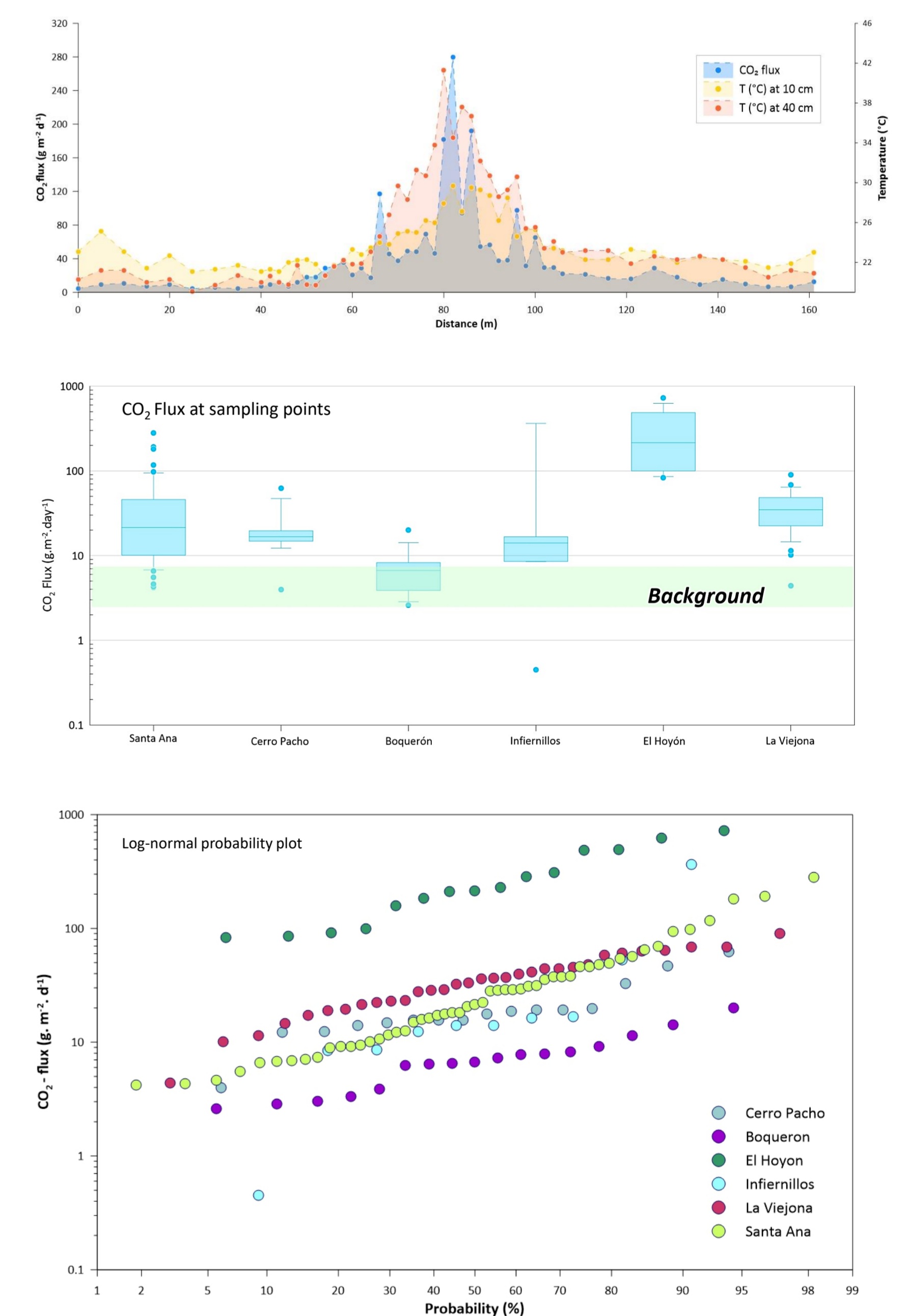
El Salvador's volcanic touristic areas



Maps of soil CO₂ fluxes and temperatures at 40 cm depth

Results and Discussion

The highest CO₂ flux values were obtained at El Hoyón crater, with a median value of 214.6 g·m⁻²·day⁻¹, whilst the lowest values were from El Boquerón, with a median value of 6.7 g·m⁻²·day⁻¹. El Boquerón maintains its carbon dioxide fluxes at background levels, also reported for Salvadoran volcanoes such as San Miguel, San Salvador and the Santa Ana-Izalco-Coatepeque volcanic complex (Cartagena et al., 2004). The log-normal probability plots (Sinclair, 1974) show the existence of polymodal distribution of the data, indicating overlapping of different populations of CO₂ fluxes at all study sites. La Viejona shows thermal anomalies at 40 cm depth that are not well reflected in high diffuse CO₂ fluxes in the soil, which may be due to the fact the soil is also highly altered by interaction with hydrothermal fluids as evidenced by argillization (Chiodini et al, 1998). Thermal and CO₂ flow anomalies were identified and sampled to be quantified.



Chemical composition of the gases showed a mixing pattern between a CO₂-dominated (up to 976,200 μmol/mol) end-member of deep origin and a N₂-dominated atmospheric component, the same pattern has been observed in the geothermal field of the San Vicente volcano (Aiuppa et al., 1996). Helium values arrived up to 4.6 μmol/mol. Only La Viejona site presented a slight enrichment in methane (up to 155 μmol/mol), whilst only El Hoyón site showed enrichment in H₂S (up to 22,800 μmol/mol). δ¹³C-CO₂ values varied from -12.6 to -3.1 ‰. Whereas the helium isotope composition, measured only in three sites, gave R/RA values comprised between 5.98 and 7.11. Such values indicate a clear magmatic contribution to the deep end-member.

Conclusions

All of the sites studied have CO₂ flow point anomalies, and the presence of different geochemical populations suggests that populations associated with background CO₂ flow overlap with deeper sources of this gas, moreover, all sites show thermal anomalies. However, El Hoyón and La Viejona are the two sites with the highest temperatures recorded in this study. These preliminary data show significant potential volcanic activity that needs continuous geochemical monitoring, and the evaluation of the risks to which tourists are exposed.

References

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