EGU24-14781, updated on 10 Sep 2024
https://doi.org/10.5194/egusphere-egu24-14781
EGU General Assembly 2024

The silent degassing of volcanoes: a useful tool for volcanic surveillance and a significant contributor to the global CO_2 emission from subaerial volcanism

Nemesio M. Pérez[1,2] and the INVOLCAN/ITER Research Team[*]
[1]Instituto Volcanológico de Canarias (INVOLCAN), 38400 Puerto de la Cruz, Tenerife, Canary Islands, Spain (nperez@iter.es)
[2]Instituto Tecnológico y de Energías Renovables (ITER), 38600 Granadilla de Abona, Tenerife, Canary Islands, Spain
[*]A full list of authors appears at the end of the abstract

Volcanoes emit significant amounts of gases into the atmosphere through visible and non-visual degassing manifestations regardless of whether volcanoes are active or quiescent. The latter, also known as diffuse or silent degassing, occurs across the entire volcanic building. Water vapour (H_2O), carbon dioxide (CO_2), and sulfur (S) are the three most abundant magmatic volatiles, with CO_2 being the least soluble in silicate melts. Diffuse volcanic degassing alters the chemical composition of volcanes' ground/soil gas atmosphere, resulting in enrichment of CO_2, He, and other gas species. Over the last 25 years, extensive research on diffuse CO_2 degassing has been conducted at volcanic and geothermal systems, indicating that silent CO_2 degassing is an important mechanism for dissipating energy at volcanoes and contributes significantly to global CO_2 emissions from subaerial volcanism. As a result, diffuse CO_2 degassing studies have been regarded as a powerful tool in geochemical monitoring programs for volcanic surveillance, particularly in volcanic areas lacking visible gas manifestations (plume, fumaroles, hot springs, etc.), a valuable tool for identifying productive geothermal reservoirs, and a potential source of large amounts of CO_2 to the atmosphere via gobal subaerial volcanism.

Diffuse degassing investigations on volcanoes involve primarily in-situ ground CO_2 efflux measurements and the collecting of gases at a certain depth for later chemical and isotopic analysis. CO_2 and He are the two most interesting gas species to investigate in diffuse degassing studies due to their similar low solubility in silicate melts at low pressures and suitability as geochemical tracers of magmatic activity. However, once exsolved from the silicate melts, their journey through the crust to the surface is considerably different. While CO_2, as a reactive gas, is influenced by interfering processes (gas scrubbing by groundwaters and interaction with rocks, decarbonatation processes, biogenic production, and so on), He is chemically inert, radioactively stable, non-biogenic, highly mobile, and relatively insoluble in water. These properties minimize the interaction of this noble gas with the surrounding rocks or fluids during its ascent towards the surface. Their geochemical differences yield higher relative He/CO_2 ratio in the fumarole gases than is actually present in the magma, but it decreases when the magma reservoir reaches enough pressure to generate incipient fracture systems approaching the eruption, thus releasing considerably more of the magma volatiles.

Quantifying global volcanic CO_2 emissions from subaerial volcanism is critical for gaining a better knowledge of the rates and mechanisms of carbon cycling, as well as their effects on the long-term development of Earth's climate across geological timescales. Recent studies show that diffuse degassing contributes 47 to 174 $Tg \cdot y^{-1}$ to the atmosphere, although our understanding of the global diffuse CO_2 degassing from subaerial volcanism could be larger.

Several examples of diffuse degassing research on many different volcanic systems around the world performed by our research team and collaborators during the last 25 years will be presented during my award/medal lecture, strongly supporting that diffuse degassing is a useful tool for volcanic surveillance and a significant contributor to the global CO_2 emissions from subaerial volcanism.

INVOLCAN/ITER Research Team: Pedro A. Hernández, Gladys V. Melián, Eleazar Padrón, Germán D. Padilla, José Barrancos, Fátima Rodríguez, María Asensio-Ramos, Luca D'Auria, Alba Martín-Lorenzo, Ana Gironés Montesdeoca, Beverley C. Coldwell, Claudia Rodríguez-Pérez, Daniel Hugo Di Nardo, David Afonso Falcón, David Martínez van Dorth, Hector de los Rios, Iván Cabrera Pérez, Matthew J. Pankhurst, Megan Expósito Brazier, Mónica Arencibia Hernández, Monika Prezor, Rubén García Hernández, Sttefany Cartaya Arteaga, Víctor Ortega Ramos, Victoria J. Leal Moreno, Violeta T. Albertos Blanchard