EGU2020-10712
https://doi.org/10.5194/egusphere-egu2020-10712
EGU General Assembly 2020
© Author(s) 2020. This work is distributed under
the Creative Commons Attribution 4.0 License.

First measurements of volcanic gas composition at Bagana volcano, Papua New Guinea

Brendan McCormick Kilbride[1], Emma Liu[2], Kieran Wood[3], Thomas Wilkes[4], Ian Schipper[5], Kila Mulina[6], Thomas Richardson[3], Cynthia Werner[7], Andrew McGonigle[4], Tom Pering[4], Alessandro Aiuppa[8], Marcello Bitetto[8], Gaetano Giudice[8], and Ima Itikarai[6]
[1]Department of Earth and Environmental Sciences, University of Manchester, United Kingdom (brendan.mccormickkilbride@manchester.ac.uk)
[2]Department of Earth Sciences, University College London, United Kingdom
[3]Department of Aerospace Engineering, University of Bristol, United Kingdom
[4]Department of Geography, University of Sheffield, United Kingdom
[5]School of Geography, Environment and Earth Sciences, Victoria University of Wellington, New Zealand
[6]Rabaul Volcanological Observatory, Papua New Guinea
[7]Cascades Volcano Observatory (Contractor), United States Geological Survey, United States of America
[8]Department of Earth and Marine Sciences, University of Palermo, Italy

Bagana volcano, Papua New Guinea, is among Earth's youngest and most active volcanoes. Bagana typically exhibits multi-year episodes of lava extrusion, interspersed with pause periods characterised by strong passive degassing. Based on satellite-based observations, Bagana is the third ranked global source of volcanic sulfur dioxide over the past 15 years. Recent work based on global correlations between volcanic gas composition and magma trace element chemistry has predicted that it may be the fifth ranked global volcanic deep carbon source. However, this indirect estimate of Bagana's potential carbon budget has yet to be ground-truthed by in-situ sampling.

We visited Bagana in September 2019 and made the first measurements of the chemical composition of the volcano's summit gas plume. We placed a miniaturized MultiGAS sensor array on board an unoccupied aerial system (UAS, or drone) and flew the sensors through the plume. Our aircraft flew beyond visual line of sight, reaching the gas plume from around 7 km horizontal distance and 2 km altitude below the summit. Such long-range UAS flights offer immense potential for studying gas emissions from such steep, active or remote volcanoes.

Our MultiGAS flights found relatively low concentrations of both sulfur dioxide and carbon dioxide in the Bagana plume. Moreover, we made coincident remote sensing measurements of sulfur dioxide emissions using ground- and UAS-based ultraviolet spectroscopy and calculated SO2 fluxes of only ~400 tonnes per day. These are an order of magnitude below the typical fluxes inferred from satellite observations. Combining MultiGAS plume composition (CO2/SO2 molar ratio, mean ~3.4) and SO2 fluxes allow us to estimate Bagana's CO2 flux into the atmosphere as only ~1360 t/d.

Our interpretation of these results is that the volcano is presently in a low state of activity. From satellite observations, we note the cessation of the most recent extrusive episode several weeks prior to our field campaign. The lack of the anticipated strong passive degassing often observed by spaceborne UV sensors is likely a result of "scrubbing" in the volcanic edifice, where rising gases interact with groundwater, resulting in dissolution of sulfur species into the groundwater and perhaps precipitation of sulfur-bearing minerals into edifice fractures. As the volcano moves towards a future extrusive episode, we might anticipate the gradual drying out of the hydrothermal system and a shift towards more truly magmatic gas compositions. Our results show that short campaign measurements may not provide data which are representative of a volcano's longterm behaviour and we suggest that caution is needed in using such data to calculate or extrapolate regional and global volatile emissions inventories.