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► **To cite this version:**

Philipson Bani, François Nauret, C. Oppenheimer, A. Aiuppa, B.U. Saing, et al.. Heterogeneity of volatile sources along the Halmahera arc, Indonesia. *Journal of Volcanology and Geothermal Research*, 2021, 418, pp.107342. 10.1016/j.jvolgeores.2021.107342 . hal-03474043

**HAL Id: hal-03474043**

**<https://hal.uca.fr/hal-03474043>**

Submitted on 10 Dec 2021

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# Heterogeneity of volatile sources along the Halmahera arc, Indonesia

Bani P.<sup>1</sup>, Nauret F.<sup>1</sup>, Oppenheimer C.<sup>2</sup>, Aiuppa A.<sup>3</sup>, Saing B.U.<sup>4</sup>, Haerani N.<sup>4</sup>, Alfianti H.<sup>4</sup>, Marlia M.<sup>4</sup>, Tsanev V.<sup>2</sup>

*1-Laboratoire Magmas et Volcans, Université Blaise Pascal-CNRS-IRD, OPGC, 63170 Aubière, France*

*2- Department of Geography, University of Cambridge, Downing Place, Cambridge CB2 3EN, UK*

*3- Dipartimento DiSTeM, Università di Palermo, 90123 Palermo, Italy*

*4- Center for Volcanology and Geological Hazard Mitigation (CVGHM), Jl. Diponegoro No. 57, Bandung 40122, Indonesia;*

## Abstract

The parallel Halmahera and Sangihe arcs in eastern Indonesia are sites of active arc-arc collision of considerable interest in developing understanding of the geodynamics and geochemistry of subduction zones. Owing to the comparative remoteness of the region, few ground-based studies of the volcanoes have been undertaken. Here, we report and integrate gas measurements and (isotope) geochemical analyses of lava samples for Dukono, Ibu, Gamkonora, Gamalama, and Makian volcanoes of the Halmahera arc. Summing gas fluxes for all five volcanoes indicates arc-scale emission budgets for H<sub>2</sub>O, CO<sub>2</sub>, SO<sub>2</sub>, H<sub>2</sub>S, and H<sub>2</sub> of 96300±27000, 2093±450, 944±400, 79±20, and 15±4 Mg/d, respectively. Dukono is the greatest source of SO<sub>2</sub> and H<sub>2</sub>, while Ibu emits the most H<sub>2</sub>O and H<sub>2</sub>S. Both Gamalama and Ibu are significant CO<sub>2</sub> sources. Dukono (farthest from the trench) releases the most CO<sub>2</sub>-poor gas. Geochemical and isotopic analyses of recent ejecta emphasize the role of high fluid fluxes in the mantle wedge, necessary for partial melting of depleted mantle. Pb, Nd, and Sr isotope ratios, combined with Ba/Nd, Zr/Nd, Ba/Th, and Zr/Nb ratios, provide evidence for compositional variability along the Halmahera arc, and indicate decreasing subducted sediment contribution from south (Makian, Gamalama) to north (Gamkonora, Ibu, Dukono). Additionally, fluids formed by dehydration of altered crust become prominent at the northern volcanoes. Isotopic and Ba/Nb ratios from the Neogene and Quaternary sources compared to the current magmas further emphasize the evolution of magma genesis since the Neogene.