Heterogeneity of volatile sources along the Halmahera arc, Indonesia

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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_2O, CO_2, SO_2, H_2S, and H_2 of 96300±27000, 2093±450, 944±400, 79±20, and 15±4 Mg/d, respectively. Dukono is the greatest source of SO_2 and H_2, while Ibu emits the most H_2O and H_2S. Both Gamalama and Ibu are significant CO_2 sources. Dukono (farthest from the trench) releases the most CO_2-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.