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Gas monitoring before, during, and after the 2022 eruption of Mauna Loa, Hawai'i: Perspectives on the magmatic system and lessons for future monitoring strategies

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Mauna Loa erupted from November 27 to December 10, 2022, for the first time since 1984. The eruption began in the summit caldera, Moku'āweoweo, and on November 28 migrated to the Northeast Rift Zone ~9 km away. Eruptive fissures produced ~150 million m^3 of basaltic lava (bulk) and outgassed 1.5-2.3 Mt of SO_2 and 0.3-0.4 Mt CO_2.

Prior to the eruption, gas compositions were monitored continuously by two telemetered multi-GAS stations: one located in Moku'āweoweo and one ~11 km to the southwest at Sulphur Cone in the Southwest Rift Zone. The multi-GAS stations measured ambient H_2O, CO_2, SO_2, and H_2S gas abundances and ratios in situ, plus meteorological parameters. Within the first few minutes of the eruption, the Moku'āweoweo multi-GAS was destroyed by lava, ending a 2.6-year long monitoring record. Despite proximity to the initial fissure, the Moku'āweoweo multi-GAS did not measure any gas-compositional changes before the eruption, nor did data from the distal Sulphur Cone multi-GAS. Instead, combined analysis of CO_2 and wind data from Moku'āweoweo identified areas of persistent CO_2 outgassing that were unchanging from April 2020-November 2022.

During the eruption gases were monitored using campaign methods. Car-based DOAS measurements revealed enormous SO_2 emission rates >300 kt/day in the first few days that dropped to <3 kt/day by the eruption's end. On November 28 a helicopter-borne multi-GAS measured plume $CO_2/SO_2 = 0.28 \pm 0.05$ (molar), indicating that magma had lost considerable CO_2 during shallow storage prior to eruption. After the eruption, ground-based multi-GAS surveys in Moku'āweoweo found that surface expressions of CO_2 outgassing identified by the Moku'āweoweo multi-GAS station had been reestablished.

These data show that the 2022 eruption proceeded without discrete intrusion of fresh, CO_2-rich magma from deeper in the system within the last ~2 years and that it was fed by CO_2-depleted magma that accumulated in the shallow system. Pathways that release CO_2 from deeper in the system were not disturbed by the eruption. Future gas monitoring should focus on site survivability and aim to collect continuous data to better understand deep magmatic processes at Mauna Loa on decadal timescales.