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Diffuse CO2 degassing precursors of the January 2020 eruption of Taal volcano, Philippines

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Taal Volcano produces powerful eruptions and is the largest volcanic threat to the Phillipines. Six of the 24 known eruptions since 1572 have resulted in fatalities, and today several million people live with a 20-km radius. Since 2008, our volcano research group has conducted a collaborative research program with Phillipine scientists on applied geochemistry for volcano monitoring. One of the outcomes of this collaborative research was to observed precursor signals to the January 2020 eruptive activity.

Significant temporal variations in diffuse CO_2 emission at the Taal Crater Lake (TLC) was observed across the ~12 years. Two periods are especially noteworthy. From March 2010 to March 2011 the diffuse CO_2 emission rate increased from 763 ± 18 to 4.670 ± 159 tons per day. This anomalous increase coincided with the occurrence of a volcano-seismic unrest characterized mainly by a significant increase in the frequency of volcanic earthquakes, which was interpreted as indicating a new magma intrusion (Arpa et al., 2013; Hernández et al., 2017). A second anomalous diffuse CO_2 degassing at the TCL, from 860 ± 42 to 3.858 ± 584 tons per day during the period October 2016 to November 2017, was observed.

In addition to the geochemical surveys of diffuse CO_2 emission from the TCL, an automatic geochemical station for continuous monitoring of soil CO_2 efflux at the northern sector of the Taal Volcano Island crater rim was installed on January 2016. Although short-temp fluctuations in the diffuse CO_2 emission time series have been partially driven by meteorological parameters, the major CO_2 efflux changes were not driven by such external fluctuations. The major long-term variation of the CO_2 emission was an increase trend of the moving average of soil CO_2 efflux measurements (168 values) in 2017. Since 14 March, 2017, the station measured a sharp increase of CO_2 emission from ~0.1 up to 1.1 kg m^{-2} d^{-1} in 9 hours and continued to show a sustained increase in time up to 2.9 kg m^{-2} d^{-1} in November 2017. These combined geochemical and

geophysical observations are most simply explained by magma recharge to the system, and represent precursor signals to the January 2020 eruptive activity.

Taal Volcano Background

Taal Volcano is one of the most active volcanoes in the Philippines and has produced some of its most powerful historical eruptions. Located on the southwestern part of Luzon Island, Taal consists of a 15-22-km prehistoric caldera, occupied by the Taal Lake and the active vent complex of Taal Volcano Island with its Crater Lake (TCL).

Arpa M. C. et al (2013). Geochemical evidence of magma intrusion inferred from diffuse CO_2 emissions and fumarole plume chemistry: the 2010–2011 volcanic unrest at Taal Volcano, Philippines. Bulletin of Volcanology, DOI: 10.1007/s00445-013-0747-9.

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