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Geochemical monitoring of Taal volcano (Philippines) by means of diffuse CO_2 degassing studies

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Observing changes in the discharge rate of CO_2 is an important part of volcanic monitoring programs, because it is released by progressive depressurization of magma during ascent and reach the surface well before their parental magma. Taal Volcano in Southwest Luzon, Philippines, lies between a volcanic arc front facing the subduction zone along the Manila Trench and a volcanic field formed from extension beyond the arc front. Taal Volcano Island is formed by a main tuff cone surrounded by several smaller tuff cones, tuff rings and scoria cones. This island is located in the center of the 30 km wide Taal Caldera, now filled by Taal Lake. To monitor the volcanic activity of Taal volcano is a priority task in the Philippines, because several million people live within a 20-km radius of Taal's caldera rim. During the last period of volcanic unrest from 2010 to 2011, the main crater lake of Taal volcano released the highest diffuse CO_2 emission rates through the water surface reported to date by volcanic lakes worldwide. The maximum CO_2 emission rate measured in the study period occurred two months before the strongest seismic activity recorded during the unrest period (Arpa et al., 2013, Bull Volcanol 75:747). After the unrest period, diffuse CO_2 emission has remained in the range 532-860 t/d in the period 2013-2016. In January 2016, an automatic geochemical station to monitor in a continuous mode the diffuse CO_2 degassing in a selected location of Taal, was installed in January 2016 to improve the early warning system at the volcano. The station is located at Daang Kastila, at the northern portion of the main crater rim. It measures hourly the diffuse CO_2 efflux, atmospheric CO_2 concentration, soil water content and temperature, wind speed and direction, air temperature and humidity, rainfall, and barometric pressure. The 2016 time series show CO_2 efflux values in the range 20-690 g m^{-2} d^{-1}.Soil temperature, heavily influenced by rainfall, ranged between 74 and 96^{o}C. Although short-temp fluctuations in the diffuse CO_2 emission time series at Daang Kastila were partially driven by meteorological parameters, the main CO_2 efflux changes were not driven by fluctuations of meteorological variables such as wind speed or barometric pressure and seem clearly to be associated with fluid pressure fluctuations in the volcanic system. These results showed the potential of applying continuous and discrete monitoring of soil CO_2 efflux to improve and optimize the detection of early warning signals of future volcanic unrest at Taal volcano.