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Monitoring diffuse CO_2 degassing at Masaya caldera, Nicaragua

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Masaya caldera complex (635m a.s.l.), located 20km southeast of Managua, is a large basaltic shield volcano of 11.5x9.6km in diameter with its long axis parallel to a Quaternary volcanic chain. Inside this caldera a new basaltic complex has grown with Masaya and Nindiri cones hosting the pit craters of Masaya, Santiago, Nindiri and San Pedro. Since 1772, an intermittent lava lake has appeared inside Santiago pit crater. El Comalito Cinder cone is an adventitious cone located 3.5km NE of Santiago crater, along a northeast-trending fracture with low-temperature fumaroles at its foot, being the place with the highest soil CO_2 fluxes measured in volcanoes worldwide. With the aim of providing a multidisciplinary approach to the volcanic surveillance program of Masaya, discrete and continuous diffuse CO_2 degassing studies have been performed in collaboration with INETER.

Soil diffuse CO_2 degassing surveys are undertaken at Masaya to investigate the level of activity of the volcano. In 2008, a survey with 600 measurements was performed with a portable fluxmeter following the accumulation chamber method (Parkinson, 1981) covering an area of 41.8km^2. From the spatial distribution maps constructed following the sequential Gaussian simulation, we estimated a diffuse CO_2 emission rate of 295 td^{-1}, with 22% (66 td^{-1}) coming from Comalito (0.09km^2). Due to this fact, we selected Comalito as a target to perform periodical discrete surveys. Diffuse CO_2 emission rates from Comalito have ranged between 14-66 td^{-1}. Since December 2008, diffuse CO_2 emission rates showed a decreasing trend from 66-14 td^{-1} on October, 2012. During this period two increments up to 51 td^{-1} on January and July, 2012 were observed together with an increment in the volcanic activity level (April-June, 2012). From October 2012 until present, diffuse CO_2 emission rates showed an increasing trend from 51-61 td^{-1} agreeing with a strongly circulation at the persistent lava lake, gas plume activity and intermittent ash emission from October, 2015 to December, 2017. Spatial distribution of diffuse CO_2 values at Comalito have shown a close spatial relationship with fumarolic areas, where high soil H_2S efflux and soil temperatures are observed, suggesting a structural control of the degassing process governed by advective transport mechanism. Between March 2002 and April 2004 a continuous geochemical station was installed at the foot of El Comalito to record in a hourly basis by means of the accumulation chamber method the diffuse CO_2 emission rate simultaneously with meteorological and soil physical parameters. Temporal variations in the diffuse CO_2 emission were observed before two seismic events occurred at 10 and 30km away from El Comalito: Las Colinas (M4.3) and a seismic swarm at Xiloa caldera (M3.6). Both seismic events were preceded by long- (1-3 months) and short-term (4-8 days) precursory signals in the diffuse CO_2 emission, respectively. These results show the potential of geochemistry as a tool for detect early warning signal of future volcanic/seismic crisis.

References

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