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Geochemical signals of unrest and eruption of Cotopaxi volcano in 2015

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Cotopaxi volcano, located 50 km south of Quito, is one of the most hazardous volcanoes in the Northern Andes. After 73 years of quiescence, the first sign of unrest was a progressive increase in the amplitude of transient seismic events beginning in early April 2015. An increase in SO2 emissions was also detected by scanning DOAS since May 19, followed by the appearance of seismic tremor on June 4. Both SO2 emissions, up to 5 kt/d, and seismic tremor were observed until August 13 when a swarm of volcano-tectonic earthquakes preceded the first phreatomagmatic explosions, on August 14. During this initial phase SO2 emissions of 12-16 kt were observed daily by the OMI/OMPS satellite-borne sensors. Three successive phases of ash emission occurred after August 14, but both the average seismic amplitude and the SO2 flux progressively decreased during these phases. The total amount of SO2 released to the atmosphere during the unrest and eruptive periods was about 470 kt. BrO was also detected in the plume since the onset of ash emission. Since late September to early November, airborne in-situ Multi-GAS measurements of CO2, SO2, and H2S revealed that the plume had a low CO2/SO2 molar ratio (< 2.1) and that SO2 was the most abundant S-containing gas (H2S was not detected). Solar-FTIR measurements of the plume detected a SO2/HCl molar ratio of 5 to 10. All of the geochemical signals suggest a magmatic and shallow source of the emitted gases. Since late November 2015 all monitored parameters have shown a significant decrease. Permanent monitoring of the flux and composition of the volcanic plume of Cotopaxi heralded the initiation of the eruptive activity and provided important information about its evolution. It has also enabled us to keep track of the location and dispersion of the eruptive plume through time.