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Degassing behavior of Mt. Etna volcano (Italy) during 2007-2008, inferred by crater plume and soil gas measurements.

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Studies on volcanic degassing have recently shown the important role of volatile release from active volcanoes in understanding magmatic processes prior to eruptions. Here we present and discuss the evolution of magmatic degassing that preceded and accompanied the 2008 Mt. Etna eruption. We tracked the ascent of magma bodies by high-temporal resolution measurements of SO2 emission rates and discrete sampling of SO2/HCl and SO2/HF molar ratios in the crater plume, as well as by periodic measurement of soil CO2 emission rates. Our data suggest that the first signs of upward migration of gas-rich magma before the 2008 eruption were observed in June 2007, indicated by a strong increase in soil CO2 efflux followed by a slow declining trend in SO2 flux and halogens. This degassing behavior preceded the mid-August 2007 summit activity culminated with the September 4th paroxysmal event. Five months later, a new increase in both soil CO2 and SO2 emission rates occurred before the November 23rd paroxysm, to drop down in late December. In the following months, geochemical parameters showed high variability, characterized by isolated sudden increases occurred in early December 2007 and late March 2008. In early May soil CO2, SO2 emission rates and S/Cl molar ratio gradually increased. Crater degassing peaked on May 13th marking the onset of the eruption. Eruptive activity was accompanied by a general steady-state of SO2 flux characterized by two main degassing cycles. These cycles preceded explosive activity at the eruptive vents, indicating terminal new-arrival of deep gas-rich magma bodies in the shallow plumbing system of Mt Etna. Conversely, halogens described a slight increasing trend till the end of 2008. These observations suggest an impulsive syn-eruptive dynamics of magma transfer from depth to the surface. Differently from the SO2 emission rates, the S/Cl ratio and the soil CO2 efflux values showed an increasing trend from mid-April to mid-July 2008, indicating steady-increasing input of deeper, gas-rich magma. Since August, geochemical parameters decreased, suggesting that new magma has not arrived from depth. According to our interpretation, both the CO2 efflux and the S/Cl ratio increases observed in early November may indicate a new input of fresh magma form depth. Finally, the estimated volume of degassing magma showed substantial equilibrium between degassed and erupted magma suggesting an “eruptive” steady-state of the volcano.