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The 2007 and 2014 eruptions of Stromboli at match: monitoring the potential occurrence of effusion-driven basaltic paroxysmal explosions from a volcanic CO_2 flux perspective

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The recent effusive unrests of Stromboli occurred in 2002 and 2007 were both punctuated by short-lived, violent paroxysmal explosions generated from the volcano's summit craters. When effusive activity recently resumed on Stromboli, on 6 August 2014, much concern was raised therefore on whether or not a paroxysm would have occurred again. The occurrence of these potentially hazardous events has stimulated research toward understanding the mechanisms through which effusive eruptions can perturb the volcano's plumbing system, to eventually trigger a paroxysm. The anomalously large CO_2 gas emissions measured prior to the 15 March 2007 paroxysmal explosion of Stromboli [1] have first demonstrated the chance to predict days in advance the effusive-to-explosive transition. Here 2007 and 2014 volcanic CO_2 flux records have been compared for exploring causes/conditions that had not triggered any paroxysm event in the 2014 case. We show that the 2007 and 2014 datasets shared both similarities and remarkable differences. The pre-eruptive trends of CO_2 and SO_2 flux emissions were strikingly similar in both 2007 and 2014, indicating similar conditions within the plumbing system prior to onset of both effusive crises. In both events, the CO_2 flux substantially accelerated (relative to the pre-eruptive mean flux) after onset of the effusion. However, this CO_2 flux acceleration was a factor 3 lower in 2014 than in 2007, and the excess CO_2 flux (the fraction of CO_2 not associated with the shallowly emplaced/erupted magma, and therefore contributed by the deep magmatic system) never returned to the very high levels observed prior to the 15 March 2007 paroxysm. We conclude therefore that, although similar quantities of magma were effusively erupted in 2007 and 2014, the deep magmatic system was far less perturbed in the most recent case. We speculate that the rate at which the deep magmatic system is decompressed, rather than the level of de-compression itself, determine if the deep Stromboli's plumbing system is prone to erupt in a paroxysm, or not.

[1] A. Aiuppa et al., Geophys Res Lett, 2010.