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Remote OP-FTIR sensing of magmatic gases driving Yasur trachyandesitic explosive activity, Vanuatu island arc

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Yasur volcano, located in the southern part of the Vanuatu island arc (Tanna island), is a small trachyandesitic cone that has grown in the resurgent (17 cm y-1) Siwi caldera. Since about 1,400 years Yasur has displayed almost continuous Strombolian-Vulcanian explosive activity and is one of the most actively erupting volcanoes worldwide. Using open-path Fourier transform infrared (OP-FTIR) spectroscopy from the crater rim (260-300 m slanting distance) and molten lava as the radiation source, we measured during several days the high frequency compositional variations of magmatic gases driving this explosive activity. Our results expand previous observations from a first FTIR measurement in 2005 [1] and complement in-situ gas measurements made in 2007 [2] within our same research framework (French ANR 'VOLGASPEC' project). FTIR absorption spectra allowed simultaneous retrieval of the molar path amounts of volcanic H_2O, CO_2, SO_2, HCl and CO, corrected for air background in case of H_2O, CO_2 and CO. We observe a rather steady composition of the crater gas release between the explosions ($\sim$one every 1-3 mn) and sharp compositional variations (increases of SO_2/HCl, CO_2/SO_2 and CO/CO_2 ratios, decrease of H_2O/SO_2) associated with the explosions, which demonstrate the ascent and bursting of deeper-derived, CO_2-SO_2-CO-enriched gas slugs. Such abrupt compositional changes of magmatic gases driving explosive activity at Yasur do resemble those recorded at Stromboli volcano [3]. However, in contrast to Stromboli, Yasur explosions generate dense ash clouds whose fast expansion significantly affects the measured column gas amounts at the onset of each event (an effect considered in our data elaboration). When referred to the pressure-related behaviour of dissolved volatiles in the trachyandesitic magma feeding Yasur (melt inclusions [2]), our results provide new constraints on the source depth(s) of the explosions and the magma degassing processes controlling the volcanic activity. Our results can also be interestingly cross-correlated with simultaneous seismic recordings.

[1] Oppenheimer et al., Appl; Physics 2006; [2] Métrich et al., J. Petrology 2011 ; [3] Burton et al., Science 2007.