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Gas flux measurements of episodic bimodal eruptive activity at Karymsky volcano (Kamchatka, Russia)

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Volcanoes of intermediate magmatic composition commonly exhibit episodes of intermittent gas and ash emission of variable duration. Due to the multiple conditions present at each system, different mechanisms have been proposed to account for the observed activity, and without key measurements at hand, a definite understanding of the situation might not be singled out.

Karymsky, the most active volcano of Central Kamchatka, has presented a remarkably stable pattern of bimodal eruption since a few weeks after its violent reactivation in 1996. Periods of quasi-periodic explosive emissions with typical recurrence intervals of 3-10 min are alternated with episodes of semi-continuous discharge which intensity has a typical modulation at a frequency of 1 Hz. Geophysical studies at Karymsky have identified the main visual, seismic and acoustic features of these two eruption modalities. From these observations, the time scales of the processes have been defined and relevant models have been formulated, according to which the two modes are controlled by the rheological properties of an intruding gas-saturated magma batch and a shallow gas-depleted magma plug. Explosions are explained as the consequence of the formation of temporary sealing, overpressure buildup and vent clearance. Clearly, direct measurements of the gas emission rate are the key parameter to test such models.

In this work, we report on the results of a field campaign for SO_2 gas measurements carried out at Karymsky during 10-14 September 2011. We deployed 2 NOVAC-type, scanning DOAS systems as well as 1 rapid wide-Field of View mini-DOAS plume tracker. With this setup, we derived time-resolved SO_2 flux, plume height, direction and speed, and detected pulses of increasing emission with high temporal resolution. We observed phases of explosive and quiescent degassing with variable amounts of ash emission and detected intensity changes of the associated acoustic signals. The repose time intervals between these phases was variable, ranging from minutes to hours. Typical emission columns rose to altitudes not higher than 1 km above the volcano summit and were dispersed to the SE during the observation period. A typical SO_2 gas emission rate for this volcano was in the order of 5 kg/s.

Our measurements corroborated the permanency of the activity of Karymsky both in terms of intensity and magnitude of SO_2 degassing and extended the record of gas observations conducted more than one decade ago.