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Volatile budget of the Nornahraun eruption of the Bárðarbunga system, Iceland

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Following two weeks of an intensive earthquake swarm coupled with approximately 60 cm E-W extension across the volcanic zone north of Vatnajökull glacier, a fissure eruption started on 29th of August 2014 in the Bárðarbunga volcanic system. The continuing eruption produced lava fountains and a lava field associated with minor tephra fallout. The lava is an almost aphyric, olivine tholeiite, containing 1 to 3 vol% of plagioclase and minor olivine and clinopyroxene phenocrysts (Gudfinnsson et al., this session).
Fast cooled tephra was collected on 31st of August and 4th and 8th of September from the vicinity of the fissure. Phenocryst phases as well as groundmass glass have been handpicked and doubly polished and analysed for H_2O and CO_2 with FTIR-spectroscopy. The phenocrysts contain glassy silicate melt inclusions with or without a fluid bubble and some phenocrysts also contain free fluid inclusions.
The fluid phase and the individual fluid inclusions were analysed by Raman Spectroscopy and the abundance of other volatiles (S, F, Cl) has been determined by electron microprobe from exposed inclusions and groundmass glass.
The H_2O content of melt inclusions varies between 0.1 and 0.5 wt% whereas the CO_2 contents are between 900 ppm and detection limit indicating various entrapment conditions of the melt inclusions after fluid saturation. S contents in melt inclusions are as high as 1600 ppm whereas F and Cl contents in the same inclusions are low ($\sim$300 and $\sim$90 ppm, respectively). Groundmass glass contains 0.1 wt% of H_2O, $\sim$400 ppm S and no CO_2. F and Cl in groundmass glass is similar to those measured in the melt inclusions.
Based on the Raman analyses individual fluid inclusions are pure CO_2. The highest determined CO_2 density was 0.642 g/cm3 (using the method by Kawakami et al., 2003). At a temperature of 1180 °C, which is assumed to be the equilibrium temperature of the basalt based on various geothermometers (Haddadi et al., this session), this CO_2 density corresponds to an approximately 3 kbar entrapment pressure ($\sim$9 km entrapment depth). This means that the basalt became CO_2 saturated at lower to mid-crustal levels. CO_2 solubility at 1180 °C and 3 kbars pressure is at least 1500 ppm in basalt (calculated by Volatilecalc, Newman and Lowernstern, 2002). Consequently all melt inclusions analysed so far must have been trapped from partially degassed basalt but before (and deeper) than the onset of H_2O and S degassing. Taking into account the current estimation of extrusion rate the estimated CO_2 output by this eruption is 500 kg/s whereas SO_2 output is on the order of 1000 kg/s.

References:

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