Geophysical Research Abstracts
Vol. 12, EGU2010-8046, 2010
EGU General Assembly 2010

Magmatic heavy halogen concentrations and degassed masses in late Pleistocene to Holocene Plinian eruptions of Nicaragua

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The Nicaraguan volcanoes, which are part of the Central American Volcanic Arc (CAVA), have produced 13 highly explosive eruptions within the last 60 ka. All of these "Plinian" eruptions reached well into the stratosphere such that their released volatiles may have induced changes of atmospheric chemistry and climate. While previous research has focussed on the sulfur and chlorine emissions during such large eruptions, we here present measurements of the heavy halogens (bromine, iodine) by means of synchrotron-XRF microanalysis. Spot analyses of pre-eruptive glass inclusions trapped in minerals formed in magma reservoirs were compared with those in matrix glasses of the tephras, which represent the post-eruptive, degassed concentrations. The concentration difference between inclusion and matrix, multiplied by erupted magma mass determined by extensive field mapping, yields an estimate of the degassed mass of heavy halogens. Br and I are probably hundreds of times more effective in destroying ozone than Cl, and can accumulate in the stratosphere over significant time scales.
The analysed deposits of 12 large eruptions have bromine and iodine contents in the inclusions of 5 to 27 ppm and 1 to 3 ppm, respectively. Br and I concentrations in matrix glasses are nearly constant at 5 ppm and 0.5 ppm, respectively. Analyses by mass spectrometry of pyrohydrolysed samples of the phenocryst-poor bulk glasses confirm the Br and I concentrations observed for matrix glasses.
On average, masses of 50 kilotons of bromine and 27 kilotons of iodine have been released during single eruptions; for the 25 ka eruption of the Upper Apoyo Tephra, however, the released heavy halogen masses are about one order of magnitude larger, reflecting both the larger erupted magma mass and higher magmatic heavy halogen concentrations. Our new data on heavy halogens will be used as input for climate models to evaluate past –and possible future – atmospheric effects.