Magma Degassing and Volatile Budget of Mount Etna Volcano

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Mount Etna, in Sicily, is one of the most active basaltic volcanoes on Earth and the greatest known permanent emittor of magmatic volatiles into the atmosphere (Allard et al., 1991; Allard, 1997). Published and new data on its crater plume emissions and on volatiles dissolved in crystal melt inclusions of the basalts allow to better constrain the dynamics of magma degassing and the volatile budget of this exceptional volcano. COSPEC data for the summit crater plume emissions of SO_2 over the past two decades, combined with other airborne and ground-based determinations of plume chemistry, confirm that Etna alone contributes about 8% of global volcanic emissions of several gas species and elements. Such a huge discharge is supplied by the variable but persistent degassing of volatile-rich alkali basalt, generated by shallow mantle diapiring at the African-European plate boundary. Compared to other (intra-plate) basalts of similar composition, Etna basalts indeed contain high amounts of dissolved water, S, Cl and F, measured in primary olivine melt inclusions, and a high original CO_2 content inferred from C/S mass flux ratios (Métrich and Clocchiatti, 1989; Métrich et al., 1993; Allard et al., 1997; Métrich et al., 2002). Crystal melt inclusion studies allow to constrain the degassing behaviour of these volatiles during magma ascent and to assess the amounts of degassing magma. Such a background serves to interprete the remarkable chemical changes which were detected in the volcanic plume before and during eruptions and lava fountains in 2000-2001 using newly performed routine FTIR remote survey (Allard et al., 2001; Burton et al., 2002). On a time-averaged basis, the gas discharge of Etna requires the degassing of magma volumes that are ~4 times larger than those actually erupted (Allard, 1997). Such an "excess" rate implies that the magmatic degassing is dominantly "intrusive" (separated bubble flow) or/and that the degassed (denser) magma is recycled downward in the conduit system through convective overturn. Its value matches rather well the volumetric proportions of the volcanic pile and of the plutonic body that was found to be emplaced in its sedimentary basement. Groundwaters on Etna additionally carry abundant amounts of dissolved magmatic volatiles (Allard et al., 1997; Aiuppa et al., 2000), however this aqueous contribution is of secondary order compared to the summit crater emissions into the atmosphere.

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