The rheological behavior of samples from Tungurahua volcano, Ecuador

F. W. VON AULOCK, Y. LAVALLEE, D. RICHARD, K-U. HESS AND D. B. DINGWELL

Department of Earth and Environmental Sciences, Section of Mineralogy, Petrology and Geochemistry, Ludwig-Maximilians Universität München (LMU), Theresienstrasse 41/III, 80333 München, Germany (Felixv.aulock@googlemail.com)

For a better understanding of eruption mechanisms it is important to investigate the rheological behaviour of the magma during its ascent in the conduit. We can reveal this information by measuring the physico-chemical properties of volcanic ejecta. Between 16th and 18th of August 2006 a large eruption occurred on Tungurahua volcano including fire fountains, ash-, rock- and pumice falls and lava flows, as well as several pyroclastic flows. Shortly after this, we collected five different rock samples from the pyroclastic flow deposit which represent the most of the mass of rocks of the pyroclastic flows produced in this eruption. The rocks of the pyroclastic flows are:

a) ~5% of dome material with a low porosity of about 15%;
b) ~90% of bread crust bombs which have a higher porosity of about 30-50%.

A reconnaissance study of the rheological properties of our samples obtained via glass transition temperature (T_g) determinations was performed. To this end we have employed an advanced dilatometric method, newly developed by Helo *et al*. (2006).

By detecting the dilatometric softening temperature (T_{gsoft}) in successive runs with the same sample at constant heating and cooling rates, we observed a shift of T_{gsoft} with increasing run number, presumably due to degassing of the supercooled liquid phase. The measured T_{gsoft} for the dome material were 974 °C for the first run and 1030 °C for the 10th run, and ~1060 °C up to ~1100 °C for the bombs. The increase of T_{gsoft} in successive runs was higher for the dome material than for the bread crust bombs.

This was unexpected as the dome material is believed to be more degassed and should therefore have a higher T_{gsoft} than bombs which had less time for degassing. But the results show the opposite trend: higher T_{gsoft} and a faster rise in T_{gsoft} for the porous bomb material. The results of this study will be discussed in terms of the relative degassing histories and kinetics of the dome versus bomb rocks as well as their crystalline textures.

References

Helo C.S., Hess K-U., Potuzak M., Dingwell D.B. (2006), “The Rheological Behavior of Multiphase Liquids Characterized by an Advanced Dilatometric Method”, *Eos Trans. AGU*, **87**(52), Fall Meet. Suppl., Abstract V43A-1781

How fast do the Alps erode? A cosmogenic nuclide study on Central Alpine river basins

F. VON BLANCKENBURG[1], H. WITTMANN, T. KRUESMANN, K.P. NORTON AND P.W. KUBIK

[1]Institute for Mineralogy, Leibniz University of Hannover, Callinstrasse 3, D-30167 Hannover, Germany
[2]Institute for Particle Physics, Paul Scherrer Institute / ETH Zürich, CH-8093 Zürich, Switzerland

Cosmogenic ^{10}Be, measured in river-borne quartz now routinely provides denudation rates at the river basin spatial scale and at the temporal scale of a few kiloyears (von Blanckenburg 2005). A north-south traverse through the Swiss Central Alps reveals that denudation rates correlate with recent rock uplift rates in both magnitude and spatial distribution. As a prerequisite, we took care to investigate the potential influence of shielding from cosmic rays due to snow, glaciers, and topographic obstructions, to calculate a possible memory from LGM glaciation, and to identify a watershed size that is appropriate for systematic sampling. Mean denudation rates are 0.27± 0.14 mm*yr^{-1} for the Alpine foreland, and 0.9± 0.3 mm*yr^{-1} for the crystalline Central Alps. The measured cosmogenic nuclide-derived denudation rates are in good agreement with post-LGM lake infill rates and about twice as high as denudation rates from apatite fission track ages that record denudation from 9-5 Myr. Cosmogenic nuclides now provide the ability to decipher correlations between denudation rate and geomorphic parameters. For example, the rates correlate with hill slope in the Mittelland catchments, but they are independent of angle in the high Alps. We interprete this to mean that high Alpine landscapes are at threshold hillslope, where slopes cannot increase any further before failure occurs. In general, denudation rates are high in areas of high relief and high altitude. Levelling measurements show that the Central Alps are uplifting today with 0.5-1.6 mm yr^{-1} (Kahle *et al*. 1997). The similarity in the spatial distribution and magnitude of denudation rates and those of rock uplift rates can be interpreted in several ways: (i) postglacial rebound or climate change has introduced a transient change in which both uplift and denudation follow each other with a short lag time; (ii) the amplitude of glacial to interglacial changes in both is small and is contained in the scatter of the data: (iii) both are driven by ongoing convergence where their similarity might hint at some form of long-term quasi steady state; (iv) enhanced continuous Quaternary erosion and isostatic compensation of the mass removed accounts for the distribution of present-day rock uplift.

References

Kahle, H., *et al*. (1997). In O. Pfiffner (Ed.), Results of the National Research Program 20 (NRP 20), pp. 251-259, Birkhaeuser Verlag, Basel.

von Blanckenburg, F. (2005) *Earth and Planet Sci. Letters* **237**, 462-479, 2005.