Geophysical Research Abstracts
Vol. 17, EGU2015-12338, 2015
EGU General Assembly 2015

The solidification of obsidian glass during drilling of the IDDP-1 drill hole

Kai-Uwe Hess (1), Donald B. Dingwell (1), Felix von Aulock (2), and Yan Lavalee′ (2)

(1) LMU, Earth and Environmental Sciences, Munich, Germany (hess@lmu.de), (2) University of Liverpool,School of Environmental Sciences, Liverpool, UK

Understanding the thermal fate of magmatic rocks during scientific high temperature drilling represents a contribution to their interpretation in terms of magmatic state and their mechanical response to the drilling process.

Chips of black crystal-poor unfoamed calc-alkaline rhyolitic obsidian have been obtained from a depth of 2100m in the IDDP-1 borehole. Five samples (20-40 mg) have been subjected to scanning calorimetry in order to evaluate the glass transition temperature, viscosity and cooling history of these obsidians that are believed to have been quenched by the drilling process. In addition to scanning runs on the raw glasses, their controlled cooling/heating cycle behavior has been determined at 5, 10 and 25K/min.

The glass transition temperatures of the raw samples lie in the range of 500-525°C. The glass transition temperature shifts with controlled cooling/heating rates yields an activation energy of 335 kJ/mol. The absolute value of the glass transition temperature has been compared with the Hess and Dingwell (1996) viscosity model for calc-alkaline rhyolite. The comparison allows the inference that the obsidian contains water contents consistent with those reported by Elders et al. (2011) Furthermore, the activation energies obtained from the Tg peak shift with cooling/heating rate are entirely consistent with those water contents. The cooling rate estimated for the raw samples are higher than 25K/min. A relatively high cooling rate for a “natural” obsidian.

These glasses have been interpreted to have been quenched from temperatures of 940-760°C (based on water content). From the present glass transition analysis it would appear that the first 200-400K of cooling of these magmas occurred above the glass transition in a plastic state, followed by ca. 500K of solid-state (glassy) cooling.

These results demonstrate that it is possible to use glassy materials derived from the drilling-induced quenching of magma to evaluate the physical state and thermal conditions attendant on deep scientific drilling of these systems.