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Subsolidus Viscosity Measurements of H_2O-saturated Montserrat Andesite and Fish Canyon Tuff Trachy-Dacite

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The viscosity of Montserrat andesite and Fish Canyon Tuff trachy-dacite under water saturated conditions (5.5 wt. %) were determined at 200 MPa between 700 and 900 K. The starting compositions were obtained by mixing appropriate proportions of oxides, hydroxides, metallic iron, carbonates, Na-silicate and natural K-feldspar. AlOOH, $Al(OH)_3$ and Al_2O_3 were used to balance accurately the amount of H_2O and Al_2O_3in the starting material. The powders were sealed in a stainless steel containers (50 mm O.D., 100 mm length) lined by molybdenum foils to avoid contamination and Fe loss during the hydrothermal synthesis experiments. The syntheses were performed in a hot hydrostatic pressing apparatus (HIP) at 200 MPa and 1373 K for 6 hours and quenched to obtain the starting glasses. The samples (14.4 mm O.D., length 6 to 15 mm) for the viscosity determination experiments were directly drilled from the containers, at least 2 mm away from the molybdenum foil to avoid contaminated material.

The compositions of the charges were checked by a JEOL 8200 electron microprobe and the results verified the absence of any contamination. SEM and BSE images confirmed the absence of quench crystals and the presence of less than 1% of bubbles due to water over saturation. The amount of bubbles was quantified analyzing the microprobe images by an image analysis program (UTHSCSA image tool).

The viscosities were determined in axial load using an internally heated gas apparatus (Paterson rig). From the relationships between stress and strain rate we obtained the power law creep behavior of the material and finally the viscosities. The activation energy (H), the pre-exponential factor (A) and the stress-exponent (n) were obtained

by fitting log stress versus log strain rate data using non linear least square regression.

The Montserrat andesite was investigated between 700 and 900 K; the deformation behavior for this material was Newtonian. Assuming n=1 we obtained H=79.90 kJ and A=52.43 Pa^{-n}s^{-1}; when the three parameter were left free to vary we obtained n=1.07, H=79.99 kJ and A=14.75 Pa^{-n}s^{-1}. The logarithm of viscosity is 11.56 at 700 K, 9.84 at 800 K and 8.51 at 900 K assuming n=1 otherwise the values varies of $\pm$0.03 log units. Data at 900 K did not fit the model, they were, therefore, treated separately. Assuming Newtonian behavior we obtained a very similar value for the activation energy (H=79.86 kJ) and a value for the pre-exponential term of 7.92 Pa^{-n}s^{-1}. Using these parameters the logarithm of the viscosity at 900 K was 9.29. These results indicate non-Arrhenian behavior of the Montserrat Andesite.

The Fish Canyon Tuff trachy-dacite was studied between 700 and 750 K. The results of data fitting highlight a non-Newtonian behavior of this material in the investigated T range. Optimum fitting produced an n-value of 1.56, a higher value of H (121.58 kJ) with respect to the andesite and, since the activation energy and the pre-exponential factor are linked, also an increase in the value of A (11.75$\cdot10^6$ Pa^{-n}s^{-1}). The viscosity decreases with increasing strain rate (n$>$1) and varies between 13.8 and 14.5 log units at 700 K, between 13.13 and 12.66 at 725 K and between 12.52 and 11.93 at 750 K. For the restricted T range of the experiments is not possible to assert if the behavior is Arrhenian or non-Arrhenian.