



High temperature steady shear and oscillatory rheometry of basaltic melt

N. Petford (1,3), R. English (2), R. Williams (2), and N. Rogers (3)

(1) University of Northampton, Northampton NN2 7AL, UK, (3) Earth and Environmental Sciences, Open University, Milton Keynes, MK7 6AA, UK, (2) School of Engineering and the Built Environment, Edinburgh Napier University, Edinburgh, EH14 1DJ, UK

There is a paucity of linear viscoelastic data on low viscosity (basaltic) silicate melts. We report here the initial results of a rheometrical characterisation (steady rotation, small angle oscillation) study on a geochemically well constrained aphyric basalt from Ethiopia (SiO_2 48.51 wt.%, Mg# 0.44), in the temperature range 1200-1400 Celsius. Experiments were done using a recently developed commercial instrument (Anton Paar FRS 1600) and a wide gap Couette geometry. To the best of our knowledge these are the first reported silicate melt viscosity data obtained using small amplitude oscillatory shear and a rheometer with a high performance electrically commutated actuator. Results show that in the temperature range the system was very fluid, with the measured shear viscosity falling to ~ 2.3 Pa s at $T = 1400$ C. The melt exhibited a linear (Newtonian) response, with the shear viscosity remaining constant across two decades of deformation rate. As expected for a Newtonian fluid, the phase angle was 90 degrees across the entire range of angular frequencies studied. Correspondingly, the storage modulus (G') was zero and the loss modulus finite exhibiting a linear increase with frequency. The complex viscosity (oscillation) and shear viscosity (steady rotation) were equal in magnitude ('Cox-Merz' equivalence). These data are best interpreted in terms of a system with relatively low 'connectivity'/polymeric character and rapid relaxation dynamics, consistent with the mafic composition of the melt. As detailed compositional data are available the experimentally determined shear viscosity values are compared with those predicted from multicomponent chemical models in the literature. Discrepancies between the experimental and theoretical values are discussed.