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Influence of H_2O, CO_2 and F on the viscosity of a natural basaltic melt

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In this study the effects of the volatiles H_2O, CO_2 and F on the viscosity of basaltic melts were determined. The starting glass was a remelted calc-alkaline basalt from Fuego volcano, Guatemala. The volatile contents were achieved by adding CO_2 as $Ag_2C_2O_4$, F as AlF_3 and H_2O as distilled water. Three groups of glasses were synthesized: CO_2-, F- and $CO_2 + F$-bearing samples, all with different amounts of water varying from 0,76-2,13 wt%. The volatiles were dissolved at 5 kbar, 1250˚C in 3 hours in internally heated pressure vessels (IHPV). For a better homogeneity the quenched glass was re-crushed, loaded into a platinum capsule and heated for short time of three minutes in the IHPV at 1250˚C and 5 kbar. Platinum remains soft after such heating and the melts could be rapidly quenched to glasses with minimal internal stress. The viscosity of the samples was investigated experimentally by parallel plate viscometry in the range of $10^{9,7}$-$10^{11,1}$ Pa•s, corresponding to temperatures of 515-710˚C. For individual samples the accessible temperature range was relatively small ($<$ 50˚C above the glass transition temperature T_g) to minimize volatile loss during the measurements. The results show that H_2O has a strong impact on the viscosity of calc-alkaline basaltic melts, in agreement with previous studies on other basalitic compositions (Misiti et al. 2009, and references therein). For example, a sample with 0,29 wt% CO_2 and 2,13 wt% H_2O has a 53˚C lower T_g (η=10^{12} Pa s) than a sample with 0,14 wt% CO_2 and 0,78 wt% H_2O. Preliminary data indicate that calc-alkaline basalt with 2,13 wt% H_2O and 0,29 wt% CO_2has a much higher viscosity than expected by comparison with a carbon-free sample containing 2,29 wt% H_2O. This suggests CO_2 may have a viscosity-increasing effect. Alternatively, this apparent viscosity increase may be caused by the presence of bubbles in the CO_2-bearing sample. First data indicate that F has a similar viscosity-reducing effect on calc-alkaline basalt as H_2O. A sample with 1,65 wt% water and 1,00 wt% F (nominal) has the same viscosity as a fluorine-free sample with 2,29 wt% H_2O. Microprobe analyses will be performed to determine the exact F content of the glasses. Additionally, Fe^{2+}/Fe^{3+}-ratios will be investigated by colorimetric wet chemistry method to specify the influence on the viscosity by this parameter.

Misiti et al. (2009), Chem. Geol. 260, 278–285.