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Calorimetric properties of magmas

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Magmatic and volcanic processes are strongly controlled by the physical and thermodynamic properties of silicate melts. Recently it has been recognized that the way in which the magma crosses the so-called “glass transition” boundary can determine whether a quiet degassing, through preferential pathways, or a catastrophic eruption will take place. On the other hand, the thermodynamic properties inform us regarding the internal energy of melts and crystals and how internal energy and other closely related thermodynamic functions change with temperature, so affecting processes as partial melting, solidification, the advective transport of heat, and volatile exsolution and degassing. The effect of volatiles on these properties is well recognized, but not satisfactorily investigated so far. In this study, calorimetric measurements were conducted on four series of variously hydrated multicomponent melts, obtained by remelting and homogenization of natural magmas in order to investigate the effect of water on the glass transition interval (T_g) and heat capacity (C_p). The hydrous samples were synthesized in a piston cylinder and measured by the employment of a differential scanning calorimeter (DSC). Pantelleritic, latitic, HK basaltic and trachybasaltic compositions have been analysed over a range of water contents up to 5.3 wt%. For each investigated melt composition the cooling rate dependence of T_g has been characterized at four different temperatures corresponding to the onset, the inflection point, the peak and the stable liquid regions of the heat capacity curves. T_g of all compositions are strongly reduced by increasing water content. Base composition also has an effect, with the lowest T_g occurring in pantelleritic suite. For all sample a clear dependence on cooling/heating rate has been recorded. Peak and onset glass transition temperatures show constant viscosity values at differing water contents. Moreover the activation energies yielded by calorimetric and viscosimetry are, within experimental error, identical. This confirms that the calculation of viscosity through the employment of a simple shift factor, as already proposed by previous authors, can be used, for the investigated samples. So far it concerns the effect of water on the heat capacities, we show that water has an important effect and that complex patterns are observed for different compositional suites.