Viscosity measurements of subliquidus magmas: a MORB of ODP Leg 206, Hole 1256D

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We carried out viscometry and sampling of crystal suspensions derived from mid ocean ridge basalt from ODP, Leg 206, Hole 1256D in the same way with Sato(2005) and Ishibashi(2007). Viscometry of suspension was performed by a rotational viscometer at temperatures from 1240 C to 1185 C under 1 atm FMQ oxygen buffered conditions. Starting material has following composition: SiO_2=51.33wt%, TiO_2= 1.07wt%, Al_2O_3=14.23wt%, $FeO*$=11.24wt%, MgO=8.11wt%, CaO=11.16wt%, Na_2O=2.13wt%, K_2O=0.09wt%. The sample was filled in a Pt crucible (30mm inner diameter and 60mm height) to a depth of 45mm.The viscometry was performed by measuring the torque on a ceramic rod (6mm diameter) which is calibrated using a standard oil for viscometry. The sample was firstly melted at 1240 C for ca 72 hours, then viscosity measurement and sampling were carried out and the charge was cooled by 10 degree in 10 minutes. Stepwise cooling by 5 or 10 degrees, keeping the temperature for ca. 24 hours, then viscosity measurement and sampling were repeated until the sample became too viscous to perform viscosity measurement.

The result shows drastic increase in viscosity from the liquidus temperature 1240 C (ca.50Pas) to 1180 C (ca.3000Pas). During cooling, plagioclase first appeared at 1220 C, then olivine at 1210 C, followed by clinopyroxene at 1205 C. The total crystal content of the sample attained 29.6vol% (plagioclase=14.1vol%, olivine=0.9vol%, clinopyroxene=14.7vol%) at 1185 C. Relative viscosity, u_r (=u_s/u_m, where u_s is viscosity of suspension and u_m is that of melt calculated by the method of Shaw(1972), respectively), exceeded the value of Eistein-Roscoe relation from 1205 C and attained 30 that is five times larger than value of Eistein-Roscoe relation at 1185 C. In the logarithmic CSD plot, plagioclase shows steep slope for smaller grains than 20 microns long, whereas, the it shows shallower gradient for larger size than 20microns long.

The large departure of the experiment of results from the Einstein-Roscoe relation may be due to the effect of plagioclase shape. At 1185 C, Plagioclase length/width ratio of the larger plagioclase crystals(more than 20 mircron meters) is large (average Length/Width=8.19). The aspect ratio is larger than the plagioclase length/width ratio in run product of Hawaiian tholeiite (average Length/Width=5.58 for grains larger than 20 microns long). So we conceive that high aspect ratio of larger plagioclase caused interaction of crystals at low concentration and may increase the measured viscosity in the MORB sample. In natural MORB samples, length/width ratio of plagioclase is smaller than those in the run products of this experiment, and further experimental studies are required to estimate accurately the relative viscosity of natural magmas from the textural parameters.