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Effect of alkalis, phosphorus, and water on the surface tension of haplogranite melt

NIKOLAI BAGDASSAROV,[1,*] ALEXANDER DORFMAN,[2] AND DONALD B. DINGWELL[3]

[1]Institut für Meteorologie und Geophysik, Universität Frankfurt, Feldbergstrasse 47,
D-60323 Frankfurt/Main, Germany
[2]Vernadsky Institut of Geochemistry, Russian Academy of Sciences, Kosygin stasse 19, 117975 Moscow, Russia
[3]Bayerisches Geoinstitut, Universität Bayreuth, D-95440 Bayreuth, Germany

ABSTRACT

The sessile drop method has been used for measurements of the surface tension of haplogranite (HPG) melts containing an excess of alkalis and phosphorous (HPG8, HPG8 + 5 wt% Li_2O, 5 wt% Na_2O, 20 wt% Na_2O, 5 wt% K_2O, 5 wt% Rb_2O, 5 wt% Cs_2O, 10 wt% P_2O_5) and of Armenian rhyolite in the temperature interval, 650–1665 °C, and at 1 bar pressure. Sessile drops were placed on graphite substrates in a Pyrox tube furnace purged with Ar. Drop shape was monitored with a videocamera and stored in a videorecorder. The surface tension was calculated by measuring the two principal radii of curvature of the drop shape in vertical cross section. The precision of the method was checked against the surface tension of water. The surface tension of HPG and rhyolite melt is ~280–300 ± 5 mN/m in the temperature interval 1200–1400 °C. Temperature dependence of the surface tension of haplogranite melts and rhyolite is weak and positive ($d\sigma/dT$ = 0.06 to 0.09 mN/m/°C). Addition of 5 wt% of alkali oxides (except Li_2O) results in a decrease of the surface tension of haplogranite melts. The HPG melts with 10 wt% P_2O_5 have 30% higher surface tension than haplogranite melts with excess alkalis, and a negative temperature derivative ($d\sigma/dT$ = –0.1 mN/m/°C). The HPG melts with 20 wt% Na_2O and 5 wt% Li_2O exhibit a decrease in surface tension with temperature ($d\sigma/dT$ = –0.02 and –0.10 mN/m/°C, respectively).

The surface tension of HPG8 melt saturated with water at 1–4 kbar was measured on sessile drops quenched at high pressure in an internally heated gas vessel at temperatures of 800–1200 °C. Water pressure significantly decreases the surface tension of melt from 270 mN/m at 1 bar (1000 °C) to 65 mN/m at 4 kbar. At 1 bar in "dry" conditions, $d\sigma/dT$ = +0.056 mN/m/°C and at 3 kbar of water pressure, $d\sigma/dT$ = +0.075 mN/m/°C. The decrease in the surface tension of HPG melt at a water pressure of several kbars is from –10 to –30 mN/m/wt% H_2O. The increase of water content to more than 10 wt% in granite melts may not result in any significant decrease in the surface tension, which may be explained by formation of a surface sublayer having physical properties very distinct from those of the bulk.