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ABSTRACT BOOK

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Experimental measurements of viscosity and melt structure of CO_2-bearing melts at high pressure and temperature

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CO_2-rich melts like carbonatitic and kimberlitic magmas are produced at pressures and temperatures of the Earth's upper mantle by low degrees of partial (redox) melting of both carbonated peridotites and eclogites. To date, despite previous studies investigated P-T-fO_2 conditions at which these melts can form, we still lack information about their viscosity and structure that strongly influence their rheological properties, i.e. the movement of these magmas from the rock source to the surface.

In this study we investigated viscosity and melt structure of carbonated melts using both synthetic glasses and rock powders for a total of four starting materials with SiO_2 content varying from 0 to ~36 wt% and CO_2 amount from ~40 to 3 wt%.

Such experiments were carried out at pressures of 1-6 GPa and temperatures between 1050 and ~2000 °C using the Paris-Edinburgh press combined with in situ synchrotron X-ray diffraction at beamline 16 BM-B of HPCAT (Advanced Photon Source, Illinois, USA). Viscosity measurements were performed using the *falling sphere* technique. A high-speed camera collecting up to 1000 frames per second recorded the fall of a Pt probing sphere in the molten sample and viscosity was then calculated using the Stokes' equation.

Structural measurements of carbonated melts were performed at high temperature and pressure over 3-4 hours by multi-angle energy dispersive X-ray diffraction technique (2 theta ranging from 3 to 28 degrees).

Our results show viscosity values from less than 0.01 Pa·s for our SiO_2-free composition, that increase up to two orders of magnitude as we consider melts with 36 wt% SiO_2 We interpret this sharp increase in viscosity as due to SiO_2 polymerization effect. The mobility for the SiO_2-free and SiO_2-bearing melt ranges from ~150 $g·cm^{-3}·Pa^{-1}·s^{-1}$ to 1.5 $g·cm^{-3}·Pa^{-1}·s^{-1}$, calculated at depths of 90-120 km. Mobility in turns influences the migration rate of these melts through upper mantle rocks that, within the same depths, has been estimated to increase from 0.01 to 0.22 km/yr.

In addition, preliminary structural measurements allowed us to determine interatomic distances of the melt at HP-HT. Results for the carbonatitic melt with 5wt% SiO_2 show M-O (M=Ca, Mg, Fe) and M-M distances being ~2.5Å and ~4Å, respectively, similarly to what noticed by Kono et al. (2014) for calcite (Ca-O=2.3Å; Ca-Ca=4.2Å) and dolomite melts (M-O=2.1Å; M-M=3.9Å). On the other hand, melts with 18 wt% and 36 wt% SiO_2 showed M-O distance of 3.3Å and 3.2 Å respectively, constant M-M distance (~4.2Å) and Si-O distance of ~1.7Å.

Results from our study allows the ascent of CO_2-rich melts to be modelled as function of pressure, temperature and mantle oxidation state with implications for the speciation of carbon from the mantle up to the surface as function of time.

Kono, Y., Kenney-Benson, C., Hummer, D., Ohfuji, H., Park, C., Shen, G., Wang, Y., Kavner, A. & Manning, C.E. (2014): Ultralow viscosity of carbonate melts at high pressure. Nat. Commun., 5, 5091.

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