

### High silicon self-diffusion coefficient in dry forsterite

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The plastic deformation of minerals in the mantle is believed to be controlled by diffusion. Si is the slowest diffusion species in most mantle minerals. It is expected to limit the creep rates [1]. [2] measured Si self-diffusion coefficient ( $D_{Si}$ ) in dry forsterite (Fo) at ambient pressure with results of  $\sim 2$ -3 orders of magnitude lower than that expected from deformation experiments [3]. We revisited DSi in dry Fo to solve this discrepancy.

Fo crystals polished in colloidal silica solution were deposited with 300-500 nm of <sup>29</sup>Si enriched Mg<sub>2</sub>SiO<sub>4</sub> films, covered by 100 nm of ZrO<sub>2</sub> films, and annealed at 1600-1800 K and 0-13 GPa for diffusion. The surface roughness after diffusion were reduced to  $< 50$  nm by polishing again in colloidal silica solution. Diffusion profiles were obtained by SIMS. Water contents were  $< 1$   $\mu\text{g/g}$  by FTIR.

$\log D_{Si}$  was determined to be  $-19.7 \pm 0.5 \log[\text{m}^2/\text{s}]$  at 0 GPa and 1600 K. It is 2.4 orders of magnitude higher than that by [2]. Their low  $D_{Si}$  could be obtained due to the bad contact of the coated films with the substrate. Our data well explains the high dislocation climb rates in deformation experiments. We determined small negative pressure dependence of DSi with activation volume of  $1.7 \pm 2.6 \text{ cm}^3/\text{mol}$ . Linear relationship of  $\log D_{Si}$  with pressure in dry Fo in this study, iron and water bearing wadsleyite and ringwoodite by Shimojuku et al. [1] implies that temperature and pressure would be essential factors that affect  $D_{Si}$  in comparison with other factors, for example, iron concentration, water content, and structural difference of (Mg,Fe)2SiO<sub>4</sub> polymorphs. Viscosity in the upper mantle should be almost constant with depth by assuming it inversely proportional to  $D_{Si}$ .

[1] Shimojuku et al., 2009, EPSL 284, 103–112.

[2] Jaoul et al., 1981, Anelasticity in the Earth, Geodyn. 4, 95–100.

[3] Kohlstedt, 2006, Rev. in Min. Geochem. 62, 377–396.

### Degassing of andesitic and basaltic melts: fluid/melt distribution of sulfur and S-isotope fractionation

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Decompression experiments were conducted to understand the distribution of sulfur and S-isotopes between melt and (aqueous) fluid during degassing of hydrous andesitic and basaltic melts. The experiments were carried out in internally heated pressure vessels at 1030°C (andesite) and 1150°C (basalt) and  $fO_2$  ranging from QFM+0.8 to QFM+4. Pressure was released continuously from 500, 400 or 300 MPa to 150, 100 or 70 MPa with rates ( $r$ ) ranging from 0.0005 to 0.17 MPa/s. The samples were rapidly quenched after decompression or further annealed for various times ( $t_A$ ) at final conditions (1 to 72 h) before quenching. The partitioning coefficient of S between fluid and melt ( $D_s^{f/m}$ ) was determined by measuring S (EMP) and H<sub>2</sub>O (FTIR) in the quenched glasses and subsequent mass balance calculations. The isotopic composition of S ( $\delta^{34}\text{S}_{melt}$ ) was determined by SIMS. The gas-melt isotopic fractionation factor ( $\alpha_{g-m}$ ) for closed-system degassing was calculated according to Holloway and Blank [1].

In andesitic melts a significant influence of  $r$  and  $t_A$  on  $D_s^{f/m}$  was determined, particularly at oxidizing conditions. In experiments reflecting non-equilibrium distribution of S between fluid and melt, with  $t_A = 0$  h at  $r = 0.1$  MPa/s,  $D_s^{f/m}$  remains constant at  $\sim 300$  over the investigated  $fO_2$  range. By contrast, in experiments reflecting near-equilibrium conditions with  $t_A > 5$  h and  $r = 0.1$  MPa/s a major decrease of  $D_s^{f/m}$  with  $fO_2$  from  $\sim 360$  at QFM+1.1 to  $\sim 40$  at QFM+1.7 was observed. SIMS analyses reveal an increase of  $\delta^{34}\text{S}_{melt}$  at  $\log(fO_2) > \text{QFM}+3$  ( $\alpha_{g-m} \approx 0.9976$ ) and a decrease of  $\delta^{34}\text{S}_{melt}$  at  $\sim \text{QFM}+1$  ( $\alpha_{g-m} \approx 1.0034$ ) upon degassing. This is in accordance with observations in arc magmas. There is no detectable effect of  $r$  and  $t_A$  on  $\alpha_{g-m}$ .

Preliminary results indicate that  $D_s^{f/m}$  for basaltic melts is lower than in andesitic melts. Under disequilibrium conditions  $D_s^{f/m}$  is  $\sim 70$  in basaltic melts ( $r = 0.1$  MPa/s,  $t_A = 0$  h, QFM+1.6). First SIMS analyses on these experiments reveal an  $\alpha_{g-m}$  of  $\sim 0.9993$ .

[1] Holloway & Blank, 1994, Rev. Mineral. 30, 187–230.