Effects of fO_2 and Degassing on Dissolved Sulfur in MORB Glasses

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Almost all mid-ocean ridge basalt (MORB) glasses are formed from silicate liquids that were saturated with sulfide melt, as shown by immiscible sulfide blebs they contain and their strong linear trend on a plot of FeO *vs*. S [1]. Here, we start with a linear reference equation for the FeO *vs*. S trend and examine scatter (±250ppm) from that trend for a large dataset of high-precision (±20ppm) S measurements by electron microprobe. Individual segments define tight trends that are subparallel and offset from each other. Our observations complement experimental work on sulfide concentration at sulfide saturation (SCSS) in silicate liquids.

We combine published data for Fe^{3+}/Fe_{total} [2,3] with our Fe and S data to show that a large part of the scatter can be accounted for by differences in fO_2 as expected from the equilibrium: $\frac{1}{2}\ S_{2(gas)} + FeO_{(silicate\ melt)} = FeS_{(sulfide\ melt)}) + \frac{1}{2}\ O_{2(gas)}$ which shows that glasses with higher fO_2 should have higher SCSS at a given FeO [4]. Data from the equatorial MAR and Endeavour segment (NE Pacific) show excellent correlations between the deviation from the FeO-S reference line and Fe^{3+}/Fe_{total}, with similar slopes. But data arrays are offset from each other, showing that fO_2 cannot be the only operative factor. We are exploring how pressure, H_2O, major elements and temperature may affect SCSS. Ultimately, it may be possible to determine Fe^{3+}/Fe_{total} and fO_2 in glasses using an electron microprobe with well calibrated standards.

Degassing can cause scatter from the trend, but this is infrequent. Highly vesicular EMORB (Popping Rocks) [5] fall >270ppm S below the reference equation. Their low S is likely caused by closed system degassing during rapid ascent to low P, where partitioning of S into CO_2-rich vapor greatly increases [6]. Calculated S/CO_2 in vesicles is 0.014. Typical EMORB do not degas much S because they lost a CO_2-rich, S-poor vapor at higher P under more open system degassing, and arrived at low P with much less CO_2 to partition S. A less likely explanation is that low S in Popping Rocks is caused by preservation of high-P equilibrium of SCSS preserved by rapid ascent.

[1] Mathez EA (1976) *JGR* **81**., 4269. [2] Le Voyer, M et al., (2014) *JGR* **120**, doi:10.1002/2014JB011160. [3] Cottrell E & Kelley KA (2011) *EPSL* **305**, 270. [4] Wallace P & Carmichael ISE (1992) *GCA* **56**, 1863. [5] Sarda P & Graham D (1990) *EPSL* **97**, 268-289. [6] Teague AJ et al. (2008) *Eos Trans. AGU* **89(53),** V21B-2086.