Introduction

Magnetic C-O-H volatiles affect the evolution of both planetary atmospheres (if degassed) and planetary interiors (if retained). Oxygen fugacity (fO₂) affects speciation and concentration of C-O-H volatiles dissolved in planetary magmas. Reducing conditions in the martian mantle, lunar mantle, and early terrestrial magma ocean (1-4) require an understanding of C-O-H volatile speciation in magmas at low fO₂.

Previous studies have found a variety of species dissolved in reduced magmas including those relating to carbon monoxide [5-9]. There have been no systematic studies of the solubility of CO-related species in reduced magmas.

**Aim:** Isolate the effect of fO₂ on C-bearing volatiles in reduced basaltic melts, by reducing H₂O-content as much as possible. We present preliminary results at 1.2 GPa/1400°C that form the basis for a larger study on a variety of FO₂, P, T, and melt compositions.

**Experimental Details**

Starting material: nominally anhydrous oxide mix based on picritic Humphrey basalt from Gusev crater.

FePt alloy used as FO₂ sensor (4 wt% Fe metal + 5 wt% Pt metal added to Humphrey oxide mix)

Capsules dried at 20-510°C prior to welding to produce variations in H₂O-content

All experiments at 1.2 GPa, 1400°C, 6 hrs in end-loaded piston cylinder apparatus under graphitized-saturated conditions

Composition of Humphrey basalt (from Gusev crater) determined by the Spirit Rover [11-12], compared to starting material used in this study.

**Dissolved volatiles**

FTIR spectra of glasses containing water-peak at 3550 cm⁻¹ and carbonate (doublet at 1430 & 1520 cm⁻¹). The 2305 cm⁻¹ peak is attributed to Fe(CO)₆ [x-x]. Peaks at 1707 and 1615 cm⁻¹ were observed by [13] in similar melts under graphite saturated conditions and fO₂ < IW +1.7. They may be related to C-O bonds within a more complex molecule [14].

**Implications**

**Volatiles in lunar magmas**

Lunar magmas are comparatively dry (0-400 ppm H₂O [17-28]), and so Fe-carbonyl is potentially the most important C-bearing volatile, in agreement with recent findings of [9] et al. [5]. Although our data suggest that at the comparatively reducing conditions attributed to common lunar magmas (9W-1), Fe-carbonyl is inhibited, at present our most reducing experiments are also relatively hydroxylic, and do not allow direct comparison with lunar conditions.

**Terrestrial magma ocean**

In the Earth’s early history, a potassic magma ocean would have both varying fO₂, as a function of depth [29], but also changing fO₂ over time as ‘self-oxidation’ occurred via Fe-disproportionation and incorporation of Fe²⁺ in Mg-pyroxenes [30].

H₂O concentrations would affect C speciation, with more CO₂ and Fe-carbonyl present under water-poor conditions and less CO₂ plus other C-bearing species present under water-rich conditions. Fe-carbonyl dissolution in a magma ocean would likely be limited to a small range of fO₂ & fCO₂, based on the conditions at which it was found dissolved in glasses in this study and in [9].

**Preliminary conclusions:** Small changes in fCO₂ have a large effect on the solubility of C-O-H species in martian basalt. With increasing fCO₂ and fO₂, ΔfO₂ (fO₂ - fO₂IW+1.7), H₂O concentrations decrease while CO₂ and Fe(CO)₆ concentrations increase. At low fCO₂, additional peaks are seen in FTIR & Raman spectra that are likely related to other forms of reduce carbon dissolved in the melt.