**Introduction:** Iron redox systematics of the high FeO shergottitic liquids are poorly known, yet have a fundamental control on stability of phases such as magnetite, ilmenite, and pyroxenes [1].

**Experiments:** We undertook experiments to constrain the $\text{Fe}^{3+}/\text{Fe}^{2+}(\text{tot})$ in high FeO glasses as a function of $f^\text{O}_2$, melt $\text{P}_2\text{O}_5$, temperature and pressure. We also performed a series of sub-liquidus experiments between 1100 and 1000 °C and FMQ+0.5 to FMQ-1 to define magnetite stability. Experiments were performed at JSC in either the 1 bar gas mixing lab, or in a piston cylinder or multi-anvil presses in the high pressure experimental petrology lab.

**Analyses:** Run products were analyzed for $\text{Fe}^{3+}$ and $\text{Fe}^{2+}$ by either Mössbauer spectroscopy [2] or micro-XANES (x-ray absorption near edge structure) spectroscopy [3].

**Results:** One bar glasses equilibrated at FMQ-3 to FMQ+3 show a much lower $\text{Fe}^{3+}/\text{Fe}^{2+}(\text{tot})$ than terrestrial basalts at the same conditions (Figure 1). As melt $\text{P}_2\text{O}_5$ contents increase from 0 to 3 wt% (at fixed pressure, temperature and $f^\text{O}_2$), $\text{Fe}^{3+}/\text{Fe}^{2+}(\text{tot})$ decreases from 0.07 to 0.05. Temperature increases between 1200 and 1500 °C cause little to no variation in $\text{Fe}^{3+}/\text{Fe}^{2+}(\text{tot})$. Pressure increases from 1 to 4 GPa cause a slight decrease in $\text{Fe}^{3+}/\text{Fe}^{2+}(\text{tot})$. The trends with pressure and temperature are in agreement with results of previous studies on terrestrial compositions [4-6].

**Implications:** Combining our new series of data allows derivation of an expression to calculate $\text{Fe}^{3+}/\text{Fe}^{2+}(\text{tot})$ for high FeO melts such as martian magmas.

$$\ln(\text{Fe}^{3+}/\text{Fe}^{2+}) = -a \ln f^\text{O}_2 + b/\text{T} + cP/\text{T} + dX\text{FeO} + eX\text{Al}_2\text{O}_3 + fX\text{CaO} + gX\text{Na}_2\text{O} + hX\text{K}_2\text{O} + iX\text{P}_2\text{O}_5$$

This expression can be used to show that decompressed melts become slightly more oxidized at the surface (compared to 4 GPa). Magnetite stability is suppressed by the lower $\text{Fe}^{3+}/\text{Fe}^{2+}(\text{tot})$ of the high FeO melts. Magnetite stability is a function of $\text{Fe}_2\text{O}_3$ and temperature and is stable ~50 °C lower than typical terrestrial basalt (Figure 2). Difficulty in producing magnetite as a liquidus phase in magmatic systems suggests either that many martian basalts are more oxidized, that the titanomagnetite only forms upon cooling below ~ 1000 °C at FMQ, or that the magnetite has a secondary origin.


![Figure 1: New results for glasses measured using Mössbauer spectroscopy illustrating that the shergottite composition remains low relative to terrestrial basalts such as mid ocean ridge (JDFD2) and Hawaiian (Kil-2) basalts (from [4]).](image1)

![Figure 2: Comparison of magnetite saturation conditions (T and $f^\text{O}_2$) for a terrestrial ferrobasalt [7] and a martian shergottite (this study and [8]). High FeO shergottite melts (dashed line) saturate magnetite about 50 °C lower than terrestrial basalt (solid line).](image2)