**Supplementary online material**

**Details for the calculation of the SCSS presented in Figure 6.**

Different models have been put forward to estimate the saturation limits of iron sulfide with different conditions of temperature, pressure, melt compositions etc. (e.g. Holzheid and Grove, 2002; O’Neill and Mavrogenes, 2002; Jugo, 2004; Liu et al., 2007; Li and Ripley, 2009). Among them, we selected models based on low-pressure experiments that allow the SCSS to be calculated as a function of the compositions to compare to our data: the O’Neill and Mavrogenes' model (2002) and the Li and Ripley's model (2009).

In the O’Neill and Mavrogenes' model, the S content of the melt in weight ppm is given by: (1)  
in which ΔG°(eq.) is the variation of the free energy of the equilibrium reaction (, details in Marrocchi and Libourel, 2013 and references therein), aFeSsulfide and aFeOsilicate melt are the activity of FeS in the sulfide melt and of FeO in the silicate melt and Cs the sulfur capacity of the melt defined by where X are mole fractions in the silicate melt and AM numerical constants with AFe >>ACa>AMg, ANa/K, ATi. Similarly to O'Neill and Mavrogenes, we assumed that aFeSsulfide = 1 and γFe = 1 for aFeOsilicate = ln XFe + ln γFe.

In the Li and Ripley's model, the mole fraction of S is given by:

(2)  
where P is in bar, T is in Kelvin and X are mole fractions in the silicate melt.

We have calculated the SCSS curves using the average composition of Sahara 97096 mesostasis (Table 1) and reported the results in a plot the expected concentration of sulfur as a function of FeO (Fig. 6). Calculations have been done at 1 bar and 1500°C to approximate the temperature conditions of the sulfide and pyroxene co-saturation. Because only few experimental data are available for silicate melts having a low FeO content, we have extrapolated the model of Li and Ripley out of the range of composition defined by the authors (i.e. for FeO < 0.64 to wt.%) (doted grey line in Figure 6). We also have extrapolated the model of O'Neil and Marvogenes out of the range of the experimental data and natural composition on which they built their model (FeO ≥ 0.57 wt. %). However, the validity of the model for low FeO contents has been shown recently by experiments at 1400°C and 1.5 GPa (Wykes et al., 2015).

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