Geophysical Research Abstracts,
Vol. 10, EGU2008-A-08884, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-08884
EGU General Assembly 2008

The incorporation of nitrogen in reduced magmas of the early Earth's mantle

A. A. Kadik (1) and Yu. A. Litvin (2),

(1) V.I.Vernadsky Institute of Geochemistry and Analytical Chemistry, RAS, Kosygin St. 19, Moscow 119991, Russia, (2) Institute of Experimental Mineralogy, RAS, Chernogolovka, Mosñow distr. 142432, Russia kadik@geokhi.ru / 7-495-137-7200

In theories of the formation of the Earth, the composition of gases extracted by primary planetary magmas is accounted for by the large-scale melting of the early mantle in the presence of the metallic Fe phase at fO_2 below fO_2(IW). The melting should have been accompanied by the formation of volatile compounds, whose composition was controlled by the interaction of H, C and N with silicate and metallic melts, a process that remains largely unknown as of yet.

In a series of experiments in the system Fe-bearing melt + molten Fe metallic phase + N+ H conducted at 4 GPa and 1550˚C and logfO_2 from 2 to 4 below logfO_2 (IW), we have characterised the nature and quantified the abundance's of N- and H-compound dissolved in an model silicate melt ($NaAlSi_3O_8$ 80% wt +FeO 20% wt).

Experiments were carried out in an anvil-with-hole apparatus. The technique of fO_2 buffering employed here relies upon the diffusion of H_2 through Pt to achieve equal chemical potentials of H_2 in the inner Pt capsule and outer solid fO_2 buffer assembly in the presence of H_2O. To create a low fO_2 in the experiments, 2, 3, 5 and 7 wt % of finely dispersed Si_3N_4 was added to the glass powder ($NaAlSi_3O_8$80% + FeO 20% wt). The initial Si_3N_4 was unstable under experimental conditions and was completely consumed according to the reactions: Si_3N_4(initial) + $3O_2 \rightarrow 3SiO_2$(melt) + 4N(melt) with the subsequent participation of nitrogen in reactions with hydrogen and components of silicate melts. The amount of H and N dissolved in the glasses was measured by ion microprobe, microprobe and CHN analysis. Hydrogen content inòcreases with

decreasing fO_2 from 0.3 wt % at $\Delta logfO_2(IW)$ = -2.2 to 0.4 wt % at $\Delta logfO_2(IW)$ = -3.9. Nitrogen content increases with decreasing fO_2 from 0.5 wt% at $\Delta logfO_2(IW)$= -2.2 to 1.9 wt % at $\Delta logfO_2(IW)$= -3.9. The present results strongly suggest that under reducing conditions nitrogen interacts with hydrogen and the silicate network. The most likely nitrogen-bearing species that can account for Raman and infrared results N-H groups (NH_3, NH_4^+). Part of incorporation nitrogen corresponds to dissolution of N_2 molecule. Significant amounts of nitrogen, comparable to those estimated for the present-day mantle, could have been incorporated in the early Earth by dissolution in a magma ocean, under fO_2 conditions relevant to those prevailing during metal segregation. It is suggested that the proportions of oxidized and reduced N, H and C species in the early atmosphere were closely connected to the character of global chemical differtiation during the formation of the metallic core.

Support*: Prog. No. 18 RAS, RFBR grant, ESD RAS project 7-1.2.*