REDOX INTERACTIONS BETWEEN IRON AND CARBON IN PLANETARY MANTLES: IMPLICATIONS FOR DEGASSING AND MELTING PROCESSES.

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Introduction: Carbon stability in planetary mantles has been studied by numerous authors because it is thought to be the source of C-bearing atmospheres and of C-rich lavas observed at the planetary surface. In the Earth, carbonaceous peridotites and eclogites compositions have been experimentally studied at mantle conditions [1] [2] [3]. [4] showed that the fO_2 variations observed in martian meteorites can be explained by polybaric graphite-CO-CO_2 equilibria in the Martian mantle. Based on thermodynamic calculations [4] and [5] inferred that the stable form of carbon in the source regions of the Martian basalts should be graphite (and/or diamond), and equilibrium with melts would be a source of CO_2 for the martian atmosphere. Considering the high content of iron in the Martian mantle (~18.0 wt% FeO; [6]), compared to Earth's mantle (8.0 wt% FeO; [7]) Fe/C redox interactions should be studied in more detail.

Experiments: Here we report new experimental results at 2 GPa (piston-cylinder) in a system containing CaO-MgO-SiO_2-CO_2 with various FeO content and oxidation conditions. By analyzing Fe in liquid and solid phases, we have determined Fe repartition and constrained Fe/C redox interactions during late differentiation processes in terrestrial planets.

Results and discussion: In the Fe-free system from 1100 to 1300°C, CO_2-rich melt forms in equilibrium with forsterite, clinopyroxene and CO_2. In the presence of Fe, forsterite disappears and Fe-opx is produced. Fe oxide (magnetite) is also found and part of the carbon is reduced to graphite (Fig.1).

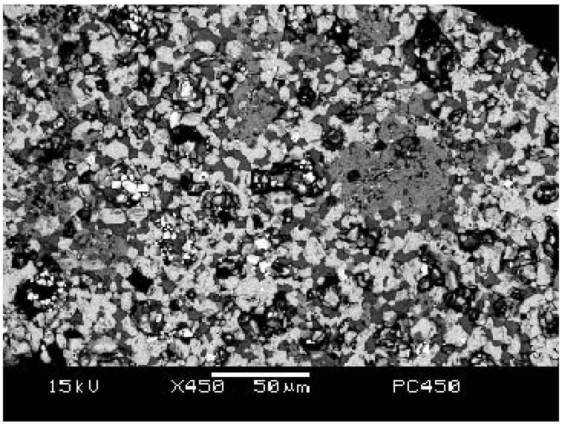

Figure 1: SEM image (back-scattered electrons) of a 2.0 GPa - 1200°C sample containing Fe-opx (light grey), Mg-cpx (medium grey), calcite (dark grey), CO_2-rich melt (interstitial), graphite (black) and Fe-oxides (white).

Thus, a reaction occurs between iron- and carbon-bearing phases:

Fe^{2+} *(in silicate,carbonate,melt)* + CO_3^{2-} *(in carbonate,melt)* = Fe^{3+} *(in oxide,silicate,melt)* + $C_{graphite}$.

Such supersolidus redox process will have an influence on the melting and degassing mechanisms. Especially, it may lower the contribution of late mantle degassing processes to CO_2 introduction into planetary atmospheres.

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