REDOX INTERACTIONS BETWEEN IRON AND CARBON IN PLANETARY MANTLES: IMPLICATIONS FOR DEGASSING AND MELTING PROCESSES. A. Martin and K. Righter, NASA Johnson Space Center, 2101 NASA Parkway, Houston, TX 77058, USA

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 fO2 variations observed in martian meteorites can be explained by polybaric graphite-CO-CO2 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 CO2 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-SiO2-CO2 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, CO2-rich melt forms in equilibrium with forsterite, clinopyroxene and CO2. 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).

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

\[ \text{Fe}^{2+} \text{ (in silicate,carbonate,melt)} + \text{CO}_2^{2-} \text{ (in carbonate,melt)} = \text{Fe}^{3+} \text{ (in oxide,silicate,melt)} + \text{C}_{\text{graphite}}. \]

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 CO2 introduction into planetary atmospheres.