# Siderophile behavior of C and N during Core formation

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Large amounts of C and N are well known by metallurgical studies to be accomodated in metallic iron. We examined here if C and N may exhibit siderophile behaviors in conditions applicable to Core formation stage of early Earth. The situation experimentally simulated here is the partitions of C and N between small metallic particles and silicates at shallow depths (~100Km) of the magma ocean.

Partition experiments were performed between Fe-Ni metal and synthetic silicates consisting of $SiO_2$-MgO-FeO-CaO-$ZrO_2$. Mixtures of metal, oxide powder, graphite and ammonium salt, encapsulated in a zirconia cell, pressed by a cubic anvil type high-pressure apparatus, were heated by a graphite heater to temperatures enough to achieve total melts of both metal and silicate. The peak temperatures were kept for 2, 4 or 8 minutes to confirm equilibration of C and N partition. The cell was then quenched to room temperature by a rate of 500ºC/sec. Dependences of the partition coefficients ($D(C) = [C]_{metal}/[C]_{silicate}$ and $D(N) = [N]_{metal}/[N]_{silicate}$) on the following parameters were examined in this study: (1) pressure between 3 to 6 GPa; (2) oxygen fugacity ranging between $-1.8 < \log(fO_2/fO_{2,Iron\text{-}Wustite}) < -0.6$; (3) silicate composition with 1.8 < Non-Bridging-Oxygen (NBO) /Tetragonal-network-formers (T) < 2.6; and (4) total carbon in the system that corresponds to $0.6 < [C]_{metal} < 3.1$wt%.

The results are as follows: (1) At 3 GPa, D(C)=4 and D(N)=70, whereas at 4-6 GPa, D(C)=30 and D(N)=500. Both C and N exhibited stronger siderophile behavior at higher pressure. (2) D(C) and D(N) both showed negative correlations with $fO_2$ at 3 GPa. (3) No dependence of D(C) and D(N) attributable to NBO/T variation was confirmed at 3 GPa. (4) When the metal approach saturation with C ($[C]_{metal}$=3.1wt%), D(C) and D(N), as low as 1 and 6, respectively, were observed at 3 GPa. A particularly worth-to-note relationship was observed between D(C) and D(N), common to all runs in this study examining various parameters: D(N) always exhibited ~10x higher values compared to D(C), suggesting that N constantly exhibit siderophile characteristics stronger than C.

Preferential N absorption, relative to C, by metallic iron during Core formation may have significantly elevated the C/N ratio in silicates from the starting primitive chondrite value (~30). We discuss if the geochemical record attributable to C & N absorption to Core could be found in the present silicate portion of Earth.