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An Experimental Study of Partially Molten Ordinary Chondrite Under Dynamic Conditions: Siderophile Abundances in Quench Fe-S-Ni Liquids

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Early differentiation in planetesimals involved a variety of different physical mechanisms. Fe-rich metallic liquid segregation can occur in a solid, partially molten or purely molten silicate body, with or without the presence of deformation. Deformation may assist the segregation of low degree metallic melts. Segregation of Fe-S-Ni liquids formed by variable degrees of partial melting of chondrites also imparts distinct geochemical signatures on the composition of the resulting metal. These chemical signatures vary according to initial parent body composition, segregation mechanisms and the degree to which early S-rich, and possibly O-bearing, core-forming liquids were extracted. In addition, the presence of deformation may both enhance kinetics and efficiency of the physical segregation process. To explore the relationship between core formation scenarios and geochemistry, deformation experiments on the Kernouve H6 ordinary chondrite were performed under partially molten conditions. The siderophile element compositions of quench Fe-S-Ni liquids dynamically segregated at different degrees of partial melting and associated Fe-Ni metal were then determined by laser ablation ICP-MS. Partition coefficients have been calculated for residual metal and the associated quench composition in the different experiments; KM-12 (P=1.2 GPa, T=900^{o}C, strain rate= 10^{-6}/s, no silicate melt present,10% strain) which contains the highest sulfur quench compositions and represents the lowest degree Fe-S-Ni partial melt, KM-10

(P=1.0 GPa, T=925^{o}C, strain rate=10^{-5}/s, 40%\ strain), KM-17 (P=1.2 GPa, T=940^{o}C, strain rate = 10^{-6}/s, 12% silicate melt present, 10% strain) and KM-11 (P=1.0 GPa, T=990^{o}C, strain rate=10^{-5}/s, 15-18% silicate melt present, 15% strain) which shows the lowest sulfur quench composition of the highest degree Fe-S-Ni partial melt. Clear trends exist in the data from high to low wt% S content. Cu partitions into the S-bearing liquid under all conditions and Ds range from 0.19 at high S contents to 0.56 at low S contents. As goes from compatible to incompatible at approximately 15 wt%\ S in the liquid. Ir, Ge and Ga show large changes in D as a function of S, ranging from $>$100 to approximately 1.0 from high to low S content but remain compatible. W and Os remain compatible and range from 1 - 5 and 5 - 7 at 13-15 wt%\ S and 6-8 wt%\ S, respectively. We find that the lower temperatures produce Fe-S-Ni liquid compositions observed at higher T in other studies. Part of the difference is likely due to the temperature gradient in the charge, but in addition, deformation may play an important role in enhancing reaction kinetics. The results also show that high sulfur, low degree partial melts have too low Ga, Ge and Ir to form IIE irons. Intermediate degrees of partial melting, represented by melt pools and veins in KM10 and KM17, are closest in composition. The compositional range of experimental melt compositions exceeds the IIE irons observed range. The IIE irons represent a limited portion of the experimental Ni-Co trend, implying generation from a limited range of redox conditions.

1060 Planetary geochemistry (5405, 5410, 5704, 5709, 6005, 6008)
3630 Experimental mineralogy and petrology
5104 Fracture and flow
5430 Interiors (8147)
5455 Origin and evolution
Volcanology, Geochemistry, and Petrology [V]
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