

## SIDEROPHILE ELEMENTS IN METAL SEGREGATED FROM PARTIALLY MOLTEN ORDINARY CHONDRITE: IMPLICATIONS FOR EARLY DIFFERENTIATION PROCESSES.

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**Introduction:** Core formation scenarios in growing planetesimals include a variety of possible segregation mechanisms for separating metal from silicate. Metal segregation can occur in a solid or partially molten silicate body and 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 have been conducted on the Kernouve H6 ordinary chondrite at different stages of melting. The physical segregation of Fe-rich metallic liquids from silicate during the partial melting of chondrites imparts a geochemical signature on the composition of the resulting metallic liquids, as evidenced by the diverse compositions of iron meteorites. These chemical signatures vary according to parent body composition, segregation mechanisms and the degree to which early core-forming liquids (S-rich, and possibly O-rich) were extracted. We present results on siderophile concentrations in metal dynamically segregated during partial melting and deformation of an ordinary chondrite.

Geochemical analyses of metal quench in several experimental charges and on metal grains in the Kernouve H6 starting material have been performed by LA-ICP-MS using the methods of [1].

**Experimental study:** Experiments have been conducted on solid cores, 0.6" long and 0.25" in diameter, of Kernouve H6 chondrite using a Griggs rock deformation apparatus. The Kernouve meteorite (supplied by the Smithsonian) is composed primarily of olivine, orthopyroxene, clinopyroxene, plagioclase, chromite and chlorapatite. Bulk analysis (wt%) of the starting material shows that the chondrite is typical in composition; 19.40% Fe metal, 1.70% Ni metal, 0.08% Co and 3.74% FeS. H<sub>2</sub>O+ is 0.10% (average for chondrites ranges between 0.1 and 0.5%). Metal and sulfide phases constitute 20-25 volume % of the sample.

Laser ablation ICP-MS analyses of individual large metal grains from Kernouve starting material, and from two experimental runs, were ana-

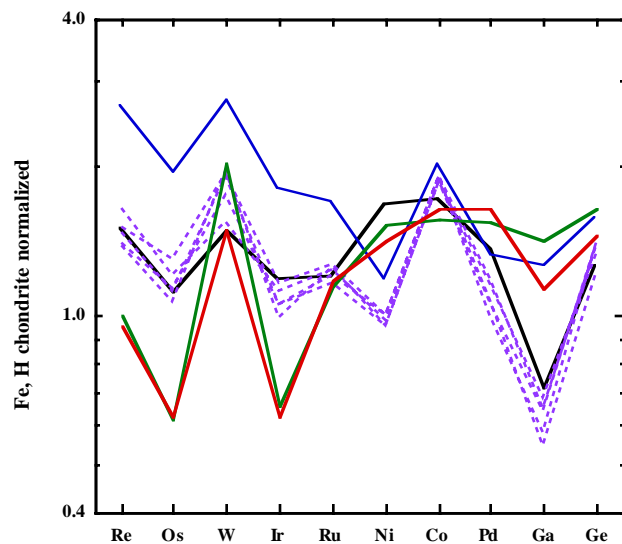
lyzed using a spot size of 40-50  $\mu\text{m}$ . Peaks monitored included <sup>7</sup>Li, <sup>57</sup>Fe, <sup>59</sup>Co, <sup>60</sup>Ni, <sup>69</sup>Ga, <sup>74</sup>Ge, <sup>101</sup>Ru, <sup>105</sup>Pd, <sup>182</sup>W, <sup>185</sup>Re, <sup>192</sup>Os, <sup>191</sup>Ir, and <sup>195</sup>Pt. Hoba IVB and Filomena IIA were used as standards [1].

**Results:** Metal from KM-10 (run conditions: P=1.0 GPa, T=925°C, strain rate=10<sup>-5</sup>/s) in a sheared vein and from unmodified zones were microanalysed for siderophile concentrations. This run contained no silicate melt, but minor quench Fe-S rich liquid metal in high stress cataclastic domains. The highly strained metal does not appear to differ significantly from starting Kernouve metal concentrations suggesting the deformation process at this temperature did not enhance diffusion in the solid metal.

Analyses of Fe-S-Ni-O quench metal in KM-17 (run conditions: P=1.2 GPa, T=940°C, strain rate=10<sup>-6</sup>/s, 10-12% silicate melt present) were performed and the results along with those from the Kernouve H6 starting material are shown in Figure 1. Figure 1 shows selected siderophile element abundances in KM-17 metal on a Fe, H-chondrite normalized plot. Bulk H4-6 metal abundances [2] are plotted as the black line. Kernouve (H6) kamacites determined by LA-ICP-MS are shown as dashed purple lines. Two main metal types were recognized in KM-17 run products. The solid blue line (KM-17e) resembles kamacite compositions and represents residual solid metal. The thin red and green lines (KM-17c,d) represent liquid compositions, which are depleted in compatible siderophiles (Re, Os, Ir, W, Co, Ru), and enriched in Ni and Pd, with weak Ga, Ge fractionation.

From these data, partition coefficients between solid and liquid metal ( $D = \text{solid metal over liquid metal}$ ) can be calculated and the values are shown in Table 1. When compared with recent data [3], they are closest to  $D$  values for short, high temperature runs suggesting that deformation may play a role in enhancing diffusion in liquid metal and/or enhancing reaction kinetics.

**Applications:** The diverse compositions of iron meteorites suggest that different



**Figure 1:** Siderophile concentrations plotted on a Fe, H chondrite normalized plot. Blue line represents residual metal data where green and red lines represent quench Fe-S rich metal data. Purple lines are the concentrations of the starting Kernouve kamacite and deviate from [2] compilation of H4,5 metal (black line) because taenite is included in these analyses.

	Liq.	Liq.	Liq.	Solid	D
	KM-17c	KM-17d	Ave.	KM-17e	(s/l)
<b>Re</b>	0.95	1.01	0.98	2.65	2.7
<b>Os</b>	0.63	0.62	0.63	1.96	3.1
<b>W</b>		1.5	2.04	1.77	2.74
<b>Ir</b>	0.63	0.66	0.65	1.82	2.8
<b>Ru</b>	1.18	1.15	1.17	1.70	1.5
<b>Ni</b>	1.43	1.52	1.48	1.19	0.8
<b>Co</b>	1.65	1.57	1.61	2.02	1.3
<b>Pd</b>	1.64	1.55	1.60	1.32	0.8
<b>Ga</b>	1.14	1.42	1.28	1.27	1.0
<b>Ge</b>	1.45	1.64	1.55	1.58	1.0

**Table 1:** D values for siderophile partitioning between solid metal (Solid) and liquid quench (Liq.).

mechanisms of segregation of metal from silicate may play a role in their formation, along with parent body bulk composition and  $fO_2$ . We plotted the concentrations of siderophiles in the solid and liquid metal from the KM-17 experiment along with data from the IIE irons [4]. Oxygen isotopes indicate that the silicate fractions of IIE irons are genetically linked to H chondrites [5]. In Ni vs. Ga, Ge, Ir and Co plots, linear fits between the KM-17 liquid metal data and data from IIE irons [4] show a good correlation except for Ir, which may be due to differences in  $fO_2$ . The residual metal from KM-17 is distinctly different in composition from either the quench metal or the IIEs. The data support the possibility that partially melting and subsequent segregation of early Fe-Ni-S liquid in an ordinary chondrite precursor may be a mechanism by which IIE irons form.

## References

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