EXPERIMENTS IN METALLIC SYSTEMS: UNDERSTANDING THE DIFFERENTIATION AND EVOLUTION OF PLANETARY BODIES.

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Introduction: As planetary bodies evolved and differentiated in the Solar System, metallic phases segregated from silicate phases, often melted either fully or partially, and then crystallized subsequently. These processes involving metallic phases were fundamental events that had a crucial impact on the nature of the resulting body. Experiments conducted in metallic systems have provided insight into the behavior and influence of metals during these important stages of planetary body differentiation and evolution, and consequently into these planetary processes themselves. In this presentation, I will give a brief overview of some of the experimental techniques commonly used to investigate metallic systems and highlight some of results and planetary implications of such experiments.

Experimental Techniques: The technique used for a metallic system experiment depends on the desired pressure for the run. Experiments at 1 atm are frequently conducted in a vertical tube furnace with the starting material contained in an evacuated silica tube. Experiments at higher pressures can be run in a piston cylinder or multi-anvil device, achieving a maximum pressure of about 25 GPa. Starting materials are usually commercially purchased metallic powders, mixed to produce the composition of interest. Figures 1 and 2 show typical run products from experiments in metallic systems, with the experiment at 1 atm (Fig.1) producing a much larger run product than the experiment conducted at higher pressure (Fig.2). Analytical techniques such as electron microprobe and laser ablation ICP-MS are used to measure the compositions of the experimental run products.

Results and Implications: The experiments produce coexisting metallic phases, the identities of which depend on the pressure and temperature conditions and the starting composition. This enables investigations into which phases are stable under which conditions as well as how elements will partition between these phases. The results of such experiments have been used to unravel the parent body histories of many meteorite types; examples include evaluating the role of liquid immiscibility during the evolution of iron meteorites, modeling the fractional crystallization of iron meteorites, investigating partial melting during the genesis of ureilites, and constraining the composition of metallic melts during the formation of enstatite chondrites. Experiments at higher pressures have provided insight into the possible compositions and nature of larger planetary cores, including that of Earth.

References: [1] Chabot N. L. and Drake M. J. (2000) *Meteorit. Planet. Sci., 35,* 807-816. [2] Chabot N. L. et al. (2008) *Geochim. et Cosmochim. Acta, 72,* 4146-4158.

Fig. 1. Experiment in the Fe-S-P system at 1 atm, resulting in three phases: solid Fe metal, S-rich metallic liquid, and P-rich metallic liquid. [1]

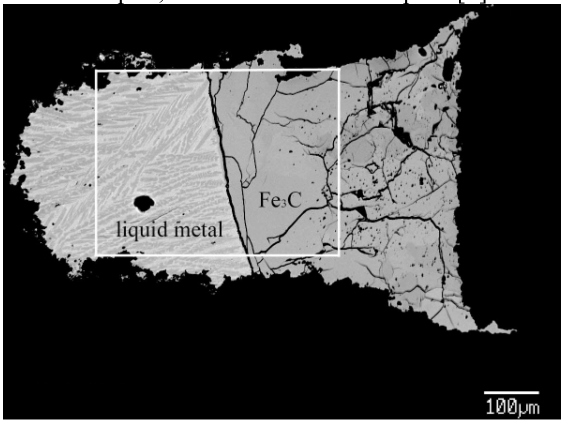

Fig. 2. Experiment in the Fe-C system at 5 GPa, resulting in two phases: C-bearing metallic liquid and solid Fe_3C. [2]