ACCRETION AND CORE FORMATION : CONSTRAINTS FROM METAL-SILICATE PARTITIONING EXPERIMENTS. Bernard Wood, Department of Earth Sciences, Parks Road, Oxford OX1 3PR, U.K. berniew@earth.ox.ac.uk

Introduction: The conditions of accretion and core formation on planetary bodies have been addressed in a large number of experimental studies since Ringwood[1] noted that the Earth's mantle is too rich in Ni, Co and Cu to have been formed in equilibrium wih the core at low pressures and was hence unlikely to have been inherited from asteroïdal « building blocks ». When metal-silicate partitioning experiments were performed at pressures of 10-20 GPa[2,3], however, it became clear that the siderophile element (e.g. Ni, Co, W, S) concentrations of planetary mantles reflect re-equilibration at high pressures and are characteristic of the planet. This means that mantle composition can be used, in principle, to constrain the conditions under which accrétion occurred. The major aim of this presentation is to show how metal-silicate partitioning is used to investigate accretionary conditions and particular emphasis will be placed on experimental errors, uncertainties and extrapolations.

In contrast to studies of accrétion conditions, attempts to determine the timescales of accrétion using both long-lived (e.g U-Pb) and extinct (e.g Hf-W) radioactivities have tended to involve arbitrary assumptions about how éléments distribute themselves between silicate, métal and gas phases. A second aim of my talk is to show how expérimental and isotopic studies may be integrated into a cohérent picture given appropriate expérimental data.

Experimental: The expérimental approach involves generating an intimate mixture of métal and silicate phases doped with the siderophile éléments of interest. After an experiment of a few minutes duration at high pressures in the piston-cylinder (1-4 GPa) or multi-anvil (4-25 GPa) apparatus the liquid métal almost invariably séparâtes into one or more large blobs having equilibrated its siderophile élément contents with those of the liquid silicate. After quenching the métal and silicate phases are readily analysed with électron microprobe or laser ICP-MS instruments.

The choice of capsule material turns out to be critical. Experimentalists use either graphite or a refractory oxide such as MgO, SiO_2 or Al_2O_3. In the case of graphite the silicate composition does not change during the experiment but the métal is saturated in carbon, meaning it contains ~5-8 weight% C. Use of an oxide capsule avoids carbon saturation but leads to changes in the silicate composition towards saturation in the oxide of concern. I will give examples of how the choice of capsule can lead to misleading results. I will also show how the data can be corrected for the effects of solutés in métal and silicate phases.

Discussion: If experimental data for the metal-silicate partitioning of several elements are considered simultaneously it becomes clear that the mantle concentrations of weakly siderophile elements such as V and Nb place strong constraints on the conditions of core separation[4]. Assuming continuous segregation of the core during accretion of the Earth, pressure-sensitive elements such as Ni and Co indicate that the core segregated at pressures which increased to ~45 GPa, presumably at the base of a largely molten "magma ocean". The weakly siderophile element contents of the mantle may only be reconciled with those of Ni and Co if the small protoEarth was very reduced and the planet became progressively oxidized as it grew. from a mantle which is chemically homogeneous but in which the Earth became more oxidized as it grew. This model yields an Si content of the core of ~6%, in good agreement with cosmochemical estimates and with recent isotopic data.

References:

[1] Ringwood, A.E. (1966) *Geochim. Cosmochim. Acta, 30,* 41-104. [2] Thibault, Y., Walter, M.J. (1995) *Geochim. Cosmochim. Acta., 59,* 991 [3] Li, J., Agee, C.B., (1996) *Nature,* 381, 686-689. [4] Wade, J., Wood, B.J. (2005) *Earth Planet. Sci. Letts,* 236, 78-95