Constraining the depth of a martian magma ocean through metal-silicate partitioning experiments: The role of different datasets and the range of pressure and temperature conditions. K.Righter[1] and N.L. Chabot[2]. [1]NASA JSC, Houston, TX 77058; kevin.righter-1@nasa.gov [2]JHU-APL, Laurel, MD 20723.

Introduction: Mars accretion is known to be fast compared to Earth [1]. Basaltic samples provide a probe into the interior and allow reconstruction of siderophile element contents of the mantle. These estimates can be used to estimate conditions of core formation, as for Earth [2]. Although many assume that Mars went through a magma ocean stage, and possibly even complete melting [3], the siderophile element content of Mars' mantle is consistent with relatively low pressure and temperature (PT) conditions, implying only shallow melting, near 7 GPa and 2073 K [4]. This is a pressure range where some have proposed a change in siderophile element partitioning behavior [5,6]. We will examine the databases used for parameterization and split them into a low and higher pressure regime to see if the methods used to reach this conclusion agree for the two sets of data.

Martian Ni/Co Ratio: One of the strongest constraints on the pressure of equilibration for Mars is the Ni/Co ratio. Because Mars has a large depletion of Ni compared to Co, the Ds for these two elements must be very different in any explanation of metal-silicate equilibrium. Indeed, D(Ni) must be ~ 175 and D(Co) must be ~ 40. In terms of the exchange equilibria, K_d(Ni-Fe) ~ 33, and K_d(Co-Fe) ~ 7.6. These D and K_d values are based on the Mars bulk composition and core size model of [8].

Results: The predictive expressions of [7] for Ni and Co can be used to predict D(Ni) M/S and D(Co) M/S across a range of temperatures and pressures ≥ 5 GPa according to expressions of the form $\ln D = a/T + bP/T + c\Delta IW + d$. The experimental database of [5] was split into two regimes – high pressure and low pressure – for Ni and Co. These expressions were for exchange partition coefficients K_d (Ni-Fe) and K_d(Co-Fe) and are independent of oxygen fugacity and therefore the expressions have the form $\ln K_d = a + b/T + cP/T$.

Using the [7] dataset results in satisfactory matches to the Ni and Co D's at 6 GPa and 2000 K and a Δ IW of -1 Using the [5] dataset results in matches at 4 GPa and 2373 K with no difference between the results of high P vs. low P datasets. And use of the expressions of the form of [9,10] yields acceptable matches at 7 GPa and 2273 K, and ΔIW = -1.

These results for Ni and Co will be augmented with an assessment for W. The preliminary results indicate the relative low PT conditions for Mars are resilient to different D(M/S) parameterization approaches. Furthermore, the low PT conditions must be reconciled with accretion and differentiation constraints provided from isotopic measurements.

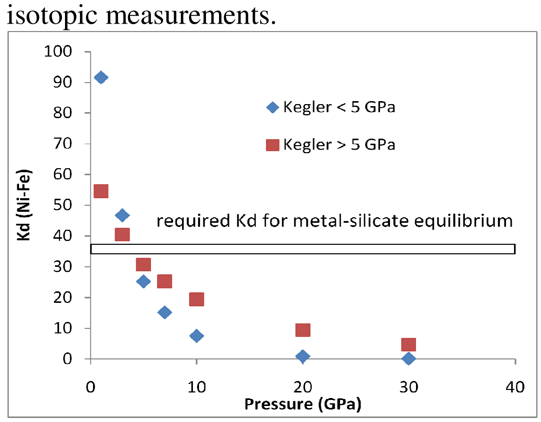

Figure 1: K_d(Ni-Fe) met/sil vs. pressure calculated for high pressure >5 GPa) and low pressure (< 5 GPa) data of [5]. K_d(Ni-Fe) of 33 is required for equilibrium in the Mars mantle, which is best matched near 4 GPa and 2373 K.

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