MAGMA MUSH ON MARS

C. D. Deering[1], S. Kuehner[1], O. Bachmann[1]. [1]Dept. of Earth and Space Sciences, University of Washington, Mailstop 351310, Seattle, WA 98195-1310. E-mail: cdeering@u.washington.edu.

Introduction: Magmatic differentiation on Earth appears to be governed by the extraction of interstitial melt from long-lived magma mushes [1]. Recent numerical models [2] indicate that effective melt extraction from crystal-rich reservoirs is confined to a 'most probable' crystallinity window (~50-70 vol.%) due to (1) low crystal settling rates at low crystallinity (as magma convects) and (2) the extremely slow melt extraction rate at high crystallinity (low permeability). A key factor in such models is that cooling, and hence crystallization rates, are slow enough for a given reservoir to remain within the optimal crystallinity window long enough for the melt extraction to occur. However, Mars is known to have a significantly lower thermal gradient (1/4 to 1/3) than Earth [3]. Consequently, the ability of magmas to remain at the optimal window of melt extraction for any appreciable length of time on Mars against this low thermal gradient may be severely restricted.

To assess differentiation processes on Mars, we performed a detailed examination of the texture and composition of pyroxene grains in the Martian meteorite NWA 5298 [4]. NWA 5298 is coarse-grained and composed predominately of large euhedral to subhedral elongated pyroxene grains (up to 4mm in length) and interstitial subhedral laths of maskelytanized plagioclase. BSE images reveal a complex textural and chemical zoning pattern in the pyroxenes, consisting of a well defined augite core that is irregularly truncated and bounded by a distinctly more ferroan mantle (sometimes discontinuous) of augite and/or pigeonite, which in turn is also irregularly truncated by an even more Fe-rich rim. The core-mantle and mantle-rim textural discontinuities are consistent with dissolution surfaces formed during magma recharge events, a common feature found in igneous rocks on Earth. Pyroxene-only modes indicate that the first recharge occurred when the crystal fraction was at least 25% and the second recharge was at least 65%. This evaluation indicates that crystal-rich mushes exist on Mars, and are maintained at intermediate crystallinities by hot recharge.

Using the MELTS software [5], we examined whether or not the most evolved Mars meteorites (Los Angeles) represent extracted liquids from a more mafic mush. We modeled the crystallization path and melt evolution of NWA 5298 at 1kbar, QFM-3 and anhydrous. Results show that the Los Angeles meteorite composition can be produced when this mush reaches 50-70% crystals. Relative to Earth, however, separation of even more evolved melts at higher crystal fractions is severely hindered on Mars by its lower thermal gradient and resultant higher degree of undercooling. This ensures that the probability of generating any significant amounts of evolved liquid (analogous to terrestrial basaltic-andesite) on Mars is extremely low.

References: [1] Sinton J.M. and Detrick R.S. 1992. *Journal of Geophysical Research* 97:197-216 [2] Dufek J. and Bachmann O. 2010. *Geology* 38:687-690 [3] Solomon S.C. and Head J.W. 1990. *Journal of Geophysical Research* 95:11073-11083. [4] Irving, A.J. and Kuehner, S.M. 2008. Abstract #5332. *Meteoritical Society Annual Meeting*. [5] Ghiorso M.S and Sack R.O. 1995. *Contributions to Mineralogy and Petrology* 119:197-212.