IRVINE: A PARENT TO BACKSTAY? A. D. Harrington[1], F. M. McCubbin[1], S. M. Elardo[1], H. Nekvasil[1], D. H. Lindsley, [1]Department of Geosciences, State University of New York, Stony Book NY 11794-2100, adharrin@ic.sunysb.edu

Introduction: Initially forming from an early planet-wide partial melting event, the Martian crust underwent further growth upon the addition of a secondary crust from contributions of magma from the mantle [1]. Both the primary and secondary crust are proposed to be thick, with the primary crust being 20-30 km thick [2, 3] and the secondary crust being 33-81 km thick [4]. With such crustal thicknesses, it is likely that magma ascent would be punctuated by ponding and crystallization. If the residual magmas continue ascending and leave behind the crystallized minerals, the upper crust would be enriched in evolved magmas [5]. These evolved magmas could be quite diverse. Using Humphrey as a possible parent, [6] showed that upon fractionation at the base of the Martian crust, with low water contents (~0.03 wt %), these evolved magmas will remain basaltic, moving toward lower silica and alumina and higher Fe, Ti, and P. Alternatively, at higher bulk water contents, residual liquids evolve towards silica enrichment. However Humphrey could not produce liquids of Backstay composition under wet or dry conditions.

As indicated by [7], Backstay is a Martian hawaiite. Using terrestrial magmas as an analog, this rock is likely not a direct mantle melt, but rather represents an evolved magma ([8, 9]). On Earth, such liquids can be derived from typical tholeiite, but what were the characteristics of the liquids parental to Backstay, that is, the Martian equivalent of terrestrial tholeiite?

The rock Irvine analyzed by the MER Spirit in the Columbia Hills [10] appears less evolved than Backstay (Figure 1), with its higher *mg#* and lower alkali contents. It appears to lie on a trend similar to that emanating from mildly alkalic basalt to hawaiite in terrestrial silica-saturated alkalic suites [8] (Figure 1). For this reason, experiments have been initiated to evaluate the possibility that Irvine composition magma could produce the Backstay composition. Since [5] suggested that Backstay composition melt could represent the type of liquid trapped by olivine of the Chassigny dunite, a less evolved liquid giving rise to Backstay composition would also lend insight into the compositional characteristics of the type of magma that was involved in earlier stages of the formation of the Chassigny dunite. Therfore, we performed experiments to investigate whether or not there could be a link between Irvine and Backstay, in hopes of identifying (i) the Martian equivalent of a terrestrial tholeiite, and (ii) a possible parent to the Chassigny dunite.

Experimental Details: Irvine composition, shown in Table 1, was created by mixing oxides with Fe^o sponge to produce a starting material to be used in crystallization experiments. For **"dry"** experiments, this mixture was loaded into graphite capsules and dried under vacuum at 800^oC in the presence of an oxygen getter to prevent oxidation of the starting material. Crystallization experiments were conducted at 10 kbar nominal (9.3 kbar) by first melting for 2.5 hours at pressure and then rapidly cooling to the desired temperature, and crystallizing for a minimum of 2.5 days. The fO_2 of these experiments likely lies between 1.5 and 2.5 log units below FMQ.

Table 1. Composition of Irvine and Backstay- class rocks where Irvine[a] and Backstay are the actual composition of the rocks analyzed by MER and Irvine[b] is the composition used in laboratory experimentation. Compositions were normalized to 100% for comparison. *All Fe reported as FeO

	Irvine[a]	Irvine[b]	Backstay
	Oxides wt%		
SiO_2	46.58	47.59	49.6
TiO_2	1.05	1.09	0.93
Al_2O_3	10.50	10.76	13.3
Fe_2O_3	7.61	n.d.*	3.33
Cr_2O_3	0.20	0.22	0.15
FeO	12.20	19.32*	10.7
MnO	0.36	0.37	0.24
MgO	10.50	10.47	8.32
CaO	5.98	5.74	6.05
Na_2O	2.66	2.76	4.16
K_2O	0.67	0.70	1.07
P_2O_5	0.96	0.98	1.39
SO_3	0.75	n.d.	0.73
Total	100.0	100.0	100.0

After quench, all experimental products were examined optically and analyzed by electron microprobe. Mass balance calculations were performed using the phase compositions obtained. These were used to ensure that the analyses were reasonable and that no phase was overlooked during microprobing. The water contents of residual glasses have not been measured to date, however, they will be measured quantitatively by micro-FTIR analysis at the American Museum of Natural History before presentation of the results in Houston.

Experimental Results: The resulting residual liquid compositions obtained thus far under dry condi-

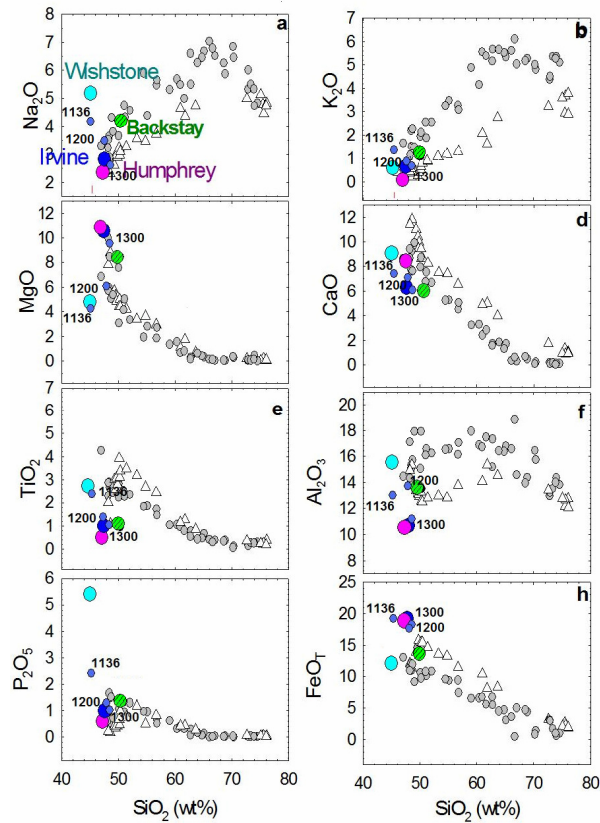tions are shown in Figure 1. Table 2 summarizes the phases observed, and Figure 2 shows the phase abunances.

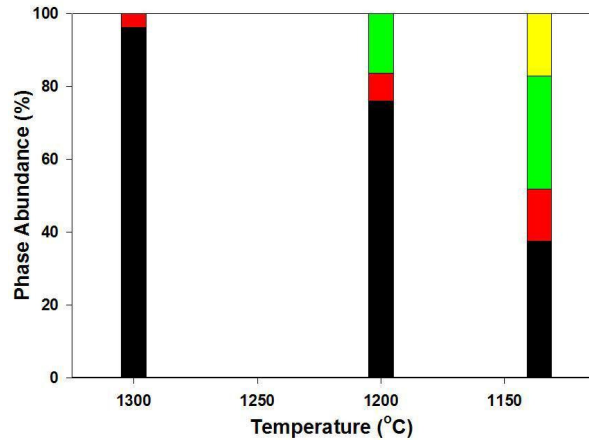**Irvine Phase Abundance Diagram 9.3 kbar, Dry**

Figure 2. Phase abundance diagram for Irvine under dry conditions. The colors represent the following phases: glass (black), olivine (red), pigeonite (green) and plagioclase (yellow). Due to its low amount, the chromite present at 1200 °C could not be represented in the above diagram at this resoluton.

Figure 1. Compositions of Irvine and Backstay [7]. Those of Humphrey and Wishstone are added for comparison. Experimental residual liquids upon crystallization of Irvine "dry" are indicated by the light blue circles. Temperatures of the experiments are given in Table 2. Terrestrial silica-saturated alkalic liquid line of descent for the Nandewar Volcano is shown by gray circles [11]; for the Thingmuli Volcano tholeiitic suite, Iceland, by open triangles [12].

Table 1. Shows the phases and respective compositions present at each crystallization temperature. Sum of the squares of the residuals (s.s.r.) are presented for each experiment after the list of phases.

T ^oC	Phases at 9.3 kbar "dry"
1300	olivine (Fo_{73}), glass [s.s.r. 0.663]
1200	olivine (Fo_{63}), pigeonite ($En_{63}Fs_{28}Wo_9$), chromite, glass [s.s.r. 0.055]
1136	olivine (Fo_{53}), pigeonite ($En_{52}Fs_{33}Wo_{15}$), plagioclase($Ab_{56}An_{40}Or_4$, glass [s.s.r. 0.037]

Discussion: As shown most clearly by the MgO vs. SiO_2 plot, under dry conditions crystallizing at the base of the crust, Irvine composition melt does not produce Backstay composition melt. Instead, it follows a silica-depletion trend much like the crystallization of Humphrey under dry conditions. Further crystallization experiments on Irvine under "wet" conditions are required to assess whether or not there could be a link between Irvine and Backstay. Therefore at this time, we cannot determine (i) the Martian equivalent of a terrestrial tholeiite, or (ii) a possible parent to the Chassigny dunite. Crystallization experiments on Irvine under both "wet" and "dry" conditions are ongoing.

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