COMBINING METEORITES AND SURFACE BASALTS TO CONSTRAIN MAGMA GENESIS CONDITIONS AND POTENTIAL FOR MANTLE METASOMATISM

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Introduction: Chemistry of basalts provide a window into the interior of a planetary interior that can be used to investigate mantle chemistry and magma genesis conditions [e.g., 1]. For Mars, the diverse data sets (meteorites, surface basalts, and average crustal compositions from orbit) provide important constraints on the chemistry of basalts through time and space. These data sets will be used to investigate the differences in melting conditions, including the potential for metasomatism, over geologic time. Two main methods have been used to calculate the average magma formation conditions in the Martian interior: inverse experimental method [2] or geochemical modeling - olivine-melt Mg-exchange thermometry, silica-activity in the melt barometry, or PMELTS calculations [1, 3, 4]. These will then be used to calculate the mantle potential temperature following previous techniques [5-7].

Before landing on the surface of Mars, our knowledge of Martian geochemistry was limited to the Martian meteorites. Martian meteorites provide a detailed but biased view of Mars because they have a relatively restricted range in age and bulk major element chemistry [e.g., 8]. The caveat being that newly found samples are starting to expand both the age and chemistry of the meteorite collection [e.g., 9]. MER Spirit analyzed basaltic rocks that have a similarly restricted range in silica-content as the Martian meteorites but have higher total alkalis and aluminum [e.g., 10]. Further, they are thought to be late Noachian/Early Hesparian instead of Amazonian in age [11]. MER Opportunity analyzed Bounce Rock at Meridiani Planum which has a bulk composition similar to the Martian meteorite EETA but is thought to be Noachian instead of Amazonian [12]. MSL Curiosity has analyzed igneous rocks with the largest range in chemistry [e.g., 13]. Further, most of the rocks at Gale Crater have much higher K/Ti ratios than other Martian basalts and values higher than can be explained by simple igneous fractionation of expected minerals (Ol, Pyx). In order to explain the high K/Ti ratios, mantle metasomatism has been suggested [e.g., 14]. Metasomatism affected not only the chemistry of the basalts but also the formation conditions with lower temperatures and pressures of formation calculated for Gale Crater basalts. Noachian aged basalts that have not been affected by metasomatism have consistent formation conditions suggesting a mantle potential temperature of ~1450 °C [5, 6]. On the other hand, Martian shergottites have a much higher mantle potential temperature (~1710 °C) consistent with formation by a hot deep localized mantle plume source.

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