EVIDENCE FOR EXOTIC FE-, TI-, AND P-ENRICHED MAGMAS ON MARS FROM METEORITE NORTHWEST AFRICA 7034.

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Introduction: Igneous rocks and melts rich in Fe, Ti, and P (FTP) have been identified on Earth (e.g., jotunites, oxide-apatite gabbronorites, nelsonites [1]), the Moon (trapped melt inclusions within mare basalt minerals and mesostasis [2]), and Mars (Wishstone Class rocks [3]). Many different mechanisms have been proposed for the petrogenesis of these materials, including crystal accumulation (magmatic and by mechanical admixture), extreme degrees of fractional crystallization, and silicate liquid immiscibility [1-4]. Santos et al. [5] identified a type of lithic clast within the martian meteorite NWA 7034 that resembles FTP-rich rocks based on their high abundance of Fe-Ti oxides and apatite (resulting in bulk clast compositions low in silica and high in TiO_2 and P_2O_5). FTP-rich rock types tend to be volumetrically insignificant in terms of planetary crusts, however this rock type can potentially provide evidence for igneous processes that have not yet been extensively considered for Mars. The aim of the current study is to better characterize the FTP clasts within NWA 7034 in order to 1) determine if they derive from the physical break up of a single parent rock, 2) determine if they are genetically related to the other igneous clasts within NWA 7034, and 3) examine different models for the petrogenesis of this clast type.

Methods: FTP clasts within NWA 7034 and pairing NWA 8674 were analyzed in a method similar to that of [5] in which mineral modes were determined from BSE images and major and minor element contents were determined for each mineral phase within the clasts using EPMA. These data were combined with calculated mineral densities to determine bulk compositions.

Results and Discussion: Bulk clast compositions and mineral chemistry provide no obvious indication that FTP clasts derived from multiple parent rocks, and so can be treated together as a single lithology. Comparison of the NWA 7034 FTP lithology to other known FTP-rich rocks shows the NWA 7034 lithology is most similar to terrestrial jotunites in terms of chemistry and mineralogy. It also has similarities to the Wishstone Class rocks. Due to these similarities, proposed formation mechanisms for Wishstone Class rocks and jotunites can be considered for the NWA 7034 lithology. A non-magmatic addition of phosphate phases during explosive eruption, as suggested by [4] for the formation of Wishstone, does not agree with the textures of the NWA 7034 FTP clasts. One proposed jotunite formation process, silicate liquid immiscibility, seems possible for the NWA 7034 FTP lithology based on the abundance of immiscibility promoting elements, however compositions of other NWA 7034 clast types from [5] do not strongly resemble expected conjugate liquids to the FTP lithology. This could reflect a difference in the compositional space defined by the binodal surfaces for terrestrial and martian liquids, or the absence of the lithology formed from the high Si liquid in NWA 7034.

References: [1] Dymek R. F. and Owens B. E. 2001. *Economic Geology* 96:797-815. [2] Shearer C. K. et al. 2001. *American Mineralogist* 86:238-246. [3] Squyres S. W. et al. 2006. *Journal of Geophysical Research* 111:E02S11. [4] Usui T. et al. 2008. *Journal of Geophysical Research* 113:E12S44. [5] Santos A. R. et al. 2015. *Geochimica et Cosmochimica Acta* 157:56-85.