MG-SPINEL EXPOSURES WITHIN SILICA RICH SETTING ON HANSTEEN ALPHA: PROBING THE GEOLOGIC CONTEXT Deepak Dhingra[1], Timothy D. Glotch[2], Tabb C. Prissel[3], Stephen W. Parman[4], Carle M. Pieters[4] and Benjamin T. Greenhagen[5] .[1]Dept. of Physics, Univ. of Idaho, ID 83843 USA (deepdpes@gmail.com), [2]Dept. of Geosciences, Stony Brook Univ., NY, USA, [3]Dept of Earth & Planet. Sc., Rutgers Univ., NJ 08554, USA [4]DEEPS, Brown Univ., RI 02912, USA, [5]JHU-APL, MD, USA

Introduction: Hansteen alpha, the arrow-head volcanic construct, is one of the red spots on the Moon which have long been suggested to be formed by silicic volcanism [1, 2]. The silicic nature of the red spots (including Hansteen alpha) was confirmed recently based on the Diviner observations [3] onboard Lunar Reconaissance Orbiter (LRO) spacecraft. Several other recent studies have added new dimensions to the understanding of Hansteen alpha [e.g. 4,5,6,7,8].

In particular, the occurrence of Mg-spinel lithology at Hansteen alpha, first identified by [5] and evaluated in detail by [9], is quite interesting due to multiple reasons: (a) Mg-spinel lithology was discovered very recently [e.g. 10,11] and its mode of origin is still an active field of research [e.g. 12,13]. So, any new exposure could be potentially important. (b) The majority of Mg-spinel detections have been found to be associated with feldspathic-rich rocks [9], with low-iron abundance (~ <5 wt%). Hansteen alpha is only one of the two locations where Mg-spinel exposures occur within a proposed dominantly silicic setting (the other being Compton Belkovich [9, 14]). It is also intriguing since silicic lithologies, such as at Hansteen alpha, are believed to be very evolved, which is supported by their generally high thorium concentrations [e.g. 15].

Here, we aim to obtain the detailed geologic context of Mg-spinel exposures amongst a dominantly silicic setting by integrating compositional, imaging and topographic datasets from multiple missions.

Geologic Context of Mg-spinel Exposures at Hansteen Alpha – New Insights: Mg-spinel exposures have been found in different geologic settings across the Moon [9]. One of the common traits across various exposures, including at Hansteen alpha, is their sporadic and highly discrete occurrence. This trait makes it difficult to detect this new lithology as well as to understand the geologic context. However, our preliminary studies of the Hansteen alpha region have identified two interesting relationships so far that may be useful in understanding the local associations of these Mg-spinel exposures:

Possible Association with Low-Fe Lithology: Mg-spinel exposures are characteristically found to be associated with low-iron lithologies (Fe< 5wt%). Interestingly, the majority of the Mg-spinel exposures at Hansteen alpha are enclosed within a broadly low-iron region (dashed region in Fig. 1a (red) and 1b (yellow)) with estimated abundances of 5-7 wt% [2]. There are however, some discontinuities that merit a closer look. The region immediately outside of this low-iron region has estimated iron abundances of 7-11 wt% [2]. Some of it may be contamination from adjoining mare deposits but some of the elevated iron might still be indigenous to Hansteen alpha based on its spatial extent.

Localized within an Age-constrained Volcanic Unit: The low-iron compositional unit (enclosing the majority of the Mg-spinel exposures) has been mapped

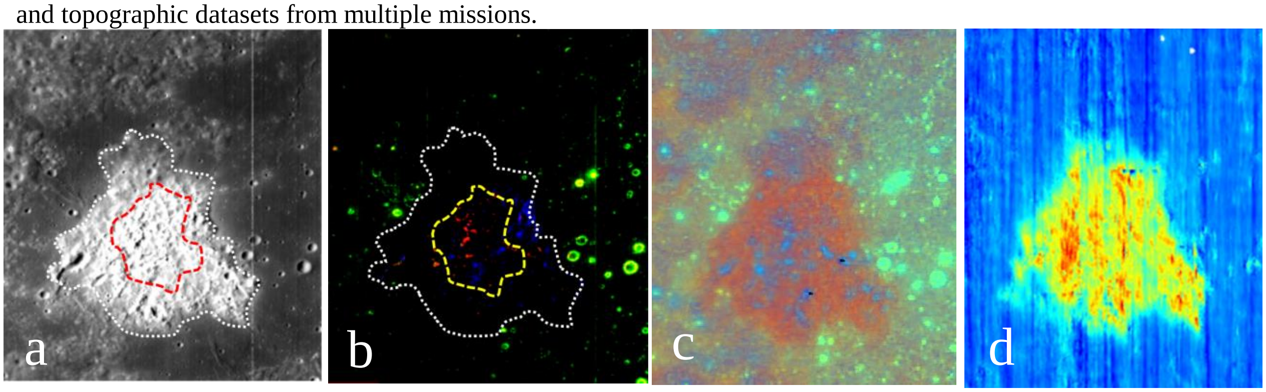

Figure 1. Different perspectives of Hansteen Alpha (a) M^3 Albedo image at 1489 nm. (b) M^3 color composite shows the distribution of Mg-spinel exposures (red) and strong hydration features (blue). Pyroxene-rich basalts are shown in green color. (c) Clementine color composite shows mature (red) and immature (blue) regions on Hansteen alpha. Strongly mafic regions are in green. (d) Diviner concavity index map. Increasingly silicic compositions are indicated in warmer colors (red being the highest). The dotted line in a and b indicates the approximate spatial extent of Hansteen alpha while the dashed inner region (red in a and yellow in b; sourced from [4]) indicates the approximate spatial extent of the low-iron region (5-7 wt%) on Hansteen alpha. The Fe map is based on [16].

by [8] as a 'Pitted Unit' based on the morphology and distinctive age (~3.5 b.y. compared to 3.75 b.y for the surrounding high-iron 'Hilly-Dissected unit'). Therefore, the Pitted Unit is interpreted as a separate volcanic episode compared to other units. Only the SE sector of the low-iron compositional unit is not mapped as the Pitted Unit. The majority of the Mg-spinel exposures however, occur within this Pitted Unit.

Nature of the Exposures from Coordinated Analysis of Spectral and Imaging Datasets: We are currently integrating multiple datasets to closely look at various features of interest. An example of this on-going analysis is shown in Figure 2. A region with strong Mg-spinel signature (magenta arrow; Fig. 2) in M^3 data seems to be a ridge in the coordinated high resolution NAC image, located on the edge of a scalloped feature in the pitted terrain. The ridge is covered with boulders (probably a few meters across) providing fresh exposures of Mg-spinel. The boulder field appears to have formed by in-situ breakdown of the rocks. Studies of additional exposures in the region, coupled with insights from other datasets, would provide a complete picture. There are also strong hydration features distributed across Hansteen alpha (blue regions; Fig. 2b). No high-iron mafic minerals have been detected so far.

Summary: New insights about the geologic context of Mg-spinel at Hansteen alpha are being obtained by coordinated analysis of information from multiple datasets. These clues should be helpful in deciphering the origin of this lithology within a dominantly silicic volcanic construct, which is so far an unusual occurrence.

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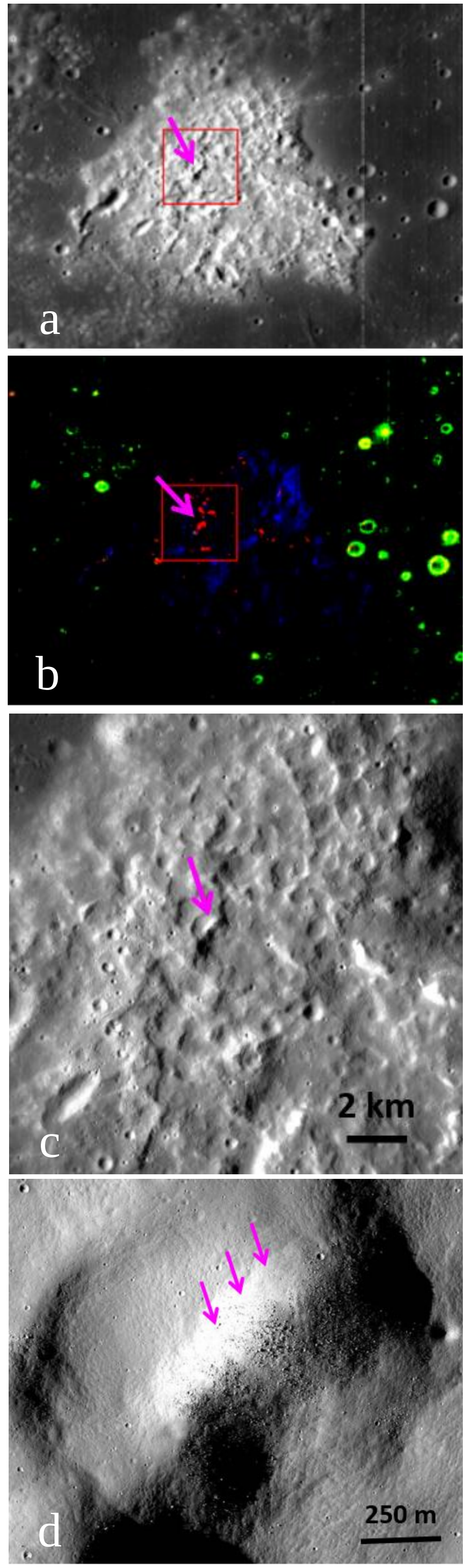

Figure 2 Detailed geologic context of a Mg-spinel location (marked with magenta arrow). (a) M^3 albedo image at 1489 nm. The red box marks the broad region of interest. (b) M^3 color composite showing Mg-spinel locations in red color, and strong hydration feature locations in blue color. High-Fe mafics are in green color. (c) LROC NAC context image. (d) NAC image shows that the Mg-spinel location of interest corresponds to a ridge covered with boulders.