THE SPATIAL RELATIONSHIP WITHIN FIELDS OF SHIELD VOLCANOES K. M. Shockey, and T.K.P. Gregg, Department of Geology, 411 Cooke Hall, University at Buffalo, Buffalo, NY 14260-3050, kshockey@buffalo.edu

Introduction: Volcanic shield distribution within fields of shields is related to the magmatic source(s) and can reveal similarities in the volcanic plumbing underlying shield fields on the terrestrial planets [1]. In this study, we constrain the spatial distribution of shield volcanoes within fields on the Earth, Mars, the Moon, and Venus. We will identify a precise location for each shield volcano and apply a nearest-neighbor analysis [2] to determine whether the shields are randomly distributed.

Here, we focus on shields within Rümker Mons (41°N, 58°W) on the Moon (Fig.1), and the Marius Hills (17°N, 51°W), to constrain the spatial distribution of volcanic constructs. These areas, along with the Grüithuisen Domes (35°N, 40°W), (Fig. 2) are the best examples of fields of shields on the Moon.

Background: The Marius Hills consist of several hundred volcanic constructs (cones, domes and shields) that range in height from 50-500 m and in diameter from 2-25 km [3]. The entire complex is ~35,000 km^2. Spectral data reveal that the constructs have Ti contents similar to those of the surrounding maria. Locally, edifices within the Marius Hills have weak mafic absorptions, which could be explained by small sizes of igneous minerals within a rapidly crystallizing melt [3].

Rümker Mons shows a spectral signature similar to its adjacent mare deposits, which contain dark-mantle deposits. Rümker Mons has a stronger mafic absorption then the surrounding area. The Grüithuisen Domes have a feldspathic signature similar to the highlands, and it has a brighter and redder signature than surrounding maria material, indicating a low titanium content [3].

Methods: The primary data set used for this study is Lunar Orbiter (LO) Images (LO-IV 22N292). These images are particularly useful because the low to moderate (~60°–70°) illumination angles [4] reveals detailed topographic information. The images (obtained from http://webgis.wr.usgs.gov/) are placed into Adobe Photoshop, image contrast is enhanced, and each shield volcano is assigned a single pixel (identified by image line and sample numbers) for its location.

The first criterion for locating a volcano on the Moon is the presence of a summit crater that was not generated by impact. If present, then the center of that summit crater is deemed to be the location of the volcano. However, most volcanic constructs on the Moon do not display summit craters. The second criterion is an obvious topographic high. If visible, then the highest point of the volcanic edifice is chosen as the volcano location. For constructs lacking both a clear summit crater and summit peak, we draw a circle around the volcano's base. This circle is determined by the smallest circumference that will fit around the entire base of the given volcano. The center of this circle is the location of the volcano.

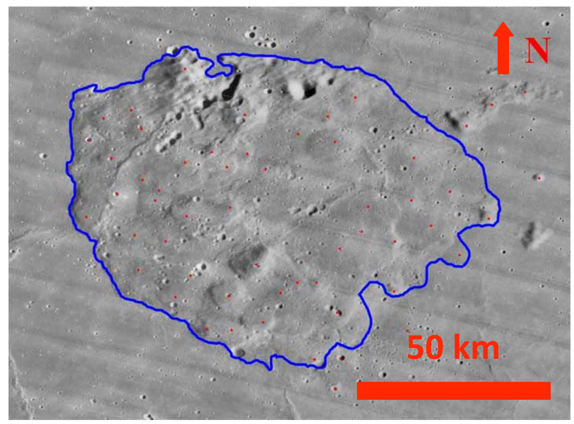

Figure 1: Mons Rümker at 41°N, 58°W (image LO 22N292 CKSPK) as shown by the Lunar Orbiter Atlas. The blue line indicates the edge of the contiguous Rümker Mons structure; red dots are the locations of the volcanic constructs included in the analysis.

Using the method outlined by Baloga and others [2] we analyze the spatial distribution of edfices within these fields [L. Glaze, personal commun., 2008]. Baloga and others [2] applied a modified nearest-neighbor analysis to constrain whether the tumuli within a given lava flow are randomly distributed; we use the same method for shields within a volcanic field. A probability density curve is plotted and classified as "classic" (random), "renormalized," "scavenged" or "classic logistic" (not random) (Fig. 3). In Fig. 3, the curve labeled "PNN" represents a classic case of a Poisson distribution. The limited spatial resolution of the LO images indicates that we will not obtain a "classic" distribution (completely random); the "renormalized" distribution accounts for the inability to identify features smaller than, or closer to each other than, pixel size. The "scavenged" curves in Fig. 3 are obtained by imparting an initial Poisson distribution and the requirement that if resources are used to create a construct in a given location, similar resources will be unavailable for a certain distance around the construct. The "classic logistic" does not assume a Poisson distribution, and, like the scavenged model, assumes limited resources. In our studies, a curve similar to the Poisson nearest-neighbor would indicate a random distribution of shields; a "classic logistic" or "scavenged" would indicate non-random distributions.

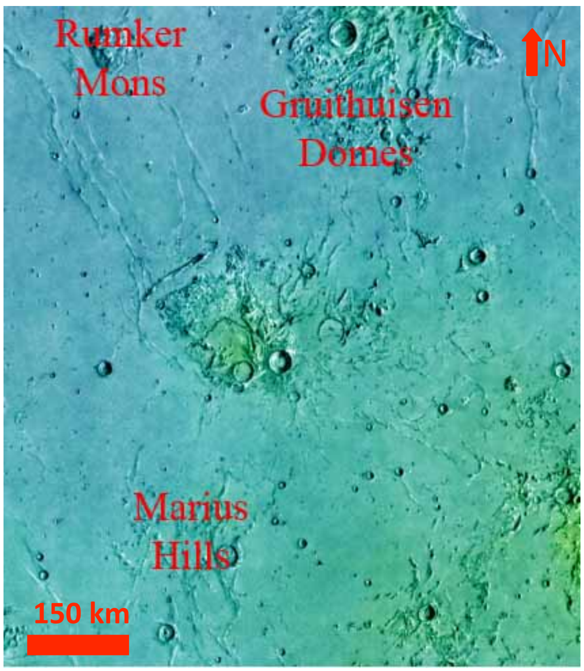

Figure 2: A shaded-relief elevation map showing the locations of the three fields of shield volcanoes, Rümker Mons (41°N, 58°W), the Marius Hills (17°N, 51°W), and the Grüithuisen Domes (35°N, 40°W).

Discussion: The method outlined in [2] provides a tool for interpreting the physical processes that have created the spatial distribution of the shields. In this case we can interpret whether we have one or more magma sources creating a single field. Distributions that are similar to "scavenged" or "classic logistic" would indicate that the volcanic constructs within the field are essentially sharing resources. In other words, the formation of a shield in one location precludes generation of a second shield within a certain distance because all available resources (magma) in that region have been used up. This is consistent with a single magma source feeding all the shields within a given field. In contrast, random spatial distribution would be more consistent with multiple, individual magma sources that do not affect or interact with each other.

Conclusions: There is little known about the spatial distribution of volcanic constructs within discrete shield fields on the terrestrial planets. It is expected that constraining the spatial distribution of individual shields within shield fields will help us to better understand the magmatic source(s) feeding these features.

In the future, we will locate and analyze shield fields on Mars, Venus and Earth to search for systematic differences among the terrestrial planets.

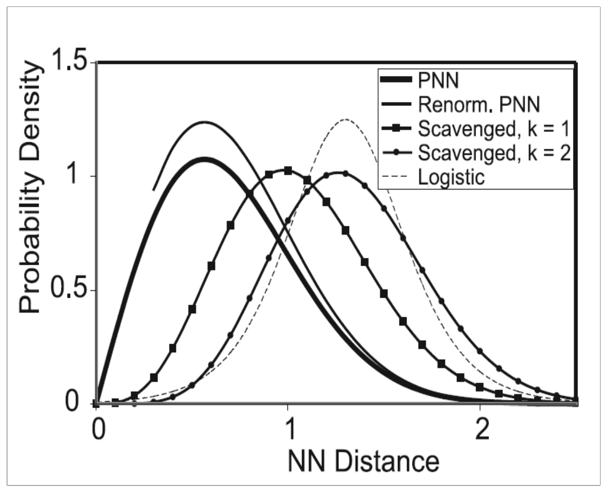

Figure 3: An example graph of probability density vs. nearest neighbor distance as analyzed by the IDL script. PNN is "Poisson nearest-neighbor," indicating a random distribution. (From [2].)

References: [1] Gregg T. K. and K. M. Shockey (2008) *GSA Abs.* Abstract 133-4. [2] Baloga, S. M. et al. (2007) *JGR,* 112, E03002. [3] Weitz, C.M., and J. W. Head III (1999) *JGR,* 104, 18,933-18,956. [4] Gillis, J. J. et al. (1999) *LPSC XXX*, Abstract #1770.