

TESTING OF A MATLAB STATISTICAL TOOL AT CHERNAVA COLLES, VENUS. N.P. Lang¹ and B.J. Thomson², ¹Department of Geology, Mercyhurst University, Erie, PA 16546 (nlang@mercyhurst.edu), ²Boston Univ. Center for Remote Sensing, Boston, MA 02215 (bjt@bu.edu)

Introduction: Small shields represent perhaps the most dominant manifestation of volcanism on Venus. Defined as volcanic constructs <20 km in diameter (average of ~1-2 km in diameter) that are cone, flat topped, dome, or shield shaped, and <<1 km in height [1-3], small shields (herein referred to as shields) represent two fundamental types of vent distribution on Venus: (1) shield plains or terrain [4-5]; and (2) shield fields [6-7], which are the focus of this contribution. Because the sizes of individual shields reside at the effective resolution [8] of Magellan Synthetic Aperture Radar (SAR) imagery (resolution of ~75 m/pixel), unraveling formational controls on shield fields and developing a shield field stratigraphy is challenging. However, given the widespread occurrence of shields across the venusian surface, constraining formational controls and stratigraphy within individual fields may provide a critical window for understanding Venus' volcanic (and possibly tectonic) history.

Here we describe our efforts to better understand the geologic history recorded at individual venusian shield fields. Specifically, we have applied a recently developed MATLAB® (MATrix LABoratory)-derived statistical tool [9] to examine potential vent alignments within Chernava Colles, a 1000 km diameter shield field centered near 10.5°S, 335°E. This reported work represents the first application of our statistical tool to Venus and, although preliminary, our results hold promise for elucidating vent orientations in other venusian shield fields. By being able to 'pick-out' preferred vent alignments, a shield field stratigraphy could potentially be delineated, which may qualitatively highlight (recent?) regional stress orientations on Venus.

Chernava Colles: Chernava Colles is a 1000 km diameter shield field centered near 10.5°S, 335°E (**Figure 1**) between Vasilisa Regio and Kanykey Planitia. It is located on northwest-trending fractures associated with Albasty Fossae and Gui Ye Chasma along which multiple coronae have formed and erupted numerous long lava flows. *Bender et al.* [10] originally mapped Chernava Colles as part of an extensive regional plains unit that postdates much of the corona-related flow material in this area; the shield field was lumped with the regional plains unit and distinct shields and flow materials associated with the field were not distinguished. Shields within Chernava Colles are predominately cone-shaped and ~1-5 km in diameter, though several domical shields ≥5 km are also present. Cone-shaped shields typically lack noticeable summit pits and obvious associated flow materials,

whereas the dome-shaped shields are more typically associated with summit pits and localized flow materials. Numerous shields within Chernava Colles occur directly on top of, and are mostly superposed on, the fractures. This suggests a genetic relation between the fractures and the shields where the fractures pre-date shield formation. Using a terrestrial analogy for the formation of cinder cones on Earth [e.g., 11], magma likely rose up preferentially along pre-existing fractures

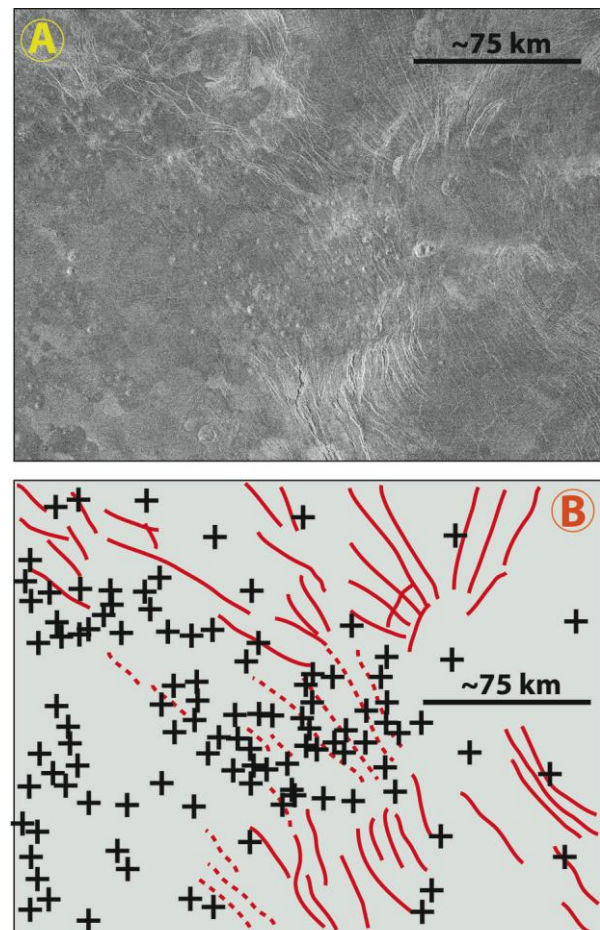


Figure 1: **A:** Magellan left-look SAR image of a portion of Chernava Colles. **B:** Simplified geologic map of the same portion of Chernava Colles from Fig. 1A highlighting the distribution of small shields and fractures. Both the shields (black crosses) and the fractures (solid and dashed red lines) have an overall NW orientation and a vast majority of the shields post-date fracture formation. Dashed red lines highlight fractures obscured or partially buried by flow materials. In both images (A and B), top of the image is north and images are centered at 10.5° S, 335° E.

and erupted to create the individual shields. In this case, stratigraphic relationships between the shield field and surrounding materials are clearly defined and there is a well-preserved qualitative record of the broad-scale stress field orientation that likely existed when Chernava Colles was emplaced.

Numerical method: Because of the unambiguous stratigraphic relationship between shields and fractures within Chernava Colles, it provides a useful first test of our statistical tool. The algorithm behind our statistical tool is described in [9] and is incorporated into a graphical user interface (GUI) built with the MATLAB® software. In the GUI, a user selects pre-processed input data, which is a CSV file that contains the center lat, lon position of each edifice in the shield field. The main body of the GUI consists of three panels. In the first panel, the distribution of point features (e.g., shields) can be visually confirmed in a x - y scatter plot. A second panel displays a raw, uncorrected histogram and rose diagram of orientation measurements. A third panel executes a user-specified number of Monte Carlo runs to randomly place an equivalent number of shields within the boundaries defined by the edge edi-

fices. A “normalized” histogram is produced from the Monte Carlo results whereby histogram cell is equal to the expected value times the observed value divided by the mean value in the Monte Carlo runs. To determine if a given normalized histogram value is statistically significant to the 95% significance level, the Student's t distribution is used to determine the 95th percentile critical threshold value. Histogram values that exceed the critical threshold value are deemed statistically significant.

Results: The results of running the statistical tool on Chernava Colles is shown in **Figure 2**. In this model run, we processed 60 shields ($n = 60$, which represents a relative sampling of the overall shield field) and ran 100 Monte Carlo models. Results (specifically, the rose diagram) show a strong overall NW to WNW trend for vent orientation at Chernava Colles, though some NE trends also exist and likely reflect local NE-trending coronae-related fractures. In the normalized histogram (far right panel), three cells ($\sim N60^\circ W$ and $N60^\circ E$) have values that exceed the 95th percentile critical threshold. This detected anisotropy is broadly consistent with the geologic mapping shown in Figure 1B.

Future work: With the success of our initial testing of this tool on Chernava Colles, our next step is to apply it to additional shield fields where vent distribution and association with fractures is not as straightforward.

References: [1] Aubele, J.C. and Sliuta, E.N. (1990), *Earth, Moon, Planets*, 50, 493-532. [2] Guest, J.E. et al. (1992), *JGR*, 97, 15,949-15,966. [3] Crumpler L.S. et al. (1997) in *Venus II*, 697– 756. [4] Aubele, J.C. (1996), *LPSC*, 27, 49-50. [5] Hansen, V.L. (2005), *GSAB*, 117, 808-822. [6] Aubele, J.C. et al. (1992), *LPSC*, 23, 47-48. [7] Head, J.W. et al. (2002), *JGR*, 97, 13,153-13,197. [8] Zimbelman, J.R. (2001), *Geomorphology*, 37, 179-199. [9] Thomson, B.J. and Lang, N.P. (2013), This volume. [10] Bender, K.C. et al. (2000), *USGS Misc. Map I-2620*, 1:5M. [11] Crumpler, L.S. et al. (2000), *Encyclopedia of Volcanoes*, 727-770.

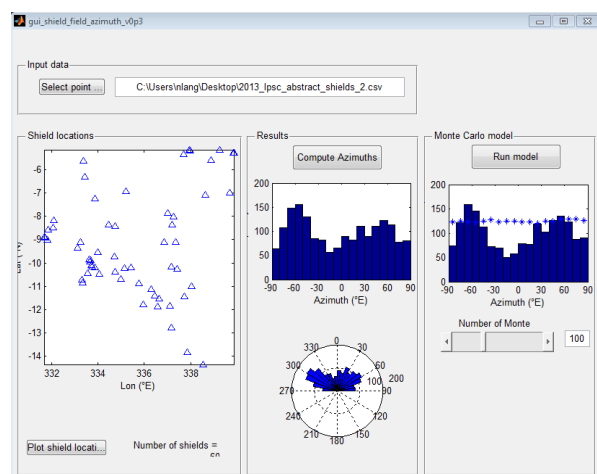


Figure 2: Snapshot of the statistical tool GUI showing the results of a run using shields from Chernava Colles. Results show a dominant NW trend for shield orientation, which is consistent with the geologic mapping shown in Figure 1B. These results give us confidence that the statistical tool should be applicable to other venusian shield fields.