HOW OLD IS VALLIS SCHRÖTERI AND IS IT THE SOURCE FOR THE YOUNGEST MARE BASALTS?

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Introduction: Vallis Schröteri is located on the Aristarchus Plateau, a block of ancient crust surrounded by basaltic maria [1]. Sinuous rilles are typically 20 to 40 km in length and less than a kilometer wide, however, the primary rille of Vallis Schröteri is 155 km long, up to 6 km in width and on average 500 m in depth [2]. The formation of Vallis Schröteri is likely the result of both lava thermal and mechanical erosion, where the primary rille was created during a large discharge event and the secondary rille formed from a smaller discharge event [3-5]. The highly sinuous secondary rille meanders across the floor of the primary rille, often eroding into its steep walls [6]. After traversing ~200 km away from the lava source [7], the secondary rille terminates in one of the youngest maria units on the Moon [8].

The formation time for Vallis Schröteri has been of interest due its position on Aristarchus plateau, its proximity to Aristarchus Crater and the youngest maria unit [8]. Although an age has not yet been determined for the pyroclastic deposits on the plateau, model ages derived from crater size-frequency distribution (CSFD) measurements indicate that Aristarchus crater is less than 200 Ma [9-12] and the youngest maria unit P60 is ~ 1.2 Ga. With the secondary rille terminating in P60, it seemed plausible that the rille is the source of the P60 maria unit. A first attempt at dating the rille was completed by [2] using CSFD techniques on Kaguya/TC images. To better understand the geologic history for the area, we obtained CSFD measurements for the rille from Lunar Reconnaissance Orbiter Camera (LROC) Narrow Angle Camera (NAC) images and investigate where the lava that carved the rille deposited outside of the plateau.

Data and Methods: We used NAC images that were processed using the Integrated Software for Imagers and Spectrometers (ISIS) [13,14]. NAC images with incidence angles between 65°-75° were considered for this study [15]. ArcGIS, count areas and CSFD measurements were defined and generated using CraterTools [15]. The CSFDs were plotted and fit in Craterstats [17], using the techniques described in [15]. The derived absolute model ages (AMAs) are based on the production and chronology functions [18], valid for lunar craters >10 m and <100 km in diameter.

CSFD measurements (Fig. 1) were conducted on three sections of the floor of the primary sinuous rille: (A) near the opening of the rille, (B) in the center, and (C) adjacent to the source vent (Cobra Head). These areas were later combined to estimate the formation age of the primary rille. Due to Vallis Schröteri's proximity to Aristarchus crater, we were meticulous to omit ejecta rays from the digitized count areas (especially for Area C). The Buffered Crater Counting technique for the primary and secondary rilles was considered, however, (1) the primary rille is too broad to use the technique, (2) the secondary rille has likely undergone a faster rate of resurfacing due to slumping from the walls of the primary rille, and (3) the secondary rille contains a large amount of blocks making it difficult to conduct CSFD measurements.

Results: Our CSFD derived model age for Vallis Schröteri is 2.5 ± 0.5 Ga (Fig. 2). This AMA was determined by combining the CSFD measurements of areas A-C (80 km²). Individually, the AMAs for areas A-C ranged from 2 to 2.7 Ga, all overlapping within their uncertainty estimates.

[2] determined the same age for the rille of 2.5 ± 0.5 Ga, however, the count area was not documented in that work and therefore, it is unclear what sections of the rille, primary or secondary, was used for age determina-

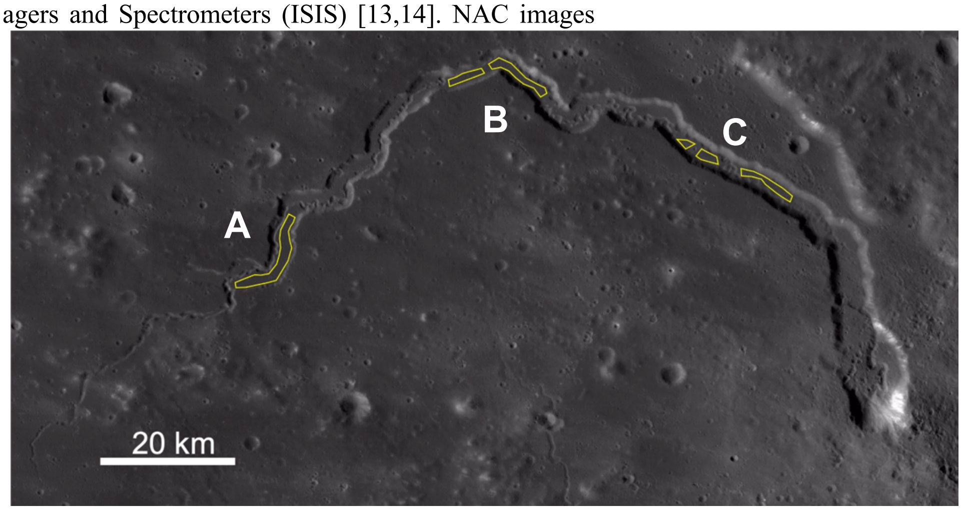

Figure 1: Vallis Schröteri shown in LROC Wide Angle Camera Global Morphologic basemap (100 m/pix)[9]. Count areas for CSFD measurements are marked in yellow boxes (A-C).

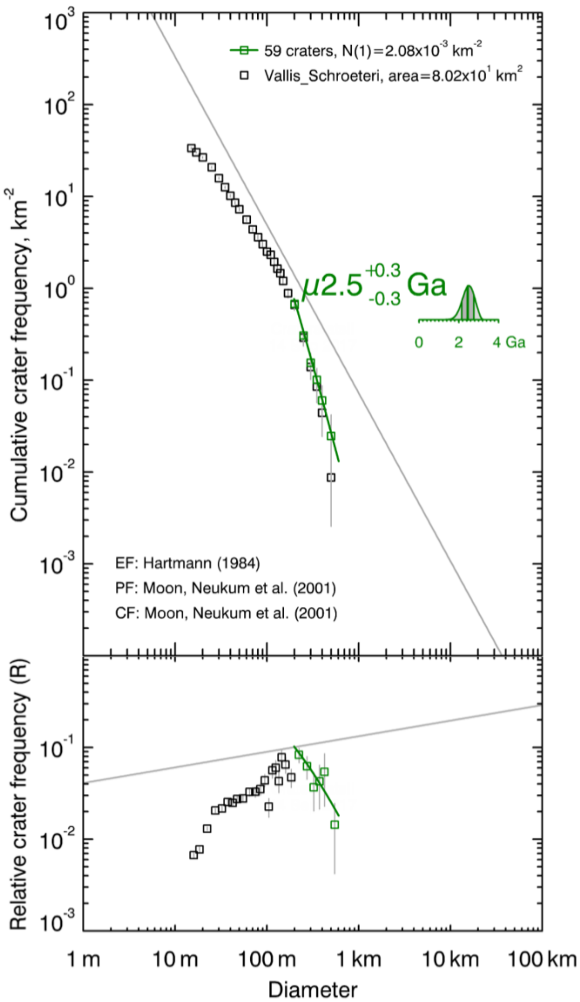

Figure 2: Absolute model age determined from the combined CSFD measurement areas on the floor of Vallis Schröteri. A Poisson timing analysis was used to fit the CSFDs. Fit shown in cumulative and r-plot.

tion. The resurfacing tool was applied to CSFDs to account for minor resurfacing due to the Aristarchus cratering event. [2] conducted CSFD measurements on the Cobra Head, attempting to correlate its age to the rille. Although an age of 3.1 (+0.3, -0.7) Ga was determined, it is likely not a representable age due to its proximity to Aristarchus Crater and therefore, being covered by ejecta material and secondaries.

Discussion: With the primary rille being Eratosthenian in age (~2.5 Ga), it is unlikely to be the source for the youngest mare basalts on the Moon (unit P60 at ~1.2 Ga). The primary rille abruptly stops at the contact to the P60 mare unit (Fig. 3), suggesting that the rille terminus was covered by the mare unit or the Aristarchus pyroclastic deposits (whose age remains unknown). If the primary rille had earlier terminated into the maria, continuing in a western direction, it is possible that the nearby P32 basalts might have been sourced by the rille

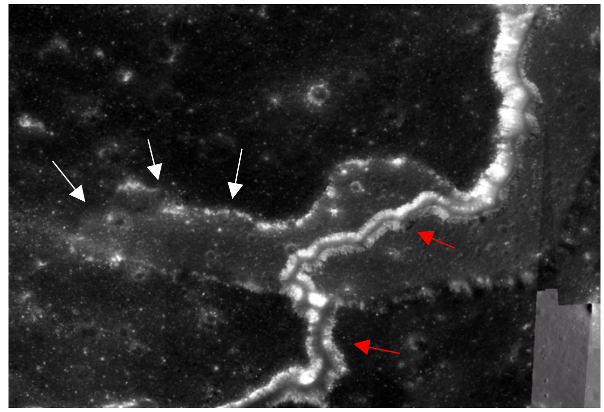

Figure 3: Low-incidence angle NAC image showing the end of the primary rille (white arrows). The secondary rille (red arrow) continues south for another ~50 km.

as their age ranges overlap with our estimates for the primary rille.

The secondary rille, however, has not completely been ruled out as being the source of P60. Where the primary rille abruptly stops, the secondary rille takes a sharp 90º to the south, where it eventually fades out into the P60 mare basalts [8]. The last 5 kilometers of the rille do not appear to be controlled by current topography, as it would have kept a southwestern flow direction instead of southeast. We consider that the region was tectonically tilted to its current position.

Higher resolution spectral data, preferably from the lunar surface via lander or long-range rover, of both rille floors and candidate mare basalts, would assist in correlating mineral abundances in the basalts. Additionally, a magnetometer could assist in finding similar field strengths and polarity between the rilles and nearby mare basalts.

Conclusion: CSFD measurements indicate that the primary rille of Vallis Schröteri is not the source for the youngest mare basalts, however, the secondary rille is still a possible source candidate. The plateau's geologic complexity continues to naturally be of interest for future lunar missions that would assist in answering the magmatic history of the Aristarchus plateau region [19].

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