THE LONGEST SINUOUS RILLE ON THE MOON (RIMA SHARP) AND ITS RELATIONSHIP TO THE YOUNG PROCCELLARUM MARE BASALTS: IMPLICATIONS FOR THE CHANG’E-5 RETURNED SAMPLES. Yuqi Qian1,2, James W. Head2, Lionel Wilson2,3, Long Xiao1*, 1Planetary Science Institute, School of Earth Sciences, China University of Geosciences, Wuhan 430074, China (longxiao@cug.edu.cn), 2Department of Earth, Environmental, and Planetary Sciences, Brown University, Providence 02912, USA, 3Lancaster Environmental Centre, Lancaster University, Lancaster LA1 4YQ, UK.

Introduction: Sinuous rilles (SR) are elongated, meandering channels that occur primarily in the lunar maria, and often begin at what appear to be circular, elongated, and arcuate depressions interpreted to be volcanic source vents, often with associated pyroclastic deposits [1]. Somewhat similar in planform to smaller lava channels, SRs are typically longer, wider, and deeper than such features and can form in the highlands where there is little evidence of flanking levees associated with a simple lava channel, before extending into the maria [2]. For these reasons, it has been proposed that SRs are related to extrusive lava flows in origin, but owe their large length width, and depth to processes of thermal and mechanical erosion of the substrate [3-4].

In a recent global study, [5] compiled a comprehensive Moon-wide catalog of lunar SR locations and characteristics, finding more than 200 SRs. As a population, these vary in length (2-566 km; median 33.2 km), in width (160 m-4.3 km; median 480 m), in depth (4.8 m-534 m; median 49 m), in slope (1.41°-0.51°, median 0.21°), and in sinuosity index (1.02-2.1, median 1.19). The highest concentration of mapped SRs (48%) occurs in Oceanus Procellarum within the Procellarum KREEP Terrain [6].

Rima Sharp: Rima Sharp, the longest SR observed (Fig. 1; red arrow) (#85 in the catalog of [5]), has a length of ~566 km from its northern source to its southern terminus and is located in Northeastern Oceanus Procellarum near the western extent of exposed highland terrain associated with the rim of the Imbrium basin and the edge of Iridium basin ejecta. [5] also noted in the detailed catalog annotation that Rima Sharp was complex at its origin to the north and also at its termination to the south. As mapped by [5], (their Fig. 9) in Rima Sharp has an average width of 840 m, an average depth of 76 m, an average regional slope of ~0.0081, and a sinuosity of 1.15, cutting predominantly into young high-Ti mare material. As mapped, at 566 km length, Rima Sharp is over 17 X longer than the median SR length, but only 1.7 X wider than the median width, 1.5 X deeper than the median depth, and a sinuosity (1.15) very near the median sinuosity (1.19) of the entire population. Because of the extremely anomalous length compared to the rest of the SR population (Fig. 1), and its similarity in width, depth, and sinuosity, we launched a more detailed analysis using new image and altimetry coverage of Rima Sharp, its source and termination regions, its along-channel characteristics, and its associated mare basalt units. A second motivation for our study was the fact that Rima Sharp traverses the young mare basalt geological unit (Em4/P58) that was the target for the successful Chang’e-5 landing and sample return mission [7-9]. Could Rima Sharp have been the volcanic feature that was responsible for the emplacement of the Em4 unit and thus the petrogenesis of the samples collected?

Results: In our analysis, we first documented the source and terminus of Rima Sharp (Fig. 2), as mapped by [5], and then examined its pathway between these two points (Fig 3) and the relationship to Em4, the young mare basaltic unit on which CE-5 landed and collected samples (Fig. 4).

We found that: 1) the beginning and end of Rima Sharp are both source vents (Fig. 2); 2) the 566 km long Rima Sharp is actually composed of two main SRs; 3) the northern source vent feeds several SRs, and the main one, Rima Sharp, flows south into Em4/P58 (Fig. 2, 4); 4) the southern source vent (here informally called Rima Mairan) begins at what was previously thought to be the rille terminus (Fig. 2), and flows northward; 5) neither source vent appears to have substantial associated pyroclastic deposits (Fig. 2); 6) Rima Mairan postdates Rima...
Sharp, and actually flows into the southern end of Rima Sharp (Fig. 3); 7) the new measured lengths of Rima Sharp (~320 km) and Rima Mairan (~150 km) place them more towards the lower end of the length-frequency distribution for the population of SRs (Fig. 1: blue arrows); 8) the mineralogy (high-Ti) of the basaltic lavas transported in both rilles appears very similar, despite their source vent separation of ~350 km; 9) both source vents and SRs appear to be traversing and emptying into mare basalt unit Em4/P58 (the young unit sampled by Chang’e 5) (Fig. 4); basalts sampled by CE-5 may have two different ages, representing the two different SR source regions [7-8].


Figure 2. Annotated maps of the main source vents for A) Rima Mairan (previously the southern termination of Rima Sharp), and B) Rima Sharp (northern end).

Figure 3. Image of the broad central area where the two SRs meet.

Figure 4. Map showing the two SRs and their relationship to Em4/P58 (outlined in black line) [8].