**MARTIAN GULLY MORPHOLOGIES.** K. A. Coleman[1] and J. C. Dixon[1,2], [1]W.M. Keck Laboratory for Space Simulations, Arkansas Center for Space and Planetary Sciences, MUSE 202, Fayetteville, Arkansas, USA <ksacolem@uark.edu>, [2]Dept. of Geological Sciences, 113 Ozark Hall, University of Arkansas, Fayetteville, Arkansas, USA.

**Introduction:** Since Malin and Edgett [1] identified gullies on the surface of Mars, numerous authors have studied heir occurrence and distribution [2-6], yet numerous morphologically distinct forms are all referred to as gullies. The variability of morphologies seen in gullies has lead to suggestions that perhaps not all gullies are formed by the same mechanism [7-9].

**Methods:** In an effort to being distinguishing between the various morphologies, we downloaded 127 High Resolution Imaging Science Experiment (HiRISE) and 46 Mars Global Surveyor Mars Orbiter Camera (MOC) images analyzing them in ENVI 4.4 and ENVI Zoom searching for various morphologies. We used ENVI because the HiRISE Science team processes, map-projects, and distributes the images on the web as lossless JPEG2000 images that are a gray-scale mosaic of all the RED-filter channels with an accompanying header file so the images can be imported directly into ENVI. The HiRISE team has also developed a HiRISE toolkit for ENVI that allows the images to be directly imported into ENVI and supports a number of Mars mapping projections. In this way, the images can be measured, compared, analyzed, and even made into mosaics. ENVI Zoom allowed us to view the images at scales other than those established by the ENVI software. This was necessary because HiRISE images are so large and detailed that an entire gully system cannot fit into the image window in ENVI. We viewed the images and began to create a database listing the types of morphological features seen in gullies within each image. We began to identify various morphologies that are described below.

**Discussion:**

*Simple Gullies:* Malin and Edgett [1] identified gullies as an erosional form having a head alcove, main and secondary channels, and a depositional apron. The alcove of these gullies (Fig. 1A) is described as forming on the upper third of the slope with a V-shape, incised channel and a distinct depositional fan that fills the slope [1]. These gullies emanate from the subsurface into a long, wide alcove then cut down through the surface as a narrow V-shaped channel is formed. The apron finally extends and widens to fill the slope as sediment carved out of the alcove is visibly deposited in the apron.

*Alcove-less gullies:* These gullies (Fig. 1B) develop from the surrounding uplands with no alcove feature. For these gullies the source region of the sediment movement will need to be identified. Alcove-less gullies generally have a smaller apron because the large alcove sediment source is missing.

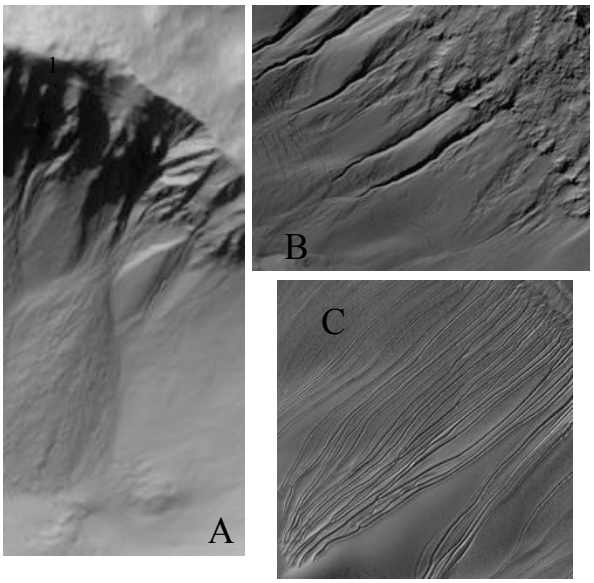


**Figure 1. A) Three part gully seen in E19000319 like those first identified by Malin and Edgett in 2000 with an alcove, channel, and apron. Image credit: NASA/JPL/ Malin Space Science Systems. B) Two alcove-less gullies seen on the northeast slope of a crater in HiRISE image PSP_008739_1425. The gullies exhibit an incised channel and depositional fan, but no alcove. C) Linear gullies on dunes in Russell Crater, seen in PSP_001441_ 1225, have narrow levied channels with no apron. They form parallel channels and run down dip.**

*Linear Gullies:* Linear gullies (Fig. 1C) with small alcoves that form just below the crest of the slope have been identified on sand dunes [10]. These gullies have very long, narrow levied channels with no depositional apron. Instead they have a distal lobe [10] reminiscent of glacial terminal moraines. These gullies are limited to occurrences on sand dunes and develop networks of parallel down-dip flows [10].

*Channel-less gullies:* Some gully-like features develop both an alcove and a depositional fan, but have no incised channel (Fig. 2A). These features resemble terrestrial debris chutes where sediment is moved down slope under the force of gravity with no involvement from fluids.

*Complex Gullies:* Some gullies are more complex. In these gullies, multiple alcoves may feed into a single or a few channels that drain a large area. The channels may be braided and/or anastomosing as in Fig. 2B. The alcove and source area is sometime undercut and the channels may exhibit point bars, cut banks, and erosion into underlying surfaces [7]. The apron may deposit along the gully and over adjacent systems [7].

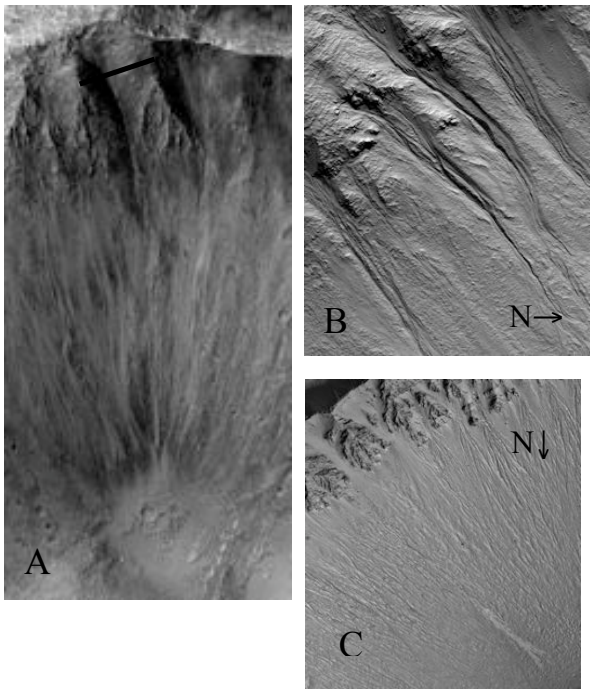


**Figure 2. A) Channel-less gullies from PSP_008984_2135. These gullies have both alcove and depositional apron, but lack an incised channel. The left alcove where marked is ~320m across. B) A complex gully from PSP_ 008833_2150 with braided channels. North is to the right. C) A bright gully deposit on the southeastern slope of a crater in from PSP_001714_1415. North is at the bottom.**

*Bright Gully Deposits:* Bright gully deposits have been found in the bottom of gully channels and in the depositional aprons of several gullies. The source of the high albedo material in these deposits is unknown. Malin [11] suggested that these deposits would darken over 1-2 year time scales, but this has not been observed in more recent HiRISE images [12].

*Slope Streaks:* Slope streaks are not considered gullies, but their occurrence in similar topographic areas and the inability to establish their nature encourages their inclusion in a study of gully form morphology on Mars. Slope streaks occur as streaks down a slope that have a visibly different albedo than the surrounding slope. They are both darker and lighter than the surrounding surface and they do not disappear with age as slope streaks from Viking images can still be seen in MOC images [13].

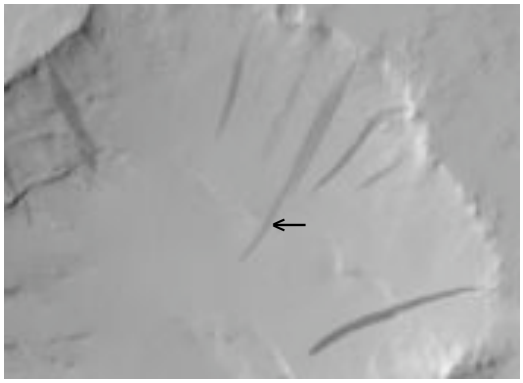

**Figure 3. Slope streaks with various orientations in HiRISE image PSP_009601_1920. The longest streak with arrow is ~740m.**

**Conclusion:** Gully forms on Mars display various morphologies. These forms can be compared to forms on Earth to begin to develop a classification of gully types on Mars. The identification of the diversity of gully forms on the martian surface will ultimately permit a more realistic evaluation of formative processes based on form/process terrestrial analogs.

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