DISTINGUISHING ENDOGENIC AND IMPACT CRATERS USING DEPTH TO DIAMETER RATIOS AND CIRCULARITIES. R.J. Dorsey[1] and R. Greeley[2], [1]Trinity University Geosciences Department, One Trinity Place #45, San Antonio TX, 78212; rdorsey@trinity.edu; [2]School of Earth and Space Exploration, Arizona State University, Tempe, AZ, 85287

Introduction: Age-dating of planetary surfaces relies mostly on impact-crater counts. Lunar surfaces are used to calibrate crater counts based on radiogenic dates from samples for extrapalation to other surfaces and planets. However, if craters of non-impact origin are incorporated in the counts, then the age of the surface would appear to be erroneously old [1]. Consequently, the recognition of non-impact craters is important for estimating surface ages based on crater counts.

Non-impact craters can result from a variety of processes. Two types of volcanic craters that form on lava flows are *collapse depressions*, resulting from the collapse of the cooled crust and *inflation pits* [2], in which the pre-flow surface prevents inflation of the flow during emplacement. The objective of this project was to assess morphometric data to distinguish impact craters from volcanic craters on lava flows (Fig. 1). The depth to diameter ratios and the circularity of craters on the McCartys lava flow (New Mexico) and data for lunar craters [3,4] were compared to craters in the Colombia Hills area in Gusev Crater, Mars. The circularity describes the shape of the crater rim in plan-form based on deviations from a perfect circle, whose circularity is 1, using the Oberbeck et al. [5] method.

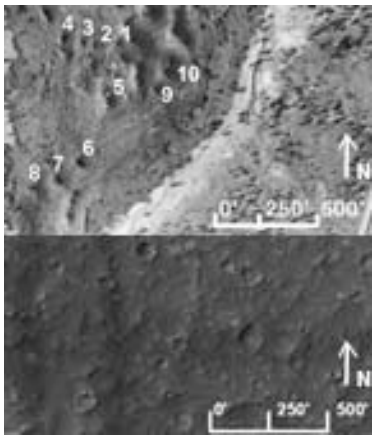

Figure 1. *Aerial images of study craters (1 to 10) in the McCartys flow (top) and craters in Gusev near the MER landing site.*

McCartys basalt flow, NM, is ~ 3000 years old and is part of the Bandera Lava Field located in the El Malpais National Conservation Area of western New Mexico. Depths and diameters for 15 inflation pits were obtained in the field and the circularities were calculated using measurements from aerial photographs.

Lunar data from Pike [3, 4] on the depths and diameters of impact craters on the Moon were compared to the McCartys and Gusev crater data. Pike's study [4] also included the diameter and depth of secondary impact craters, cratered cones, and cratered domes. It should be noted that the lunar craters are substantially larger than the McCartys and Gusev examples.

Colombia Hills, Gusev Crater; *Mars*. 13 craters were selected near the landing site of the Mars Exploration Rover, Spirit, on basaltic lavas [6]. Craters were chosen to have diameters (≲ 35m) similar to the McCartys lava flow craters. Topographic data from the USGS Flagstaff were used to determine the depth to diameter ratio for the Gusev craters and circularities were determined using a High Resolution Imaging Science Experiment (HiRISE) image.

Results & Discussion: Lunar impact craters and Gusev craters show a consistent relationship between the depth and diameter, while the lunar cratered cones, domes, and secondary impact craters and the McCartys craters show a poor correlation (Fig. 2). When plotted together, the McCartys and the Gusev crater depth to diameter ratios show no overlap (Fig. 3) nor is there an apparent correlation between the depth to diameter ratio and circularity (Fig. 4).

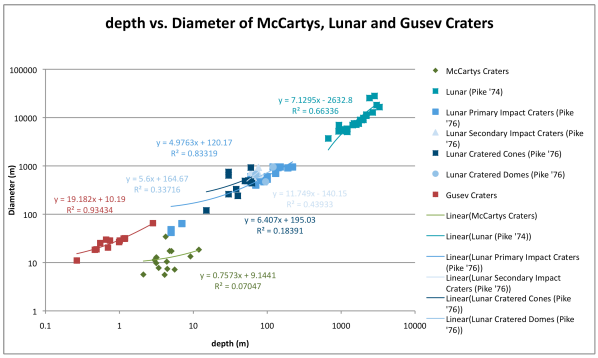

Figure 2. *Depth to diameter relationship of all craters studied. Data sets are color coded by planet; Moon (blue), Mars (red) and Earth (green). Each data set also has a linear equation and a value for the correlation within the data set.*

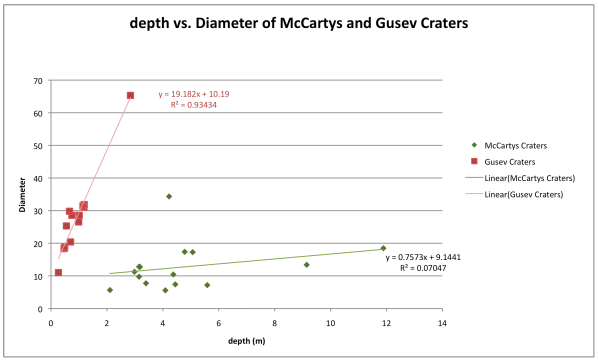

Figure 3. *Depth to diameter relationship for McCartys and Gusev craters showing no overlap between the two types of craters; Mars (red) and Earth (green). Each data set also has a linear equation and a value for the correlation within the data set.*

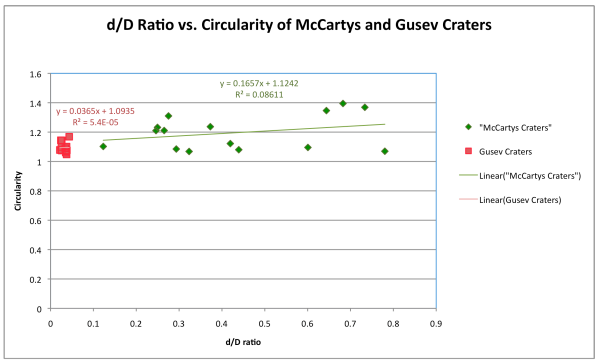

Figure 4. *d/D ratio and circularity index for the McCartys and Gusev craters showing no overlap between the two types of craters; Mars (red) and Earth (green). Each data set also has a linear equation and a value for the correlation within the data set.*

Conclusions: The endogenic volcanic craters on the McCartys basalt flow show no correlation between d/D ratio and circularity; they have a higher d/D ratio than impact craters and a slightly higher circularity index, suggesting that these characteristics enable distinction from impact craters. Oberbeck et al. [5] found average circularities are 1.04 for impact craters, 1.05 for martian craters, and 1.1 for volcanic craters. The McCartys flow crater circularities average 1.20, indicative of their volcanic origins. The mean circularity of the martian Gusev craters is 1.09 and falls between the volcanic and martian mean values, suggesting the possibility of mixed origins.

Acknowledgments: This research was made possible by an internship sponsored by the Planetary Geology and Geophysics Undergraduate Research Program at SUNY-Buffalo.

References: [1] Greeley, R., Gault, D. E. (1979) Proc. Lun. Plan. Sci. Conf. 10, 2919-33. [2] Zimbelman, J. R. et al. (2010) LPSC XLI, Abstract 1826. [3] Pike, R. J. (1974) GRL, 1, 291-294. [4] Pike, R. J. (1976) The Moon, 15, 463-477. [5] Oberbeck, V. R., Aoyagi, M., Murry, J. B. (1972) Modern Geology, 3, 195-199. [6] Greeley, R. et al. (2005) JGR, 110, doi:10.1029/2005JE002401.