WHAT MAKES A GREAT TERRESTRIAL PLANETARY ANALOG?

P. J. Mouginis-Mark[1], [1]Hawaiõi Institute Geophysics Planetology, University Hawaiõi, Honolulu, HI 96822 (pmm@higp.hawaii.edu).

Introduction: Having worked in both the planetary and terrestrial communities for more than 45 years, frequently combining volcanology field work with the analysis of volcanoes on Mars, I have some thoughts on terrestrial analog research. This perspective is, in part, guided by the 13 week-long planetary volcanology workshops on the volcanoes of Hawaiõi that I have run with Scott Rowland since 1992 [1, 2]. Three classes of analog work are now described.

New Understanding of Process: One of the best insights into the impact cratering process came from the field investigations of the Manicouagan impact structure in the 1970s and 1980s [3]. Large ejecta blocks ñfrozenò in quenched melt provided new understanding of the process that would subsequently be investigated on the Moon by LRO [4]. The distribution of material within giant landslides, such as the ones observed in Valles Marineris on Mars [5, 6], is another process that is impossible to model because of scale. The Socompa landslide in Chile [7, 8] provides a rare opportunity to observe where material from different elevations within a large landslide finally came to rest.

Although field observations from the Opportunity Rover [9] have provided important insights into the subsurface structure of impact craters, it was the field observations of basal scouring of the ejecta blanket of Ries Crater in Germany [10] that subsequently proved to be directly relevant to the emplacement of the ejecta layers around fresh impact craters on Mars [11]. Other examples include thermal measurements of active lava lakes [12] with direct relevance to the models of volcanic activity on Io [13], enabling temperature and area combinations to be determined. The Channeled Scablands of Washington, USA, were used to interpret the geomorphology of outflow channels on Mars [14]. At 10s of meter scale, the mode of formation of the lava plates within Cerberus Fossae, Mars, became clear following terrestrial fieldwork [15].

Testing New Instruments: The instrumentation carried to the planets will continue to become more sophisticated with time and need to be tested. One of the earliest analog experiments was conducted with imaging radars flown on Earth but used to understand the radar backscatter characteristics of lava flows on Venus, as revealed by the Magellan spacecraft [16]. The characterization of geologic surfaces on Earth using laser altimeters (e.g., [17]) enable terrain analysis of lunar and Mars altimeters [18, 19].

New Operational Procedures: Another reason for finding terrestrial analogs is that they help us learn new operational procedures for future rover [20] and human exploration [21]. For the exploration of lava tubes, the amount of new volcanology science to be gleaned from human exploration of, say, lunar or Martian lava tubes is quite low, given that the walls and roof of the tube reflect the final phases of eruption. But learning about ingress/egress from a tube as a ñsafe placeò for astronauts during a solar flare is important [22].

Recommendations: As the community plans for more terrestrial analogs in the future, some useful criteria to consider to maximize the returns include:

- What planetary geologic process can we only fully understand with the benefit of field studies?
- Can instrument testing only be done in the field? If so, does the field site have to mimic another planet?
- What operational procedures require a field site that mimics a planetary surface analog?

Refs: [1] Rowland, S.K. et al. (2011), *Geol. Soc. Amer. Sp. Pub. No. 483*, 401 ï 434. [2] Mouginis-Mark, P.J. et al. (2011). *Geol. Soc. Amer. Sp. Pub. No. 483,* 435 ï 448. [3] Simonds, C.H. et al. (1976). *Proc. Lunar Sci. Conf.* 7^{th}, 2509 - 2528. [4] Carter, L. et al. (2012). *JGR* 117 (E00H09). [5] Lucchitta, B.K. (1979). *JGR* 84, 8097 ï 8113. [6] Lucas, A., Mangeny, A. (2007). *Geophys. Res. Lttrs*. 34 (10). [7] Francis, P.W. et al. (1985). *Geology* 13, 600 ï 603. [8] van Wyk de Vries, B. et al. (2001). *J. Volcanol. Geotherm. Res*. 105, 225 ï 247. [9] Crumpler, L.S. et al. (2015). *JGR* 120, 538 ï 569. [10] Horz, F., Banholzer, G.S. (1980) *Proc. Conf. Lunar Highlands*, 211 ï 231. [11] Boyce, J.M., Mouginis-Mark, P.J. (2006). *JGR* 111 (E10005). [12] Flynn, L.P. et al. (1993). *J. Geophys. Res*. 98, 6461 ï 6476. [13] Blaney, D.L. et al. (1995). *Icarus* 113, 220 ï 225. [14] Baker, V.R. (1979). *J. Geophys. Res*. 84, 7985 ï 7993. [15] Keszthelyi, L et al. (2004). *Gechem. Geophys. Geosys*. 5, Q11014. [16] Campbell, B.A. et al. (1993). *JGR* 98 (E9) 17,099 ï 17,113. [17] Morris, A.R. (2008), *JGR* 113 (E12007). [18] Smith, D.E. et al. (2017) *Icarus* 283, 70 ï 91. [19] Aharonson, O. et al. (2001). *JGR* 106 (E10), 23,723 ï 23,735. [20] Yingst, R.A. (2013). *Acta Astro*. 90, 311 ï 317. [21] Hurtado, J.M. et al. (2013). *Acta Astro*. 90, 344 ï 355. [23] Haruyama, J., et al. (2012). In: Moon, Springer, Berlin, 139 ï 163 pp.