**Crater-fill on Mars: Sediment Traps and Long Term Stratigraphic Record:** R. A. De Hon, Department of Geography, Texas State University, San Marcos, TX (dehon@txstate.edu)

**Introduction:** Martian craters are natural closed basins that exhibit a variety of secondary floor materials which manifest themselves as smooth, shallow floors; concentric rings; fans and deltas; and central mounds. The origin of these crater-filling materials may be ascribed to various processes operating on Mars in the past including volcanic, aeolian, fluvial, alluvial, lacustrine, groundwater, and glacial processes. Identification of some of these materials in surficial exposures by morphologic details is possible, but ambiguity exists for others. In the early days of Mars studies, much of the smooth crater fill was attributed to volcanic action, but as understanding of the importance of water and wind action in Mars history has grown, these interpretations require re-evaluation. The planet-wide dust cover makes identification of surface units by chemical signature difficult. Mars rovers are providing in-the-field observations of the textural and mineralogical detail to make refined conclusions.

**Floor Materials:** Various types of crater infill are examined in the following paragraphs.

*Volcanic* materials may be in the form of fluid lava flows or pyroclastic materials either of which may produce a blanketing layer or may mound over vents on the floor. Volcanic ash layers are important as wide-spread, intra-crater, marker beds within rather undistinctive, wide-spread loess deposits.

*Aeolian* infill produces fine-grained silt or clay-sized materials in flat-lying beds. Abundant dust storms [1] on Mars produce blanketing layers of aeolian materials in all craters. Thick loess-like (duststone) deposits mixed with material of other origins are to be expected. Aeolian deposits are the latest deposits following earlier periods of maritime, humid climate. Dune fields of remobilized clastics are common in many mid-latitude craters. Aeolian deposits are superposed on all other materials.

*Fluvial* and *fluviolacustrine* infill is incurred by water flowing into the crater from an outside source. A onetime influx during a catastrophic flood may flood the crater without breaching the rim and leave a standing body of water to seep out by infiltration through the bottom of the crater or evaporate over time. A graded deposit of rapidly settled debris may be expected as a blanket across the crater floor with a top layer of evaporitic materials.

On the other hand, if a sustained flow spills into the crater for a length of time, a breach is eroded in the crater wall and a delta or alluvial fan will form [2]. Depending on the duration and discharge, a standing lake may be established and a delta will encroach across the crater floor [3, 4]. If the lake fills the crater, spillover of the downslope crater rim erodes a breach to allow the flow to continue downslope. Once breached, continued flow cuts a channel across the floor.

*Pluvial* lakes formed by accumulation of precipitation during a wetter period on Mars lead to standing-crater-lakes with no fluvial inlet or outlet. Evidence from Gale crater suggests a complex and long lacustrine history of hundreds to thousands of years duration. Sediment source is localized to erosion of the crater walls and air fall deposits of dust storms or volcanic ash. Interior fill is at the expense of the crater rim and walls as wall material is shed onto the floor of the crater by mass wasting, rain fall runoff, and groundwater seepage. Sediment is coarsest on the edges of the floor and graded to finer material in the interior.

*Groundwater* lakes are expected in craters that excavate below the water table or in existing craters by a rising water table during wetter intervals. Little sediment other than evaporates will be deposited from groundwater sources, but the combination of groundwater and surface runoff from the interior rim may produce mixed phyllosilicate and clastic materials. McLaughlin Crater contains evidence for Mg–Fe-bearing clays and carbonates that probably formed in an alkaline, groundwater-fed lacustrine setting [6]. Long-lived lakes require continuing surface input or groundwater effluent to maintain water levels for thousands or millions of years. Large craters are more likely to interact with ground water; therefore, lakes in large craters are able to maintain water levels for extended periods. Groundwater saturation of sediments is important to cementation of sedimentary materials.

*Glacial* and *fluvioglacial* deposits are formed by melting of standing ice within the crater or by glacial streams breaching the crater wall [8]. Crater-bound ice will eventually sublimate or form melt-water pools. Concentric crater fill is interpreted to have formed by glacial ice flow and debris covering [9]. Sediments are unsorted, debris carried in the ice which maybe overlain by glacial flour of finely-ground rocks suspended in melt water pools.

**Discussion:** Crater size controls important factors in lake deposits. Larger craters are more likely to interact with the water table. Crater size controls catchment area. Strata in small craters will show more lateral continuity than in large craters.

Crater floor deposits record episodic influx of water—either fluvial, precipitation, or fluctuation in water table height. Deposits representing more widespread factors including planet-wide dust storms and changing climatic conditions are preserved, including the declining water availability and the desertification of the planet. Evaporitic deposits are expected as climate becomes more arid and crater lakes shrink. Correlation by planet-wide markers will be important in establishing a planet-wide geologic column. In the absence of deep drilling capabilities, current and near future assessment of crater floor stratigraphy must rely on exposures by cross-crater channels; intercrater faults; or erosional remnants (such as in Gale Crater).

**References:** [1] Gotzinger, J. P. and R. E. Milliken, in *Sedimentary Geology of Mars,* SEPM spec. Publ. 102, 1-48. [2] Cabrol N. A. and E. A.Grin (2010) in *Lakes on Mars* (Cabrol and Grin) Elsevier, 1-30. [3] Malin M.C. and K. S. Edgett (2003) *Science*,, **302** (5652): 1931–1934. [4] Carr M. H. and J.W. Head (2010) in *Lakes on Mars* (Cabrol and Grin) Elsevier , 31-68 . [5] Grotzinger J.P. et al. (2014) *Science* , **343** (6169), 1242777**.** [6] Michalski J. R., et al. (2013) *Nature Geoscience* **6**, 133–138. [7] Pondrelli M. et al. (2015) *Geol. Soc. Am. Bul*., B31225.1. [8] Garvin J. et al. 2002. Lunar Planet. Sci: 33. Abstract # 1255**.** [9] Fastook J. L. and J. W. Head (2014) *Planetary and Space Sciences*, **91**, 60-76.