GEOMORPHOLOGY OF LARGE BASIN IMPACT EJECTA, MOON AND MARS. J. C. Cawley, R.P Irwin III, and R. A. Craddock, Center for Earth and Planetary Studies, National Air and Space Museum, Smithsonian Institution, 6th St. at Independence Ave. SW, MRC 315, Washington DC 20013. cawleyj@si.edu.

Introduction:

Large basin impact ejecta provides significant surface landscape structure on both the Moon and on Mars. The lunar Imbrium and Orientale ejecta provide a baseline for dry geomorphology on an airless body.

On Mars,the original surface morphology of such ejecta has been removed or overprinted by weathering followed by aeolian and fluvial erosion [1]. Martian impact craters have acted as radially dispersive landforms with concave longitudinal profiles, such that relatively little fluvial or aeolian work could produce stable erosional and depositional surfaces. The presence of the atmosphere and water weathered basalts and glasses to clays and weathered textures, then aided transport and cementation of those materials in depositional basins [2].

Using Lunar Reconnaissance Orbiter imaging and topography with equivalent datasets from Mars, we compare the lunar landscape with parts of Terra Cimmeria, Noachis Terra, and Libya Montes, where aqueous and aeolian processes modified the Noachian Hellas and Isidis giant impact basin ejecta.

Coarsely textured lunar Orientale ejecta are divided into the knobby Montes Rook Formation within the basin and the radially lineated, hummocky high terrains of the Hevelius Formation outside [3,4]. The Fra Mauro Formation of Imbrium consists of burial and infill materials possibly associated with more localized fluidized or density flow during emplacement, along with subsequent modification [5].

Martian degraded craters exhibit radial retreat of the interior walls, crater floor infilling, and differing amounts of fluvial channel development on crater walls through time [6]. By contrast, features are preferentially smoothed but not buried in upland areas. Upslope erosional surfaces tend to be of reduced thickness, while downslope portions aggraded toward equilibrium. Deposition in low areas tend to bury emplaced melt pools; these would likely be obscured by fine grained sedimentary material being deposited and cemented in basins.

A. Basin Ejecta Emplacement and Surface Weathering: Large basin impacts produced ballistic ejecta followed by a wash of high temperature supercritical melt which pooled and sealed breccia and structural materials. The Orientale ejecta blanket provides a model of such emplacement [7]. On Mars, ejecta and melt is composed of basaltic materials.

Where volatiles, even in relatively small amounts, are present, portions of the ejecta blanket may be a more melt-rich density flow with greater mixing, and compositional complexity. In either case, emplacement on the airless Moon was followed by "dry"weathering and erosion such as micrometeor diffusion, space weathering, and charged-particle movement of dust to remove material from high, exposed materials.

Subsequent weathering on Mars likely included exfoliation, spalling, and heating/cooling effects. Nonlinear and intermittent breakdown of melt glass, suevite and of impact basalt material to small fines aided in producing sedimentary landscape elements mostly devoid of detrital gravel sized material.

B. Fluidized Emplacement, Suevite Equivalents and Bole Bed Analogs: Where fluidized materials are emplaced, the brecciated material may be pre-hydrated. When this material is buried, it may continue to chemically weather at depth even without additional water[8]. Chemical similarities (including limited amounts of available water) with interbasaltic flow "bole bed" analogs on Earth may be noted [9].

Bole beds on Earth occur as reddened weathered clay and iron rich inter-flow sediment layers between episodic basalt flows. They may be interpreted as baked paleosols, including airfall and ash, which have weathered and hydrated either prior to or subsequent to burial [10].

Porous and potentially clay rich suevites and or bole-bed like layers on Mars could provide buried "soft" preferentially erodible layers within multiple layered or overlapping ejecta blankets.

C. Melt Glass, Silica Gel, Spalling and Devirtification: Glass and melt weather quickly, particularly if they are pre-hydrated [11,12] and/or experience wet acidic or basic conditions.

Combinations of early shattering by differential cooling augmented by later breakdown of basalts and hydrated silicates to clays break down the surficial material due to weathering and devitrification, while deeper diagenesis may produce both clays and serpentine [13]. Clays and oxides produced may be expected to participate in localized regolith sealing if precipitation occurs, as small particles are carried downward to clog local permeability and porosity. Silica gel/secondary silica would be expected to develop along cracks and on surfaces, producing opaline or hyaline secondary deposits.

Conclusions: In portions of the lunar Hevelius Formation relatively near to the basin terrain is characterized by more prominent and more common kilometer-scale roughness, thicker lobes and large-scale sculpture including kilometer sized blocks and linear features, while the landscape grades outwards to thinner lobes and smooth, light plains. Orientale ejecta deposits and or melt sheet are estimated to be some 2.9 km thick at the Cordillera ring but decay to less than 500 m on average at one radius from the Orientale rim, the approximate boundary of continuous ejecta deposits [14,15]. Removal of an equivalent amount of material or less might result in an eroded, weathering overprinted landscape similar to what is observed on the large basin ejecta blankets of Hellas and Isidis on Mars.

Photogeologic analysis suggests that removal of less than one km of ejecta would be required to erase most or all lunar-like terrain textures that are no longer present on martian great basin ejecta.

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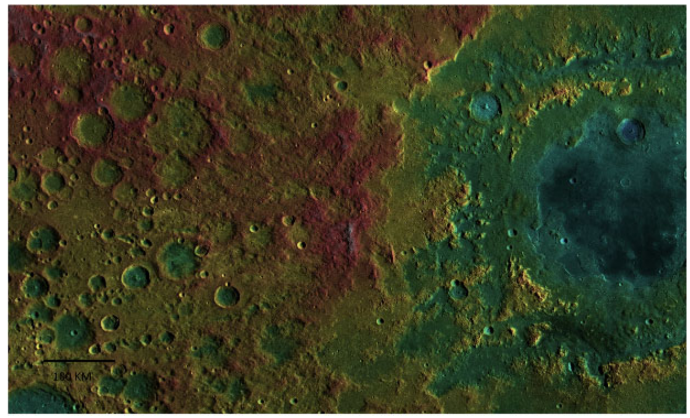
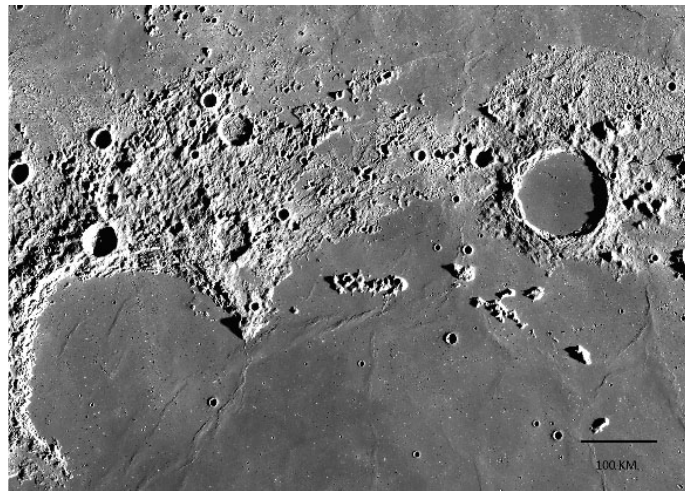
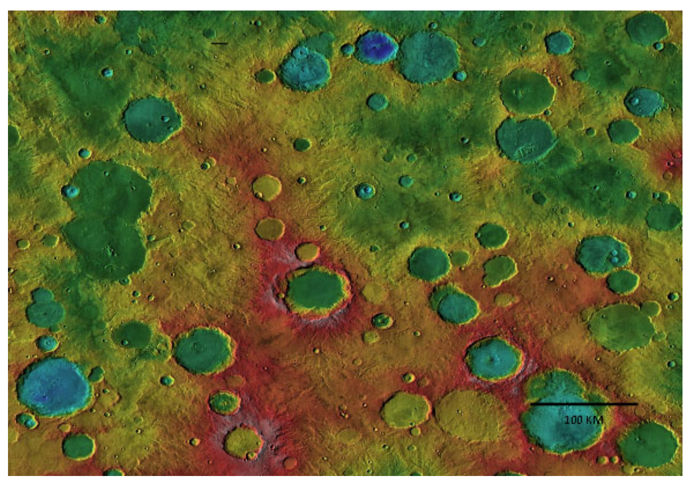


Portion of Orientale Basin, Moon.



Portion of Imbrium Basin, Moon.



Portion of Terra Cimmeria, Mars.