Rethinking Lunar Mare Basalt Regolith Formation: New Concepts of Lava Flow Protolith and Evolution of Regolith Thickness and Internal Structure.

James W. Head[1] and Lionel Wilson[2,1] [1]Brown University, Providence, Rhode Island 02912 USA. [2]Lancaster Environment Centre, Lancaster University, Lancaster LA1 4YQ UK. james_head@brown.edu

Introduction: Lunar mare regolith is traditionally thought to have formed by impact bombardment of newly emplaced coherent solidified basalt [1]. We use new models for emplacement of basalt magma [2-5] to predict and map out thicknesses, surface topographies and internal structures of the fresh lava flows and pyroclastic deposits that form the lunar mare regolith parent rock, or *protolith*. The range of basaltic eruptions produces widely varying initial conditions for regolith protolith (Figure 1), including 1) "*auto-regolith*", a fragmental meters-thick surface deposit that forms upon eruption and mimics impact-generated regolith in physical properties, 2) lava flows with significant near-surface vesicularity and macro-porosity, 3) magmatic foams, and 4) dense, vesicle-poor flows. Each protolith has important implications for the subsequent growth, maturation and regional variability of regolith deposits, suggesting wide spatial variations in the properties and thickness of regolith of similar age. Regolith may thus provide key insights into mare basalt protolith and its mode of emplacement.

Some promising areas of investigation include: 1) Analysis of orbital remote sensing data for their ability to detect and map variations in protolith/regolith parameter space (e.g., radiometry, radar, surface roughness, photometry, mineralogy, maturity indices, etc.). 2) Measurements of the vertical structure of lava flows and regolith characteristics revealed in rille, impact crater and pit crater walls should be revisited in the context of the different lava flow regolith protoliths, and *in situ* exploration of vertical sections should be given high priority. 3) Regolith protolith variability data may provide additional insight into regolith and underlying lava flow physical properties, thickness and internal structure relevant to past and future seismic), heat flow, surface and orbital ground penetrating radar, and surface electrical properties data. 4) Analyzing assumptions about crater degradation processes and CSFD ages to take into account potentially varying protolith and regolith processes may help to explain the often high degree of local and regional regolith. 5) Revisiting the Apollo-Luna-Chang'E data on the lunar regolith in the context of this forward-model protolith/regolith growth paradigm may provide new insights into regolith production and evolution and its variability.

References: 1. Langevin & Arnold (1977) *Ann. Rev.* 5, 449; McKay et al. (1991) Ch. 7, *Lunar Sourcebook*; Wilcox et al. (2005) *MAPS* 40, 695; 2. Head & Wilson (2017) *Icarus* 283, 176; Wilson & Head (2017) *Icarus* 283, 146; 3. Wilson & Head (2017) *GRL* 45, 5852; 4. Rutherford et al. (2017) *AM* 102, 2045; 5. Wilson & Wilson & Head (2017) *JVGR* 335, 113.

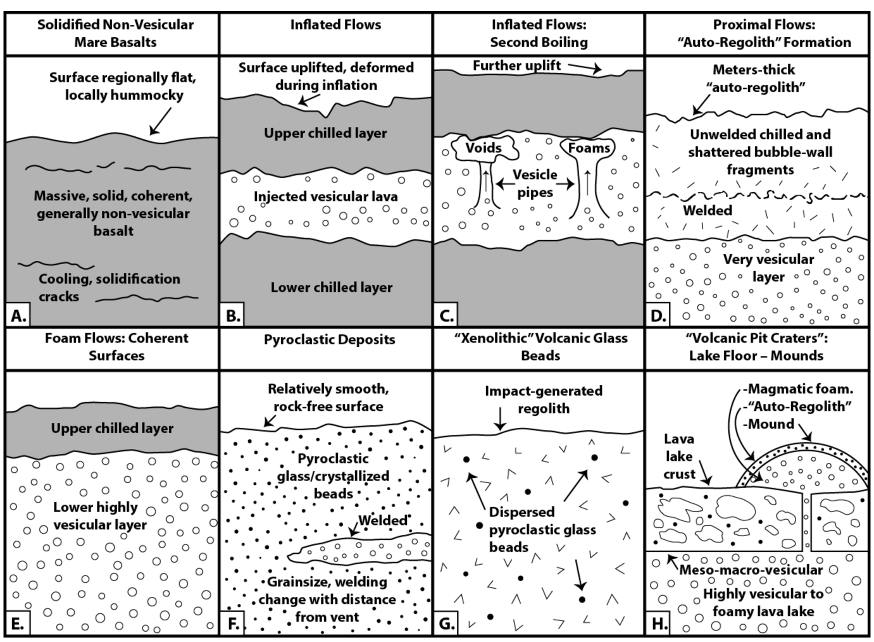

Fig. 1. Regolith protolith types.