NEW VIEWS OF THE MOON 2: LUNAR VOLCANISM (VOLCANIC FEATURES AND PROCESSES)

James Head[1], Brown University; Harald Hiesinger[1], Westfälische Wilhelms-Universität Münster (co-leads)
Carloyn van der Bogert[2], Westfälische Wilhelms-Universität Münster; Lisa Gaddis[3], USGS Astrogeology Science Center; Junichi Haruyama[4], Institute of Space and Astronautical Science; Debra Hurwitz Needham[5], NASA Marshall Space Flight Center; Lauren Jozwiak[6], John Hopkins Applied Physics Laboratory; T. Morota[7], Nagoya University; Carle Pieters[8], Brown University; Tabb Prissel[9], Rutgers University; Lionel Wilson[10], Lancaster University; Jennifer Whitten[11], Smithsonian National Air and Space Museum

Lunar volcanism is a fundamental process in the geological and thermal evolution of the Moon. Early studies have used geological, petrological, and remote sensing data to define and characterize deposits and features associated with lunar volcanism, and to model the generation, ascent and eruption of lunar magma. Remote sensing data have been used to define and characterize geological units of volcanic origin, to link these units to samples returned from Apollo and Luna missions, and to assess the role of volcanism in lunar thermal history. The advent of Galileo and Clementine remote sensing data permitted more extensive definition and characterization of units, and impact crater size-frequency distribution (CSFD) analyses provided an important assessment of the chronology of emplacement. Improved data (e.g., spatial and spectral resolution and coverage) permitted further documentation of the characteristics of lunar volcanic features and deposits and the implications for the generation, ascent and eruption of magma. A plateau was reached in 2006 with the synthesis and publication of New Views of the Moon, a compendium of the geology, remote sensing, petrology, chronology and thermal evolution of the Moon and, implicitly and explicitly, the role of volcanism.

In the decade since this time, a flood of new data has been acquired and continues to be acquired for the Moon. Missions such as Lunar Reconnaissance Orbiter, Chandrayaan-1, SELENE-Kaguya, Chang'e 1-3, LADEE, LCROSS, and GRAIL have provided views of the Moon and its environment in unprecedented detail. Much of this new information has significant implications for the characterization and understanding of lunar volcanism. From these missions, extremely high-resolution image data have revealed the characteristics and distribution of volcanic features and structures (sinuous rilles, cones, domes, flow fronts, vents, pits, etc.) and permitted improved and more extensive chronology from CSFD analyses. Spectral data have revealed the mineralogy of volcanic features, and gravity data have provided new insight into the thickness and physical properties of the lunar anorthositic crust that mantle-derived melts must transect. These new data have permitted a host of analyses in the last decade that have changed our view of lunar volcanism and the processes of magma generation, ascent and eruption. We now have an improved understanding of the array of volcanic features and provinces: irregular mare patches, IMPs, interpreted as very recent volcanism; floor-fractured craters and evidence for shallow intrusions and eruptions; the global distribution and characteristics of sinuous rilles; new definitions of shield volcanoes; improved understanding of pyroclastic deposits; improved definition and documentation of cryptomaria; documentation of silicic domes and pyroclastic deposits; improved understanding of the cones, domes and flows in volcanic complexes; and many other features. New data have permitted improved chronology for lunar volcanic deposits on the lunar nearside and farside adding constraints on the geological and thermal evolution of the Moon. Finally, these new data have permitted the reassessment of the generation, ascent and eruption of magma on the Moon [1-2].

Progress Since the Last Workshop: New Views of the Moon 2 provides a unique opportunity to synthesize the important developments of the last decade in our understanding of lunar volcanism and its implications for lunar petrology and the thermal evolution. Equally importantly, we are working to identify the set of outstanding questions that will help us improve our current understanding in the coming decades. In the future exploration of the Moon, where do we need to go and what do we need to do to address these most critical questions? How can this information inform the design of new instruments and spacecraft and the architecture of new lunar exploration strategies? What are the roles for robotic orbiters, landers, rovers, and sample return missions? What are the roles for human exploration and human-robotic partnerships? How can humans contribute from lunar orbit or cislunar space?

[1] L. Wilson and J. Head (2017) Generation, ascent and eruption of magma on the Moon: New insights into source depths, magma supply, intrusions and effusive/explosive eruptions (Part 1: Theory), Icarus, 283, 146-175, doi: 10.1016/j.icarus.2015.12.039.. [2] J. Head and L. Wilson (2017) Generation, ascent and eruption of magma on the Moon: New insights into source depths, magma supply, intrusions and effusive/explosive eruptions (part 2: observations), Icarus, 283, 176-223, doi: 10.1016/j.icarus.2016.05.031.