NEW DISCOVERIES OF PYROCLASTIC DEPOSITS ON THE WESTERN LIMB OF THE MOON

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Introduction

It has become increasingly evident that lunar pyroclastic volcanism played an important role in the formation and resurfacing of many areas on the Moon. On-going analysis of lunar Orbiter and Apollo photographs continues to locate and identify pyroclastic deposits and suggests that they just may be more ubiquitous than once thought. Located near mare/highland boundaries, many of these deposits formed contemporaneously with effusive mare volcanism. The mantling deposits formed as products of fire-fountaining.[e.g., 1,2,3] Probable source vents for these deposits include irregular depressions at the head of associated sinuous rilles and/or along irregular fractures in the floors of ancient craters.[4] Here, we provide a brief synopsis of the nature of the dark mantling deposits and briefly discuss several newly identified deposits on the western limb.

Lunar Dark Mantle Deposits

Based on recently acquired geologic and remote sensing data two genetically distinct types of pyroclastic deposits are known: regional and localized. Both the regional dark mantling deposits (RDMD) and localized dark mantling deposits (LDMD) are widely distributed across the lunar nearside (Figs. 1 and 2). The larger RDMD are typically located in lunar highland areas adjacent to many of the major lunar maria, while the smaller LDMD are often found on the floors of pre-Imbrian and Imbrian craters.

While all of the RDMD are basaltic in nature, returned sample and telescopic remote sensing data indicate that several of the RDMD contain a significant amount of Fe^{2+}-bearing glass. Volcanic green, orange and black glass spherules returned by the Apollo 15 and 17 missions are believed to be relatively unfractionated samples of the deep lunar interior. These glasses are thought to have originated from a depth of approximately 300 km or greater.[1] Volatile-rich coatings on the surfaces of these spherules strongly suggest the existence of a gaseous phase in their eruptive history. It has been suggested that the RDMD eruptions are analogous to terrestrial strombolian-type eruption activity and, as such, are likely to disperse and sort the pyroclasts over thousands of 1000's km^2[(5)]. In these deposits the coarser material is concentrated in a zone peripheral to the vent while the finer debris is scattered over much greater distances.

Localized dark mantling deposits (LDMD) are generally associated with small (<3 km) endogenic dark halo craters. The endogenic source craters for the LDMD may be distinguished from the other exogenic or impact craters in that they lack obvious crater rays and are generally non-circular in shape.[5] An eruption mechanism similar to terrestrial vulcanian eruptions is suggested to be the origin for these deposits.[5] For these types of eruptions on the Moon, the maximum dispersion range of pyroclasts larger than 1 cm is about 4 km,while the smaller clasts may be ejected up to tens of kms. Magma source depths for these deposits are thought to be relatively deep also although material from different levels along the conduit walls is often entrained in the body of magma erupted.

Recent analyses of near-infrared and infrared reflectance data[6,7] of various LDMD has shown that although they may be genetically and morphologically similar, they are spectrally, and thus compositionally, distinct. Three types or classes of LDMD have been identified thus far based on the depth, center and overall shape of the ~1 μm band. Group 1 contains highland-type material with minor amounts of olivine and/or volcanic glass. Group 2 spectra resemble mature mare basalts and Group 3 have olivine and pyroxene as the dominant mafic constituents.

Analyses of western limb photographs and newly collected telescopic spectral reflectance data indicate that many of the pyroclastic deposits on the western limb fall into the LDMD categories. Twenty-three pyroclastic mantling deposits have been studied thus far (Fig. 3), some of which are newly identified. These include: Aestatis (68.4W, 15.0S, 320 km^2), Autumni (82.2W, 9.5S, 330 km^2), Cavalerius 66.9W, 5.1N, 880km^2), 4 at Crüger (66.7W, 16.7S, 50-760 km^2), a probable coalesced deposit at Grimaldi (68.3W, 5.2S, 1200 km^2), Grimaldi F

(66.2W, 7.9S, 90 km^2), 3 in Hedin (77.0W, 3.0N, 113-150 km^2), Hevelius (67.5W, 2.2N, 76 km^2), Lagrange C (65.0W, 292.9S, 1900 km^2), 4 in Mersenius (49.2W, 21.5S, 53-91 km^2), 5 in Riccioli (83.0W, 2.5S, 20-1400 km^2), and Schlüter A (82.2W, 9.2S, 40 km^2). Thicknesses for these deposits are thought to vary from several meters to several tens of meters.

Looking more closely at several of these deposits, Riccioli crater is host to six pyroclastic deposits of varying sizes. The largest deposit mantles most of the northern floor of the crater. The deposit thins radially outward. No source vents are obvious in the photos for this large deposit. Four other, smaller, deposits exist on the southeastern and western fringes of the crater interior. The southeastern deposit is very thin and elongate about the head of a sinuous rille. It covers approximately 40 km^2. The four deposits on the western side of the crater vary in size from 20 to 100 km^2 and from relatively thin to thick. These deposits also flank small, somewhat circular source craters. Spectra of these deposits indicate a mare affinity, and put them in the Class II spectral group.

Another similar set of deposits is located 150 km northwest in the floor of Hedin. Three separate pyroclastic deposits have been identified on the western-northwestern floor of the crater. Each of these deposits flanks an irregular source crater. The Grimaldi F deposit is approximately 90 km^2. Spectra of this deposit also classifies it as a Class II member: mare-like. Similarly, four tiny deposits in the floor of Mersenius are Class II. These deposits average 70 km^2 in extent.

Conclusion

Pyroclastic deposits on the western limb are much more common than previously thought. Based on telescopic spectral evidence, they are predominately Class II-type; mare-rich. The return of Galileo data will help to further identify and classify pyroclastic deposits on the western limb of the Moon.

References

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Figure 1: Locations of major RDMD.

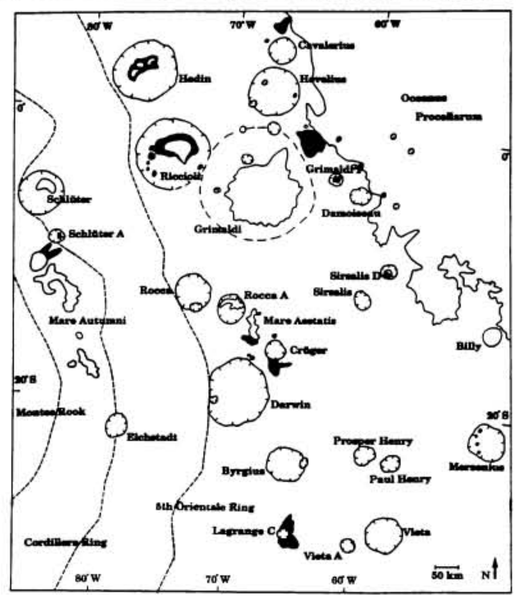

Figure 3: Location of some western limb pyroclastic deposits (dark patches).

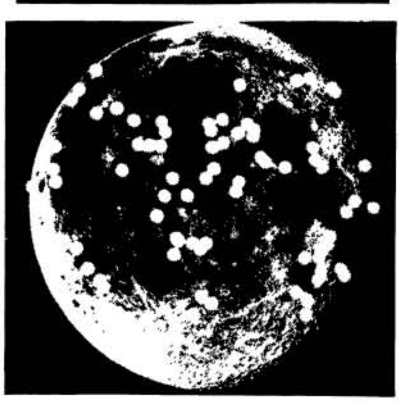

Figure 2: Locations of major LDMD.