GEOLOGIC MAPPING OF LUNAR DARK MANTLE DEPOSITS IN SINUS AESTUUM AND MARE VAPORUM.
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Introduction: We are producing a USGS geologic map of the Moon at 1:1M scale from 18.5° W to 9.5° E and 0° N to 16° N on a WAC basemap (Figure 1), which includes the pyroclastic dark mantle deposits (DMDs) in Sinus Aestuum, Rima Bode, and Mare Vaporum. Lunar DMDs were produced in explosive volcanic eruptions and are identified based upon their relatively low albedos, surface smoothness, mantling relationship to underlying terrain, low radar circular polarization ratios, and spectral absorption bands due to the presence of iron-bearing volcanic glasses [1-4].

Multiple data sets were used to better refine the extent of pyroclastics for these three DMDs, identify and characterize plausible source vents for the DMDs, map and determine the compositions of the mare and highlands within the study region, perform crater counting to establish ages, explore the geologic setting and history of the mapping region, and attempt to characterize the eruption(s) that emplaced each DMD. An improved understanding of the distribution, composition, and eruptions conditions that produced the pyroclastic deposits gained through stratigraphic, morphologic and mineralogic characterization has the potential to reveal important information about the thermal and volcanic history of the Moon.

Although the Sinus Aestuum DMD appears as several distinct patches on highland materials along southern Aestuum basin, the DMD has been interpreted as a single deposit formed during an explosive volcanic eruption [5]. More recent analysis from M^3 hyperspectral data has shown that the Sinus Aestuum DMD likely contains Al- and Fe-rich pleonaste spinel produced during the same volcanic eruption that emplaced the pyroclastics [6]. Additionally, the Sinus Aestuum DMD is the only regional pyroclastic deposit that lacks a high water content [7]. These observations are consistent with all the DMD at Sinus Aestuum representing the collective product of a single explosive eruption. The Rima Bode DMD, which is located adjacent and to the northeast of the Sinus Aestuum DMD, lacks the spinel signature and has an elevated water content compared to Sinus Aestuum. The Mare Vaporum DMD is situated along the southern highlands of the Vaporum basin. A smaller localized DMD was confirmed at Rima Hyginus [8].

Geologic Units: We mapped twenty-four different geologic units and divided them into four groups: Crater Units, Dark Mantle Deposit Units, Mare Units, and Highlands Units. All craters >500 m in diameter have been mapped and are identified in age as either Copernican (Cc), Eratosthenian (Ec), Imbrian (Ic), and Nectarian (Nc) based upon the characterization and extent of their rim and ejecta. Larger craters have been mapped into different units including their central peaks (Cp), smooth floors (Cs), rough floors (Cr), and high TiO_2 ejecta (Ce).

Five mare units were mapped and distinguished based upon color differences related to variations in TiO_2 and FeO abundance (e.g., Figure 2). These include Emh1 (high TiO_2 mare 1 unit), Emh2 (high TiO_2 mare 2 unit), Imm (medium TiO_2 mare unit), Iml (low TiO_2 mare unit), and Imx (mixed TiO_2 mare unit).

Seven highlands units were mapped based on roughness, topography, relative brightness, and presence or absence of lineations, comparable to those mapped previously [e.g., 9]. Our highlands units include Nbl (Basin lineated unit), Nt (Terra unit), Ia (Alpes Formation), Ifm (Frau Mauro Formation unit), Ibk (Blocky highlands unit), Ilp (Light plains unit), and Idp (Dark plains unit).

Four DMD units were mapped, including Idlc (Localized DMD unit), Iddf (Diffuse DMD unit), Idtk (Thick DMD unit), and Idtn (Thin DMD unit).

Surface features mapped include secondary craters and crater rays marked by bright ejecta from Copernicus crater. Numerous linear features were mapped, such as sinuous volcanic rilles, wrinkle ridges, faults, scarps, and grabens.

The main differences between our map and previous USGS maps [9,10] of this region include our broader distribution of the DMDs for both Sinus Aestuum and Rima Bode, smaller mare units not previously mapped, and our mapping of dark plains that are mixtures of highlands and mare materials (Figure 3).

Implications for Eruptions that emplaced the DMDs: We are using the distribution of each DMD to evaluate the size of the eruptions and plausible source vent locations. Our mapping shows the pyroclastics extend further out for both the Sinus Aestuum and Rima Bode deposits than was mapped previously, indicating the volcanic plumes must have been larger in size to expel glasses to these greater distances.

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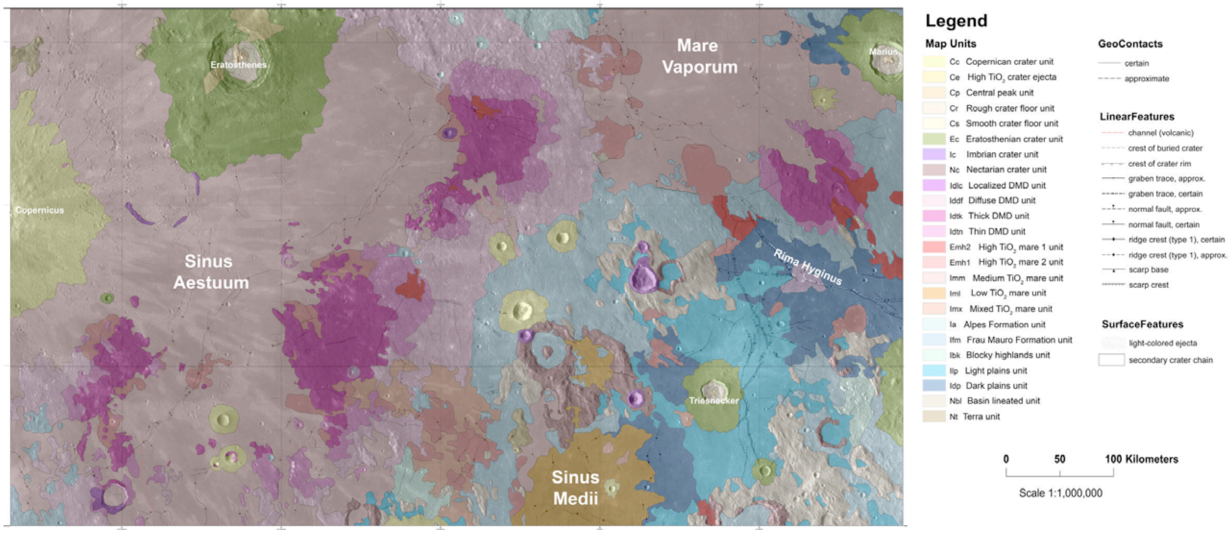

Figure 1. Current version of our geologic map.

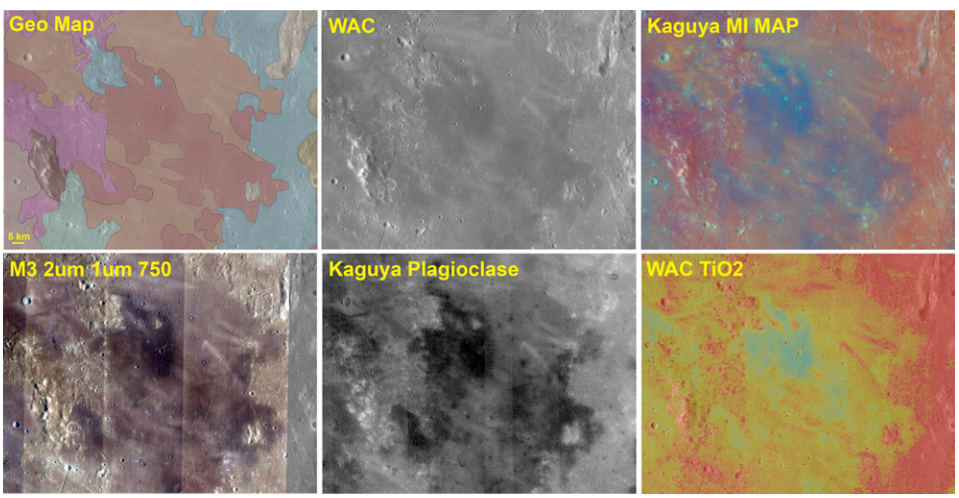

Figure 2. Our geologic map and several data sets used to map contacts between mare and highlands units.

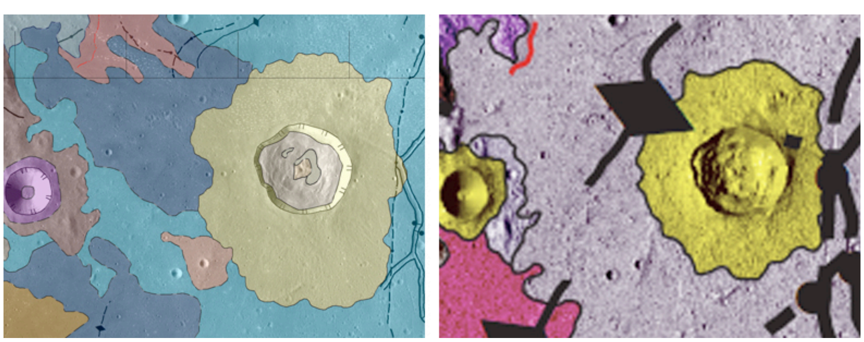

Figure 3. Comparison of a region in our map (left) to the same region in the USGS global map (right; [9,10]). Our geologic map includes a Dark Plains unit for materials that are mixtures of mare overlain by highland ejecta.