ESTIMATING COMPOSITION OF DARK MANTLE DEPOSIT IN SCHRÖDINGER BASIN USING SELENE SPECTRAL DATA.

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Introduction: Dark Mantle Deposit (DMD) regions are considered to contain glassy or crystallized pyroclastic beads which refer to the composition of uncrystallized primitive magma spread over the area [1]. Therefore, observing DMD facilitates understanding the chemical composition of the magma, which is very important for determining the thermal evolution on the Moon. The TiO_2 content of the pyroclastic beads (Apollo sample) has a range from 0.5wt.% green glass to over 13wt.% red glass [2-4].

On the near side of the Moon, there are large regional DMDs (Taurus Littrow, Suplicius Gallus, Mare Vaporum, Rima Bode, Sinus Aestuum, Aristarchus Plateau, and Orientale). Weitz [5] analyzed these DMD regions by Clementine five-channel UV-visible data, and mentioned that the glassy-crystallized mixing line explains the composition of DMD using 750 nm/950 nm reflectance ratio. A greater 750/950 ratio means a higher content of the glassy beads since glass' spectra have a wide absorption around 1000 nm. However, it is difficult to analyze the chemical composition of DMD, particularly TiO_2 content, using only reflectance ratios of the visible range spectrum due to space weathering and other effects.

In this study, we used the spectrum data acquired by SELENE Multi-band Imager (MI) to analyze DMD in detail. MI is a nine-band, visible-to-infrared, push-broom camera with nadir telescopes. The instrument spatial resolution is 20 m (visible: 415, 750, 900, 950, 1000 nm) or 62 m (near-infrared: 1000, 1050, 1250, 1550 nm) per pixel at the observation orbit altitude of 100 km. We have been able to obtain spectral absorption forms around 1000 nm by using both the high resolution visible and near-infrared band data. Consequently, we could acquire a new aspect of the DMD spectrum and estimate TiO_2 amounts of the pyroclastic beads there might be in DMD region.

Analyzed DMD: We analyzed an areal extent of DMD of about 560 km^2 inside the Schrödinger multi-ring impact basin (320 km in diameter) centered at 138°E, 75°S (Fig. 1 a). The DMD (Schrödinger DMD) was studied by Shoemaker [6] using Clementine UV-visible spectral data. They reported differing 1000 nm absorption between Schrödinger DMD and mare region (northwest of the DMD). DMD regions on the lunar near side have been well researched [e.g., 7, 8]. Schrödinger DMD, however, is on the lunar far side, so that it has scarcely been studied [6, 9]. Thus, studying Schrödinger DMD is important to determine whether near-side and far-side compositions of magma source are consistent. Moreover, Schrödinger DMD is valuable for understanding the conditions of the eruption from which DMD originated. Because the DMD has a clear vent formed by volcanic eruption along a southwest-to-northeast aligned rill, it becomes possible to understand the spatial relation between the eruption site and deposits. The initial velocity of ejected pyroclasts can be estimated using the distance from the vent to the deposits. Furthermore, the initial velocity gives information on the volatile content of magma [e.g., 10]. We found another topographical characteristic of Schrödinger DMD using MI altitude data. The vent is on the top of a cone-like ~300 m high hill.

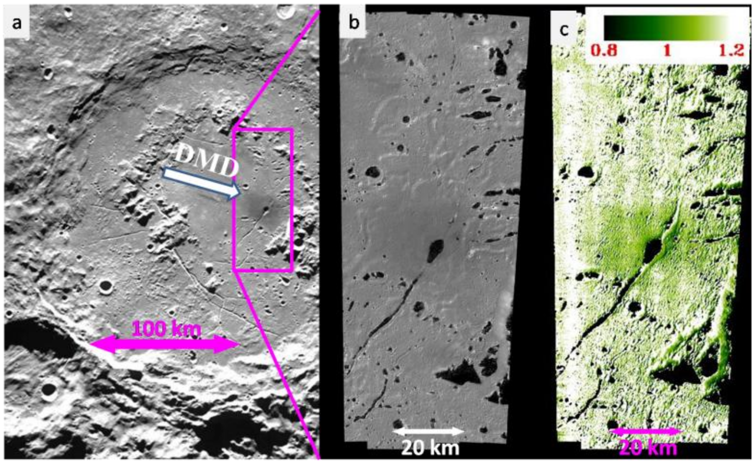

Fig. 1 a) Clementine UVVIS 750-nm image of Schrödinger basin. b) Schrödinger DMD image taken by SELENE MI 750 nm band. c) MI 1000 nm/1050 nm absorption depth ratio from 0.8 to 1.2.

DMD Composition: Absorption depths were derived by dividing each reflectance spectrum by its continuum. A continuum was defined as a line connecting the reflectance values in the log-scale between two optimized wavelengths (750 nm and 1550 nm) the ratio of the continuum. We realized that the 1000 nm/1050 nm absorption depth ratio of the DMD was lower than that of surrounding regions (Fig. 1 c). Therefore, we analyzed compositions of Schrödinger DMD mainly using the 1000 nm/1050 nm absorption depth ratio.

We assume candidate materials in Schrödinger DMD to be pyroclastic beads consisting of orange glass (OG) (74220, 806), black beads (BB) (74001, 439), and green glass (GG) (15401 JBA3.2). The Apollo sample spectrum data we used in this study were taken from the RELAB data base (orange glass and black beads) and Fig. 1 d in Pieters et al. [11] (green glass). The spectrum of the pyroclastic beads did not match that of the DMD when compared with neither of the beads.

We considered mixing background (BG) spectrum with pyroclastic beads' spectrum to approximate that of the DMD. The mixing calculation model was derived from Hapke's radiative transfer model and space weathering model [e.g., 12, 13]. In this calculation, we shifted the weight percentage ratio of pyroclasts and the background plus Fe metal (up to 0.1 wt. %).

Figure. 2 presents the results of the mixing calculation. It depicts a triangular distribution with three apexes (background, green glass 100% and orange glass 100%). DMD spectra were close to the background and green glass, and could not explain the background plus minerals. To decide which calculated spectrum best suited DMD, we selected a few spectra and absorption forms.

Conclusions: Figure. 3 demonstrates that the best-fit spectrum for Schrödinger DMD was PG15BG85Fe0.02. In conclusion, Schrödinger DMD was composed of 85 wt.% background material and 15 wt.% low TiO2 pyroclastic glass. The Schrödinger DMD region is thus covered with low TiO_2 glass of 15% in surface density. This low percentage of pyroclastic glass might be inferred from the background composition; if the background contains glass formed by impact, the background spectrum should be similar to that of pyroclastic glass since both glass of impact origin and glass of volcanic origin exhibit a wide absorption band around 1000 nm [11]. Indeed, the background spectra exhibit such an absorption feature.

References: [1] Heiken et al. (1974) *GCA 38*, 1703-1718. [2] Delano (1980) *PLPSC 11*, 251-288. [3] Delano (1986) *JGR 91*, D201-D213. [4] Shearer et al. (1993) *GCA 57*, 4785-4812. [5] Weitz et al. (1998) *JGR 103*, 22,725-22,759. [6] Shoemaker et al. (1994) *Science 266*, 1851-1854. [7] Gaddis et al. (1985) *Icarus 61*, 461-489. [8] Hawke et al. (1990) *PLPSC 20*, 249-258. [9] Craddock et al. (1997) *LPS 28th*, 1499. [10] Wilson and Head (1981) *JGR 86*, 2971-3001. [11] Pieters et al. (2005) LPS 36th, 1346. [12] Hapke (1993) *LPS 24th*, 605-606. [13] Hapke (2001) *JGR 106*, 10039-10074.

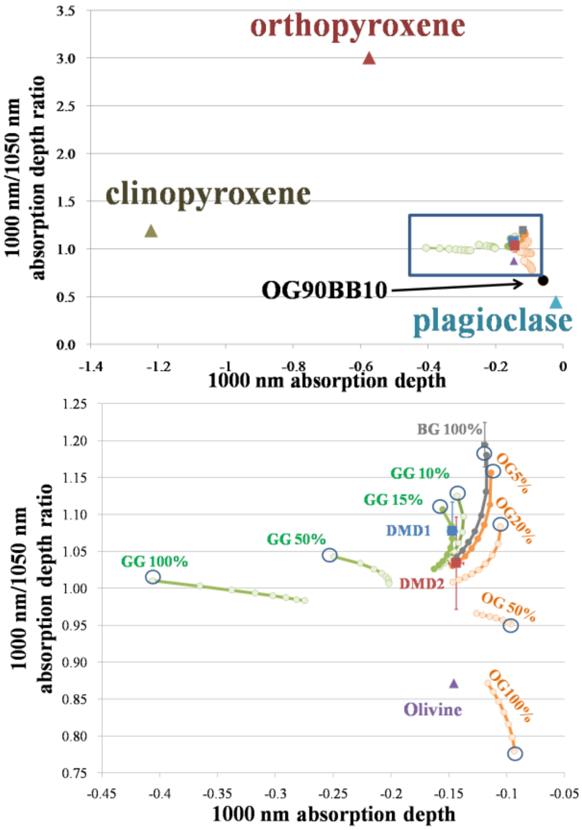

Fig. 2 Results of mixing calculations with major minerals on the Moon. The lower figure is the blue square region in the upper figure. The DMD data are mean of 1 km^2 (50 pixel x 50 pixel) data. Points surrounded by blue circles indicate Fe 0% contents and the next points of the circles on the same line indicate Fe 0.01% contents respectively.

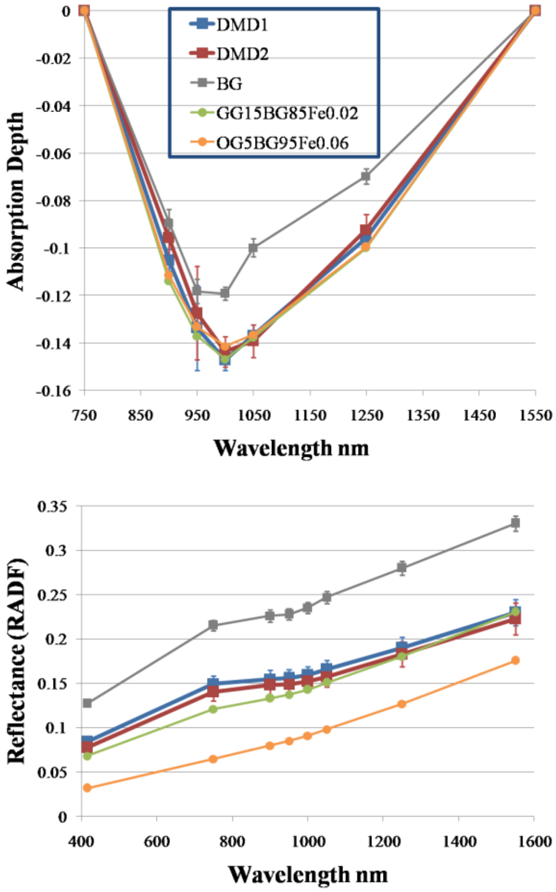

Fig. 3 Comparison between DMD and selected spectra in Fig. 2 Upper graph indicates absorption forms, and lower graph is reflectance at MI bands.