EJECTA THICKNESS OF LUNAR IMPACT BASIN. T. Morota[1], J. Haruyama[1], M. Ohtake[1], T. Matsunaga[2], S. Yamamoto[2], Y. Ishihara[3], C. Honda[4], S. Kobayashi[1], Y. Yokota[2], M. Furumoto[5], and H. Takeda[6], [1]JAXA/ISAS (morota@planeta.sci.isas.jaxa.jp), [2]NIES, [3]NAOJ, [4]Univ. Aizu, [5] Nagoya Univ., [6]Univ. Tokyo.

Introduction: Unraveling the cratering process of lunar impact basins is necessary for understanding the geologic history of the Moon. These basin-forming events excavated deeply into the lunar crust, redistributed a large amount of material in the form of ejecta, and created a well-mixed megaregolith layer at the surface of the Moon ranging from a few meters to several kilometers deep [e.g., 1–3]. In this study, we performed new crater size-frequency distribution (CSFD) measurements for impact basins on the northern faside of the Moon to place constraints on the ejecta thickness models for impact basins using image data obtained by the SELENE Terrain Camera.

Effect of Resurfacing by Basin Ejecta on CSFD: Figure 1 shows the cumulative size-frequency distribution of craters superposed on the Hertzsprung basin. The model age of the Hertzsprung basin is estimated to be ~4.1 Ga from the CSFD for > 5 km using the cratering chronology model proposed by Neukum [4]. However, the CSFD for < 2 km gives a younger model age (3.84 Ga). The deflection of the CSFD, generating two distinct model ages suggests that the Hertzsprung floor has been resurfaced by ejecta from younger basins and small craters have been preferentially obliterated. This idea is supported by the fact that the CSFD for small craters corresponds to that for the youngest Orientale basin (Fig. 1) [4–6]. Such a deflection of CSFD was also observed in the floors of the Korolev and Mendeleev basins. The crater diameter where the deflection occurs depends on the thickness of the overlaying layer (i.e., ejecta of younger basins). We compare the observed CSFDs with those predicted by ejecta thickness models.

Ejecta Thickness Models: On the basis of studies of craters on the Moon and the Earth and laboratory cratering experiments, ejecta thickness models have been modeled as follows,

$$t = T\left(r/R\right)^{-3.0}$$

where t is the ejecta thickness at the location of interest, T is the ejecta thickness at the rim of the crater, R is the radius of the transient crater, and r is the distance from the crater center to the location of interest [7, 8]. McGetchin et al. [7] defined T as

$$T = 0.14R^{0.74}$$

while Pike [8] defined T as

$$T = 0.033R.$$

On the basis of dimensional analyses of cratering models, Housen et al. [9] suggested the following ejecta thickness model in the gravity regime,

$$t^* = \frac{K_3(e_r - 2)}{2\pi}(\sin 2\theta)^{e_r - 2} r^{*-e_r} \times \left[1 + \frac{4e_r - 5}{3}\left(\frac{r^*}{\sin 2\theta}\right)^{-(e_r-2)/2} \frac{K_1^{1/e_x}}{r^*}\right]$$

where t^* is the nondimensional ejecta thickness, e_r is the range exponent in the debris profile, θ is the ejecta launch angle, r^* is the nondimensional distance from the crater center, e_x is the launch-position exponent in velocity distribution, and K_1 and K_3 are constants. In this study, we assume two target materials, water (e_r = 2.83 and e_x = 1.81) and Ottawa sand (e_r = 2.61 and e_x = 2.44) [10, 11]. We also assign K_1 = 0.62 based on laboratory experiments for sand targets [12] and $\theta = 45^\circ$.

Table 1 lists the ejecta thicknesses at the Hertzsprung basin from younger basins such as Orientale, Imbrium, and Serenitatis, estimated from the ejecta thickness models. Using the ejecta thicknesses, formation ages of these young basins, and the relation between the crater diameter and rim height [13], we

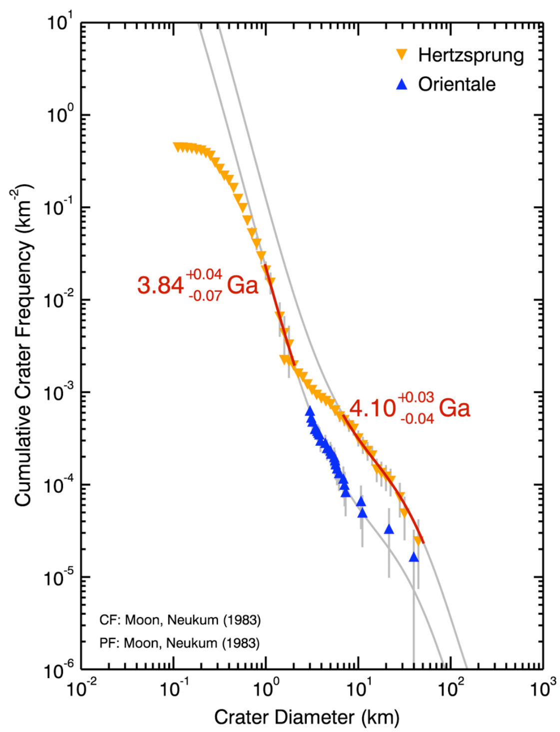

Figure 1. Cumulative size-frequency distribution for craters superposed on the Hertzsprung basin. Gray curves indicate the lunar crater production function polynomials [4, 6] fitted to the observed CSFD.

can predict CSFDs for the Hertzsprung basin.

Comparison of the observed and predicted CSFDs: Figure 2 compares the observed and predicted CSFDs for Hertzsprung. The McGetchin et al. model cannot explain the small diameter range of the observed CSFD. On the other hand, we find that other models can explain a wide range of the observed CSFD. The Housen Ottawa sand model indicates the best agreement with the observation.

We also made CSFDs for Korolev and Mendeleev using the ejecta thickness models and compared them with the observed CSFDs. The results also indicate that the observed CSFDs can be explained by the Housen Ottawa sand model as well as the Hertzsprung model.

Acknowledgments: We used the software tool "craterstats" [15] to derive model ages from crater size-frequency distributions.

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Table 1. Ejecta thickness calculated for the Hertzsprung basin.

	Orientale	Imbrium	Serenitatis	Others
Age [Ga][a]	3.84	3.91	3.98	–
Radius of transient crater [km][b]	212.8	472.6	340.2	–
Distance from the Hertzsprung basin [km]	1191	3272	4177	–
Ejecta thickness [m]				
Pike et al. [8]	43.5	93.0	21.7	1.8
McGetchin et al. [7]	7.6	13.2	3.3	0.3
Housen et al. [9] Water	38.0	81.0	19.7	1.8
Ottawa sand	50.6	113.4	31.1	2.9

a. Neukum [4]; Neukum and Ivanov [6]. b. Ishihara et al. [14].

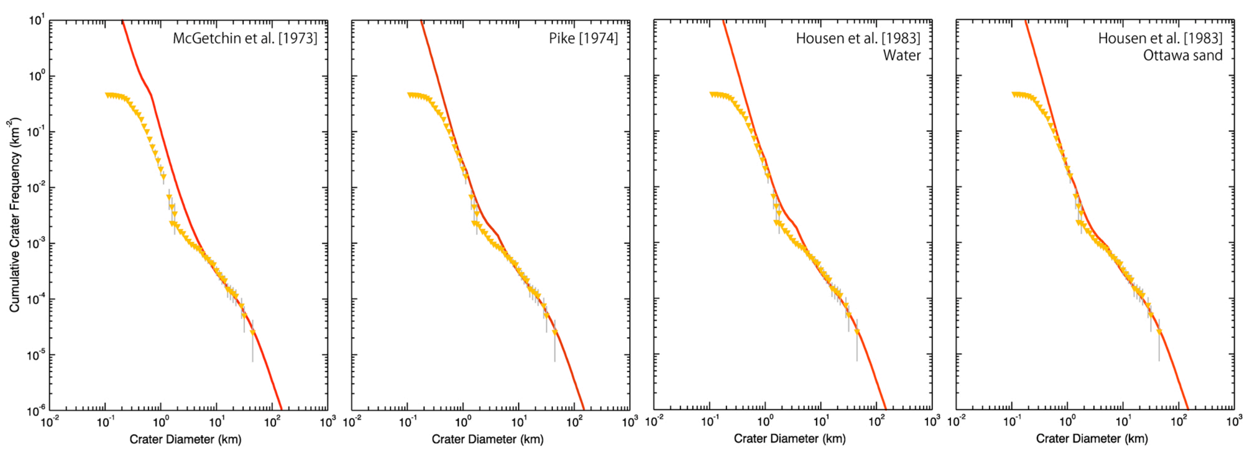

Figure 2. Comparison of the observed CSFDs and those predicted by the ejecta thickness models [7–9] for the Hertzsprung basin.