YOUNG MARE VOLCANISM IN THE ORIENTALE REGION CONTEMPORARY WITH ~2GA PKT VOLCANISM PEAK PERIOD. Y. Cho[1], T. Morota[2], M. Yasui[3] , N. Hirata[4], J. Haruyama[5], and S. Sugita[6], [1]Dept. Earth and Planetary Sci., Univ. Tokyo. (cho@astrobio.k.u-tokyo.ac.jp), [2]Dept. Earth and Env. Sci., Nagoya Univ., [3]Org. Adv. Sci. & Tech., Kobe Univ., [4]Research Center for Advanced Information Sci. & Tech, Univ. Aizu, [5]ISAS, JAXA, [6] Dept. Complex. Sci. & Eng., Univ. Tokyo.

Introduction: The Orientale basin is a multi-ring basin, located at the western limb of the Moon (19 S, 93 W). The basin is surrounded by the rings called the Inner Rook, the Outer Rook, and the Cordillera ring (480 km, 620 km, and 900 km in diameter, respectively) in concentric arrangement [1]. The largest mare occurs at the center of the basin (Mare Orientale, 90000 km^2) and other smaller mare deposits mainly occur along northeastern part of the rings and are called Lacus Veris (12500 km^2) and Lacus Autumni (5000 km^2) [1].

Because the Orientale basin is located between the PKT (Procellarum KREEP Terrane) at the nearside and FHT (Feldspathic Highlands Terrane) at the farside, or the boundary of the lunar global dichotomy, mare forming eruptions at the Orientale basin may reflect the characteristics of magma source near the boundary of the dichotomy.

In this study, we attempt to constrain the volcanic history of the moon around the nearside-farside boundary by examining the ages of the mare deposits within the Orientale basin using high-resolution images obtained by Kaguya (SELENE) spacecraft.

Crater counting: In order to estimate the age of mare deposits, we conducted crater counts on the images obtained by the Terrain Camera (TC), an instrument onboard the Kaguya (SELENE) spacecraft [2]. The spatial resolution of the images is 10 m/pixel. An image mapped at 59 m/pixel of resolution is also used to estimate the age of the Orientale basin formation and the Mare Orientale occurrence.

In this study, we manually performed crater size-frequency measurements. Model ages of the mare deposits are determined with the Craterstats program [3], which provides model isochron fittings. The cratering chronology and production functions by both *Neukum* [4] and *Neukum et al.* [5] are used to evaluate model dependence of crater retention ages. After crater size-frequency distribution is acquired, craters with diameter >250 m are fitted to those production functions to estimate the ages. In a couple of cases, model fits are applied for >400m craters, since the maria are so old that the number of small craters reaches the saturation. We have carefully avoided areas resurfaced by ejecta by choosing low albedo regions for counting. Obvious secondary craters are eliminated from crater counts based on their morphological characteristics.

Crater retention age: Figure 1 shows the count regions along with the map of the model ages. Our preliminary results of model age determination are summarized in Table 1. Note that the results using the *Neukum* [4] model are shown here. Our count indicates that the Orientale basin was formed 3.79(+/- 0.02) billion years ago, which is consistent with several previous studies [6, 7, 8].

The eastern and northwestern part of Mare Orientale have almost the identical age, 3.2–3.3 Ga (Table 1). This coincidence suggests these flow units may be formed by a single volcanic event.

The polygonal mare unit located at the southwest to the Mare Orientale [8] has the same age as the south-

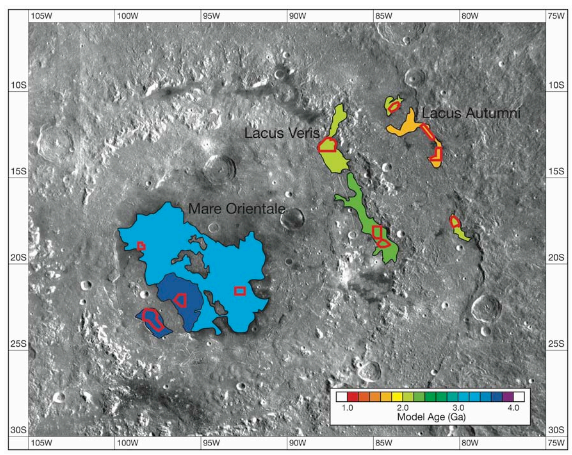

Figure 1. Model age map of the mare deposits in the Orientale basin with count regions highlighted by the red polygons.

Table 1. Model ages of Orientale.

	Neukum (1983) [4]		
	Age (Ga)	+ error (Ga)	- error (Ga)
Orientale Event	3.79	0.02	0.02
Mare Orientale NW	3.24	0.12	0.30
Mare Orientale E	3.28	0.08	0.14
Mare Orientale SW	3.77	0.02	0.02
SW Polygon	3.77	0.01	0.01
Lacus Veris N	2.16	0.18	0.18
Lacus Veris S	2.20	0.19	0.19
Lacus Autumni N	2.03	0.35	0.35
Lacus Autumni M	1.75	0.19	0.19
Lacus Autumni S	2.16	0.36	0.37

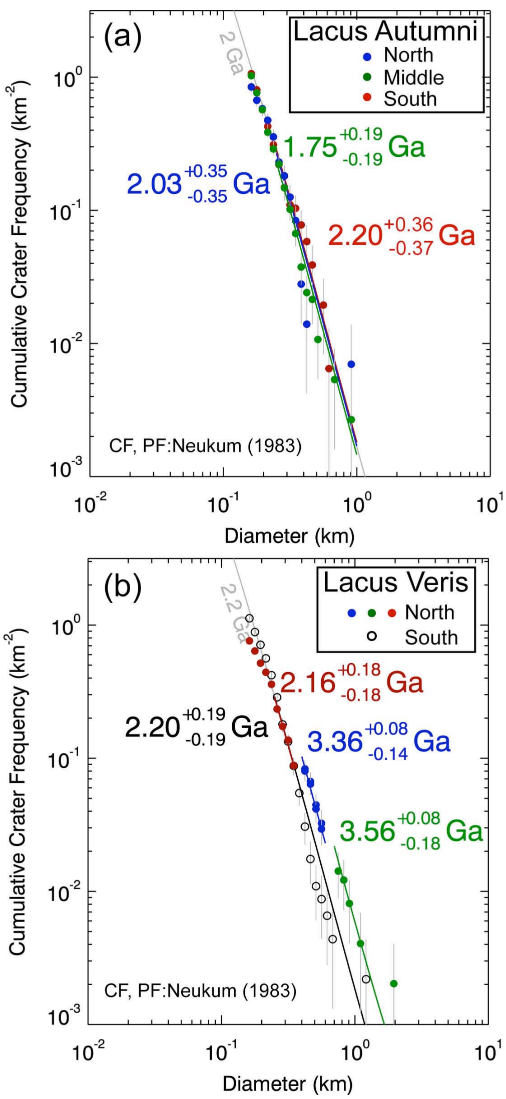

Figure 2. Crater size-frequency distribution plot and cumulative frequency fit. (a) The three distinct parts of Lacus Autumni. (b) The two separate parts of Lacus Veris.

western part of Mare Orientale. *Whitten et al.* [8] noted that the polygonal unit tilts northward due to thermal subsidence that formed the inner depression in Orientale Basin, based on the topographic data of the Lunar Orbiting Laser Altimeter (LOLA). It is possible that the mare deposits erupted at ~3.3 Ga was unable to reach these areas because of the negative slope to the basin center and such older mare deposits are preserved near the rim of Mare Orientale.

Figure 2 (a) shows all the three measured parts of Lacus Autumni are consistently dated at ~2 Ga, ranging from 1.5-2.5 Ga when errors are considered. *Whitten et al.* [8] pointed out that Lacus Autumni is as young as ~1.66 Ga and the occurrence of mare deposits coincides with volcanism occurred on the lunar near side, while the model age suffers from a large error (+0.83/-0.96 Ga) due to poor count statistics. In addition, the discrepancy in ages among the mare deposits in Lacus Autumni was as large as ~2 Ga and remained difficult to explain. Using high-resolution TC data, in contrast, we show a series of consistent and uniform model ages of the mare basalts in Lacus Autumni. Our data reveal that the ages of the three separate units of Lacus Autumni range from 1.8 to 2.2 Ga with smaller errors (Table 1). These recent mare volcanism coincides with the elevated volcanic activity episode proposed for the PKT region on the nearside at around ~2 Ga, suggesting a possible correlation with volcanic activities in the PKT region [9, 10].

We then investigated two separate parts of Lacus Veris and found that they have somewhat complicated stratigraphy of three lava units, with youngest units of ~2.2 Ga for both of the two separate parts (Table 1; Fig. 2(b)). *Whitten et al.* [8] and *Greeley et al.* [6], on the other hand, reported that the age of Lacus Veris is 3.20 (+0.13/-0.30) Ga and 3.50 (+0.05/-0.08) Ga, respectively. However, our crater count analyses also yield consistent ages (~3.3 Ga and ~3.5 Ga) for the same larger diameter ranges examined in these previous studies. Thus we assume that a thin lava flow covering the older units is newly discovered by the high-resolution data. Note that resurfacing correction [3] is applied to the crater counts here.

Our results above indicate that the mare deposits in the basin rim regions occurred ~1.8 billion years after the basin formation event (Fig. 1; Table 1). However, it is unlikely that the basin formation impact directly induced such late magma emplacements, according to a model calculation conducted by *Ghods and Arkani-Hamed* [11]. Some other volcanic mechanisms are required to account for such late volcanic eruptions.

The uniform age (~2 Ga) of the mare deposits around the Orientale basin rims, rather far away from PKT, suggests that the suspected peak of volcanic activity at around 2 Ga [10] may not have been confined within the PKT regions but more widespread on the Moon.

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