SELENE (KAGUYA) TERRAIN CAMERA OBSERVATION RESULTS OF NOMINAL MISSION PERIOD. J. Haruyama[1], M. Ohtake[1], T. Matunaga[2], T. Morota[1], C. Honda[1], Y. Yokota[1], Y. Ogawa[2], LISM working group. [1].Japan Aerospace Exploration Agency, Institute of Space Astronautical Science, Yoshinodai 3-1, Sagamihara City, Kanagawa 229-8510, Japan. [2]National Institute for Environmental Studies, 16-2 Onogawa, Tsukuba City, Ibaraki 305-8506, Japan.

Operation Overview: On 31 October 2008, the Japanese Moon explorer SELENE (KAGUYA) completed its nominal observation period of about one-year from December 2007 and entered the extended-mission period that is expected to be about a half year using surplus fuel. During the SELENE nominal mission period, the push-broom Terrain Camera (TC) [1] aboard KAGUYA, successfully acquired 10 m-resolution stereoscopic data at solar elevation angles of around 30° and monoscopic data at angles of less than 30° for almost the entire surface of the Moon. The rate of discrete cosine transform (DCT) compression of TC data was 10 to 20% (100% without compression). There was very little or no block noise due to compression. Most image data was acquired by TC in sequential revolutions of SELENE (interval of about 2 hours) and thus was easily superposed with sequential overlapped image data to yield large mosaicked data. Unobserved areas that totaled less than 5% of the whole surface of the Moon and are planned to be observed in the extended-mission period. The TC is currently working very well after the end of the nominal-mission period. No defective pixels have been found so far.

Ground Procedure Overview: The TC data are transmitted to the SELENE Operation and Analysis Center (SOAC) in Sagamihara City, Japan, and processed by the Level-2A (L2A) processing system (raw data production by decompression, re-ordering data, PDS label attachment, and scene size cutting by a number of lines), the Radiometric calibration and Geometric Correction (RGC) system, and the Digital Terrain Model (DTM) production system [2]. The L2A procedure for the TC nominal-mission period data has been completed and registered in the SELENE Level-2 data base. The TC flat-level calibration data and temperature-dependent dark-level calibration data were produced for each TC observation cycle (one month) and applied to L2A data in the RGC system. The TC dark level and flat level produced from the data after launch are very similar to those attained in the pre-flight tests; the difference is less than several percent. The first version of a mosaicked image map was produced with typical calibration data for each cycle with uncorrected SELENE orbit data by considering the detailed lunar gravity field data based on tracking data of the Relay satellite and VLBI satellite (in addition to that of the main SELENE spacecraft) which will be considered at the next version. TC ortho and DTM products have also been produced for each L2A scene. The elevation differences in TC DTMs for the same areas but produced from data acquired on different SELENE revolutions are less than 100m, which results from the error offset of instrument view vectors. After offset correction, the relative difference should become less than 10m.

Scientific Results (selected): The TC stereoscopic and monoscopic observation covered almost the entire surface of the Moon including high latitudes (> ± 20°) and the far side of the Moon that previously lacked high-resolution image data [3]. Scientifically important analyses have been conducted for lunar polar regions and far-side regions based on the TC data.

The TC could detect faint scattered light from numerous permanently shadowed areas (PSAs) in craters of polar regions (Figs. 1, 2). For the floor surface of the south-pole crater Shackleton where Clementine bi-static radar experiments suggested the existence of water ice [4], the TC data revealed no evidence of an ice outcrop at 10 m resolution, as excellent ground-based radar experiments previously implied for the upper portion of the crater wall [5]. The TC data also implied no surface deposit of water ice in two north-pole craters of 15 km in diameter (> 89.6N) (Fig. 2). The hydrogen concentration that was suggested by the Neutron Spectrometer aboard the Lunar Prospector [6] probably forms water ice in very small amounts or buried under the surface, or the Neutron Spectrometer may just have detected implanted solar-wind protons.

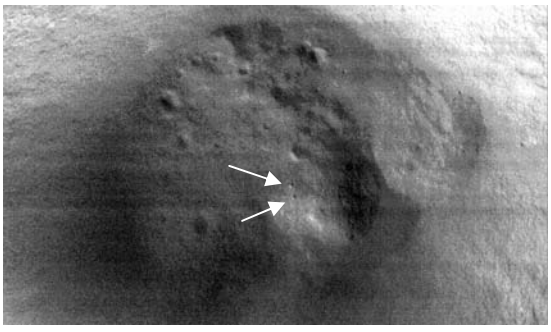

Fig. 1 A raw image data of the floor (~ 3.3 km across) of Shackleton crater near the lunar south pole taken by SELENE Terrain Camera (TC) (7 November, 2008). The floor of Shackleton crater is not directly lit by solar light but lit by scattered light from the illuminated portion of the crater inner wall. On the floor, several craters hundreds meters in diameter exist. Two boulders of 2~30 m (arrows) are on a central hill that is ~ 200 m in height.

The TC high-resolution image data were also used for determining the model age for lava units of the far side. We found several thin (several tens of meters) 2.5Gyr-old lava units in some mare deposits [7] in both the northern and southern hemispheres (e.g., mare deposits of Antoniadi crater, those of Apollo N crater, and those of the mare Moscoviense (Fig. 3) [8]). The TC data furthermore indicates that mare deposits in the mare Orientale are also 2.5Gyrs old, similar to the age of Lacus Autumni (2.85Gyrs) [9] which is located between the inner rim and the outer rim of the Orientale basin. These results mean the lunar far-side volcanism continued until relatively more recent days than had been previously found (3.0Gyrs) [9].

.

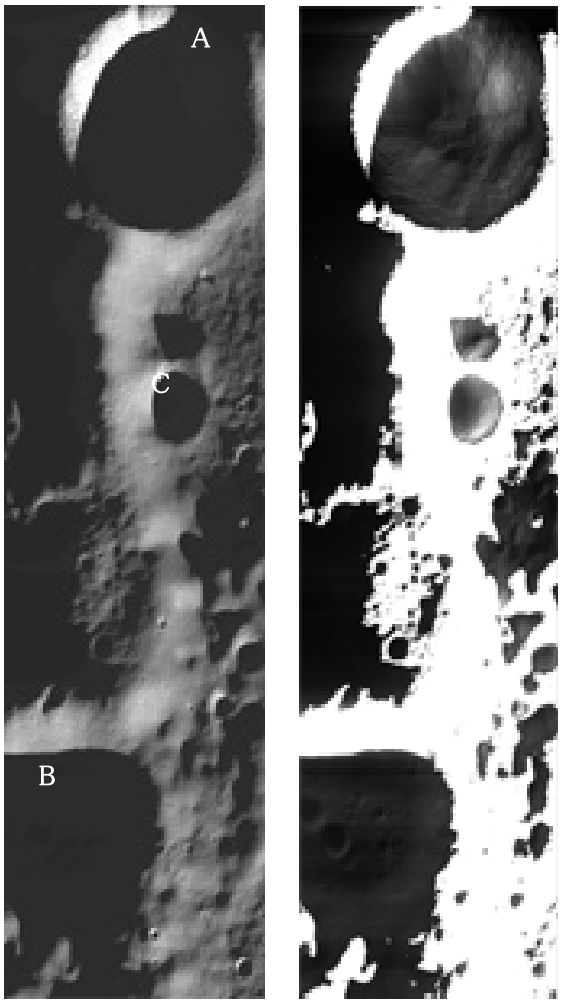

Fig. 2. (left) A TC image data of the north pole region (20 May, 2008). (right) An enhanced image of (left). The inside of craters A (89.1N, 120E; 14 km in diameter), B (89.4N, 300E; 14 km), and C (89.6N, 120E; 4 km) are permanently shadowed areas that are very cold to keep the water ice but is no region with significant albedo is found in the data.

Data Product Release Plan: Some TC data products (e.g., TC mosaicked map products based on TC monoscopic observation under lower solar elevation angle conditions and TC ortho/DTM scene data) will be released via the SELENE level-2 data release system one year after the end of the nominal-mission period (November 2008).

We hope that the TC data products will contribute to the progress of lunar and planetary sciences. Prior to the release next November, some TC image products and movies (Fig. 3) were released on the KAGUYA image gallery as a public outreach effort

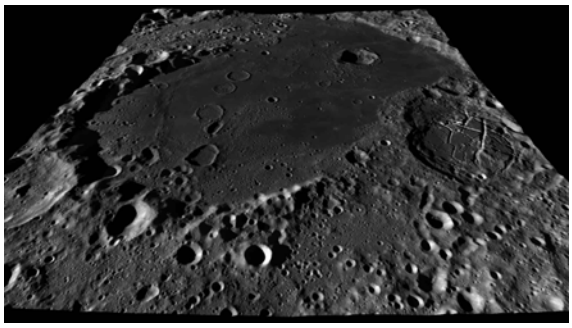

Fig. 3. A perspective view of Mare Moscoviense (~ 250 km across) produced fromTCstereo-pair data (17 January, 2008).

References: [1] Haruyama J. et al. (2008) *Earth Planets and Space*, 60, 243-255. [2] Haruyama J., et al. (2006) *Adv. in Geosciences. 2005*, 228-236. 4151, 32-39. [3]Wilhelms, D.E. (1987), The Geologic History of the Moon (U.S.Geol. Surv.).[4] Haruyama J., et al. (2008) *Science*, 322, 938-939. [5] Campbell, D.B. et al., (2006) 443, 835-837. [6] Nozette, S., et al. (1996), Science 274, 1495 -1498. [7] Haruyama J., et al. (2008) *Science*, DOI: 10.1126/science. 1163382. [8] Morota, T. et al., (2009), *LPSC XL*, in this issue. [9] Greely, R. et al., (1993) *J. Geophys. Res.* 98, 17183.

Link:

KAGUYA home page site (English):
http://www.selene.jaxa.jp/en/index.htm,
Kaguya image gallery (English):
http://wms.selene.jaxa.jp/selene_viewer/index_e.htm