STRUCTURE OF THE LUNAR SOUTH POLE-AITKEN BASIN FROM KAGUYA(SELENE) GRAVITY/TOPOGRAPHY. S. Sasaki[1], Y. Ishihara[1], H. Araki[1], H. Noda[1], H. Hanada[1], K. Matsumoto[1], S. Goossens[1], N. Namiki[2], T. Iwata[3], M. Ohtake[3]. [1]RISE Project, National Astronomical Observatory of Japan (2-12 Hoshigaoka, Mizusawa-ku, Oshu, Iwate 023-0861, Japan; sho@miz.nao.ac.jp), [2]PERC, Chiba Institute of Technology (2-17-1 Tsudanuma, Narashino, Chiba 275-0016, Japan), [3]ISAS/JAXA (3-1-1 Yoshinodai, Sagamihara, Kanagawa 229-8510, Japan).

Introduction: The South Pole-Aitken (here after SPA) basin is the largest, deepest impact basin in the solar system. It is about 2500km in diameter and degraded morphology as well as abundant superimposed craters suggests that it should be older than other lunar impact structures [1]. Although the SPA basin is large enough to have excavated the lunar crust, previous remote-sensing observations show that the SPA floor is mainly occupied by materials in lower crust as well as impact melt/mare basalt [2, 3]. Analysis of gravity/topography data also suggest the existence of lower crust at the SPA floor [4, 5].

Using topography, Fe and Th abundance data, Garrick-Bethell and Zuber [6] (hereafter GZ09) stated that the SPA basin is characterized by an ellipse with axes 2400 by 2050 km with 53.2S – 191.8E center. They advocated that the basin was formed by an oblique impact. However, the lack of accurate far-side gravity data and topography data around the south pole region prevents quantitative discussion on the morphology and the interior structure of the SPA basin. Here, we analyze the structure of the SPA basin using the first precise global lunar gravity and topography data obtained KAGUYA (SELENE) mission.

KAGUYA Gravity and Topography Data: The Japanese lunar explorer KAGUYA (SELENE) was launched successfully on September 14th, 2007 by JAXA and ended its operation on June 10th, 2009. KAGUYA takes polar orbits and obtained global topography and gravity of the Moon.

KAGUYA has a laser altimeter (LALT) which measures the distance between the satellite and the lunar surface with accuracy of 1 m [7]. During the nominal mission period from December 2007 to October 2008, the LALT obtained more than 10 million range data.

KAGUYA has two small subsatellites, Rstar (OKINA) and Vstar (OUNA) for gravity measurement [8]. We tracked the three satellites by new methods: 4-way Doppler tracking between the main satellite and Rstar for the farside gravity and multi-frequency differential VLBI tracking between Rstar and Vstar. The tracking data of KAGUYA over one year (from 20 October, 2007, until 30 October, 2008) together with pre-Kaguya tracking data are used to create a spherical harmonics model of degree and order 100, SGM100h (SELENE Gravity Model) [9]. The large gravity error in the far-side in previous models is drastically reduced.

Structure of the South Pole-Aitken Basin: Using KAGUYA altimetry data, we obtained a topography map of the SPA basin including the polar region (Fig. 1 and 2). In Fig. 2, the blue curve shows the topography along the short axis of the SPA ellipse (proposed by GZ09) whereas the red curve denotes the topography along the long axis. Although the depression along the long axis is affected by a couple of large craters to the north, the overall depressed extent is larger along the long axis as was discussed in GZ09.

From altimetry and (free-air) gravity data, using crustal density 2800, mantle density 3360, and mare basalt density 3200 kg/m^3 and assuming a uniform crust, Bouguer gravity anomaly, Moho depth, and crustal thickness are obtained [10]. The crustal thickness is constrained from the condition that the minimum thickness is not negative. Bouguer anomaly is relatively flat in SPA as well as in the farside highland. This should indicate that the surface morphologies primarily by impacts are supported elastically.

The crustal thickness map in the SPA region is shown in Fig. 3. The direction of an ellipse denoting the depression is similar to that of GZ09 although the aspect ratio is slightly smaller. The thinnest crust in SPA is at Apollo basin. The central SPA region with the thinner crust is slightly offset southward from the center of the SPA. This may be explained by the oblique impact hypothesis for the SPA basin origin.

We obtained cross section of Moho depth across SPA (Fig. 4). Moho depth just outside the SPA basin is about 60-80 km, whereas Moho at the central region of SPA is as shallow as 35 km. The extent of shallow Moho region is shorter along the short axis of GZ09. The same trend was seen in Bouguer gravity [9]. Crustal thickness at the SPA central region is around 30km. There is a possibility that lower crust should have been exposed but significant exposure of mantle material is doubtful. This is compatible with previous estimate of crustal thickness beneath the SPA [5].

The Multiband Imager on board KAGUYA, with a high spatial resolution of optimized spectral coverage, showed global distribution of (upper) lunar crust of high plagioclase abundance [11] primarily using data of crater central peaks. Their results show that the central peaks of Leibnitz S and O'Day craters in the northern part of SPA have nearly pure plagioclase exposure. Plagioclase-rich crust should exist beneath some parts of SPA.

References: [1] Wilhelms, D. E., 1987. The geologic history of the Moon. USGS. [2] Head, J. W. et al. (1993) JGR, 98, 17149. [3] Pieters, C. M. et al. (2001) JGR, 106, 28001. [4] Wieczorek, M. A., Phillips, R. J. (1999) Icarus 139, 246. [5] Wieczorek, M. A., et al. (2006) In The New Views of the Moon, pp. 221-364. [6] Garrick-Bethell, I. and Zuber, M. T. (2009) Icarus 204, 399. [7] Araki, H., et al. (2009) Science, 323, 897. [8] Namiki, N., et al. (2009) Science 323, 900. [9] Matsumoto, K. et al., (2010) JGR submitted.[10] Ishihara, Y., et al. (2009) GRL, 36, L19202. [11] Ohtake, M. et al. (2009) Nature 461, 237.

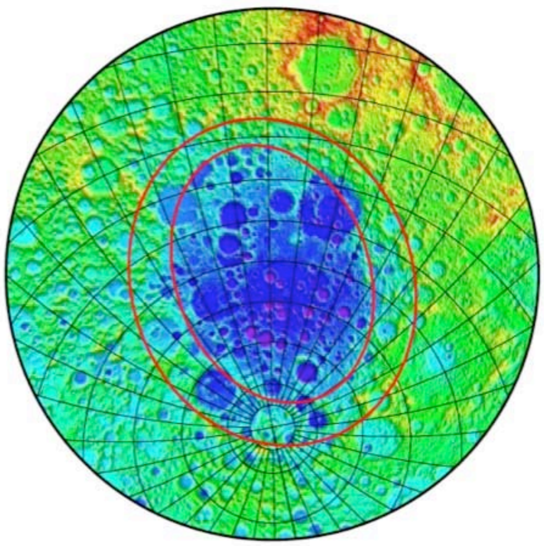

Fig. 1 KAGUYA topography of the SPA region where ellipses proposed in GZ09 are superimposed. Map projection is centered at 53.2S – 191.8E [6].

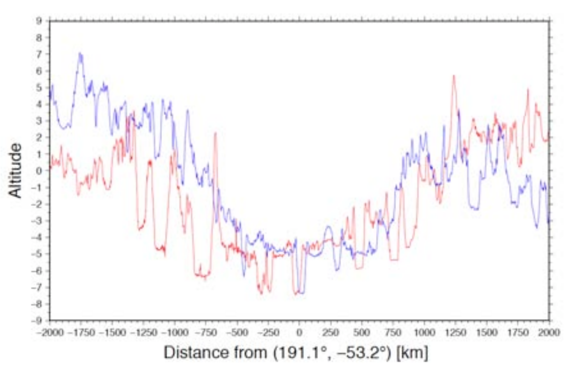

Fig. 2 Cross section of basin topography along the long axis (red) and the short axis (blue) of an ellipse denoted in GZ09.

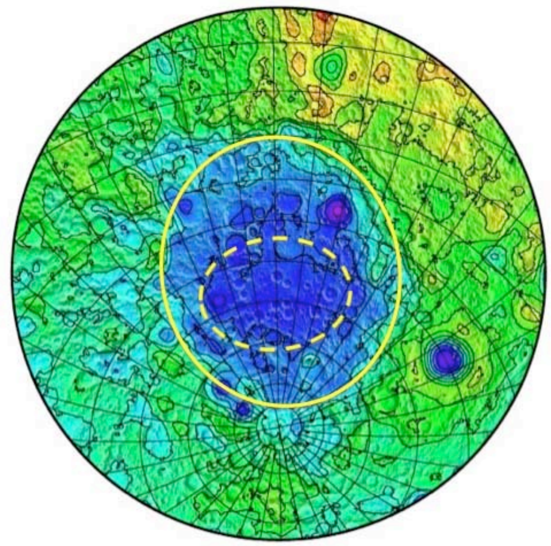

Fig. 3 Crustal thickness of the SPA region where an ellipse of a solid curve denotes the outer depression of the basin and an ellipse of a dashed curve denotes the inner depression. The same projection as Fig. 1.

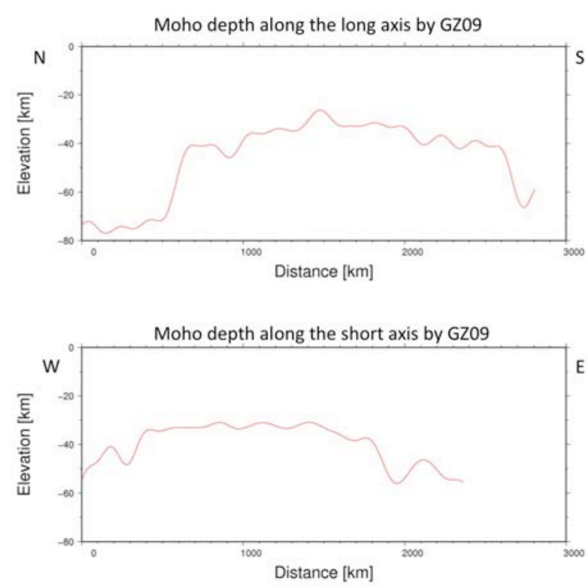

Fig. 4 Moho (crust/mantle boundary) depth profiles along the long axis and the short axis of an ellipse denoted in GZ09.