STUDIES BASED ON GLOBAL SUBSURFACE RADAR SOUNDING OF THE MOON BY SELENE (KAGUYA) LUNAR RADAR SOUNDER (LRS). A. Kumamoto[1] , J. Haruyama[2], T. Kobayashi[3], Y. Yamaguchi[4], A. Yamaji[5], S. Oshigami[6], K. Ishiyama[1], N. Nakamura[1], and Y. Goto[7], [1]Tohoku University, Aoba, Aramaki, Aoba, Sendai 980-8578, Japan. (kumamoto@stpp.gp.tohoku.ac.jp), [2]Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency, Sagamihara, Japan, [3]Korea Institute of Geoscience and Mineral Resources, Dajeon, South Korea, [4]Nagoya University, Nagoya, Japan, [5]Kyoto Universitry, Kyoto, Japan, [6]National Astronomical Observatory of Japan, Oshu, Japan, [7]Kanazawa University, Kanazawa, Japan.

Introduction: The Lunar Radar Sounder (LRS) onboard the SELENE (Kaguya) spacecraft successfully performed subsurface radar sounding of the Moon and passive observations of natural radio and plasma waves from the lunar orbit. The operation of LRS started on October 29, 2007. Until the end of the operation on June 10, 2009, 2363 hours' worth of radar sounder data and 8961 hours' worth of natural radio and plasma wave data were obtained [1]. We found subsurface regolith layers at depths of several hundred meters, which were interbedded between lava flow layers in the nearside maria. [2]. Using the measured depths and structures of the buried regolith layers, we could determine several key parameters on the past tectonic processes and volcanism in the maria as follows.

Tectonic processes in the maria: From the stratigraphy of lava flows in Mare Serenitatis, Ono et al. (2009) [2] suggested that the folds of lava flow unists S22 and S28 on the surface, and the folds of lava flow unit S11 below the surface were formed by the compressive stress after 2.84 Ga due to global cooling.

Volcanic activity in the maria: Based on the depth of the buried regolith layers, Oshigami et al. (2014) [3] determined the lava flow volumes below the surface, and their ages with reference to the ages of their connected lava flow units on the surface, which were determined by crater chronology [e.g. 4]. The average eruption rate of the lava flow in the nearside maria was estimated to be 10^{-3} km^{-3}/yr. at 3.8 Ga and decrease to 10^{-4} km^{-3}/yr at 3.3 Ga.

Physical property of the basalt: Pomerrol et al. (2010) [5] indicated that most echoes were found in low-TiO_2-abundant area, which suggested that the ilmenites attenuated the radar pulses. Ishiyama et al. (2013) [6] determined the permittivity of the uppermost basalt layer in the maria, and suggested that the porosity of the basalt (19-51% in Mare Humorum) was higher than that of Apollo rock sample.

Magnetic anomaly: Bando et al. (2015) [7] confirmed that there is no subsurface layer in depth range from 75 m to 1 km below the Reiner Gamma, and suggested that the source of magnetic anomaly was strongly magnetized thin (<75m) breccia layer.

Synthetic aperture radar analysis: Thanks to the high downlink rate from the SELENE/LRS (0.5 Mbps), we could obtain almost raw (simply pulsecompressed) waveform data from the lunar subsurface radar sounding. Using this dataset, synthetic aperture radar (SAR) processing was applied with trying several permittivity models in the analyses on the ground. Kobayashi et al. (2012) [8] applied SAR processing to this dataset and suggests that clear SAR image can be obtained even with simplified media model.

Summary: As described above, buried regolith layers found by SELENE/LRS are good indicators of the boundaries of the multiple lava flows below the surface. They will support the future investigations on the evolutions of volcanic activity and global and local tectonic processes. The SELENE/LRS dataset is provided via SELENE Data Archive (http://l2db.selene.darts.isas.jaxa.jp/index.html.en), which will be useful for researchers who are going to apply them to investigations based on new ideas.

References: [1] Ono T. et al. (2010) *SSR 154*, 145-192, doi:10.1007/s11214-010-9673-8. [2] Ono T. et al. (2009) *Science 323*, 909-912, doi:10.1126/ science.1165988. [3] Oshigami S. et al. (2014) *JGR Planets 119*, 1037-1045, doi:10. 1002/2013JE004568. [4] Morota T. et al. (2011) *EPSL 302*, 255-266, doi:10.1016/j.epsl.2010.12.028. [5] Pommerol A. et al. (2010) *GRL 37*, L3201, doi:10.1029/2009GL041681. [6] Ishiyama K. et al. (2013) *JGR Planets 118*, 1453-1467, doi:10.1002/jgre.20102. [7] Bando Y. et al. (2015) *Icarus 254*, 144-149, doi:10.1016/j.icarus.2015.03.020. [8] Kobayashi T. et al. (2012) *ITGRS 50*, 2161-2174, doi:10.1109/TGRS.2011.2171349.