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Observations of the lunar subsurface structures and Jovian hectometric radiation by the Kaguya Lunar Radar Sounder

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The Lunar Radar Sounder (LRS) onboard the Kaguya (SELENE) spacecraft [Ono et al., 2000; 2008; Kasahara et al., 2008; Ono et al., 2010] successfully obtained 2363-hours worth of radar sounder data and 6570-hours worth of natural plasma wave data in the nominal operation period from October 29, 2007 to September 10, 2008 and 2390-hours worth of natural plasma wave data in the extended operation period until June 10, 2009.

It was found by the LRS observation that there are distinct subsurface reflectors with a depth of several hundred meters below the surface of the nearside maria. The reflectors are inferred to be paleoregolith layers covered by the basalt layers [Ono et al., 2009]. In several maria, the lava flow units have been identified based on the Clementine multispectral data [Heather et al., 2002; Hiesinger et al., 2003]. By analyzing Clementine multispectral image around the impact crater, Weider et al.[2010] estimated the thickness of lava flow units, and pointed out that the estimated thickness coincided with that reported by LRS. Kaguya multi-band imager (MI) [Ohtake et al., 2008] obtained multispectral images around the impact crater with higher resolution. The comparison between MI and LRS data will be important to determine the electric permittivity of the surface material, which is needed to derive the actual depth of the paleoregolith layers, and the evolution of the lave flow flux from LRS data.

Based on the analyses of LRS data, Oshigami et al [2009] reported that the subsurface echoes are found only in 10% of the western nearside maria such as Mare Humorum, Mare Imbrium, and Oceanus Procellarum. Pommerol et al. [2010] also suggested that detectability of the subsurface echoes depend on abundance of TiO2 and FeO in the surface material, which was obtained based on Clementine multispectral image data. Kobayashi et al. [2009] proposed the estimation method of the thickness of the surface regolith layer by the apparent difference of altitudes measured by laser altimeter (LALT) [Araki et al., 2008] and LRS. It enables us to obtain the thickness of the surface regolith with several m, which is much less than the range resolution of LRS, or 75m.

In order to take advantage of lunar global subsurface radar soundings performed by the Kaguya spacecraft, we have to establish the analysis methods of radar sounder data obtained not only in nearside maria but also in farside highland regions and polar regions. We have two ideas of analysis methods: (a) Echo simulation based on the surface topographic data obtained by LALT and Terrain Camera (TC) [Haruyama et al., 2008], and (b) synthetic aperture radar (SAR) analyses [Kobayashi and Ono, 2002a; 2002b; 2006; 2007].

LRS was operated not only for the subsurface radar sounding but also for the passive radio wave observation. Through the operation period from October 2007 to September 2008, we could detect numerous events of auroral kilometric radiation (AKR), 39 events of type III solar radio bursts, and 7 events of Jovian hectometric (HOM) radiation with resolution of 2 sec or 0.1 sec. Fine structures were found in the spectrogram of Jovian HOM. The drift rate of the emissions was about 20 kHz/sec, which suggests the source motion with a velocity of 300 km/s. It is known that planetary radio emissions often shows narrow-band with a frequency drift, e. g. Jovian S-burst, and striated auroral kilometric radiation (AKR). Some previous studies explained that they are caused by kinetic Alfven waves and ion holes with ion acoustic velocity, which can modify the electron velocity distribution at the radio emission source. The velocity of 300 kHz derived from HOM observed by the Kaguya was however a little smaller than Alfven velocity (3000 km/s) and much less than ion acoustic velocity (15 km/s).

Keywords: Kaguya (SELENE), Lunar Radar Sounder (LRS), Paleoregolith, Synthetic aperture radar (SAR), Jovian hectometric radiation (HOM)