RADON GAS EMANATION ON THE LUNAR SURFACE OBSERVED BY KAGUYA/ARD. K. Kinoshita[1], K. Kojima[1], M. Itoh[1], T. Takashima[2], T. Mitani[2], K. Yoshida[3], S. Okuno[4], and J. Nishimura[2], [1]Kobe University, 3-11, Tsurukabuto Nada-ku, Kobe 657-8501 Japan (itoh@radix.h.kobe-u.ac.jp), [2]JAXA/ISAS, Yoshinodai, Chuo-ku, Sagamihara, Kanagawa 252-5210 Japan, [3]Shibaura Institute of Technology, Saitama-shi Saitama 337-8570 Japan, [4]Kanagawa University, Yokohama-shi, Kanagawa 221-8686 Japan.

Introduction: ^{222}Rn and its descendants including ^{210}Po provide us with information on the distribution of ^{238}U on the moon and the crustal structures such as fissures and faults through which the radon gas produced in the subsurface region migrates to the surface. Detection of ^{222}Rn indicates that there was gas emission within several days prior to the observation, and that of ^{210}Po indicates that there was gas emission within ~60 years. The radioactive nuclides ^{222}Rn and ^{210}Po can be probed with the alpha particles from their radioactive decay. It was first discussed by Kraner et al. [1], and detailed description of the process can be found in Lawson et al. [2] for example.

Alpha particles from ^{222}Rn and ^{210}Po on the lunar surface were detected by the experiments on board Apollo 15, 16, e.g., [3], [4], [5] and Lunar Prospector [2]. They detected ^{222}Rn alpha particles in the regions including craters Aristarchus and Kepler and discovered that distributions of ^{222}Rn and ^{210}Po are different which suggests spatial and temporal variation of the radon gas emanation. The regions including craters Aristarchus and Kepler are known as locations where Lunar Transient phenomena have been observed, e.g., [6]. However, spatial resolution in these observations was limited to ~300 km, and temporal variation of the signal was not directly detected mainly because of the limited statistics of the data.

To advance the lunar science with the radon alpha particles as the probe, Alpha Ray Detector (ARD) [7] was on board Kaguya [8]. It was designed to have large area of 326 cm^2 and anti-coincidence detectors to reduce the cosmic-ray background so that we can improve the spatial and temporal resolution to examine the alpha-particle signal. Here, we report the results obtained from ARD.

Observations and Analysis: We analyzed data obtained by ARD in January to June 2008 during the nominal-mode operation of Kaguya. After applying some data selection procedure, we obtained effective observing time of ~6.5×10^8 sec.

For the analysis of ^{210}Po alpha-particle signal, we integrated the entire data because time variation is not expected for the time scale of the observation period. To produce the alpha-particle intensity distribution, we utilized the information on the angular response function which allowed us to have angular resolution of ~80 km (FWHM) on the lunar surface. To evaluate the alpha-particle signal intensity, we utilized the spectral information; we modeled the background spectrum with a power-law function and evaluated the excess signal in the ^{210}Po alpha particle energy range. For the analysis of the ^{222}Rn alpha-particle signal, we divided the observing period into time segments each of which is 2-weeks long because the signal is expected to vary with the time scale of ~10 days. Then, we derived intensity distribution of the signal above the background in the ^{222}Rn alpha particle energy range for each time segment. For the detection of the statistically significant signal, we applied sliding-window algorithm to the intensity distribution map. In the analysis, we did not use the anti-coincidence function because of some problems indicating malfunction.

Results: From the analysis of ^{210}Po alpha particles, we detected signals above 4σ level at Crater Aristarchus and Crater Kepler C. Because of the improved spatial resolution, we were able to pinpoint the location to the craters (Fig. 1). The extent of the distribution was smaller than previously assumed. One of the possible reasons is larger efficiency of adsorption of radon on the lunar surface.

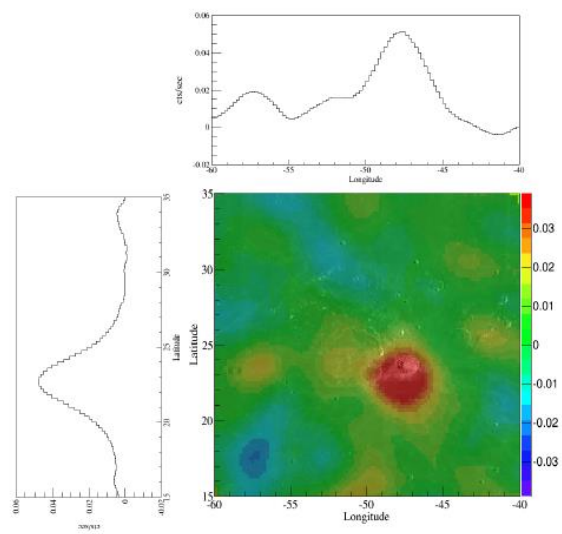

Figure 1. ^{210}Po alpha-particle intensity map of the Aristarchus region overlaid with the optical image.

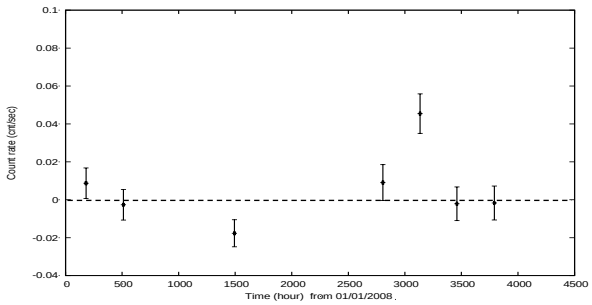

Figure 2. Time variation of ^{222}Rn alpha-particle intensity from the eastern region of Mare Frigoris. The intensity enhancement with the statistical significance of ~4.3σ was detected.

From the time-resolved analysis of the ^{222}Rn alpha-particle signal, we detected 9 events of intensity enhancement above 4σ level. An example is shown in Fig. 2. This is the first direct detection of the temporal variation of the ^{222}Rn alpha-particle signals. We are looking into temporal relation with events such as passage of the terminator and meteoroid impacts.

References: [1] Kraner H. W. et al. (1966) *Science, 152*, 1235–1236. [2] Lawson S. et al. (2005) *JGR 110*, E09009. [3] Gorenstein P. et al. (1973) *Science, 179*, 792-794. [4] Bjorkholm P. et al. *Science, 180*, 957-959. (1973) [5] Gorenstein P. et al. (1974) *Science, 183*, 411-413. [6] Crotts A. P. S. (2009) *ApJ 697*, 1-15. [7] Nishimura J. et al. (2006) *AdSR, 37*, 34-37 [8] Kato M. et al. (2008) *AdSR, 42*, 294-300.