Significance of Kaguya GRS-detected Si bundance and distribution. K. J. Kim[1], H. Nagaoka[2], N. Hasebe[2], D. Hamara[3], J. A. P. Rodriguez[4], S. Kobayashi[5], N. Yamashita[6], R. C. Reedy[6], Y. Karouji[7], M. Kobayashi[8], J. Machida[2], [1]Geological Research Division, Korea Institute of Geosciences & Mineral Resources, Dajeon, South Korea (kjkim@kigam.re.kr), [2]Research Institute for Science and Engineering, Waseda University, Tokyo, Japan, [3]Lunar and Planetary Laboratory, University of Arizona, Tuscon, AZ, USA, [4]Planetary Science Institue, Tucson, AZ, USA, [5]National Institute of Radiological Sciences, Japan, [6]Planetary Science Institute, Los Alamos, NM, USA, [7]Japan Aerospace Exploration Agency, Kanagawa, Japan, [8]Planetary Exploration Research Center, Chiba Institute of Technology, Chiba, Japan.

Introduction: Gamma ray spectrometry (GRS) provides a powerful tool to map and characterize the elemental composition of the upper ten centimeters of solid planetary surfaces. GRS maps have been produced for Mercury, the Moon, Mars, and astroids [1-9]. Early Lunar GRS Th, K, and Fe maps were produced during the Apollo 15/16 mission, and covered ~20% of total surface. However, it was not until recently that global GRS elemental maps, obtained by the Lunar Prospector, Kaguya, Change-2 missions, became available to the scientific community [1-7]. The Kaguya GRS (KGRS) provided over 200 gamma ray peaks [10]. Elemental maps generated by the KGRS include natural radioactive as well as major elements maps (e.g., Fe, Ca, and Ti) [2-4, 7].

Methodology: Recent investigaton of Si gamma ray peaks using three peaks of 3539.5, 4934, and 1779 keV was performed. This investigation shows that the counting rates of between 3539.5 and 4934 keV gamma ray peaks have a good correlation and produced reliable results in producing their Si maps. The 1779 keV Si inelastic gamma ray peak is known to be interfered by the gamma-ray produced by the background material of Al. Therefore, for this study, the Si gamma ray has been investigated using the 4934 keV Si peak (Fig. 1) produced by the thermal neutron interaction $^{28}Si(n,g)^{29}Si$, generated during the interaction of galactic cosmic rays and surface material containing Si.

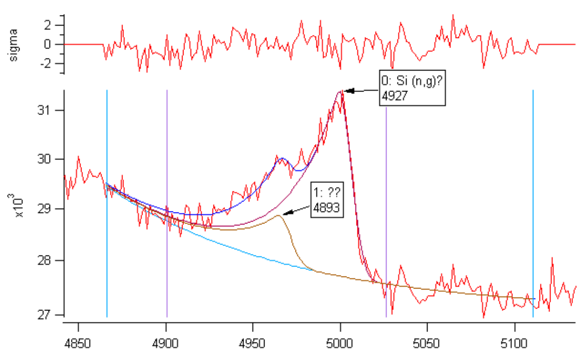

Fig 1. Gamma-ray peak for the 4934 keV Si using IGRO PRO.

The used analysis program is a custom IGOR Program developed at University of Arizona. The 5 degree uncorrected map of Si after smoothing (Fig. 2) shows a range of uncertainty from 5.31 to 31.73 percent of the Si values in cpm (count per minute). We also used another gamma ray data analysis program (Aquarius) developed by IRAP (The Research Institute in Astrophysics and Planetology, CNRS, France). The reason of using two GRS analysis programs was cross check results and produce more reliable elemental maps.

The Si GRS data have been corrected for thermal neutron effect. The emisson rate of neutron-capture gamma rays is directly propotional to the product of the abundance of Si and neutron number density from the lunar surface. Thus, we corrected the Si GRS data by a low energy neutron data (< 0.1 eV) obtained by Lunar Prospector [11] because Kaguya orbiter did not carry a neutron detector. We used the relative change in thermal neutron number density as a function of topography measured by Lunar Prospecctor [12].

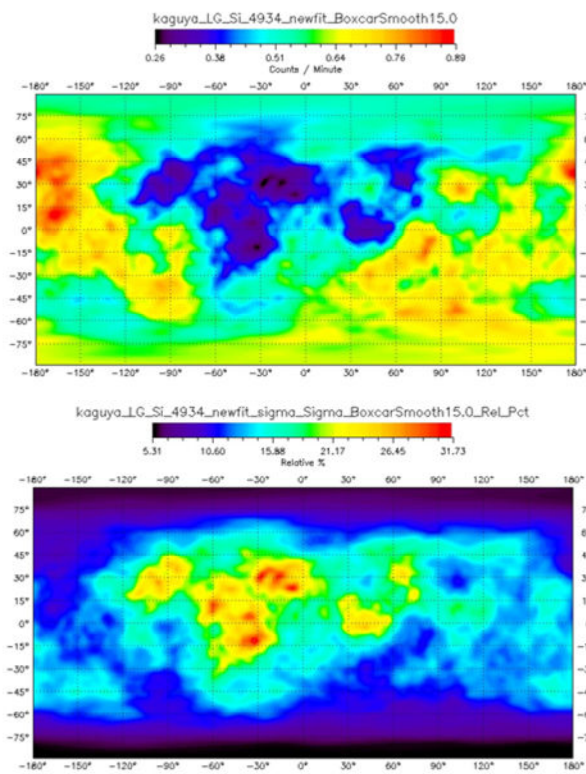

Fig. 2. A 5 degree Si map (cpm) (top) for without neutron density correction and uncertainty map (%) (bottom) of Si obtained by KGRS generated using IGRO PRO.

We used Si data obtained by the Aquarius program and the results of the Si peak analysis for the reference Apollo sample sites (Fig. 3) were plotted in Fig. 4. For this analysis, GRS data were corrected for altitude and thermal neutron number density correction mentioned above.

The significance of the Si abundance: The Si abundance permits the quantification of the relative abundance and distribution of mafic or non-mafic lunar surfaces materials. Our KGRS data analysis shows that highland terrains are Si-enriched relative to lower basins and plains regions, which appear to consist of primarily of mafic rocks.

Our preliminary elemental map of Si using Kaguya GRS data shows that the highland areas of both near side and farside have higher abundance of Si and the mare regions of the near side have the lowest Si abundance on the Moon. When the Si map of Kaguya GRS data is compared with LRO's mineralogical map, a reasonable agreement in understanding of the diatonomy between lunar mafic and feldspathic regions of the moon is confirmed (Fig. 5). Further investigation on obtaining Si elemental map of Si using KGRS will be accomplished by the normalization of KGRS data with Apollo samples in the near future.

The Apollo lunar samples show significant degree of variation in the content of Si, with the widest documented range corresponding to the Apollo 17 samples. Some of the samples deviate compositionally from the GRS footprint signature in which they occur, pointing to a diverse range in the geochemistry of regional surface geologic materials. On the other hand, compositional matches between the surface rocks and GRS data may represent the dominant rock composition for a given region. Further investigation is needed with additional Apollo sample data for the final normalization step of Kaguya Si data to produce a reliable Si abundance map.

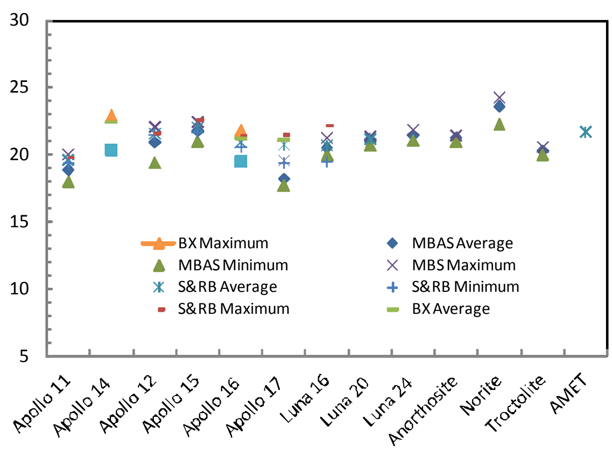

Fig. 3. Si abundance (Y axis) obtained by various samples. MBAS, S&RB, and BX stand for mare basalts, soil and regolith breccias, and polymict breccias, respectively. AMET stands for Antarctic lunar meteorites. Highland monomict rocks are listed by individual rock type name as anorthosite, norite, and troctolite [13].

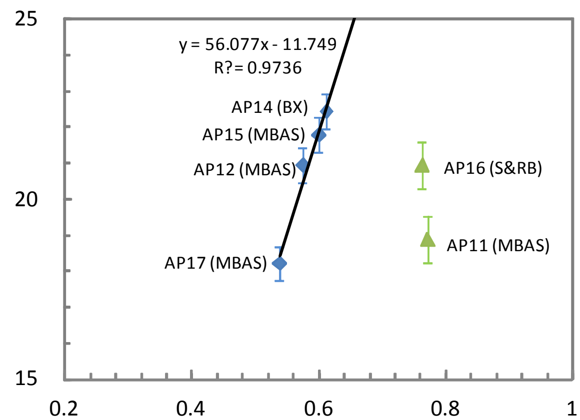

Fig. 4. Comparison of Si (Y axis) between Apollo sample data (%) and Kaguya GRS data (cpm). [13].

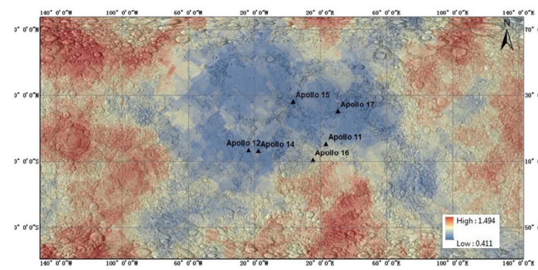

Fig. 5. The Kaguya Si map of the lunar surface. This neutron corrected partial global Si map generated by the ArcView GIS program corresponds well to the region on the Diviner mineral map obtained by LRO [14].

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