PRELIMINARY ANALYSIS OF SELENE GRS DATA – THE IRON CASE. O. Gasnault[1], O. Forni[1], B. Diez[1], C. d'Uston[1], S. Maurice[1], N. Hasebe[2], O. Okudaira[2], N. Yamashita[2], S. Kobayashi[2], Y. Karouji[2], M. Hareyama[2], E. Shibamura[3], M.N. Kobayashi[4], R.C. Reedy[5], and the Selene GRS team, [1]Université de Toulouse, France (Olivier.Gasnault@cesr.fr), [2]Research Institute for Science and Engineering, Waseda University (Tokyo, Japan), [3]College of Health Science, Saitama Prefectural University (Saitama, Japan), [4]Nippon Medical School (Kanagawa, Japan), [5]Planetary Science Institute (Los Alamos, USA).

Introduction: The lunar surface offers a variety of rock and regolith compositions that result from the complex evolution of the Moon during the first third of its existence [1, 2]. Today's crust is a mixing of feldspathic suites, various basalts (a small part in volume), and some materials enriched in incompatible and rare earth elements (KREEP). The global compositional maps, such as those returned by gamma-ray and X-ray spectrometers or derived from imagery cameras, are useful to study these geologic processes in more details.

SELENE (KAGUYA) carries a high-purity germanium gamma-ray spectrometer (hereinafter KGRS), which is sensitive to the elemental composition of the regolith [*Reedy R. et al.,* these proceedings]. These measurements are grouped into three periods for which the instrument characteristics were different [*Kobayashi M. et al.,* these proceedings]. The spectral lines of thorium, potassium, and uranium were integrated to produce maps of these radioactive elements [*Yamashita N. et al.,* these proceedings].

The KGRS spectra are a combination of surface elemental composition, surface neutron fluxes, backgrounds, instrument responses and other minor effects. These data can be processed by Independent Component Analysis (ICA) to obtain mutually independent spectra, which in principle represent independent groups of chemical elements. The elements that are naturally correlated will be found in the same ICA component. Previous works demonstrated that several ICA components make sense, either because their spectrum counterpart shows the lines of well identified elements [3], or their map counterpart reveals the well known lunar terranes [4].

We focus on two time frames within the KGRS periods (21 Dec 07 – 19 Feb 08, and 7 Jul 08 – 31 Oct 08 respectively) and on a restricted energy range (0.75 – 3 MeV) for a preliminary analysis of the ICA components that seems to represent thorium and iron. KGRS spectra were spatially filtered before analysis.

Comparison with Lunar Prospector: To gain an insight into the ICA components derived from the KGRS spectra, we first correlate them with the Lunar Prospector Gamma-Ray Spectrometer (LP-GRS) maps. Iron and thorium abundances were successfully derived from LP-GRS data with a spatial resolution (FWHM) of ~80 km [5, 6]. Other elements (O, Si, Ti, Al, Mg, Ca, and K) were tentatively mapped with a coarser resolution of ~150 km or more [7]. For simplicity we will do all the comparisons using 5-deg equal-area map bins (~150 km).

5-deg	KGRS			
	period 1		period 2	
LP-GRS	ICA1	ICA2	ICA1	ICA2
O	-0,75	-0,54	-0,67	-0,55
Si	-0,58	-0,64	-0,43	-0,64
Ti	0,82	0,66	0,70	0,68
Al	-0,82	-0,62	-0,74	-0,64
Mg	0,56	0,57	0,46	0,57
Ca	-0,49	-0,15	-0,51	-0,17
K	0,52	0,97	0,36	0,97
Fe	0,87	0,76	0,76	0,78
Th	0,56	0,96	0,40	0,96

Table 1: The Pearson correlation factors between the LP-GRS maps and the two ICA components derived for two different periods of observations with KGRS.

Table 1 reveals that the second ICA component is strongly correlated with thorium and potassium, and to less extent with iron. This is typical of the KREEP materials, which have high concentrations of incompatible elements (including Th and K), intermediate abundance of iron, and are found in the Procellarum KREEP Terrane (PKT) [8]. The first ICA component is more ambiguous: it is primarily correlated to iron, and shows also some relationship with aluminum and titanium. Moreover the correlations are weaker in the second period. Lunar mare basalts are Fe-rich and show variable amount of titanium, while the aluminum is found in the felspathic highlands which is consistent with Table 1. Although the first observation period was shorter, the spectral resolution of the instrument was better hence a better separation of the 847 keV iron line from other background lines, which may explain the lower correlation factors in period 2.

Tentative iron map with KGRS: The relationship between the iron abundance (*Fe*) and the counting rate in the corresponding spectral line (C) can be described by:

$$Fe = \left(\frac{C}{\varepsilon g f}\right) + n' \quad (1)$$

where ε is the efficiency of the spectrometer, g is a geometric factor combining the surface observed and the solid angle of that surface seen from the detector, f is the flux of photons/mn/cm^2/wt% emitted by the iron atoms on 2π sr, and n' is the line background (i.e. any contribution other than the lunar iron). The difficulty is that f, and possibly n', depend on the neutron flux, which itself depends on the iron abundance in the soil [9]. Therefore the relationship between Fe and C may not be linear and rather in the form of:

$$Fe = k_1 + k_2\sqrt{k_3 C + k_4} \quad (2)$$

where the constants k_1, k_2, k_3, k_4 are functions of the previous parameters.

However it seems that the domain of values considered here can be very well approximated by a linear function. This is confirmed by a scatter plot of the LP-GRS iron map with the correlation factors between the KGRS spectra and the first ICA component (Figure 1).

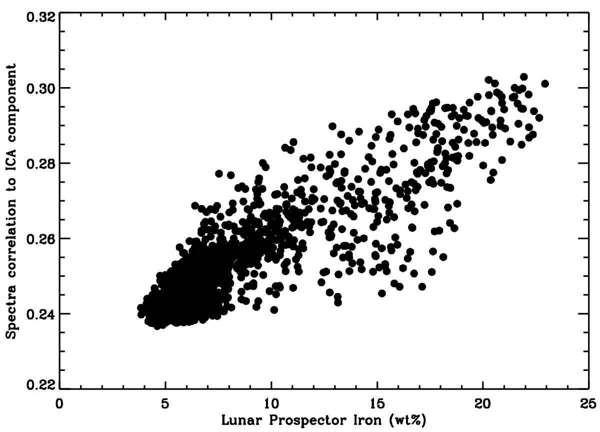

Figure 1: Comparison at 5-deg. resolution with the LP-GRS iron map (x-axis). The y-axis shows the correlation factors between the first period KGRS spectra and the first ICA component.

Discussion: Figure 1 was used to build a preliminary KGRS iron map shown in Figure 2 through a simple linear regression. Because of the good correlation shown in Table 1, the linear relationship shown in Figure 1, and the fact that the lunar compositional poles of feldspathic highlands, mare basalts, and KREEP materials can be identified with the two ICA components [4], we have some confidence in this map. However there are some discrepancies with the LP-GRS iron map (e.g. Mare Frigoris). Consequently, the quantitative values must be used with caution since this map was not corrected for neutron fluxes and instrument background.

This work shows that maps of elements such as iron will be available with the KGRS data, in addition to the radioactive maps already existing. Although this preliminary analysis enforces the quality and the consistency of the data, it also shows that further efforts are necessary to understand all the corrections needed to obtain quantitative results.

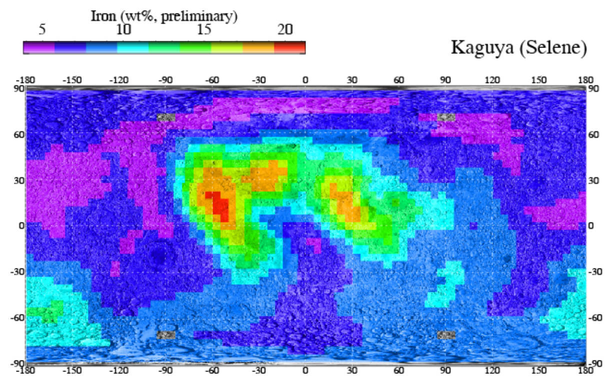

Figure 2: Uncorrected iron map derived from the Selene (Kaguya) gamma-ray spectra (see text). The abundances values were obtained through a linear correlation with the Lunar Prospector iron map. The map is projected on a quasi-equal area grid of 5x5 degrees at the equator.

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