MAPS CHARACTERIZING THE LUNAR REGOLITH MATURITY. V. Kaydash[1], Yu. Shkuratov[1], D. Stankevich[1], V. Omelchenko[1], C. Pieters[2], and L. Taylor[3], [1]Astronomical Institute, Kharkov National University. 35 Sumskaya St., Kharkov. 61022. Ukraine. [2]Dep. of Geological Science, Brown University, Providence, RI 02912. [3]Planetary Geosciences Institute, University of Tennessee, Knoxville, TN 37996. vkaydash@astron.kharkov.ua

Introduction: There are several parameters characterizing maturity of the lunar regolith [1,2]. Most reliable of them are the ratio I_s/FeO, characterizing relative concentration of nano-phase reduced iron, and the agglutinate content. The ratio I_s/FeO is often called the degree of maturity of the lunar regolith. Studies of lunar samples show that the agglutinate content correlates with the maturity degree [1]. Besides, the abundance of crystalline component, independently of its composition, anti-correlates with the maturity degree. In present paper we examine these correlations, mapping the parameter I_s/FeO, the abundance of agglutinates in the lunar regolith, and the abundance of the crystalline component presented with pyroxene, plagioclase, olivine, and ilmenite. We use measurements of lunar samples made by Lunar Soil Characterization Consortium (LSCC) [3] and multispectral lunar data of high spatial resolution available after the Clementine mission to the Moon.

Data and technique: Spectral, chemical, and mineralogical data on lunar samples returned with Apollo 11, 12, 14, 15, 16, and 17 missions were used in our analysis. All these samples are presented with three size fractions (<10 μm, 10-20 μm, and 20-45 μm). Totally we analyzed 52 samples. This set is significantly wider than in our previous studies [4,5]. To map the maturity degree (I_s/FeO), agglutinate abundance (*Agg*), and content of crystalline component (*CrComp*), we used UVVIS Clementine mosaics provided by USGS. Exploiting of all the five spectral bands 0.42, 0.75, 0.90, 0.95, and 1.00 μm of the UVVIS camera leads to noisy results with the prominent residual latitude trend that is often revealed in analyses. Our studies have shown that the best results can be obtained using the three bands 0.75, 0.95, and 1.00 μm.

The main point of our approach is to find the closest correlation between a studied parameter (chemical or mineral) and a linear combination of spectral albedo of samples $\log P = k_1 \cdot A_{0.75} + k_2 \cdot A_{0.95} + k_3 \cdot A_{1.00} + k_4$, varying the weight coefficients k_i (i=1..4) of the linear combination (albedo A is given in natural units). Actually we minimized the RMS deviation of predicted values of studied parameters from the measured ones. The values k_i and correlation coefficients r are given in Table for the parameters I_s/FeO, *Agg*, and *CrComp*. In all the cases the correlation coefficients are fairly high.

Table

	k_1	k_2	k_3	k_4	r
I_s/FeO	-20.00	15.92	1.91	1.96	0.92
Agg	-5.66	-6.37	10.76	1.80	0.80
CrComp	6.29	10.86	-15.59	1.50	0.75

Results of mapping: Having determined the weight coefficients, we produced maps of the parameters. The map of *CrComp* is shown in Fig. 1a. Dark color corresponds here to low values of the crystalline content. We note that higher content of the component is characteristic of craters and their rims and rays. For maria the main crystalline component is pyroxene, whereas for highland this is plageoclase. The maps of I_s/FeO and the agglutinates content are respectivly presented in Figs. 1b,c. The majority of craters and ray systems reveal low maturity degree, as can be expected (see, e.g., the crater Aristarchus and Tycho). There are almost no mare/highland differences in the distributions of the parameters I_s/FeO, *Agg*, and *CrComp* proving that they are almost insensible to compositional variations. All these distributions look fairly similar. In captions to Figs. 1a-c we give the average contents and the RMS variations, σ.

Correlations: We study correlations "I_s/FeO-*Agg*" and "I_s/FeO-*CrComp*". The diagrams are shown in Figs. 2 and 3. The first diagram reveals a complicated relationship between I_s/FeO and crystalline component distributions, at least three oblong clusters can be seen here, each shows close anti-correlation between the parameters. The direct correlation between I_s/FeO and *Agg* (Fig. 3) reflects the process of increasing the total amount of nano-phase iron in the volume of regolith particles during agglutination. Like in previous case, the detailed analysis of the diagram in Fig. 3 shows several parallel trends in the common direct correlation. The two main clusters correspond to the maria and highlands. Craters and their ray systems form tails of the clusters.
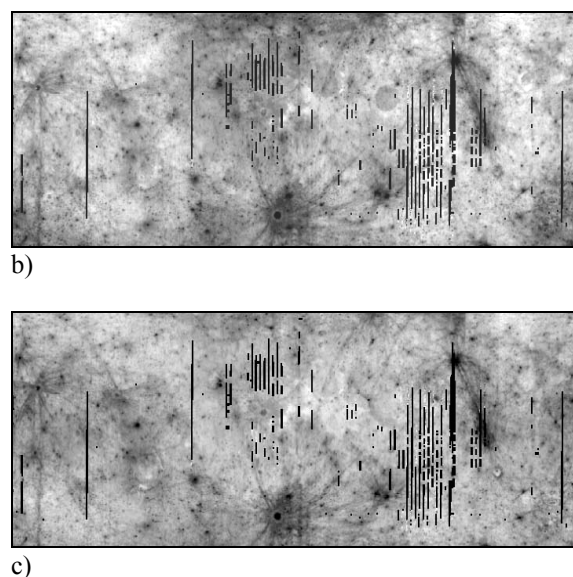

a)

b)

c)
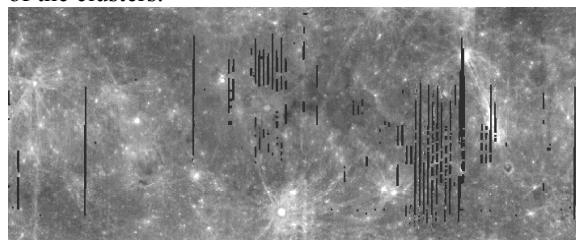
Fig. 1. Maps of the maturity-correlated parameters: (a) content of crystalline component (average is 44%, σ = 4.3%); (b) I_s/FeO (average is 63, σ =10.8); (c) agglutinate content (average is 49 wt. %, σ = 3.56 %).
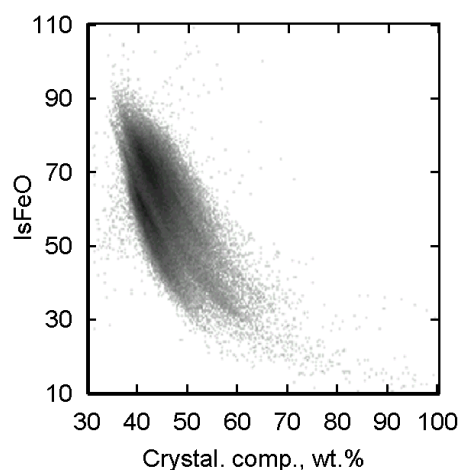

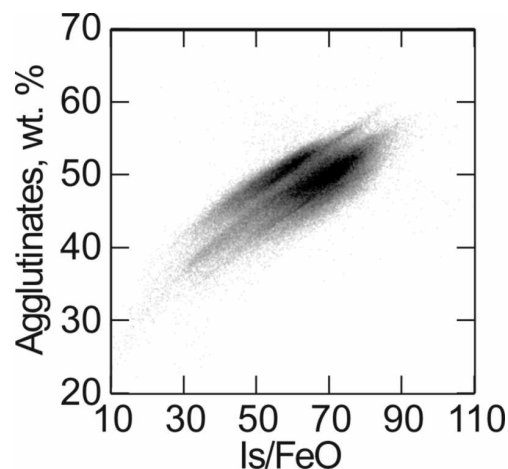Fig. 2. The correlation diagram "I_s/FeO-*CrComp*" made with Figs. 1a and 2b data.

Fig. 4. The correlation diagram "$I_s/FeO – Agg$" made with Fig. 1b,c data.

Conclusion and future work: Our technique [5] allows us to map three maturity-correlated parameters: the maturity degree I_s/FeO, the agglutinate content, and the content of crystalline component. We found a close correlation between I_s/FeO and agglutinate content as well as anti-correlation between I_s/FeO and crystalline content. It qualitatively consists with the laboratory data [1]. We plan to make a cluster analysis of the correlation diagrams shown in Figs. 2 and 3 in order to map different types of the lunar surface.

References: [1] Morris R. (1977) *Proc. LSC 8th*, 3719-3747. [2] Lucey P. et al. *JGR, 105 (E8),* 20,377-20,386. [3] Taylor L. et al. (2001) *JGR 106*, E11, 27,985-28,000. [4] Pieters C. et al. *Icarus 155*, 285-298, 2002. [5] Shkuratov Yu. et al., (2003) *JGR 108*, E4. 1-1 – 1-12.