THE AVALANCHE DEPOSITS IN LUNAR CRATER REINER. V.V.Shevchenko[1,2], P.C.Pinet[1], S.Chevrel[1], Y.Daydou[1], T.P.Skobeleva[2], O.I.Kvaratskhelia[3], C.Rosemberg[1]. [1]UMR 5562 “Dynamique Terrestre et Planetaire”/CNRS/UPS, Observatoire Midi-Pyrenees, Toulouse, 31400 France; [2]Sternberg Astronomical Institute, Moscow University, Moscow, 119992, Russia, [3]Abastumany Astrophysical Observatory, Georgian Academy of Sciences, Georgia. shev@sai.msu.ru

Introduction: Space weathering processes on the Moon affect the optical properties of an exposed lunar soil. The main spectral/optical effects of space weathering are a reduction of reflectance, attenuation of the 1-μm ferrous absorption band, and a red-sloped continuum creation [1]. Lucey et al. [2 - 4] proposed to estimate the maturity of lunar soils from Clementine UVVIS data using a method which decorrelates the effects of variations in Fe^{2+} concentration from the effects of soil maturity. The method calculates optical maturity defined as parameter OMAT [5]. Pinet et al. [6] used the method to analyse the ‘Reiner-γ – Reiner’ region on the basis of Clementine spectral image data.

Crater Reiner: Crater Reiner is located in western Oceanus Procellarum. Diameter of the crater is 30 km, its depth is 2.4 km and its central peak height is about 700 m (Fig. 1).

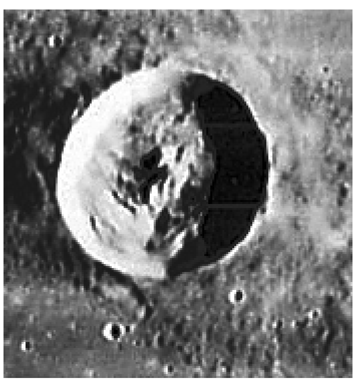

Fig.1

Fig. 2 shows west-east profile of the crater in which vertical scale is 3^x horizontal scale. Topographic data are taken from lunar map [7]. General slope of the western part of the inner walls is about 20°. There is a terrace on the western wall slope. Slope of the eastern crater inner wall is in range $17^\circ – 18^\circ$.

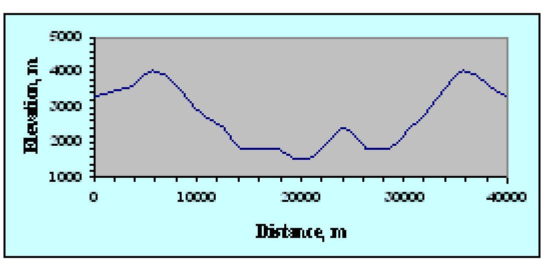

Fig.2

Fig. 3 represents the Clementine image of the crater Reiner.

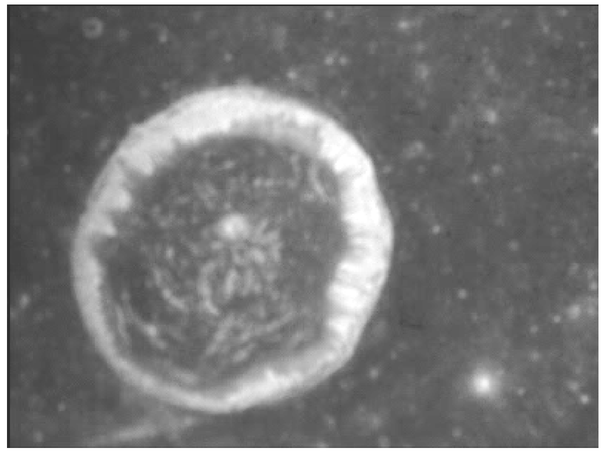

Fig.3

Evidence of avalanching and of other downslope movement of material is clearly visible on the inner walls of the crater. In general, freshly exposed lunar material is brighter than undisturbed materials nearby. The brightness of the avalanche scars is an indication of their freshness. The image shows numerous bright avalanche deposits on the steep crater walls, apparently originating at outcrop ledges near the top of the wall. On the western wall, most avalanches stop in a moat at the base of the wall (near terraces). On the eastern wall, avalanches extend out onto the irregular, inward- sloping floor.

Spectral analyses of the crater Reiner: A detailed remote sensing survey of the crater Reiner region has been carried out by means of Clementine spectro-imaging data with the purpose of establishing the regional distribution of the chronology index and weight percent of iron content in the lunar soils. The spectral dataset has been instrumentally calibrated and a radiometric calibration using previous telescopic spectra has been made, resulting in the production of absolute reflectance spectra [6] organized in an image cube.

The spectral influence of both the soil maturity and iron content is quantified according to Lucey's method [2] and our previous analyses, based on the independent spectropolarization method [8, 9], provide with soil maturity estimates in good agreement with the present results.

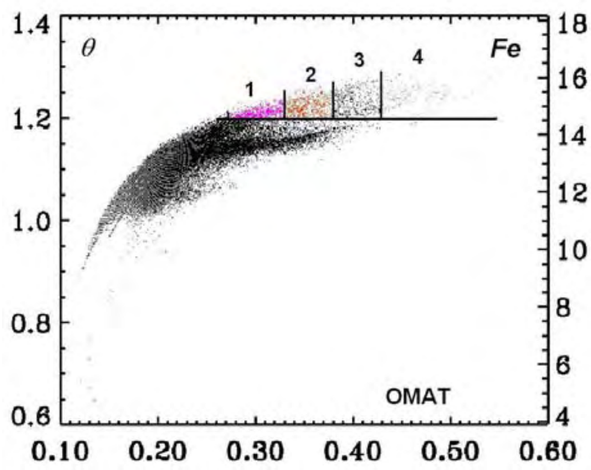

Fig. 4

The diagram, depicted in Fig. 4, plots Lucey's parameters (or Fe content in weight % versus maturity index OMAT). The spatial distribution associated to the color scale coded boxes (1 to 4) displayed in fig. 4 is shown in fig. 5. It reveals the presence of extremely immature soils (coded in color box 4) at the hundred meters scale in the crater Reiner area. Also the soil iron content in the regions is higher (up to 16%) than in the surrounding mare background soils (about 11-12%).

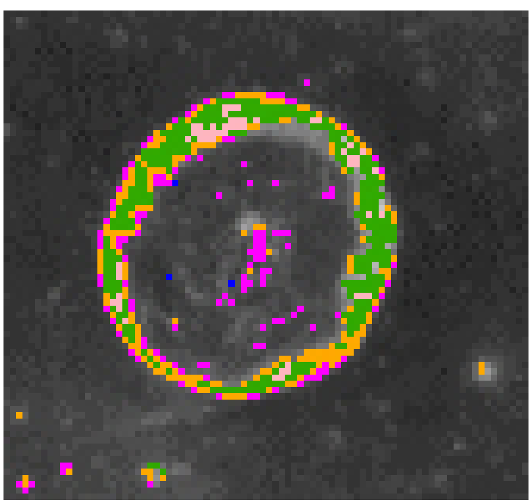

Fig. 5

Immature soils (coded in green, box 3) occupy most areas of the inner wall slopes of the crater. Extremely immature materials (coded in light grey, box 4) are observed in the north-north-western part of the inner walls.

Interpretation: Distribution of the immature soils shown in Fig. 5 correlates with distribution of the bright materials on the wall slope of the crater as it is seen in Fig. 3. Most bright slope areas in Fig. 3 coincide with most immature soil regions in Fig. 5. The smallest craters seen in the image are about 400m in diameter with depth on the order of 80m. Inner slopes of walls for these small craters are up to 40°. The local OMAT estimates points out at the occurrence of slope instability processes.

Also, we note that the iron content estimates of these slope soils reach locally maximal values of 16%, with a systematic increase of Fe content with regolith depth for the investigated region.

Using similar Clementine data for other lunar regions of mare and highland types, we obtain a scale of conformity between OMAT, I_s/FeO (by Morris [10]) and spectropolarimetric maturity indexes [9].

The maturity index values ranging from box 2 to box 4 correspond to exposure age from 6 to 0.5 million years [9]. Exposure age of the irregular, inward-sloping floor surface material is equal about 50 Myr in that chronology system. Material on the central peak slopes has exposure age about 20 Myr (box 1).

The presence of very immature soils on the inner wall slopes and on the central peak of the crater Reiner suggests recent intensive slope processes.

The most immature soils cover inner walls of young small craters of which the origin age may be equal to the exposure age of the surface layer on their inner walls and be as less as 10 Myr.

Conclusions: Avalanching appears to be a major means of the current erosion on steep lunar slopes. Many features of the surface structures occur where the wall is bowed outward and probably represent slump deposits where portions of the crater wall have collapsed into the crater. Soil inner friction angle is not more than 20^{o} for upper layer matter. Bulk density of the surface soil is about 1.5 g/cm^3 in the case. The age of the observed lunar slope degradation is very young.

On Mars, similar slope failures are possibly caused by erosion from “running” water.

However, the lunar triggering mechanism of the down slope movement of the material remains unclear. It’s needed to study many questions regarding the stability of natural lunar slopes else.

References: [1] Fischer E.M., Pieters C.M., (1994) *Icarus*, *111*, 475-488. [2] Lucey P.G., et al. (1995) *Science*, *268*, 1150-1153. [3] Lucey P.G., et al. (1998) *JGR*, *103*, 3679-3699; [4] Lucey P.G. et al. (1998) LPS *XXIX*, Abstract # 1356. [5] Jolliff B.L. (1999), *JGR*, No.E6, 14,123-14148. [6] Pinet P.C. et al. (2000), *JGR*, Vol. 105. No. E4. 9457-9475. [7] Lunar chart, 1 :1000000 (1963), NASA-ACIC, LAC 56. [8] Shevchenko V.V. et al. (1993), *Sol. Syst. Res.* , *27*, 16-30. [9] Shevchenko V.V. et al. (2003), *Sol. Syst. Res.*, *37*, 198-219. [10] Morris R.V. (1978), *Proc.LPSC IX*, 2287-2297.