HYDROXYL IN LUNAR PYROCLASTIC DEPOSITS: RESULTS OF NEUTRON SPECTRSCOPY AND NIR REFLECTANCE SPECTROSCOPY.
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Introduction: Lunar pyroclastic deposits (LPDs) are regions dominated by basaltic material and glass ejected by volcanic eruptions [1]. Two LPDs, Gay-Lussac N and Gay-Lussac NE, are located about 150 km north of the crater Copernicus [2]. In the recent analysis in [3] relying on neutron spectroscopy measurements of the Lunar Exploration Neutron Detector (LEND) [4], a suppressed neutron flux is described, among others, for these two LPDs, indicating the presence of hydroxyl (OH). In this study we provide a comparison with NIR hyperspectral data acquired by the Moon Mineralogy Mapper (M³) [5] instrument.

Neutron Spectroscopy: To estimate the epithermal neutron flux the following equation for the suppression factor δ is used [6]: $\delta = (N_{\mathrm{ref}} - N_{\mathrm{ex}})/N_{\mathrm{ref}}$, where N_{ref} is the average count rate of the omnidirectional sensor (SETN) [7] of LEND for a reference area, and N_{ex} is the average count rate for the studied area (Gay-Lussac LPDs). The first reference area is located in a mare region north of the crater Gay-Lussac, the second area is placed in the highlands slightly to the south [3]. The following results were obtained (cf. also [3]):

	Gay-Lussac N	Gay-Lussac NE
latitude [°]	14.9	14.8
longitude [°]	-20.7	-18.4
δ [%]	2.9	5.3
std. error [%]	0.94 (3.1 σ)	0.95 (5.6 σ)

It is known that the epithermal neutron flux is inversely proportional to the hydrogen content in the studied regions. Thus, the measured positive suppression factors correspond to increased hydrogen content. This fact indicates the excess of hydrogen at up to 1 m depth, especially concerning the NE deposit. The typical statistical fluctuation of the δ value is 1-2% for the equatorial region; it means that depression of the neutron flux at the LPD regions is statistically significant.

Let us note that the neutron flux is smaller by about 18% in Cabeus crater in comparison with the surrounding regions, corresponding to a homogeneous hydrogen content of about 500 ppm [8]. If we make the first-order approximation of a proportionality between the depression of the neutron flux and the hydrogen content, the average hydrogen content at 1 m depth in the Gay-Lussac N and Gay-Lussac NE LPDs may be enriched by 80 and 150 ppm, respectively, in comparison with the surrounding regions.

NIR Reflectance Spectroscopy: Complementary to the LEND data, we have analysed the possible occurrence of OH in the LPDs based on spectral reflectance data acquired by the M³ instrument. OH in the lunar surface material is known to generate an absorption band at wavelengths beyond 2700 nm [9]. Relying on the M³ version V03 radiance data [10] and GLD100 topographic data [11], we have generated refined digital elevation models (DEMs) of high lateral resolution as well as topographically and photometrically corrected spectral reflectance data sets normalised to standard illumination and viewing geometry (30° incidence angle, 0° emission angle, 30° phase angle [12]). A detailed description of the applied processing chain (DEM construction, correction for thermal amission and topography, photometric correction) can be found in [13]. As a measure for the depth of the OH absorption band we used the reflectance ratio between M³ channels 77 (2657 nm) and 81 (2817 nm).

For a region of 2° by 2° around each of the two examined LPDs, Fig. 1 shows our refined DEM, the topographically corrected 1579 nm reflectance normalised to standard geometry, and the R_{2657} / R_{2817} spectral ratio. The pyroclastic material appears as dark areas in the reflectance images. Both examined LPDs exhibit positive anomalies of the OH absorption depth with respect to their surroundings. This behaviour indicates the presence of OH in the LPDs, which is consistent with the LEND results.

Conclusion: The two independent methods of neutron spectroscopy and NIR reflectance spectrospcopy consistently indicate the presence of OH in the Gay-Lussac N and NE LPDs at the surface and at up to 1 m depth.

References: [1] Gaddis et al., 2003 *Icarus* 161, 262-280; [2] Gustafson et al. (2012) *JGR* 117, E00H25; [3] Sinitsyn et al. (2013) *4th Moscow Solar System Symp.*, 4MS3-PS14; [4] Mitrofanov et al. (2010a) *Space Sci. Rev.* 150(1-4), 183-207; [5] Pieters et al. (2009) *Current Science* 96(4), 500–505; [6] Boynton et al. (2012) *JGR* 117, E00H33; [7] Litvak et al. (2012) *JGR* 117, E00H22; [8] Mitrofanov et al. (2010b) *Science* 330, 483-485; [9] Clark et al. (2010) *LPSC XXXXI*, abstract #1533; [10] http://pds-imaging.jpl.nasa.gov/volumes/m3.html; [11] Scholten et al. (2012) *JGR* 117, E00H17; [12] Pieters (1999) *Workshop on New Views of the Moon II*, abstract #8025; [13] Grumpe et al. (2013) *Adv. Space Res.*, in press.

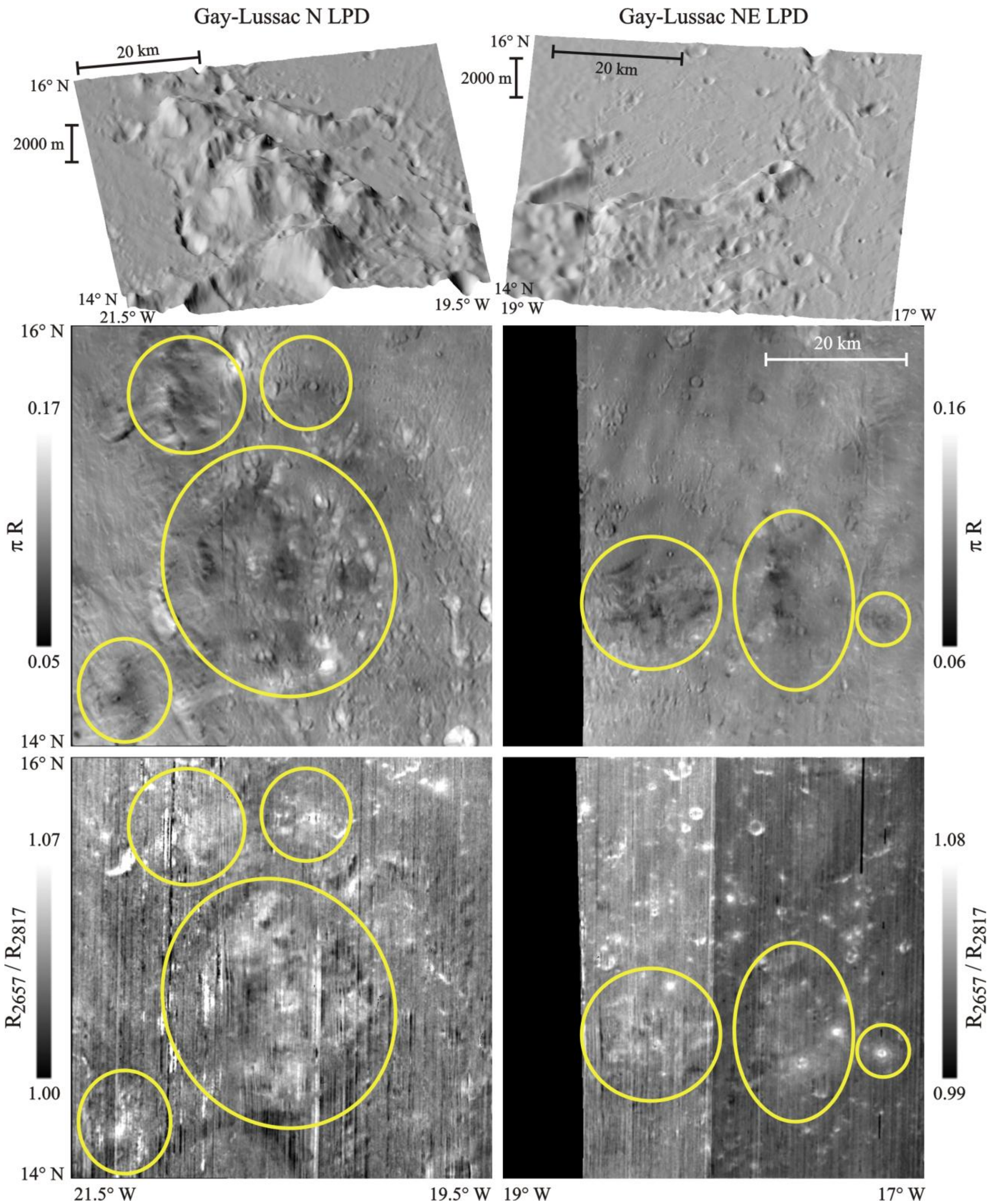

Figure 1: Gay-Lussac N and NE LPDs. First row: Constructed DEMs of high lateral resolution. The elevation axis is scaled by a factor of three. Second row: Thermally, topographically and photometrically corrected M³ reflectance at 1579 nm (this wavelength is outside the major spectral absorption bands). Third row: Spectral ratio R_{2657} / R_{2817}. The OH content is increasing with increasing R_{2657} / R_{2817} value. Yellow ellipses mark pyroclastic material.