

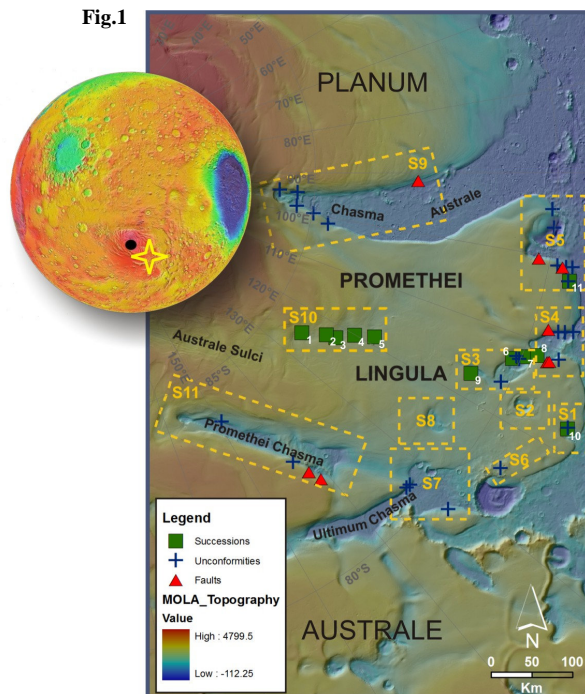
# **“UNCONFORMITY-BOUNDED” UNITS ON MARS SPLD (PROMETHEI LINGULA): A FIRST STEP TOWARDS FORMAL STRATIGRAPHIC CLASSIFICATION?**

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**Introduction:** Mars South Polar Layered Deposits (SPLD) geological history is spatially and temporally complex. SPLD have been affected by several depositional and erosional events, marked by different layered sequences usually bounded by regional unconformities. This “ice&dust body” has been analyzed by several authors in order to describe mayor layers successions defining different units [1,2,3,4,5]. Nevertheless, a formal stratigraphic classification has not been narrowed yet.

In order to define stratigraphic units regionally cartographable and correlable, several questions occur before: with available dataset, which layers characteristics may be choosed to make stratigraphy and, therefore, to define units? Are them regionally correlable? And if so, with which elements? Are layers cyclities recognizable? In other words, is it really possible a SPLD stratigraphic classification using the same criteria utilized for geological units on Earth? Answers are not presumed.

Fig.1



**Observations:** Starting from our previous work [6], in the present study we focus on the marginal erosional scarps and on the walls of low morphologies (chasmas and troughs) of Promethei Lingula region, between 80°-85° S Lat and 90°-150° E Long (Fig.1,

Sites S1÷S11, Sections 1÷11). For visual observations we used HRSC and THEMIS Vis plus several high-resolution CTX, MOC NA and HiRISE images. The elevations of surfaces are calculated from MOLA 512 pix/deg grid topography. Visual images will be completed with SHallow RADar subsurface data.

Several problems arise during images observations: the presence of a shallow mantling deposit and the different lighting conditions of scarps during image acquisition (defined by Sun Azimuth and Incidence Angle) affect layers and discontinuities exposures. In some cases local topography creates shadows that modifies the apparent albedo. In other cases the image orientation respect to the local topography and/or to the bedding attitude creates apparent discontinuities. Due to data gaps, detailed informations on grain-size and depositional textures are not available, and due to their similar “ice&dust” nature, layers distinction using lithologic definitions is not possible.

Therefore SPLD mapping and stratigraphy analysis is based on three elements, indirectly linked with layers properties, mainly with their dust/ice content and/or with their competence: 1)Albedo (light or dark toned layer); 2)Shallow morphology and erosional pattern; 3)Thickness (for measurements layers regional dip has been supposed sub-horizontal and not interested by regional tectonic deformations. Faults are visible only at local scale [7], Fig. 1).

At present, the total observed succession thickness is around 1400 m. Type sections are generally characterized by two successions (Fig. 2, Section 11 as example), divided by a quite clear erosional surface (unconformity - Red dotted line in Fig. 3), showing a: 1)“Ridge&Trough Morphology” [8] (underlied succession - RTM): alternation of dark toned (trough shaped) and light toned (ridge shaped) thin layers (metrical thickness - Fig.2a) sometimes spaced out by homogeneous layers ridge shaped (decametrical thickness) showing shallow pitted erosional pattern and/or notched edges. Average observed thickness: about 400 m - 600 m; 2)“Stair Stepped Morphology” [8] (upper succession - SSM): layers/layers blocks (decametrical thickness) with benched morphology, showing shallow pitted erosional pattern and notched edges. Average observed thickness: about 100 m - 300 m.

*Erosional surfaces.* Several unconformities (Aun), some dubious, have been detected on about 20 sections

so far (blue crosses in Fig.1), between 1300 m±2500 m in MOLA height. A particular example is the unconformity (locally angular) between RTM and SSM successions (Aun2 in Fig.4 → Upper yellow dotted line, S3, Section 6). AUn2 seems to have a low dip direction towards the Lingula margin (East) and it is located at the average quote of about 1800 m.

**Discussion:** We can define a preliminary informal classification of stratigraphic units, as it follows (e.g. Fig.3): 1) *Stratigraphic units (major order)*. Lower (U1: Ridge&Trough Morfology) and Upper (U2: Stair Stepped Morfology). Regionally cartographicable, divided by regional unconformity Aun2 (red dashed lines in figure); 2) *Stratigraphic sub-units (minor order)*. Layers blocks showing similar characteristics and/or cyclicity (green dashed lines in figure). Lateral variability (i.e. lateral pinch-out); 3) *Stratigraphic base units*. Layers or minor order layers blocks within stratigraphic sub-units supposed as linked to the same depositional event (blue dashed lines in figure).

The following step would be the formalization of these units. For this purpose regional correlation between major units are ongoing comparing different stratigraphic logs along several cross profiles. To do it we are trying to use discontinuities or key surfaces (e.g. erosional discontinuities or depositional marker beds) with time-stratigraphic significance. In particular Aun2 unconformity shows the sufficient regional continuity to be choosed as a possible temporal marker. Another one (Auc1), lower, is not yet certain as regional and it is under evaluation. If confirmed, this methodology could be referred to the “Unconformity-Bounded” stratigraphic formal classification (i.e. Allostratigraphy) used on Earth [9,10].

**Conclusions:** At present (Fig.5) we hypothesize for PL region two main depositional events at least (U1 and U2) interrupted by one main erosional event

(marked by Auc2). Future visual images analysis and the extension of the study area to other polar regions will allow us to find further erosional/depositional events and to better understand geological history of SPLD. Subsurface ShaRAD's data will be helpful to complete this picture. Our final goal is to relate defined units to possible periodic climatic changes (Cyclostratigraphy). To do it we have choosen to try a FFT spectral analysis of stratigraphic records, already used on Earth and in different martian areas by several authors [11,12,13,14]. In our opinion, this analytical technique could be a valuable support to the visual correlation between SPLD's logs.

**References:** [1] S.M. Milkovich et al. (2009) *JGR*, 114, E03002, 10.1029/2008JE003162. [2] S.M.Milkovich and J.J. Plaut (2008) *JGR*, 113, E06007, 10.1029/2007JE002987. [3] S.M. Milkovich et al. (2008) *LPSC XXXI*, Abstract #1466. [4] S. Byrne et A.B. Ivanov (2004) *JGR*, 109, E11001, 10.1029/2004JE002267. [5] E.J. Kolb and L. Tanaka (2006) *Mars*, 2, 10.1555/mars.2006.0001. [6] L. Guallini et al. (2009) *LPSC XL*, Abstract #1602. [7] L. Guallini et al. (2010) *LPSC XL*, this issue. [8] M.C. Malin and K.S. Edgett (2001) *JGR*, 106, E10, 2000JE001455. [9] K.H. Chang (1975) *Geol. Soc. of America Bull.*, 86, 10.1130/0016-7606(1975)86<1544:USU>2.0.CO;2. [10] Intern. Subcomm. on Stratigr. Classification (A. Salvador Chairman) (1987), *Geol. Soc. of America Bull.*, 98, 10.1130/0016-7606(1987)98<232:USU>2.0.CO;2. [11] J. Laskar et al. (2002) *Nature*, 419, 375-377. [12] S.M. Milkovich and J.W. Head (2005) *JGR*, 110, E01005, 10.1029/2004JE002349. [13] S.M. Milkovich et al. (2007) *PSS*, 56, 266-288, 10.1016/j.pss.2007.08.004. [14] K.W. Lewis et al. (2008) *Science*, 322, 1532, 10.1126/science.1161870.

**Fig.2-2a-3.** “Type Section”. Site 5, Section 11 – (2,3) CTX P1\_005222\_1021 (7.5 m/pix), (2a) HiRISE PSP\_004721\_1000 (0.25 m/pix); **Fig.4.** Regional unconformity Aun2. Site 3, Section 6; **Fig.5.** Schematic time-diagram of PLD depositional/erosional events – HRSC DEM (3x v.e.).

