SEDIMENTARY AND PALEOCLIMATIC RESEARCH ON THE PROMETHEI BASIN IN THE SOUTH POLAR CAP OF MARS.

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INTRODUCTION:

Impact cratering is one of the most important planetary geological processes in the forming of relief in terrestrial planets. On Mars, many impact craters and basins are probable candidates for sedimentary basins.

Impacts form an uplifted rim as well as a lower basin, creating this way a suitable area for the study of sedimentary processes. Even on *Viking* imagery, a number of eroded sedimentary series have been identified on the craters of Mars' highlands.

Promethei Basin, a half crescentic depression at the border of Planum Australe, is probably the best example of a Martian sediment trap, since its 900 km wide original impact basin could harbor sedimentary layers several kilometres deep.

Fig. 1: Geological map of the Promethei Basin. Amazonian sediments appear in white and blue (Apl, Api), those with Hesperian age in pink (Hdu), medium brown (Hdl), and purple (Hr). Finally, Npl1 (in yellow) and Promethei Rupes (dark brown) are Noachian units. [9]

This basin has been selected because it is located in an area with some specific characteristics which may yield relevant conclusions on the geological and climatic history of Mars. It possesses a most complete geological history as it contains layers whose ages range from Noachian to Amazonian. (Fig. 1)

These sediments come mainly from Chasma Australe, which was carved in Amazonian times [1] providing us therefore with an insight into the recent geological history. The basin was also filled through channels coming from the western edge of Dorsa Argentea [7], with sediments which possibly contain older rock succession. (Fig. 2)

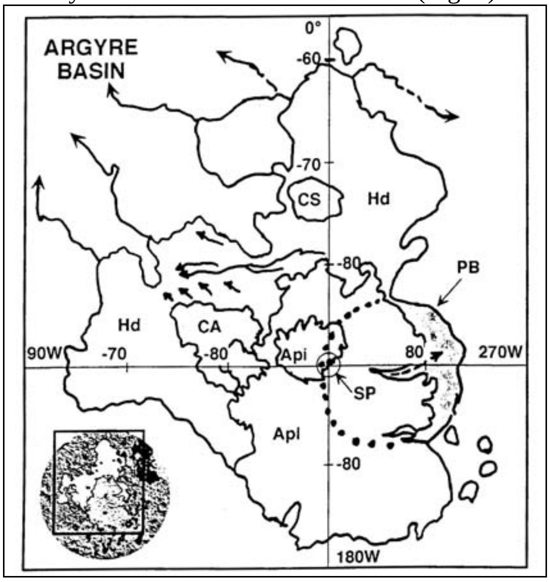

Fig. 2: Sketch map showing the location of the channels leading from the western edge of the Dorsa Argentea Formation to the surrounding lowlands and into the Argyre Basin. The distribution of Api, Apl, Hd, and HNu and features associated with the south polar deposits are also shown. SP, south pole; PB, Prometheus Basin; dotted line shows extension under polar cap; dashed line shows Chasma Australe; CA, Cavi Angusti; CS, Cavi Sisyphi; arrows within Hd are Dorsa Argentea esker-like ridges, and arrows outside Hd are channels interpreted to be draining Hd. [7]

The Promethei Basin is located close to the south pole of Mars (75º-85º South and 45º-135ºEast). Fishbaugh and Head [3] follow hypotheses according to which Mars' climate changes from cold and wet to colder and dry could be due to changes in the planet's obliquity. If this has been the case, then, the most outstanding climate changes would have taken place simultaneously in both polar caps, and therefore it should be possible to find evidence of these changes in the sedimentary record of both hemispheres.

If this however proved not to be the case, other possible causes for the climatic change can be proposed [3]. Among them, we should mention local subcap volcanic eruptions, a higher geothermal heat flux in the past, a much thicker cap, outgassing of volatiles and/or variations in solar luminosity, polar wander, cap compositional differences, and, finally, frictional heating due to basal sliding.

After a first analysis, using *Themis* context images, we have concluded that the basin fill has taken place through fluvial-alluvial, glacial, aeolian and gravitational processes. The alternation of alluvial and glacial sediments should be an indication of Mars climatic changes because these deposits are formed in very different environmental contexts. At present, it is highly improbable that water liquid can flow over the Mars surface, because in case that it happened, it would directly sublimate, due to the low atmospheric pressure. Nevertheless, the presence of fluvial deposits an paleochannels proves that liquid melting water did flow through this area.

EVOLUTION OF THE SEDIMENTARY FILL AT PROMETHEI BASIN

In this note, a preliminary geomorphological map based in Themis context images is presented. It includes the main morphological features and sedimentary units of paleoclimatological interest. Subsequent research will improve this preliminary map.

From the base to the top of the sequence (figure 3), we find:

1. Recessional front moraines, shaped as sinuous strings. They overlie the cratered terrain outside the basin as well. They record the first great glaciation, and the biggest one of which we have evidence. These materials are the most cratered, and therefore the oldest sediments in this area.
2. Alluvial deposits. They are also highly cratered, but most of them (and therefore also the bigger ones) are eroded. We have found braided drainage networks, which are visible in at least one place near the basin rim.
3. Sheet-flow deposits. These deposits are characterized by the lack of big craters. We have found in this area, near the mouth of Chasma Australe, an exhumed relief including ridges with the same direction as unit 1. Although this terrain is not the only one that contains pedestal craters, this morphology appears frequently.

4. Base of slope deposits. This unit is composed by materials very similar to unit 2, with most of the bigger craters eroded. In this area we have found both gravitational slope deposits as well as fluvial processes as gullies
5. Frontal moraines unit. Similar to 1, though it drapes all but the youngest terrains. It covers units 2,3 and 4.
6. Alluvial fans.
7. Upper glacial unit. It unconformable overlies units 1 and 5, and is in turn overlain by the PLD. Here we have found esker structures.
8. Polar Layered Deposits (PLD). They are very young deposits, since they do present very few craters. Here, we find several deep valleys or chasmata, the deepest and biggest of them being Chasma Australe. It is interesting to note that we haven’t found any trace of sedimentary remains near its mouth.
9. Barkhanoid dunes present on the bottom of chasmas. We consider them to be recent formations, as they cover all other materials.

Altogether, the sedimentary fill bears the trace of at least four glacier advances and recessions. Further geomorphologic analyses will surely bring to light an even more complicated palaeoclimatic history.

PENDING QUESTIONS:

- Where are the sediments eroded from Chasma Australe? Even supposing that most PLD materials were ices, one would expect to find well-defined deposits draping the mouth of the chasma, from which at least $30 \cdot 10^6$ km^3 have been eroded.
- Why eskers are limited to only a small part of the basin?
- To discuss the range of transport mechanisms of Chasma Australe and the other re-entrants.
- Has there been only one glacial period which formed moraines in all the Basin areas, even outside the basin? Or have there been two glacial periods, one at older terrains and another glacial advance on more recent terrains?

PENDING TASKS:

- To use HRSC images to improve the mapping of the geomorphologic units. For instance,
  - To clear the relations between fluvial and glacier processes at the number 7 area [see map]
  - To study in detail the possible dendritic network at area 2.
  - To delve in the apparent tectonic control of the deposits inside the craters outside Promethei Basin included at unit 4.
  - To study in detail the minor re-entrants at unit impact 5.
  - To map the different alluvial sediment units.
  - To analyse the Dorsa Argentea erosive network [7]

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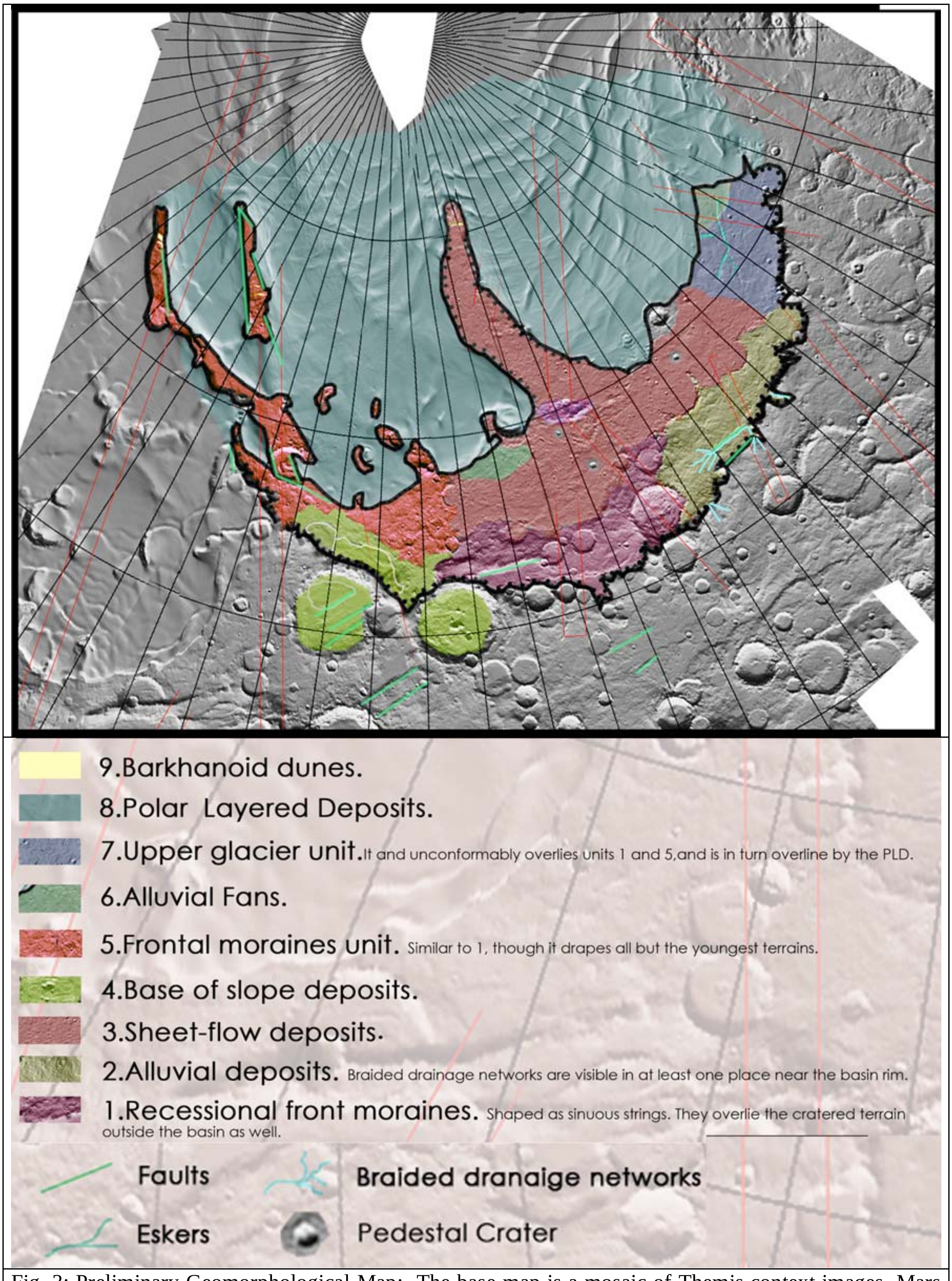

Fig. 3: Preliminary Geomorphological Map: The base map is a mosaic of Themis context images, Mars Odyssey Mission.