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Geological map of the Echus Chasma region (Mars) by using HRSC (MEX) data

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Abstract. The aim of this work is to realize a preliminary geological map of the Echus Chasma region of Mars (Fig. 1) to better understand the geological history of the area. The mapping work was performed using the HRSC data and other high-resolution images from previous Martian missions. The detailed mapping allowed to distinguish different geological and geomorphological units and to hypothesize the temporal succession of the principal geologic events that have characterized the region of Echus Chasma.

Key words. Mars – Echus Chasma – sapping valleys – geological map – drainage pattern – water – layered deposits

1. Introduction

The Echus Chasma trough extends in the north-south direction for about 1000 km between Lunae Planum and the Tharsis volcanic rise and its northern part is connected to the outflow channel system of Kasei Valles. Although Echus Chasma is not directly connected to other Chasmata of the Valles Marineris systems, the trend of the southern part of the canyon, and the geometrical relationships with neighbouring Hebes Chasma, suggesting a common origin for all these structures (Lucchitta et al. (1992)).The presence in the region of well-developed, water-related morphologies like dendritic drainage systems (surficial runoff) and sapping valleys (ground water flows) makes this area particularly interesting from a geological and geomorphological point of view.

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2. Methodology

In order to realize the geological map we have utilized the HRSC dataset processed in order to obtain high-resolution images (12,5 m/pixel) and DTMs (Digital Terrain Models). THEMIS data from the 2001 Odyssey mission and MOC images from the Mars Global Surveyor mission are also used to better characterize the observed morphologies.

3. Description of main geological units

1. Top Layered Deposits Unit

The plateau surrounding Echus Chasma appear to be formed by layered rocks. We recognize at least eight main stratifications (Fig. 2). These rocks of uncertain origin appear to be eroded, and totally disappear in the western part of the plateau. Here, the presence

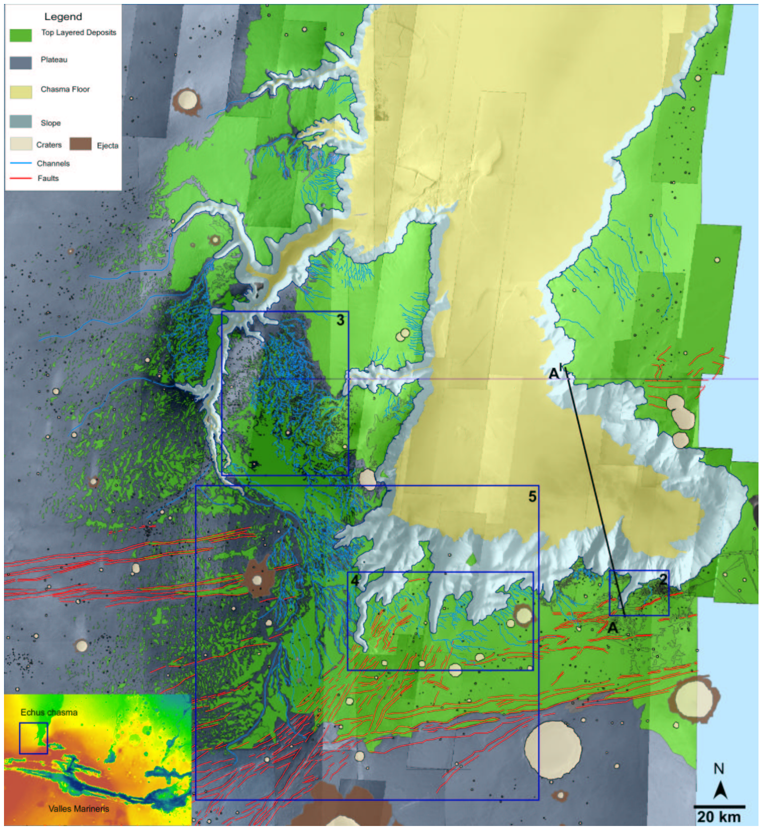

Fig. 1. Geological map of the Echus Chasma region.

of some inverted stream morphologies indicate that probably eolian processes have had a predominant role in the erosion of this unit (Mangold et al. (2004)).

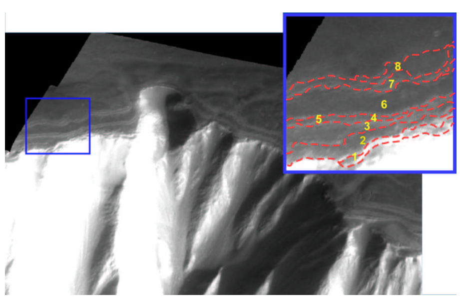

Fig. 2. Layered deposits.

2. Chasma Floor Deposits Unit

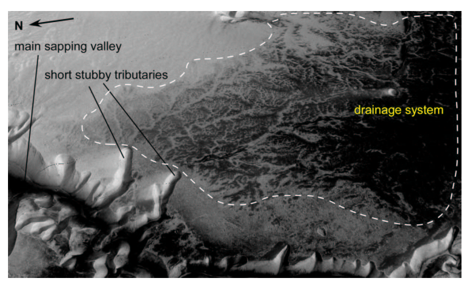

Fig. 3. Sapping valley and drainage systems.

The internal part of the Echus Chasma trough appear as a flat and smooth plain. This fact suggests that Echus Chasma had a different geological evolution with respect to other chasmata (i.e.neighbouring Hebes), which appear filled by thick sequences of layered and chaotic material. The chasma floor onlap the

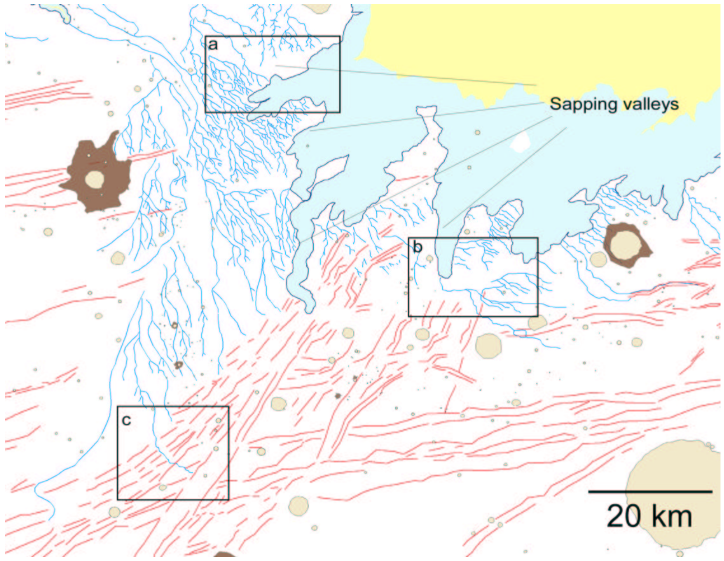

Fig. 5. Particular of the geological map of Fig.1. a) channels cut by sapping valley b) channels connected by valley head c) channels that cut faults

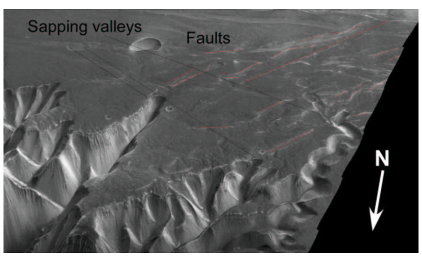

Fig. 4. Structural control of the sapping valley formation.

chasma walls and then postdates this unit. A more detailed mapping of this Unit is work in progress.

Geomorphological features

1) Channels

Several sinuous channels etch the Top Layered Deposits Unit, especially westward of Echus Chasma. In this area they form a drainage system similar to those that form on Earth by surface runoff: this is suggested by the high degree of branching of the drainage systems (Fig. 3). The floor of the channels is filled by sand dunes.

2) Sapping valleys

A system of depressions (0,5 - 2,5 km deep) are connected to the chasma walls and dissect the plateau toward south and west. These valleys show several characteristics resembling those of terrestrial sapping valleys, such as: i) theather valley heads, ii) short stubby tributaries, and iii) a structural control of the valley allignment (Fig. 3, Fig. 4). These characteristics, then, are in agreement with a sapping origin for these depressions (Carr (1996)).

Structural features

Two series of shallow grabens dissect the portion of the plateau occurring southward of Echus Chasma. The main directions of the faults are W-E and SW-NE.

4. Stratigraphical relationships

1. Channels / Sapping Valleys

Interesting relationships exist between the channels and the sapping valleys. Some channels are connected with a few valley heads (like some terrestrial examples) (Fig. 5b) while other are cutted by the valleys (Fig. 5a). Those relationships show that the channels were active both before and after the development of the sapping valleys.

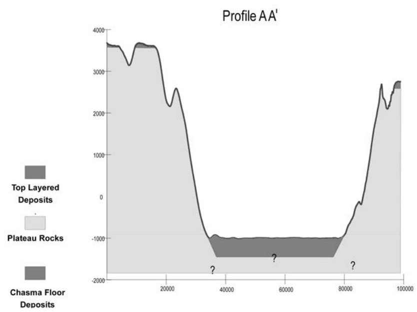

Fig. 6. Geological profile of Echus Chasma.

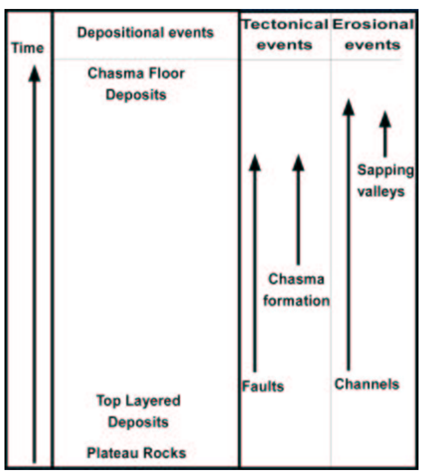

Fig. 7. Temporal succession of main geological events of Echus Chasma region.

2. Channels / Faults System

Channels occurring in the plateau southward to Echus Chasma cut the structural features (Fig. 5c). In other regions, instead, the channels follow the faults alignment. These relationships show that both channels and faults have formed in the same time period.

3. Channels / Top Layered deposits

Because channels are carved on the Top Layered Deposit Unit, channels are older (or at least contemporaneous) than the Top Layered Deposit Unit.

4. Faults System / Sapping Valleys

The sapping valleys which cut the southwestern part of the plateau are aligned with the main direction of the faults system (Fig. 4). This indicates that the development of the valleys postdates the structural features and that the underground flows responsible for the sapping processes are affected by the presence of the fractures.

5. Chasma Floor Deposits Unit / Other Units

Chasma Floor Deposits are the youngest unit of the region as shown by the lack of any erosional and tectonical features on its surface.

5. Conclusions

On the basis of the detailed geological mapping and the reconstruction of the stratigraphical relationships it is possible to draw a preliminary diagram (Fig. 7) of the geological evolution showing the time-sequence of events that occurred in the Echus Chasma region. The diagram shows that in this area the presence of liquid water for a long time period is necessary to explain the observed geologic units. In fact, the high degree of branching of the drainage systems and the presence of sapping valleys imply a large amount of liquid water flowing for a long time period. This occurred both above and under the martian surface. Further stratigraphical analyses and surface-age determination by means of crater counting method are necessary to interpret the origin of the water and to better constrain geological and geomorphological units.

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