Interior Layered Deposits in the Eastern Valles Marineris and Chaotic Terrains on Mars

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Introduction

Interior Layered Deposits (ILDs) are widespread throughout the whole Valles Marineris. They have been known and analysed for many decades but their origin remains uncertain. There are several hypotheses concerning the origin of ILDs (eolian [1] or lacustrine deposition [2], pyroclastic volcanism in subaerial [3,4,5,6] or sub glacial environments [7,8]). They all imply that the ILDs are younger than the troughs in which they formed. Contrary ILDs may also be ancient deposits exhumed due to uplift of the basement [9,10].
We concentrate on ILDs in the eastern Valles Marineris and chaotic terrains and analyse their elevation, thickness, stratigraphic position, competence, state of alteration, and mineralogical composition.

Overview

The ILDs occur at different elevations from -6000 up to -800m but always lie below the surrounding plateau rim. In contrast to ILDs in the Eastern Valles Marineris (e.g. Candor, Hebes and Ophir Chasma) that reach or even overlap the canyon rim with elevations from ~ -5000 up to ~3500 m.
ILDs vary in morphology. Mostly they appear as light-toned layered outcrops. In Gangis Chasma there are isolated mounds of light-toned material. One ILD in the research area differs from the others in morphology and elevation. It is comparable to that of Hebes Chasma and shows light and dark layering with a flat top and steep slopes. Aram and Aureum Chaos show ILDs with cap rock material.
Further ILDs are eroded into yardangs and often show surface structures that may be eolian. There are some fan-like morphologies and heavily fractured and rugged surfaces in Aurorae Chaos that indicate flow directions from the north (in contrast to the flow direction inferred from Juventae Chasma). Flow-like structures embaying mounds of chaotic terrain are also observed in Iani Chaos.
Sometimes there is a distinct layering within an ILD e.g. Iani Chaos so each layer can be mapped (Fig. 1a). At least ten layers are distinguished.
Some ILDs show layering in the lower parts and massive material with higher thickness in the upper parts (Fig. 2).
The thickness of the ILDs is smaller in areas without enclosing basins due to erosion.
Most ILDs occur at an elevation of about -4000m. Changing thicknesses may be caused by erosion.

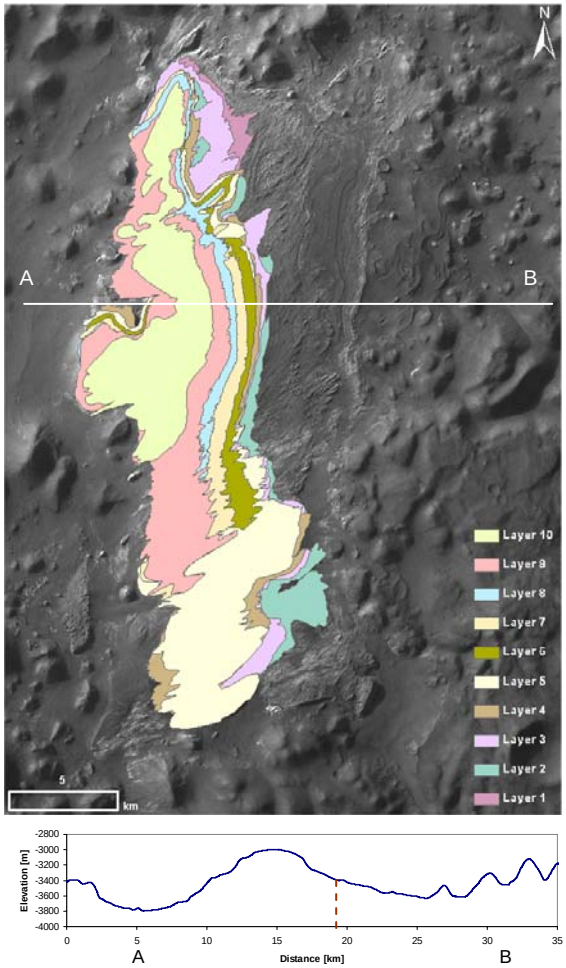

Fig. 1a: Iani Chaos. Mapping of different layers within an ILD on HRSC orthoimage. Fig. 1b: Cross section WE. Dashed line: change in dipping direction.

A classification of the surface structure into at least two types is possible:
1.: coarse, massive surfaces
2.: fine surface and appearance as cap rock.
Type 1 is found in Gangis Chasma as well as in Iani Chaos (at -4700 to -3200m) and Type 2 in Aureum, Aram and Iani Chaos (at -4300 to -3000m).

Mineralogy

In Iani and Aram Chaos, hematite and sulfates were detected by TES [11] and OMEGA [12] as well as polyhydrated sulfates in Capri Chasma [12]. Sulfates point on aquatic conditions since they form by hydrothermal alteration of volcanic material or evaporation under decreasing water availability.

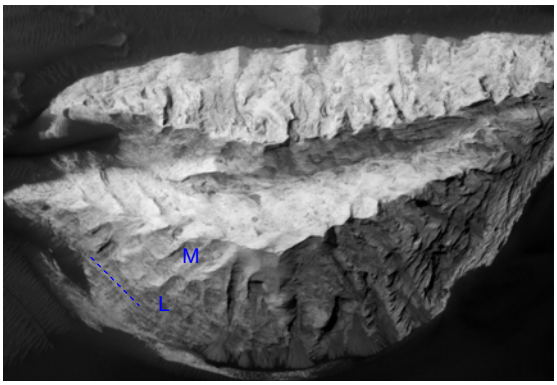

Fig. 2: Southern block of a dissected ILD in Gangis Chasma (MOC image). M: massive upper part, L: layered lower part, dashed line: trend of layering

Layer Geometry

Measurements with ORION structural analysis software on HRSC DTMs (50m/px) with corresponding orthoimages from HRSC-data indicate horizontal to sub horizontal layering at an ILD in Iani Chaos (Fig. 3). The layers dip with up to ~9° (horizontal) to western directions (wall slope ~15°). In the eastern part of this ILD, the dips show changes in direction but not in angle (Fig. 4). This change is apparent in the topography too as the eastern part of this ILD is flatter (Fig. 1b) indicating a post-depositional tilting of the layers.

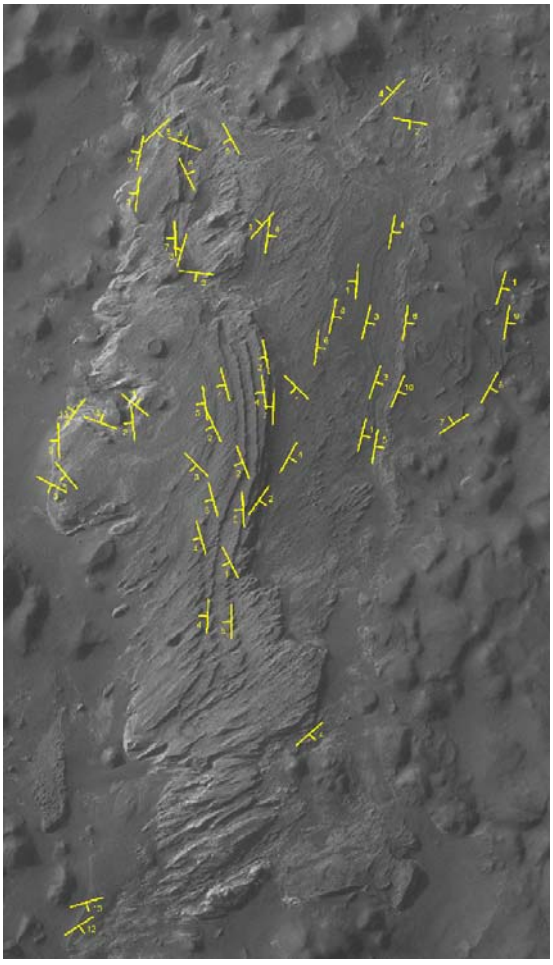
Fig. 3: Iani Chaos - Strike and dip measurements.

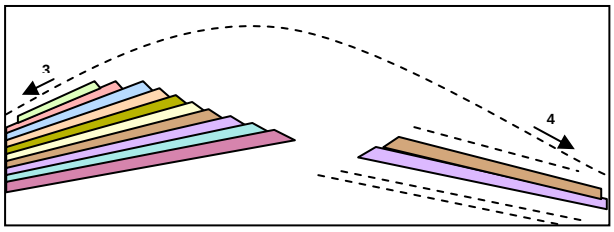

Fig. 4: Scheme of possible layering in Iani Chaos ILD (Fig. 1, 3). The dashed line above suggests the topography. The arrows display the dip of the layers (Fig. 3). The thickness of the layers is unknown.

Interpretation

We consider that the ILDs originated under lacustrine conditions, because of their internal layering and their topographic position below the plateau rim. In addition, changes in mineralogy of the ILDs – as observed by OMEGA and TES - may be explained by episodic shifts of water availability.

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