

TIMING CONSTRAINTS OF INTERIOR LAYERED DEPOSIT EMPLACEMENT IN VALLES MARINERIS

C. Quantin¹, N. Mangold², E. Hauber³, J. Flahaut¹, L. Le Deit², F. Fueten,⁴ T. Zegers⁵ and ISSI international Team on ILD

¹Laboratoire des Sciences de la Terre, UMR CNRS 5570, Université Claude Bernard, 2 rue Raphaël Dubois, 696222 Villeurbanne Cedex, France, ²Laboratoire de Planétologie et Géodynamique UMR 6112, CNRS, Université de Nantes, 2 chemin de la Houssinière, 44322 Nantes, France. ³Institute of Planetary Research, German Aerospace Center (DLR), Rutherfordstr. 2, 12489 Berlin, Germany. ⁴Department of Earth Sciences, Brock University, St. Catharines, Ontario, Canada . ⁵Faculty of Geosciences, Utrecht University, Utrecht, The Netherlands. quantin@univ-lyon1.fr

Introduction: The discovery of layered deposits on Mars in Valles Marineris by Mariner 9 in the 1970, marked the beginning of sedimentological studies on Mars. The Martian grand canyon is partly filled by thick and central layered deposits called Interior Layered Deposits (ILD). Recent instruments (OMEGA and CRISM) brought mineralogical clues revealing sulfates rich deposits [1, 2]. Several hypotheses for their origin have been proposed, like lacustrine or eolian sediments [3,4], pyroclastic deposits [5,6,7], subglacial deposits [8] or spring deposits [9], or pre-Valles Marineris exhumed sediments [10]. In these hypotheses, the age is a crucial question. For some authors, the deposits predate the basaltic plateau of Valles Marineris and have been exhumed during the opening of the canyon [10]. For others, the deposits emplaced after or during the formation of Valles Marineris [4, 11, 12, 13]. In the present study, we investigated in different Chasmata of Valles Marineris the contact of the base and the top of ILD with the surrounding material such as the wallrocks and we performed crater counts on the top of ILD when possible. Landslides covering the deposits can also be used to retrieve a minimum age of ILD by counting craters.

Basal stratigraphic contact of ILD :

The base of the ILD is often hard to observe despite the high resolution coverage. The main reason is the presence of sand dunes, boulders or debris aprons that cover the foothill of the ILD and canyon walls. However, we observe the base of the light-toned layered deposits at different places.

We observe that the ILD are on the top of canyon floors in 2 canyons forming the head of outflow channels : Juventae Chasma and Capri Chasma. In these 2 canyons, the ILD sequence definitively overlaps the chaotic buttes forming the typical floor of outflow channels. This observation suggests an emplacement of the ILD after the outflow channels formation.

In the central canyons of Valles Marineris like Melas Chasma, the contact between ILD and the lava flows forming the walls of Valles Marineris is observed at ILD perched high on the walls of Valles Marineris [14]. There, high-resolution images display the thin light-toned layers lying unconformably above the

suite of 10s m thick basaltic lava flows of the wall rock. The contact has been mapped at different elevations between -566 and +71 m suggesting that the ILD are draping the walls.

ILDs which occur in chaotic terrains (e.g. Aram Chaos) and in large craters (e.g. Gale crater) equally show stratigraphic relationships indicating that the ILD formed late in the geological sequence of events. In Chaotic terrains deposition of light toned layered deposits post-date the fracturing event forming the chaotic terrain.

Top of ILD:

The ILD are impacted by large craters that give a minimum age of 3-3.5 Gy. These impacts date the formation of the erosion of the ILD. This conclusion from crater count is comforted by the relative stratigraphy of the ILD mesa with Valles Marineris landslides. Some landslides overlap the flanks of ILD mesa like in Ganguis Chasma or in Melas Chasma. These landslides have been dated by [15] and are more than 3 Gy years old.

Conclusions:

Gathering all these observations, the ILD of Valles Marineris should have formed after the canyon formation or at least after proto-canyons formation. However, their formation ended very early in the canyon history and their erosion into mesa ended at around 3-3.5 Gy.

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