

KARST LANDFORMS IN NORTHERN SINUS MERIDIANI, MARS. D. Baioni¹, M. Sgavetti¹, F.C. Wezel²
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Introduction

Sinus Meridiani is part of the large area known as Terra Meridiani, located near the southwestern margin of Arabia Terra, in the equatorial region of Mars. In this area several studies showed evidence of past aqueous activity preserved in several distinct units that were identified and classified as layered deposits with monohydrated and polyhydrated sulfate spectral signatures [1]. Further studies on spectral analyses defined and mapped several distinct stratigraphic units in which exposure of hydrate sulfates and Fe/Mg smectites were recognized [2].

In this work we investigate the area in the northern region of Sinus Meridiani located between 1°N to 2°N latitude and 3°W to 1°E longitude (Figure 1), where laterally extended, almost horizontal morphologic surfaces are exposed on top of distinct stratigraphic units of overall Noachian-lower Hesperian ages [3]. We studied in great detail the various units by analyzing MRO HiRISE images, and in particular: a) we focused our analysis on morphologies that appear to be comparable with landforms observed in terrestrial karst terrains; b) we investigated the possible processes involved in their formation and shaping; and c) we evaluated the persistency in lateral distribution of these morphologies. We suggest a possible significant contribution of karst processes in the formation of the morphologies observed in the study area, as they lack evidence of wind action and do not display erosional features that would be associated with the evolution of impact craters.

The aim was to provide a detailed description of surfaces characterized by a well defined, distinct degree and type of possible karstification. Ongoing work is addressed to evaluate the possibility that these surfaces can be used as geomorphic markers with local, relative chronostratigraphic significance in the northern Sinus Meridiani area.

Karst-like morphologies

Different levels and kinds of apparent karstification characterize the units. The possible karst features include dolines and collapse dolines of polygenetic origin, which can be observed throughout the whole study area. These features are inferred to be related to solutional and corrosional processes, comparable to those commonly occurring in high mountain karst regions on Earth. However similar features have also been recorded in other regions of Mars [4].

According to shape, size and distribution of the karst features, three morphologic units can be identified (Figure 2):

Morpho-unit 1: here dolines occur both scattered and isolated and have an elongate rounded shape. They are often located along alignments and are connected by channels that in some cases display a sinuous trend, resembling the thermokarst landscape that can be found on Earth.

Morpho-unit 2: here dolines are bowl-shaped or rounded, or with an elongate shape with a wide top and a narrow bottom. Generally they have diameters up to 20 m, display asymmetrical walls and have concave-up or flat floor geometry. These landforms strongly resemble similar terrestrial features, displaying close morphological similarities with dolines that develop in all kinds of evaporite karst terrains, including morphologies formed by pure solutional processes and by sheet wash water flow during ice melt.

Morpho-unit 3: here bowl or rounded shaped dolines occur in tight clusters that form polygonal karst landscapes. Dolines display well defined shapes with sharp divides and have diameters that range from 30 m to more than 100 m. Viewed from above, these areas have an irregular “egg-box-like” topography and the divides between adjacent depressions form a cellular mesh pattern, as typically happens in evaporite terrains on Earth, where the inherently high solubility of evaporite rocks make densely-clustered depressions [5].

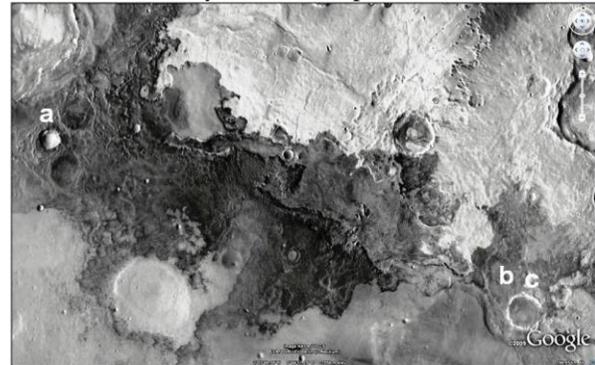


Figure 1. Study area in northern Sinus Meridiani; a, b, c.: locations of figure 2.

Image NASA/USGS/ESA/DLR/FU Berlin, taken from Google Mars.

Summary and conclusions

The detailed analysis carried out in this study suggests that:

- i) The landforms indicate the presence of solutional processes, inconsistent with other processes such as wind erosion, or with impact craters heavily eroded or reworked by geomorphic processes.

ii) In the study area, different evolution degrees of the karst-like features can be clearly distinguished, which we interpret as due to different solutational properties of the varied units (e.g.: mineral chemistry and concentration, and/or sedimentary texture and architecture), with important implications in the interpretation of the rock unit compositions and origin.

iii) Where these karst landforms, they would also suggest a response of the rocks to climatological change, requiring the presence of enough liquid water to form the observed landforms.

iv) The landform characteristics and their erosional age allow us to suppose that probably they have been affected by a single geologically short "cool-wet episode" during their history, with a first phase characterized by sufficient water available, probably occurring in the Amazonian period, followed by a dry climate period.

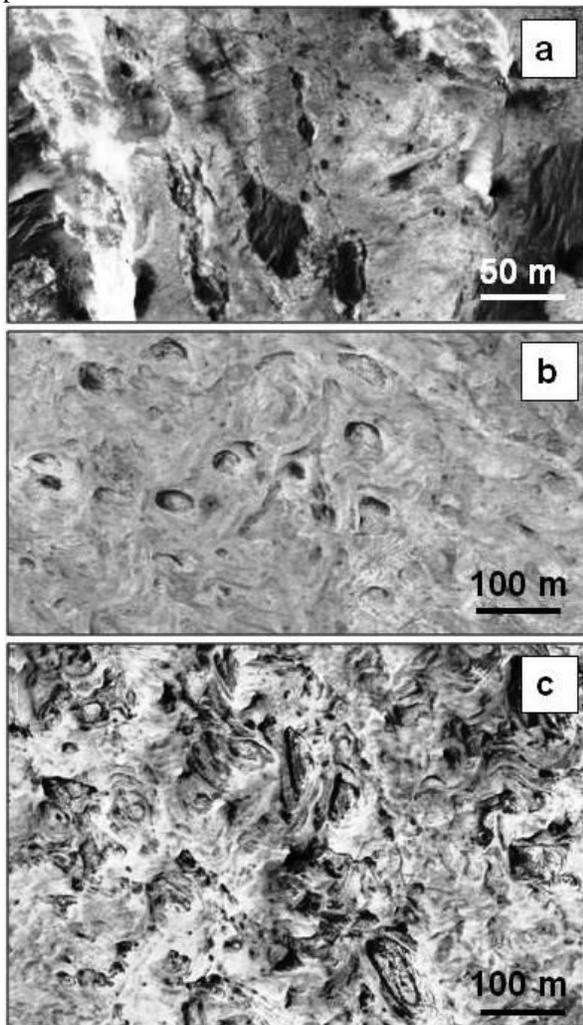


Figure 2. Morpho-units displaying different level and kinds of karstification; a) morpho-unit 1 (M.R.O. HiRISE ESP_011277_1825 north toward up); b) morpho-unit 2 (M.R.O. HiRISE PSP_010222_1815 north to-

ward up); c) morpho-unit 3 (M.R.O. HiRISE 010222_1815 north toward up).

References:

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