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Geomorphological assemblages in Arcadia Planitia: clues about a global scale event?

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Abstract

Mound-like features have been detected in the Arcadia Planitia region in the Northern hemisphere of Mars. Particularly, we investigated a surface covering ~100.000 Km^2 where three different landforms were observed. Due to their morphological characteristics and surface distribution we suggest that some of these mounds could be interpreted as water related features, such as mud volcanoes or spring vents.

1. Introduction

When unconsolidated materials are buried and confined in the subsurface in correspondence of a source of fluids, upwelling pulses occur when the buoyancy forces that push these sediment mixtures exceed the confining lithostatic pressure, such as in case of new fluid supply, increasing of pore pressures and a decrease of viscosity [1]. The northern lowlands are considered to have hosted large bodies of water in the Martian geological past that could have provided the conditions for deposition and storage of large quantities of sediments. Today these regions, and particularly Arcadia Planitia (centered at N47° E184°, ~4 Km below the mean elevation), show various assemblages of morphologies that could have recorded and contributed to these sediment and fluid resurgences [2].

2. Observations

The observations of the region of interest in central Arcadia Planitia were performed on 46 CTX (Context Camera onboard of Mars Reconnaissance Orbiter) images at 6 m/pixel resolution. Three different kinds of mound-like features were recognized according to morphological traits.

Low Light Features (LLF)
These features are the main constituent of the thumbprint terrain present in the area, consisting of circular mounds predominantly organized in the typical arcuate parallel chains. LLF are several hundred of meters in diameter and are defined by a bright albedo (compared to the surrounding plane), very low elevation, perimetral moats and swellings, rough surface and central pit surrounded by concentric ring-like features expressed as multiple apical incisions.

High Dark Features (HDF)
These mounds are rounded but irregular in shape, characterized by dark albedo, several kilometers wide and clearly elevated in respect of the surrounding plain, which trait is highlighted by blankets of debris covering the basal slopes. Their dark surfaces are rough and show one or multiple pits often recognizable in either apical or distal positions. HDF appear to be less densely distributed than the LLF in the study area. They are single or coalescent structures organized in clusters that can be associated in places to ghost crater rims, polygonal troughs and thumbprint terrain ridges.

Intermediate features between LLF and HDF can be also recognized in isolated contexts where LLF are superimposed to HDF either on apical or distal portions, or blended together alternating layers of light and dark materials showing mixed characteristics along ridges.

Circular Pitted Mounds (CPM)
Around 150 of these mounds have been detected within rim and floor of a degraded crater. Key traits are circular neat base, smooth surfaces, central pits surrounded by concentric ring-like features and multiple concentric crestal, distal and perimetral

incisions [3]. CPM are either single or coalescent structures organised in clusters or short alignments.

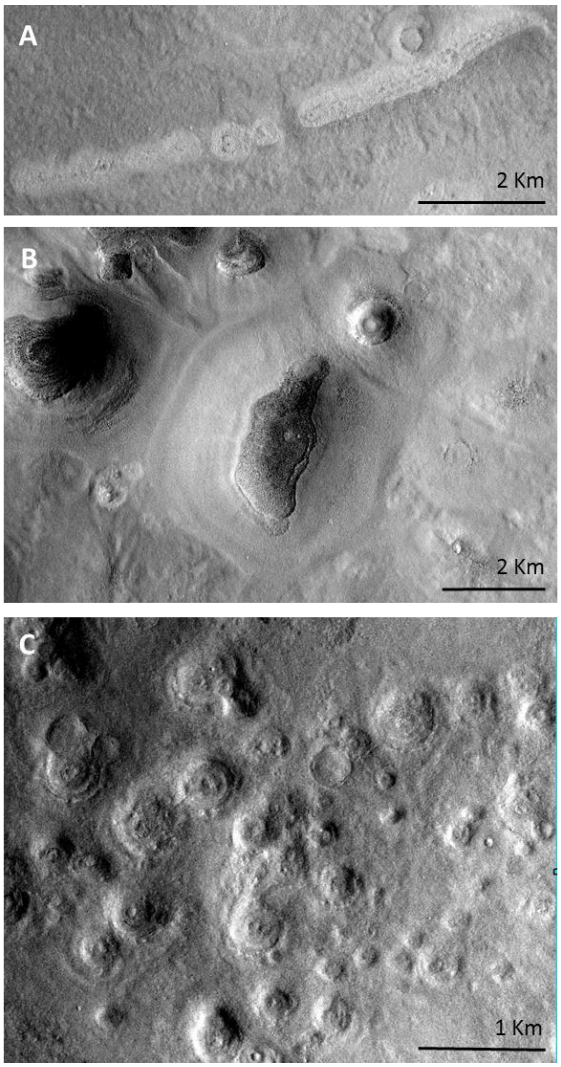

Figure 1: (a) chain of LLF; (b) cluster of HDF; (c) cluster of CPM.

3. Measurements and conclusions

Cluster and fractal analyses were performed on LLF and CPM to derive the thickness of the fractured medium that lays beneath the mound populations, which have acted as reservoir and pipeline for fluids and sediments [4]. The outcomes of this study mark a connection between these features and similar morphologies in the Northern Plains at comparable latitudes but on the opposite side of the planet, which are the surface expression of identical extents of networks of connected fractures and have been interpreted as mud-water resurgences [5]. Hence, such evidence suggests a putative common origin that could potentially be linked to a single triggering phenomenon that acted on global scale.

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