Characterizing the landscape of west Coogoon Valles and southeast Oxia Planum, Mars

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Abstract

We produced a geomorphological map of the area of western Coogoon Valles and southeast Oxia Planum to characterize its landscape. The highland unit, which corresponds to the Coogoon Valles region, is heavily cratered and dissected by valleys related to fluvial and probably sapping erosion. The basin unit, within Oxia Planum region, displays less cratered and relatively flat terrains. Here, sediment accumulation by unconfined flows from Coogoon Valles developed fan-shaped deposits with subdued distributary channels. We paid special attention to geometrical relationships among geomorphological units to obtain information on the relative chronology of the mapped landforms.

1. Introduction

Oxia Planum, in west Arabia Terra, Mars, has been recently chosen as the preferred landing site for the ESA's ExoMars 2020 rover due to evidence indicative of the presence of liquid water in the past, including widely reported phyllosilicate-rich layered deposits (e.g., [1][2][3][4][5]). This work characterizes the landscape of west Coogoon Valles and southeast Oxia Planum through the elaboration of a detailed geomorphological map (centered in 17.30ºN, 23.37ºW, Fig. 1).

2. Geomorphological map

Recently, a geologic map of the Coogoon Valles region was published by [6]. We have produced a geomorphological map covering an area of ~10,490 km^2, including western Coogoon Valles and southeast Oxia Planum (Fig. 1). It was elaborated in a GIS environment using an HRSC-derived DEM, a CTX panchromatic image mosaic (75 m/pixel and ~6 m/pixel, respectively), and THEMIS-derived thermal inertia images (100 m/pixel).

The study area is located astride two well-differentiated geomorphic domains: the highland and basin units. The highland unit (H, Fig. 1), which corresponds to the Coogoon Valles region, is mostly late Noachian in age [6]. It is heavily cratered and dissected by valleys related to fluvial and possibly sapping erosion. The NW-directed valley network (V unit, Fig. 1) is carved in this topographically higher unit. The basin unit (B, Fig. 1), within Oxia Planum region, shows less cratered and relatively flat terrains of late Hesperian age [6]. The mouth of Coogoon Valles is located on the southeast edge of the basin. Here, sediment accumulation by unconfined flows from Coogoon Valles developed a fan-shaped depositional unit (Fd unit, Fig. 1) with subdued distributary channels. There is another fan with a similar size to the south but apparently disconnected from the valley network. This fan was probably developed by the western branch of Coogoon Valles before its piracy, as suggests a sharp bend (elbow of capture) located close to the fanhead, or by a Noachian outflow channel as proposed by [6]. The largest crater, located in the NE corner of the mapped area, displays a fan-shaped deposit at the mouth of a valley carved into the crater rim, and a terrace-like depositional unit (Td unit, Fig. 1) at the foot of its northern escarpment.

The region shows numerous closed depressions that have been classified as impact craters (Cr unit, Fig. 1) and other uncertain-origin depressions (uD unit, Fig. 1). All the impact craters larger than 0.5 km in diameter were mapped. A significant number of craters are surrounded by deposits of fluidized ejecta (Ed unit, Fig. 1) that may indicate the presence of groundwater during the impact. The uncertain-origin depressions may display the following features: (1) elongated shapes that may be the result of the coalescence of adjoining depressions, (2) lack of spatially associated ejecta deposits, (3) occurrence of residual reliefs (Rr unit, Fig. 1) such as flat-topped mesas that may be dissected by channels, and (4) the presence of shadow valleys surrounding their margins that may indicate later fluvial activity [6]. These lines of evidence suggest that the depressions may have formed by sapping processes acting on previously filled coalescent craters, and/or by thermokarst or volcanic activity as indicated by [6]. In fact, in the southeastern part of the region, a scarp-edged upland shows theater-headed valleys possibly related to headward erosion by localized sapping processes. Eolian landforms (El unit, Fig. 1) mainly occur in low-lying areas such as impact craters, valleys and other depressions. These are dune fields mostly with parallel ridges. A dominant SE wind direction can be inferred from the bright streaks probably formed by

deposits that occur in the leeward edges of some crater rims. This indicates that dunes are dominantly of the transverse type since their crests are perpendicular to the wind direction. The region also shows morphostructural features such as wrinkle ridges with a dominant NW-SE direction. These linear landforms may correspond to tectonic structures such as faults, that have influenced the fluvial network.

We paid particular attention to geometrical relationships among geomorphological units (e.g., cross-cutting, inset, superposition) in order to obtain information on the relative chronology of the mapped landforms. The eolian deposits, which overlie the rest of the landforms, are the most recent landforms. The relative age of some impact craters can also be determined by onlapping relationships of their ejecta deposits. Fluidized and multilayered ejecta deposits released from the central impact crater of ~16 km in diameter have partially buried the fluvial valleys along tens of kilometers.

3. References

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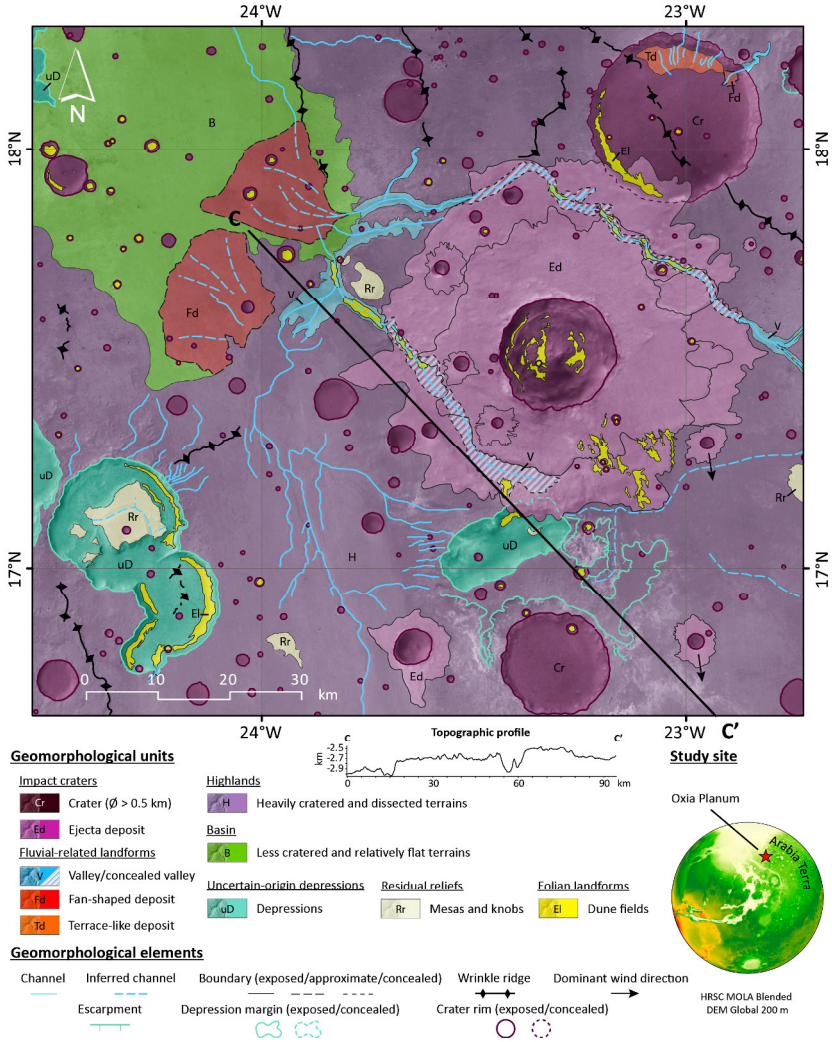

Figure 1. *Geomorphological map of W Coogoon Valles and SE Oxia Planum, superimposed on a subset of CTX image mosaic (Source of CTX mosaic: NASA/JPL/MSSS/Caltech Murray Lab/Esri).*