EPSC Abstracts
Vol. 12, EPSC2018-934, 2018
European Planetary Science Congress 2018

The Ancient Fluvial Catchment of the Candidate ExoMars 2020 Rover Landing Site in the Oxia Planum Basin

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1. Introduction

As part of an ongoing regional study, we present preliminary observations of catchments associated with the Oxia Planum ExoMars 2020 rover landing site in northwest Arabia Terra. With the primary goal of searching for signs of past and present life on Mars, the ExoMars rover will investigate the geochemical environment in the shallow subsurface over a nominal mission of 218 martian days (sols) [1]. To meet this ambitious mission goal, and for the results of the geochemical experiments to be meaningful, it is crucial to understand the context of the landing site as a whole, and to consider the geological processes that might affect the potential for the formation, concentration and preservation of biomarkers within strata exposed in the landing ellipse.

Here, we present the first stage of a study to characterise the Noachian to early Hesperian geological context of the Oxia Planum landing site.

Ancient fluvial systems fed into the Oxia landing site region from the southeast; we compare a hydrological model of the modern topography with geomorphological indicators of ancient fluvial activity such as channels, visible in remote sensing data. We use differences between the two to understand (1) the size of the Oxia Basin catchment which might have sourced potential biomarkers feeding the sediment fan identified within the landing ellipse, and (2) how the catchment may have changed though Martian history.

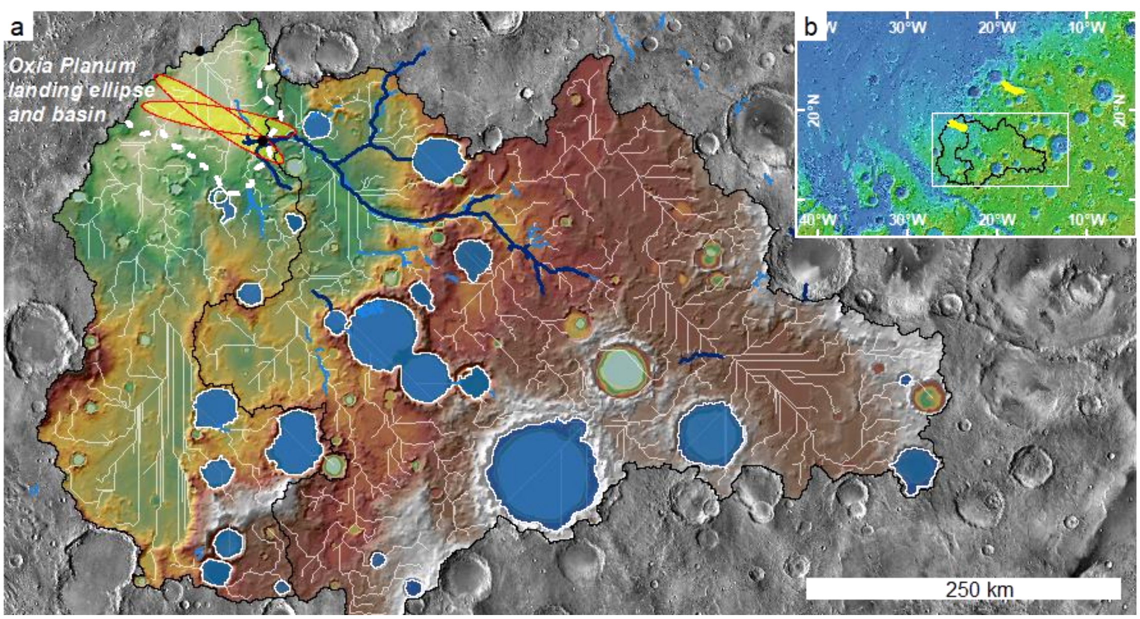

Figure 1: *Model catchments (black) flow accumulation paths (white) and impact craters with smooth sedimentary floors that fall below the elevation in the catchment that water should pond (blue areas) of the Oxia Planum basin. Overlain with the observed fluvial network from this study (light blue) and Hynek et al (2010): dark blue).*

2. Method

The model palaeo-watershed area and a drainage network map were calculated using the ArcMap 10.5 Spatial Analyst 'ArcHydro' toolset [2] and MOLA topography data. Ongoing geomorphological observations of fluvial features are being made using THEMIS, HRSC and CTX data, digitized on to a HRSC basemap at a scale of 1:50,000. The data were then visually compared to identify where the model flow accumulation agrees with, or deviates from, the geomorphological observations.

3. Observations

The model watershed and flow accumulation (Figure 1) shows that the Oxia Planum landing ellipse lies within an area with two contributing catchments. The larger, covering ~$1.5x10^5$ km^2 enters the Oxia Basin at the eastern end of the landing ellipse area and the smaller, of ~$0.6x10^5$ km^2, contributes flow to Oxia Basin from the south.

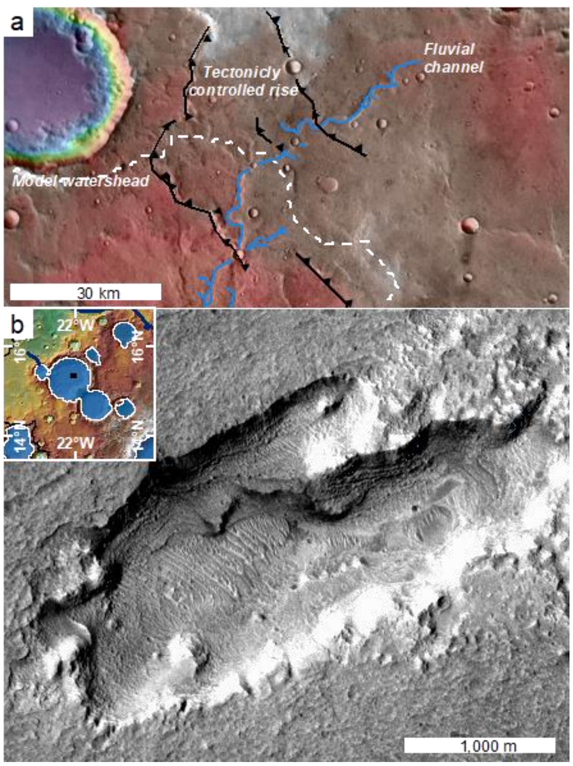

Figure 2: *(a) Fluvial channel uplifted by a wrinkle ridge crossing the model watershed and (b) a pit in the smooth floor of a possible crater lake showing layered sediments in CTX image B19_016961_1970_XN_17N022W.*

The model watershed is broadly representative of the observedchannel network and includes the large valley *Coogoon Valles* [3]. However, there is an important deviation to the north of Coogoon, where a channel crosses the model watershed (figure 2a). Here the topography has been affected by the formation of a wrinkle ridge, showing that regional tectonic activity postdates the observed fluvial network, and that the true catchment area for the Oxia basin is more extensive than the model suggests.

The model catchments include several basin forming craters (Figure 1), which are found below the elevations at which water should pond. None have previously been identified as candidate paleolakes because they do not have feeder channels. However, may have channel-like incisions in the interior walls. onlapped by smooth, layered crater floor deposits (Figure 2b). The lack of feeder channels may be ascribed to the crater's location on a topographic rise at the edge of the Oxia basin catchment but the possibility of ground water fed paleo lakes remains to be investigated.

4. Conclusions

Thus far our ongoing work shows that: (1) The Oxia basin has been fed by an extensive fluvial system with a minimum catchment area of ~$2.1x10^5$ km^2. (2) Tectonic activity postdates the formation of the fluvial network, consequently the catchment may be significant larger than the model value. (3) Several craters suggest there may be evidence for interior palaeolakes, although, being located on a topographic rise, they do not have feeder channels. It is likely they were sustained by ground water.

References

[1] Vago et al., Habitability on Early Mars and the Search for Biosignatures with the ExoMars Rover. Astrobiology, 17, 6-7, 471-510, 2017. [2] Esri, How Watershed Works, http://desktop.arcgis.com/en/arcmap/10.5/tools/spatial-analyst-toolbox/how-watershed-works.htm,2016. [3] Molina et al., Coogoon Valles, western Arabia Terra: Hydrological evolution of a complex Martian channel system, Icarus, 293, 27-44, 2017.