POLYGONAL TERRAINS ASSOCIATED TO CANDIDATE FLUVIAL-DERIVED DEPOSITS IN ARABIA TERRA. M. Mirino[1], M. Balme[1], P. Fawdon[1], P. Grindrod[2], [1]Walton Hall, Milton Keynes, United Kingdom, [2]Natural History Museum, London, United Kingdom (melissa.mirino@open.ac.uk).

Introduction: Numerous inverted fluvial channels have been identified in Late Noachian-Early Hesperian terrains within Arabia Terra [e.g. 1, 2, 3]. A well-studied example of inverted channel belt is Aram Dorsum [4] of which sub-units have shown a strong association with different types of decameter-scale, polygonally-patterned terrains [4]. These can have both negative (fractures) or positive relief (ridges) margins (more resistant to erosion), and can be classified based on polygon diameter and fracture width [4]. Aram Dorsum system contains polygons that present both a distinct spatial distribution and a consistent stratigraphic pattern. Furthermore, we have recently reported similar polygonal networks recognized in association to other inverted channels in Arabia Terra [5], proving that these type of features frequently develop within in fluvial-derived terrains. If the polygon-forming processes can be understood, these polygonal networks offer an opportunity for a deeper understanding of the processes involved in martian inverted channel development in this region.

To better understand the local or regional formation processes of the polygonal terrains and their dependence on inverted channels-related terrains, we performed two HiRISE-based (25 cm/pixel, [6]) studies in Arabia Terra. Firstly, we extended our preliminary regional survey observations (following [5]) and then we selected four inverted channel systems to explore the relationship between the polygonised terrains and various geological units within those inverted channels to evaluate if the patterns observed for Aram Dorsum are respected.

Method: A database of inverted channels systems in Arabia Terra [7] was compared with HiRISE image coverage using ArcGIS software. 241 HiRISE images were used for the identification of the polygonised terrains (observation-scale 1:2000). Observations were made for all inverted channels covered by at least one HiRISE image. To evaluate whether polygonal networks are present also in areas away from inverted channels (i.e., a 'control group'), 43 additional images, randomly selected at different distances from the mapped inverted channels, were also analysed. Then, four candidates for deeper analysis and mapping (Cantabras Dorsum, Arago Dorsa, Piscinas Serpentes and an un-named systems in proximity to Mawrth Vallis) were selected.

Polygonal types were classified based on width of fractures/ridges, margin relief type, and their lateral dimensions (polygon diameter).

Regional results: 61% of the analysed images present polygonal ground (e.g., Fig.1a) with size ranging between 2-50 m and fractures width between <1-7 m. We identified many other polygonal features in Arabia Terra associated with: (i) inverted channels' upper surfaces, flanks and material at the bottom of the ridges, (ii) valley floors, (iii) candidate alluvial fans, (iv) materials surrounding the ridges which may have been affected by water alteration or represent remains of floodplains. These distribution suggest that a link between polygon formation and water-deposited sediments (not necessarily limited to inverted channels) is possible and occurs at regional scale. This has been also confirmed by the control-group survey' where only a few polygons were found, but almost all of those were associated with fluvial valleys.

Deeper studies results: Many (20/25) irregular orthogonal fracturing styles (intersecting at 90° or 120°), and less frequent (5/25) rectangular patterns (intersecting at 90°) were identified. Ridged polygons are generally stratigraphically below or at the same level as the fracture polygons, and present similar trends, patterns and polygon diameters to proximal fractures. When at the same stratigraphical level, the ridges are observed to in-fill and transition into the fractures (e.g., Fig.1b). Comparing the spatial distribution of polygonal grounds for the four studied systems, reveals that each mapped unit generally presents a distinctive polygonal network, and fracture width and polygon size appear to scale positively with the units' thicknesses. Since polygons type appear connected to the different mapped sub-units, there is clearly some stratigraphical control of polygonal type.

However, when comparing the four sites with the stratigraphical pattern in Aram Dorsum [4], the studied systems present more variability and complexity. It is also clear that the stratigraphical pattern in the Aram Dorsum area is not respected within the newly mapped sites. The only system which present a strong similarity to Aram Dorsum in term of morphologies, thicknesses and development, and stratigraphical trend, is the closest system, Cantabras Dorsum, in Meridiani Planum.

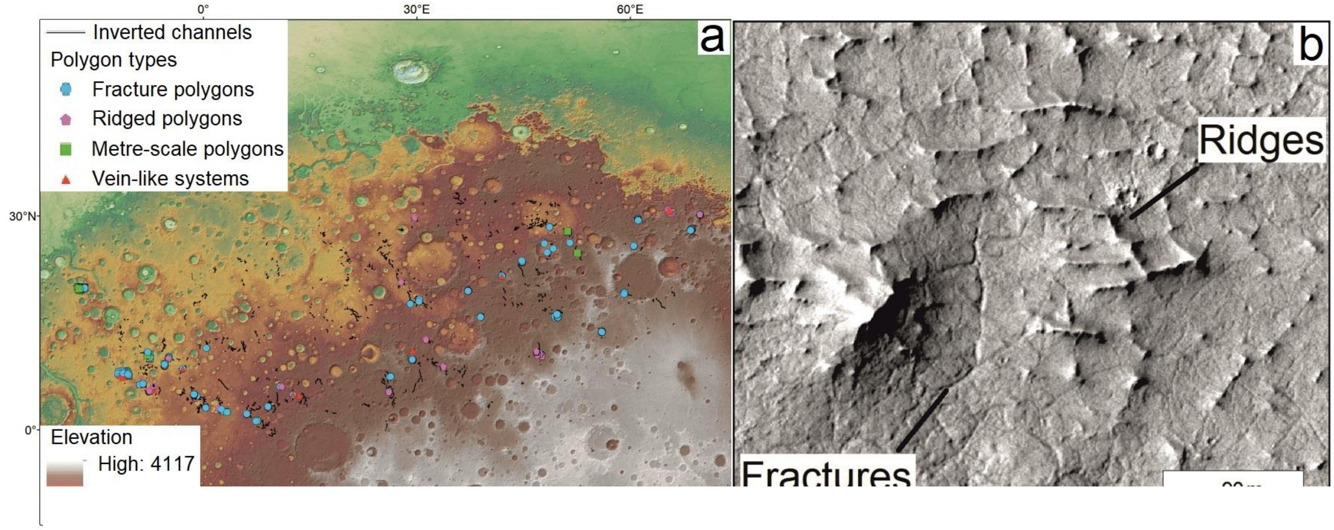

Figure 1:a-*Distribution of HiRISE-scale polygonal terrains linked with inverted channels in Arabia Terra. Basemap MOLA DEM. b-Example of ridges which transition into fractures as seen in a HiRISE image (ESP_034932_1900, centred at 9.94°N, 29.,32°E).*

Discussion and Interpretation: The identification of similar types of Aram Dorsum polygonal features in so many areas in Arabia Terra suggest that a common phenomenon acting regionally explains their formation and development within these fluvial deposits. The presence of irregular orthogonal fractures suggest that multiple events of fracturing propagation occurred [9], or the processes leading to these fracturing styles influenced some layers more than others. A strong correlation between the recognised polygonal networks and the units' thicknesses is present, as seen in terrestrial soils or bedrocks [e.g.,10,11]. Thus, the persistence of the spatial distribution, and a regional stratigraphical trend, suggest a connection with the physical proprieties of the inverted channel materials (for a fluvial origin probably mudstone, siltstone, sandstone) and their response to either (i) a regional stress, if the polygons formed underground as joints, or (ii) a surface process such as desiccation, thermal contraction or possibly a combination of the two.

Considering: (i) the presence of resistant ridged polygons and their infilling of fractures, (ii) the fractures persistent in 20-60 m of vertical thickness deposits cutting unit boundaries, (iii) evidence of exhumation of the inverted channels and (iv) the presence of similar polygonal networks in the region, we suggest a combination of un-loading due to erosion and sub-surface hydrofracturing caused by groundwater movements (with consequent mineral precipitation and formation of veins), are the most likely processes involved.

Conclusions: Many other HiRISE-scale polygonal terrains have been observed and mapped in and around inverted channels and other fluvial-related deposits in Arabia Terra, suggesting that fluvial facies are likely to be associated with this type of polygonised terrain. A general spatial-stratigraphical trend with ridges of the polygons filling fractured polygonal networks has been observed, but deeper studies show that polygonal morphology is strongly related with the lithology and the thickness of units. Thus while there is clearly an association between polygon morphology and unit type/position, the specific stratigraphic trend seen in Aram Dorsum [4], is not widely replicated in the other detailed studies.

Considering the widespread distribution of polygonal networks, we suggest that polygon formation in fluvial deposits occurred throughout the region. The wide spatial distribution of preserved positive relief polygonal (Fig. 1a) and positive networks (most likely veins formed by mineral precipitation) is in line with relatively deep, groundwater movements. Again, this seems likely to have occurred across the region.

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