ANALOG STUDIES OF ICE-WEDGE POLYGONS IN SVALBARD: 2011 FIELD CAMPAIGN, TOPOLOGY AND GEOMETRY. P. Pina[1], G. Vieira[2], H. H. Christiansen[3], M. T. Barata[4], M. Oliva[2], M. Neves[2], L. Bandeira[1], M. Lousada[1], M. Jorge[2], J. Saraiva[1,3], [1]CERENA/IST, Lisboa, Portugal; (ppina@ist.utl.pt), [2]CEG/IGOT, Lisboa, Portugal, [3]UNIS, Svalbard, Norway, [4]CGUC, Coimbra, Portugal.

Introduction: In the framework of project ANAPOLIS, ice-wedge polygons are being studied in detail in the Adventdalen, a coastal fluvial valley in the largest island of the Norwegian archipelago of Svalbard, above the arctic circle [1, 2]. The location can be seen in Figure 1. This collaboration effort between Portuguese and Norwegian teams aims at a substantial improvement in understanding polygonal networks on Mars, namely those related to periglacial activity, of which the Adventdalen examples can be seen as very close analogues.

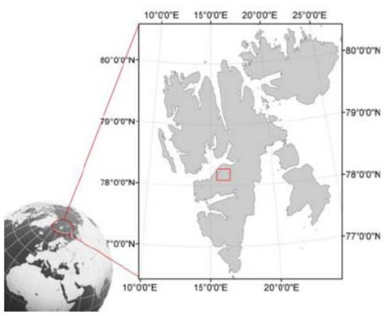

Figure 1: Location of Adventdalen in Svalbard

Fieldwork: Two lines of work have been followed in this study. First, remotely sensed images have been purchased from different operators (the Norwegian Polar Institute, NPI, and a private company, Kolibri GeoServices, which operates a small plane with attached off-the-shelf digital camera); these have been used as a guide for field work, to detect and correct situations where the images do not reveal the true extent and/or position of wedges and so establish a fully validated ground-truth, and as a test-bed for the application of an automated methodology for network delineation [3, 4] whose results can thus be confronted with the ground-truth. Other than this, a complete set of data has been collected for the whole extension of an accessible network, including precise GPS location, topography, geometry, soil sampling, depth of active layer and distribution of vegetation cover. This will allow for extensive correlation of factors that may explain the evolution of this polygonal terrain and highlight their relative influence in the creation of this type of landscape – and especially to determine which of those can provide relevant information when, as is the case with Mars or remote locations on Earth, all that is available to study them is remotely acquired imagery.

Geometry and topology: Our first focus is on the comparison of the geometry and topology of the network as determined by different means (aerial imagery and fieldwork). The reason for this is the need to extend the analysis to include all or most of the polygonal networks that exist in the Adventdalen, in order to understand what, if any, differences are there between them and what factors can contribute to explain those. To achieve that goal, we must have confidence in the delineation of the networks made either by hand or automatically (depending on the adaptation of the methodology to terrestrial instances); this validation demands a full comparison of the geometric and topologic characteristics determined for the network. Thus, the network was fully mapped by manual analysis of both sets of aerial images and by fieldwork (Figure 2).

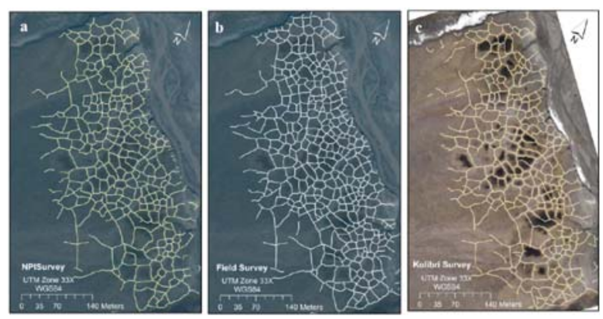

Figure 2: Comparison of network mapping from aerial imagery (left and right) and fieldwork (center).

The major influence on these characteristics is the failure to detect, on the images, the lines that correspond to separations between adjacent polygons (an example can be seen in Figure 3, top). This can be due to conditions related to the acquisition of the image, such as light and shadow or platform stability, but also to conditions in the terrain, such as water content and vegetation growth (these, of course, are not relevant to Mars). Spatial resolution can be another factor, especially in cases where line junctions (network vertexes) occur too close to one another, leading to erroneous counting of vertex valence (see Figure 3, bottom). It is important to assess how often these can occur and what confidence can we have in correcting them. For instance, the joining in one point of five lines seems a rare event on terrestrial ice-wedge networks, and there is no reason to think that it could be more common on Mars.

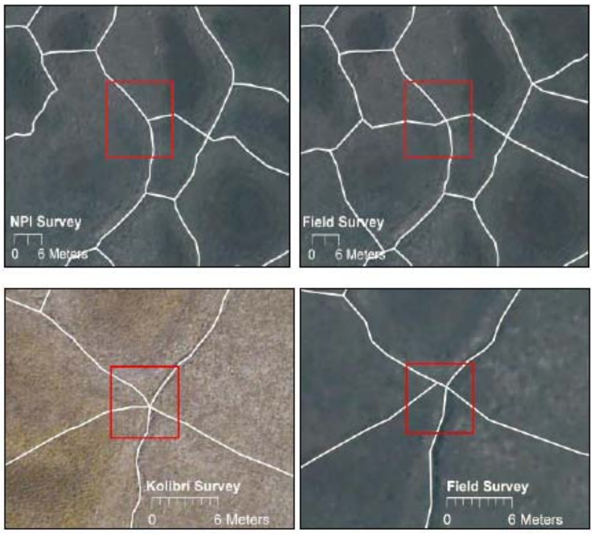

Figure 3: Typical errors that occur in hand delineation, and their corresponding field reality.

The average number of neighbors of a polygon determined for the three instances is, as expected, never very far from 6. This is a fact that has been demonstrated for many diverse types of natural networks, including Martian examples [5].

The distribution of polygon areas again reflects the existence of some lines that went undetected in the aerial images analysis, but were clearly identified in the field. Thus, some supposedly large polygons correspond in fact to a number of smaller ones, concentrating the area values in the lower reaches of the range (Figure 4). This is an issue that can be expected to affect the analysis of martian networks; when considering areas, one should keep in mind that a few very large polygons are probably not real and correspond to the spurious joining of many small ones.

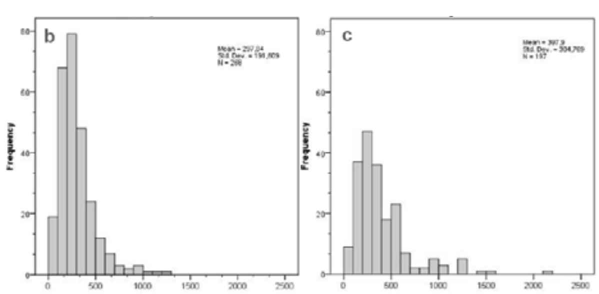

Figure 4: Distribution of polygon areas determined from the NPI images (right) and in the field (left).

Conclusions: The use of high spatial resolution images to analyze geometry and topology of polygonal networks is clearly possible, since it does not introduce any blatant errors in the computations. Thus, we plan to extend analysis to the full extension of the Adventdalen for which we have images from the NPI.

In the meantime, the several types of data collected will be used to create a detailed image of the polygonal network chosen for the full study. We expect to find correlations between terrain characteristics and the geometry and topology of this network that can point to clues to look for when analyzing images of Martian networks. This study is thus expected to contribute to a better understanding of the origin and evolution of this type of feature on the red planet.

References: [1] Pina P. et al (2010) *LPS XLI*, Abstract # 1372. [2] Pina P. et al (2011) *LPS XLII*, Abstract # 1387. [3] Pina P. et al (2008) *Planet. Space Sci.*, *56*, 1919-1924. [4] Bandeira L. et al (2010) *Patt. Recog. Lett.*, *31*, 1175-1183. [5] Saraiva J. et al (2009) *Phil. Mag. Lett.*, 89, 185-193.

Acknowledgments: This work is supported by FCT (Portugal) in the framework of project ANAPOLIS (PTDC/CTE-SPA/99041/2008). MO, LB, ML, MJ and JS acknowledge finantial support from FCT through BPD, BD and BI grants.