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Micro-relief and geometry of ice-wedge polygons in Adventdalen (Svalbard, Norway)

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Ice-wedge polygons mostly occur in flat areas, but they have also been found in slopes with gradients as high as 25°; in these cases, they are commonly elongated in the downward direction. However, even seemingly flat terrains exhibit small-scale topography; in this work, we conduct a detailed analysis of polygon shape in relation with micro-relief in a polygonal network in the Adventdalen valley, in Svalbard (Norway).

In the frame of the ANAPOLIS (Analysis of Polygonal Terrains on Mars based on Earth Analogues) project, we have made two field campaigns to fully characterize an extensive polygonal network (with an area circa 80x10^3 m^2) in this periglacial area in the Arctic (78° N). Included in this, a topographic survey was conducted with a GNSS-RTK geodetic system. X, y and z coordinates were collected in a grid, approximately every 5 meters along parallel lines separated by 10 meters. The central area of the network, comprising close to 150 polygons, was subject to an even more detailed coverage, with coordinates collected approximately 2 meters apart along the whole contour of each polygon, as well as in its center. A Digital Terrain Model (DTM) was interpolated from 8166 x, y, z points gathered in the two campaigns. The detailed central area, with 40000 $m^2$of polygonal terrain, was considered an ideal test field to study the geometry of the polygons and investigate its variations in relation with micro-topography.

The methodology employed consisted in determining the lengths of major and minor axes for the polygons in the test area, while the elevation of the terrain on both extremities of each axis was obtained from the DTM. From this, the rise or Vertical Distance (VD), the difference in elevation between two points, was calculated for the two axes of the polygons. The relation between length of axis and respective vertical distance was assessed: it shows that VD is generally greater for the major axis.

Eccentricity or elongation was calculated from the ratio between the major and minor axis of the envelopes (the minimum rectangular area that covers the polygon geometry) of the polygons, to evaluate if there is a correlation between the slope of the terrain and the elongation of polygons.

Preliminary results point to an existing relation between the orientation of the major axis of polygons and that of the slope of the terrain; in other words, the distribution of major axis orientations follows closely the distribution of slope gradients.