

# Geomorphometric analysis of patterned ground on Svalbard from High Resolution Stereo Camera (HRSC-AX) data: Analogue studies for Mars

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## 1 INTRODUCTION AND BACKGROUND

Because the landscape of Svalbard is under the influence of a dry and cold climate it is a good analogue for comparative Martian studies. The mean annual air temperature is about  $-5^{\circ}\text{C}$  at the sea level in central Svalbard and the mean annual precipitation is about 180 mm. One of the most widespread landforms within the periglacial landscapes of Svalbard are polygonal structures formed by thermal contraction cracking of the ground. Furthermore, stone circles and nets are particularly well developed on flat areas indicating cryoturbation (i.e. freeze-thaw cycles).

A variety of similar shaped surface features on Mars has been interpreted as periglacial in origin. The study of their characteristics, distribution and spatial associations would therefore allow conclusions on the climate history of Mars. Particularly, polygon patterns are well explored and used to infer the presence of permafrost on Mars.

Dedicated studies of terrestrial analogues, however, are required to obtain reference information needed to interpret remote sensing data of Mars. Successful analogue studies involve field investigations providing information about subsurface conditions and physical properties of periglacial structures. In addition, terrestrial remote sensing data are necessary that have a quality and scale comparable to that of planetary data.

## 2 DATA AND METHODS

Extremely high-resolution images and topographic information of periglacial landforms on Svalbard were acquired in summer 2008 with HRSC-AX an airborne version of the HRSC camera currently orbiting Mars. Color orthoimages (20 cm/pixel) and corresponding Digital Elevation Models (DEM) with a cell size of 50 cm and a vertical accuracy of 20 cm are available for a total of seven regions on Svalbard. HRSC-AX data from western and central Svalbard were used for quantitative terrain and remote sensing analyses.

In July/August 2009, a field campaign was conducted on Svalbard at two study areas. The main objectives were the description and analysis of periglacial landforms by measurements and observations of geomorphological characteristics, soil properties, and collection of soil samples. The observed parameters are used as ground truth dataset for the HRSC-AX measurements. One study area is situated on Kvadekusletta in western Svalbard. The site is renowned for its well-developed sorted stone circles. A second study area is the Adventdalen valley in central Svalbard. It offers a variety of periglacial landforms and particularly thermal contraction crack polygons in different settings.

## 3 FIRST RESULTS AND DISCUSSION

Stone circles, nets, and labyrinths were observed on Kvadehuksetta inside of comparably moist and shallow depressions dammed by beach ridges. Diameters are ranging from 0.5 m to 5 m. Raised rims (up to 50 cm high) consist of stones with diameters of a few centimeters. Sorted structures on Kvadehuksetta are always located in areas in which adequate water supply exists. Recently observed sorted circles on Mars show significant differences to the structures on Svalbard with respect to shape and dimension, and stone ring particle size. Maximum diameters of individual Martian stone circles range to 23 m and stones within the rings have diameters of 1 – 2 m.

Ice wedge polygons were analyzed on many flat and inclined surfaces in the Adventdalen. High center polygons in the upper valley appear inactive as frost cracking could not be observed. They have diameters of 10 – 20 m and are separated by well-developed wide and deep troughs. Various polygons on Mars share the characteristics of the high center polygons in the upper Adventdalen. HRSC-AX data have sufficient spatial and vertical resolution to enable the three-dimensional geomorphometric analysis of polygonally patterned ground and the interpretation of small-scale variation in periglacial environments.