Location and climate factors governing morphological features of ice wedge polygons in arctic zone

Abstract

This thesis reports the geometry of active soil and ice-wedge polygonal network located along the Canadian Arctic and in Alaska. This High Arctic periglacial environment was chosen to ensure active thermal-contraction cracking of permafrost in Holocene allowing comparison of observed ice-wedge polygons with existing climatic data. Geoinformatic software (Google Earth, ArcGIS) was used to obtain and digitalize satellite images of polygonal networks located around Eureka, Mould Bay, Churchill, Rankin Inlet, Inuvik, and Kotzebue.

Defined polygonal networks were statistically analyzed in order to define predominant environmental factors controlling morphological parameters of these polygonal networks. Polygon size (overall influence computed on the basis of coefficient of determination) is determined mostly by the duration of development (18 %), frequency of cyclonic passage (17.8 %) and winter air temperature (16.1 %). Conversely, polygon regularity results mainly from nature of the substrate (21.8 %), winter wind speed (15.1 %) and snow cover thickness (12.2 %). Dominant polygon elongation in the polygonal network follows closely the winter wind direction (3/4 of all networks) as the result of snow thickness redistribution. Polygon diameter decreases with age of polygonal network by 0,7 m per 1000 years. Moreover polygonal size varies for high and low-centred polygons.

Observed polygonal morphology differs significantly in High Arctic (ET in Köppen climate classification) and in subpolar climate region (Dfd); thus, offering new approach to paleoclimate reconstruction using relict polygonal structures of middle latitudes.

Keywords: arctic zone, thermal-contraction cracking, permafrost, polygonal network morphology, ice-wedge polygons, frost wedge, glacioisostatic rebound.