what the initial process for the lake formation was if not for the occasional discovery of the GEC-1.

Thus, the rate of thermal denudation measured in terms of area expansion: 1) inside the GEC ranged from 865 square meters per year in 2014-2015 to 2200 square meters in 2016; 1) on the adjacent lakeshore thermal denudation expanded by 1100 square meters per year in 2012-2015 and was as high as 2600 square meters in 2016. In both landforms higher rates were observed in the warmest 2016 and were rather similar. Lower rate for the GEC-1 at its initial stage is due to its steep slopes and narrow hole with little sunshine reaching lower parts of the hole.

Adjacent lake providing basis of erosion for both features expands towards the GEC-1 lake and outside into tundra by thermal denudation activity and determines formation of a new feature: merged lake with components having different origin.

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STUDY OF CRATERS ON THE YAMAL PENINSULA USING REMOTE SENSING DATA AND GROUND-BASED OBSERVATIONS

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The objective of the study is to determine geomorphic, landscape and cryolithologic properties of the sites surrounding 3 known Yamal craters. Then, based on landscape-key method, we analyzed the probability of craters existence in a given area. The work uses processing of high resolution images. The objective was reached through the development of Digital Elevation Models (DEMs) for 5 key areas and known craters. Thematic maps (geomorphologic, landscape units and tabular ground ice extent) were compiled using image interpretation, DEMs analysis, and specific identification code (legends). Combined use of satellite imagery and DEMs resulted in improved accuracy and

reliability of interpretation of landscape components and terrain geometry.

The DEMs are developed using the following elevation systems: 1) standard spheroid reference surface WGS84, and 2) geoid elevations EGM2008. During compilation of geomorphologic maps, we have identified a number of terrace shaped surfaces consisting of marine and shallow marine Quaternary sediments. Slope gradient and curvature layer served as a temporary derivative technological product. The results obtained from this exercise were also included in the structure of legends developed for the thematic maps. These legends take into account environmental factors that affect in our opinion the possibility of crater formation.

The inland water system (hydrographic network) mapped on the basis of the available satellite images is an important feature for landscape mapping and study of its genesis. We created a single hydrographic network layer, which was used in all thematic maps. The major water features, including lakes, medium and large rivers, have initially been identified automatically during classification of the satellite images and afterwards they were processed and updated manually.

A morphodynamic legend is developed to capture the landscape morphology, genesis, landforms and distribution of modern geomorphologic processes for the Geomorphologic map. Geodynamic zones are subdivided as Denudation, Transit, Accumulation and Human impact. Each geodynamic type of relief is characterized by different landforms and elements, as well as morphological and morphometric features.

A Landscape units map contains 19 units. They differ by drainage, surface geometry, dominating vegetation, dominating soils and additional properties, such as windblown sands, landslides, small drainage hollows not visible at map scale.

Depth of tabular ground ice table is mapped on the basis of the indicators and conclusions derived from earlier ground ice analysis conducted for the site to the north of the study area having similar landscape features and permafrost conditions. Based on our long-term observation data, abundant small lakes on slopes are evidences of active thermokarst, which in its turn indicates shallow tabular ice table. A depth range for tabular ground ice table has been defined for each landscape unit as per earlier developed classification 1-5 m, 5-10 m, >10 m.

We conclude from analysis of the maps and field observations that known craters are located on relatively gentle slopes, in shrubby tundra,

in clayey deposits, with ground ice close to the surface. These locations are considered the most dangerous in terms of the possibility of the craters formation.

Field data used in this study was obtained through the RSF grant 16-17-16-17-10203

GEOMORPHOLOGIC CONDITIONS OF THE ANTIPAYUTA GAS-EMISSION CRATER BASED ON REMOTE SENSING

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As a continuation of Yamal gas-emission craters research we started the study of the Antipayuta crater located in the western part of the Gydan Peninsula in the upper reaches of the Yuribey River (Kizyakov et al, 2017). Remote sensing is used to assess the geomorphological effect of crater formation. Digital elevation models are created based on processing of very-high spatial resolution stereo pairs both before and after the formation of the Antipayuta crater to characterize relief evolution. Stereo pairs closest to the time of the crater formation and available for ordering are acquired on August 21, 2013 and October 11, 2014.

As a result of photogrammetric processing of satellite stereo pairs DEMs have been produced with a 1-m grid pattern. The automated measurement of the x-parallax within sub-pixel accuracy allowed us to increase DEM accuracy, which we estimated as 0.35m for 2013 and 0.55m for 2014. In this regard, relief changes less than 0.9 m have not been analyzed, because they are within the DEMs accuracy. Under the present environmental conditions it is possible to conventionally equate the notions of digital surface model (DSM) and digital elevation model (DEM), since tundra vegetation of the key-site does not exceed 0.5 m.

The remnants of the third terrace, widely distributed within the study area, are significantly dissected by erosion-thermokarst processes. The crater is located on the terrace edge, bordering with the small flat-

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