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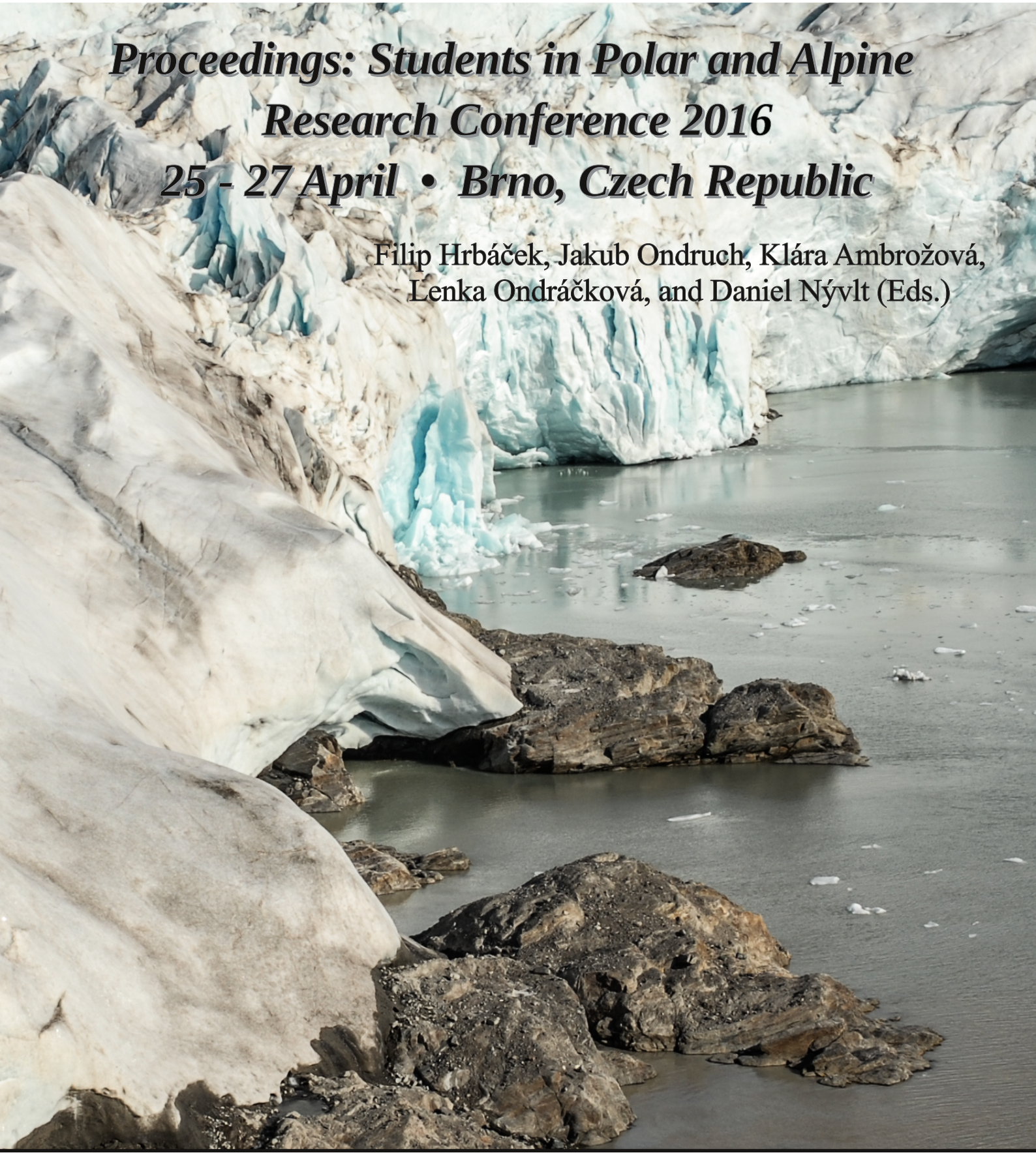
Filip Hrbáček, Jakub Ondruch, Klára Ambrožová,
Lenka Ondráčková, and Daniel Nývlt (Eds.)



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UNIVERSITAS MASARYKIANA BRUNENSIS

Students in Polar and Alpine Research Conference 2016 - Preface

Filip Hrbáček, Jakub Ondruch

Dear young polar scientists,

It is our pleasure to welcome you again on the ground of Department of Geography, Masaryk University, Brno, Czech Republic at the occasion of the second year of "Students in Polar and Alpine Research Conference 2016". Comparing to the first year in 2015, we decided to expand our interest by the Alpine environment. We suppose this step is logical, since there are a lot of similarities between these two unique environments and the conference should attract wider range of students and young researchers.

We are very glad that the interest of young students to participate in our conference has increased. We received 31 abstracts, including four key-note speakers, on various topics of geo- and biosciences, with 23 oral presentations and 8 posters. We believe that the interest of us, young researchers, in a cold environment will further grow and we will meet in Brno again in 2017.

In Brno 25 April, 2016
Filip Hrbáček and Jakub Ondruch

Proceedings
Students in Polar Research Conference

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Editors
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Abstracts in proceedings were not reviewed, authors are responsible for the content and formal validity of their contributions.

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Late Quaternary environments in the highest Iberian mountain ranges since the Last Glaciation

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Keywords: Iberian Peninsula, periglacial processes, mountain ranges

The Iberian Peninsula is located between the subtropical high pressure belt and the mid-latitude westerlies, and its climate is regulated by the seasonal shifts of these systems. The mountainous geography of Iberia, together with these synoptic climate patterns and the fact that most of these ranges are aligned east-west, determines a wide spectrum of topoclimatic regimes not only generally across the Iberian Peninsula, but also within individual mountain ranges (e.g. Mora, 2010). During the Last Glaciation glaciers in Iberia were confined to the high mountain ranges, never reaching the surrounding lowlands. By contrast, periglacial processes were very intense in the Iberian mountains near the glaciated domain. The lowest periglacial deposits and landforms in Iberia formed during this glacial stage with well-documented periglacial conditions in coastal environments of NW Iberia (Pérez-Alberti, 1988; Serrano et al., 2010) as well as in the inland Meseta. Deglaciation (Figure 1) resulted in increased minimum altitude of periglacial activity, with formerly glaciated areas being replaced by active periglacial processes during the paraglacial stage. The transition to the Holocene saw the reactivation and intensification of periglacial processes during the very cold and dry Younger Dryas when most of the rock glaciers inactive today in the highest mountain ranges were formed (Andrés et al., 2015). During the Holocene, the periglacial belt remained at the highest elevations of the Iberian mountains, shifting up or down the valley by hundreds of meters in altitude according to the combination of cold and moisture availability. In general, during colder periods periglacial processes were more intense and expanded to lower elevations whilst warmer stages restricted periglacial activity to higher areas. This alternation was last seen during the historical LIA cold phase and the subsequent period until the present when periglacial activity is weak to moderate in the highlands of the highest mountain ranges.

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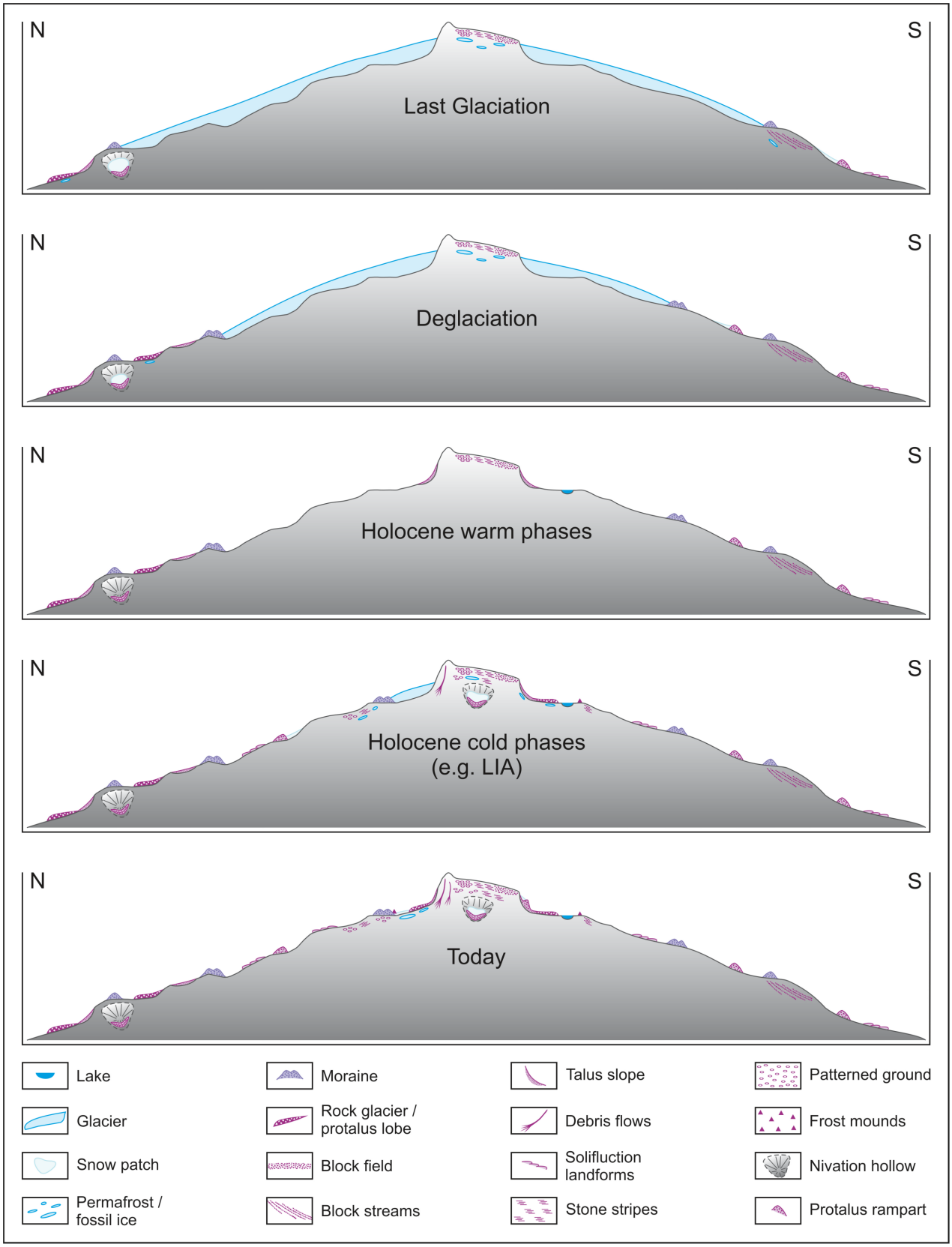

Figure 1 Summary of periglacial activity in Iberian Mountains since the Last Glaciation until nowadays.

Sediment budget in cold environments – Polish perspective – experiences from the Arctic and Antarctic

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Keywords: SEDIBUD, sediment budget, Svalbard, King George Island

In the changing environment it is of great importance to qualify and quantify processes driving sediments circulation and storage. Polar regions are thus crucial because of the intensity of climate changes influencing landscape diversity, rock weathering, water and sediments mobility in terms of energy balance and relief dynamics.

Sediment budget in cold environment studies are based on monitoring key-sites (catchments) that are located in areas of operation of permanent and temporal Polish stations in Svalbard (Spitsbergen – Hornsund, Kaffioyra, Petuniabukta) and King George Island, South Shetlands (Figure 1).

As for Spitsbergen sites, the following significant factors determining water and sediments circulation were pointed: (a) substantial seasonal diversification of energy inflow to the system, (b) limitation of water infiltration through impermeable bedrock and shallow permafrost table, and (c) occurrence of ice masses. During summer the discharge is mainly controlled by weather conditions, within which air temperature changes and their horizontal and vertical gradients play a crucial role. Precipitation, changing physical state with altitude, influences river regimes depending on sub-regional conditions; however, snow cover meltout is of very high importance at the ablation season beginning. When the temperature drops toward the end of the season, the amount of solids transportation decreases and reaches an untraceable level. It also significantly increases water mineralization. After few days of negative temperatures, the discharge volume is stabilized at the level of about 2% of summer ablation average and follows, in the case of gla-

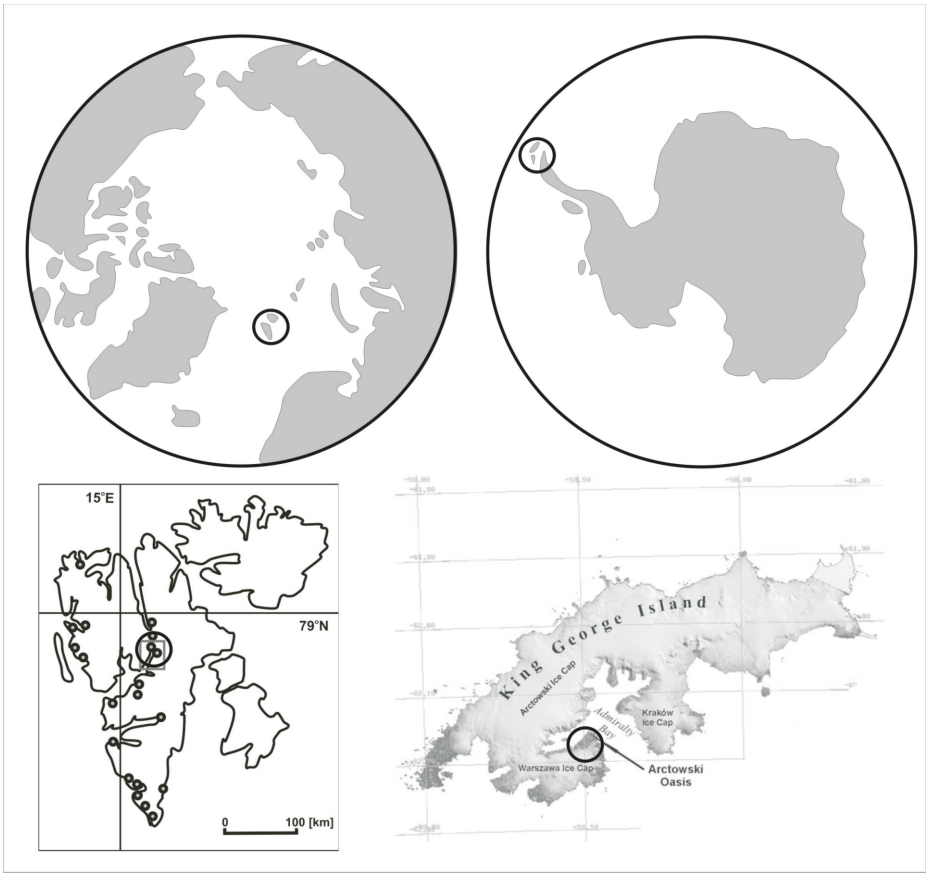

Figure 1 Study locations in Svalbard and King George Island.

ciers, pathways of deep circulation that may point to the existence of layers or areas of temperate ice. This type of circulation may be also alimented from non-glacier covered areas of catchments, where the main source of ions (hydrocarbon, calcium, and sulfatic) is a permafrost active layer or weathering processes within stream, which may also lead to significant CO_2 budget disturbances. The quality of water discharging from the catchment and the transported material reflect a distinct influence on the diversification of polar landscape in terms of relief dynamics, geology, and past and present glacier cover, as well as ongoing environment changes.

In the case of Antarctic glacier-covered catchments, every hydrological period is dominated by discharge of suspended sediments over the dissolved material, whereas the domination in the non-glacier covered catchments is reversed. The high activity of these processes is occurring during the mobile period (December-January), mainly by meltwater supply from snow and glacier thaw or groundwater storage with non-continuous occurrence of permafrost.

It is very clear that in terms of denudation rate, the dominance of glacierized catchments over non-glacierized catchments is mainly due to amounts of water discharge and the size of the catchments. Analysis of the runoff, ion and solid drainage from analysed catchments allowed to trace the sources of sediments and water supply as well as their tracks and circulation effects in catchment areas, and thus the system state. The size of sediments discharge into the coastal area of neighbouring fiords is a result of many factors, among which only few might be highlighted. Indicated regularities point at large variability depending on water supply and the availability of dissolved and solid sediment transport despite size differences. This represents a significant geodiversity of the analyzed catchment areas in a relatively small space. At the same time, a large variation in the intensity of denudation processes, in terms of time and spatial diversity in geoecosystems, suggests that deglacierized areas are in an early stage of formation, and thus may be considered an initial geosuccession.

The problem of environmental response is multidirectional because of temperature rise and changes in precipitation character which influences e.g. glaciers and snow coverage, permafrost condition and ground temperature, vegetation structure etc. as well as relations between these components.

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New approach to air temperature modelling in high latitudes

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Keywords: temperature modelling, non-linear regression, Svalbard

With polar amplification of ongoing climate change (Collins et al., 2013), it is likely that more human activities will be relocated to high latitudes. With respect to this assumption, natural hazards in polar regions, such as avalanches, should receive more attention. An avalanche prediction requires knowledge of a near-surface air temperature field (University Corporation for Atmospheric Research, 2010), which is, as a consequence of sparse observation networks, often calculated by linear regression with elevation as an independent variable. However, the eventual temperature field acquired by linear regression can be inaccurate in high-latitude areas due to frequent occurrence of air temperature inversions (Serreze et al., 1992).

In this contribution, a mathematical function for modelling of near-surface air temperature profiles in high latitudes is presented. The function is defined as follows:

$$y = \frac{a((bx + c)^4 + d(ex + f)^2)}{(gx + h)^4 + i} + j \quad (1)$$

where y would represent the estimated temperature, x would be elevation and a–j parameters to be obtained by non-linear regression. The model can be used for an approximation of profiles with either only one inversion or with one surface and one upper inversion (Figure 1), although possibilities for modification of the function above the aforementioned "inversions" are still limited. A minor drawback of the function is its complexity, since at least ten observations are necessary to calculate the function parameters via non-linear regression (Bates and Watts, 1988).

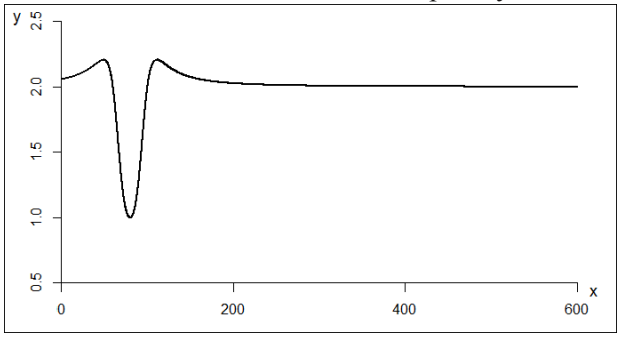

Figure 1 Graph of the mathematical function (Eq. 1) for the following parameter values: a, d, i and j = 1; b, e and g = 0.05; c, f and h = -4.

An ability of the mathematical function to produce reliable near-surface temperature field was tested in a case study from Svalbard. Air temperature measurements from seven observation points and mobile temperature measurements in the vicinity of Longyearbyen (Svalbard) were acquired during a field campaign of the University Centre in Svalbard in February 2016. The point measurements were used to derive starting values of the parameters of the mathematical function for two hourly measurements, but non-linear regression could not have been used for the adjustment of the parameters due to lack of observations. Therefore, the starting values of the parameters were used for a calculation of modelled near-surface temperatures. The mobile temperature measurements were used to derive real near-surface temperatures in the same area; hence for the function performance validation.

The mean absolute error and the root mean square error, applied for the calculated temperature field assessment, were comparable to corresponding values in other studies (e.g. Jabot et al., 2012). It is likely, however, that the mathematical function performance validation was affected by different accuracy of the mobile and the point measurement sensors. Moreover, the predicted and observed values would probably have fitted better if the parameters could have been adjusted by non-linear regression.

Acknowledgements

The data used in the study belong to the University Centre in Svalbard and were obtained during the fieldwork of AGF-350/850 "The Arctic Atmospheric Boundary Layer and Local Climate Processes" course. The research was financially supported by the Norway Grants programme as project No. NF-CZ07-INS-6-299-2015 "Modelling of Spatial Variability of Air Temperature: case study at selected high-latitude locations".

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Glacier retreat in Central Andes since the Last Glacial Maximum: case of the South West slope of Nevado Coropuna

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Keywords: glaciers, climate, ELA, AABR, tropical glaciers, Coropuna

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The Central Andes are characterized by high altitudes, low temperatures and dry conditions. Its glaciers are very important as an indicator for climate research and also an important water supply for the population who lives around. Nevado Coropuna (6426 m, 15° 33'S, 72° 39' W) is the highest peak of the Cordillera Ampato as well as the highest volcano in Peru and is located 150 km northwest of Arequipa. The main aim of this research was to reconstruct the LLGM (local last glacial maximum) and the 1955 and 2007 glacial phases on the South West slope of Nevado Coropuna in order to obtain valuable information on the changes that have occurred and analyze the glacier evolution. For this purpose, the ELA (Equilibrium Line Altitude) indicator has been used as a reference, estimated by the AABR (Area x Altitude Balance Ratio) method, based on the principle of weighting the mass balance according to the distance above or below the ELA of that area.

In order to calculate the ELA and paleoELAs, the glaciers were delimited using aerial photographs and satellite images. In the case of paleoglaciers, before the delimitation, moraine mapping and the contour line reconstruction steps were done, each contour line was modified to adjust it to a hypothetical reconstruction of the ice surface and volume. After that, the ELAs and paleoELAs were calculated using the AABR method.

An ELA of 4762 m was obtained for the LLGM, 5779 m for 1955 and 5850 m for 2007, implying a vertical shift of 1088 m from the LLGM to 2007 and of 71 m from 1955 to 2007. The total glaciated surface was reduced by 21.5% between 1955 and 2007 and the temperature shift from LLGM to 2007 was 9.13°C (0.0091˚C/m). The ice of glaciers makes them valuable for climate research. This method offers quantitative information and the analysis of this data may contribute to research of climate change and climatic trends for future predictions.

Assessment of recent ozone depletion based on Brewer measurements at the Marambio Base, Antarctic Peninsula

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Keywords: total ozone column, ozone hole, Marambio Base, Antarctica

In the last few decades, severe stratospheric ozone layer thinning was observed in Antarctica. The ozone hole, which is defined as the area where total ozone column (TOC) is lower than 220 DU, occurs over Antarctica each spring since around 1980 (Farman et al., 1985). Because ozone absorbs large quantities of harmful UVB radiation, its monitoring is extremely important. This study brings a general overview of a formation and break-up of the ozone depletion at the Marambio Base in the period 2010–2014. The Marambio Base is a permanent Argentine Antarctic station located on Seymour Island (Figure 1a) in the Antarctic Peninsula region (64°14′27.65″S 56°37′36.31″W, 196 meters above sea level, Figure 1a). The Brewer spectrophotometer B199, owned by the Czech Hydrometeorological Institute (Figure 1b), was installed there in February 2010. Since then, regular TOC observations have been carried out several times every day. The Brewer spectrophotometer can only perform measurements when the solar elevation is greater than 10°, at the Marambio Base it means since mid-August to the end of April. The B199 spectrophotometer can apply various methods to perform TOC observations. The most accurate is the Direct Sun (DS) method, which gives the accuracy of ± 1%. Another commonly used method is based on the Zenith Sky (ZS) measurement, which can be employed under cloudy conditions and gives the accuracy of ± 2–3%. During a short period in 2010, when the instrument's solar tracker was out of order, it was necessary to employ the Global Irradiance (GI) method, which gives the accuracy of ± 3–5%. Every year, the spectrophotometer is serviced by the workers of the Czech Hydrometeorological Institute or International Ozone Services, Canada.

In 2010–2014, the maximal area of the ozone hole varied between 21.1 and 26.1 million km^2, which is about 71 to 87% of the largest recorded ozone hole area (29.9 million km^2 in 2001). The yearly minimal TOC value at the Marambio Base was 39–66 DU higher than the all-time Antarctic minimum (84 DU) recorded in 2006 (Ozone Hole Watch, 2016). The maximal daily mean TOC during the period 2010–2014 (395 DU) was recorded on 6th November 2013, while the minimum (123 DU) was recorded on 16th October, 2011 (Figure 2). During the period 2010–2014, the mean TOC at the Marambio Base was 267 DU, with the largest monthly mean in December (304 DU) and the lowest in September (213 DU). In September, TOC drops below

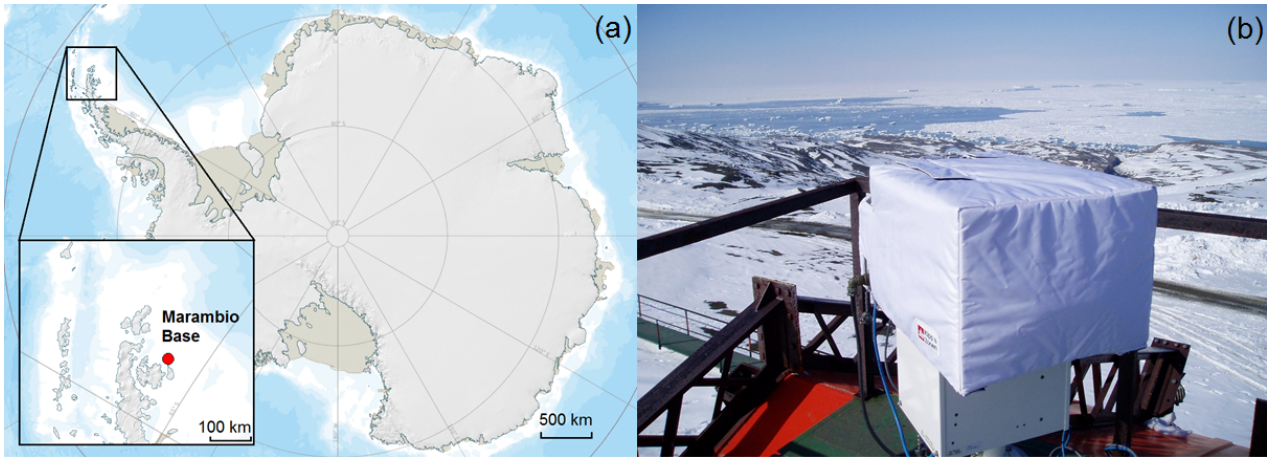

Figure 1 Location of the Argentinian Marambio Base in the Antarctic Peninsula region (a) and installation of the Brewer spectrophotometer B199 at the Marambio Base (b). The modified map is based on the Antarctic Digital Database topography available at http://www.add.scar.org/home/add6/.

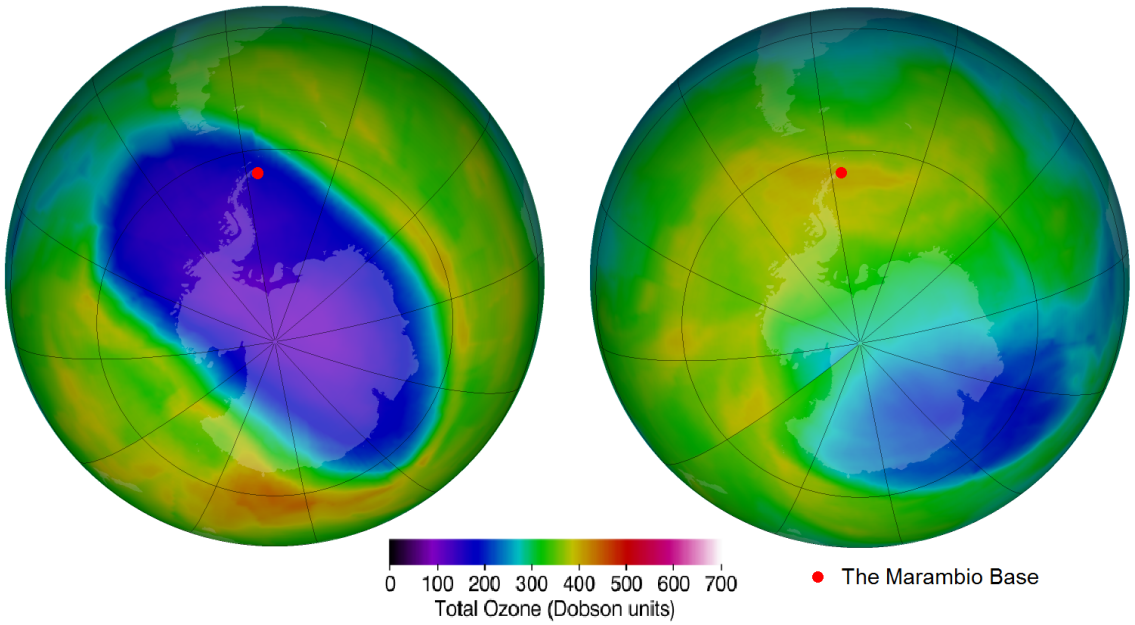

Figure 2 Total ozone column over Antarctica on 16th October 2011 (left) and 6th November 2013 (right); adapted from Ozone Hole Watch (2016).

220 DU in 40–80% of days in a given year. The largest number of spring days with TOC ≤ 220 DU was recorded in the season 2011–2012. Due to very large and cold polar vortex during winter, the 2011 ozone hole was one of the 10 most severe ozone holes since 1979 (Klekociuk et al., 2014). The lowest number of spring days with TOC ≤ 220 DU occurred in the spring of 2010. The 2010 ozone hole was one of the smallest in the past twenty years, which was attributed to relatively warm lower stratosphere temperatures and therefore a weak polar vortex (Klekociuk et al., 2011). The ozone hole break-up is dependent on atmospheric circulation pattern and thermodynamic processes in the atmosphere (Petkov et al., 2016). It takes place in October, November and/or December. These months show the greatest TOC variability, because the ozone layer recovery can occur at a different time each year and its speed varies as well.

In general, the ozone hole was recorded at the Marambio Base in every year in the period 2010–2014. The ozone thinning starts in early Antarctic spring (August, September) and the ozone layer recovers from October to December, depending on the atmospheric conditions. The changes in maximal ozone hole area show there might be signs of gradual long-term ozone layer recovery.

Acknowledgments

This research was supported by the project "The contribution of the Czech Republic to the detection of the stage of the Earth Ozone layer and solar UV-radiation in Antartica, paleo-climatological and paleogeographical reconstruction of the selected area of Antartica and related geological research" (SPII1A9/23/07) and the project of the State Environmental Fund of the Czech Republic "Monitoring of the Earth Ozone layer and UV-radiation in Antarctica" (No. 03461022).

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Parametrization of surface temperature standard deviation for modelling surface melt of the Greenland Ice Sheet with a temperature-index method

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Keywords: Greenland Ice Sheet, temperature-index method, PDD, surface melt, glacier mass balance

Methods used to approximate the surface ice/snow melt play a key role in modelling the waxing and waning of continental-scale ice sheets over millennial time scales. These can be subdivided into two groups: complex models based on the calculation of the surface energy balance and more simple models using a temperature-index method. The first group of models requires the calculation of energy fluxes at the ice/snow-atmosphere interfaces, whereas the only input needed by the second group is surface temperature. The surface energy balance models require a large array of input data, which is commonly available for a limited time interval and limited locations. On the other hand, models using a temperature-index method typically obtain the necessary input from various paleoclimate records and currently represent the only tool that can be effectively used for modelling the evolution of ice sheets over glacial cycles.

Recent studies have demonstrated that ice melt rates derived from a temperature-index method are highly sensitive to the choice of one of its major parameters, namely the surface temperature standard deviation (STSD). Analyses of numerous observational data show that this parameter varies from 1.3 to 8.0°C depending on the season and location. In contrast, early ice sheet modelling studies typically employed a range of spatially and temporally uniform values of 4.5–5.5°C. It is still common practice in ice sheet modelling to assume that this parameter is uniform in space and time, regardless of temporal and spatial scales covered by the simulations.

The assumption of spatially and temporally uniform distribution of the STSD is, however, in poor agreement with growing evidence from automatic weather stations (AWS) operating in currently ice-covered regions. Fausto et al. (2009) were the first to infer that the STSD varied spatially and suggested a parametrization that linearly related the STSD to surface elevation, latitude and longitude. Later they demonstrated that the STSD also varied from season to season and published an updated season-dependent parametrization (Fausto et al., 2011). Furthermore, a dependence on surface temperature was inferred based on the analysis of the ERA reanalyses (Seguinot and Rogozhina, 2014) and later confirmed by the results of a statistical analysis of the GC-Net Network of AWSs from selected glaciated areas (Wake and Marshall, 2015). Although both teams revealed the dependence of the STSD on surface temperature, they came up with quite different parametrizations relating these two quantities. It is apparent that there is a general agreement about the spatially and temporally variable nature of the parameter. However, it has not yet been demonstrated whether any of these parametrizations can be applied in modelling studies covering millennial time scales.

Here we present a series of simulations of the Greenland Ice sheet using the polythermal ice sheet model SICOPOLIS (Greve, 1997). We have run a series of simulations with existing parametrizations of the STSD and an extended range of uniform values under the present-day and palaeo-climate conditions to assess the performance of different parametrizations under quasi-realistic scenarios. As a measure of similarity between the simulated and the observed geometries of the Greenland Ice Sheet, we use the total ice volume and the misfit between the calculated and observed ice thickness. As a result of this analysis, we have arrived at the conclusion that the use of the parametrizations by Fausto et al. (2009) and Seguinot and Rogozhina (2014) leads to a significant underestimation of ice melt rates. In contrast, the use of the other two parametrizations (Fausto et al., 2011; Wake and Marshall, 2015) leads to a relatively good agreement with the observational data. Among all simulations, the minimum misfit between the model and observations was, however, obtained using a

commonly employed spatially and temporally uniform values of 4–5°C. In particular, we have observed that the best-fit palaeoclimate simulation favoured a higher value of STSD (5°C) than the best-fit steady-state simulation driven by the present-day climate forcing (4°C), which can be attributed to a generally colder and thicker interior of the ice sheet derived from palaeoclimate simulations.

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Differences in ground thermal regime between two climatically contrasted ice-free areas in Livingston Island and James Ross Island, Antarctic Peninsula region

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Keywords: active layer, Antarctic Peninsula, ground thermal regime

The Antarctic Peninsula (AP) region is considered to be one of the fastest warming areas on Earth since the 1950s, with the most intensive increase in air temperature during 1990s. The effect of warming caused changes in cryospheric systems including permafrost and active layer, which reacts very sensitively to climate variability (e.g. Anisimov et al., 1997). However, the number of studies focusing on the active layer dynamics rose substantially after the International Polar Year in 2007–2008 (Vieira et al., 2010). Still, there are significant gaps in the current knowledge of differences and similarities in the active layer thermal regime and its behaviour between the western AP (e.g. South Shetlands) and eastern parts of the AP (e.g. James Ross Island) (Figure 1). In this contribution, we present results of ground temperature data comparison between two ice-free environments distributed in the western AP (Byers Peninsula, Livingston Island) and eastern AP (Ulu Peninsula, James Ross Island), which is the first study contrasting these two different areas of AP (Hrbáček et al., 2016b).

We examined air and ground temperature data between February 2014 and January 2015 from two sites located in similar topographic conditions. The mean air temperature varied between -2.6°C and -2.7°C in the Byers Peninsula, while it ranged from -7.0°C to -7.9°C in the Ulu Peninsula. Similarly, the near surface ground temperature at 5 cm was significantly higher in Livingston Island (-0.7°C to -1.3°C) than in James Ross Island (-6.2°C to -6.3°C) and the same applies to the ground temperature at the base of the boreholes at 80 cm depth (-0.4°C to -0.7°C in Livingston Island and -6.0°C

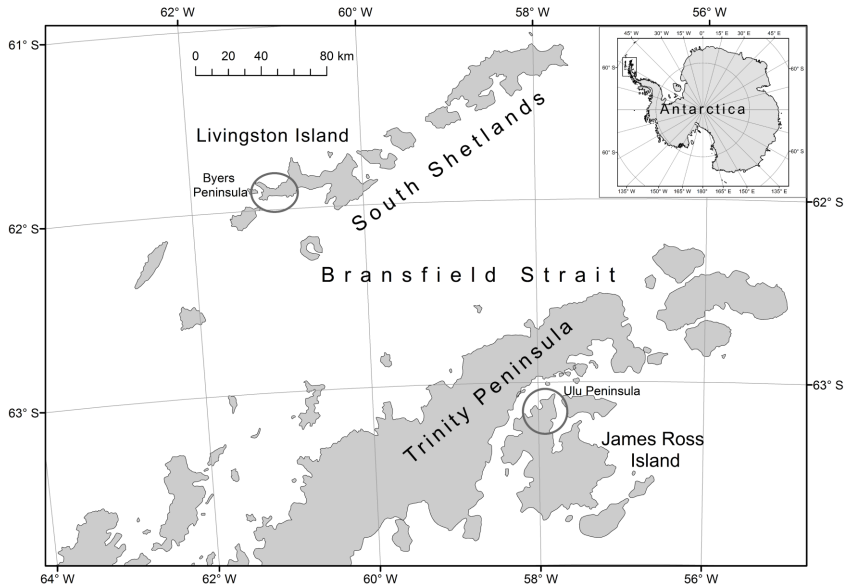

Figure 1 Location of the Ulu Peninsula (James Ross Island) and the Byers Peninsula (Livingston Island) in northern Antarctic Peninsula region.

to -6.6°C in James Ross Island, respectively).

Analyses of daily amplitudes of ground temperature at 5 cm depth and freezing n-factor were further used to evaluate snow cover effect on the ground thermal regime (e.g. de Pablo et al., 2014; Hrbáček et al., 2016a). Data showed a significant insulating effect of snow cover on ground thermal regime in the Byers Peninsula while it significance was much lower in the Ulu Peninsula. Very low freezing n-factor (0.33 to 0.60) in the Byers Peninsula was contrasted with significantly higher values (0.88 to 0.98) observed in the Ulu Peninsula. These results were confirmed by very low daily amplitudes of ground temperature at 5 cm, with mean daily value ranging from 0.9°C to 1.7°C in the Byers Peninsula and from 3.0°C to 4.0°C in the Ulu Peninsula.

Finally, we inferred the active layer thickness based on the depth of the 0°C isotherm. It was found deeper in the Byers Peninsula (> 85 cm) than in the Ulu Peninsula (52 to 85 cm). Local variability of active layer thickness in the context of close proximity of active layer thickness observations in the Byers Peninsula and the Ulu Peninsula suggests high importance of other climate and geological factors on development of active layer thermal regime and its thickness. The interactions between lithology, snow occurrence and moisture regime must have significant effects also on the heat properties of the soils. Therefore, a better understanding of these factors should improve the present-day knowledge about soil thermal regime in continuous and discontinuous permafrost regions in the AP region.

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Compositional characteristics of olivine in back-arc volcanites from James Ross Island

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Keywords: olivine, James Ross Island, Antarctica, back-arc volcanites

James Ross Island, located in the northern part of the Antarctic Peninsula, is currently a dormant volcano with more than 50 recorded eruptions over the last 6 Ma. Situated in a back-arc basin linked to the Phoenix plate subduction system, it forms a major part of the James Ross Island Volcanic Group (Nelson, 1975), which is a 6000 km^2 large volcanic province consisting mainly of alkaline basalts and tholeiites (Smellie, 1999).

Geologists are working in the area since 1970s (Nelson, 1975), focusing mainly on palaeontology and sedimentology research. Petrology of present volcanic rocks came into attention much later (Smellie, 1999), with only minor recent geochemical studies available (Košler et al., 2009 and references therein).

Samples for this study were taken from two distinct locations in the Ulu Peninsula, which is the largest deglaciated area of James Ross Island. Only fresh unaltered rocks were chosen. During a detailed petrographic study, it was confirmed that the olivine in these rocks lacked any signs of alteration and, therefore, was suitable for further geochemical investigations (Figure 1).

Microprobe analysis of the studied olivine crystals showed great variation in Mg# values (58–81) suggesting a various degree of fractionation from the parent mantle-derived melt. Furthermore, the CaO and TiO_2 contents clearly show that the olivine is of igneous origin and does not represent mantle xenocrysts (Foley et al., 2013).

We also analyzed the isotope ratios of noble gases entrapped in olivine concentrates from both studied localities. The results are in agreement with other studies of such ratios in back-arc volcanites (e.g. Hahm et al., 2012 and references therein). There is, however, a distinguishable pattern suggesting contamination by subducting oceanic crust, but further research is needed to definitely prove this hypothesis.

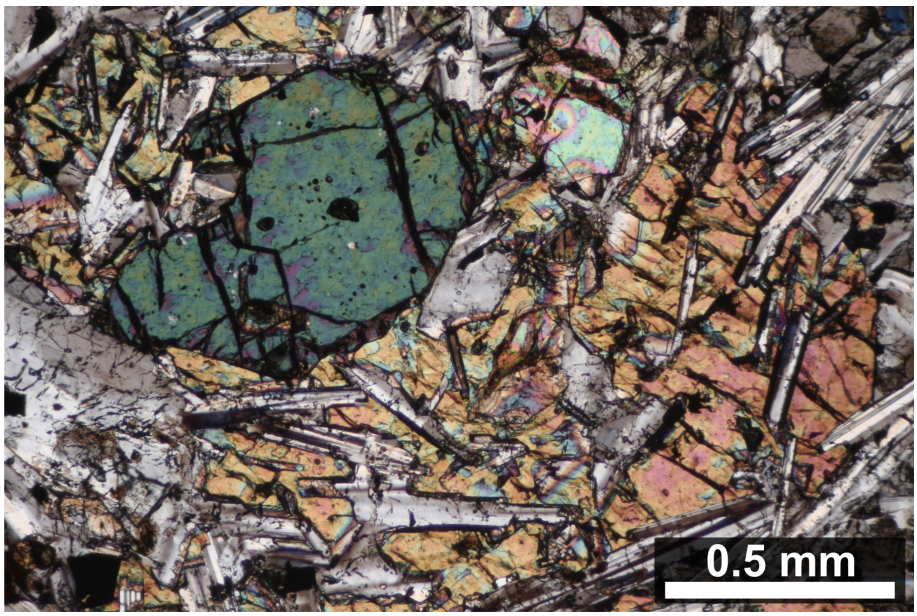

Figure 1 Photomicrograph of euhedral olivine crystal enclosing Cr-spinel. Olivine is surrounded by plagioclase laths with interstitial clinopyroxene.

Acknowledgements

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Multiclass ensemble classifier for polar land cover mapping using very high resolution satellite remote sensing data

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Keywords: cryospheric remote sensing, ensemble classification, polar land cover

We address a technique wherein we fused 4 different image classification methods to improve the accuracy of cryospheric land cover mapping from very high-resolution WorldView-2 (WV-2) satellite images of the Larsemann Hills, east Antarctica. In order to integrate the 4 different supervised classification results, we applied an ensemble classifier system based on the winner-takes-all (WTA) method. Consensus theory for voting in our WTA model was applied, which involves combining probabilities from multiple classifiers according to a consensus rule. A common consensus rule, the linear opinion pool (LOP) was applied, which computes the joint posterior probability of pixel X belonging to class ω_i for S classifiers. We used four distinctly different methods to classify the WV-2 pansharpened data: a support vector machine (SVM), a maximum likelihood classifier (MXL), a neural net classifier (NNC), and a spectral angle mapper (SAM). Three classes of land cover – land mass/rocks, water/lakes, and snow/ice – were classified using identical training samples. The final thematic land cover map of the study region was integrated using ensemble classification based on a majority voting-coupled WTA method. Results suggest that the WTA integration method was relatively accurate than the MXL, NNC, and SAM classification methods. The overall accuracy of the WTA method was 97% with a 0.96 kappa coefficient. The accuracy of the other classifiers ranged between 93% and 95% with kappa coefficients in the range 0.91 to 0.93. This work demonstrates the strengths of different classifiers to extract land cover information from multispectral data in the remote cryospheric regions.

Slushflow as a landscape shapping factor and its relationship to recent vegetation characteristics

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Keywords: vegetation, slushflow, fluvial morphology, atmospheric conditions

Vegetation cover in the Arctic is, among others, influenced by geomorphological processes. Abrupt changes in material transport on slopes have direct effect on establishing of plants – mainly pioneers. These are able to germinate rapidly and regenerate from vegetative diaspores. There was a UAV survey performed on a debris flow fan, next to the Czech Polar station in Petunia, in order to acquire precise morphological data. HR-DEM of the studied area was made with a 10 cm cell size. Consequently, different morphological areas were delimited using DEM data along with field mapping. The mapped areas reflect both, the quantitative characteristics (slope, aspect and altitude) as well as the dynamics of the processes (frequent vs. non frequent/absent debris/slush flow channel).

The area is regularly affected by rapid slope processes – slushflows. Time-lapse camera has been installed to monitor slope dynamics and identify the affected areas. Such event has been observed between June 3rd 23:30 and June 4th 03:30, 2013 (UTC). It is very likely that it was triggered by local atmospheric conditions. Local air temperature has increased significantly in the three preceding days (from 0 to 6°C) complemented with low humidity and high radiation level. Such conditions led to fast meltdown and disintegration of snow cover on a steep slope above the debris flow fan. An upcoming atmospheric front, which brought precipitation and increased the humidity again to 100%, has probably triggered the slush flow (Figure 1).

To document geomorphological processes through the vegetation cover, vegetation mapping has been done in August, 2013 in 4 cross profiles. The profiles have been chosen to cover all specific morphological zones of the debris flow fan. Special characteristics of one of pioneer species, *Saxifraga oppositifolia*, were measured (size of plant and reproductive status of the plant) as well, in order to compare the morphological characteristics to the age and frequency of debris flow.

It is obvious that fast slope processes, such as avalanches or slushflows, are one of the most important factors influencing vegetation cover and species diversity, especially in the high Arctic mountainous areas.

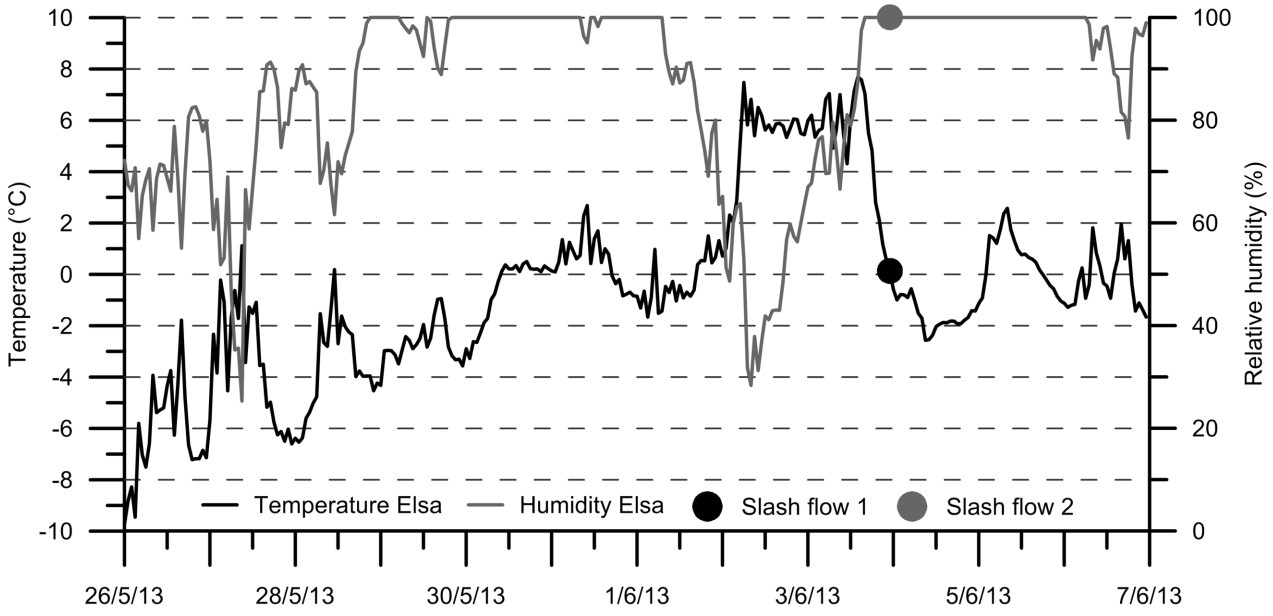

Figure 1 Atmospheric conditions preceding the sudden slushflow event between June 3rd and June 4th (marked with dots).

Acknowledgements

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Hydrology and suspended sediment dynamics in small proglacial streams, James Ross Island, Antarctica

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Keywords: proglacial, suspended sediment, transport, hydrology, James Ross Island, Antarctica

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Retreat of land terminating glaciers as a response to changing environmental conditions in the Antarctic Peninsula affects the evolution of terrestrial ecosystems. One of the most important consequences of glacier change is the alteration of fluvial systems. These systems have a substantial role in shaping the landscape (Carrivick et al., 2013) and driving the flow of energy and matter (Conovitz et al., 2006), which in turn controls the development of habitat for living organisms.

Despite acknowledged importance of fluvial system in proglacial areas, studies in Antarctica are sparse and located in several regions such as McMurdo Dry Valleys (e.g. Conovitz et al., 1998) and Shetland Island (e.g. Rosa et al., 2014). This study presents seasonal data on hydrology of two proglacial streams (Bohemian and Algal) on James Ross Island, Antarctic Peninsula, complemented by suspended sediment transport data from Bohemian Stream.

Our measurements captured a period of high Antarctic summer, during which the mean discharge of the Bohemian Stream reached 0.19 m^3 s^{-1} and the Algal Stream 0.06 m^3 s^{-1}. Peak discharges in late January/early February and continuous runoff persisting until early March points to a prolonged melt-season (~4 months) in comparison with more continental McMurdo Dry Valleys.

The daily regime of proglacial water discharge strongly correlated with air temperature (AT) and ground temperature (GT). Runoff completely stopped only in short time periods, when both AT and GT dropped below 0°C. This suggests that an active layer of permafrost represents an important reservoir of water for streams´ runoff. Further, we found the effect of global radiation on seasonal variation in discharge as negligible. Effect of snowfalls on the water discharge during ablation season was negligible due to its quick melt and small thickness of snow cover (< 4 cm).

Suspended sediment concentrations, studied on Bohemian Stream reached very high values possibly due to a high availability of fine-grained material as a result of aeolian activity and high erodibility of local rocks. Despite small water discharge, suspended sediment yield is relatively high in comparison with other (nearly) deglaciated catchments in Arctic and alpine environments. Observed anti-clockwise hysteresis during diurnal manual sampling on 29th/30th January followed by clockwise hysteresis one week later (6th/7th February) suggests varying spatio-temporal material availability within the catchment.

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Alteration of the low-rank coal by basaltic lava flows on the Faroe Islands

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Keywords: Suðuroy Island, low-rank coal, basalt lava, alteration, mineralization

The Faroe Islands were formed during extensive Palaeogene volcanic activity within the North Atlantic Igneous Province. The tholeiitic plateau basalts are interbedded with volcaniclastic interlava sediments containing coal layers. The thickest coal seam (up to 1.5 m) is connected with tuffitic claystones of the Prestfjall Formation located mainly on the Suðuroy Island. Additionally, sporadic coal lenses also occur in sedimentary sequences within the older basaltic Beinisvørð Formation on the Mykines Island (Ellis et al., 2002).

Coal on the Suðuroy Island has been mined since 18th century. The abandoned mines and thin coal seams exposed at cliffs provided a total amount of 24 samples for a study of chemical and petrographic composition of the coal. The results show a restricted effect of alteration by adjacent basaltic lava flows. In the view of the alteration, it is possible to split the samples into two groups: normal coal which is only slightly affected and altered organic matter with totally changed structure.

The group of normal coal was classified as low-rank lignite to subbituminous coal with average ulminite reflectance of 0.44% Rr. Despite the coal rank, the samples have thermally affected thin surface crust that megascopically resembles anthracite – the crust is bright, lustrous and has a typical conchoidal fracture (Figure 1). Nevertheless, the ultimate and proximate analyses of the whole samples along with their low reflectance disproved the higher coal rank as is typical for thermally affected coal on a short distance in case of contact with an igneous body (e.g. Golab and Carr, 2004). The restricted effect of the thermal alteration on the Faroe Islands is related (i) to the low initial rank of the coal that undergone an intensive gelification, (ii) to the greater distance between the coal seam and the contact with the basalts which fluctuates between 3 and 14 m and (iii) to the relatively fast cooling of the overlying basalt lava (Malinstindur Formation) as proved by the presence of volcanic glass (tachylyte).

The second group, altered organic matter, includes samples with only 2–17 wt.% of organic carbon and very high ash content (74–94 wt.%). Although these samples megascopically resemble a dull coal, microscopically they contain only rare organic particles dispersed throughout the mineral mass do-

Figure 1 Coal sample with an „anthracite-like“ crust.

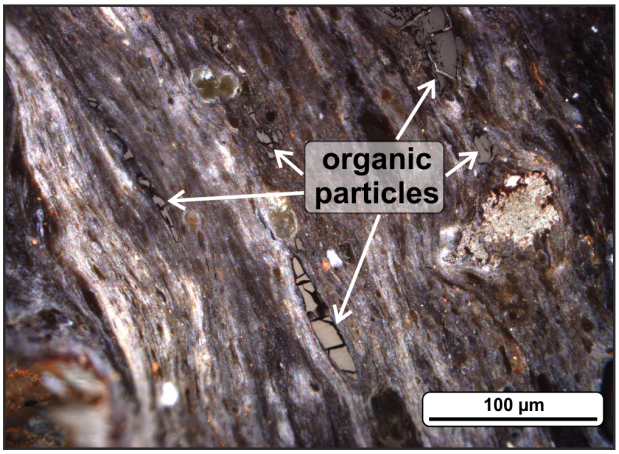

Figure 2 Photomicrograph of an altered sample (reflected light). Tiny organic particles are dispersed throughout the mineral matter.

minated by clay minerals (Figure 2). These inorganic components are very probably a product of hydrothermal decompostion of plagioclase from both the overlying basalt from the Malinstindur Formation and the surrounding feldspar-rich tuffitic claystone. The chemical composition of the altered organic matter is enriched with trace elements such as Sr, Zr, Cu or Zn. Additionally, altered samples are characterised by elevated contents of Cr and Ni. These transition metals are primary characteristics for basaltic rocks (McDonough and Sun, 1995), suggesting a decompostion of olivine and Cr-rich spinel and transport via hydrothermal fluids migrating along faults to the coal seam. In contrast, the altered samples are depleted in Hg. Whereas the normal coal characterises Hg contents between 35 and 210 ppb, the altered organic matter contains only 3–9 ppb of Hg, which is related to increasing solubility of Hg with higher temperatures and subsequent leaching from the organic matter by the hydrothermal fluids (Fein and Williams-Jones, 1997).

One sample of charcoal that is different from both groups was found. This sample megascopically exhibits well-preserved wooden structure and microscopically shows thermal changes of wooden tissues with increase of reflectance up to 0.87% Rr. Charcoal usually forms during wildfires in forests (Cope and Chaloner, 1985), but we can not exclude that charcoal on the Faroe Islands was formed by charring of a wooden relict by present lava flow.

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Paleogeographical effects of the Scotia Sea relief evolution

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Keywords: Scotia sea, geodynamics, palaeogeography, analogue modeling, marine geomorphology

The Scotia Sea lies between Antarctica and South America near the Falkland Islands. It is a sea encircled with islands (South Georgia, South Sandwich and South Orkney Islands, etc). Its biggest part is situated within the Atlantic Ocean (Figure 1). The Scotia Sea is connected with the Pacific Ocean by the Drake Passage, located in the west part of the study area. The sea occupies an area more than 1.3 million km^2. The floor depth exceeds 5 thousand meters.

The Scotia Sea extension is associated with the opening of the Southern Ocean and with the breakup of Gondwana. This region evolution predetermined in many respects the development of the whole South region (different depth flow initiation, aggradation, formation of iceberg movement).

So, for example, the Drake Passage is one of the main factors of the Antarctic Circumpolar Current (ACC) existence, which isolates Antarctic Continent of the other warm surface water ingression. The Drake Passage arose during the active relief forming processes in the Scotia Sea. Consequently the Scotia Sea relief evolution could affect the present-day features of the Passage.

The difficulty of studying this region evolution is contained in multidirectional magnetic stripes and their interruption, different types of transform faults, a quantity of heterochronous aseismic rises and ridges. Analyses of the main evolutional hypothesis consecrating this area (Maldonado et al., 2000; Eagles and Livermore, 2002; Barker, 2001; Udintsev and Schenke, 2006; Verard et al., 2012) has allowed to establish the main features of the relief development in the Scotia Sea: a) before the Gondwana breakup the Scotia Sea had the form of one continental bridge consisting of the different

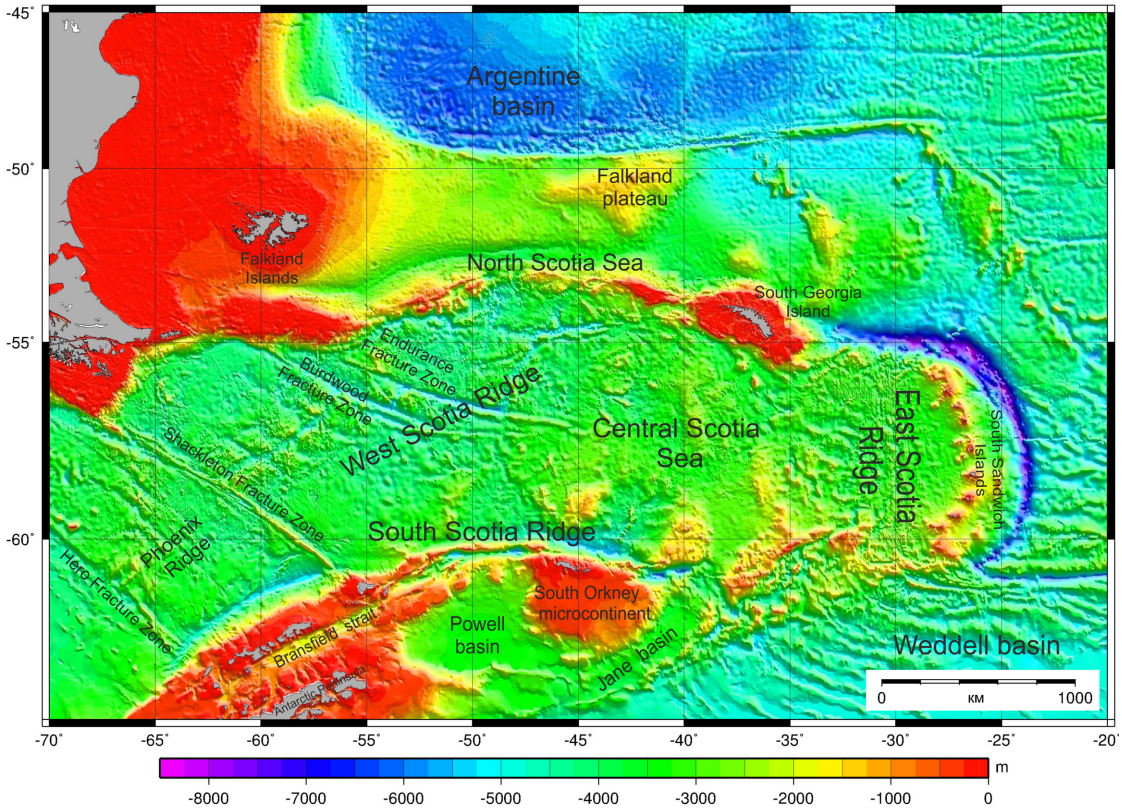

Figure 1 The main structures of the Scotia Sea.

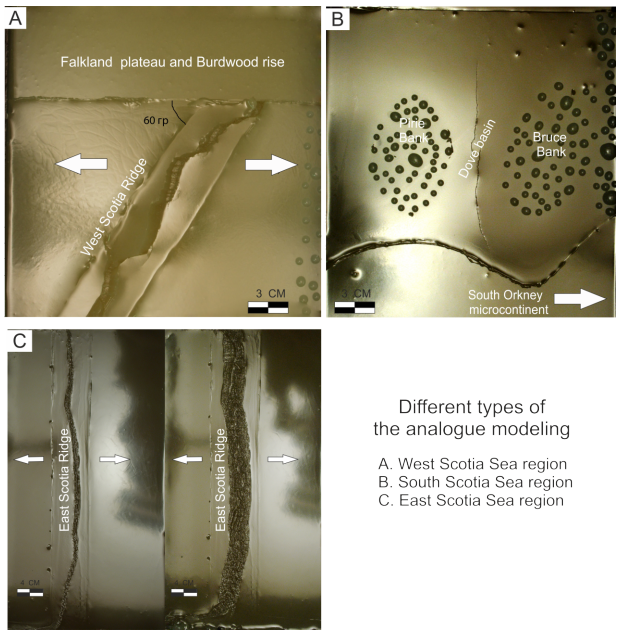

Figure 2 Different types of the analogue modelling: (A) West Scotia Sea region; (B) South Scotia Sea region; (C) East Scotia Sea region.

rises and plateaus; b) there were two active spreading systems (NW-SE in the west part of the Scotia Sea and submeridional in the East) during the opening stage of the Sea; c) Powell basin falls into the category of small basin. Its extension had interrupted cause of Discovery bank migration and spreading in the central part of the Scotia Sea (Eagles and Livermore, 2002).

The main paleogeographical effects of the Scotia Sea relief evolution were determined: a) the forming of the Drake Passage and the ACC; b) the beginning of the iceberg movement from the Weddell Sea after the Bransfield Strait opening; c) morphological changes of the biggest part of banks and rises and formation planation surfaces cause of abrasion at the early stage of this region evolution.

For checking different evolutional hypothesis some experimental works were made at the Laboratory of analogue modeling in the Geodynamics department of the Earth Science Museum at Moscow State University (Figure 2). Subsequent to the results of the analogue modeling, morphological and geodynamical analyzes and the map of different crust types some evolutional hypothesis were confirmed.

Just collision between West Scotia Ridge (WSR) and continental block of Falkland plateau in the North and formation of structural and temperature heterogeneous features in the central part of the Scotia Sea had caused stopping spreading in WSR and localization of the pulling stress in the central part of the Scotia Sea. Probably these processes had led to the extension and the subsidence of the crust that could be caused in their turn the forming present-day heterogeneous features in the centre of the Scotia Sea.

Moreover, the south boundary evolution of the Scotia Sea has impacted the forming of Bransfield Strait and East Scotia Ridge (ESR). So, for example, some geodynamical processes were activated in the East (where there are spreading ridge at the present day) during forming strike-slip zone in the South of the Scotia plate.

The experimental works also show that unusual form of the south boundary, which was formed cause of heterogeneous features in the centre part of the Scotia Sea, constrained the forming of the small basins divided some subsidence micro-continental block.

Acknowledgements

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Mineralogy and formation conditions of hydrothermal veins from James Ross Island (Antarctica)

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Keywords: calcite veins, zeolites, Whisky Bay, Hidden Lake, James Ross Island, Antarctica

The principal aim of our pilot study was mineralogical and genetic characterization of hydrothermal mineralization (epigenetic calcite veins) in the Cretaceous rocks of the James Ross Island, northeast of the Antarctic Peninsula. Samples hosted by the Hidden Lake Fm. and the Whisky Bay Fm. were collected in 2013. Both formations are exposed in the deglaciated area of the Ulu Peninsula. The presence of calcite was mentioned in some previous studies (Pirrie et al., 1997; McArthur et al., 2000; Hayes et al., 2014; Elster et al., 2016), however, description and genetic investigation of the hydrothermal veins is completely lacking.

In our study, the samples of hydrothermal veins were studied by conventional optical and cathodoluminescence (CL) microscopy. Special attention was paid to microthermometry of fluid inclusions. Additionally, mineral chemistry of hydrothermal phases was investigated using an electron microprobe.

The studied veins occur most frequently as filling of fissure systems which are perpendicular to bedding planes. Thickness of the hydrothermal veins range from several millimeters to 2 meters. They could be both simple and zoned with a massive coarse-grained center and border zone formed by fibrous calcite. Majority of samples show no signs of zonality in CL suggesting relatively stable conditions during their formation (Figure 1A, B).

Two-phase aqueous primary, pseudosecondary

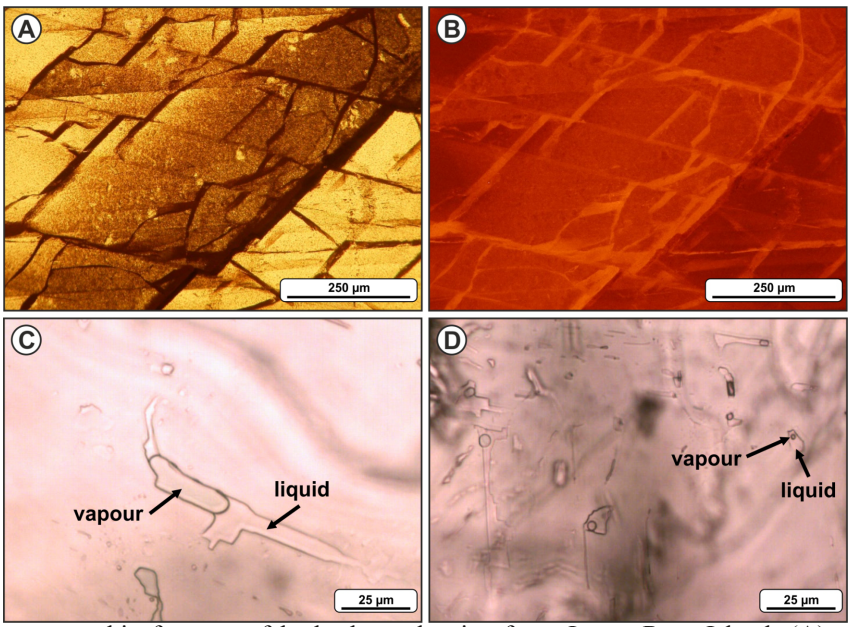

Figure 1 Selected petrographic features of hydrothermal veins from James Ross Island. (A) coarse-grained vein calcite in thin section (sample JRK 07; Whiskey Bay Fm.); (B) the same view in the cathodoluminescence, showing the absence of growth zonality and highlighted cleavage fractures; (C) primary two-phase aqueous fluid inclusion hosted by calcite (sample JRK 45; Hidden Lake Fm.); (D) group of pseudosecondary two-phase aqueous fluid inclusions hosted by calcite (sample JRK 45; Hidden Lake Fm.).

and secondary fluid inclusions were identified in the collected samples (Figure 1C, D). The majority of homogenization temperatures for primary or pseudosecondary inclusions range from 200 to 320°C. Fluid inclusions are characterized by low salinity between 1.0 and 6.5 wt. % NaCl equiv.

In the sample JRK 07 (Whiskey Bay Fm.), the presence of heulandite-group zeolite was recognized, which is indicative of a genetic relation with volcanic activity. This is in line with a paper by Montenegro (2013), who mentioned calcite and zeolite fillings in amygdules of basalts from the James Ross Island Volcanic Group.

Acknowledgements

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Palaeoecology of Mimerbukta, central Svalbard, around 11 000 BP based on fossil biota from uplifted marine terraces

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Keywords: Svalbard, palaeoecology, molluscs, early Holocene, uplifted marine terraces

Mimerbukta is a small bay in the northern part of Billefjorden in the centre of Spitsbergen Island. Mimerdalen valley follows the Mimerbukta bay towards the west into the land. Relicts of Pleistocene and Holocene glacigenic, marine, deltaic and glacifluvial sediments are located on the valleysides of Mimerdalen. These sediments record the history of glaciation during the Last Glacial Maximum as well as subsequent deglaciation during the Holocene. Mimerdalen was flooded by the sea after the retreat of glaciers and it formed an extending part of Mimerbukta. During the Late Glacial and Holocene glacioisostatic uplift of Spitsbergen, regression of the sea and uplift of sediments (up to 65 m a.s.l.) occurred. Today, the sediments form morphologically prominent terraces. Present Mimerbukta is, therefore, a relic of an originally larger bay.

Sediments of early Holocene age are known from two localities in Mimerbukta. The first locality is a series of terraces (65–51 m a.s.l.) west of the Pyramiden town. The terrace closest to the town, at 53 m a.s.l., was investigated within the Bertil 1 section. The second locality (MD1 section) is a terrace on the south side of Mimerdalen (28 m a.s.l.). Age of both sections was determined by means of AMS ^{14}C method based on shells of bivalve mollusc *Mya truncata*. The resulting radiocarbon ages have been calibrated using the Mixed Marine NH dataset (Reimer et al., 2013) with 90% marine influence.

The section Bertil 1 is in its lower part formed by diamictons and in the upper part by inclined layers of gravel, gravely sand and sand. Diamictons represent subglacial-supraglacial tills. Gravel and sand units are either gravelly beach or longshore drift deposits. One unit in gravely sand contains shells of molluscs in living position (Figure 1). From this unit, two radiocarbon ages, indicating an

Figure 1 Bivalve *Mya truncata* in living position with preserved siphon at the Bertil 1 section.

Figure 2 Accumulation of shells of *Mytilus edulis* in the MD1 bottomset unit. The shells are redeposited from a tidal zone, because *M. edulis* requires stony substrate where it is attached using a byssus.

Table 1 Approximate values of conditions at every unit obtained from sedimentology and synthesis of palaeoenvironmental and ecological indicators of found species based on Peacock (1993), Gordillo and Aitken (2000), Funder et al. (2002) and Kaczmarek et al. (2005).

	Bertil 1	MD1 Diamicton 3	MD1 Bottomset
water temp. during year [°C]	-2 to 8	0 to 10	0 to 14
depth [m]	5 to 15	10 to 30	0 to 10
salinity [‰]	5 to 13	10 to 17	10 to 30
substrate type	fine-medium grained gravelly sand with occasional kelps	diamicton with silty matrix with occasional kelps	fine to medium sand with dispersed pebbles and occasional kelps
age	11 178 ± 58 cal. BP	10 500 ± 104 cal. BP	10 416 ± 135 cal. BP

age of 11 082 ± 140 cal. BP and 11 165 ± 105 cal. BP, were retrieved. Other units contain isolated redeposited valves. Occasional hummocky cross-stratification proves redeposition of the sediment by storm waves. Redeposited valves indicate an age of 11 218 ± 114 cal. BP.

The MD1 section is, from the base to the surface of the terrace, formed by diamictons (subglacial-supraglacial tills), silts and silty diamicton (marine pelagic deposits), sand (bottomset of coarse-grained delta) and gravels (foreset and topset of coarse-grained delta). The silty diamicton (Diamicton 3) was deposited by sedimentation of fine particles from suspension on surface of supraglacial till. The Diamicton 3 contains some taxa preserved in living position. Dating indicates depositional ages of 10 573 ± 138 and 10 403 ± 159 cal. BP. Deltaic bottomset contains only redeposited fossils dated to 10 416 ± 135 cal. BP.

The main goal of this study was to determine environmental characteristics with the use of proxies hidden in organic remains, mainly fossil molluscs, during observed ages, which can complement sedimentological reconstructions. For this purpose, units with fossil remains were examined using palaeontological methods. Sections were cleaned, fossiliferous layers were properly examined and fossils were collected by hands. At least 240 individuals of fossil molluscs were collected from each of all three fossiliferous units.

The oldest section (Bertil 1) has the simplest diversity of organisms. Altogether 242 individuals have been recovered from the Bertil 1 site – 56% of *Mya truncata*, 33% of *Macoma calcaera* and 11% of *Hiatella arctica*. Three complete individuals and a few fragments of the echinoid *Strongylocentrotus droebachiensis* were also revealed in this section. The second section (MD1 Diamicton 3) contains more mature community (243 individuals were examined). The presence of species with higher thermal needs (Peacock, 1993) such as *Mytilus edulis* (4%, probably redeposited from a tidal zone) and *Arctica islandica* (1%) represents the main difference when compared to the Bertil 1 section. Percentage ratios of *M. truncata* (54%), *M. calcaera* (27%) and *H. arctica* (12%) are virtually the same as in the Diamicton 3. Other differences between the Bertil 1 and the Diamicton 3 sites are the presence of Gastropoda species (relatively thermally demanding *Boreotrophon truncatus* and the predator *Cryptonatica affinis*, both representing 0.5% only) and remains of the barnacle *Balanus balanus*. Both sections (Bertil 1 and Diamicton 3) also contain remains of macroalgae rhizoids (probably macroscopic Phaeophyta – brown algae). Fossil remains from the delta bottomset in the MD1 section are formed by a community which is thermally the most demanding (369 individuals were examined). *M. edulis* (56%), *M. calcaera* (18%) and *M. truncata* (12%) were the most abundant. A high percentage of *M. edulis* (Figure 2) and the presence of the gastropod *Littorina littorea* (4%) suggest low depth conditions with low salinity. On the other hand, the gastropod *Margarites groenlandicus* and the bivalves *Astarte elliptica*, *A. montagui* and *Thyasira sarsii* were also found in the MD1 bottomset (although they compose in total only 2%). All these species require high salinity conditions (around 20‰ and more; Peacock, 1993). The conclusion is that the tidal species (*M. edulis* and *L. littorea*) were probably redeposited from low depth conditions with a high amount of freshwater from retreating glaciers. There was also a whale bone (probably a part of a rib) revealed in the upper part of the MD1 bottomset. Approximate environmental values at every unit are summarized in Table 1.

Increased diversity and the presence of relatively thermophile organisms such as *Mytilus edulis*, *Arctica islandica* and *Littorina littorea* clearly indicate rapid growth of sea water temperature during the observed time interval of ~750 years in the northern part of the Billefjorden area. The presence of species, which prefer tidal and warmer conditions (e.g., *M. edulis* and *L. littorea*) also supports the absence of complete sea ice freezing during winters in the time of the MD1 section formation. All these findings indicate considerably warmer shallow sea environment than in present time.

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Sediment flux conditions in the connective middle-mountain river basin – a case study of the Černá Opava River

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Keywords: bed load, connectivity, field survey, sediment flux, Černá Opava River

Upper reaches of rivers are very important in the context of the whole river basin, because they represent zones of erosion. Eroded material is transported down the river basin. High-gradient streams are mostly situated in the mountains or in the forested uplands. The Černá Opava River basin represents one of the examples of connective middle-mountain river basins in the Czech Republic.

The studied river basin is located in the Hrubý Jeseník Mountains in the Eastern Sudetes and its area is 58.9 km^2. The Černá Opava River is 18.6 km long and its river basin is interwoven with many tributaries. The sources of water are primarily from rainfall and spring snowmelt. Maximum flow rates are in spring or summer due to flash floods. A typical characteristic of this river basin is variable topography (1204–529 m a. s. l.). The Černá Opava River is a high-gradient stream with mean channel slope of 26.8‰ and with V shape cross profiles on the upper segment of the river and on the tributaries. Almost 60% of the valley network is connective (Brierley et al., 2006), which means very close contact between the slopes and the channels (slope-channel coupling phenomenon; Wistuba, 2014).

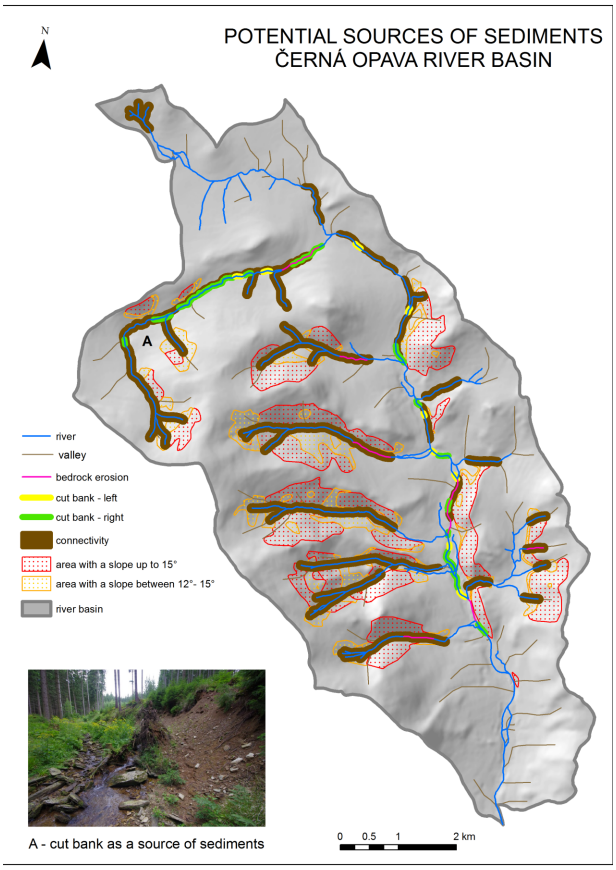

Figure 1 Potential sources of sediments located in the Černá Opava River basin.

This contribution presents comprehensive information about existing findings on this river basin. A field survey has been performed since 2012. The main goal of this study is to identify sediment sources, to define areas of erosion and sediment accumulation for selected streams and to clarify sediment transport down the river basin together with description of the blockages in sediment transport. Geomorphological classification based on Montgomery and Buffington (1998) was carried out at the beginning of the field survey in the summer season 2012–2013 (Ondráčková, 2013). The Černá Opava River has a straight channel pattern with a hint of meandering and many reaches with step-pool character (4.3%), parts with channel bars or parts with bedrock channel pattern (2.7%). The dominant type of channel reach is plane-bed channel, especially on the lower reach of the Černá Opava River (76.3%).

The sediment sources for the Černá Opava River were divided into three groups.: the point sources (local cut bank, root balls, sediment accumulation), the linear sources (channel reaches with bedrock erosion) and the potential areas (Figure 1). The material moves down the river basin, but the transport is not continuous. Although the Černá Opava River basin is located in the Protected Landscape Area Jeseníky (PLA Jeseníky), sediment transport is disrupted due to the human impact both in the channel and in the landscape surrounding the river. The anthropogenic influence is most pronounced at the end of the river in the town of Vrbno (concrete steps, dikes, wooden log steps…). For more detailed information regarding the geomorphology of the Černá Opava River basin, the reader is encouraged to consult Ondráčková (2015).

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Coastal erosion and soil carbon flux on Bolshoy Lyakhovsky Island, NE Siberia

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Keywords: Siberia, coastline, permafrost, CORONA, GIS

Erosion of Arctic permafrost coastlines is an important topic in modern polar research. Shoreline retreat caused by thermoerosion threatens coastal infrastructure, local communities and ecosystems and constitutes a source of greenhouse gases. To understand the scale and variability of this phenomenon, knowledge of the coastlines' state in the past is needed. Far North is a sparsely populated, remote area, thus reliable coastline position measurements are rare, and aerial photographs are often unavailable, particularly from Siberia. Data from spy surveliance satellites created during the Cold War were previously used to study coastline change in the Laptev Sea area, but they were not employed to survey islands in the Arctic.

The work is an attempt at assessment of coastal erosion rates in the eastern part of the Bolshoy Lyakhovsky Island, the biggest island in the New Siberian Archipelago, located to the north-east of Siberia (Figure 1A). Declassified satellite imagery from American spy surveillance programmes CORONA and HEXAGON, taken in 1968 and 1980, is used as a base for the study. The photographs are high-resolution images made available freely by the USGS. The sea-land border on images from the two time points was vectorised and the difference in position was measured with use of basic GIS techniques within the ArcGIS software. These operations enabled calculating erosion rates along the island's coast. The Northern Circumpolar Soil Carbon Database (Hugelius, 2013) was the primary source of Soil Organic Carbon Content data which were, together with the information about erosion, used to assess the transfer of organic carbon from the terrestrial environment of the island's coastal zone to the surrounding seas. The data collected there are derived from geological maps as well as multiple published fieldwork results, conducted on a single site in the southern part of the island, the mouth of Zimov'e river (Figure 1A). Additionally, information about cliff heights from Soviet topographical maps was used. A method for calculating volume of displaced sediments by Are (1999) was adopted for the computations.

The results show great variability of erosion rates along the coastline with highest erosion rates reaching 7.13 metres per year and aggradational areas advancing at a rate as high as 4.35 metres per

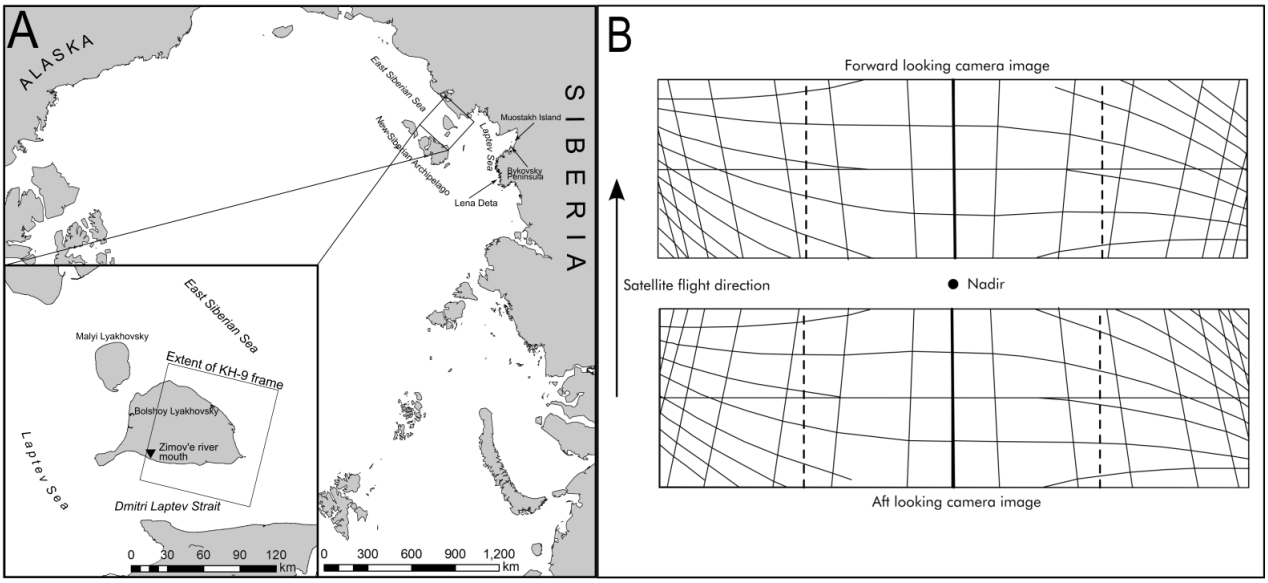

Figure 1 (A) Map of Bolshoy Lyakhovsky Island within the Arctic. (B) Erosion rates in the studied part of Bolshoy Lyakhovsky Island. Source of coastline shapes is NOAA (2015).

year (Figure 1B). The assessment of uncertainty of shoreline displacement values was based on Sannel and Brown (2010) and has shown that the margin of error is high, locally greater than the measured values. Two reasons behind the rates' variability are proposed. Firstly, cryomorphological structure of the cliffs in different parts of the coastlines is pointed. According to Lantuit et al. (2011) alas and thaw slump coasts are more prone to erosion than other kinds of sediments and wide beaches may protect sedimentary cliffs from wave action and erosion. Secondly, dominating wind and sea current patterns are hypothesised to be a factor. The dominating eastward flow of water between Laptev and East Siberian seas results in variation of erosional pressure, exerted primarily by storm events and wave action. The values of erosion rates are in agreement with other published data. The coasts of the studied island seem to erode faster than comparable nearby sites. Similar comparison of carbon flux information could not produce satisfactory results, as the values are less reliable than erosion rate measurement results. The reason behind this is greatly simplified methodology and uncertainty, which, though hard to determine, is probably high.

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Geomorphological setting of the Clearwater Mesa, James Ross Island, Antarctic Peninsula

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Keywords: geomorphology, mesa, periglacial, deglaciation, Quaternary, Antarctic Peninsula

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With a concept of global climate change accepted in the scientific community, there is a need for more field-based data of climate and environmental evolution from many more localities, which will feed the global circulation models and allow for reconstruction of large-scale landscape evolution. In spite of its undisputed importance for the global climate, however, the scarcity of data from the Antarctic calls for more basic field-oriented research. During the austral summer field campaigns in the years 2015 and 2016, the first geomorphological study and mapping of the Clearwater Mesa area were conducted. Bordered from the north and west by the Croft Bay and from the south and east by the Haddington Ice Cap and its tidewater outlet glaciers, the mesa represents a rare unglaciated locality (in the perspective of the entire Antarctic) and it is therefore suitable for investigating the non-glacial landsystem evolution in severe periglacial climate (Davies et al., 2013).

The mesa was formed during the Pliocene in a subglacial volcanic eruption that produced steeply dipping lava-fed deltas of hyaloclastite breccias capped by the subhorizontal impermeable layer of basaltic lavas (Smellie et al., 2008). Numerous lakes with connected or isolated drainage basins fill the topographic hollows between the pahoehoe lava lobes. The origin of a relatively complex uneven topography could be attributed to selective erosion, or more likely to conservation of the original volcanic relief by the cold-based dome or plateau glacier for extended periods of time. This explanation is supported by the almost ubiquitous presence of autochthonous blockfields formed by the in situ frost weathering (Davies et al., 2013) and, in depressions, a very thin pebble-cobble gravel interpreted as a glacigennic erratic-poor drift (ibid). This erratic poor drift is thicker and more clearly developed in the low-lying areas between the mesa and the ice cap margins, where the paraglacial processes, namely wind-driven deflation, created the lag deposits, i.e. coarse pebble-cobble armour over finer particles of hyaloclastite breccia tuff. Periglacial assemblages further comprise solifluction lobes and steps on low-gradient slopes, possibly rock glaciers and protalus ramparts on debris-rich steeper slopes beneath the mesa's cliffs, and abundant patterned ground landforms in water-saturated depressions. The morphometry and clast analysis of sorted circles, nets and polygons were measured at eight typical localities, supplemented by a photogrammetric analysis of the landforms at two localities.

Other paraglacial processes are evident near the ice cap margin. A degraded moraine close to the flat ice-divide area documents a recession of the glacier snout by ~200 m. Parallel to the moraine edge, a dry fluvial valley was probably formed as an ice-marginal (lateral) meltwater stream incised deeply into breccia tuffs. Adjacent to the present-day glacier snout is an analogous, but active lateral meltwater channel. Another example of recent landscape changes in terminoglacial areas can be found in the vicinity of the ice-contact lake Florencia and proglacial lakes Malvina and Rosa; a series of horizontal strandlines (topographical steps in glaciofluvial and glaciolacustrine sediments) several metres above the present-day lake levels is an indicator of the past lake-level fluctuations. In the case of Florencia Lake, the strandlines occur up to 60 m higher than the present lake level and must have been formed during the paleolake high stand, when the lake was wedged between the valley side and the greatly enlarged outlet glacier. The position of the strandlines was recorded with differential GPS, which will enable us to reconstruct volume of the paleolake and the past minimum thickness of the outlet glacier.

One of the primary objectives of the field campaign was establishing the chronology of these observed landscape changes and the deglaciation of the mesa in particular. For this purpose, we sampled a surficial rock material of 18 granite erratic boulders for exposure dating by *in-situ* pro-

duced cosmogenic radionuclides 10Be and 26Al. These erratics of various size (up to ~2 m in a-axis) have been carried to the mesa from the batholith of the Antarctic Peninsula by the Antarctic Peninsula Ice Sheet during the glacials (Nývlt et al., 2014). We also attempted to establish a relative chronology by measuring the intact rock strength of >90 boulders using the Schmidt hammer. The resultant R-values correspond to visual inspection of the degree of weathering, with the lowest R-values (<40) for the most weathered boulders and the mid to high R-values (50–60) for the less weathered boulders, respectively. Several investigated erratics, however, have developed desert varnish, which could pose difficulties in the relative dating, as their high R-values (~70) are related to the prolonged exposure to weathering factors rather than their low age. A few erratics and one basalt outcrop were striated, probably indicating a glacial abrasion and thus offering a different view on the glacier dynamics over the mesa in the course of the Quaternary. The mesa was probably covered from most part by a cold-based plateau glacier, but was overridden and shaped by the (warm-based?) Antactic Peninsula Ice Sheet or Haddington Ice Cap on several occasions; however, resolving the absolute timing of the youngest of these events will only be possible with the results of exposure dating.

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Geochemistry of Cenozoic volcanic rocks of the Faroe Islands with a focus on their ultra-trace contents of Hg

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Keywords: Faroe Islands, tholeiitic basalt, mercury content, continental crust

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The Faroe Islands are an exposed remnant of an extensive, predominantly subaerial, Palaeogene basalt lava sequences. The archipelago is a part of the North Atlantic Igneous Province, a large volcanic region which extends from the northeastern coast of Canada to the western coast of Norway. On the Faroe Islands, the lava sequences have huge stratigraphic thickness (at least 6.6 km). The basalt lava flows are divided into seven formations based on lithology (in succession from the oldest to the youngest): Lopra Fm. (reached only in the Lopra-1 borehole), Beinisvørð Fm., Prestfjall Fm., Hvannhagi Fm., Malinstindur Fm., Sneis Fm. and Enni Fm. (Passey and Jolley, 2009 and references therein.

According to geophysical research performed in the eastern part of the North Atlantic, many authors (e.g. Casten, 1973; Bott et al., 1974) inferred that the basalt flows on the Faroe Islands overlie a continental metamorphic basement supposedly of Precambrian age. With respect to this, we focused our study on determination of ultra-trace mercury contents by means of atomic absorption spectrometry to test this hypothesis. Based on the work of Coufalík et al. (2014), mercury contents in basalts seem to be a sensitive tool for distinguishing between the basalts not affected by interaction with the continental crust and the basalts enclosing crustal xenoliths.

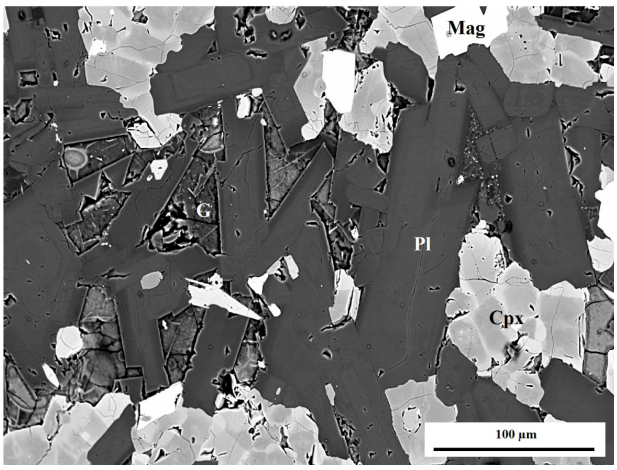

Figure 1 Backscattered electron image of zoned palgioclase (Pl), clinopyroxene (Cpx), magnetite (Mag) and altered glass (G) in sample from Beinisvørð Formation.

Rock samples for our study were taken from Beinisvørð, Malinstindur, Sneis and Enni Formations. The result of combined optical microscopy, electron microprobe and whole-rock chemical study revealed that the studied volcanites are fine-grained and aphyric to feldspar phyric tholeiitic basalts with primary phenocrysts or microphenocrysts of plagioclase and pyroxene ± olivine in a matrix composed of tiny plagioclase laths ± tachylyte in various stages of alteration (Figure 1). The forsterite content of volcanic olivine ranges widely (74–90%). Pyroxene is typically zoned and corresponds to augite, diopside and/or pigeonite. Plagioclase displays a zonal structure and in majority of samples reaches values between An_{40} and An_{80}.

Contents of Hg show great variability between samples even within the same formation. The obtained values are presented in Table 1. We presume that high concentrations of Hg in some samples are related to stagnation of individual pulses of parent magma in the continental crust below the Faroe Islands. Our idea is supported by the work of Dahren

Table 1 Ranges of mercury contents in studied samples. The Malinstindur, Sneis and Enni Formations show volcanic members with higher values compared to the Beinisvørð Formation.

Formation	Hg content (ppb)
Beinisvørð	0,5–2,4
Enni	0,5–7,1
Malinstindur	0,9–7,4
Sneis	0,9–8,4

et al. (2015), who found a correlation between plagioclase chemistry of basalts from the Faroe Islands and supposed magma storage in the continental crust.

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Background concentrations of metals in regolith near J. G. Mendel Czech Antarctic Station

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Keywords: metal, regolith, James Ross Island

The least inhabited continent on the Earth was visited by many researches during polar expeditions in the 20th century. The anthropogenic activities, especially construction and operation of polar stations, should be harmless to the environment. This work focuses on determination of metals in regolith in the vicinity of the Johann Gregor Mendel Czech Antarctic Station (S 63°48'02", W 57°52'57") on James Ross Island. The station is in operation only one decade; however, this location was used by polar expeditions as a camping site for many decades.

A geological profile was collected near the station (from the depth of 0–50 cm). Another group of samples was collected in the surroundings of a fuel store, a watercraft hangar, diesel generators, waste processing and a substation. Other samples were collected at the distance of 100 m and 200 m from the station. Two subsamples (0–5 and 5–10 cm) were acquired from every sampling site. The determination of content of As, Cd, Co, Cr, Cu, Ni, Pb, Sn, and Zn in regolith was performed in aqua regia leachate prepared according to ISO 11466. Mobile fractions of As and Pb were extracted by $MgCl_2$ solution. The content of metals in leachates and extracts was determined using ICP-OES.

Determined concentrations of metals that are oftentimes related to human activities could be regarded as geological background. Mobile fractions of As and Pb were below the limit of detection. The regolith in this location was not polluted by metals during building of the station and its operation.

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Biosciences section

Health problems in polar regions

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Keywords: health problems, cardiovascular risk, cardiac biomarkers

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In polar regions, human organism is forced to find specific adaptation mechanisms to extreme conditions. In general, the conditions for life are unfavorable due to the harsh climate and rapid changes in circadian rhythm. Antarctica is a completely uninhabited area. In the Arctic, population density is very low, infrastructure is almost absent and access to health care is usually limited, particularly in some areas. Even the smallest health problem may become very serious or even life-threatening.

How does human organism adapt to the hostile polar environment? Which adapation mechanisms are well-understood or documented? Are there any specific diseases related to the human presence in polar regions?

The author will try to answer all of these questions. A few practical recommendations (related to health) for those willing to travel to polar regions will be proposed.

Moreover, a short note will be given to present the results of proper scientific observations of the author. These include chronobiological analyses of arterial blood pressure and changes in blood levels of cardiac biomarkers after physical activity in participants of scientific expeditions to Antarctica.

Vegetative survival of polar terrestrial algae - A case study of *Zygnema* spp.

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Keywords: polar algae, *Zygnema*, stress

Many algae from stressful environments including polar regions do not form any specialized dormant stages and survive environmental stresses in vegetative state. Nevertheless, vegetative cells in natural or experimentally induced stressful conditions differ from growing, non-stressed vegetative cells in many ways. They are usually characterized by reduced physiological activity, accumulation of storage products and thick cell walls.

Formation of such stress tolerant vegetative cells, their performance under various conditions, physiology and biochemical composition have recently been investigated in Arctic and Antarctic *Zygnema*, filamentous conjugating green algae of the class Zygnematophyceae. They typically occur in shallow freshwater pools where they are subject to various environmental stresses (e.g. desiccation, UV radiation, freezing). Typical young vegetative cells of *Zygnema* are highly vacuolized and possess two star-shaped chloroplasts. During natural development of *Zygnema* populations the vegetative cells gradually develop into mature cells called pre-akinetes. A similar process can be induced in laboratory conditions via nitrogen starvation. Pre-akinetes are much more stress-tolerant than young vegetative cells. They survived when exposed to osmotic stress (Pichrtová et al., 2014a), desiccation (Pichrtová et al., 2014b), UV radiation (Holzinger et al., 2009), freezing (Hawes, 1990) and they were even observed to be the main overwintering stages (Pichrtová et al., 2016).

The strategy of vegetative survival is highly advantageous in the unstable conditions of polar terrestrial environments. Naturally hardened pre-akinetes with their storage accumulations give the algae a competitive advantage during early polar summer as they support rapid growth. On the other hand, populations growing early in the spring are susceptible to damage caused by diurnal, short-term freeze-thaw cycles.

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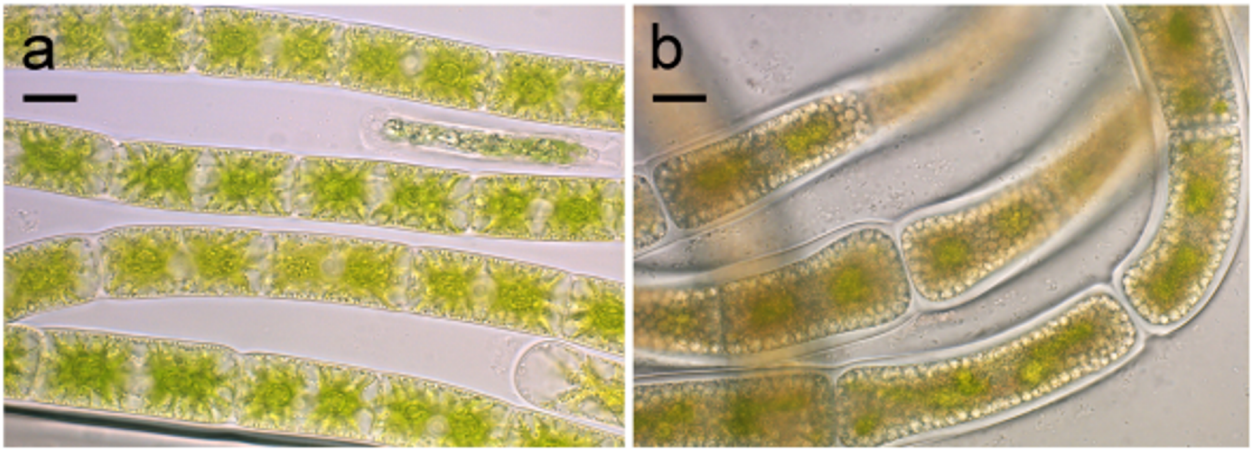

Figure 1 Young vegetative cells with star-shaped chloroplasts (a) and mature cells (pre-akinetes) filled with lipid droplets (b). Scale bars 20 µm.

Cold origin of land plants?

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Keywords: Zygnematophyceae, glacial ecosystem, albedo, Snowball Earth

The origin and diversification of land plants was one of the most important biological radiations. The attempts to better understand the evolutionary process received continuous attention since the delimitation of Streptophyta (a phyllum consisting of green Charophycean algae and Embryophytes). The split of Chlorophyta (the rest of green algae) and Streptophyta was probably crucial for the colonization of terrestrial habitat and it coincides with large glaciation events of the Cryogenian. Here we propose a possible role of life on glacial surfaces – an abundant aquatic biotop in the late Neoproterozoic – in the evolution of land plants. According to current knowledge, the sister lineage of Embryophytes is the highly diversified order Zygnematales (Desmids). At the same time, the typical eukaryotic photosynthetic inhabitant of the bare ice in ablation zones of recent glaciers is a Desmid belonging on morphological basis to the genera Cylindrocystis, Ancylonema or Mesotaenium. Our research effort focuses on sampling, cultivation, sequencing and characterization of the autecology of these organisms in two regions of the Arctic (Svalbard and Greenland). The aim is to integrate them into the dynamic mozaic of the phylogeny of Streptophyta in order to clarify whether they could be the crucial player in the origin of land plants.

Tolerance of diatoms (Bacillariophyceae) to experimental freezing: comparison of polar and temperate strains

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Keywords: diatoms, Bacillariophyceae, Polar microorganisms, stress tolerance, dormancy

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Polar areas are characterized by extreme environmental conditions (low temperatures, fluctuation of temperatures, lack of liquid water etc.), which could seem unfavorable for life. In spite of this, some groups of microorganisms were able to adapt successfully to the harsh polar environment. Diatoms (Bacillariophyceae), cyanobacteria and green algae (Chlorophyta) are dominant phototrophic organisms in many Arctic and Antarctic freshwater habitats and according to recent studies, a high number of Antarctic diatoms are endemic species (e.g. Cremer et al., 2004; Van de Vijver et al., 2014).

Extremely inhospitable polar environment with desiccation-rehydration and freeze-thaw cycles is stressful for microorganisms. These changes in liquid water availability can cause lethal damages of cells. To avoid the negative effects of freezing, there are many protective mechanisms (cryoprotective molecules – proteins, lipids, alcohols). A lot of microalgae survive as resting cells, spores or cysts. However, most freshwater diatom species are not known to form spores and there are only a few studies about pennate diatom resting stages. Their long-term survival is thus probably connected to the adaptation of vegetative cells to low temperatures and desiccation. The stress tolerance of temperate benthic diatoms seems to depend on habitat type (Souffreau et al., 2013). Additionally, a study of Antarctic cyanobacteria showed that strains isolated from seepages are less tolerant to desiccation and freezing than those from other wetland habitats (Šabacká and Elster, 2006).

The aim of this study was to compare the tolerance of polar and temperate diatoms from freshwater and terrestrial habitats to experimental freezing. Their ability to survive different freezing modes (including those simulating natural conditions) was experimentally tested. Diatom strains for the experiments were isolated in 2014 using natural samples from Antarctica and Spitsbergen. Further strains were acquired from culture collections of microorganisms (CCCryo and BCCM/DCG). In total, 26 strains representing species from both terrestrial and freshwater habitats were used for the experiments.

The experiments consisted of four different freezing treatments to which the vegetative and resting cells of the strains were exposed: 1. control (standard growth conditions); 2. continuous freezing to -4°C, -20°C and -40°C followed by fast thawing; 3. abrupt freezing to -20°C followed by slow thawing; 4. abrupt freezing to -190°C followed by fast thawing.

The study concludes that vegetative cells of diatoms are sensitive to freezing. The results did not emphasize the importance of resting cells for the survival of freezing treatments. Both vegetative and resting cells of all the strains survived the -4°C treatment. Most of the strains survived -20°C using continuous freezing followed by fast thawing. Only two terrestrial strains survived abrupt freezing and slow melting, which suggests that the speed of freezing and melting plays a role in survival. Five strains survived the -40°C freezing experiment and four of these also survived the liquid nitrogen treatment (-190°C) followed by fast thawing. These were strains belonging to the *Pinnularia borealis* species complex, represented by two terrestrial temperate, one freshwater polar and one terrestrial polar strain(s). This indicates that *Pinnularia borealis* is an extremely resistant species complex. The results of this study confirm that the tolerance to temperature extremes is habitat-dependent.

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Terrestrial diatom communities from Ulu Peninsula (James Ross Island, NE Antarctic Peninsula)

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Keywords: diatoms, soil, James Ross Island, Antarctica

Diatoms (Bacillariophyta) are one of the most divers and abundant algal groups in the Antarctic Region and play a dominant role in almost all freshwater and terrestrial ecosystems. Recent ecological surveys have dealt with freshwater, semi-aquatic and moss-inhabiting diatom communities of the Ulu Peninsula. Despite increased diatom research and efforts, the diversity, ecology and taxonomy of the terrestrial diatom flora of James Ross Island remain poorly known and a more thorough ecological and taxonomical survey was highly needed. The main aim of this study was to define ecological, taxonomical and biogeographical characterization of terrestrial diatom communities from an ice-free area of the Ulu Peninsula, James Ross Island. Diatom samples were collected during January and February 2015 from terrestrial habitats on James Ross Island, a 2,600 km^2 large island situated in the north-western part of the Weddell Sea, close to the northern tip of the Antarctic Peninsula. A total of 86 diatom taxa (including species, varieties and forms) belonging to 25 genera has been found during an analysis of 54 samples. Species richness per sample ranged from 5 to 35, with an average number of taxa per sample of 17. The most abundant species were *Hantzschia amphioxys* f. *muelleri*, *Luticola muticopsis* and *Pinnularia borealis* s.l. The most species-rich genera included *Luticola* (22 species), *Humidophila* (9 species), *Pinnularia, Nitzschia* (8 species), *Achnanthes*, *Hantzschia*, and *Muelleria* (5 species). Biogeographically, the soil diatom flora of the Ulu Peninsula is composed of cosmopolitan, Antarctic and endemic elements. Canonical Component Analysis was used to classify the samples based on their chemical characteristics, indicating that specific conductivity, moisture and TOC were the main factors dividing the samples into four different groups. The present study is the first analysis focusing on ecology of terrestrial diatom communities on James Ross Island, revealing the presence of a rather species-rich diatom flora and relationships between site-specific environmental parameters and diatom diversity.

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Interspecific differences in photosynthetic parameters of Antarctic foliose lichens at low temperature as evaluated by chlorophyll fluorescence parameters

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Keywords: Kautsky kinetics, *Physconia muscigena*, *Umbilicaria antarctica*, James Ross Island, Galindez Island

Chlorophyll fluorescence (ChlF) measurements represent an effective tool for evaluation of photosynthesizing organism response to different environmental stressors (Roháček et al., 2008). Compared to routinely used parameters focused on potential (Fv/Fm) and actual effectivity (Φ_{PSII}) of primary photosynthetic processes of lichen photobionts, characteristics derived from slow ChlF transient (Kautsky kinetics) are used much less frequently in ecophysiological studies. In lichens, slow ChlF transient was used to characterize sensitivity to photoinhibition (e.g. Conti et al., 2014) and freezing stress (Mishra et al., 2015). In our study, we exploited slow ChlF transient approach to evaluate a short-term response of two Antarctic chlorolichens (*Physconia muscigena, Umbilicaria antarctica*) to decreasing thallus temperature (20, 15, 10 and 5 °C) with a 10 min acclimation at each temperature. We hypothesized that the parameters derived from the ChlF transient shape and particular ChlF signals would be well related to selected ChlF parameters which resulted from application of saturation pulse technique and quenching analysis. For laboratory measurements at EEL (CzechPolar infrastructure), a HFC-10 fluorometer (PSI, Czech Republic) and a cooling unit (ConBrio) equipped by a thermostated water loop (Labio, Czech Republic) were used.

Slow ChlF transients showed temperature-dependent changes in their time courses (Figure 1, 2) and the same applied to parameters derived from the transients: RFd (sensu Lichtenthaler et al., 2005), Fp/Fs ratio, F_R (Smillie and Hetherington, 1984) and induction time at which S peak was achieved. These parameters were well related to ChlF parameters obtained by a saturation pulse method: Fv/Fm, Φ_{PSII} (effective quantum yield of photosynthetic processes in PSII), qN, NPQ (non-photochemical quenching) since they were found temperature-dependent, similarly to our earlier studies.

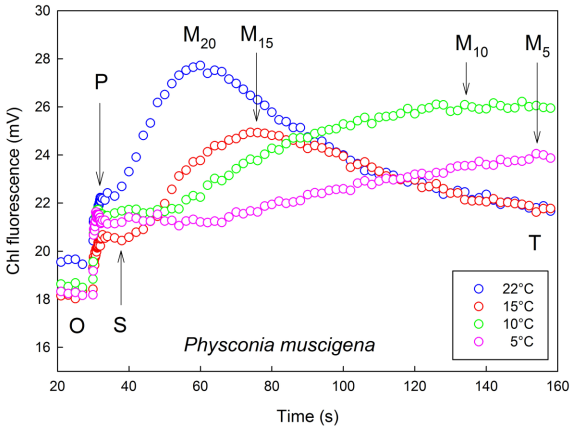

Figure 1 Slow chlorophyll fluorescence transients in *Physconia muscigena*, a lichen from James Ross Island, recorded at 20, 15, 10, and 5°C. Each curve represents a mean of fat least three replicates. Temperature-induced changes in O, P, S, M, T chlorophyll fluorescence signals are indicated by arrows.

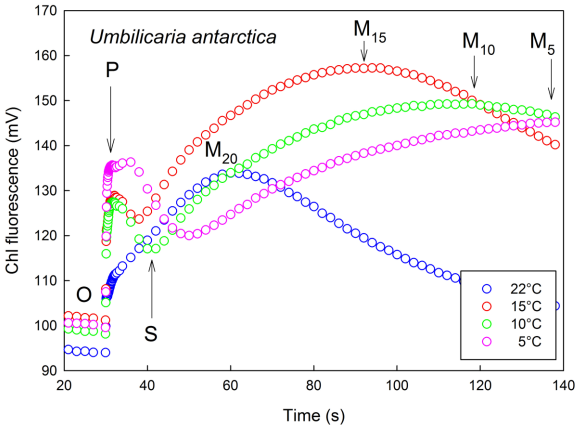

Figure 2 Slow chlorophyll fluorescence transients in *Umbilicaria antarctica*, a lichen from Galindez Island, recorded at 20, 15, 10, and 5°C. Each curve represents a mean of at least three replicates. Temperature-induced changes in O, P, S, M, T chlorophyll fluorescence signals are indicated by arrows.

It was, therefore, concluded that species-specific changes in the slow ChlF transients can be potentially used as indicators of low temperature stress in photosynthetic apparatus of lichen algal photobionts, altered redox state of plastochinone pool in particular.

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Preliminary report on piscicolid leeches from notothenioid fishes in Prince Gustav Channel

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Keywords: ectoparasite, Antarctica, Hirudinea, *Trematomus*, *Notothenia*

Fish leeches (Hirudinea) in Antarctica occur in marine habitats. Some members of the family are restricted to the Southern Ocean only and have not been recorded in other parts of the world (Utevsky, 2007). Utevsky (2007) mentions existence of 21 species belonging to 13 genera and three "subfamilies" from all the Antarctic Seas.

Our study is focused on the abovementioned group of annelids and aims to report species composition and genetic variability of Antarctic leeches from notothenioid fish in the Prince Gustav Channel (Weddell Sea). In total, 23 specimens belonging to four species have been collected from the *Trematomus bernacchii* (prevalence 33%, intensity of infection 1–4), *T. hansoni* (6%, 1–3) and *Notothenia coriiceps* (7%, 1). The determination is still in progress. We presume these four genera in our material: *Nototheniobdella* (Piscicolinae), *Trulliobdella* (Piscicolinae), *Moorebdellina* (Pontobdellinae), and *Cryobdella* (Platybdellinae). They differ in localisation on host body (gills or under gill lids, skin and fins). Specimens assigned to genus *Nototheniobdella* fed on host gill tissue and thus caused important, macroscopically noticeable changes.

Our material was measured and documented by microphotographs from light microscope and two individuals were observed by scanning electron microscopy. DNA analyses will be performed to elucidate the exact species determination. The nuclear 28S rRNA gene portion, mitochondrial tRNA Leu gene with nicotinamide adenine dinucleotide dehydrogenase subunit one (ND1), 12S rRNA and cytochrome oxidase subunit one (COI) fragments will be amplified.

Acknowledgements

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Inductively coupled plasma mass spectrometry in analysis of Antarctic otoliths

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Keywords: otoliths, laser ablation, inductively coupled plasma mass spectrometry, Antarctica, Nototheniidae

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A fish otolith, also called an ear stone, has been long known as a timekeeper, which grows continually until fish dies, and acts as a recorder to preserve every environmental and biological event of the fish, from its hatching until its death. It is possible to get the whole chronological lifetime of the fish retrospectively. However, the Antarctic otoliths have not been properly studied yet; therefore, this study is focused on the analysis of Antarctic otoliths from James Ross Island. Regrettably, there is still lack of information about water chemistry or climate change, which seem to be necessary conditions for the best chance to find any relatively unknown Antarctic species.

During the Czech Antarctic expedition in 2014, 102 fish of five different species (*Trematomus hansoni*, *T. newnesi*, *T. bernacchii*, *Parachaenichthys charcoti* and *Notothenia coriiceps*) were caught in the Prince Gustav Channel, which separates the Antarctic Peninsula from James Ross Island. For the purpose of this work, only sagittal otoliths were examined.

Otoliths of 27 fish individuals were analysed using laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS), with two different types of laser, femtosecond (fs) and nanosecond (ns), employed. The main difference between short (>1 ps) and ultra-short (<1 ps) laser pulses is based on fundamental understanding of the laser ablation processes. Using ultra-short pulses, small and uniform particles are generated, which facilitates particle atomization and ionization. The fractionation effects are strongly reduced, as well as thermal effects. Each sample was analysed by both laser ablation systems maintaining identical conditions.

First of all, the comparison of ns and fs lasers has been performed. Our results showed significantly higher intensities of internal standard ^{43}Ca in SRM NIST 610 by a factor of 80 using fs laser over ns laser. In the case of a real sample, the ^{43}Ca intensity was even higher, by a factor of 100.

Moreover, typical isotopes for otolith analysis have been chosen: ^{24}Mg, ^{25}Mg ,^{43}Ca, ^{55}Mn, ^{56}Fe, ^{63}Cu, ^{66}Zn, ^{88}Sr and ^{138}Ba, as well as heavy isotopes, which would potentially indicate a human impact on the Antarctic environment: ^{52}Cr, ^{107}Ag, ^{111}Cd, ^{202}Hg and ^{208}Pb.

In addition, the interpretation of the life history of fish is usually expressed by elemental ratios of Sr/Ca, Ba/Ca and Mn/Ca, which are used as markers of migration pathways, biological or environmental events. After a comparison of all samples, similar profiles with characteristic marks within species have been found, which probably represent typical events in fish life. As an alternative to the Sr/Ca ratio, the ^{87}Sr/^{86}Sr ratio, which takes fish migration into account, is also used. Therefore, the strontium isotope ratio of all samples was determined as well. Finally, a comparison between water and otolith chemistry has been made.

In summary, a completely new perspective on the Antarctic environment, and especially information obtained from local fish species, is introduced and may help in future studies of these particular species.

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Classification of psychrotrophic pseudomonads

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Keywords: psychrotrophic, *Pseudomonas* species, Antarctica, phenotyping, genotyping, taxonomy

Within Czech polar expeditions to Johann Gregor Mendel Station on James Ross Island, Antarctica, biotic and abiotic microbial samples were collected. We picked out 439 presumptive pseudomonads isolated in the years 2011–2014 for further investigation. Initial sorting based on two genus-specific PCRs (Mulet et al., 2009; Nair et al., 2014) distinguished 240 strains as *Pseudomonas* species and these were then characterized in more detail.

Phenotypic methods included e.g. the ability to utilize various saccharides and growth on special media or under different temperature conditions. Some results of biochemical analysis were used for species identification by software TNW lite 7.0. However, we could identify only about 54% of the strains with sufficient reliability. The rest of the isolates have too many unusual results to be identified by this system or they belong to species that are not included in TNW database. To show the overall phenotypic similarity of our samples we performed a cluster and an ordination analysis. Both methods separated 28 strains with problematical identification from the main cluster and we suspect that these were probably inaccurately included among pseudomonads by the genus-specific PCRs.

For genotyping we used a repetitive PCR approach (Versalovic et al., 1991). Acquired fingerprints were processed using the BioNumerics 7.6 system and the R 3.2.1 software environment. Surprisingly, the dendrogram based on the rep-PCR method did not correspond very much to the phenotyping results. We chose seven strains which were identified as *Pseudomonas fluorescens* by TNW lite for sequencing of *Pseudomonas* conservative genes. Each of these strains was localized in different cluster across the whole genotypic dendrogram. Nevertheless, we found a cluster of unidentified species that had the same structure in both (phenotypic and genotypic) cluster analyses. Thus one representative of them was chosen for conservative gene sequencing as well.

Our results show how much the species determination of psychrotrophic pseudomonads is limited on the phenotype level. We also assess if the repetitive PCR approach is a suitable method for this type of samples and expected species resolution.

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Assessment of the phototrophic potential in the cryosphere by laser-induced fluorescence emission (L.I.F.E.) technology

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Keywords: ice, laser-induced fluorescence emission (L.I.F.E.), non-invasive, porphyrin, phototrophic potential, Antarctica

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Global warming increases the availability of liquid water in ice ecosystems which enhances microbial activity and leads to a change in the phototrophic potential. In some areas, glacier retreat is even unstoppable (Rignot et al., 2014). Yet, there exists no reliable monitoring system for these parameters. The standard methodology to detect microbial life in icy environments involves severe manipulation of the ecosystem (e.g. coring, cutting and melting). The sensitivity of many psychrophiles to even moderate changes in temperature results in a distortion of *in-situ* conditions. Sampling at remote study sites is often hampered due to logistical constraints which limits the sample capacity. Spatial data up-scaling decreases the spatial data resolution and therefore restricts its accuracy. Hence, the development of suitable *in-situ* monitoring tools covering large areas at high spatial resolution is of critical importance.

Here we present a new prototype device for a non-invasive *in-situ* detection and quantification of porphyrin biomarker molecules which are considered as suitable biomarkers for detection of life (Suo et al., 2007) and as indicators of phototrophic potential of an ecosystem. They are widely distributed molecules among living organisms and feature strong durability regarding temperature and low pH conditions (Edwards et al., 2005). Further, porphyrins are involved in pigmentation, electron transport (cytochrome using iron), energy conversion (chlorophylla with magnesium), oxygen transfer (hemoglobin using iron as central atom) and other important biological processes (Groemer et al., 2014). The *in-situ* detection of these molecules can be performed by using laser-induced fluorescence emission technology. L.I.F.E. occurs when matter absorbs a fraction of an incident laser beam and emits a longer wavelength (lower energy) photon. This technology is arguably the single most sensitive active photonic probe of biomolecular intracellular and extracellular targets that does not require sample preparation, sample destruction, or consumable resources other than power.

Based on previous experience (Groemer et al., 2014) we improved the hardware design and eliminated limiting factors such as the influence of stray light and temperature issues. The data acquisition process is fast and easy and the data reduction is done internally. The main features include a temperature stabilized 16 bit Raman spectrometer, temperature stabilized lasers (405 nm and 532 nm), a GPS unit, autofocus and a resistive touchscreen that can be controlled with gloves. The L.I.F.E. prototype can be used as a handheld device or mounted on a tripod. The files are accessible via USB, Wlan or LAN. The prototype has been tested during the TAWANI 2015 Antarctic expedition at Lake Untersee, Dronning Maud Land.

Acquiring high spatial and spectral resolution data of porphyrins in extreme habitats is of crucial importance in context with global change. Future climate models will benefit from our monitoring tool because high resolution data from biological processes at the ice-atmosphere boundary have not been implemented in climate models yet. Moreover, non-invasive tools provide far more reliable data of sensitive environments due to the lack of manipulation and should be the way to go when it

comes to monitoring of subzero habitats.

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Seal remains as sources of mercury for Antarctic environment

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Keywords: mercury, speciation, soils, Antarctica

The northern part of James Ross Island (Antarctica) presents a location with an unusual occurrence of seal carcasses. Today, more than four hundred of seal remains are mapped in the ice-free areas of the island. Due to their high trophic position, seals are known to carry a significant mercury body burden. When a seal dies, its decomposing remains gradually release both nutrients and contaminants into the subsoil. The main goal of this study was to estimate importance of this mercury source and mercury fate in the environment. Moreover, HPLC-ICP-MS with isotopic dilution was used for determination of the most toxic mercury form, methylmercury. Also, the relationship between mercury and organic carbon was investigated.

The contents of mercury in underlying soils were found to be up to five times higher than the background levels. Methylmercury formed up to 2.8% of total mercury. Also, the levels of total organic carbon were significantly elevated. The input of nutrients enables growth of lichens and mosses with mercury accumulative potential. Thus, further accumulation of mercury can be expected.

According to the results, seal remains represent a clear source of mercury in the observed area. It seems that the nutrient-rich oases formed around seal carcasses are also hotspots of mercury and its further accumulation.

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