WP	**05a**
Agenda Item:	2.1
Person Responsible:	Representative from Czech Republic

XXXIII SCAR Delegates Meeting

Auckland, New Zealand, 1-3rd September 2014

Application of the Czech Republic for Associate Membership

Executive Summary

Title: Application of the Czech Republic for Associate Membership

Authors: Czech authorities

Important Issues or Factors: From the SCAR Rules of Procedure:

Applications for Associate Membership:

1.3.1 are usually expected to precede application for full membership; and

1.3.2 shall be accompanied by a statement of what the applicant hopes to contribute to and/or gain from the Charity.

Recommendations/Actions and Justification: Delegates are requested to consider the Czech application for Associate Membership of SCAR.

Budget Implications: $5,000 annual membership fee for Associate Membership.

RECTOR OF MASARYK UNIVERSITY

Dr Mike Sparrow, SCAR Executive Director
Scientific Committee on Antarctic Research
Scott Polar Research Institute
Lensfield Road
CB2 1ER Cambridge
United Kingdom

Your Letter (Ref. No. / Date)	Reference Number	Contact / Email	Place, Date
		Pavel Kapler, Ph.D. kapler@sci.muni.cz	Brno, November 18, 2013

Subject: Czech Republic's Application for the Associate Membership in the SCAR

Dear SCAR Executive Director,

hereby the Masaryk University is presenting its Application for the Associate Member Status to the Scientific Committee on Antarctic Research - SCAR (the Charity).

The Czech Republic, as the newest member with the consultative party status to the ATCM and the newest member of COMNAP (both since 2013), intends to achieve a next step and becomes the Associate Member to the SCAR. The Masaryk University, as the owner and operator of the Johann Gregor Mendel Czech Antarctic Station, James Ross Island (i.e. the only Czech scientific base in the Antarctica), declares that it represents the Czech Republic's National Antarctic Programme. It has a full ability to abide by and support the Charity in its mission to advance and promote scientific knowledge, understanding and education on any aspect of the Antarctic region, on the role of the Antarctic region in the Earth system and on the effect of global change. The Masaryk University representatives feel a high level of self-identification with the ideas of the Charity as well as they can see the importance and necessity of the international cooperation especially in the scientific research and the protection of Antarctica.

This Application of the Masaryk University for the Associate Member Status to the Charity is the logical continuation of our ongoing activities. The additional detailed information required to accompany this Application for the Associate Member Status is contented in attached enclosures.

On behalf of the Masaryk University I would like to hope in your kind acceptance of this Application and I look forward to cooperate more closely with the Charity and its members in the future.

Sincerely Yours,

doc. PhDr. Mikuláš Bek, Ph.D.
Rector of the Masaryk University

Enclosures:
Appendix I *The ASCR's recommendation of the Masaryk University as the Czech National Lead Agency to the Charity.*
Appendix II *Statement of the Czech national and scientific achievements in Antarctica.*
Appendix III *Identification of the organisation that would act as the Czech National Lead Agency to be involved in the Charity.*

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ACADEMY OF SCIENCES OF THE CZECH REPUBLIC

PRESIDENT

Dr Mike Sparrow, SCAR Executive Director
Scientific Committee on Antarctic Research
Scott Polar Research Institute
Lensfield Road
Cambridge
CB2 1ER
United Kingdom

Prague, November 12, 2013
Ref. No. KAV-3341/P/2013

Recommendation of the Masaryk University as the Czech National Lead Agency to the SCAR

This is to certify that

the Academy of Sciences of the Czech Republic, as the member of the International Council for Science (ICSU), declares that the Masaryk University is eligible body to act as The Czech National Lead Agency to the Scientific Committee on Antarctic Research - SCAR (the Charity) as an Associate Member.

The Academy of Sciences of the Czech Republic hereby nominates and recommends Masaryk University, as the owner and operator of the Johann Gregor Mendel Czech Antarctic Station, James Ross Island (i.e. the only Czech scientific base in the Antarctica), to be accepted as an Associate Member of the Charity on behalf of the Czech Republic's National Antarctic Scientific Research Program.

The Masaryk University is fully responsible to cover all costs related to its membership in the Charity. There will not be any financial commitments on the side of the Academy of Sciences of the Czech Republic.

Sincerely yours

Professor Jiří Drahoš

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Appendix II

Statement of the Czech national achievements in Antarctica

Index

Executive Summary
As the Czech Republic has no other interest in Antarctica other than scientific research, this overview brings the information on Czech Antarctic research that has been carried out since 1994 at different locations in Antarctica: King George Island, Galindez Island, James Ross Island and Antarctic peninnsula in particuar. An overview is presented for main research directions of the Czech scientific community, *i.e.* Geosiences, Climatology, Systematic biology, and Experimental biology. In the report, brief history of scientific investigations in particular Antarctic locations, the methods used for individual research projets and the most important results are presented as well as references to relevant publications.

Geosciences
The recent substantive scientific research of Czech geoscientists in the northern Antarctic Peninsula and James Ross Island has been launched by means of two framework projects financed by the Czech Ministry of the Environment since 2003 and performed by the Czech Geological Survey, Faculty of Science, Charles University, Institute of Geology, Czech Academy of Science, and the National Museum. The research covers several major topics: 1. Topographic, geological and geomorphological mapping, 2. Genesis and tectonic evolution of the Antarctic Peninsula, 3. Thermochronology of back-arc James Ross Basin evolution, 4. Palaeontology and palaebiogeography of Cretaceous high latitudes communities based on fossil material from James Ross Basin, 5. Cenozoic subglacial back-arc volcanism on James Ross Island, 6. Sedimentary processes associated with subglacial volcanism and glacial to interglacial climate changes during the Neogene, 7. Glaciology and recent changes of local glaciers, 8. Landscape evolution of deglaciated parts of James Ross Island during the Holocene in a semi-arid sub-polar region, 9. Physical and chemical limnology. The geoscientific research resulted in a large number of peer-reviewed publications in international journals listed below. As a substantive contribution to basic scientific knowledge we consider a new detailed topographic map of the northern part of James Ross Island, subsequently a new geological map of this area and corresponding interpretation of the geological setting and evolution, documented in numerous scientific papers. As highlights, new palaeontological findings of the first fossil sponge in Antarctica of a mid-Cretaceous age can be considered. Currently a skeleton of a marine reptile belonging to the Elasmosauridae family (plesiosaurus) from the Upper Cretaceous is being reconstructed. From the field glaciological measurements on a small land-terminating glacier at the northern James Ross Island can be evidenced their positive mass balance during exceptionally cold and wet years of 2007, 2009, 2011 or 2012. Thus small glaciers could grow at a scale of individual years, in spite of global warming of the atmosphere around the Antarctic Peninsula. Importantly this, however, does not contradict the general trend of their retreat at a scale of decades or few centuries.

Climatology
Since 1994, atmospheric and climate research have been carried out primarily on King George Island (Polish Arctowski Station, South Shetland Islands). The measurements of components of surface energy balance and thermal regime of the active layer were taken at a vegetation oasis. Second site was situated at the Ukrainian Vernadsky Station (Galindéz Island - Argentinean Islands). Results provided the first comprehensive information about the energy balance and the dynamic of its components at the Antarctic coastal vegetation oasis in daytime and throughout summer. Recently, climatological research presents a comprehensive analysis of the relationship between stratospheric ozone, cloudiness and solar UV radiation carried out in the region of Antarctic Peninsula and James Ross Island since 1995. Special attention is given to modeling of incident UV radiation. Nonlinear regression model was

developed that improved the way how to estimate daily UVeff (UV effective) radiation incident on the Earth's surface in the region. Long-term monitoring of climate variability in the region of Antarctic Peninsula and James Ross Island represents an important part of climatological research. A network of automatic weather stations has been established at the following locations: James Ross Island (10 stations), Antarctic penninsula (Botany Bay), Antarctic peninsula (O´ Higgins), and Seymour Island, in order to study climate variability at regional scale.

Systematic Biology
Research in this particular field of science is directed mainly to evaluation of biodiversity of autotrophic microorgamisms abundant at James Ross Island with a special respect to cyanobacteria. Enormous piece of work has been done on field collection of samples from different Antarctic habitats, and determination of the species using anatomical, morphological and molecular biology apparoaches. Main emphasis is given to the investigation of cyanobacterial diversity in microbiological mats that are quite frequent in lakes, streams and other moist habitats of James Ross Island. There are several particular subprojects running recently. Among them, studies on origin of Antarctic microflora and its specificity, biodiversity of autotrophic organisms from Antarctic lakes, microbial colonization of deglaciated soils and rocks, autecology of different species and their adaptation processes to moist and cold environment, biological composition of soil crusts must be mentioned.

Experimental Biology
Field- and laboratory-based experiments comprising different aspects of physiological processes in Antarctic extremophilic organisms started in 2002. First, Czech plant physiologists participated as international scientists in expeditions to King George Island and Galindez Island. Since 2006, they have been investigating physiological processes in Antarctic mosses, lichens, algae at James Ross Island (J.G. Mendel station). A wide array of topics has been studies: The effect of long-term elevated air temperature on structure and function of vegetation (open top chambers installed in Antarctica), *in-situ* monitoring of physiological activity of microbiological mats, long-term monitoring of photosynthetic processes in Antarctic moss using chlorophyll fluorescence approach. In laboratory experiments, physiological background of the resistance of Antarctic lichen and their algal photobionts to a variety of stresses such as photoinhibition, desiccation, osmotic stress, low and freezing temperature, and excess UV radiation is studied. Physiological properties of black microfungi, soil bacteria isolated from the samples collected at James Ross Island are studied as well.

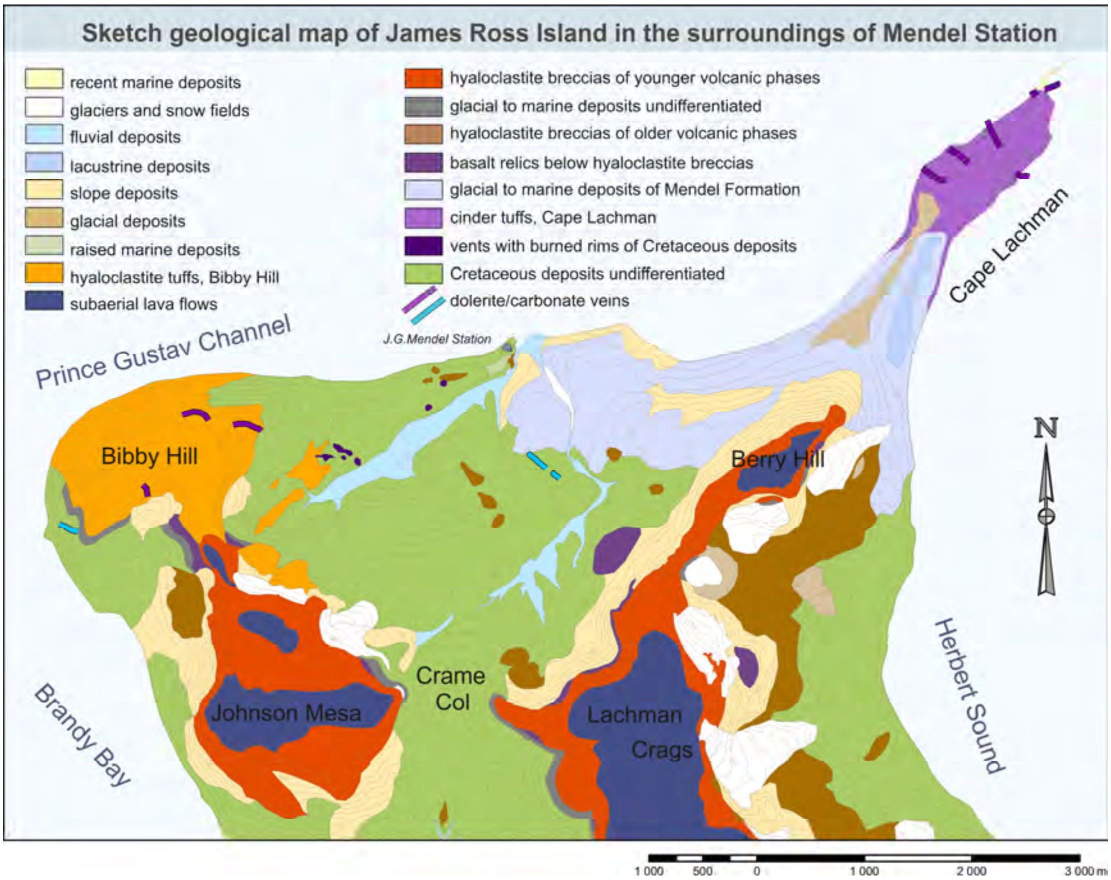
Geosciences

The research of Czech geologists in the area of the northern Antarctic Peninsula started in 2003 with the R &D project "Geological Research of Antarctica" (SB/VaV/660/01/03, period 2003–2005; project leader P. Mixa, Czech Geological Survey) financed by the Ministry of the Environment of the Czech Republic. This was followed by other R & D project "Contribution of the Czech Republic to the investigation of the ozone layer and solar UV radiation in Antarctica, palaeoclimatic and palaeogeographic reconstruction of selected Antarctic territory and related geological study and mapping" (VaV SP II 1a9/23/07, period 2007–2011; project leader P. Mixa, Czech Geological Survey). During the work on both projects researchers from the Czech Geological Survey; Faculty of Science, Charles University; Institute of Geology, Czech Academy of Science and National Museum worked on numerous topics in individual geoscientific disciplines including geology, geochemistry, geomorphology, palaeontology, limnology or glaciology. Many of the topics resulted however from the collaboration with researchers supported by other scientific project, such as the project "Recent deglaciation of the northern part of James Ross Island, Antarctica" supported by the Czech Science Foundation (GAČR 205/09/1876, period 2009–2012; project leader K. Láska, Masaryk University, collaboration with the Czech Geological Survey and Charles University).

Topographic, geological and geomorphological mapping

The initial phase of the geological research in the northern ice-free region of James Ross Island showed an urgent need of a detailed topographic base map and digital terrain model (DTM) for any mapping and other field geoscientific research. The only available topographic map at the moment was a BAS topographic map of James Ross Island at the scale of 1:100,000 (BAS, 1995) with contours every 100 m, which failed to be detailed enough for any of in-depth research activities in the area of concern. The first attempt to construct the topographic map based on the satellite SPOT stereo-pairs failed due to the high cloud coverage during three consecutive summer seasons of 2005 to 2007. Therefore, aircraft-borne aerial photographs of the British Antarctic Survey and the Royal Navy have been used. Planimetry and a DTM were stereoplotted in cooperation with the GEODIS Brno from the abovementioned aerial imagery using digital photogrammetric methods. The exterior orientations of the aerial photographs were calculated by aerotriangulation method. More than 70 points were measured in 2008 by dual frequency GPS/GLONNAS equipment for the ground control at easily located places, such as large hyaloclastite/erratic boulders, sharp edges of mesas, slope brakes etc. The bundle block adjustment results differ for individual images. The newest BAS (2006) photographs enabled the RMSE resolution of 0.7 m and 0.8 m in plane and height respectively. The survey VINTEN 70 stereo-photographs brought the lowest RMSE resolution of 2 m in both plane and height. This resolution was sufficient enough to plot the map at the 1:25,000 scale. The areas constructed using the newest photographs are of the European standards for construction of DTM at the scale of 1:10,000. The contours at the 10 m basic interval with secondary contours every 5 m in flat areas were derived from the acquired DTM. The map was published in bilingual version (English and Spanish) incorporating formal British names originating from the UK Antarctic Placenames Committee, informal Argentinean names previously published or unpublished and new place names proposed by the Czech Antarctic Community. All names are listed in English and Spanish, the two world languages broadly used in this part of Antarctica. The data are actually incorporated in the Antarctic Digital Database (ADD) of the SCAR, from which it could be downloaded for non-commercial purposes. The previous use of both the published and digital version of the topographic map proved the necessity and importance of this work. It helped significantly not only to a safer movement on land and along the coast, but also for subsequent research in wide fields of geoscience, biology and chemistry undertaken on James Ross Island.

One of the main aims of the field geological research at the northern ice-free part of Ulu Peninsula, James Ross Island was the geological mapping. In spite of the long history of geological research of Argentinean and British geologists in this territory, no geological map has been produced for the Ulu Peninsula yet. Four major geological units crop out in the northern James Ross Island. These are Cretaceous marine sediments of the back-arc James Ross Basin (*e.g.* Olivero et al., 1986; del Valle et al., 1992; Francis et al., 2006); Neogene to Quaternary mostly subglacial back-arc volcanic rocks of the James Ross Island Volcanic Group (*e.g.* Nelson, 1966; Smellie et al., 2008) with intercalated Neogene glacial to glaciomarine sediments (*e.g.* Pirrie et al., 1998; Lirio et al., 2003; Nelson et al., 2009; Nývlt et al., 2011) covered by Late Pleistocene to Holocene glacial, periglacial and paraglacial deposits (*e.g.* Carrivick et al., 2012; Davies et al., 2013; Nývlt et al., in review). Individual geological units mapped in the ice-free part of the Ulu Peninsula are described in detail below. The geological mapping of this area was undertaken in collaboration with Argentinean geologists, which have very wide local knowledge especially in Cretaceous sediments. The preliminary geological map was presented by Mlčoch (2013).



Sketch geological map of the northern ice-free part of Ulu Peninsula, James Ross Island

Concurrently with geological mapping Czech geoscientists mapped also main landforms of the ice-free are of the Ulu Peninsula, James Ross Island. Beside the structural landforms associated mostly with volcanic rocks of the James Ross Island Volcanic Group and Cretaceous marine sediments of James Ross Basin the main groups of landforms are connected with the glacial, periglacial and paraglacial processes, less common are gravitational, fluvial and marine types of landforms. Geomorphological map was presented in collaboration with British geomorphologists in Davies et al. (2013).

Published results:

Czech Geological Survey, 2009. James Ross Island – Northern Part. Topographic map 1 : 25 000. Czech Geological Survey, Praha.

Janoušek, V., Nývlt, D., Mlčoch, B., Vodrážka, R., 2012. Geologické výzkumy České geologické služby v Antarktidě (ostrov Jamese Rosse a přilehlá část Grahamovy země). Vesmír, 91, 426–431.

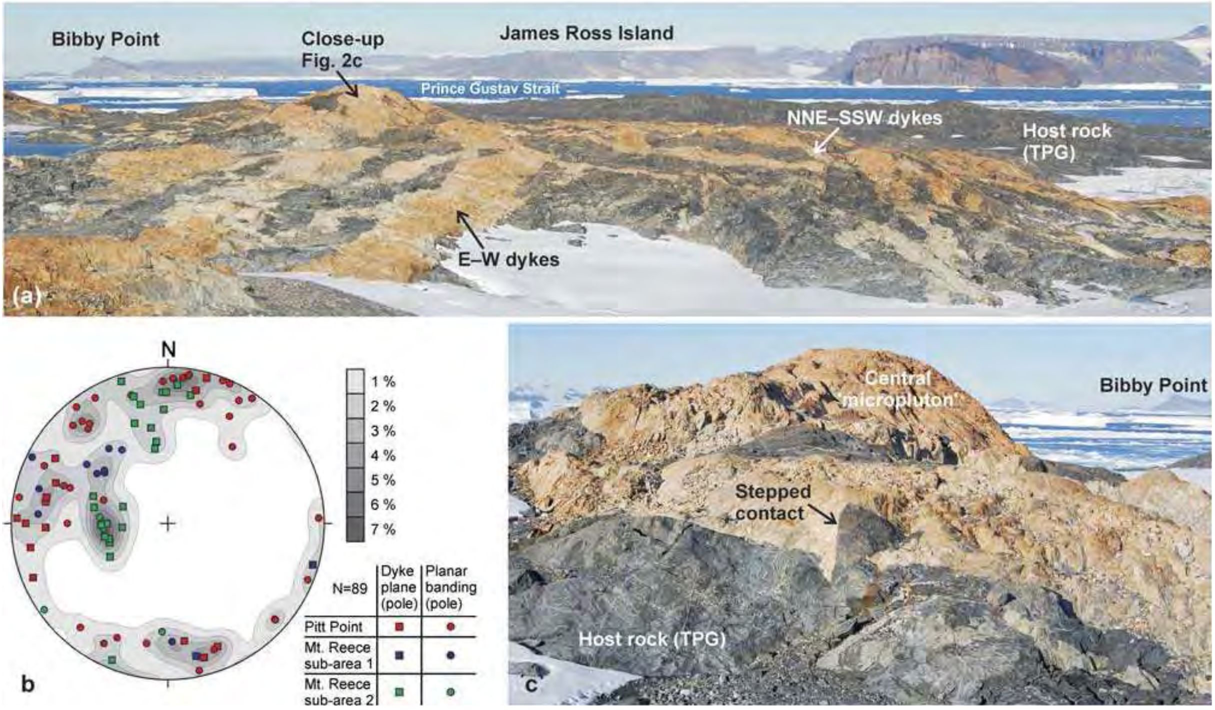
Mlčoch, B., 2013. 5.2.2 Geologické mapování ostrova Jamese Rosse. In: Prošek, P. (ed.): ANTARKTIDA. 249–253, Academia, Praha.

Davies, B.J., Glasser, N.F., Carrivick, J.L., Hambrey, M.J., Smellie, J.L., Nývlt, D., 2013. Landscape evolution and ice-sheet behaviour in a semi-arid polar environment: James Ross Island, NE Antarctic Peninsula. In: Hambrey, M.J., Barker, P.F., Barrett, P.J., Davies, B., Smellie, J.L., Tranter, M. (eds): Antarctic Palaeoenvironments and Earth-Surface Processes. Geological Society, London, Special Publication, 381.

Genesis and tectonic evolution of the Antarctic Peninsula

Superbly exposed felsic dykes at the Pitt Point and along the north-eastern slope of Mount Reece near the Victory Glacier, east coast of the Graham Land, north-eastern Antarctic Peninsula allowed for direct observation of contact relationships against the metamorphic host rock, flow banding and effects of its synmagmatic deformation. The field observations were combined with the AMS data in order to interpret the dyke emplacement mode and magma flow directions. Finally, the possible regional tectonic setting of the dykes were inferred and broader implications for the geometry of crustal extension linked to the early stages of the south-western Gondwana break-up and the mid-Jurassic formation of the Larsen Basin (north-western Weddell Sea) were discuss by Žák et al. (2012). The felsic dykes examined in this study are hosted in the Permian–Middle Triassic quartzose metasandstones, metagreywackes, and metapelites of the Trinity Peninsula Group (TPG; Smellie, 1991). The tectonic setting of these turbidite siliciclastic successions remains unclear (fore-arc, trench-slope, or back-arc basins), but most studies concur in the interpretation that the TPG has been involved in the subduction-accretion complex along the proto-Pacific active margin of south-western Gondwana (*e.g.* Barbeau et al., 2010). The TPG has been affected by polyphase deformation and late Permian to early Triassic low-grade regional metamorphism under prehnite–pumpellyite to greenschist-facies conditions (Smellie et al., 1996, Wendt et al., 2008). These basement rocks are unconformably overlain by the Lower to Middle Jurassic siliciclastic successions dominated by conglomerates and sandstones of the Botany Bay Group (Farquharson, 1984). Samples from the Botany Bay Group dated using the U-Pb method on detrital zircons yielded maximum ages of deposition of 169 ± 1 Ma (Hunter et al., 2005) and 162–168 Ma (Barbeau et al., 2010); it is devoid of volcanic rocks except for a single lapilli tuff horizon approximately in the middle of the succession, dated at 167 ± 1 Ma (U-Pb on zircons; Hunter et al., 2005). The Botany Bay sedimentary rocks were interpreted as having been deposited as debris flows, alluvial fans, and flood-plain deposits in relatively small fault-bounded basins (grabens) linked to the incipient lithospheric extension during the early stages of Gondwana break-up (Hathway, 2000).

The siliciclastic rocks of the Botany Bay Group are overlain conformably by subaerial volcanic rocks of rhyolitic and andesitic composition (formerly referred to as the Antarctic Peninsula Volcanic Group, recently redefined as the Graham Land Volcanic Group; Riley et al., 2010). The volcanic rocks are dominated by ignimbrites and agglomerate tuffs. Lava flows, small domes, and sills are subordinate. At Camp Hill, U-Pb on zircons from an ignimbrite gave an age of 167 ± 2 Ma (Pankhurst et al., 2000). Elsewhere along the eastern coast of Graham Land, comparable volcanic rocks were dated at ~162–171 Ma with the peak of igneous activity at ~168 Ma (Riley et al., 2010).



Felsic dykes and associated structures in the Pitt Point area

In terms of lithology and field relationships, the felsic dykes examined in the study of Žák et al. (2012) compare closely with the volcanic rocks found at Camp Hill and Crystal Hill. The Pitt Point and Mount Reece areas may thus expose a deeper, sub-volcanic section of now eroded volcanic apparatus, whereby the dykes may represent 'fossil' feeder zones (Riley and Leat, 1999). The dykes are felsic, ranging from granite porphyry with feldspar and quartz phenocrysts up to 0.5 cm across to fine-grained or aphanitic rhyolite. They are all characterized by complex geometry and internal structures as described in great detail below. The new high-precision LA-ICP-MS zircon dating of these dykes yielded concordant U-Pb ages of 174.2 ± 0.6 Ma (2σ), 175.2 ± 0.7 Ma (Mount Reece), and 178.6 ± 0.7 Ma (Pitt Point), indicating the time span of dyke emplacement as ~174–179 Ma (Early to Middle Jurassic; Janoušek and Gerdes, unpublished data). Further west, the TPG is intruded by a shallow-level granite pluton that makes up much of the Mount Reece nunatak. The pluton is composite and consists of several granite varieties (Žák et al., 2012). Perhaps the most widespread is a medium- to coarse-grained weakly porphyritic biotite granite. None of the granites displays evidence of syn-magmatic or sub-solidus deformation. The pluton/TPG contact is sharp, curviplanar or stepped and largely discordant to structures in the TPG. The emplacement of the granites thus clearly post-dated the lowgrade metamorphism and regional deformation of the TPG. Field relationships indicate that the relative ages of the felsic dykes and the granite are more complex (Žák et al., 2012). The porphyritic biotite granite truncates the dyke complex in the pluton roof, but some rhyolite dykes also cross-cut a medium-grained equigranular schlieren-rich granite. This is consistent with the new geochronological data that indicate a prolonged granitic magmatism at Mount Reece (~166–185 Ma; Janoušek & Gerdes, unpublished data).

The study of Žák et al. (2012) concludes that the Early to Middle Jurassic (Toarcian–Aalenian) steep rhyolite dykes at Pitt Point form two nearly perpendicular sets (NNE–SSW and E–W). These two sets were emplaced simultaneously and define a large-scale chocolate-tablet structure, implying biaxial principal extension in WNW–ESE and N–S directions. At Mount Reece, the WNW–ESE set locally dominates, suggesting variations in the direction and amount of extension. Magnetic fabric in the dykes is predominantly 'normal' (the maximum and minimum principal susceptibilities lay within the dyke plane) and indicates dip-parallel to dip-oblique (?upward) magma flow. All the above is consistent with the dykes representing sub-volcanic feeder zones above a magma source. The dyke emplacement was synchronous with the onset of opening of the Weddell Sea, but it remains unclear whether it was driven by regional stress field, local stress field above a larger plutonic body, or by an interaction of both.

Published results:

Janoušek, V., Gerdes, A., Žák, J., Soejono, I., Venera, Z., Erban, V., Lexa, O., Mixa, P., 2011. Nature, origin and causes of Jurassic felsic igneous activity in the Victory Glacier area (Eastern Graham Land). In: Williams, P., Mitchell, R. (eds): Mineralogical Magazine. Goldschmidt Abstracts 2011, 75, A1103.

Janoušek, V., Nývlt, D., Mlčoch, B., Vodrážka, R., 2012. Geologické výzkumy České geologické služby v Antarktidě (ostrov Jamese Rosse a přilehlá část Grahamovy země). Vesmír, 91, 426–431.

Janoušek, V., Venera, Z., 2013. 5.2.1 Geologický výzkum Antarktického poloostrova. In: Prošek, P. (ed): ANTARKTIDA. 245–249, Academia, Praha.

Janoušek, V., Žák, J., Soejono, I., Venera, Z., Erban, V., Lexa, O., Mixa, P., 2011. Nature and tectonic setting of Jurassic felsic igneous activity in the Victory Glacier area (Graham Land, Antarctic Peninsula). In: Lexa, O., Jeřábek, P., Závada, P., Ulrich, S: Travaux Géophysiques, 40. p. 30, Geofyzikální ústav AV ČR, Praha.

Žák, J., Soejono, I., Janoušek, V., Venera, Z., 2012. Magnetic fabric and tectonic setting of the Early to Middle Jurassic felsic dykes at Pitt Point and Mount Reece, eastern Graham Land, Antarctica. Antarctic Science, 24, 45–58.

Thermochronology of back-arc James Ross Basin evolution

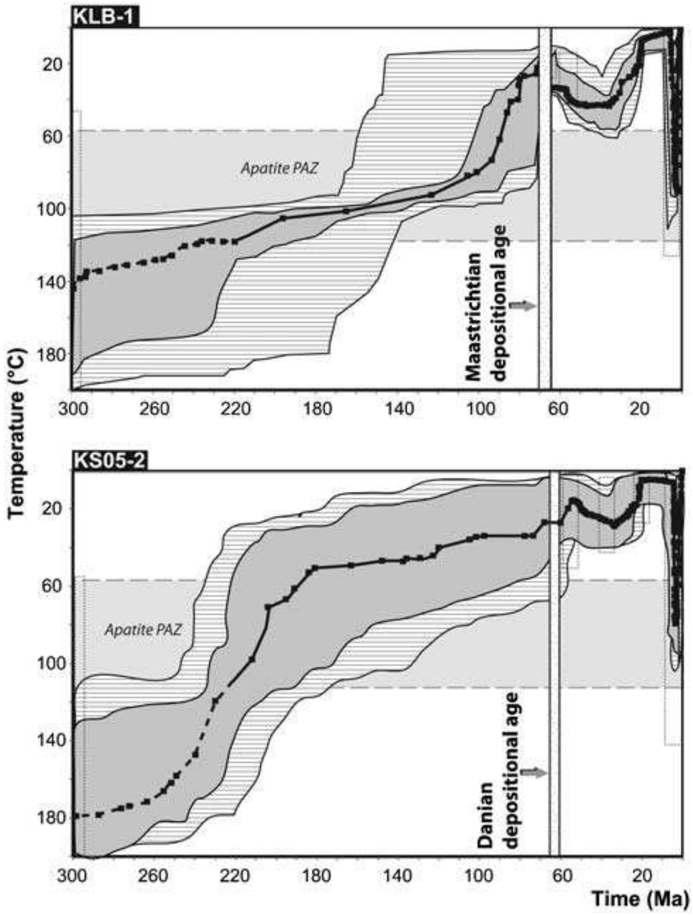
The James Ross Basin (JRB; Elliot, 1988) developed behind an evolving magmatic arc of the Antarctic Peninsula evolving by terrane accretion and collision (Vaughan and Storey, 2000). The arc was formed by the south-eastward subduction of Protopacific plates beneath the southern margin of Gondwana (Whitham, 1993; Hathway, 2000). The more than 5 km thick sedimentary infill of this continuously subsiding back-arc basin represent one of the most complete Jurassic-Paleogene sedimentary succession in the Southern Hemisphere (*e.g.* Crame et al., 1991; Francis et al., 2006) strongly affected by ongoing volcanic activity (del Valle et al., 1992). In order to reconstruct the potential sources of JRB sediments and their post-depositional evolution fission track (FT) geochronology to detrital zircons and apatites was applied.

The FT data were obtained from sandstones collected from the James Ross and Seymour islands. They contain detrital zircon and apatite grains derived from various rocks and their deposition ranges stratigraphically from the Aptian to the Eocene. The minerals in these sediments therefore retain inherited sources, reflecting their potential provenance areas and show a wide spread in single-grain ages, which could be used in provenance analysis. The coarse-grained sedimentary rocks of the Gustav Group represent rapidly deposited proximal accumulations in the subsiding back-arc James Ross Basin along the fault-controlled western margin (Ineson, 1989; Pirrie et al., 1992). Two zircon samples from the Gustav Group, NW James Ross Island represent well-clustered single-grain ages of unreset samples and yielded two groups of ages: the less important Late Cretaceous (~94 ± 15 Ma) and the more frequent Early Jurassic (~186 ± 15 Ma) age. The second age interval is concordant with the new LA-ICP-MS zircon dating of felsic dykes from the Mt. Reece and Pitt Point area, indicating concordant U-Pb ages of 174–179 Ma (Žák et al., 2011) and a prolonged granitic magmatism at Mount Reece dated to the interval of 166–185 Ma (Žák et al., 2011) and is concordant with regional plutonic events in the Antarctic Peninsula (Leat et al., 1995). This origin of rocks is compatible with palaeocurrent and provenance data (Ineson, 1989; Buatois and Medina, 1993). Single zircon FT ages >~200 Ma, which were determined for a significant number of grains relate to Trinity Peninsula Group and Botany Bay Group rocks. The peak ages of these two rock groups originating from the northern part of Antarctic Peninsula centred between 270 and 280 Ma (Barbeau et al., 2010). The samples originating from the Marambio Group of the James Ross Island show FT zircon ages between 137.0 ± 7.4 Ma and 155.9 ± 7.8 Ma, which are overlapped within 1σ errors. The FT zircon ages obtained form Seymour Island show a wide range from 126.5 ± 6.7 Ma to 194.1 ± 15.2 Ma. The Cretaceous age could be correlated with volcanic succession in the northern Antarctic Peninsula region (Vaughan et al., 1998). All dated FT zircon ages yield cluster of ages around ~90–80 Ma, indicating a uniform regional cooling episode documented by Brix et al. (2007) over wide area of the entire Antarctic Peninsula. Some of the tracks were collected in the proximity of volcanic stocks (which was especially true for the Gustav Group samples) and thus the shortening of track found in the samples might be explained as a result of a heating after deposition.

A combination of vitrinite reflectance studies of Whitham and Marshall (1988); Pirrie et al. (1994) and Scasso and Kiessling (2001) with the bottom sea temperatures studies by Pirrie and Marshall (1990) and Dingle and Lavelle (2000) was applied to establish the burial history of JRB sediments and compare them with the FT thermochronological results. Comparison with direct depth-temperature measurements in similar basins, such as the Vienna Basin (Franců et al., 1989, 1990) showed on the burial depths of 2–2.5 km and <1.5 km for Gustav Group and Marambio Group sediments respectively. The vitrinite reflectance value of 0.5% corresponds to temperatures ~90–120 °C (Franců et al., 1989), which may produce partial FT annealing in apatite. The assessed maximum depths and calculated temperatures for individual time intervals according to the geological evidence range from 200 m to 3000 m and 12 °C to 102 °C respectively. The maximum burial of these strata took place during the Early Maastrichtian time (~70 Ma), when started the denudation of the northwestern James Ross Island strata. The calculated burial temperatures were not sufficient to change fission tracks in zircons, which corresponds to zircon grains mean track lengths of ~10–11 μm and a dominantly unimodal distribution without systematic reduction of FT length. The possible shortening of some tracks in zircons from the northwestern part of the James Ross Island were the subject to a heating connected with the Late Cenozoic volcanism (*e.g.* Smellie, 1999). In the case of apatites, ages younger than the depositional age suggest that apatites have been strongly annealed and that the host rocks experienced a more heated part of the partial annealing zone for apatites.

In addition, two-dimensional thermal inverse modelling of detrital apatites using the HeFTy software (Ketcham, 2007) permitted an estimation of exhumation/denudation rates for the sedimentary basin fill for the Seymour Island Group. The track length distribution of the two modelled samples show on the annealing below the partial annealing zone with a similar subsequent cooling history, involving a period of total thermal annealing, subsequent cooling, when both samples were above 120 °C until the Late Triassic (~220 Ma), and a period of steady cooling through the whole apatite partial annealing zone to the minimum temperature during their depositional time (Paleocene/Early Eocene). The most rapid denudation of the northwestern James Ross Island strata occurred during the Paleogene, with average rates of ~50–70 m/Ma and a progressive reduction in denudation rate in the Neogene and Quaternary basing on the apatite FT analysis. The final exhumation connected with accelerated uplift started at ~35 Ma to 20 Ma and coincides with the first trace of glaciation in the Seymour Island area (Ivany et al., 2006). Glacial erosion was a very strong agent in removing fine-grained sedimentary rocks during the last ~30 Ma. The volcanic record of the James Ross

Island Volcanic Group started as early as 12–10 Ma (Dingle and Lavelle, 1998; Marenssi et al., 2010) and continued until present, however evidence of associated volcanic rocks on the Seymour Island is rather scarce. Modelling of Seymour Island FT data shows that the time-temperature trajectory of the measured confined horizontal tracks and obtained FT ages gives the best statistical fit under the same conditions that were observed for the James Ross Island volcanic record, therefore they probably underwent similar volcanic activity.



''Best-fit'' thermal histories obtained from modelling of apatite fission-track data (samples KLB-1 and KS05-2, see text for details) by HeFTy software (Ketcham 2007). Modelled results in the T-t diagram are indicated by three different reliability levels: (a) horizontal hatching envelope as acceptable fit; (b) grey envelope as good fit; and (c) black line is the path with the best fit (trajectory marked by dashedline is potential T-t path bellow PAZ). Independent geological constraints are indicated by a dashed-line rectangle.

Published results:

Svojtka, M., Murakami, M., Nývlt, D., Macáková, J., Filip, J., Mixa, P., 2007. Provenance and post-sedimentary low-temperature evolution of the James Ross Basin sediments (Antarctic Peninsula) based on zircon and apatite fission-track analysis. Geochimica et Cosmochimica Acta 71, 15, A990–A990 Suppl. S.

Svojtka, M., Nývlt, D., Murakami, M., Macáková, J., Filip, J., Mixa, P., 2007. Zircon and Apatite Fission-Track Dating of the James Ross Basin Sediments (Antarctic Peninsula). In: Venera, Z. (Ed): CzechTec 07, Proceedings and excursion guide. p. 84, ČGS Praha.

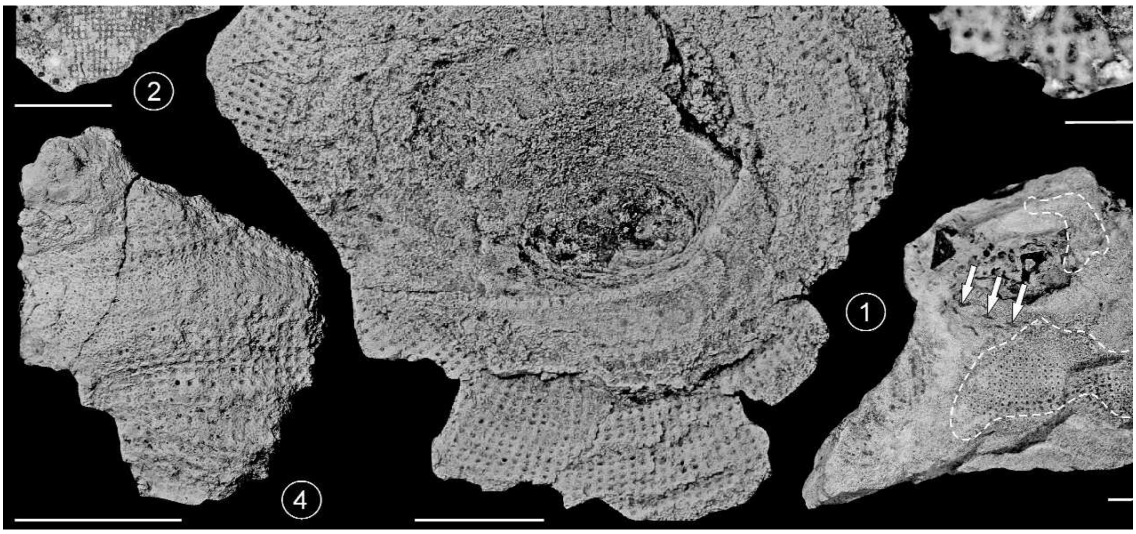
Svojtka, M., Nývlt, D., Murakami, M., Vávrová, J., Filip, J., Mixa, P., 2009. Provenance and post-depositional low-temperature evolution of the James Ross Basin sedimentary rocks (Antarctic Peninsula) based on fission track analysis. Antarctic Science, 21, 6, 593–607.

Palaeontology and palaebiogeography of Cretaceous high latitudes communities based on fossil material from James Ross Basin

The shallow marine Cretaceous to Paleogene deposits of the James Ross Basin are known for common floral and faunal fossil remains. Czech specialists focused not only a general palaeontological description of individual fossil group, but also on palaeobiobiographical implications of the finds.

The Cretaceous biostratigraphy of the James Ross Island region is generally based on palynomorphs and macrofossils (bivalves, ammonites). During geological mapping of the northern James Ross Island a number of samples from Upper Cretaceous lithologies were gathered to test the presence of foraminifers as a possible tool for stratigraphic evaluation of Upper Cretaceous strata. Limited number of samples did not provide a foraminiferal content large enough to give relevant information for biostratigraphic conclusions. Samples from older sediments of Whisky Bay and Kotick Point formations (Albian – Turonian) were either not fossiliferous or contained scarce specimens of agglutinated foraminifers. Foraminiferal assemblages from younger sediments of Hidden Lake and Santa Marta formations (Coniacian – Campanian) contained species with both agglutinated and calcareous types of tests. Many of studied marine sediments were barren of foraminifers, probably due to late diagenetic secondary decalcification. Taxonomy of low-diversified assemblages was carried out and a biostratigraphical and palaeobiogeographical significance discussed by Hradecká et al. (2011). Švábenická et al. (2012) have on the other hand tested the use of calcareous nannofossils as a possible tool for stratigraphic correlation of Cretaceous and Neogene strata. Only a few samples with a poor nannofossil content gave useful information for biostratigraphy. The Lower Campanian *Chiastozygus garrisonii* Zone and *Gephyrobiscutum diabolum* Subzone, respectively, was established in the lower part of the Santa Marta Formation, Lachman Crags Member, from the common occurrence of *Gephyrobiscutum diabolum* associated with *Broinsonia parca parca* and *Acuturris scotus*. Deposits of the Late Miocene Mendel Formation yielded exclusively reworked nannofossils from the older Upper Cretaceous deposits. Nannofossils indicate at least two distinct stratigraphic levels: Middle Coniacian and Santonian–basal Campanian, and these must have been sourced from the immediate area. The majority of studied samples were barren of nannofossils, probably due to late diagenetic secondary decalcification.

The first fossil sponge from Antarctica was reported by Vodrážka and Crame (2011). Laocoetis piserai n. sp. (Hexactinellida, Porifera) originates from the mid-Cretaceous (i.e. Albian - Cenomanian) of James Ross Island. This new occurrence of a formerly widespread genus was restricted to relatively deep waters on the margins of an active volcanic arc. Its occurrence in Antarctica is further evidence that the genus Laocoetis underwent a dramatic reduction in its geographic range through the Cenozoic. The only living species of the genus at the present day is Laocoetis perion from Madagascar.



Laocoetis piserai n. sp. - The first fossil sponge from Antarctica.

A collection of fish scales from the La Meseta Formation (Paleogene, Eocene; Seymour Island, Antarctica) has been studied by Přikryl and Vodrážka (2012). They characterized five clearly distinguishable morphotypes; three of them are comparable to scales of recent trachichthyids, clupeids, and gadids. The other two morphotypes are represented only by two poorly preserved specimens; however, they probably pertain to perciform and pleuronectiform fishes. The latter is a new record for the La Meseta Formation. The mixed composition of the fish scale assemblage reflects substantial redistribution of fish remains within a high-energy, shallow marine environment. Scales were recovered from calcareous sandstone concretions, which accounts for their overall good preservation. This was the most diversified assemblage of fish scales yet reported from the fossil record of Antarctica (Přikryl and Vodrážka, 2012).

Fossil plants from Late Cretaceous strata (Hidden Lake Formation and Santa Marta Formation) of James Ross Basin exposed in the northern part of the James Ross Island were preliminary described by Kvaček and Sakala (2011). Both formations contain plant mega fossils, petrified wood, and charcoalified mesofossils. Fossil plants from the Hidden Lake Formation are represented by leaf impressions of pteridophytes (*Microphyllopteris*, *Delosorus*, *Lygodium*), conifers (*Elatocladus*, *Brachyphyllum*, *Pagiophyllum*, *Araucaria, Podozamites* vel *Lindleycladus*), Bennettitales vel Cycadales (*Zamites* vel *Dioonites* sp.) and angiosperms (*Cinnamomoides, Dicotylophyllum* ssp., *Proteophyllum, Juglandiphyllum* vel *Dicotylophyllum*). Fossil wood can be attributed to the very broadly defined morphogenus *Antarctoxylon* Poole & Cantrill.

Published results:

Hradecká, L., Vodrážka, R., Nývlt, D., 2011. Foraminifera from the Upper Cretaceous of the northern James Ross Island (Antarctica): a preliminary report. Czech Polar Reports, 1(2), 88–95.

Kvaček, J., Sakala, J., 2011. Late Cretaceous flora of James Ross Island (Antarctica) – preliminary report. Czech Polar Reports, 1(2), 96–103.

Přikryl, T., Vodrážka, R., 2012. A diverse Eocene fish scale assemblage from Seymour Island, Antarctica. Geodiversitas, 34, 895–908.

Švábenická, L., Vodrážka, R., Nývlt, D., 2012. Calcareous Nannofossils from the Upper Cretaceous of the northern James Ross Island, Antarctica. Geological Quarterly, 56(4), 765–772.

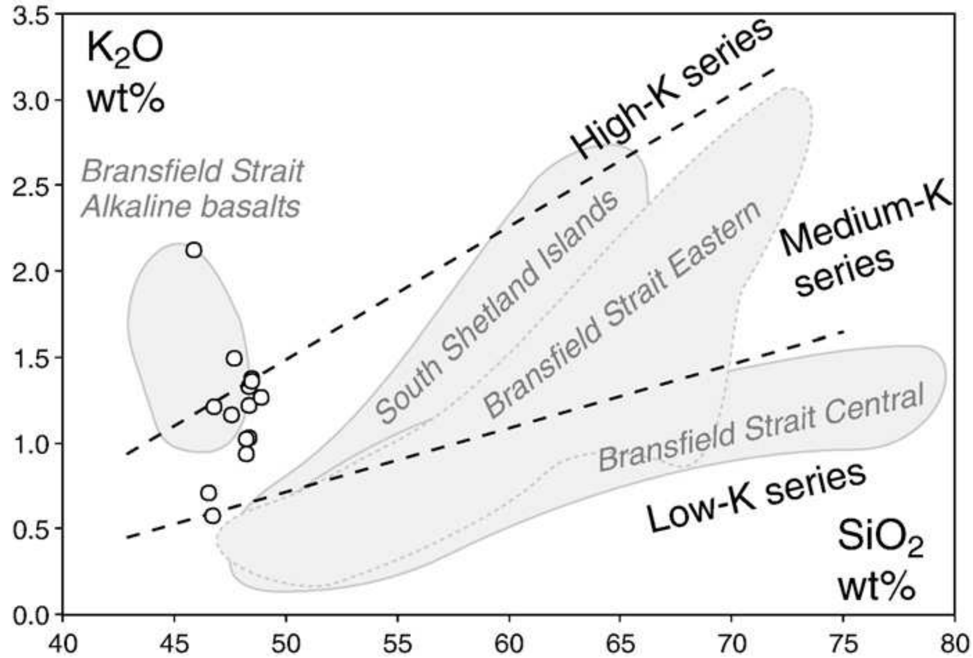
Vodrážka, R., 2013. 5.2.5 Paleontologický výzkum pánve Jamese Rosse. In: Prošek, P. (ed): ANTARKTIDA. 276–281, Academia, Praha.

Vodrážka, R., Crame, J.A., 2011. First fossil sponge from Antarctica and its paleobiogeographical significance. Journal of Paleontology, 85, 48–57.

Cenozoic sub-glacial back-arc volcanism on James Ross Island

Intrusions of Late Cenozoic volcanic rocks that occur east of the northern part of the Antarctic Peninsula are referred to as James Ross Island Volcanic Group (Nelson, 1966). James Ross Island is the largest island built of the James Ross Island Volcanic Group rocks, however only the northern part of the Ulu Peninsula is largely ice-free and volcanic rocks are accessible. Lava-fed deltas built of hyaloclastite breccia foresets and subaerial lava flows as topsets are the main volcanic products being complemented here by less common tuff or cinder cones, subordinate pillow lavas, basaltic dykes and subvolcanic plugs. They intrude Permian to Triassic sediments and metasediments of the Trinity Peninsula and Botany Bay Group rocks (Barbeau et al., 2010) and Jurassic to Paleogene sediments of the James Ross Basin (del Valle et al., 1992). The post-Gondwanan tectonic evolution of this region includes a south-east subduction of the Phoenix plate (now part of the Antarctic plate) under the Antarctic Peninsula, collision of the Phoenix plate spreading centre with the continental margin and subsequent slowing of the plate convergence in the Paleogene and progressive diachronous migration of the subduction towards the north-east (McCarron and Larter, 1998). During the accretion and build-up of a thick accretionary wedge on the lithospheric crust, the subduction migrated north-west, away from the Antarctic Peninsula and it probably continues till present at a very slow rate (Larter, 1991). The lithospheric compression was later replaced by extension across the fore-arc and magmatic arc regions and it was associated with rifting and alkaline to calc-alkanine volcanism (McCarron and Smellie, 1998; Keller et al., 2002). The study of Košler et al. (2009) brings the first comprehensive geochemical (major and trace elements) data set including Sr–Nd–Pb–Li isotopic data for a suite of back-arc alkaline volcanic rocks from the James Ross Island Volcanic Group to discuss the petrogenesis and document differences in magma composition between individual settings and magma contamination by overlying clastic sediments. The age of basaltic lava-fed deltas of the northern Ulu Peninsula lies between 6.16 and 3.95 Ma according to the ^{40}Ar–^{39}Ar dating of Kristjánsson et al. (2005) representing the oldest dated in situ volcanic rock of the James Ross Island Volcanic Group (Smellie et al., 2008). Volcanism in James Ross Island Volcanic Group was both subaerial and subaquatic, with development of features typical of lava-sea water interaction, such as pillow lavas and voluminous hyaloclastite breccia. Marine fossils in some of the volcanoclastic products also suggest that some eruptions occurred in the marine environment while other show features indicative of magma intrusion under an ice cover (*e.g.* Lirio et al., 2003; Smellie, 2006; Nelson et al., 2009).

The studied volcanic rocks belong to the potassium-rich trend as previously defined for the rocks of James Ross Island Volcanic Group (Smellie, 1987). They also show 20–90-fold enrichment in incompatible elements, including light REEs and deviate significantly from the composition of N-MORB and E-MORB. While trace elements patterns follow the composition of OIB, marked depletion in Rb, Ba, Th, P and also HREE makes the James Ross Island Volcanic Group lavas distinct from the composition of other OIBs. Also, lack of depletion in high-field-strength elements (*e.g.* Nb) and higher contents of LREEs discriminate them from basaltic melts associated with magmatic arc settings [paper 4]. The James Ross Island suite differs significantly from other (non alkaline) lavas from the Bransfield Strait that have, consistently with their derivation from magmatic arc setting, higher Th and lower Nb contents. The isotopic composition of Sr and Nd in the James Ross Island Volcanic Group suite corresponds well to the isotopic composition of alkaline volcanic rocks from the Antarctic Peninsula (Hole et al., 1993) or straddles the boundary between the composition of the Antarctic Peninsula alkaline volcanics, and alkaline volcanic rocks from the eastern part of the Bransfield Strait (Fretzdorff et al., 2004) and those from the South Shetland Island (Keller et al., 2002). The Pb isotopic composition also corresponds to the composition of alkaline basalts from the Antarctic Peninsula with only two samples that have composition rather similar to the volcanic rocks from the Bransfield Strait. The Li isotopic composition is similar to those of the rocks associated with magmatic arcs, mid-ocean ridge settings and terrestrial mantle, it also shows a weak correlation with indices of crustal assimilation and/or crystal fractionation. The James Ross Island Volcanic Group alkaline basaltic lavas are collective different from the subduction (arc)-related magmatic rocks from the Bransfield Strait and from the Antarctic Peninsula. The main differences found in the lavas from James Ross Island (comparing to the South Shetland and Bransfield Strait volcanic rocks) include higher K/Na ratio, higher content of incompatible elements, lack of a negative Nb anomaly and more radiogenic isotopic composition of Pb (Košler et al., 2009).



Major element contents in olivine basalts from the northern part of James Ross Island showing their K-rich composition compared to the Bransfield Strait and South Shetland Islands volcanic rocks.

Results of the modelling of magma formation for olivine basalts from the northern part of James Ross Island suggest that the composition of James Ross Island Volcanic Group lavas can be explained by a mixing of depleted mantle-driven magma (such as the E-MORB) with ~25–35 wt.% of OIB-like source (such as is the enriched mantle component EMII). The decreasing input of fluid phase originating from subducting plate into the melting region provides further evidence of drastically reduced role of sedimentary component in generation of James Ross Island Volcanic Group back-arc volcanics compared to the South Shetland Islands volcanic rocks. Magma contamination by clastic sedimentary rocks of the James Ross Basin (Francis et al., 2006) derived originally from the Antarctic Peninsula provides a possible source for a radiogenic Pb found in basaltic lavas from James Ross Island. Numerous field evidences for variable contamination of basaltic magma by non-assimilated sediments were found on diverse outcrops of the northern James Ross Island. It varies from occurrences of up to 20 cm large sedimentary xenolith in the basalts to partial and sometimes almost complete melting of the sedimentary xenoliths and sediments adjacent to magma intrusions. The available data do not allow for a quantitative estimate of the sediment contribution to the magma, but the field observations suggest that assimilation of the sediments did not have a profound effect on the composition of the James Ross Island Volcanic Group lavas. Due the generally high Li concentrations in most sedimentary rocks even small and often localized contamination of magma by sedimentary material may affect the Li content and isotopic composition of the lavas (Košler et al., 2009).

Published results:

Janoušek, V., Nývlt, D., Mlčoch, B., Vodrážka, R., 2012. Geologické výzkumy České geologické služby v Antarktidě (ostrov Jamese Rosse a přilehlá část Grahamovy země). Vesmír, 91, 426–431.

Košler, J., Magna, T., Mlčoch, B., Mixa, P., Nývlt, D., Holub, F. V., 2009. Combined Sr, Nd, Pb and Li isotope geochemistry of alkaline lavas from northern James Ross Island (Antarctic Peninsula) and implications for back-arc magma formation. Chemical Geology, 258, 3–4, 207–218.

Košler, J., Magna, T., Mlčoch, B., Mixa, P., Holub, F. V., Nývlt, D., 2009. Sr, Nd, Pb and Li isotope geochemistry and Ar-Ar dating of alkaline lavas from northern James Ross Island (Antarctic Peninsula) - implications for back-arc magma formation. Geophysical Research Abstracts 11. s. #EGU2009-9969, Wien.

Mlčoch, B., Nývlt, D., 2013. 5.2.3 Vulkanismus a zalednění prostoru ostrova Jamese Rosse. In: Prošek, P. (ed): ANTARKTIDA. 253–264, Academia, Praha.

Sedimentary processes associated with subglacial volcanism and glacial to interglacial climate changes during the Neogene

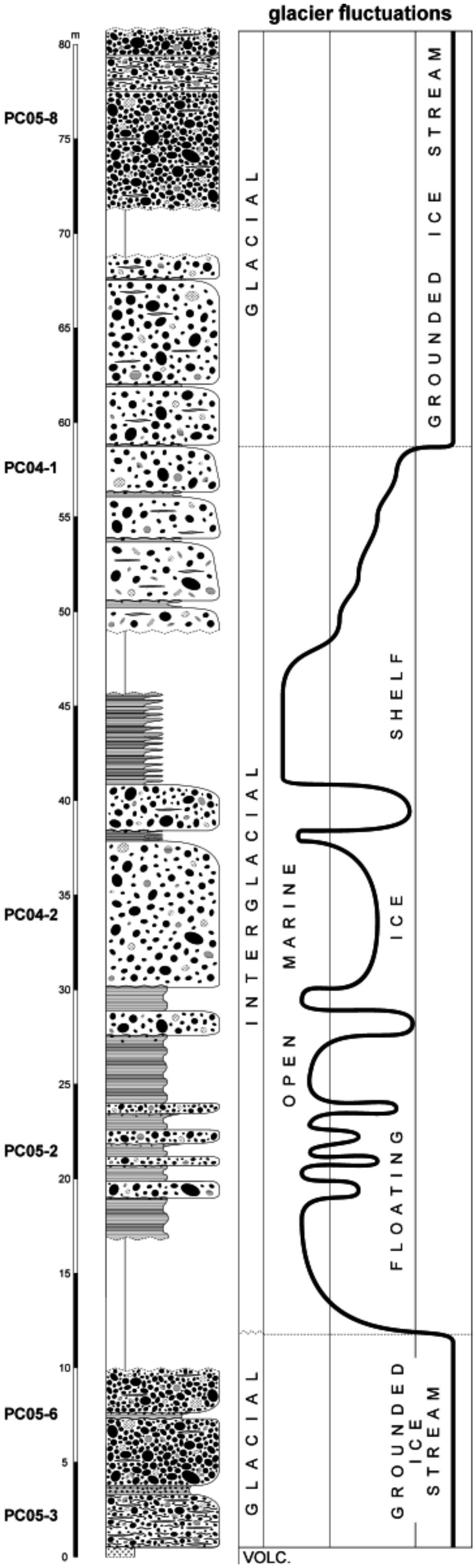
Neogene glacigenic and glaciomarine deposits have been found in several places in Antarctica during the last few decades. The oldest glacial sedimentary deposits around the Antarctic Peninsula lie at the top of the La Meseta Formation on Seymour Island (Ivany et al., 2006) and are dated to the Oi-1 glaciation event (Pälike et al., 2006) close to the Eocene/Oligocene transition (~34 Ma), however these results are disputed by others, as the dated palaeontological material may be reworked to much younger deposits (Gaździcki et al., 2004; Marenssi et al., 2010). Other Oligocene glacial sequences are known from King George Island as the Polonez Cove and Cape Melville Formations, ~30 Ma and 23 Ma old respectively (Birkenmajer, 1987; Dingle et al., 1997). Several younger glacial/interglacial sedimentary sequences occur below and within the James Ross Island Volcanic Group in the James Ross archipelago (*e.g.* Andersson, 1906; Bibby, 1966; Pirrie et al., 1997b; Jonkers et al., 2002; Lirio et al., 2003, 2007; Hambrey et al., 2008; Smellie et al., 2008; Nelson et al., 2009; Williams et al., 2010). The Cenozoic sedimentary successions around Antarctica allow the reconstruction of palaeoenvironmental and palaeogeographical conditions in the terrestrial settings and the surrounding oceans. These reconstructions are crucial not only for understanding climatic changes connected with advances and retreats of the East and West Antarctic ice sheets, but they are also important for modelling future climatic change in the Antarctic. A detailed multidisciplinary study of an extensive and thick sedimentary deposit in the Ulu Peninsula, northernmost part of James Ross Island by Nývlt et al. (2011) allowed reconstruction of the palaeoenvironment and palaeoclimate for this part of Antarctic Peninsula in a short time interval in the latest Miocene.

The timing of the Late Cenozoic sedimentary units found in association with volcanic rocks of the James Ross Island Volcanic Group was determined mostly by $^{87}Sr/^{86}Sr$ dating of pectinid bivalves or $^{40}Ar/^{39}Ar$ dating of associated volcanic rocks. According to the field mapping in the northern Ulu Peninsula at least 70 localities with sedimentary sequences associated with James Ross Island Volcanic Group are known at present, however most of them do not contain datable fossil material. A potential source of errors in interpreting strontium dates lies in the reworking of shell fragments into the subglacial terrestrial of glaciomarine environment, as is common in many sedimentary units of the James Ross Island Volcanic Group.

During the geological mapping in the northernmost Ulu Peninsula, sedimentary rocks representing former ‘pecten conglomerates’ of Andersson (1906) or ‘tuffaceous conglomerates’ of Nelson (1966) have been found and subsequently mapped in detail in the area between Cape Lachman, Berry Hill and Mendel Base. They represent sediments deposited in open marine, glaciomarine and terrestrial glacigenic environments. A new formal name – Mendel Formation – was proposed for the sedimentary succession, because according to the data described here it does not correspond to any of the other Neogene sedimentary formations found on James Ross Island (Drift Refugio San Carlos of Rabassa, 1983; Hobbs Glacier Formation of Pirrie et al., 1997; Belén Formation of Lirio et al., 2003; Gage Formation of Lirio et al., 2003; Terrapin Formation of Lirio et al., 2003). The Mendel Formation is named after the nearby Czech Johann Gregor Mendel Base, which is named for the famous scientist Johann Gregor Mendel – founder of the science of genetics – and is located on the Holocene marine terrace at the western tip of the sedimentary succession between Cape Lachman and Bibby Point, Ulu Peninsula, James Ross Island.

The Mendel Formation overlies Cretaceous marine strata (Whisky Bay and Hidden Lake Formations of the Gustav Group; Crame et al., 1991; Francis et al., 2006) in its southern and south-western part; at the neck of Cape Lachman in the north it overlies a subglacial volcanic sequence built of pillow lavas, hyaloclastite tuffs to breccias and dykes of one of the oldest phases of the James Ross Island Volcanic Group. The contact between basalt and the overlying Mendel Formation diamictite at the PC05-3 section is erosional, sharp and undulating. The maximum potential age of the Mendel Formation, based on the dating the pillow lava (JR-1) using $^{40}Ar/^{39}Ar$ dating puts the age at 5.85 ± 0.31 Ma. There are no outcrops showing the contact with Cretaceous rocks in the west; however, reworked Cretaceous fossils can be found in the lower diamictites of the PC04-1 section, indicating a position close to the Cretaceous basement. The upper contacts were not studied on any of the documented outcrops available in the relevant areas. However, the Mendel Formation is unconformably overlain the basal Lachman Crags volcanic delta dated by Smellie et al. (2008) with a minimum age of 5.32 ± 0.16 Ma. The Mendel Formation occurs in the altitudinal range 0–155 m having the maximum sedimentary thickness exceeding 80 m. But it can reach up to 160 m as the nature of the Mendel Formation basal and top surfaces in its southern part on the slopes of Berry Hill is not known. Five shells of *Austrochlamys anderssoni* originating from the PC05-1 section were dated giving the weighted average age of 5.71 + 0.14/–0.18 Ma (two ages are given in Nývlt et al., 2011; further three ages have not been published yet). Their physical appearance allows these ages to be interpreted as depositional ages of the middle part of the Mendel Formation. Beside samples of these ages, three other dateable pectinid shell samples were collected from terrestrial subglacial till units (PC05-6/1, PC05-6/5, PC05-8/1) of the Mendel Formation. Their $^{87}Sr/^{86}Sr$ ages fall into the lower Miocene (20.6–17.4 Ma), and they represent re-deposition from older sediments, as evidenced by their presence in terrestrial glacigenic sediments and their strongly fragmentary nature. The other dated shell fragment (from PC04-1/2 unit) represents reworked Cretaceous fossil material; a conclusion that is supported by abundant reworked macro- and micro-fossil finds (Nývlt et al., 2011). According to the review of the ages listed above, the Mendel Formation was deposited during the late Miocene between 6.16 Ma and 5.23 Ma, taking into account 2 sigma uncertainties. Nevertheless, its deposition most probably occurred during a much shorter time in the middle of this interval. The type section with visible lower contact and subglacial tills is close to the sea level at the neck of Cape Lachman (S 63.79287°; W 57.81103°). Section PC05-2 (S 63.80385°; W 57.87252°), which was documented on slopes of a deeply incised stream valley in front of a small ice accumulation close to Mendel Base, represents the open marine and glaciomarine type section of the Mendel Formation.

The Mendel Formation is composed of terrestrial glacigenic and glaciofluvial, glaciomarine and open marine sedimentary rocks. Terrestrial sedimentary deposits are composed of lodgement tills, subglacial melt-out tills and glaciofluvial sandstone, all of them subglacial or englacial in origin. Marine sedimentary deposits include glaciomarine debris-flows, glaciomarine diamictites to waterlain tills and tuffaceous horizontally laminated sandstones or siltstones. The whole succession constitutes a cycle of sedimentation starting as terrestrial glacigenic grading through glaciomarine sedimentation towards marine pro-delta sedimentation and back to terrestrial glacigenic deposition. It differs significantly from the Hobbs Glacier Formation (Pirrie et al., 1997b) not only in the thickness of the sedimentary succession, but especially by the cycle of sedimentation from terrestrial through glaciomarine and open marine back to terrestrial deposition with common erratic material originating mostly from the Antarctic Peninsula Batholith (Leat et al., 1995) and the Trinity Peninsula Group (Trouw et al., 1997). However, regionally metamorphosed rocks, orthogneisses and amphibolites might originate from the Silurian-Triassic basement of the Antarctic Peninsula (Hervé et al., 1996) or even from the Transantarctic of Ellsworth Mountains.



Composite section of the Mendel Formation with the position of individual described sections and an interpretation of the glacial and interglacial conditions and glacier fluctuations.

The generally high proportion of striated clasts (typically 30–45% in terrestrial glacigenic sediments and 20–30% in subaqueous diamictites), together with the degree of clast roundness (mostly subangular to subrounded) and the prevailing silty to fine-sandy matrix point mainly to warm-based glacier, active subglacial transport and glacial ploughing as very important factors. The importance of brittle fractures on quartz sand grains in subglacial tills, which is mostly attributed to glacier crushing (Mahaney, 1995), was shown by the study of quartz microtextures. However, they are commonly masked by edge abrasion, which is the most common mechanical superficial microtexture, implying that brittle fractures originated by older comminution processes. They are not necessarily only glacial in origin. Grain breakages require grain to grain contacts during transport (Fuller and Murray, 2002) and may have originated in submarine density flows at the slope or slope apron depositional environment or in the subaqueous volcanic environment. However, their glacial origin is more probable, and they are commonly taken to be indicators of subglacial transport at the base of thick ice sheets (with thickness usually greater than 1000 m), rather than under thin valley glaciers (Mahaney, 1995). Subsequent edge abrasion and clast rounding is connected with active transport of material in warm-based subglacial conditions, where surface abrasion causes particle rounding (Benn and Ballantyne, 1994) and fractures are less common due to less common grain to grain contacts owing to the water present. Edge abrasion is not typical of glaciomarine and marine deposits, where intense post-depositional weathering is present. The presence of highly weathered grains, with a low proportion of crushed and abraded grains, by material transport by small glaciers that did not completely inundate the topography; therefore, much debris transported supraglacially or englacially was deposited without being substantially modified (Cowan et al., 2008). This shows a complex transport history of the grains before their final deposition; however, glacial transport dominates the shaping of the grain surfaces, as shown by Mahaney et al. (1996) for different tills from Antarctica. Warm-based subglacial environments and active subglacial ploughing of particles were very common features for all Neogene glacial sequences associated with the James Ross Island Volcanic Group (*e.g.* Hambrey et al., 2008; Nelson et al., 2009), but these environmental conditions differ strongly from recent cold-based local glaciers of James Ross Island (Carrivick et al., 2012).

Cape Lachman was a small volcanic island separated from James Ross Island by an ~2 km wide channel. A grounded Antarctic Peninsula ice streams advanced eastwards through the Prince Gustav Channel and crossed the northernmost part of the present James Ross Island. The form of Prince Gustav Channel originated before the late Miocene and its present pronounced glacial over-deepening with depth up to more than 1000 m resulted in multiple grounded glacier advances through this valley during the Neogene and Quaternary. After the retreats of the grounded ice stream, the sea advanced from the East and the glacier front began floating, building a small ice shelf, which was later replaced by a grounded ice stream advancing in west-east direction.

Sedimentary changes indicate different depositional distances from the glacier margin of the grounded glacier during glacials and floating ice shelf during interglacials. This gives us direct evidence of a Late Miocene climate cyclicity, which was driven by the obliquity cycles with a ~41 ka period (Lisiecki and Raymo, 2007; Naish et al., 2009). The Mendel Formation sequence is composed of at least two glacial and one interglacial interval. Therefore, the whole sequence may have been deposited within less than 100,000 years, when the sea level changes between glacial lowstand and interglacial highstand were >50 m.

The problem of the reworking of macro-fossils from the underlying Late Cretaceous strata to the Late Cenozoic mostly glacial sediments has also been found as an important topic. The importance of reworking of micro- and meso-fossils from Late Cretaceous deposits into the basal terrestrial glacigenic deposits of the Mendel Formation due to the glacial erosion by advancing Antarctic Peninsula ice stream through the Prince Gustav Channel has been studied by Švábenická et al. (2012). The nannofossils are badly preserved and mostly fragmented. Strong etching is obvious especially on placoliths (the central fields are usually missing) and holococcoliths show signs of overgrowth. Probable secondary impoverishment of the assemblage was caused by carbonate dissolution as indicated by the relative high numbers of *Watznaueria barnesiae*. The assemblage taphocoenose is formed by 17 species and contains at least two types of nannofossil assemblages: i) an assemblage with *Micula staurophora* and *Quadrum gartneri*, Middle to Upper Coniacian, UC10 Zone; ii) an assemblage with *Arkhangelskiella specillata*, *Prediscosphaera* cf. *grandis* and *Lucianorhabdus inflatus* may document the Santonian and ?probably also the lowermost Campanian. Similarly reworked Campanian–Maastrichtian nannofossil taphocoenoses were recovered by Gaździcka and Gaździcki (1994) from the Pliocene Cockburn Island Formation. Reworked nannofossils originates most probably from the Hidden Lake (Coniacian) and Santa Marta (Santonian/?lowermost Campanian) formations. The short distance reworking of the Upper Cretaceous nannofossils transported into the Mendel Formation is shown by the fact that both the Santa Marta and Hidden Lake formations crop out in the immediate vicinity of the basal contact of the Mendel Formation.

Published results:

Janoušek, V., Nývlt, D., Mlčoch, B., Vodrážka, R., 2012. Geologické výzkumy České geologické služby v Antarktidě (ostrov Jamese Rosse a přilehlá část Grahamovy země). Vesmír, 91, 426–431.

Lirio, J. M., Concheyro, A., Chaparro, M. A., Nyvlt, D., Mlcoch, F., 2007. Diamictita Cabo Lamb, un nuevo depósito fosilífero marino Cenozoico en la Isla Vega, Península Antártica. In: Actas del VI° Simposio Argentino y III° Latinoamericano sobre Investigaciones Antárticas, Buenos Aires 10 al 14 de Septiembre de 2007. CD-ROM, Resúmen Expandido N° GEORE818, 4 pp., Buenos Aires.

Mlčoch, B., Nývlt, D., 2013. 5.2.3 Vulkanismus a zalednění prostoru ostrova Jamese Rosse. In: Prošek, P. (ed): ANTARKTIDA. 253–264, Academia, Praha.

Nývlt, D., Košler, J., Mlčoch, B., Mixa, P., Lisá, L., Bubík, M., Hendriks, B.W.H., 2011. The Mendel Formation: Evidence for Late Miocene climatic cyclicity at the northern tip of the Antarctic Peninsula. Palaeogeography, Palaeoclimatology, Palaeoecology, 299, 363–384.

Nývlt, D., Košler, J., Mlčoch, B., Lisá, L., Bubík, M., Hendriks, B.W.H., 2010. Late Miocene climatic cyclicity at the northern tip of Antarctic Peninsula reconstructed from Mendel Formation sediments. 18th International Sedimentological Congress, ID 196, p. 656, Mendoza, Argentina.

Švábenická, L., Vodrážka, R., Nývlt, D., 2012. Calcareous Nannofossils from the Upper Cretaceous of the northern James Ross Island, Antarctica. Geological Quarterly, 56(4), 765–772.

History of glacier changes in the northern deglaciated part of James Ross Island since the Last Glacial Maximum

Deglaciation of the Weddell Sea outer shelf started here around 18.3 cal. ka BP (recalibrated age of Heroy and Anderson, 2007). It is very probable, that the most important retreat from outer to middle shelf occurred during Meltwater pulse 1A (MWP-1A), i.e. ~14.5–14.0 ka (Weaver et al., 2003; Clark et al., 2009). In spite of the subsequent climatic deterioration during the Antarctic Cold Reversal (ACR; ~14.1–12.4 ka; Stenni et al., 2001) around Antarctica, which interrupted the Antarctic Late Glacial warming, individual ice streams of the north-eastern part of AP continued to retreat as was shown for the Southern Prince Gustav Ice Stream by Evans et al. (2005) and Pudsey et al. (2006). The retreat of ice streams even during unfavourable climatic conditions of ACR was provoked by rising sea level due to continuing thawing of Northern Hemisphere ice sheets (*e.g.* Rinterknecht et al., 2006; Simms et al., 2007) and by an earlier warming in marginal parts of Antarctica (such as JRI area) as has recently been shown by deuterium excess calculated temperature anomalies from the

James Ross Island Ice Cap (Mulvaney et al., 2012). It could be shown from their data, that the most prominent warming in the area of JRI occur between 13 and 12 ka (Mulvaney et al., 2012). This was connected with the change of grounded glaciers to floating ice shelves and the grounding zone retreat. The debuttressing effect from break-up of ice shelf edges accelerate retreat and affected coastal lower-lying land areas, which have ceased to be supplied by ice from ice streams and deglaciated rapidly, as is the case with the neck of Cape Lachman, northern JRI (Nývlt et al., in review).

The Cosmic Ray Exposure dating applied to erratic boulders from Cape Lachman, northernmost JRI show on the beginning of the deglaciation before 12.9 ka (Nývlt, in review) and lower-lying areas of the Ulu Peninsula were ice-free at the beginning of the Holocene. This changes corresponds to this transition of grounded ice stream to floating ice shelf in the inner to middle shelf part of the northern Prince Gustav Channel (PGC; Nývlt, in review). This is similar to the southern part of PGC, where the transition at the inner-middle shelf area occurred in the time interval of 10.5 and 13.9 cal. ka BP (recalibrated ages of Pudsey and Evans, 2001; Pudsey et al., 2006 by Johnson et al., 2011), but more probably at the beginning of this interval. The transition ages of individual grounded ice streams to floating ice shelves around the AP reflect a clear north–south and west–east trend. The western AP ice streams being changed into floating ice shelves in the inner shelf areas between 13.2 ka in Palmer Deep (Domack et al., 2001; Brachfeld et al., 2002) and 12.3 ka in the Belgica Trough (Hillenbrand et al., 2010) in the north–south transect. The eastern AP ice streams transition to floating ice shelves in the inner continental shelf areas took place usually later than on the western coast. It started in the northern PGC between 12.5 and 10.7 ka (Nývlt et al., in review). A floating ice shelf covered the southern PGC before 10.5 ka (Pudsey et al., 2006). Further south at the inner continental shelf of the Larsen A and B ice shelves the transition took place at 10.7 ka and 10.2 ka respectively (Brachfeld et al., 2003; Domack et al., 2005). More details about the Late Glacial deglaciation and the transition from grounded ice streams toward the floating ice shelf in the northern PGC could be found in Nývlt et al. (in review).

Deglaciation of individual parts of JRI was altitude dependent due to a gradual increase of the local equilibrium line altitude (ELA), therefore individual mesas here became ice-free between 8 and 6.6 ka (Johnson et al. 2011). Small glaciers have persisted only in higher locations and few advances of local glaciers are known only from the Mid Holocene (~4.7 ka BP; Hjort et al., 1997) and Late Holocene ("Little Ice Age"; Carrivick et al., 2012) time, when the local ELA was significantly lower than at present. This is well supported by other independent data inferred from diverse proxy records originating from lake sediments (Ingólfsson et al., 1992, Björck et al., 1996). The recent generally low-lying landscape thus remains widely ice free due to the absence of higher-located accumulation areas for local glaciers (Nývlt et al., in review). However, the remaining ice-cover of volcanic mesas is very probably persistent since at least the Pleistocene, as was demonstrated by Johnson et al. (2009) for Patalamon Mesa on the western coast of JRI.

Further study focused on the mesoscale or centennial-scale measurements of glacier character and behaviour in the Antarctic Peninsula area. This was achieved by (1) holistic geological descriptions of the topography, geomorphology and sedimentology of prominent moraines immediately adjacent to a range of contemporary land-terminating glaciers, (2) interpretation of the character and behaviour of those glaciers while they were at this relatively advanced position and (3) quantification of the geometric changes to these glaciers between their last advances during the Little Ice Age and present.

Dated erratic bouldersfrom the glacigenic accumulation at the Cape Lachman neck, James Ross Island.

Prominent moraine ridges immediately in front of all studied glaciers have crests that are typically 20–40 m higher in elevation than the present glacier surface. All of the moraines are ice-cored. Multiple crests are evident at most of the glaciers, particularly in the region of the glacier snout, *i.e.* at lowermost elevations (Carrivick et al., 2012). All of the moraine crests have an undulating or hummocky surface and sides sloping at 30–40°. Hummocky ridges, shallow surface depressions, some of which contain ponded water and mass movements of the overlying sediments are present here as well. The volumetric decrease of these glaciers is a function of both glacier snout recession and glacier's ablation part surface lowering. The magnitude of retreat of the glacier snout position is remarkably similar between glaciers and varies from 75 m at Triangular Glacier to 130 m at San José Glacier (Carrivick et al., 2012). The glacier surfaces have lowered (9–23) ± 1.6 m on average since the LIA. Surface lowering at each glacier declines in magnitude with increasing altitude up to the maximum elevation of moraine crest. It is hard to reconstruct the LIA ice surface about the maximum elevation of moraine crest. Overall, the glaciers have lost 0.16–0.44 km^2, which equates to 12–46 % of their LIA surface area (Carrivick et al., 2012). The land-terminating glaciers have each decreased in volume since the LIA by 0.01–0.03 km^3. All the changes are summarised in a table located in this chapter. Generally the glaciers with the largest amounts of snout recession have also experienced the greatest reduction in surface elevations and volume (Carrivick et al., 2012). The LIA glaciers were more extensive, thicker and with a convex long profile, which clearly demonstrate that they had a positive mass balance. In contrast, the present asymmetric surface morphology and linear-slope long profile, the absence of contemporary surface crevasses or moraines (Carrivick et al., 2012) could be taken to imply modern negative mass balance of these glaciers, as is supported by remote data and field observations (*e.g.* Engel et al., 2012 and chapters below). The ongoing glacier changes are reflected also in changing glacier thermal regime. The Late Holocene ice-marginal retreat and surface lowering has caused a transition from polythermal glaciers to cold-based glaciers (Carrivick et al., 2012). Land-terminating glaciers on the Ulu Peninsula are now apparently cooler despite a warmer climate. More details on the Late Holocene glacier changes are given in Carrivick et al. (2012).

The evolution in surface elevation reflects an increasing importance of wind-blown snow for glacier accumulation in the warming period between the LIA and present (Carrivick et al., 2012). Specifically, the enhanced accumulation on eastern glacier sides is most likely to be a product of orographically enhanced accumulation via snow drifting by prevailing westerly/southwesterly winds, which are typical of the northern part of JRI (*e.g.* Láska et al., 2011). The other meteorological factors, such as gross precipitation and air temperature have become less important with time.

Summary of properties of selected glaciers on the Ulu Peninsula, JRI and their changes between Little Ice Age and present. Surface lowering is the mean value for the glacier ablation area. Volume change is the mean of five interpolation routines.

Glacier name	Snout elevation m a.s.l.	Altitude range m	Aspect	Max elevation of moraine crests m a.s.l.	Snout recession m	Surface lowering m	Area change km^2 (%)	Volume change km^3
Triangular	115	135	SW	230	75	15	0.25 (33)	0.013
Unnamed	195	115	NW	280	100	9	0.18 (23)	0.009
Lachman	186	164	SW	290	120	23	0.44 (46)	0.016
San José	134	156	S	240	130	20	0.16 (22)	0.012
Alpha	24	226	SE	160	115	15	0.25 (12)	0.022
Whisky	219	231	N	365	90	14	0.41 (15)	0.032

Published results:

Carrivick, J.L., Davies, B.J., Glasser, N.F., Nývlt, D., Hambrey, M.J., 2012. Late Holocene changes in character and behaviour of land-terminating glaciers on James Ross Island, Antarctica. Journal of Glaciology, 58(212), 1176–1190.

Carrivick, J., Davies, B., Glasser, N., Nývlt, D., Hambrey, M., 2013. Late Holocene changes in character and behaviour of land-terminating glaciers on James Ross Island, Antarctica. Geophysical Research Abstracts, vol. 15, EGU2013-1501.

Glasser, N., Davies, B. J., Hambrey, M., Carrivick, J., Nývlt, D., Smellie, J., 2012. Glacial history of Prince Gustav Channel and James Ross Island. In: AGU Fall Meeting, San Francisco, 3–7 December 2012, Session GC21D: Past Climates and Current Weather Events.

Nývlt, D., Braucher, R., Engel, Z., Mlčoch, B., ASTER Team, in review. Late Glacial retreat of the Northern Prince Gustav Ice Stream from the Antarctic Peninsula continental shelf and the James Ross Island. Quaternary Science Reviews, in review.

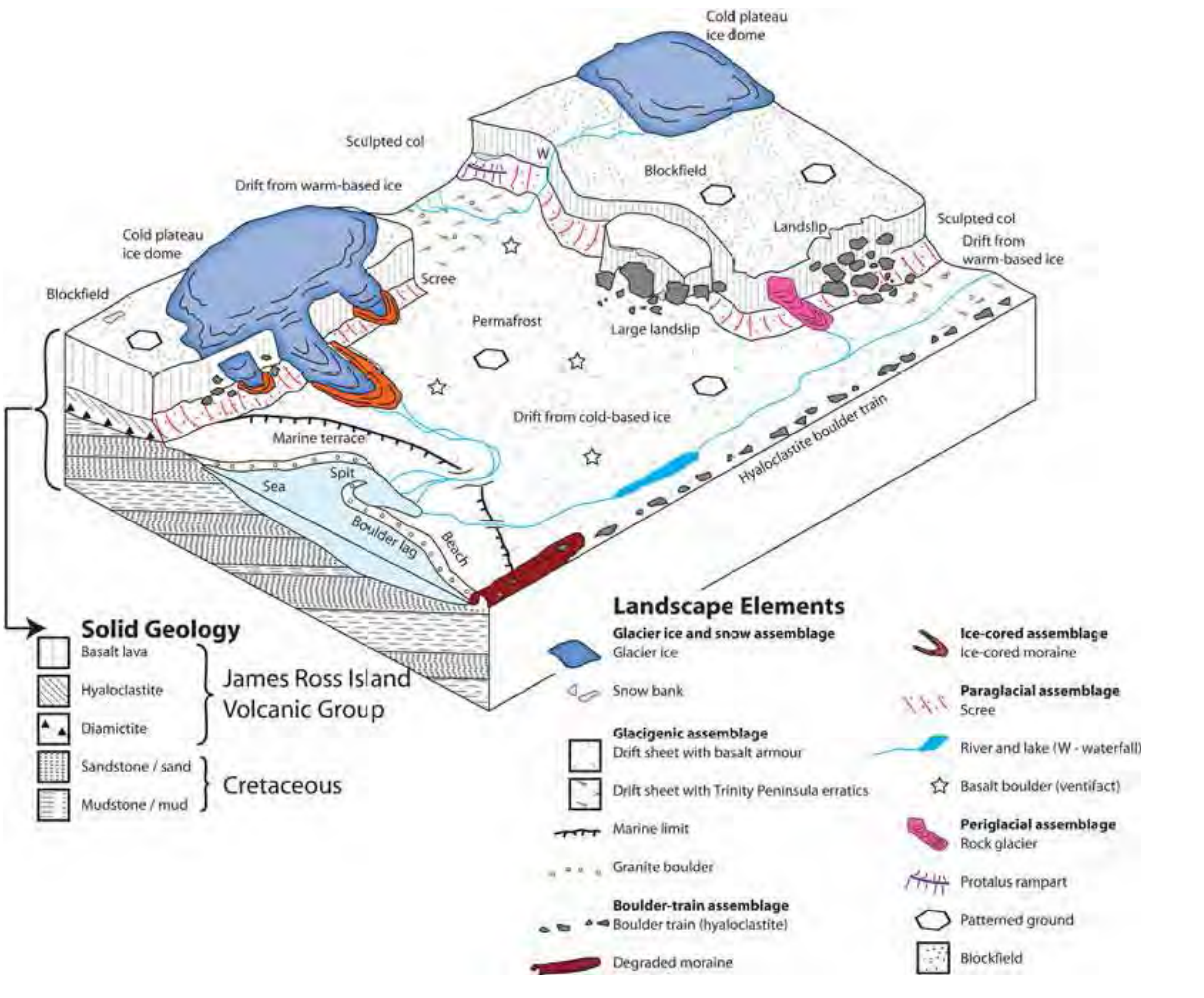
Nývlt, D., Engel, Z., Carrivick, J.L., Davies, B. J., Glasser, N. F., Braucher, R., Láska, K., Bourlès, D., Mlčoch, B., 2012. Glacial history of James Ross Island since the Late Glacial. In: Blahůt, J., Klimeš, J., Štěpančíková, P., Hartvich, F. (eds): Geomorfologický sborník 10, 12. mezinárodní konference Stav geomorfologických výzkumů v roce 2012, Sokolov 18.-20.4.2012, 35–36, IRSM AS CR, Praha.

Landscape evolution of deglaciated parts of James Ross Island during the Holocene with special attention to glacial, periglacial and paraglacial sediment-landform assemblages in a semi-arid sub-polar region

Geomorphological processes in polar deserts are poorly understood despite their widespread occurrence in present both in the Arctic (*e.g.* Svalbard, Canadian High Arctic) and the Antarctic (*e.g.* Vestfold Hills, Dry Valleys; Alexander Island) and an even more extensive spreading in high- and mid-latitude continental interiors during the Pleistocene. The interrelationship of geomorphological (such as cold-based and warm-based glacial, periglacial and paraglacial) processes in polar deserts has been the subject of relatively few studies (*e.g.*

Fitzsimons, 2003; Haeberli, 2005; Waller et al., 2009) though they provide information on past and present ice sheet and glacier dynamics and stability, mass and contribution to sea level rise (Waller, 2001; Kleman and Glasser, 2007).

Landsystems use modern analogues to understand geomorphological processes and process-form relationships through the characterisation of terrain with repeated patterns in surface form and sediments (*e.g.* Evans and Twigg, 2002; Benn and Lukas, 2006; Hambrey and Fitzsimons, 2010). When constrained by detailed modern analogues, large-scale geomorphological mapping and a landsystem approach can provide proxy data for palaeo-glaciological models and palaeoclimatic reconstructions (Evans, 2011). Landsystem models have been presented, among others, for cold-based glaciers in East Antarctica (French and Guglielmin, 1999; Fitzsimons, 2003; Hall and Denton, 2005), glaciated Alpine valleys (Spedding and Evans, 2002), active temperate ice sheets (Evans and Twigg, 2002; Evans, 2003a) and polythermal glaciers (Glasser and Hambrey, 2003), but an original model has yet to be developed for a semi-arid polar desert. Such a model was presented for the northern ice-free area of the Ulu Peninsula, James Ross Island by Davies et al. (2013) basing on a holistic and systematic study including detailed geomorphological mapping both in the field and from remotely-senses images; sedimentary descriptions; clast lithology, shape and roundness analyses.



Conceptual model illustrating the principal processes and sediment-landform assemblages in a semi-arid polar desert, based on Ulu Peninsula of James Ross Island, showing simplified geology and surficial sediments.

Six sediment-landform assemblages have been defined and interpreted for this area: 1) the glacier ice and snow assemblage; 2) the glacigenic assemblage, which relates to Last Glacial Maximum sediments and comprises both erratic-poor and erratic-rich drift, deposited by cold-based and wet-based ice and ice streams respectively; 3) the boulder train assemblage, deposited during a mid-Holocene glacier re-advance; 4) the ice-cored moraine assemblage, found in front of small cirque glaciers; 5) the paraglacial assemblage includes scree, pebble-boulder lags, and littoral and fluvial processes; 6) the periglacial assemblage includes rock glaciers, protalus ramparts, block fields, solifluction lobes and extensive patterned ground. The interplay between glacial, paraglacial and periglacial processes in this semi-arid polar environment is important in understanding polygenetic landforms. Crucially, cold-based ice was capable of sediment and landform genesis and modification. This landsystem model from a semi-arid sub-polar region can aid the interpretation of past environments, but also provides new data to aid the reconstruction of the last ice sheet to overrun James Ross Island. Crucially, when compared with the few other polar landsystem models, it could be shown that the availability of melt water encourages strong landform modification by periglacial processes. These processes would have been similarly important in the Northern Hemisphere during the Late Pleistocene epoch. Therefore the landsystem model presented here is a modern analogue to be used in the interpretation of past glaciated environments. The research presents new information regarding the thermal regime of the Antarctic Peninsula Ice Sheet during Last Glacial Maximum glaciation. The data and model for the interplay between cold-based, warm-based and streaming ice challenges the theory that cold-based glaciers do not erode or deposit. Geomorphological and sedimentological data presented by Davies et al. (2013) help interpret the presence of cold-based sheet flow in other Quaternary glaciated environments. Finally, this paper presented important new data regarding the thermal regime and character and behaviour of the Last Glacial Maximum ice sheet on James Ross Island, which will aid reconstructions of the Last Glacial Maximum ice sheet in northern Antarctic Peninsula.

Published results:

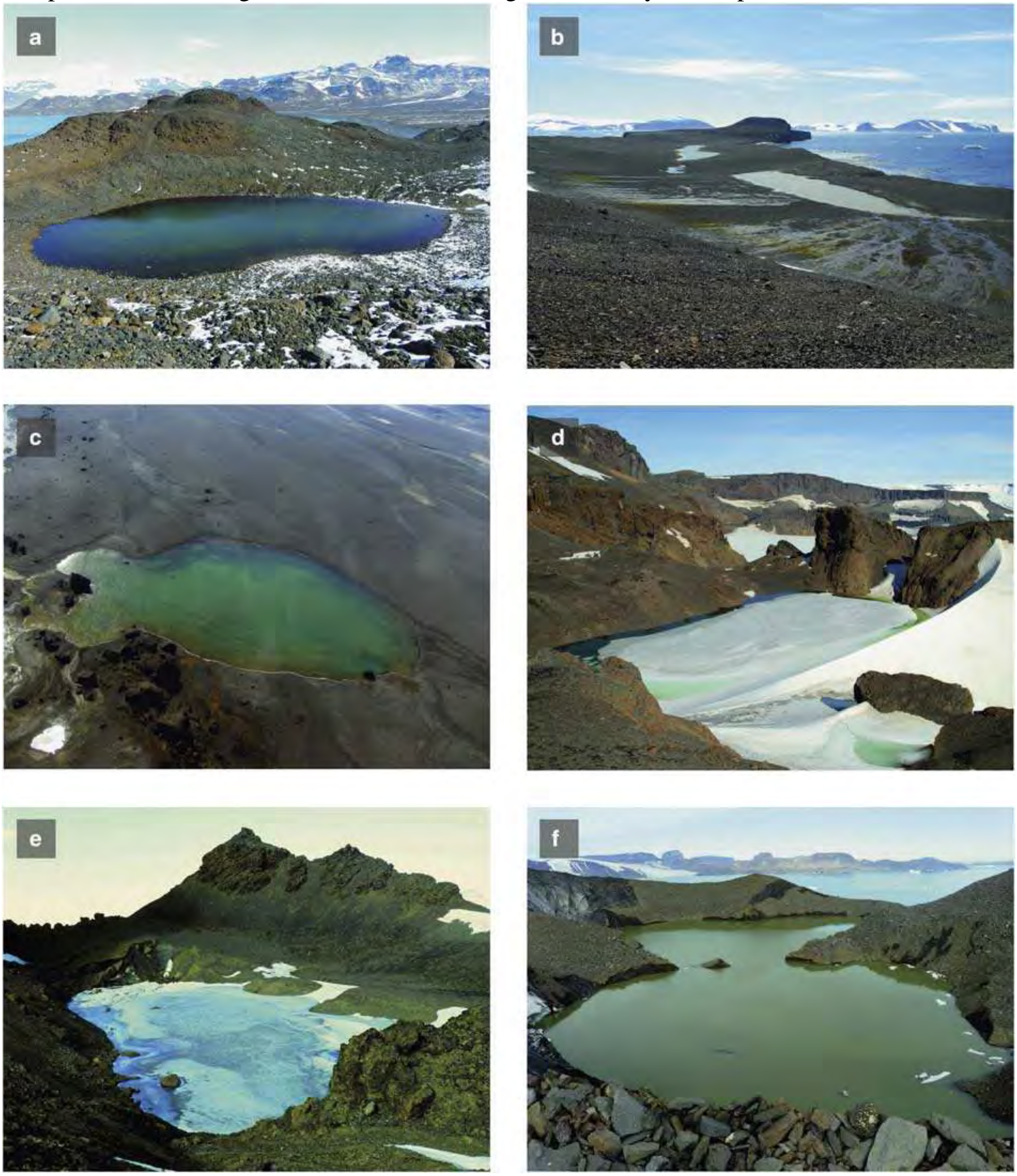
Davies, B., Glasser, N., Carrivick, J., Hambrey, M., Smellie, J., Nývlt, D., 2012. Landscape evolution and ice-sheet behaviour in a semi-arid polar environment: James Ross Island, NE Antarctic Peninsula. In: XXXII SCAR and Open Science Conference Abstracts, Session 19: Antarctic Permafrost, Periglacial and Ice-Free Environments.

Davies, B.J., Glasser, N.F., Carrivick, J.L., Hambrey, M.J., Smellie, J.L., Nývlt, D., 2013. Landscape evolution and ice-sheet behaviour in a semi-arid polar environment: James Ross Island, NE Antarctic Peninsula. In: Hambrey, M.J., Barker, P.F., Barrett, P.J., Davies, B., Smellie, J.L., Tranter, M. (eds): Antarctic Palaeoenvironments and Earth-Surface Processes. Geological Society, London, Special Publication, 381.

Engel, Z., Nývlt, D., 2013. 5.2.4 Reliéf a geomorfologický vývoj ostrova Jamese Rosse. In: Prošek, P. (ed): ANTARKTIDA. 264–276, Academia, Praha.

Physical and chemical limnology

Although the Antarctic continent is almost completely covered by an ice sheet, one of its characteristic features is a surprising diversity and abundance of lakes. Besides subglacial lakes (Siegert et al., 2005), the majority of them are situated in coastal oases in continental Antarctica such as the McMurdo Dry Valleys, Vestfold Hills, Larseman Hills, Bunger Hills, Syowa Oasis and Schirmacher Oasis (Verleyen et al., 2012). However, many ice-free areas with lakes can also be found on the Antarctic Peninsula and surrounding islands. These lakes mostly occupy depressions created by glacial erosion and were formed following Holocene ice sheet retreat (Vincent and Laybourn-Parry, 2008), or isostatic uplift (*e.g.* Roberts et al., 2011). Limnological surveys of freshwater lakes in this region have been carried out, for example, on the South Shetland Islands (Toro et al., 2007), and on Beak Island (Sterken et al., 2012). However, lake distribution, their physical and chemical characteristics, and biology are generally poorly known around the Antarctic Peninsula. Additional studies are thus needed to complete the knowledge of the current limnological diversity in this part of Antarctica.



Subset of lakes representing various lake types found on the Ulu Peninsula. a. Stable shallow lake of higher-lying levelled surfaces, b. shallow coastal lakes, c. stable lake in old moraine, d. small unstable lake in young moraine, e. deep cirque lake, and f. kettle lake.

James Ross Island belongs to a transitory zone between the maritime Antarctic and continental Antarctic regions. More than 80% of the island surface is covered with ice and only the northernmost part of the island, the Ulu Peninsula, is significantly deglaciated and represents one of the largest ice-free areas (oasis) in the northern part of the Antarctic Peninsula. Multiple glaciation of the island with ice streaming from James Ross Island and the Antarctic Peninsula has resulted in deeply incised glacial valleys, which lie partly on land and are partly flooded by the sea at present (see *e.g.* Nývlt et al., 2011). The origin of the lakes on

James Ross Island is related to the last deglaciation of the Antarctic Peninsula ice sheet and the retreat of the James Ross Island ice cap during the Late Glacial (Nývlt et al., in review) and the Holocene, and to relative sea level changes resulting from postglacial isostatic recovery (Hjort et al., 1997). Interaction between volcanic landforms and glacial geomorphology during previous glacial-interglacial cycles and Holocene paraglacial and periglacial processes and relative sea level change has resulted in the complex present-day landscape of James Ross Island (Davies et al., 2013). All of these processes have influenced the development of the lakes, which are found on the Ulu Peninsula at altitudes ranging from <20 m a.s.l. near the coast to ~400 m a.s.l. in the mountain areas. Detail description of lake types found on the Ulu Peninsula, James Ross Island including their origin, age, morphometry, and physical and chemical characteristics was presented by Nedbalová et al. (2013). The results of this study can serve as baseline information for future limnological investigations in the region of the Antarctic Peninsula, and also for biological assessments of the lakes.

Six lake types can be distinguished within the group of the lakes on the Ulu Peninsula basing on their origin, geomorphological position and hydrological stability. 1) Stable shallow lakes on higher-lying levelled surfaces are among the oldest in the studied region. The last deglaciation of these glacially-levelled volcanic surfaces took place during the early Holocene and the lakes must have originated after that. Therefore, the lakes are regarded as permanent and old to very old, with a persistence of hundreds to thousands of years. They are situated mostly not far from the coastline at middle to higher altitudes (40–235 m a.s.l.). The lakes are typically small and shallow with a maximum depth of few meters. 2) Shallow coastal lakes developed mostly in the early to mid Holocene, following relative sea level fall and/or glacier retreat in the coastal areas. They are very shallow (maximum depth is only 0.3 m) and lie in the proximity of the sea at very low altitudes. High aeolian input of silty–sandy material originating mostly from Cretaceous sediment affects depositional rates, their bottoms are therefore composed of a thick (up to >2 m) layer of sediments. High sediment deposition and irregular water supply mostly from thawing snow patches limit their stability and desiccation events during the history of these shallow lakes cannot be excluded. This was confirmed in February 2012, when one of the Lachman Lakes was found dry (Váczi et al., 2011; please note that this volume has been issued in July 2012, see Experimental Biology). This lake group was most probably formed during the mid-Holocene times. These lakes are very old (they are present for thousands of years) and semi-permanent, as seasonal drying cannot be excluded. 3) Stable lakes in old moraines originated during the degradation of large moraine ridges and till plains during the Holocene neoglacial advance of local glaciers. Only the largest and most stable have lasted until the present. Hence these lakes are permanent and very old, with their persistence in the order of thousands of years. They are located at low to mid-altitudes. They have a very variable area and are generally very shallow (maximum depth 0.5 m), with the exception of the Monolith Lake, which is up to 2.2 m deep. 4) Small unstable lakes in young moraines are located in front of the retreating local glaciers. They are young and originated from the last retreat of local glaciers during the Little Ice Age (see Carrivick et al., 2012). They have quite high maximum depths and are ephemeral, as they are mostly ice-dammed marginal lakes and further glacier thawing may induce their complete discharge. Their surface and catchment areas are amongst the smallest of the studied lakes. 5) Deep cirque lakes evolved due to the recent decay of local glaciers on the lee sides of some volcanic mesas, where accumulation of drifting snow allowed the formation of cirque glaciers. They are young and originated during the last retreat of local glaciers. Their key feature is the presence of extensive ice cover, large water volume and relative depths. These lakes are stable in the order of tens of years; however, further thawing due to increasing temperatures will induce their decay, they are therefore assigned as less-stable. 6) Kettle lakes are youngest and least stable lakes, which evolved in debris covered glaciers by ice degradation in kettle-holes subsequently filled with water. These lakes are the most abundant lake type on James Ross Island. They might persist for years or a few decades only and are therefore assigned as very young and ephemeral. The maximum and relative depths are also very high and temporarily variable. Kettle lake outbursts are quite common on James Ross Island. One of these events was recently described by Sone et al. (2007).

As it is described above the freshwater lakes of the ice-free Ulu Peninsula, James Ross Island basically differ in their origin and history, which influences their morphometry, hydrological stability, and physical and chemical characteristics. The diversity of lakes is further related to the differences in bedrock composition. Therefore, the lakes on James Ross Island represent a very valuable set of lacustrine habitats in the transitional zone between maritime and continental Antarctica (Nedbalová et al., 2013).

Published results:

Nedbalová, L., Elster, J., Komárek, J., Nývlt, D., 2009. Lake ecosystems of James Ross Island: short characteristics. In: Barták, M., Hájek, J., Váczi, P. (eds): Structure and function of Antarctic Terrestrial Ecosystems. Oct. 22–23, Book of Abstracts and Contributed Papers, 33–34, Muni Press, Brno.

Nedbalová, L., Nývlt, D., Elster, J., 2012. Jezera ostrova Jamese Rosse – zranitelná centra antarktické biodiverzity. Vesmír, 91, 432–437.

Nedbalová, L., Nývlt, D., Kopáček, J., Šobr, M., Elster, J., 2011. Freshwater lakes of Ulu Peninsula (James Ross Island, NE Antarctic Peninsula): I. Origin, geomorphology and physico-chemical limnology. In: 4th International Conference on Plar and Alpine Microbiology (PAM 2011), Ljubljana, September 4–8, Ljubljana.

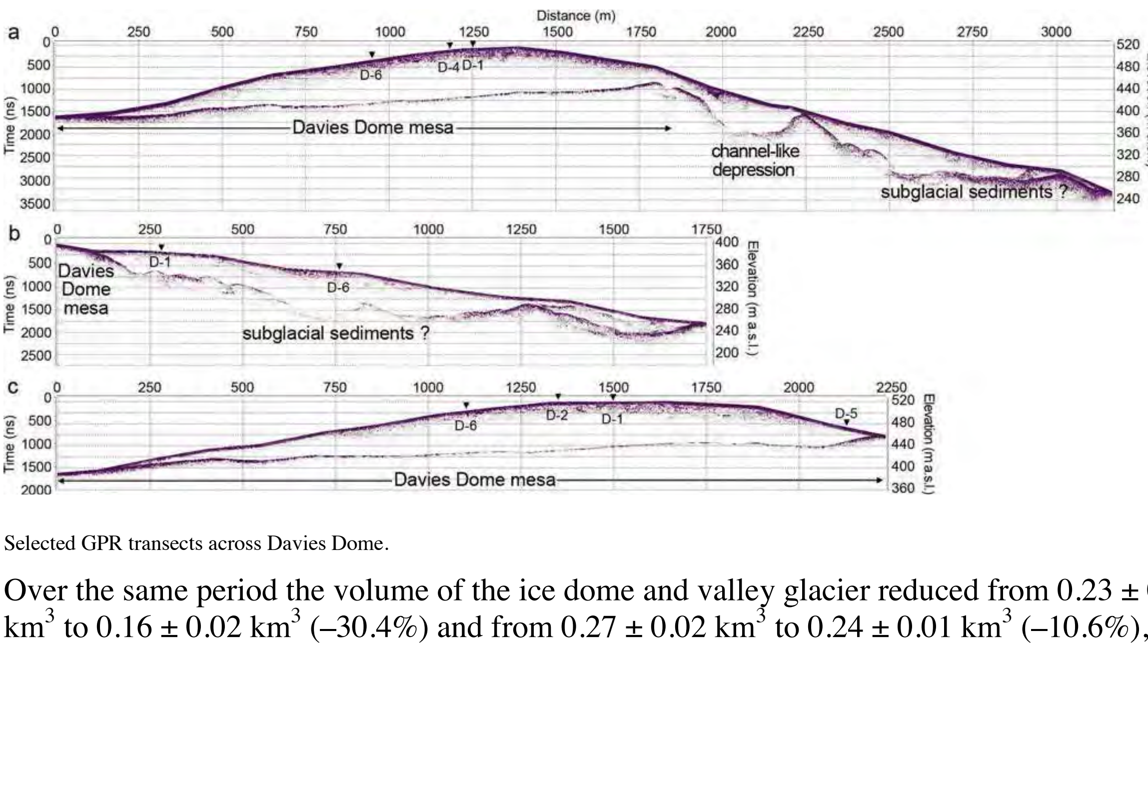
Nedbalová, L., Nývlt, D., Kopáček, J., Šobr, M., Elster, J., 2013. Freshwater lakes of Ulu Peninsula (James Ross Island, NE Antarctic Peninsula): Origin, geomorphology, physical and chemical limnology. Antarctic Science, first view, doi: 10.1017/S0954102012000934.

Glaciology and recent changes of local glaciers

More than 3/4 of James Ross Island (JRI) surface is covered with ice. Only the northernmost part of the island, the ~600 km^2 large Ulu Peninsula, is significantly deglaciated and represents one of the largest ice-free areas in the northern part of the Antarctic Peninsula (AP; Nedbalová et al., in press). The first inventory of glaciers and their classification was presented by Rabassa et al. (1982), however many of the glaciers named in this study disappeared since that time. Newest glacier inventory for the northernmost AP by Davies et al. (2012) focused mostly on larger glaciers. However, they also classify the glaciers according to their size, elevation, aspect, hypsometry and equilibrium line altitude. The southern part of JRI is almost completely covered by an ice cap with numerous outlets and only small masses of rock protrude to the surface (Engel et al., 2012). By contrast, most ice has retreated from the northern part of the Ulu Peninsula, where small individual glaciers persisted in higher locations (Engel et al., 2012). These include mostly small dome, outlet, valley, piedmont, cirque, apron and covered glaciers.

The mean annual temperature in the Antarctic Peninsula region has increased by 1.5–3.0 °C since the 1950s (*e.g.* King, 1994; Vaughan et al., 2003). This warming has coincided with the disintegration of ice shelves and the retreat of many land-terminating glaciers in the region (*e.g.* Skvarca et al., 1998; Cook et al., 2005; Glasser et al., 2011). Land-based glacial mass loss has been most prominent at the northern tip of the AP due to the pronounced glacier acceleration (Rignot et al., 2008). Detailed analyses of satellite imagery and some isolated mass-balance measurements together suggest that small land-terminating glaciers are especially sensitive to climate change (Rau et al., 2004; Skvarca et al., 2004). Along with direct mass-balance measurements, changes in surface area and volume of glaciers are important indicators of climate changes. Volumetric characteristics are necessary for improved understanding of: (1) the responses of these sensitive glacier systems to climate change; (2) the present contribution of glaciers around the Antarctic Peninsula to sea level rise; and (3) future predictions of Antarctic Peninsula glacier behaviour. Glacier bed topography and ice thickness are important for understanding ice dynamics (Rippin et al., 2011a) and for assessing basal pressure and thermal regimes (Rippin et al., 2011b). Determination of glacial mass changes may be used to detect shifts in climate and to predict glacial changes associated with future climate conditions (Paterson, 1994; Fountain et al., 1999). In Engel et al. (2012), volumetric data for Davies Dome ice dome and Whisky Glacier on James Ross Island have been presented. The changes in elevation, area and geometry between 1979 and 2006 were derived from digital elevation models (see Czech Geological Survey, 2009 for further details) and aerial photographs. Ice thickness was measured during a field campaign in January and February 2010 using ground-penetrating radar (GPR). Glacier volume and glacier bed elevations were then derived from these data. Davies Dome is an ice dome, which originates on the surface of a flat volcanic mesa at >400 m a.s.l. and terminates as a single 700m wide outlet in Whisky Bay. In 2006, Davies Dome had an area of ~6.5 km^2 and lay in the altitude range 0–514 m a.s.l. Whisky Glacier is a cold-based land-terminating valley glacier, which is surrounded by an extensive area of debris-covered ice (Chinn and Dillon, 1987; Davies et al., 2013). In 2006, the glacier covered an area of ~2.4 km^2 and ranged from 520 to 215 m a.s.l.

Maximum measured ice thicknesses of Davies Dome and Whisky Glacier are 83 ± 2 and 157 ± 2 m, respectively. The mean ice thickness of Davies Dome and Whisky Glacier is 32.4 ± 1.2 and 99.6 ± 1.8 m, respectively. Between 1979 and 2006, the area of the ice dome decreased from 6.23 ± 0.05 km^2 to 4.94 ± 0.01 km^2 (–20.7%), while the area of the valley glacier reduced from 2.69 ± 0.02 km^2 to 2.40 ± 0.01 km^2 (–10.6%). These values are in agreement with retreat rates of Davies Dome reported by Davies et al. (2012b) for the period 1988–2009. However, they are higher than mean annual areal changes of ice caps on Livingston Island (Calvet et al., 1999; Molina et al., 2007) and King George Island (Simões et al., 1999) over the period 1956–2000. By contrast, the mean annual area decrease of Davies Dome and Whisky Glacier is an order of magnitude less than the mean annual area loss of cirque glaciers on King George Island (Simões et al., 2004). Overall, the increase in glacier retreat observed on James Ross Island is similar to the accelerated area loss reported for glaciers on King George Island in the period 2000–2008 (Rückamp et al., 2011).



Selected GPR transects across Davies Dome.

Over the same period the volume of the ice dome and valley glacier reduced from 0.23 ± 0.03 km^3 to 0.16 ± 0.02 km^3 (–30.4%) and from 0.27 ± 0.02 km^3 to 0.24 ± 0.01 km^3 (–10.6%), respectively. The mean surface elevation decreased by 8.5 ± 2.8 and 10.1 ± 2.8 m. The mean elevations of Davies Dome and Whisky Glacier decreased by 0.32 ± 0.10 and 0.37 ± 0.10 m a^{-1}, respectively. These values correspond well with the mean surface lowering of 0.32 m w.e. a^{-1} observed over the period 1988–1997 at Rothera Point on the south-western Antarctic Peninsula (Smith et al., 1998) and with the mean lowering rate of 0.2 m a^{-1} reported from the summit of Bellingshausen Dome on King George Island (Rückamp et al., 2011). This could also be compared with the mean surface lowering of the Glaciar del Diablo located on the northern coast of Vega Island ~30 km northeast of the studied glaciers published by Skvarca et al. (2004). The annual mean surface lowering of this glacier was –0.32 m w.e. over the period of 1999–2003, which is however much lower than mean values of –1.00 m w.e. over the period of 1985–1998 published by them for the same glacier. Pritchard et al. (2009) and Rückamp et al. (2011) reported however a much higher values of ~1.5 m a^{-1} on the South Shetland Islands for the periods 2003–2007 and 2000–2008.The mean annual volume loss of 1.1% a^{-1} and 0.4% a^{-1} was calculated between 1979 and 2006 for Davies Dome and Whisky Glacier respectively. The value for Whisky Glacier corresponds with mean annual glacier volume losses for the glacier from South Shetland Islands for the period 1956–2000 (0.2–0.3% a^{-1}; Molina et al., 2007). The volumetric loss of Davies Dome is three to four times higher than these values. Generally the average areal (~0.048–0.011 km^2 a^{-1}) and volumetric (~0.003–0.001 km^3 a^{-1}) changes of Davies Dome and Whisky Glacier are higher than the majority of other estimates from Antarctic Peninsula glaciers (Engel et al., 2012).

A comparison of the spatial data with earlier glaciological observations suggests that Davies Dome and Whisky Glacier were subject to greater retreat, surface lowering and ice volume loss than other island ice domes and valley glaciers in the Antarctic Peninsula region. If the recent rate of volume loss continues, they could disappear within 62 ± 52 and 227 ± 220 years, respectively. This approximated timing corresponds well with the value based on mean rate of areal loss for Whisky Glacier (228 ± 22 years to extinction), but the volumetric change of Davies Dome is more rapid than its areal change (104 ± 5 years). However, it could be assumed that area rather than volume has the largest control on the future development of both glaciers (Engel et al., 2012).

Published results:

Carrivick, J.L., Davies, B.J., Glasser, N.F., Nývlt, D., Hambrey, M.J., 2012. Late Holocene changes in character and behaviour of land-terminating glaciers on James Ross Island, Antarctica. Journal of Glaciology, 58(212), 1176–1190.

Engel, Z., Kopačková, V., Láska, K., Nývlt, D., 2013. 5.4 Glaciologický výzkum ostrova Jamese Rosse. In: Prošek, P. (ed): ANTARKTIDA. 294–302, Academia, Praha.

Engel, Z., Nývlt, D., Láska, K., 2012. Ice thickness, areal and volumetric changes of Davies Dome and Whisky Glacier (James Ross Island, Antarctic Peninsula) in 1979–2006. Journal of Glaciology, 58(211), 904–914.

Láska, K., Nývlt, D., Engel, Z., Budík, L., 2012. Seasonal variation of meteorological variables and recent surface ablation / accumulation rates on Davies Dome and Whisky Glacier, James Ross Island, Antarctica. Geophysical Research Abstracts, vol. 14, EGU2012-5545.

Láska, K., Nývlt, D., Engel, Z., Kopačková, V., 2011. Meterorological data and mass balance measurements on Davies Dome and Whisky Glacier in 2006–2010, James Ross Island, Antarctica. Geophysical Research Abstracts, vol. 13, EGU2011-4858.

Láska, K., Prošek, P. Barták, M., Nývlt, D., 2010. Climatic and glaciological investigations on the James Ross Island near Antarctic Peninsula. Geografie pro život ve 21. století: Sborník příspěvků z XXII. Sjezdu České geografické společnosti pořádaného Ostravskou univerzitou v Ostravě 31. 8 – 3. 9. 2010, 193–197, Ostrava.

Nývlt, D., Kopačková, V., Láska, K., Engel, Z., 2010. Recent changes detected on two glaciers at the northern part of James Ross Island, Antarctica. Geophysical Research Abstracts, vol. 12, EGU2010-8102.

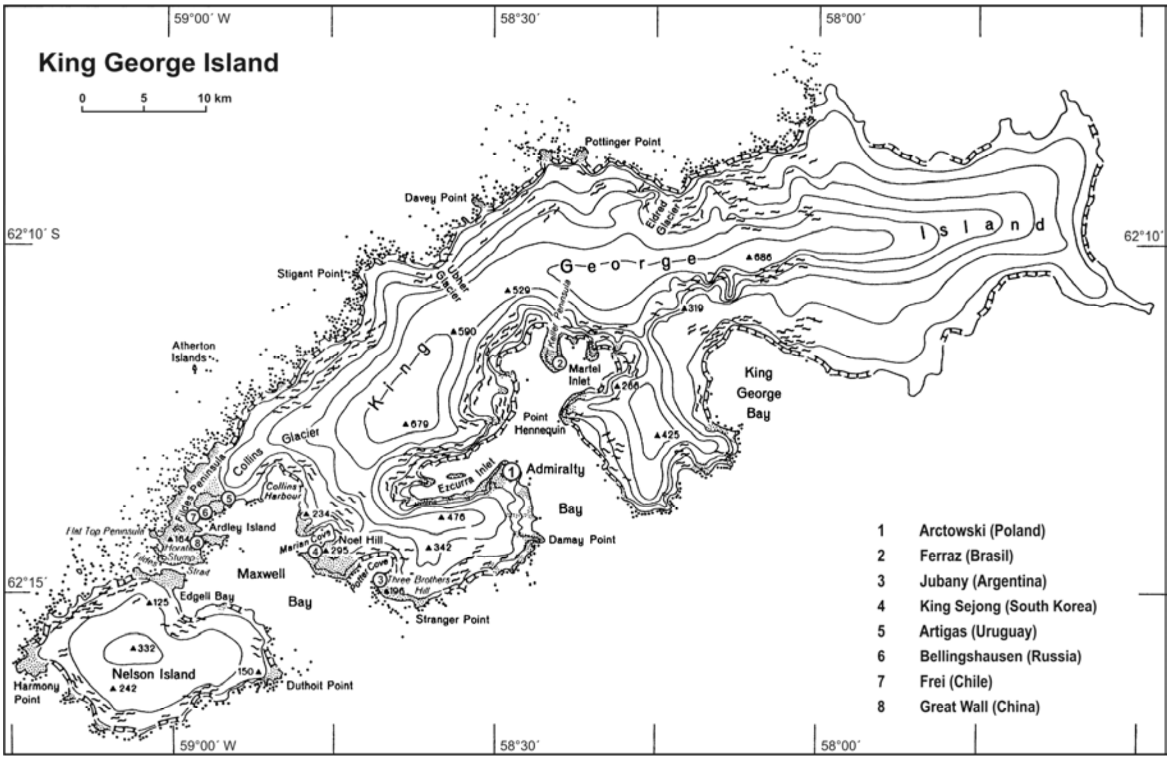
Nývlt, D., Láska, K., Kopačková, V., Engel, Z., 2009. Glacio-meteorological measurements on two glaciers at the northern part of James Ross Island, Antarctica. In: Barták, M., Hájek, J., Váczi, P. (eds): Structure and function of Antarctic Terrestrial Ecosystems. 7–8, Muni Press, Brno.

Nývlt, D. et al., 2012. Ústup ledovců. National Geographic Česko, 6/2012.

Atmospheric Sciences

The role of atmospheric circulation on the specific weather pattern in the maritime Antarctica

Antarctica plays a very significant role in many environmental aspects and processes of the Earth (Prošek 1999). Its impact on the global climate system (considerable influence on the planet Earth albedo, long "climate memory" of the huge mass of ice, important factor of the meridional exchange of air masses) and water circulation in the world oceans is essential (Prošek 2013). Air masses of different origins, which are transported over ocean or land surfaces, can result in variable air temperature and humidity (Prošek and Janouch 1997a). Therefore, energy fluxes near the surface are strongly influenced by synoptic conditions. Neal and Fitzharris (1997) pointed out that little was known about the relationship between atmospheric processes on one hand, and energy exchange between atmosphere and snow or ice surfaces on the other hand.



Location of the study area (1) at the Polish Arctowski Station, King George Island.

Since 1994, atmospheric and climate research have been carried out primarily on King George Island (South Shetland Islands). Measurements and observations of surface weather conditions were realized in the vicinity of the Polish Arctowski Station (located on the western coast of Admiralty Bay) in the period 1994-1997 (Kejna and Láska 1997a, 1997c). In order to evaluate weather conditions, changes in the atmospheric circulation patterns were analyzed and compared with the multiyear data (Kejna and Láska 1997a). The description of atmospheric circulation was based on the calendar of circulation types derived from the classification by Niedźwiedź (1981). In general, our results confirm that synoptic-scale weather systems, air-sea temperature differences and character of the ground play major roles in forming local climate conditions on King George Island, Admiralty Bay in particular (Kejna and Láska 1999). In 1996 weather conditions at the Arctowski Station were formed by cyclonic circulation (79.0% of the days), with frequent advection of warm and humid air masses from the west. The weather patterns at the Arctowski Station were also influenced by local orography with the prevailing winds from the following directions: NNW (13.2%) from the Ezcurra Inlet, WSW (11.3%) from Warszawa Icefield, and SE (8.7%) from the open water of Admiralty Bay. The highest air temperatures, ranging from 1.5°C to 2.1°C, were primarily found at the north and northwest winds, occurred during cyclonic circulation associated with the circulation types Nc and NWc (Prošek and Janouch 1997b).The lowest mean temperature (-15.1°C) was often linked with the occurrence of southern and eastern airflow. The steep orography of central part of King George Island provides an effective barrier, through which there are channeling and drainage effects accompanied by an increase in surface wind speed, turbulence intensity and stress (Kejna and Láska 1999).

Standard meteorological screen in winter conditions at the Polish Arctowski Station, King George Island.

Published results:

Kejna, M., Láska, K., 1997a. Dependence of weather conditions on wind directions at the Arctowski Station (South Shetland Islands, Antarctica) in 1996. In Głowacki P (ed) Polish Polar Studies. 24th Polar Symposium, 153-157.

Kejna, M., Láska, K., 1997b. Weather conditions at the H. Arctowski Station (South Shetland Islands, Antarctica) in 1996. (Polish) In: Problemy Klimatologii Polarnej 7, Wyższa Szkola Morska Gdynia, Komitet Badań Polarnych PAN, 91-108.

Kejna, M., Láska, K., 1997c. Influence of Adélie penguin colony on the temperature of the air layer near the surface (King George Island, Antarctica) in spring 1996. In Repelewska-Pękalowa J (ed) Polish Polar Studies. 26th Polar Symposium, 113-119.

Kejna, M., Láska, K., 1999. Weather conditions at Arctowski Station, King George Island, South Shetland Islands, Antarctica in 1996. Polish Polar Research, 20(3), 203-220.

Prošek, P., 1999. Mořský led – základ potravinového řetězce v Antarktidě. Geografické rozhledy, 5, 116-117.

Prošek, P., 2013. Klima Antarktidy. In: Prošek, P. (ed): ANTARKTIDA. Academia, Praha, 52-62.

Prošek, P., Janouch, M., 1997a. České meteorologické a klimatologické aktivity v Antarktidě po 25 letech. Část I. Klimatografie Antarktidy. Meteorologické zprávy, 50(1), 17-22.

Prošek, P., Janouch, M., 1997b. České meteorologické a klimatologické aktivity v Antarktidě po 25 letech. Část II. Prozatímní výsledky. Meteorologické zprávy, 50(2), 33-45.

Effects of surface energy balance on thermal regime of permafrost active layer

Many aspects of the Antarctic climate, such as *e.g*. seasonal changes of sea ice in the Southern Ocean, temperature stability of the atmosphere, barrier and katabatic winds, are affected by the annual regimens of surface energy balance and solar radiation subsequently (Prošek et al. 1996). As a result of climate change, specific and very intensive Earth modelling processes occur in the surface layer above the long-term frost substrate (permafrost) that may considerably change its character (*e.g*. frost weathering, water erosion, transport and sedimentation of the weathered material, etc.). Atmospheric warming around Antarctic Peninsula and South Shetlands caused an increase in the ground surface temperature (Kejna and Láska 1999, Guglielmin et al. 2008). The rate of periglacial activity is dependent on freeze-thaw processes and is thus a valuable climatic proxy (French 2007). The assessment of surface energy balance and possible effects of warming trend on the ground thermal regime and on the stability of permafrost conditions in this region may be indicative for the whole maritime Antarctica (Prošek et al. 2000). Moreover, soils that develop in permafrost areas are recognized to be sensitive to climate change and provide both positive and negative feedback associated with vegetation succession and changing soil properties (Walker et al. 2003, Chapin et al. 2005). Annual data for both the surface energy balance and thermal regime of the active layer are available from a few locations in maritime Antarctica (Ramos et al. 2008), despite the fact that the maritime Antarctic is experiencing a recent period of air warming (Turner et al. 2007).

Location of the automatic weather station (AWS) for microclimate and surface energy balance measurements at the Polish Arctowski Station, King George Island.

Our research aims to contribute to understanding the relationship between spatial and temporal variability of the surface energy balance, ground surface temperature and active layer thickness at two locations in the maritime Antarctic (Kejna and Láska 1999). The measurements of components of surface energy balance and thermal regime of the active layer were taken at a vegetation oasis in the close vicinity of Polish Arctowski Station (King George Island - South Shetland Islands) in the period 1994-96. Second site was situated at the Ukrainian Vernadsky Station (Galindéz Island - Argentinean Islands). Our results provided the first comprehensive information about the energy balance and the dynamic of its components at the Antarctic coastal vegetation oasis in daytime and throughout summer (Prošek et al. 1996). The results acknowledge both the importance of the radiation balance in energy gain and the turbulent mechanism of heat exchange in energy losses, and very significant predominance of the energy exchange between the ground surface and the atmospheric boundary layer above the energy accumulation in the soil substrate (Prošek et al. 2000, Kejna and Láska 1997a). Moreover, we estimated that active layer is thicker under barren ground than under vegetated surface (Kejna and Láska 1999, 2002), confirming previous observations conducted in the Antarctic (*e.g.* Kratke and Wielbińska 1981, Kejna and Láska 1997b).

Published results:

Kejna, M., Láska, K., 1997a. Freezing and defreezing of the soil in the region of Arctowski Station (King George Island, Antarctica) in 1996. (Polish) In: Rzeźba, współczesne procesy morfogenetyczne i problemy zmian środowiska obszarów polarnych, 25-27.

Kejna, M., Láska, K., 1997b. Ground temperature at the H. Arctowski Station (South Shetland Islands, Antarctica) in 1996. (Polish) In: Problemy Klimatologii Polarnej 7, Wyższa Szkola Morska Gdynia, Komitet Badań Polarnych PAN, 109-124.

Kejna, M., Láska, K., 1999. Spatial differentiation of ground temperature in the region of Arctowski Station, King George Island, Antarctica in 1996. Polish Polar Research 20(3): 221-241.

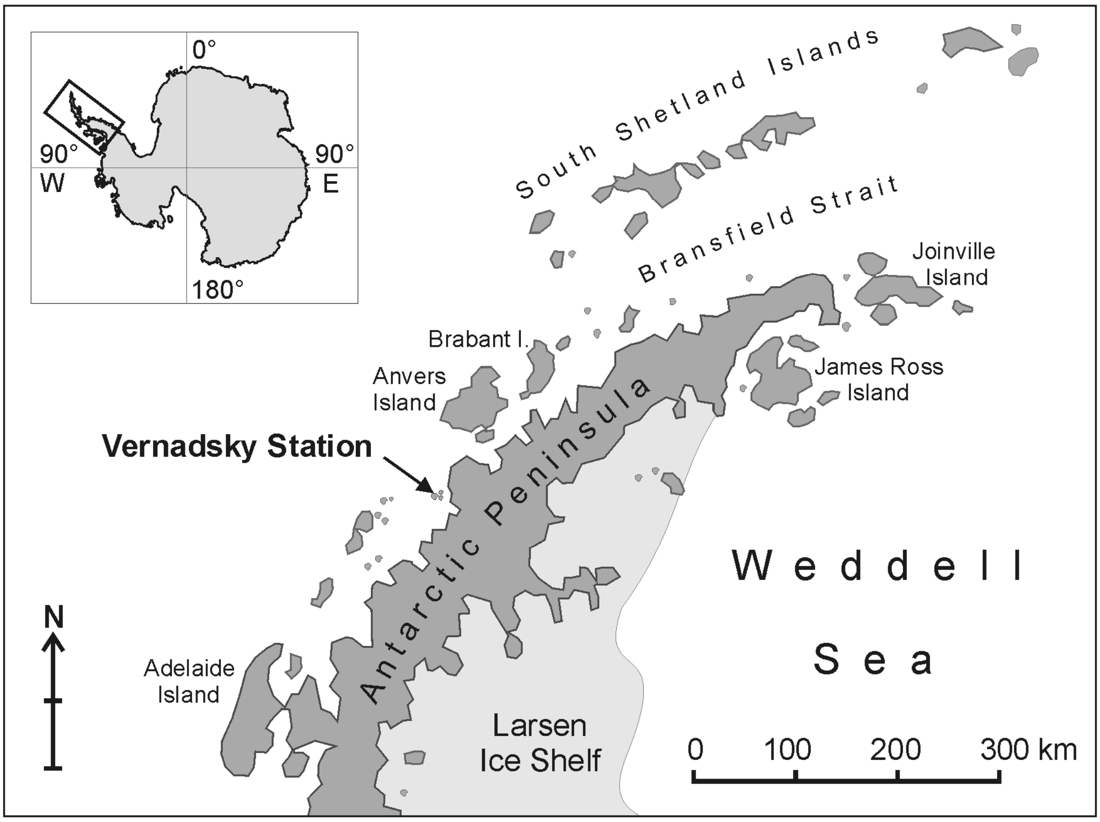
Kejna, M., Láska, K., 2002. Snow cover in the vicinity of the Arctowski Station (South Shetland Islands, Antarctic) in the period 1978-1996. In: Problemy Klimatologii Polarnej 8, Uniwersytet Mikołaja Kopernika, Komitet Badań Polarnych PAN, 79-93.

Prošek, P., Janouch, Kruszewski, G. 1996. Components of radiation balance and their regime in the summer of 1994/95 at H. Arctowski Station (the South Shetlands). In: Problemy Klimatologii Polarnej 6, Wyższa Szkola Morska Gdynia, Komitet Badań Polarnych PAN 107-138.

Prošek, P., Janouch, M.,Láska, K., 2001. Components of the energy balance of the ground surface and their effect on the thermics of the substrata of the vegetation oasis at Henryk Arctowski Station, King George Island, South Shetlands. Polar Record, 36(196), 3-18.

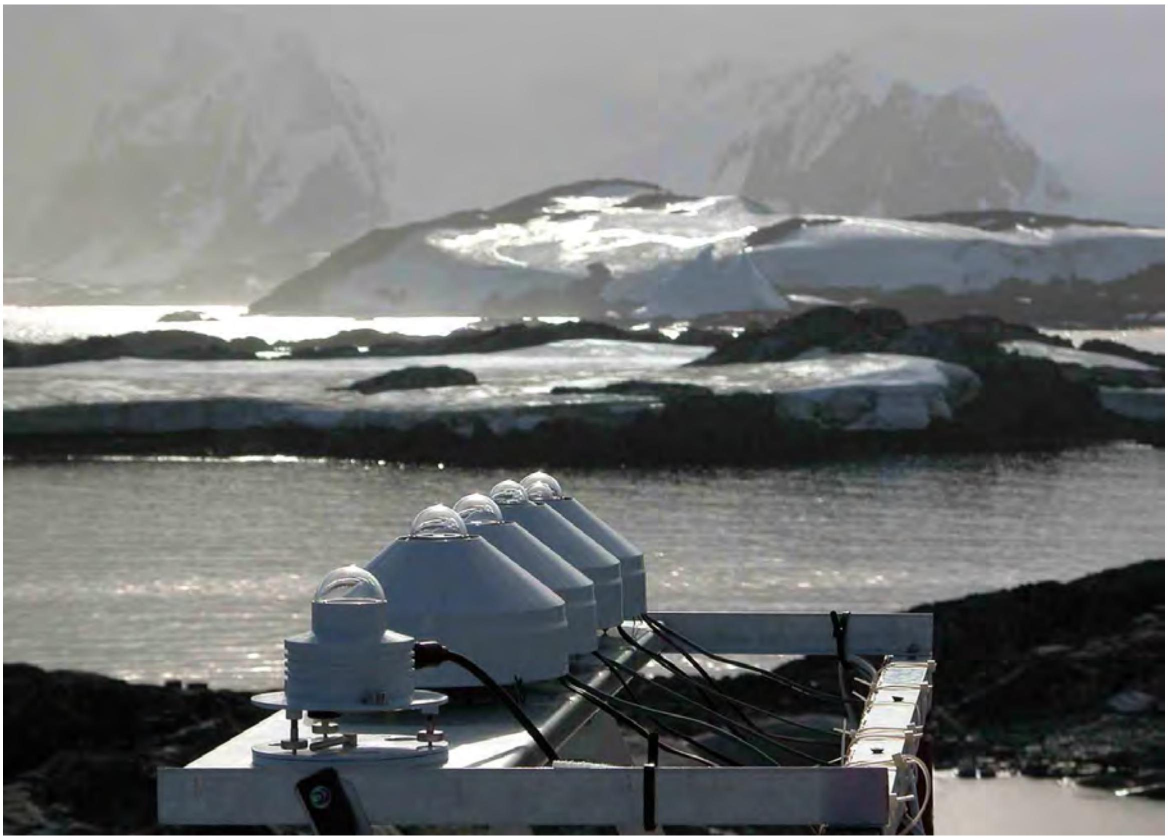
Effects of ozone depletion on the solar UV radiation in the region of Antarctic Peninsula and James Ross Island

In the last few decades interest in UV radiation has increased within the scientific community as it has been found a broad variety of environmental and health effects (*e.g.* Slaper et al. 1996, Weihs et al. 2012). UV radiation depends on many atmospheric factors. Among the most important atmospheric factors are total ozone content (TOC), clouds, and the atmospheric aerosol. Over the last two decades there has been a large-scale depletion of the stratospheric ozone in Antarctica, except the year 2002, when an unprecedented major sudden stratospheric warming resulted in an almost no-ozone-hole episode (Varotsos 2004, Láska and Prošek 2013b). Several studies indicate that both atmospheric circulation and stratospheric temperature play an essential role in the intensity of ozone losses over both hemispheres (Hofmann et al. 2009). Apart from that, the consecutive deceleration of ozone losses over Antarctica during the last decade was reported (Kravchenko et al. 2009). The most recent paper indicates that Antarctic ozone hole could show initial signs of recovery within 10 years (Hassler et al. 2011). In high latitude locations, the cloudiness and total ozone content in the atmosphere are the most important factors affecting the incident UV radiation. As shown by several authors, the amount of cloud, cloud position relative to the Sun, cloud type and its optical properties strongly modulate the course of incident UV radiation (*e.g*. Luccini et al. 2003, Villán et al. 2010, Prošek et al. 2004).



Northern part of the Antarctic Peninsula showing the location of Vernadsky Station.

Our research presents a comprehensive analysis of the relationship between stratospheric ozone, cloudiness and solar UV radiation carried out in the region of Antarctic Peninsula and James Ross Island since 1995. The measurements were accomplished using three type radiometers: pyranometer CM11 (Kipp-Zonen, the Netherlands), total UV broadband radiometer CUV3 (Kipp-Zonen, the Netherlands), and UV-Biometer Model 501 version 3, manufactured by Solar Light, USA). The instruments were installed at three Antarctic bases in different time period: Polish Arctowski Station (King George Island - South Shetland Islands) in the period 1995-1998, Ukrainian Vernadsky Station (Galindéz Island - Argentinean Islands) in 2002-2006, and at the Czech Johann Gregor Mendel Station (James Ross Island) since 2006 up to now (Láska and Prošek 2013). The statistical analysis support the fundamental influence of the two main factors (cloudiness and TOC) on the time variation of both total UV radiation and UVB radiation (Prošek and Janouch 1997, Prošek et al. 2001). Effect of the factors, however, differed significantly from year to year due to the pattern of atmospheric circulation, stratospheric temperature variation and development of ozone depletion in early spring period (Prošek et al. 2004). At the same time, the analysis of regime of UV irradiances, TOC and cloudiness confirm that as a result of the maximum ozone depletion roughly from mid-September through the first half of October, i.e. during the period of low radiation intensities at the beginning of the Antarctic summer, the presence of significant, high solar irradiance determined only by a low TOC are not possible (Láska et al. 2009). The high intensity of UV radiation only occurs in the second half of November and December, i.e. during the period when the Sun is closest to its zenith. However, even during this period, the frequency of days with high UV irradiance is significantly reduced by the high amount of clouds and low number of clear-sky days (Budík et al. 2009). Attention to the other factors influenced the regime of UV radiation fluxes, among others albedo, optical air mass and cloud genera is the main objective of solar radiation monitoring programme at the Czech J. G. Mendel Station (Láska and Prošek 2013a).



Radiometers equipped with the ventilation units installed on a special platform at the Ukrainian Vernadsky Station (Galindéz Island, western Antarctic Peninsula).

Published results:

Budík, L., Budíková, M., Láska, K., Prošek, P., 2009. Aplikace regresního modelu UVB záření na data ze stanice J. G. Mendela v Antarktidě. In 8th International Conference on Applied Mathematics (APLIMAT 2009). Strojní fakulta Slovenské technické univerzity, 749-756.

Láska, K., Prošek, P., Budík, L., Budíková, M., 2009. Analysis of erythemally effective UV radiation at the Mendel Station, James Ross Island in the period of 2006-2007. Geophysical Research Abstracts, vol. 11, EGU2009-3731.

Prošek, P., Janouch, M., 1997. České meteorologické a klimatologické aktivity v Antarktidě po 25 letech. Část II. Prozatímní výsledky. Meteorologické zprávy, 50(2), 33-45.

Prošek, P., Láska, K., Budíková, M., Milinevsky, G., 2004. The regime of total and biological effective ultraviolet radiation at Vernadsky Station (Argentine Islands, Antarctica) and the impact of ozone and cloudiness in 2002 and 2003. In: Drbohlav, D., Kalvoda, J., Vozenilek, V. (eds.): Czech Geography at the Dawn of the Millenium. Palacky University in Olomouc, 211-223.

Prošek, P., Láska, K., Janouch, M., 2001. Ultraviolet radiation intensity at the H. Arctowski Base (South Shetlands, King George Island) during the period December 1994 – December 1996. Folia Facultatis Scientiarum Naturalium Universitatis Masarykianae Brunensis, Geographia, 25, 35-48.

Láska, K., Prošek, P., 2013a. Klima a klimatický výzkum ostrova Jamese Rosse. In: Prošek, P. (ed): ANTARKTIDA. Academia, Praha, 284-293.

Láska, K., Prošek, P., 2013b. Ozónová anomálie. In: Prošek, P. (ed): ANTARKTIDA. Academia, Praha, 63-69.

Evaluation and forecasting of erythemally effective ultraviolet radiation in Antarctica

Solar UV radiation plays a very significant role in many biological processes, including harmful effects on DNA, human skin and the overall immune system (De Fabo et al. 1990, Schmalwieser et al. 2002). The biological effectiveness of UV radiation (hereafter UVeff radiation) depends on the wavelength and can be either measured or estimated by various theoretical approaches. Therefore, it is important to understand both the geographical distribution of stratospheric ozone over Antarctica and the changes in solar UV radiation during the last few decades (Newman et al. 2004). In order to study and evaluate the effects of atmospheric factors on UV radiation, different types of the models were developed (*e.g.* radiative transfer models including multi-scattering, physical models with a simple parameterization for district wavelengths, statistical models). However, most models based on a solution to the radiative transfer equation do a poor job of treating clouds and their properties. Moreover, most of the UV radiation models were designed and parameterized outside the Antarctic vortex. The specific feature of the Antarctic continent and its atmosphere, such as high surface albedo and the highest temporal variation of total ozone content (TOC) and cloudiness at 50–70°S, made it difficult to simply transfer the models without previous validation.

Therefore, we focused on two major objectives: (i) to develop a nonlinear model, which will be addressing to both the character of the available data and the specific conditions of the Antarctic continent, (ii) to validate the global UV forecast model, which was developed and operationally used at the Institute of Medical Physics and Biostatistics, University of Veterinary Medicine in Vienna, Austria (Schauberger et al. 1997).

Broadband radiometers installed at the Czech J. G. Mendel Station (James Ross Island).

Newly developed nonlinear regression model improved the way how to estimate daily UVeff radiation incident on the Earth's surface (Láska et al. 2009). Instead of the widely used ozone transmissivity exponential function (Kondratyev and Varotsos 1996), we proposed a new approach based on a quantum transmission model using hyperbolic attenuation of the solar radiation (Láska et al. 2008, Budík et al. 2009). The model was validated at two Antarctic sites: Ukrainian Vernadsky Station (formerly the British Faraday Station) located on Galindéz Island off the western coast of the Antarctic Peninsula (Láska et al. 2010), and the Czech Johann Gregor Mendel Station situated on the northern tip of James Ross Island (Láska et al. 2011). The quality of the nonlinear model was examined by the mean average prediction error reaching 4.4% only. Several case studies were successfully accomplished for different variation of amount of clouds, cloud types, TOC and the solar elevation angle (Láska et al. 2010, Láska et al. 2012). Furthermore, we have closely cooperated on worldwide validation and forecasting of the Austrian UV Index model (Schmalwieser et al. 2001). The involved radiation model was a fast spectral model based on measurements of Bener (1972) at Davos (Switzerland) following a suggestion of Diffey (1977). Input parameters were zenith angle, distance between the Earth and Sun, elevation above sea level as well as a global TOC dataset prepared by a simple scheme (Schmalwieser et al. 2001) to be appropriate for the UV Index forecast. Since the UV Index is mainly a tool of radiation protection, the worst case was assumed for input parameters denoting cloudless skies, less aerosols, and solar noon. The validation was done by comparing forecast values to measurements made by UV broadband meters Model 501 (Solar Light, Inc., USA) at six sites in four continents, ranging from 67°N to 60°S. One of the southernmost locations used for model validation was the solar radiation data measured at the H. Arctowski Station in the period 1996-98 (Prošek and Janouch 1997, Prošek et al. 2001). Quality control was undertaken in respect to radiation protection. Therefore besides the hit rate, special attention was put on the frequency of underestimation. The pure model delivers a hit rate (60.5 UV Index) of 53.8% and a rate of underestimation of 5.0%. The TOC forecast flattens and broadens the frequency distribution. The hit rate of the forecast is 49.4% and underestimation was found occur in 7.4% of all cases. Randomly organized forecast data would lead to a hit rate of 12 and 30% for underestimation (Schmalwieser et al. 2002).

Published results:

Láska, K., Prošek, P., 2013. Klima a klimatický výzkum ostrova Jamese Rosse. In: Prošek, P. (ed): ANTARKTIDA. Academia, Praha, 284-293.

Láska, K., Budík, L., Budíková, M., Prošek, P., 2011. Method of estimation of solar UV radiation in high latitude location based on satellite ozone retrieval with improved algorithm. International Journal of Remote Sensing, 32(11), 3165-3177.

Láska, K., Budík, L., Budíková, M., Prošek, P., 2012. Analysis of solar UV radiation at the Mendel Station, Antarctica, based on satellite ozone retrieval and cloudiness variation. Proceedings of Quadrennial Ozone Symposium 2012, 27–31 August 2012, Toronto, Canada, QOS-6132.

Láska, K., Prošek, P., Budík, L., Budíková, M., Milinevsky, G., 2008. Modelling of erythemally effective UVB radiation in dependence on the atmospheric factors. Geophysical Research Abstracts, vol. 10, EGU2008-A-05233.

Láska, K., Prošek, P., Budík, L., Budíková, M., Milinevsky, G., 2009. Prediction of erythemally effective UV radiation by means of nonlinear regression model. Environmetrics, 20, 633-646.

Láska, K., Prošek, P., Budík, L., Budíková, M., Milinevsky, G., 2010. Estimation of solar UV radiation in maritime Antarctica using nonlinear model including cloud effects. International Journal of Remote Sensing, 31(4), 831-849.

Prošek, P., Janouch, M., 1997. České meteorologické a klimatologické aktivity v Antarktidě po 25 letech. Část II. Prozatímní výsledky. Meteorologické zprávy, 50(2), 33-45.

Prošek, P., Láska, K., Janouch, M., 2001. Ultraviolet radiation intensity at the H. Arctowski Base (South Shetlands, King George Island) during the period December 1994 – December 1996. Folia Facultatis Scientiarum Naturalium Universitatis Masarykianae Brunensis, Geographia, 25, 35-48.

Schmalwieser, A.W., Schauberger, G., Janouch, M., Nunez, M., Koskela, T., Berger, D., Karamanian, G., Prošek, P., Láska, K., 2002. Global validation of a forecast model for irradiance of solar, erythemally effective ultraviolet radiation. Optical Engineering, 41(12), 3040-3050.

Schmalwieser, A.W., Schauberger, G., Janouch, M., Nunez, M., Prošek, P., Láska, K., Karamanian, G., Berger, D., 2001. Worldwide forecast of the biologically effective UV radiation: UV-index and daily dose. Proceedings of the Society of Photo-Optical Instrumentation Engineers (SPIE), Vol. 4482, 259-264.

Long-term monitoring of climate variability in the region of Antarctic Peninsula and James Ross Island

The Antarctic Peninsula is experiencing mean annual warming in excess of the global mean (Turner et al. 2005). In this regard, the Antarctic Peninsula and surrounding islands (where climate change has been well documented) have been attracting the attention of climatologists and other scientists. Data sets on air temperature recorded at stations on the Antarctic Peninsula show high variability and increasing mean surface air temperature. Vaughan et al. (2001) reported a considerably stronger warming trend in the northwest Antarctic Peninsula than the mean trend in Antarctic surface air temperature. King and Comiso (2003) noted that near-surface temperatures on the west coast of the Antarctic Peninsula show extreme interannual variability and a weak correlation with temperatures on the east coast of the Antarctic Peninsula.

Meteorological tower with the array of wind sensors at the Czech J. G. Mendel Station (James Ross Island).

The considerable high mountains of the Antarctic Peninsula, which are globally oriented in the W-E direction, offer to study the effects of orography on the atmospheric circulation, structure of the airflow, clouds and to thus express effects on the spatiotemporal variation of climate conditions along the Antarctic Peninsula (Láska et al. 2008, 2009). The western part of the peninsula is therefore typical by very strong cyclonal activity manifesting itself in a considerable variability of physical properties of the atmosphere, meteorological phenomena and clouds (*e.g.* Kejna and Láska 1999, Láska and Prošek 2013). The eastern part of Antarctic Peninsula has an entirely different atmospheric circulation pattern thanks to the enclosed water circulation in the Weddell Sea, large area of the sea ice and cloud development on the leeward side of the Antarctic Peninsula (Schwerdtfeger and Amaturo 1979, King et al. 2003). Differences in atmospheric circulation and water vapour transport lead to resulting contrasts in climate variability in dependence on altitude and distance from the coastline (Láska et al. 2011). James Ross Island with highly variable characteristics of natural surfaces represents a convenient environment for investigations of these interactions (Láska and Prošek 2013).

In our research, we focused on description of the climate conditions and its variability along the Antarctic Peninsula and James Ross Island in different time periods. Time series of surface air temperature recorded at eight stations upon the northern Antarctic Peninsula and South Shetland Islands (Bellingshausen, Faraday/Vernadsky, Rothera, Esperanza, Frei, O'Higgins, Arturo Prat and Marambio) were analyzed for the period 1971-2000. Erroneous values and inhomogeneities were searched for. Monthly, seasonal, and annual trends in surface air temperature were analyzed, and their statistical significance calculated (Šťastná 2010). Spatial variability in surface air temperature trends was determined and three distinct regions identified: a southern region (Vernadsky, Rothera), eastern region (Esperanza, Marambio), and northern region (Bellingshausen, Prat, Frei, O'Higgins). The surface air temperature on the northern coast (O'Higgins) and in the northern region shows the smallest changes in temperature (Láska et al. 2010). The lowest surface air temperature and greatest warming trends during 1971-2000 were recorded on the eastern coast (Marambio and Esperanza) in autumn. The analyses confirm a warming trend (except for spring) at some stations (Šťastná 2010). Research on the climate variability of James Ross Island and the northernmost part of the island (Ulu Peninsula) is primarily based on surface weather data measured at the Czech Johann Gregor Mendel Station since 2004 up to now (Prošek 2013). The climate of Ulu Peninsula is characteristic with the short summer (December - February) when the surface air temperatures fluctuate between -10°C and +8°C. Global solar radiation can reach the maxima as high as 35 $MJ.m^{-2}$ on clear sky days around summer solstice (Láska and Prošek 2013). Annual mean air temperature at the J. G. Mendel station is -6.6°C (2004-2009). The warmest month is January with the monthly mean of 1.8°C while the coldest one is August in which the monthly mean temperature is -15.8°C. Minimal temperature may drop below -25°C during episodic short-term events (Láska et al. 2010). Rapid interdiurnal changes of air temperature and relative humidity are caused mainly by cyclonic activity and fast movements of air masses along 50 and 60°S latitudes (Láska et al. 2011). The barrier and glacier winds flowing down from the ice cap of Trinity Peninsula and in the Prince Gustav Channel represent a local high-speed circulation system causing a wind speed of which often exceeds 25 $m.s^{-1}$ (Láska et al. 2008).

Published results:

Kejna, M., Láska, K., 1999a. Weather conditions at Arctowski Station, King George Island, South Shetland Islands, Antarctica in 1996. Polish Polar Research, 20(3), 203-220.

Láska, K., Barták, M., Hájek, J., Prošek, P., Bohuslavová, O., 2011. Climatic and ecological characteristics of deglaciated area of James Ross Island, Antarctica, with a special respect to vegetation cover. Czech Polar Reports, 1, 49-62.

Láska, K., Prošek, P., 2009. Meteorological measurements and observation at the J.G. Mendel station, James Ross Island, Antarctica. In Structure and function of Antarctic terrestrial ecosystems. Book of abstracts and contributed papers. Barták M, Hájek J, Váczi P (eds). Masaryk University, 5-6.

Láska, K., Prošek, P., 2013. Klima a klimatický výzkum ostrova Jamese Rosse. In: Prošek, P. (ed): ANTARKTIDA. Academia, Praha, 284-293.

Láska, K., Prošek, P., Barták, M., Elster, J., Mixa, P. 2008. Climate measurements as a part of multidisciplinary project at the James Ross Island, Antarctica. Geophysical Research Abstracts, vol. 10, EGU2008-A-11117.

Láska, K., Prošek, P., Barták, M., Nývlt, D., 2010. Klimatologické a glaciologické výzkumy na ostrově Jamese Rosse, Antarktida. In Geografie pro život ve 21.století: Sborník příspěvků z XXII. sjezdu České geografické společnosti, 193-197.

Láska, K., Prošek, P., Budík, L., 2010. Seasonal variation of air temperature at the Mendel Station, James Ross Island in the period of 2006-2009. Geophysical Research Abstracts, vol. 12, EGU2010-3880.

Šťastná, V., 2010. Spatio-temporal changes in surface air temperature in the region of the Northern Antarctic Peninsula and South Shetland islands during 1950–2003. Polar Science, 4(1), 18-33.

Systematic Biology

Botany - phycology

The first Czech botanical (phycological) activities in Antarctica started in the year 1965, when the phycologists Jiří Komárek and Jiří Růžička from the Czech Academy of Sciences studied the material of freshwater algal assemblages, collected from the benthos of continually frozen lakes from the vicinity of Schirmacher Oasis and Wolthate mountain ridge in Eastern Antarctica, collected by members of the Czech team of geologists and astrophysics. The study was oriented on the diversity of dominant cyanobacteria and green algae in benthic communities, their taxonomic identification and fytogeographic distribution. It was the first description of important benthic cyanobacterial communities from Antarctic Lakes (Komárek et Růžička 1966, Růžička 1967).

Later studies were focused on several important problems concerning the Antarctic microvegetation, many years later: Cyanobacteria represent one of the main components of photosynthetic flora in Antarctica and their investigation is therefore essential for numerous ecological studies. In the second half of the 20. century appeared already the tendencies to introduce more exact methods into the evaluation of organismal diversity, especially molecular and phylogenetic analyses in taxonomic research, and, in the case of cyanobacterial microflora, also the application of exact ecological and ultrastructural methodics. From this approach followed the orientation of phycological themes, urgent for Antarctica. The basis to all further works was the revision of diversity, exact definition of revised taxonomic units, description of their detailed ecology and mainly the recognition of the function of simple habitats, seasonal changes and adaptation processes. As important background to these studies were important up to now published results from several important floristic-taxonomic papers by various authors, mainly from various deglaciated parts of Antarctica (Broady 1981, 1986, 1989, 1996, 2005, Broady & Kibblewhite 1991, Ohtani 1986, Mataloni & al. 2000 and others), and also results from several valuable projects, oriented to microvegetation of Antarcic special ecosystems. The American projects *e.g.* focused on the bottom microflora of lakes (Parker & al. 1972, 1977, 1980, Simmons & al. 1981) or on the endolithic microflora of Antarctic deserts (Friedmann 1980, Friedmann & al. 1976, 1982 and others) were extremely important for understanding the role of microphyte communities in Antarctic ecosystems. Unfortunately, the use of modern papers, based exclusively on molecular sequencing of Antarctic samples, was restricted in respect to their incompatibility to natural populations and previous results, which were based only on the morphological taxonomic classification.

Czech botanists, phycologists and microbiologists worked in the following year as hosts of other Antarctic stations, mainly in the Polish Antarctic station „Henryk Arctowski“ (in 1995/1996 J. Komárek and O. Komárek, in 1996/1997 J. Elster, in 1997/1998 L. Rektoris), in Peruan station „Machu Picchu“ (in 2001 O. Komárek), in Uruguayan station „Artigas“ (in 2002 J. Komárek), in Argentinian „Marambio“ (in 2011/2012 K. Kopalová), or in the continental Belgian station „Princess Elisabeth“ (in 2010 J. Elster). Czech ecologist M. Šabacká worked during several Antarctic seasons on the American station McMurdo from 2005. The more easy situation started after construction of the special Czech Polar Station „Gregor Johann Mendel“ on the north coast of the James Ross Island in the NW part of the Weddell Sea, localized on the very profitable place between the large geographic regions of Maritime and Continental Antarctica. Here were fully realized the introductory important themes oriented to the recognition and evaluation of the vegetation of cyanobacteria and algae in the Antarctic continent. From the year 2004 J. Elster participated in the several expeditions and from 2006 worked in this station. The phycologists J. Elster, J. Komárek, O. Komárek and L. Nedbalová worked there over several seasons and during the whole Antarctic summer periods.

The work of Czech botanists in Antarctica was supported by special grants from the Czech Ministry of Education and Science, smaller part was realized with the financial supply and in the frame of the invitation to collaboration from the foreign institutions. The investigation of the Antarctic microflora and plant communities was based mainly on the morphological system. The molecular methods were also widely applied in last years, but, unfortunately not always in compatible relations to the previous results. From this point of view, the ecological results are more valuable and acceptable from the resulting articles than the results concerning the diversity, based on the modern combined evaluations. The new re-evaluation of the diversity of plant vegetation, especially of composition of cyanobacterial, algal and moss communities with respect to the polyphasic combination of molecular, morphological and ecophysiological criteria is highly required. The older Czech studies participated also on the first floristic-taxonomic reviews. Prof. Váňa from the Charles University in Prague was co-author of the review of the Flora of liverworths of Maritime Antarctica (Ochyra & Váňa 1989a, b), they were also published several reviews of cyanobacterial vegetation, mainly from the South Shetlands and from Maritime Antarctica (Komárek 1999, Komárek & al. 2008). However, the modern re-evaluation of the diversity, the re-definition of cyanobacterial and algal taxonomic units and the precisation of the role of different species in plant communities and various Antarctic habitats is now the main future problems, which are also the main aims and topics of the Czech botanical research in Antarctica. The combination of precise traditional evaluation methods with most modern molecular and genetic methods is inevitable in this research.

The present and future study of Czech botanists and ecologists in Antarctica concerns the following main themes and the following basic data, which follow from the results of the previous Czech results and which are substantial for the Antarctic research, is necessary to accept for the future research.

Re-evaluation of the diversity on the basis of modern polyphasic approach, with combination of molecular, morphological and ecological criteria.

The complex evaluation of various taxa was already started. Several populations were already complexly studied, sometimes in collaboration with abroad specialists. As examples is necessary to mention revision of several cyanobacterial genera (*Gloeocapsopsis* - Mataloni & Komárek 2004, *Leptolyngbya* - Komárek 2007, *Phormidesmis* - Komárek & al. 2009, *Plectolyngbya* - Taton & al. 2011, *Wilmottia* - Strunecký & al. 2011, *Calothrix, Hassallia* - Komárek & al 2012), or green algae (*Hazenia* - Škaloud & al. 2013).

The continuous systematic work on the analysis of various assemblages was started in selected area of maritime Antarctica and the results were compared with previous published results. In various habitats of Antarctica the specific communities occur, which contain characteristic species, evidently endemic and special for this one ecological situation in Antarctica. Cryovegetation containing green and red algae communities is very characteristic in coastal Antarctica on melted snow fields, surface of glaciers and in cryoconits. In Antarctica species composition in this community is more rich than in other similar localities on the world (high mountains, Arctic region) as concerns both species diversity and quantity of biomass, developing on the snowy substrate. In the results of Czech botanists, also the dependence of the development of cryosestic algal assemblages on the vicinity of rookeries and other sources of nutrients, agglomerated on the surface of snow and ice fields was explained. The diversity, ecology and periodicity of these communities were published in several studies (Komárek & Komárek 2001, Komárek & Nedbalová 2007). - An important example of the specificity of Antarctic microflora is the rich vegetation of cyanobacteria in seepages. The special species composition, seasonality during the Antarctic vegetation season and microzonation represent mat communities in seepages, which form with mosses the very wide communities in wetland ecosystems, especially in maritime Antarctica (Komárek & Komárek 2003, 2010). Similar species specificity was recognized in other habitats in deglaciated Antarctica, *e.g.* in soils, dripping rocks, various type of streams and lakes (Komárek & Komárek 2001, Komárek & Elster 2008, Komárek & al. 2008, Nedbalová & al. 2009, Elster & al. 2009, Kopalová & al. 2012, Elster & Nedbalová 2013).

Origin of Antarctic microflora and its specificity.

The cyanobacterial microflora of Antarctica was considered to be mainly secondary. The consequence of such premise was the common practice to identify the Antarctic cyanobacterial populations according to monographs and keys, based mostly on populations from Northern temperate zone (Geitler 1932, Prescott 1951, Starmach 1966 and others), which was also in accordance with the hypothesis of cosmopolitan distribution and very wide ecological plasticity of cyanobacterial taxa.

The easy transport of diaspores by wind and human activities (particularly in the last decades) was supported by the exact studies by Wynn-Williams (1991) and Broady & Smith (1994). The continental input of new cyanobacterial spores to Antarctica surely exists, but cannot explain the special stable diversity of Antarctic cyanobacteria. Our studies indicate the specificity and stability of Antarctic cyanobacterial communities and several modern data derived from recent articles support our results.

Recent studies of cyanobacterial flora indicate a high percent of species unknown from other regions. Former authors (West &West 1911, Fritsch 1912, Carlson 1913 and others) described several species from Antarctica which were recently confirmed and are evidently endemic for Antarctica. However, in later period of presupposed "cosmopolitan distribution of cyanobacteria" several floristic papers occurred, in which majority of identified species from Antarctic habitats were designated by names of widely distributed taxa. This happened in spite of the fact, that the taxa were originally described from very different ecological situations (from bark of tropical trees, etc.; see, *e.g.* in Pankow & al. 1987). From our analyses of cyanobacterial populations, it follows that about 60% of new or not identifiable species are from the King George Island, S Shetland Islands, and only 20-40% of species are known also from regions outside of Antarctica (Komárek 1999). The same situation was found in James Ross Island, NW Weddell Sea, where only maximally 20% of registered morphological taxa have wider distribution and were found earlier outside of continental and/or maritime Antarctica (Komárek & al. 2008). The number of described endemic species from continental Antarctica is already higher than 150, however, many ecotypes still wait for their taxonomic definition.

This situation was fully supported by recent molecular analyses of Antarctic cyanobacterial microflora. The relation of published phylogenetic trees to morphological morpho- or ecospecies is usually respected only unsufficiently. Contrastingly, from published and our trees follows, that the Antarctic strains are concentrated mostly in special clusters (Fig. 1) (cf. Nadeau & Castenholz 2000, Gordon & al. 2000, Taton & al. 2003, Jungblut & al. 2005, Strunecký & al. 2009 and others). Of course, the published results do not prove the absence of such clusters from other regions. However, the first results support the high percentage of specific genetically delimited clusters in Antarctic habitats.

Recent knowledge of the wide cyanobacterial diversity in relation to special ecological conditions support also the genetic variation among the populations of morphologically similar types. There were found the genetic relations in populations from one extreme habitat (Garcia-Pichel & al. 1998), but also the genetic diversity of morphologically very similar (morphospecies) from geographically and partly ecologically distant localities (Casamatta & al. 2005, Gugger & al. 2005, Strunecký & al. 2009, and others). This process is commonly valid for diversification strategy of cyanobacteria. The stabilization and adaptation of cyanobacterial populations in such extreme conditions, as are Antarctic ecosystems, is evident. This fact coincide to the data about the possible rapid physiological and genetic adaptation of cyanobacterial ecotypes (Hagemann 2002).

The ecophysiological adaptations were found in the Antarctic cyanobacterial populations, which proved their long-term adaptations to Antarctic conditions. Rapid utilization of light intensity (measured by chlorophyll fluorescence kinetics – see Fig.2), high rate of special pigments (carotenoids) production in cells of several species, high amount of antioxidants in cells, and the special life strategies enabling the rapid change from vegetative to dormant stages with the ability to survive in dried and frozen state support the idea of long-term adaptation.

In numerous Antarctic habitats, such as *e.g.* lakes, glacial creeks, seepages, wet soils, etc., special complex communities with the same species composition, zonation, succession and proportion of dominants develop repeatedly every year (cf. Komárek & Komárek 2003, Komárek & Komárek 2009, Elster & al. in press,). The dominants are represented by special morphospecies, which are not common in habitats of a region, from which diaspores are transported. The development of the same communities every year proves the existence of stable adapted geno- and morphotypes endemic for Antarctic habitats.

The dominant species overwinter on all the distinct localities and form every year the community with the same species composition. Our results and analyses of the origin of Antarctic cyanoprocaryotic microflora proved the autochthonous origin of cyanobacteria in Antarctica, which was supported also by our genetic comparison of Antarctic and Arctic populations and from the analysis of the evolution of cyanobacterial vegetation in Antarctica from Paleozoic time (Comte & al. 2007, Strunecký & al. 2010, 2012).With this problematic is connected closely also the question of endemism and occurrence of endemic types in specialised habitats. From our previous results clearly follows that there is a very high share of endemic genotypes, especially in dominant and characteristic types of Antarctic cyanobacteria. This situation must be precise and studied in detail also in future and in all Antarctic ecosystems.

The ecological function of cyanobacterial communities (mats)

Algae and cyanobacteria play in various Antarctic ecosystems important ecological role. The constant composition of microcommunities and the function of dominant species in these communities, their periodicity and life cycles is the urgent problem. It concerns all the freshwater aquatic ecosystems (rivers, seepages, glacial pools, all assemblages connected wit all the type of lakes, etc.), but also the deglaciated soils, ornithogenic soils or wetted rocks. The special study is oriented in cryovegetation (cryoseston, vegetation in cryoconits). In this field have been published some important specialized papers or reviews. The microflora of cyanobacteria is not quite uniform also not in one ecosystem, depends, *e.g.* on the character of lakes, on the substrate or glaciation. The registration and exact description of communities from different modifications of deglaciated areas is t one from the aims of our work. Special ecological studies in the vicinity of the Czech Station J.G.Mendel are focused in several research topics.

In the vicinity of the station (northern Ulu Peninsula) the most productive ecosystems are (1) the wetland communities (moss – cyanobacteria - algae seepages) dominated by moss cushions and carpets, and (2) snowmelt streams with periphyton communities dominated mainly by mucilaginous algal clusters and gelatinous algal-cyanobacterial biomass in water and, less commonly, cyanobacterial mats and crusts. Moss seepage carpets are usually small in extent, up to several or a few dozen meters square. The most frequent and largest moss carpets occur on the lower northwestern slope of Berry Hill. Smaller moss carpets also line the streams and its tributaries southwest of the station construction site. Other moss carpets occur to the east of Bibby Point, south of Cape Lachman, near the coast of Halozetes Valley and along the top of Bengtson Cliffs. Two seepages sites, composed of a mosaic of mosses, cyanobacteria and algae occur east of Bibby Point and in Halozetes Valley, and are selected for long-term ecological study.

Typical cyanobacterial mats forming a layer over a stream bottom, James Ross Island.

There are a few streams of melt water from snow patches or small glaciers in the study area. The stream known as Waterwork Creek runs close to the station construction area, draining an area of several square kilometres demarcated by the summit plateau of Bibby Point in the west and by Berry Hill in the east. The stream flows around the station construction site from the south and east. It is the longest stream in the broader vicinity of the station with a measured flow rate about 50 - 70 $l.s^{-1}$ (March 2004). This stream has 12 tributaries, the longest of which arises from small snowfields in the upper part of the north-eastern slope of Bibby Point. The stream, including its tributaries, is rich in periphyton biomass. The second stream (Alga Creek) is also in close proximity of the, and flows into the sea east of the station. This stream is also very rich in periophyton biomass. There is a third stream on the north coast close to Bibby Point. This stream erodes and transports a high quantity of material (mostly soft sand). Periphytic communities are rather sporadic here. In addition, there are several streams on the east coast in the vicinity of Halozetes Valley and Bengtson Cliffs. Some of them are very short while others have the character of seepages. Alga Creek are selected for long term ecological study.

The permanent study sites mentioned above, seepages, the stream and shallow and stratified lakes are studied for diversity of bacteria, microfungi, cyanobacteria, algae, mosses and invertebrates (spatial/vertical distribution) and primary and/or secondary production. Again, data-loggers are used to measure air-water temperature, irradiance, flow rate and water physico-chemical conditions (concentration of mineral nutrients, pH, conductivity) arebe established. These measurements will be repeated regularly over the first five years and repeated at less frequent intervals over the following ten years.

Ecological characterization and distribution of habitats in deglaciated areas of coastal and inland Antarctica with convenient conditions to the evolution of microphyte communities is there the most urgent problem. Role of these communities in different ecosystems is the basic problem of the Antarctic ecology. The activities of Czech ecologists are focused in following main themes:

Shallow lotic wetlands (or streams) - There are a few streams saturated by melting waters from snow patches or small glaciers in the area of interest. Waterworks Creek runs in close vicinity to the station construction area. The stream drains an area of several square kilometres demarcated by the summit plateau of Bibby Point in the west and by Berry Hill in the east. The stream flows around the station construction site from the south and east. It is the longest stream in the broader vicinity of the station construction area with a seasonal flow rate about 50 to 70 $l.s^{-1}$ (measured by the March expedition). This stream has 12 left-side tributaries, the longest of which rises under snowfields on the upper part of the north-eastern slope of Bibby Point. The stream, including its tributaries, is rich in periphyton biomass. Periphyton consists mainly of algal mucilaginous clusters and jelly biomass floating in water, and less commonly cyanobacterial mats and crusts. From this stream and its tributary 21 water samples were collected for physical-chemical analyses as were 9 samples of periphyton, of algae and cyanobacteria for species diversity study. A second stream in close vicinity to the station is Algae Creek, which flows into the sea east of the proposed station site. This stream is very rich in periophyton biomass. Nine water samples for physical-chemical analysis and 6 samples of periphyton for cyanobacterial and algal analyses were collected here.

The third stream on the north coast is a stream running close to Bibby Point. Six water and 2 periphyton samples were collected here for laboratory analyses. This stream erodes and transports a high quantity of material (mostly soft sand). Periphytic communities are rather sporadic here.

There are several streams as well on the east coast in the areas of the Halozetes Valley and Bentson Cliffs. Some of them are not very long, the others have the character of seepages. This area was visited only one time and only a few water and periphyton samples were collected.

Shallow wetlands (seepages) - Seepages frequently occur in and around the whole area of interest.They can be divided into two types: a) moss seepages, b) cyanobacteria seepages. In some cases, seepages may be composed of a mosaic of mosses, cyanobacteria and algae, and in other cases they may be moss or cyanobacteria monocultures. S set of water, cyanobacteria, algae and moss samples were collected here for later analysis.

Lentic wetlands (lakes) - Stagnant water-bodies can be divided into two types: a) shallow lakes occurring on raised coastal areas, frequently brackish or saline, b) frozen stratified lakes.

We collected samples of water for physical-chemical analyses from lakes in the area of Cape Lachman. Many similar lakes can be also found in the areas of Brandy Bay and Abernethy Flats. However, during summer access some of these lakes is complicated by soft muddy surroundings. One of the biggest lakes of this area Phormidium Lake on the west coast of Brandy Bay can be placed in this category. Regular study of some of these lakes is possible only after freezing.

Frozen stratified lakes are located on the eastern part of Ulu Peninsula in the areas of Halozetes Valley, Bengtson Cliffs, and also below an ice stream on the south-eastern part of the Bibby Point plateau. Frozen lakes differ in the size and most commonly occur on deglaciated moraines or bare subglacial depressions. During the summer period only shore sections melt. Water samples for physical-chemical analyses were also collected here. On the bottom develope a great biomass of cyanobacterial communities, the composition, periodicity and ecological significance is quite specific for Antarctic ecosystems. Quite special vegetation was found in geological old lake systems. The special type of calcareous carbonate depositions and origin of special communities was characteristic for these habitats (Elster & al. 2009, Nedbalová & al. 2009, Komárek & al. 2012).

Wet rocky walls and waterfalls - They can be found in upper parts of Bibby Point, Berry Hill and Lachman Crags. The most extensive site is on the south wall of Lachman Crags. However, in all these habitats access is limited without alpinist equipment and experience. These habitats were not visited.

Soil cryptogamic crust and microbial communities of active layer of permafrost - Soil crusts represent an important component of the area of interest. They are composed of microbial components (bacteria, fungi, cyanobacteria, algae, lichens and zoo-edaphon). The soil surface (crust) is conglomerated not only by the various organisms but also frequently pervaded by different salts which create a specific coloration of their surface. Soil crusts and phyto- and zoo-edaphon in the active layer create a complicated mosaic of microhabitats. No soil samples were collected.

Subglacial systems - There are several flumes and canons, which are crossed by streams in the area of interest. The streams often bore tunnels under snow patches and small glaciers. From these tunnels it is possible to collect subglacial soils for the study microbial ecosystem. However, collection of these samples requires special equipment and experienced sample collectors (speleologists).

Snow and ice microbiotas – The area of interest is permanently covered by a huge icecaps at the summits. Furthermore there are many small glaciers or snow patches here. Due to the high vertical variability of the terrain there are many different snow/ice localities. Their respective microbiota differ remarkably.

All together 51 samples of fresh-water for physico-chemical analyses, 35 samples of periphyton and 3 snow samples were collected for species diversity analyses. In addition, 7 moss and 6 lichen samples were collected from dominant plant communities.

Colonization of deglaciated soils and rocks

The colonization of deglaciated soils is one from the most urgent problem of Antarctic ecology. Therefore the study of diversity and ecology of soil crusts is considered as a special problem. Soil crust ecosystem appears to play especially an important role in polar desert soil.

This ecosystem forms the surface and subsurface of the soil, composed by cyanobacteria, algae, microscopic fungi, bacteria and invertebrates, which together create a distinct layer, called the soil crust. In undisturbed ground, soil crusts cover entire landscape of deglaciated Antarctica, and their combined biomass represents a sizable pool of global fixed carbon (Elster, 2002; Elster & al. 1999; Howard-Williams & al., 1986; Vincent, 1988; Vincent & Howard-Williams, 1986; Vincent & al., 1993; Vincent & James, 1996). Their production reacts sensitively to changes of physical, chemical and biological factors.

The formation of the ecosystem under study, soil crust, results from a series of physical, chemical and biological processes. Over time, these processes are progressively controlled by climatic variables, geological type of substrates and are greatly influenced by topography. Living organisms colonize soils from the very early stages of their formation. In early stages mainly photosynthetic microorganisms, later also bryophytes and lichens fix atmospheric carbon and nutrients from the weathering pattern parent materials and incorporate them into their issues. The photosynthetic microorganisms release metabolic exudates into the soil. These processes are supplemented with microbial by-products and animal mucus and polysacharides to form part of metabolic organic matter of the soil.

The complex nature of the ecosystem requires multidiscipline research covering all main components of soil crust ecosystem. The abiotic, microbial and zoological parameters are proposed to monitor in OTCs and control plots during the five years of experiment to describe the changes in the main components of the crust and in their interactions. The experimental design using OTCs and controls was already preliminarily tested by Belgian team in Princess Elisabeth station vicinity, during the austral summer of 2009/10. The structure of cyanophyta community was monitored in this experiment using molecular biology techniques. This proposal adds many another parameters to measure and extends the investigation to James Ross Island too. The higher environmental diversity of James Ross Island is reflected by more sophisticated experimental design including the four sites representing the four combinations of two environmental factors (geological ground and moisture).

The effects of the soil warming seems to be a combination of an acceleration of biological processes with temperature increase and moisture changes. In general, experimental soil warming has led to increased soil respiration, organic matter decomposition, and nutrient mineralization. Microbial biomass was documented to increase with warming, however it can decrease too, possibly due to decreased soil moisture (Bell et al. 2010).

Activity of soil extracellular enzymes (EEA) play an important role in the transformation of carbon compounds from the dead organic matter (Baldrian & al., 2008). Enzyme activity assays are commonly used to indicate variation in soil microbial function in response to changes in environmental conditions, as EEA reflects the metabolic requirements of the microbial community (Bell & al. 2010). EEA may indicate potential microbial activity and often correlate with other indicators of microbial activity such as soil respiration, ATP content. EAA may be expressed as an enzyme activity per unit of microbial biomass (specific enzyme activity), EEA responses per unit of soil dry mass can reflect changes in microbial biomass in addition to that (Bell & al. 2010). This parameter may also provide information about the potential for transformation of specific sources of energy (Hopkins & al. 2008). Enzymes are active in Antarctic soils (Tscherko & al. 2003). EEA were greater in less extreme soils of maritime Antarctic (Tscherko & al. 2003) than that reported from the Dry Valleys, reflecting the less extreme environmental conditions and greater overall biological activity (Hopkins & al. 2008). The soil from Antarctic dry valleys responded to an addition of carbon during the field experiment by increasing respiration and the activity of b-glucosidase, phosphatase and arylsulphatase. The parameters showed the sensitivity to nutrients input despite no changes in the community structure detected by means of esterlinked fatty acid analysis (Hopkins & al. 2008).

The parameters are measured in the laboratory after the transport of samples to the Czech Republic using standard protocols. Soil respiration is measured as CO_2 production from the soil using the methodology after Hopkins & al. (2008). Quantification of microbial biomass will be estimated based on phospholipid fatty acid (PLFA) analysis (Fostegård & Bååth, 1996, Baldrian & al. 2008). Total bacterial numbers and total bacterial biomass is determined by epifluorescence microscopy after Tscherko & al. (2003). Extracellular enzymes (EEA) b-glucosidase, alkaline phosphatase, acid phosphatase and N-acetyl-b-D-glucosaminidase is assayed using the colorimetric determination of p-nitrophenol released when soil was incubated with p-nitrophenyl b-D-glucopyranoside, p-nitrophenyl phosphate in acid and alkaline buffer and 4-Methylumbelliferyl N-acetyl-β-D-glucosaminide. The details of enzymatic assays is modified after Šustr & Frouz (2002), Hopkins & al. (2008) and Baldrian & al. (2008).

Molecular analyse of cyanobacteria performed in Dr. A. Willmotte laboratory in Liege are part of this project. The cyanobacterial diversity in Antarctic soil crusts is based on morphospecies determionation followed by 16S rDNA sequences. Investigation of the genetic diversity of cyanobacteria is also combined to the analysis of the cytomorphological features of either isolates or natural samples using light, epifluorescence, confocal (CLSM) and electron microscopy (TEM).

Chlorophyll fluorescence of soil crust is measured by AquaPen-P AP-P 100 instrument (PSI Brno). Subsamples for algae, cyanobacteria and other cryptogams (lichens and mosses) are be collected aseptically as intact cores and transported in a frozen state to the laboratory in the Czech Republic. First the morphology and cryptogamic dominants of crusts developed on core surfaces is characterized using stereo- and epifluorescence microscopy. Algal and cyanobacterial communities are studied in detail in homogenized samples. Species composition of algae and cyanobacteria is determined using dilution plate and moist plate ("growth slide") methods, dominant morphotypes and abundance by direct cell counting under epifluorescence microscope (Elster & al. 1999, Lukešová 2001). Lichen and moss communities are studied under generally used methods. Samples of lichen and mosses will be determined using stereo- and light- microscopy.

Study of microflora of inland deglaciated areas in Antarctica

The colonization of the deglaciated rocks in the centre of Antarctic continent is still open problem. The role and metabolism of especially adapted, endolithic cyanobacterial types was studied by Friedmann (1980) and Friedmann & al. (1976, 1982), but still many questions remain open.

It is well known that nunatacs are habitats in glaciated remote areas where life could persist for several glaciations (several millennia). During glaciation these localities are isolated from the closest terrestrial habitats by pristine glacial cover. Cyanobacteria and algae are only components which are usually able to survive in such an extreme and isolated environment of the Antarctica. The transport of genomes between these distant localities and surrounded deglaciated lands is made the most frequently only by air masses. Resting stages of cyanobacteria and algae have usually small dimensions (usually less than 5 mm in size) and therefore can be transported for long distances. These wind-born particles can be deposited on the nunatacs, in either dry or wet form (Chalmers et al., 1996). It has been proposed that living cyanobacteria and algae originating in hot and/or cold terrestrial deserts are especially important for the transmission of their genomes because of their special adaptations to be able to persist in uncommonly extreme and variable conditions (temperature, light intensity and spectral quality, water supply, desiccation, etc.) (Flechtner, 1999; Van Thielen and Garbary, 1999; Garty, 1999; Elster &Benson, 2004).

The botany analyses of diversity and abundance of soil cyanobacteria and algae together with description of lichens and mosses diversity and cover describe geographic distribution of these communities in connection to recently known or during the project obtained climatic and geological data.

Vertical rock walls represent moist environment available for development of cyanobacterial mats that thrive well in austral summer season (left) and during winter period (right).

Homogenized samples are used for quantitative and qualitative analyses of soil algal-cyanobacterial communities (species composition, abundance, and biovolume). Biovolume and the number of algal and cyanobacterial cells is determined using epifluorescence microscopy (Olympus BX 60). Different groups of cyanobacteria and algae are recognized under epifluorescence microscopy according to their morphological features (unicellular, filamentous and colony producing) and further divided according to their size categories. The cell numbers and biovolume per g of soil is calculated and amount og pigments present in the sample evaluated.

The species composition of cyanobacteria and algae in the soil samples are determined by two methods: A) Dilution plate method, and B) Thin layers of homogenized soils are spread on Petri dishes, moistened with distilled water and later with BBM medium, covered with sterile cover glasses and incubated as above. This allows algae to attach to the cover glasses. Then, the algae are examined microscopically at regular intervals (one week, one month, and three months after incubation). This method is mainly convenient for diatoms and cyanobacteria, especially for those species which grow poorly on agars.

Selected obtained uni-algal strains (cyanobacteria and algae) are kept in the algal collection of the Institute of Botany, AS CR in Třeboň (www.butbn.cas.cz.CCALA) for later cytomorphological/ecophysiological and molecular genetic study (polyphasic approach) with the aim to describe in detail the most important species in respect of their biology and taxonomical position. These results are regularly compared with species isolated and studied in others geographical regions.

Autecology of different species and adaptation processes

Autecology of various species is closely connected with the physiological problem of adaptation mechanisms. The study of ecophysiological characters of dominant and characteristic species is particularly necessary. The development is dependent on the mastering of cultivation of different morpho- and ecotypes in these studies. The adaptation mechanisms, cytological, ecophysoiological and biochemical acclimation of various species to Antarctic seasonality, extreme temperatures and intense radiation during the austral summer season is specific and represents a common, important biological problem. The adaptation processes in various species must be an integral part of the future autecological studies concerning Antarctic specialized taxa. The complex evaluation of Antarctic microflora, explanation of its origin, function and prognosis to further evolution is therefore the main aim of the work of Czech botanical group.

Published results (for Systematic Biology)

Caisová L, Komárek J, Elster J, Nedbalová L (2009) Two freshwater filamentous, branched green algae, newly discovered in Antarctica. In Structure and function of Antarctic terrestrial ecosystems. Barták M, Hájek J, Váczi (eds), Masaryk University 14-22.

Comte K, Šabacká M, Carre-Mlouka A, Elster J, Komárek J (2007) Relationships between the Arctic and the Antarctic cyanobacteria; three *Phormidium*-like strains evaluated by a polyphasic approach. FEMS Ecolology 59(2): 366-376.

Economou-Amilli A, Elster J, Komárek J (1998) Summer phytoplankton composition in transect from Weddel Sea to La Plata. Polish Polar Research 19(3-4): 187-204.

Elster J (2012) Welcome address. In: Polar Ecology Conference 2012, 30th September – 4th October 2012, České Budějovice, Czech Republic, Abstract & Contact list. Bernardová A, Kavan J, Strunecký O (eds). Faculty of Science, University of South Bohemia in České Budějovice 5.

Elster J (2011) Czech Contributions to Polar Science. IASC Progress: 4.

Elster J (2002) Ecological classification of terrestrial algal communities of polar environment. In GeoEcology of terrestrial oases. Beyer L, Boelter M (eds). Springer-Verlag 303-319.

Elster J (1998) A brief history of Czech scientific activities (former Czechoslovakia) in Polar Regions. NIPR News 142: 7-8.

Elster J (1998) Čeští algologové a polární výzkum. Třeboňský svět 98 (12): 15.

Elster J (1997) Využití periphytonu ledovcových potoků při osidlování mimozemských těles. In Sborník referátů XI. Limnologické konference České a Slovenské limnologické společnosti. 23 - 25.

Elster J, Benson EE (2004) Life in the polar terrestrial environment with a focus on algae and cyanobacteria. In: Life In The Frozen State. Fuller B, Lane N, Benson EE (eds). Taylor and Francis 111- 149

Elster J, Degma P, Kováčik Ľ, Valentová L, Šrámková K, Pereira AB (2008) Freezing and desiccation injury resistance in the filamentous green alga *Klebsormidium* from the Antarctic, Arctic and Slovakia. *Biologia* 63(6): 839-847.

Elster J, Delmas RJ, Petit JR, Řeháková K (2007) Composition of microbial communities of aerosol, snow and ice samples from remote glaciated areas (Antarctica, Alps, Andes). Biogeosciences Discussions 4: 349-384.

Elster J, Komárek J (2013) Život v moři. In Antarktida. Prošek P et al. (eds). Academia 132-135.

Elster J, Komárek J, Nedbalová L (2013) Mořské řasy. In Antarktida. Prošek P et al. (eds). Academia 133-135.

Elster J, Komárek J, Nedbalová L (2013) Sinice a řasy. In Antarktida. Prošek P et al. (eds). Academia 88-101.

Elster J, Komárek J, Nedbalová L (2013) Biodiverzita sinic a řas. In Antarktida. Prošek P et al. (eds). Academia 303-311.
Elster J, Komárek O (2003) Periphyton ecology of two snow-fed streams in the vicinity of H. Arctowski station, King George Island, South Shetlands, Antarctica. Antarctic Science 15(2): 189-201.
Elster J, Kvíderová J (2011) Cyanobacteria. In Encyclopedia of Astrobiology. Gargaud M, Amils R, Quintanilla JC, H. Cleaves HJ II, Irvine WM, Pinti DL, Viso M (eds). Springer 394-397.
Elster J, Nedbalová L, Komárek J, Vodrážka R (2009) Biogenic calcite structures in Green Lake, James Ross Island, Antarctica. In Structure and function of Antarctic terrestrial ecosystems. Barták M, Hájek J, Váczi (eds), Masaryk University 38-40.
Elster J, Prošek P, Komárek J (1997) Česká věda a polární výzkum. Akademický Bulletin AV ČR 12: 6-7.
Elster J, Strunecký O, Kvíderová J, Šabacká M, Kováčik Ľ (2012) Ekologická úloha sinic a řas v polárních ekosystémech. In Ekologická fyziologie rostlin - výzkum v polárních oblastech. Univerzita Karlova a Česká společnost experimentální biologie rostlin 16-18.
Elster J, Svoboda J, Ohtani S, Kanda H (2002) Opportunities and requirements for future phycological research in Polar Regions. Polar BioScience 15: 114-122.
Gonzáles-Toril E, Amils R, Delmas RJ, Petit J-R, Komárek J, Elster J (2009) Bacterial diversity of autotrophic enriched cultures from remote, glacial Antarctic, Alpine and Andean aerosol, snow and soil samples. Geobiosciences 6: 33-44.
Gonzáles-Toril E, Amils R, Delmas RJ, Petit J-R, Komárek J, Elster J (2008) Diversity of bacteria producing pigmented colonies in aerosol, snow and soil samples from remote glacial areas (Antarctica, Alps and Andes). Geobiosciences Discussions 5: 1607-1630.
Hájek J, Kvíderová J, Worland R, Barták M, Ester J, Váczi P (2009) Snow algae and lichen algae differ in their resistance to freezing temperature: an ice nucleation study. Phycologia 48: 37-38.
Komárek J (2008) Antarktické vegetační oázy 6. Sinice a řasy. – Živa 6: 260-264.
Komárek J (2007) Phenotype diversity of the cyanobacterial genus *Leptolyngbya* in maritime Antarctica. Polish Polar Research 28(3): 211-231.
Komárek J (2001) Review of the cyanoprokaryotic genus *Romeria*. Czech Phycology 1: 5-19.
Komárek J (1999) Diversity of cyanoprokaryotes (cyanobacteria) of King George Island, maritime Antarctica - a survey. Algological Studies 94: 181-193.
Komárek J (1993): Přínos československých biologů k výzkumu polárních oblastí. - In Současné polární výzkumy. PF UJEP 65-72.
Komárek J & Elster J (2008) Ecological background of cyanobacterial assemblages of the northern part of James Ross Island, NW Weddell Sea, Antarctica. Polish Polar Research 29(1): 17-32.
Komárek J, Elster J (1993) Ekologický přehled biotopů řas humidních polárních oblastí. In Současné polární výzkumy. PF UJEP 73-88.
Komárek J, Elster J, Komárek O (2008) Diversity of the cyanobacterial microflora of the northern part of James Ross Island, NW Weddell Sea, Antarctica. Polar Biology 31: 853-865.
Komárek J, Elster J, Nedbalová L, Komárek O: Český výzkum ostrova Jamese Rosse - Výzkum biodiverzity sinic a řas. In Antarktida. Prošek P et al (eds) Academia
Komárek J, Kaštovský J, Ventura S, Turicchia S, Šmarda J (2009) The cyanobacterial genus Phormidesmis. Algological Studies 129: 41-59.
Komárek J, Komárek O (2009) Specificity of cyanobacterial microflora in Antarctica. In Structure and function of Antarctic terrestrial ecosystems. Barták M, Hájek J, Váczi (eds), Masaryk University 23-28.
Komárek J, Komárek O (2003): Diversity of cyanobacteria in seepages of King George Island, maritime Antarctica. In Proceedings of VIIIth SCAR International Symposium 2001: Antarctic Biology in a Global Context. Huiskes AHL (ed). Backhuys Publishers 244-250.
Komárek J, Nedbalová L (2007) Green cryosestic algae. In Algae and cyanobacteria in extreme environments. Seckbach J (ed). Springer. 321-342.
Komárek J, Nedbalová L, Hauer, T (2012) Phylogenetic position and taxonomy of three heterocytous cyanobacteria dominating the littoral of deglaciated lakes, James Ross Island, Antarctica. Polar Biology 35(5): 759-774.
Komárek J, Růžička J (1966) Freshwater algae from a lake in proximity of the Novolazarevskaya Station, Antarctica. Preslia 38: 237-244.
Komárek O, Komárek J (2010) Diversity and ecology of cyanobacterial microflora of the seepages habitat. Comparison of King George Island, Shetland Islands, and James Ross Island, NW Weddell Sea, Antarctica. In Microbial mats. Seckbach J, Oren A (ed). Springer Verlag 517-539.
Komárek O, Komárek J (2001) Contribution to the taxonomy and ecology of green cryosestic algae in the summer season 1995-96 at King George Island, S. Shetland Islands. In Algae and extreme environments – ecology and physiology. Elster J, Seckbach J, Vincent W, Lhotský O (eds). Nova Hedwigia Beiheft 123: 121-140.

Komárek O, Komárek J (2001) Two year phytobenthos investigation of Petrified Forest Creek at maritime Antarctic King George Island - preliminary study. Folia Facultatis Scientiarum Naturalioum Universitatis Masarykianae Brunensis, Geographia 25: 103-110.

Komárek O, Komárek J (1999) Diversity of freshwater and terrestrial habitats and their oxyphototroph microflora in the Arctowski Station region, South Shetlands Islands. Polish Polar Research 20(3): 259-282.

Komárek O, Komárek J (1996) Some preliminary results of Czech/Polish phycological activities at Henryk Arctowski station, King George Island, South Shetlands in Australian summer 1995/1996. In: Antarctic research in coastal and terrestrial areas. Olech M (ed). Jagellonian University 10.

Kvíderová J, Elster J (2009) Evaluatin of nutriet limitation and heavy metal inhibition in Antarctic streams by miniaturized algal bioassay. In: Structure and function of Antarctic terrestrial ecosystems. Book of abstracts and contributed papers. Barták M, Hájek J, Váczi P (eds). Masaryk University 29.

Kvíderová J, Lukavský J (2005) The ecological characteristics of *Stichococcus* (Chlorophyta) strains isolated from polar and temperate regions. Algological Studies 118: 127-140.

Mataloni G, Komárek J (2004) Gloeocapsopsis aurea, a new subaerophytic cyanobacterium from maritime Antarctica. Polar Biology 27(10): 623-628.

Michaud AB, Šabacká M, Priscu JC (2012) Cyanobacterial diversity across landscape units in a polar desert: Taylor Valley, Antarctica. FEMS Microbiology Ecology 82: 268-278.

Segečová J, Elster J, Kováčik Ľ (2012): Effects of exposition to various stress conditions on filamentous green alga *Klebsormidium* (Streptophyta) strains, isolated from both polar regions and Slovakia. Acta Botanica Universitatis Comenianae Vl. 47: 19-26.

Segečová J, Elster J, Kováčik, Ľ (2012) Stresová rezistencia jednodruhových kmeňov kultúr vláknitej zelenej riasy z rodu *Klebsormidium* (Streptophyta) izolovaných z polárnych oblastí a zo Slovenska. In Študentská vedecká konferencia PriF UK. Zborník recenzovaných prispevkov, Universita Komenského 600-605.

Segečová J, Elster J, Kováčik Ľ (2011) Filamentous green alga *Klebsormidium flacidum* as a laboratory model for the study of dormancy. Acta Botanica Comenianae VI. 46: 49-53.

Segečová J, Elster J, Kováčik Ľ. (2011) Študium dormancie na kmeňových kultúrach vláknitej zelenej riasy z rodu *Klebsormidium* izolovaných z polárných oblastí a zo Slovenska. Študentská vedecká konferencia PriF UK, Biólogia 682-688.

Shukla SP, Kvíderová J, Elster J (2011) Nutrient requirements of *Chlorella*-like species. Czech Polar Reports 1(1): 1-11.

Singh SM, Elster J, Sharma PK, Kumaran KPN, Ravindra R (2010) Biomarkers and their application in palaeoecological study of Lake Ecosystem of Schirmacher oasis, Antarctica. In Scientific report of XXIII[rd] Indian scientific expedition to Antarctica. MoES Technical publication 21:213-228.

Strunecký O, Elster J, Komárek J (2012) Molecular clock evidence for survival of Antarctic cyanobacteria 1 (Oscillatoriales, *Phormidium autumnale*) from Paleozoic times. FEMS Microbial Ecology 82: 482-490.

Strunecký O, Elster J, Komárek, J. (2011) Taxonomic revision of the fresh-water cyanobacterium „*Phormidium*“ *murrayi* = *Wilmottia murrayi*. Fottea 11(1): 57-71.

Strunecký O, Elster J, Komárek J (2010) Relationship in geographically separate *Phormidium* like cyanobacteria: Is there a link between north and south Polar Regions? Polar Biology 33: 1419-1428.

Šabacká M (2011) Spatial distribution of microorganisms in the Polar Regions. In Encountering the changing Barents – research challenges and opportunities. Fryer P, Brown-Leonardi C, Soppela P (eds). Arctic Centre Reports 73-81.

Šabacká M (2009) Tracking wind in the McMurdo Dry Valleys.The LTER Network News 22:18.

Šabacká M, Elster J (2006) Response of cyanobacteria and algae from Antarctic wetland habitats to freezing and desiccation stress. Polar Biology 30: 31-37.

Šabacká M, Priscu JC, Basagic HJ, Fountain AG, Wall DH, Virginia RA and Greenwood MC (2012) Aeolian flux of biotic and abiotic material in Taylor Valley, Antarctica. Geomorphology 155-156: 102-111.

Tashyreva D, Elster J (2012) Production of dormant stages and stress resistance of polar cyanobacteria. In Life on Earth and other planetary bodies. Hanslmeier A, Kempe S, Seckbach J (eds). Springer 367-386.

Taton A, Wilmotte A, Šmarda J, Elster J, Komárek J (2011) *Plectolyngbya hodgsonii* – a remarkable filamentous cyanobacterium from Antarctic lakes; comparison with related cyanobacterial types. Polar Biology 34: 181-191.

Tscherko D, Bölter M, Beyer L, Chen J, Elster J, Kandeler E, Kuhn D, Blume H-P (2003) Biomass and enzyme activity of two soil transects at King George Island, Maritime Antarctica. Arctic, Antarctic, and Alpine Research 35 (1): 34-47.

Zapomělová E, Hrouzek P, Řeháková K, Šabacká M, Stibal M, Caisová L, Komárková J, Lukešová A (2008) Morphological variability in selected heterocystous cyanobacterial strains as a response to varied temperature, light intensity and medium composition. Folia Microbiologica 53: 333-341.

Experimental Life Sciences

Field- and laboratory-based experiments comprising different aspects of physiological processes in Antarctic extremophilic organisms started in 2002. First, Czech plant physiologists participated as international scientists in expeditions to King George Island and Galindez Island. Since 2006, they have been regular crew members of Czech Antarctic expeditions to James Ross Island (J.G. Mendel station). There were several research projects that focused autotrophic components of Antarctic vegetation oases, lichens in particular. Among them, the following three were of major importance: (1) Ecology of the coastal Antarctic oasis (MSM 143100007), (2) Multidisciplinary study of Antarctic terrestrial vegetation within the IPY framework (ME 945), and (3) Photoinhibition and photoprotection in lichens under extreme conditions (GAČR 522/03/0754). Within the projects, functioning of extremophilic organisms under *in situ* and laboratory conditions was studied with a special respect to the environmental factors limiting their photosynthesis, growth and production. Team of scientists consists mainly of the members of Department of Experimental Biology, Masaryk University, Brno.

Long-term effects of elevated air temperature on Antarctic vegetation

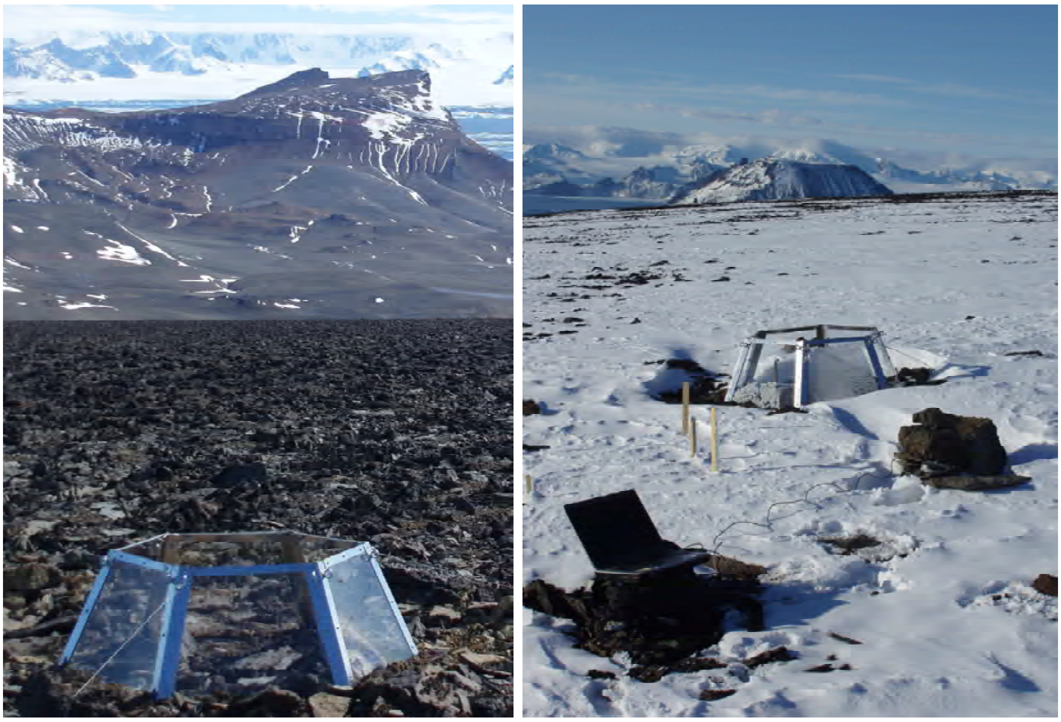
Terrestrial vegetation oases in Antarctica are very simple containing primary producers such as mosses, lichens, algae, and cyanobacteria. The primary productivity of oasis is limited especially by water availability and the rate of decomposition of organic substances, inputs of nitrogen and other minerals. Ongoing climate change may increase area suitable for the existence of the Antarctic oases of vegetation. Over last decade, Czech plant physilogists have carried out several projects aimed to (1) CO_2 fixation, storage and release of C related to physiological processes (photosynthesis, respiration), (2) long-term controlled field experiments aimed to manipulated environment approach (use of open top chambers, OTCs - Barták et al. 2009) in order to predict the likely changes in biomass production, community structure and biodiversity of Antarctic vegetation under global climate change.

<u>*Microclimatological data analysis in OTCs and control plots*</u>

Since 2007, data from installations of open top chambers (OTCs) placed over typical vegetation covers at the James Ross Island have been analyzed. We built up altogether 9 OTCs at coastal area (3), plateau of a deglaciated mesa (3), and galcier forefield at a mesa (3). For OTCs and control plots, temperature sensors (Cu/Co, Pt100) were put at (*a*) the height of 30 cm above surface, into the substrate to the depths of (*b*) 5, (*c*) 10, (*d*) 15 cm and also (*e*) into the surface cover (moss or lichen). Year-round data on temperature and air humidity are measured in a 1 h step and recorded into a datalogger. The data are dowloaded once a year. Then, the data are analyzed, and the differences between OTC and control plots evaluated. The differences are related to a variability of local climate at James Ross Island.

<u>*Evaluation of changes in vegetation cover*</u>

During each Antarctic summer season high resolution images of typical vegetation cover at permanent experimental plots are taken repeatedly in order to evaluate seasonal (hydration- and growth-dependent changes) and inter-seasonal (growth and development-realated) changes. Sets of images is processed by advanced image analysis using newly developed algorithms of vegetation mapping, especially determinative/evaluation of image elements (objects). During processing, two methods are applied: (a) pixel-based classification, and (b) object-based classification of objects in order to find suitable technique allowing evaluation of small-scale changes in vegetation cover. The new method of processing distinguishes objects related to plant species, type of substrate and their changes. In this way, spatiotemporal changes dependent on type of vegetation cover and microclimate are evaluated.



Open top chambers installed on a plateau of Berry Hill mesa, James Ross Island.

Published Results

Barták, M. (2013): Vliv oteplování klimatu na antarktickou vegetaci a její stresová fyziologie (The impact of climate warming on Antarctic vegetation and its stress physiology – *In Czech*). In: Prošek, P. (ed): ANTARKTIDA. 318-322, Academia, Praha.

Hájek, J., Barták, M., Váczi, P., Gloser, J., Láska, K., Prošek, P. (2010): Physiological processes in mosses and lichens in response to local climate: Case study from the James Ross Island, Antarctics. In: IPY Oslo Science Conference, Lillestrøm, June 8-12, 2010.

Barták, M., Láska, K., Váczi, P. (2008): *In-situ* estimation of physiologically active time in Antarctic terrestrial vegetation at manipulated air temperature. In: Klepikov, A. (ed.): Polar Research-Arctic and Antarctic Perspective in the International Polar Year. State Scientific Centre RF, Arctic and Antarctic Research Institute, p. 206-206

Barták M., Láska K., Prošek P., Hájek J., Váczi P. (2009): Long-term study on vegetation responses to manipulated warming using open top chambers installed in three contrasting Antarctic habitats. In: M. Barták, J. Hájek, P. Váczi (eds.): Structure and Function of Antarctic Terrestrial Ecosystems. Book of Abstracts and Contributed Papers. Conference, Brno, October 22-23, 2009. Masaryk University, Brno, Czech Republic, p. 48-51.

In-situ monitoring of physiological activity of microbiological mats

Since 2007, limnological investigation of terrestrial lakes has been carried out at James Ross Island, Antarctica. The lakes in scope differ in their size, origin, geomorphological and hydrological characteristics. In several selected lakes, dissolved oxygen is measured repeatedly by oxygen electrode and a datalogger each summer season in order to quantify lake- and weather-related differences. For this study, typical reresentatives of (i) coastal shalow lakes, and (ii) high-altitude lakes with cyanobacterial mats were chosen. We present data on dissolved oxygen measured in 3 d interval during January 2010. Within this time, water temperature decreased gradually from 13 to 3^{o}C, as well as dissolved oxygen concentration. It varied within in the range of 12.50-18.0 mg l^{-1} indicating the values close to saturation and suprasaturation, respectively. Dissolved oxygen concentration showed slightly decreasing trend in a course of time. In majority of cases, the lakes with rich cyanobacterial flora showed higher dissolved oxygen concentrations than Lachman Lake 2 which posses less cyanobacterial mats than other the lakes involved into the study. Due to air temperature decrease, Dulanek lake, a high-altitude lake, freezes in the last week of January. Timing of this event is, however, season-dependent and affected by variability of local climate.

Published Results

Váczi, P., Barták, M. (2011): Summer season variability of dissolved oxygen concentration in Antarctic lakes rich in cyanobaterial mats. Czech Polar Reports, 1, 1, 42-48.

Váczi P., Barták M. (2009): Variability of oxygen content in different lakes of the James Ross Island as dependent on actual weather conditions. In: M. Barták, J. Hájek, P.Váczi (eds.): Structure and Function of Antarctic Terrestrial Ecosystems. Book of Abstracts and Contributed Papers. Conference, Brno, October 22-23, 2009. Masaryk University, Brno, Czech Republic, p. 35-37.

Váczi, P., Barták, M., Nedbalová, L., Elster, J. 2011 Comparative analysis of temperature courses in Antarctic lakes of different morphology: Study from James Ross Island, Antarctica. Czech Polar Reports, 1, 2, 78 - 87.

Austral summer season measurements of dissolved oxygen concentration in Small Lachman Lake.

Long-term monitoring of photosynthetic processes in Antarctic moss

To estimate photosynthetic processes and physiologically active time of vegetation of the James Ross Island, Antarctica, several permanently-installed fluorometers have been used. In February 2008, a modified PAM-210 fluorometer (Heinz Walz, Germany) were installed to measure chlorophyll fluorescence and effective quantum yield of photosynthetic processes in photosystem II (Φ_{PSII}) as dependent on hydration/dehydration and microclimatic parameters. For the calculation, the equation $\Phi_{PSII} = (F'm - Fs) / F'm$ was used where values of steady state chlorophyll fluorescence (Fs) and maximum chlorophyll fluorescence in light adapted state (F´m).

In 2009, two different fluorometers were used to measure diurnal courses of Φ_{PSII}: (1) a multichannel monitoring fluorometer Moni-PAM (Heinz Walz, Germany), and (2) a

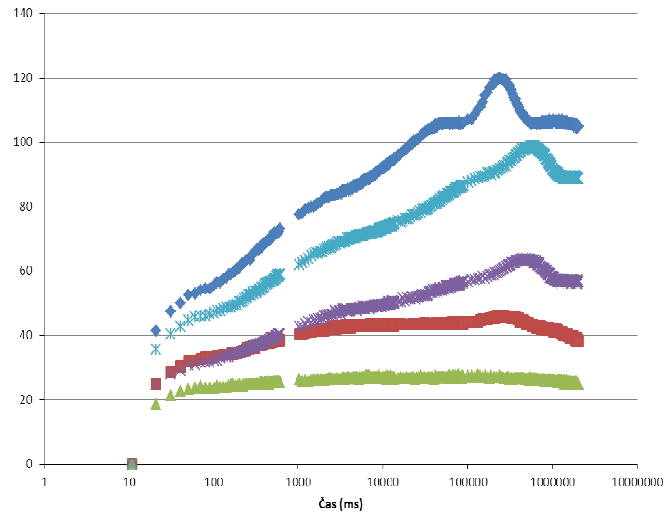
FluorPen FP-100 fluorometer (Photon Systems Instruments, Czech Republic). General technical description of the Moni-PAM system and its operation in the field conditions is given by Porcal-Castell et al. (2008). In our field experiment, we used 3 monitoring heads connected to a data-collecting unit and an on-line linked PC. Such set up allowed us to use repetitive saturation pulse method. The pulses of light (duration 1 s, intensity 3 500 µmol m^{-2} s^{-1}) were applied on moss thalli in light-adapted state under natural irradiantion each 15 min. Since 2009, FluorPen FP-100 fluorometers (Photon Systems Instruments, Czech Republic) have been used. Datasets provide an information on yearly courses of photosynthetic activity of *Bryum* sp. as affected by light avilability, hydration status of moss cussion, and above zero and freezing temperature. Recently, 4-year-long data set is available.

Two types of fluorometers installed temporarily (left) of permanently (right) over a moss cushion (*Bryum* sp.) at experimental field plot located close to a seashore of James Ross Island.

Sensitivity of Antarctic lichens to photoinhibition

A wide array of chlorophyll (Chl) fluorescence techniques is used to assess the effects excess light (1000 to 2000 µmol m^{-2} s^{-1} of photosynthetically active radiation) on lichen photosyntetic characteristics of lichen thalli, individual photobionts and algae/cyanobacteria. Photoinhibition in Antarctic lichens has been studied by our team since 2003. Lichen samples are collected mainly at James Ross Island. Generally, Chl fluorescence parameters are measured under controlled laboratory conditions on wet lichen thalli. Several Chl. Fluorescence parameters are measured before, during and after the exposition to individual light intensity and duration - treatments. In short-term treatments (tens of minutes), Chl fluorescence parameters is measured each 15 min during the treatment and during 6 h recovery. In long-term treatments (tens of hours), interval of Chl fluorescence measurements is typically 1 or 2 h. Typically, the following parameters are used (1) Fast Chl fluorescence kinetics (OJIPs) that characterizes photosystem II functioning, (2) Kautsky Chl fluorescence kinetics supplemented with quenching analysis. The parameters recorded in this approach characterizes partitioning of absorbel light energy into photochemical and non-photochemical processes of photosynthesis. The emphasis is given to the involvemet of non-photochemical during particular treatments and recovery: qP- photochemical quenching, qN, NPQ non-photochemical quenching, qE energy-dependent quenching, qT state1-state2 quenching (transition), qI photoinhibitory quenching. Other chlorophyll fluorescence approaches are (3) Chlorophyll fluorescence imaging: evaluation of intrathalline heterogeneity of photosynthesis, (4) Timecourses of Φ_{PSII} during short-term high light exposition: sensitivity to photoinhibition.

In samples exposed to UV-B (□=310 nm) and UV-B+PAR photoinhibitory treatments, xanthophyll-cycle pigments are extracted from lichen thalli and isolated algae/cyanobacteria in 1.5 ml of methylsulphoxide for 1 h at 65 °C and determined spectrophotometrically. Samples are taken before, during and after the treatments so that time-dependent changes



Effect of photoinhibition of photosynthesis in a lichen (*Usnea antarctica*) induced by high light treatment (photosynthetically active radiation). Chlorophyll fluorescence curve (fast kinetic: OJIP) is severely affected from control (deep blue curve) to moderately (red) and heavily photoinhibited state of photosynthetic apparatus (green). The violet and soft blue curves represent fast recovery (tens of minutes) from high-light stress.

could be evaluated as well as relation of particular chlorophyll fluorescence parameters (NPQ, qE, qI) to de-epoxidation state of xantophyll-cycle pigments (DEPS) which is associated with activation of light-dependent interconversion of xanthophyll cycle pigments. In extracts, viola-, anthera-, and zeaxanthine (V, A, Z) and glutathione is be determined by HPLC. They is evaluated as de-epoxidation state of the xanthophyl cycle pigments (DEPS= V+A/V+A+Z) and the oxidized to total glutathione ratio (GSSG/GSH).

Published results:

Barták, M., Hájek. J., Vráblíková. H., Dubová, J. 2004 High-Light Stress and Photoprotection in *Umbilicaria antarctica* Monitored by Chlorophyll Fluorescence Imaging and Changes in Zeaxanthin and Glutathione. Plant Biology, 6, 333-341.

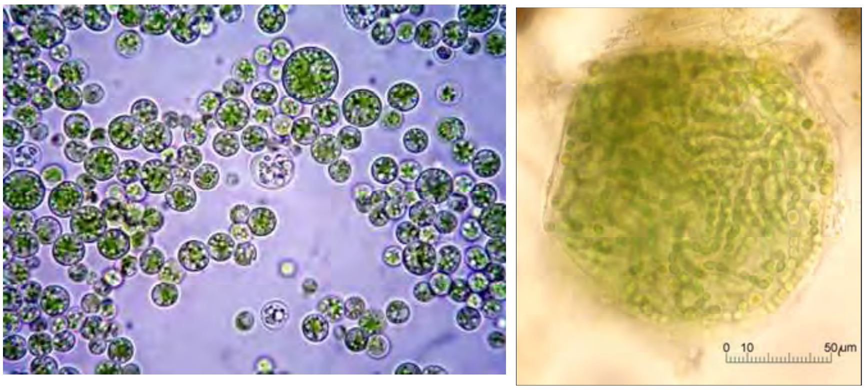
Barták, M., Hájek, J., Očenášová, P. 2012. Photoinhibition of photosynthesis in Antarctic lichen Usnea antarctica. I. Light intensity- and light duration-dependent changes in functioning of photosystem II. Czech Polar Reports, 2, 1, 42-51.

Barták, M, Vráblíková, H, Hájek, J. 2003 Sensitivity of Photosystem 2 of Antarctic Lichens to High Irradiance Stress: Fluorometric Study of Fruticose (*Usnea antarctica*) and Foliose (*Umbilicaria decussata*) Species. Photosynthetica, 41, 497-504.

Vráblíková, H., Barták, M., Wonisch, A. 2005 Changes in glutathione and xanthophyll cycle pigments in high light-stressed lichens *Umbilicaria antarctica* and *Lasallia pustulata*. Journal of Photochemistry and Photobiology B: biology, Elsevier, 79, 3, 35-41.

Freezing tolerance of lichens and their algal photobionts

A newly-designed method of the evaluation of freezing resistance is applied. Wet samples of individual are placed into the cooling chamber linked to a 20 l Dewar flask with liquid nitrogen and cooled from 20 to -40°C at constant rates (2.0, 0.5 °C s^{-1}). Simultaneously with the cooling, chamber and sample temperature are measured as well as chlorophyll fluorescence parameters evaluating potential (Fv/Fm), and actual quantum yield of photosynthetic processes (Φ_{PSII}), non-photochemical quenching (NPQ). Since both Fv/Fm and Φ_{PSII} produce typical *S* curves with temperature decline, several characteristics enabling interpecific and treatment-dependent (the rate of cooling) differences. From the curve, several characteristics might be derived such as *e.g.* the temperature causing the first signs of decrease of particular parameter, the slope of decline and critical temperature. Such method is sensitive enough to distingush differences in the response of photosynthetic apparatus of lichens (their photobionts) to freezing temperature.



Freezing tolerance is studied on *Trebouxia* sp. (left) and *Nostoc commune* (right).

To assess the cryoresistance of lichen symbiotic algae *Trebouxia* sp. (both cultured and freshly isolataed strains), *Nostoc commune*, and symbionts isolated from experimental lichen species, their viability is evaluated as a ratio of number of living/total cells (within 100 cells) using an optical microscope and image processing software. For this purpose, cultures are exposed to linear cooling protocol(s) (to minus 40 °C) or shock-frozen in liquid nitrogen, then innoculated on a BBM agar and cultivated in vitro. On the 1st, 5th and 10th day after the cooling and innoculation, interspecific differences in number of living cells, i.e. viability is assessed. Our resuts show high cryoresistance and viability of lichen symbiotic algae of genus *Trebouxia*.

Published Results

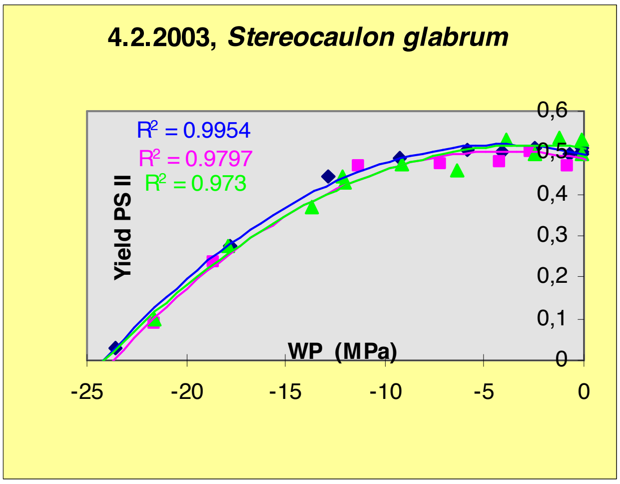
Hájek, J., Kvíderová, J., Worland, M.R. (2010): The ice nucleation activity of green algae isolated from low-temperature environments. In: IPY Oslo Science Conference, Lillestrøm, June 8-12, 2010.

Hájek, J. 2009. Differential Scanning Calorimetry (DSC) and Ice Nucleation Spectrometry (INS). In In: N. Walter (ed.): CAREX Publication #1: CAREX Transfer of Knowledge Grants 2008 Reports. European Science Foundation, Strasbourg Cedex, France, 2009. 2 p.

Hájek, J., Váczi, P., Barták, M., Jahnová, L. (2012): Interspecific differences in cryoresistance of lichen symbiotic algae of genus *Trebouxia* assessed by cell viability and chlorophyll fluorescence. Cryobiology, Great Britain. 64, 3, 215-222.

Photosynthesis of extremophilic autotrophs in response to dehydration

This study evaluates the effective photosynthetic quantum yield (Φ_{PSII}) and the Photochemical Reflectance Index (PRI). Simultaneous measurements of Φ_{PSII} and PRI are taken to assess of photosynthetic performance of Antarctic lichens during controlled dehydration. In such set up, water potential (WP) decreases from full hydration (WP=0 Mpa) to fully dehydrated state (WP below -25 MPa). Simultaneously with dehydration, photosynthetic chracteristics are measured. For this study lichen species collected at Galindez Island and the James Ross Island have been used. Lichen thalli exhibit curvilinear relationship (S-shape curve) of decreasing □$_{PSII}$ values with decreasing water potential (WP) of thalli. During initial phase of desiccation (WP from 0 to -10 MPa), no decrease of □$_{PSII}$ was apparent, further desiccation (WP from -10 to -20 MPa) led to fast □$_{PSII}$ decrease from 0.6 to 0.1 indicating strong inhibition of photosynthetic processes. Critical WP at which photosythetic processes are fully inhibited was found bellow -25 MPa in both lichen species.



Desiccation-response curve of photosynthesis in a lichen (three thalli of *Stereocaulon glabrum*), Galindez Island, Antarctica. Effective quantum yield of photochemical processes in photosystem II (Yield PS II) shows decreasing trend from fully hydrated thallus state (water potential, WP = 0) to fully inhibited state that is reached under severe dehydration (WP = -24 MPa).

Photochemical Reflectance Index (PRI) exhibits curvilinear increase with thalli desiccation (decreasing WP). At full thallus hydration, the PRI reaches the value of -0.18 typically. Under strong dehydration (WP from -20 to -30 MPa), however, PRI value ranges from -0.04 PRI to WP relationship is discussed and compared to existing evidence from higher plants and poikilohydric organisms.

Recently, dehydration-dependent changes in photosynthetic apparatus of Antarctic chlorolichens (*e.g. Usnea antarctica*) collected at James Ross Island are carried out using fast chlorophyll fluorescence kinetics (OJIPs). Within the OJIPs, four levels of chlorophyll fluorescence denoting particular phases of electron transport within photosystem II (PS II) can be distinguished. Using parameters derived from the OJIPs that are indicative of physical stressors, evaluation of the effects of drought stress on electron transport within the PS II of selected species can be made and analyzed by a special model (UP Olomouc).

Published Results

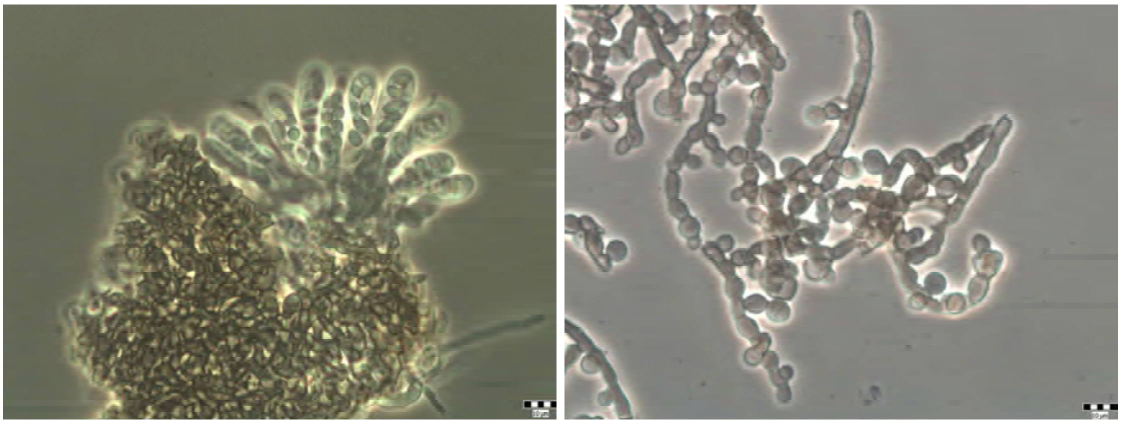
Barták, M., Gloser, J., Hájek, J. (2005): Visualized photosynthetic characteristics of the lichen *Xanthoria elegans* related to daily courses of light, temperature and hydration: a field study from Galindez Island, maritime Antarctica. Lichenologist, s. 433-443.

Moudrá, A., Barták, M. (2009): Comparative study of dehydration-response curves of photosynthesis in Antarctic lichen and *Nostoc commune*. In: M. Barták, J. Hájek, P.Váczi (eds.): Structure and Function of

Antarctic Terrestrial Ecosystems. Book of Abstracts and Contributed Papers. Conference, Brno, October 22-23, 2009. Masaryk University, Brno, Czech Republic, s. 59-61.

Biodiversity lichens and microorganisms of James Ross Island

Since 2008, biodiversity of heterotrophic microorganisms and lichens found at James Ross Island has been evaluated by sampling, consequent cultivation, and molecular biology techniques used for taxonomy. Samples from typical (vegetation oases, seepages, bird colonies) and extreme (rock walls, subglacial sediments) are collected annually and



Black meristematic microgungi isolated from rock and stone samples collected at the James Ross Island are typical representatives of extremophilic psychrophilic organisms.

determined (quantified) after the trasfer in the laboratories of the Czech Collection of Microorganisms (CCM MU Brno) and Photosynthetic Microorganisms Collection in Třeboň (CCALA). Special attention is given to microfungi and bacteria. Biodiversity of yeasts, bacteria, fungi, cyanobacteria and microalgae using the methods specified in Leichmannová et al. (2009). Collected data help to evaluate trends in biodiversity, quantify interactions of species forming investigated communities etc. Recently, *Pseudomonas prosekii*, a new species of Antarctic bacteria is described form James Ross Island (Kosina et al. 2013, accepted).

Rich moss and lichen flora developed form lines on slightly inclined surfaces of sorted soils (patterned ground).

Published results

Kosina M., Barták M., Mašláňová I., Teshim A., Šedo O., Lexa M., Sedláček I. (2013-accepted). *Pseudomonas prosekii* sp. nov., a description of novel psychrotrophic bacterium from Antarctic samples. EMBL.

Láska, K., Barták, M., Hájek, J., Prošek, P., Bohuslavová, O. (2011): Climatic and ecological characteristics of deglaciated area of James Ross Island, Antarctica, with a special respect to vegetation cover. Czech Polar Reports, 1, s. 49-62.

Laichmanová, M., Selbman, L., Barták M. (2009): Diversity of microfungi from James Ross Island, Antarctica. In: M. Barták, J. Hájek, P.Váczi (eds.): Structure and Function of Antarctic Terrestrial Ecosystems. Book of Abstracts and Contributed Papers. Conference, Brno, October 22-23, 2009. Masaryk University, Brno, Czech Republic, s. 10-13.

Sedláček, I., Holochová, P., Pantůček, R., Švec, P., Barták, M. (2011): Diversity of pink pigmented psychrophiles from Antarctica. Inaugural Meeting of Bergey's International Society for Microbial Systematics (BISMiS 2011). Peking, Čína, 19.-23.5. 2011. Program and Abstracts, s. 104.

Ševčíková, A., Bednářová, J., Bartáková, S., Ševčík, P. 2011. Microbial diversity of internal environment of Johann Gregor Mendel Station, Antarctica. Czech Polar Reports, 1, 1, 34 – 41.

Stress physiology of Antarctic algae, cyanobacteria and lichens

UV-radiation

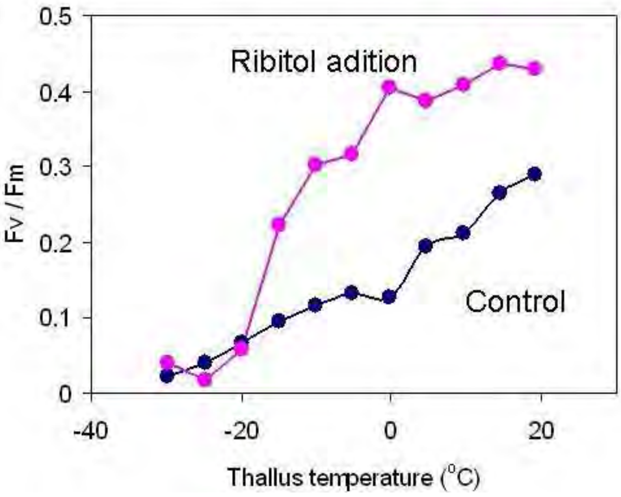
Samples, *i.e.* (1) whole thalli of experimental species, (2) fragmentes thalli with separated cyanobacterial and algal part are exposed to UV ($\lambda = 254$ nm, 10 kJ m^{-2}) for several individual periods (2,4,6, 12 h) either at wet and dry state. The effects of UV exposition and treatments (wet/dry) on photosynthetic parameters (based on chlorophyll fluorescence) is assessed assessed as a difference between their values recorded in wet state before and after the UV treatments. UV-induced synthesis of phenolics is evaluated spectrophotometrically from samples extracted from lichen thalli before and after UV-B treatments. Pigment composition (Chla, Chlb, Chltot, Cartot) in response to UV-B treatment is evaluated as well. This approach allows to evaluate the capacity of Antarctic lichens to cope with natural fluctuations of UV.

Osmotic stress

To study resistance of lichen symbiotic algae to dehydration, the relation between oxygen evolution rate (OER) and quantum yield of photochemical reactions in photosystem II (Φ_{PSII}) was examined in lichen symbiotic alga *Trebouxia erici* (recently reclassified as *Asterochloris*) exposed to different irradiances and osmotic stress. Linear relationship was found between OER and Φ_{PSII} in untreated cell suspension within irradiance range of 0 - 500 μmol m^{-2} s^{-1}. Under osmotic stress, OER and Φ_{PSII} were significantly reduced.. The highest used irradiance (500 μmol m^{-2} s^{-1}) was photoinhibitory for osmotically-stressed *T. erici* because non-photochemical quenching (NPQ) increased substantially. Energy-dependent quenching represented major part of NPQ increase. Osmotic stress led also to the reduction of capacity of photochemical processes in PS 2 (FV/FM) and increase in Fo/FM. These changes indicated negative effects of osmoticum on structure and function of photosynthetic apparatus of lichen symbiotic alga *Trebouxia erici*.

Low-temperature stress

Both field- and laboratory based experiments have been made on several lichen species collected at King George Island, Galindez Island and James Ross Island under a variety of experimental stress factors. The aim of the series of experiments was to find temperature-dependet responses of photosynthetic process in Antarctic lichens to low temperature. Within last decade, *Umbilicaria antarctica, Xanthoria elegans, Usnea antarctica*, *Leptogium puberulum*, *Caloplaca* sp., have been investigated. It was found, that for majority of species, low but above zero temperature do not bring substantion limitation of photosynthetic processes if optimum hydration status of a thallus is not changed.



Temperature-dependent decrease of photosynthetic processes in a lichen (*Usnea aurantiaco-atra*, collected at Galindez Island, Antarctica) during linear cooling from +20°C to -30°C. Addition of sugar alcohol (ribitol) increases freezing tolerance.

Published Results

Barták, M., Gloser, J., Hájek, J. (2005): Visualized photosynthetic characteristics of the lichen *Xanthoria elegans* related to daily courses of light, temperature and hydration: a field study from Galindez Island, maritime Antarctica. The Lichenologist, Academic Press, 37, 5,. 433-443.

Barták, M., Váczi, P., Hájek, J., Smykla, J. (2007): Low temperature limitation of primary photosynthetic processes in Antarctic lichens *Umbilicaria antarctica* and *Xanthoria elegans*. Polar Biology, 31, s. 47-51.

Gómez, F., Barták, M., Bell, E. (2012): Extreme Environments on Earth as Analogues for Life on Other Planets: Astrobiology. In. (E.Bell (Ed.): Life at Extremes. Environments, Organisms and Strategies for Survival. Wallingford, United Kingdom: CABI, 2012. ISBN 978-1-84593-814-7, pp. 522-536.

Barták, M., Váczi, P. (2006): Photosynthesis of lichen symbiotic alga *Trebouxia erici* as affected by irradiance and osmotic stress. Biologia Plantarum, 50, 2, 257-264.

Váczi, P., Komárek, O., Barták, M. (2005): Determination of temperature and light optima for photosynthetic activity and growth of green algal lichen photobionts of the genus *Trebouxia*. In Book of abstracts, Photosynthesis and stress. Brno: Masarykova univerzita Brno, 2005. p. 71.

Lake biology and geochemistry

Study of Sr/Ca-isotope is applied to water and organic samples collected from several James Ross Island to distinguish the sources of base cations (variability of $^{44}Ca/^{40}Ca$)**.** The $\delta^{44}Ca$ values are unlike the $^{87}Sr/^{86}Sr$ values affected by the microbiological processes in waters. The shift in $\delta^{44}Ca$ values is related to biochemical cycles and microbiological fractionation of Ca in microbial carbonates metabolism. Microbial cyanobacterial and algae mats in Green Lake I and II produce $CaCO_3$ through lithification. The process is thought to be driven by a metabolically-induced increase of the $CaCO_3$ saturation state in the microbial mat. In Green Lake I and II, it is unknown how microbes incorporate calcium into the external $CaCO_3$ structures whether by biotic or abiotic pathways. Using Ca isotopic fractionation methods may help to clarify this process. Original water from Green Lake I and II along with the boulders covered by stromatolite like rock are placed into the experimental chambers. Then amount of $^{43}Ca/^{48}Ca$ is added to double spike of the known isotopic ratio into the water prior to cultivation (cultivation in light treatment with photosynthetic activity and in dark without photosynthetic activity, respectively). The isotopic composition of Ca ($\delta^{44}Ca$) and the $^{43}Ca/^{48}Ca$ double-spike ratio in water and stromatolitelike are measured just before and after the experiment. During cultivation, the growth of stromatolite inside the experimental chambers is be supported by mineral nutrients (N, P). Metabolism of Ca would be measurable as a shift in $\delta^{44}Ca$ and $^{43}Ca/^{48}Ca$ ratios. Lithificating and $CaCO_3$ precipitating stromatolite communities will show that crusts are formed by metabolic processes through the cell membrane, the $\delta^{44}Ca$ in $CaCO_3$ crusts is lower than stock solution (the existence of fractionation). Thus we are able to trace calcium pathways and cycling inside the experimental chambers.

During the 2011 expedition, small team of Czech Geological Survey performed geochemical mapping of the major rivers and lakes on the northern part of James Ross Island. Sampling sites were selected with respect to lithology of bedrock, which is a key nutrient resource of the study area due to weathering processes. The bedrock on James Ross Island consists of two main geological domains (volcanic and sedimentary) with different geochemical and isotopic composition. Thus, the chemistry and physical parameters of surface waters is likely variable because of these contrasting source lithologies. The research program focused on the geochemical conditions for successful development of microbiota in deglaciated regions of James Ross Island. One of the objectives was to locate the sources of Ca and other base cations in glacial lakes and meltwater streams. Isotopic composition of Sr shall be used as tracer of possible contributing sources in order to study the biogeochemical cycles and microbiological fractionation of Ca in polar wetlands. Thus isotopic composition of Ca and Sr in the samples is in the centre of interest. Furthermore, total silicate and chemical analyses is be carried out in these samples to determine the content of base cations and other compounds along the isotopic values. Sampling on selected sites consisted of collecting water, stream sediments and further materials influencing the streamwater chemistry such as rocks, snow, glaciers etc. Basic hydrochemical parameters were measured onsite (pH, conductivity). All collected samples were taken to the Czech Republic for further investigation in the Czech Geological Survey laboratories. Chemical analyses of rock and water samples is performed according to accredited procedures. Isotopic analyses is be performed in two steps, one comprising the column ion exchange chromatography, the second instrumental ratio determination.

Published results:

Míková, J. (2012) Strontium isotopic composition as tracer of weathering processes, a review with respect to James Ross Island, Antarctica. Czech Polar Reports, 2, 1, 20-30.

Soil Chemistry with a special respect to metal ions

Soil profile development in the coastal zone of James Ross Island was investigated. The main objective was the characterisation of soil horizons. The contents of As, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Ni, P, Se and Zn were measured using ICP-MS technique. Soil parameters like organic carbon content, pH and content of sub-63 μm fraction were also determined. Based on the results obtained, the mineral-depleted and mineral-enriched layers in the soil profile were distinguished. With increasing depth, the shallow soil profile consisted mainly of weathered regolith.

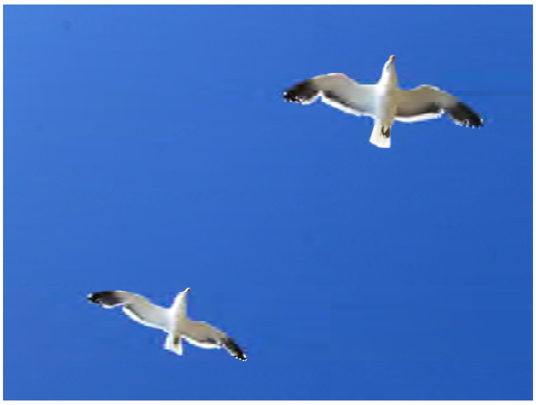
Published results

Zvěřina, O., Coufalík, P., Vaculovič, T., Kuta, J., Zeman, J., Komárek, J., (2012) Macro- and microelements in soil profile of the moss-covered area in James Ross Island, Antarctica. Czech Polar Reports, 2, 1, 1-7.

Biology of South Polar Skua

Following earlier studies from Nelson Island (South Shetlands, Antarctica), ornithological research of James Ross Island started in 2008. The main aim of the study was detailed study of breeding biology, incubation behaviour and breeding success (egg/nest predation) of one of the most abundant bird species breeding on James Ross Island - South Polar Scua (*Stercorarius maccormicki*). Population size, distribution and breeding of other seabirds at

James Ross Island in the close proximity to the Czech Polar Station were assessed. A new human settlement (J.G.Mendel station with experidion creww during austral summer season) allowed us to study the influence of human presence on intact bird communities. Incubation behaviour of South Polar Skua was monitored by continuous video surveillance to access ≥24 h records from each nest (*e.g.* Praus & Weidinger, 2010) Survival of the nests (egg/nest predation) was estimated. An ability of South Polar Skua to recognise its own eggs from potential prey was be tested by experiments with artificial eggs placed close to the nests. The distribution and breeding of bird species on James Ross Island was monitored by surveying the inland and coastal areas on foot or from water (using small boats).



Typical representatives of avifauna of northern part of the James Ross Island. *Laurus dominicanus* (left), and *Stercorarius maccormicki* (right).

Pavel, V., Weidinger, K. 2012. First records of the white-rumped sandpiper and brown-hooded gull south-east of the Antarctic Peninsula.. Antarctic Science, doi:10.1017/S0954102012001137.

Weidinger, K 1997. Breeding cycle of the Cape petrel Daption capense at Nelson Island, Antarctica. Polar Biology, 17, 5, 469 - 472

Weidinger, K 1998. Effect of predation by skuas on breeding success of the Cape petrel Daption capense at Nelson Island, Antarctica. Polar Biology, 20, 3, 170 - 177

Appendix III

Identification of the organisation that would act as the Czech National Lead Agency to be involved in the Charity (SCAR)

The Czech National Lead Agency

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