

Piotr Angiel

Polish Academy of Sciences – Department of Antarctic Biology  
02-141 Warsaw, ul. Ustrzycka 10/12  
University of Warsaw – Faculty of Geography and Regional Studies  
00-927 Warsaw, Krakowskie Przedmieście 30  
e-mail: piotr@angiel.pl

**GEOGRAPHICAL RESEARCH OF THE 30<sup>TH</sup>  
POLISH ANTARCTIC EXPEDITION AT ARCTOWSKI  
POLISH STATION (KING GEORGE ISLAND,  
SOUTH SHETLAND ISLANDS, ANTARCTICA)**

**Abstract:** This paper presents the scope of geographical research conducted at Arctowski Station during the 30<sup>th</sup> Polish Antarctic Expedition. The research included meteorological, climatological, geomorphological and glaciological issues. During the expedition, research was conducted on sandur sediments on the outwash plain of Sphinx Glacier, the size of the aeolian transport, intensity of periglacial phenomena, and the way in which environmental conditions are recorded on quartz grains collected on the Admiralty Bay beaches. Detailed measurements of the basic meteorological components were made, geomorphological maps of the outwash plains of Sphinx, Baranowski, and Windy Glaciers were also completed.

**Keywords:** Antarctica, meteorological measurements, geomorphological charting, glacier retreat, periglacial phenomena, aeolian processes, beach sediments, sedimentological analysis.

**INTRODUCTION**

Geographical research undertaken during the 30<sup>th</sup> Polish Antarctic Expedition (30<sup>th</sup> PAE) continued the contribution of data collected by Polish scientists to the knowledge of the functioning of Antarctic ecosystems. The data collected constitute the background for biological research, allowing for the monitoring of the functioning and changes

of the geographical environment of the west coast of Admiralty Bay, King George Island, South Shetland Islands, Antarctica.

Research at the Polish Arctowski Antarctic Station (62°09'41"56 S, 58°31'49"99 W) has been conducted without interruption since 1977. Since 2007-2008 has been announced as the International Polar Year (IPY), the 30<sup>th</sup> PAE scientific research was particularly intensive including a large range of geography-related topics. Some of the most important are topics covered are a re-introduction of the meteorological observations at the station, geomorphological charting of the outwash plains of glaciers, monitoring of the changes of the range of the glacier termini during the Nov. 2005 – Feb. 2007 season, sedimentological and geomorphological study of sandur, periglacial, aeolian, and beach sediments.

#### METEOROLOGICAL AND CLIMATOLOGICAL RESEARCH

The accelerated melting of the ice caps and ice tongues caused by climate warming on King George Island caused, in turn considerable transformations in its ecosystems (Rakusa-Suszczewski 2003; Zwolska, Rakusa-Suszczewski 2007). Meteorological research has been conducted at Arctowski Station since 1977. At the beginning of the 21st century (2001-2005), research was abandoned for a few years. Taking into account the important role of meteorological data in the assessment of the local climate changes, meteorological observations were reinstated at the beginning of the 30th PAE (November 2005). New meteorological instruments were purchased (high-performance automatic instruments made by the LAB-EL company), electronic temperature and humidity sensors as well as a rugged anemometer made by the R M Young Company. At the end of the expedition (November 2006) additional temperature sensors were installed, introducing temperature monitoring at depths of 0, 5, 10, 20, and 50 cm as well as at 5 cm above ground level and a barometric pressure sensor was also installed. Currently, the monitoring equipment continues to collect data. This equipment allows for a wide range of detailed meteorological research, automatic monitoring and data recording can be performed as often as every second. Such data can be applied, for example, in the case of measuring wind direction and speed during stormy weather caused by katabatic winds. Earlier measurements

allowed only for the assessment of the force of the strongest wind gusts. Results obtained from the automatic meteorological station show that the force of gust winds can increase from 10 m/s to as much as 67 m/s within a few seconds. The possibility of measuring particular elements of climate by an automatic meteorological station allows for collecting of homogeneous meteorological data; these data will be used for future climate research projects.

### GEOMORPHOLOGICAL MAPS OF GLACIER OUTWASH PLAINS

The glacier regression on King George Island (Battke *et al.* 2001; Pudelko 2003; Braun & Hock 2004), which was equal to around 4–4.5 m/year for the Ecology Glacier in the years from 1956/57 to 1988/89, increased to over 30 m/year in the years from the 1988/89 season to 2000/01 (Birkenmajer 2002). Due to this phenomenon, significant areas free of ice became exposed. The remaining glaciers in the ASPA-128 (formerly SSSI-8) terrain also retreated quickly. Denudation and periglacial processes began to occur. The outwash plains became the new habitat of animals, plants, lichens, algae, and fungi. This area is characterized by clearly visible surface features which are groups of forms that allow for the reconstruction of the development and manner of deglaciation.

During the summer seasons 2005–2006 and 2006–2007, research was conducted on the ASPA-128 glaciers. Specifically, geomorphological charting of the outwash plains of the glacier was done using GPS (measurements with the accuracy of 3 m). Detailed maps will be made in GIS programs a geomorphological map of the outwash plain of Windy, Sphinx, and Baranowski Glaciers.

During the consecutive expeditions, changes in the range of the glacier termini have been recorded and during the 30th expedition detailed measurements charting the locations of all termini were carried out on the terrain of the ASPA-128. In 2005, monitoring of the changes of the range of glacier termini on ASPA-128 was started (Windy, Thawing, Baranowski, Sphinx, and Ecology Glaciers) using photographs from permanent and GPS marked topographical points.

## ANALYSIS OF TEXTURAL FEATURES OF SANDUR MATERIALS: THE SPHINX GLACIER SANDUR

Due to climate warming on King George Island, Sphinx glacier's terminus has retreated by over half of a kilometre in the last thirty years. As a result, a large area, was exposed when the braided rivers flood the depressions between the terminal moraine ramparts and created single troughs in the segments cutting through the moraine.

Samples for sedimentological analyses of moraine and sandur deposits were collected from the outwash plain of Sphinx Glacier. The samples were taken from trough sediments, bar bridges, and bars. Sedimentological analysis was performed by means of the method recommended by Rutkowski (1995), which takes into account all the fractions comprising the deposit. Similar studies of the textural features of outflow deposits conducted on Iceland allowed for an accurate interpretation of the dynamics of the sedimentation environment (Angiel et al. 2005; Angiel 2006).

## PERMAFROST

Meteorological studies using measurements of ground temperature, the number of times that the air temperature at ground level crosses the 0°C point, as well as determination of water balance elements (Jahn, Walker 1983) indicate the activity of periglacial processes. Due to the climate warming in the region of the Polish Antarctic Station (Kejna 2003), these conditions cause changes in the intensity of the processes related to the sorting of the surface material. To determine the intensity and rate of the processes, sediment samples from surface sorting forms (stone circles) were collected. They allow for the estimation of the susceptibility of the sediments to frost heave, according to Beskow's rate of heave limits (Beskow 1935). Geomorphological studies of periglacial surface forms (structural grounds such as stone circles, stone stripes, islands, and others) were performed. Samples for sedimentological analysis were collected and photographic documentation was done. Additionally, during the Antarctic summer of 2006, observations of the changes in the thickness of the active layer in the vicinity of the Polish Antarctic Station were conducted. The selection of the points depended on the exposition, ground cover, and the genesis of the relief.

## ANALYSIS OF THE INTENSITY OF AEOLIAN PROCESSES

The goal of the study was to estimate the amount of mineral and organic matter carried by wind near the terrain's surface. The sediment traps used allowed for detailed identification of both quantitative and qualitative characteristics of the sediment (identification of mineral matter, plant parts, lichens, algae, seeds, spores, etc.) (Janiec 1996).

## ANALYSIS OF BEACH SEDIMENTS IN ADMIRALTY BAY

Samples of beach materials from about fifteen sand beaches (mostly basaltic sands) on the west coast of Admiralty Bay were collected. The sediments undergo observations with the use of an electronic microscope. The goal of the study is to determine how climatic conditions influence quartz grains. The clearly legible record of climatic conditions, preserved on the grain surface would be an important diagnostic feature for similar grains from fossil environments of the Great European Plain.

## SUMMARY

Geographical research performed during the 30<sup>th</sup> Polish Antarctic Expedition was particularly intensive. The results of the research are undergoing laboratory analyses and detailed descriptions, and will be soon published as separate publications.

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