Polish research in the polar regions of the Earth

White Ends of the Earth

A. Guterch runs seismic surveys to probe Arctic seabed

A. Gaździcki takes paleontology to the Earth's poles

P. Głowacki studies the changes in polar ice caps

M. Grad explores the deep structures of the Earth

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The years 2007-2008 have been declared the 4th International Polar Year. Poland has a long history of Arctic and Antarctic exploration, and is now ready to join the international effort

The polar regions are among the most intriguing and the least known places on the globe. Yet they are so technologically demanding, that no single nation can afford to explore all their secrets alone. In order to advance the state of polar science, this year, following a proposition made by the International Committee of Science Unions (ICSU), the years 2007-2008 have been declared the 4-International Polar Year (4-IPY), marking the 125th anniversary of the 1-IPY (1882--1883). The planned research is unprecedented in scale. According to the Initial Outline Science Plan, adopted by the ICSU 4-IPY 2007-2008 Planning Group, "the concept of the International Polar Year 2007-2008 is of an international programme of coordinated, interdisciplinary scientific research and observations in the Earth's polar regions to explore new scientific frontiers, to deepen our understanding of polar processes and their global linkages, to increase our ability to detect changes, to attract and develop the next generation of polar scientists, engineers and logistics experts, and to capture the interest of schoolchildren, the public and decision-makers."

For many decades, Arctic and Antarctic scientists - geologists, geophysicists, paleontologists and glaciologists - made great advances within their own fields. Using new technologies, it is now possible to perform joint interpretation and confrontation of results in all these fields. For a complete understanding of geodynamic processes in Arctica and Antarctica in a planetary context, new large-scale interdisciplinary projects have to be carried out, via international cooperation. Polish science has a long tradition of polar exploration and is now ready to join such international activity during the 4-IPY 2007-2008.

Back to the roots

Poland's presence in the polar regions, dating back over two centuries, was conditioned by the tragic history of the country itself, and has followed different routes in the Arctic and the Antarctic. Beginning in the Arctic in the middle of the 18th century, the Polish contribution was closely related to the exploratory activities undertaken in the northern parts of Siberia by Polish political exiles, whose names can be found there today in many geographical locations. The Polish presence in Antarctica, in turn, was marked by the participation of Polish scientists in polar expeditions organized by other nations. Two scientists from Gdańsk, subjects of the Polish king, the father-and-son pair Johann Reingold and Georg Adam Forsters, took part in the English expedition of Captain James Cook (1773-74). More than a century later, Henryk Arctowski and Antoni Bolesław Dobrowolski, members of scientific staff of a Belgian expedition, were among the first men to winter in Antarctica (1897-99).

After regaining independence in 1918, Poland organized its own expeditions to the Arctic and carried out scientific investigations there. Participating in the 2nd International Polar Year of 1932/33, Poland established a research station on Bear Islands,

Andrzej Gaździcki

Adélie penguins on Petermann Island, Antarctic Peninsula

organized expeditions to Spitsbergen (1934, 1936, 1938) and Greenland (1937), and took active part in international co-operation.

After World War II, the Polish presence in the polar regions became permanent and was extended to Antarctica. That has added not only new political and economic dimensions, but also widened the spectrum of scientific methods and forms of polar research, reflected in multidisciplinary studies and multifaceted investigations. Important milestones on that road were marked by Poland's active participation in the 3rd International Geophysical Year 1957/58, establishing the permanent, year-round research station at Hornsundfjord on Spitsbergen in 1957, opening the seasonal A. B. Dobrowolski Station on the Antarctic continent in 1959, establishing the permanent, year-round H. Arctowski Station on King George Island in West Antarctica in 1977, and organizing seven Antarctic oceanological and marine biology expeditions, as well as four Antarctic geodynamic expeditions.

Common territory

Scientific exploration and research activities play an important, sometimes even a dominant role as a factor supporting countries' political and economic position in the polar regions, which have a complex political and legal status. The 1920 Paris Treaty on Spitsbergen, of which Poland is a signatory, as well as Poland's observer status in the Arctic Council established in 1996 by the eight Arctic states, constitute the main legal basis for the Polish presence and activities in the northern polar region.

Poland's persistence on its long and difficult path to the 1959 Antarctic Treaty has contributed to the Antarctic Treaty System (ATS) both substantially and procedurally. The milestones on that route were marked by Poland's declaration in 1959 of its intention to participate in the Washington Antarctic Conference, its adherence to the Antarctic Treaty in 1961, and finally its receipt of Antarctic Treaty consultative status in 1977. Since then, Polish diplomatic representatives and members of the PAN Committee on Polar Research have actively participated in all Antarctic Treaty System endeavors.

Research projects in the region of Svalbard Islands in the Arctic and in West Antarctica are realized by the PAN, Polish universities and governmental institutes. The projects are mainly financed by the state Committee for Scientific Research (KBN). The main platforms for the research are two permanent Polish stations: the Polar Station in Hornsund on Spitsbergen (operated by the PAN Institute of Geophysics) and the Henryk Arctowski Station at King George Island, West Antarctica (PAN Antarctic Biology Department). There

are also seasonal stations run by Nicolaus Copernicus University in Toruń and Maria Curie-Skłodowska University in Lublin, and bases located in regions of special interest on Spitsbergen, kindly made available by the Norwegian authorities to Maria Curie-Skłodowska University, Adam Mickiewicz University in Poznań, as well as Jagiellonian University and the University of Mining and Metallurgy in Kraków. The PAN Institute of Oceanology also conducts polar studies aboard its research ship, the *Oceania*.

High-latitude secrets

The continents surrounding the Arctic Ocean represent an agglomeration of tectonic plates and collisional zones dating from the Early Precambrian (3-4 billion years ago) to the Tertiary (several million years ago). Fram Strait, which separates the North Atlantic from the Arctic Ocean, also separates the North American continental plate from the Eurasian plate (Svalbard Islands, Northern Europe and Siberia) with a system of active oceanic rifts and transform faults, and the associated volcanism. Extensional forces reign in the entire North Atlantic-Arctic transition seafloor. The Arctic Svalbard Islands, uniquely located at the north-westernmost corner of the Eurasian plate opposite the Greenland-North American plate, are an ideal place to study the geodynamics and evolution of the Earth's crust. Svalbard's sedimentary strata, including oil- and phosphate-bearing deposits, provide valuable information on changes in the environment during the Paleozoic and the Mesozoic, allowing for studies in paleoecology, paleobiology, geology, geophysics, oceanology and climatology.

Polish permanent research stations in the polar regions

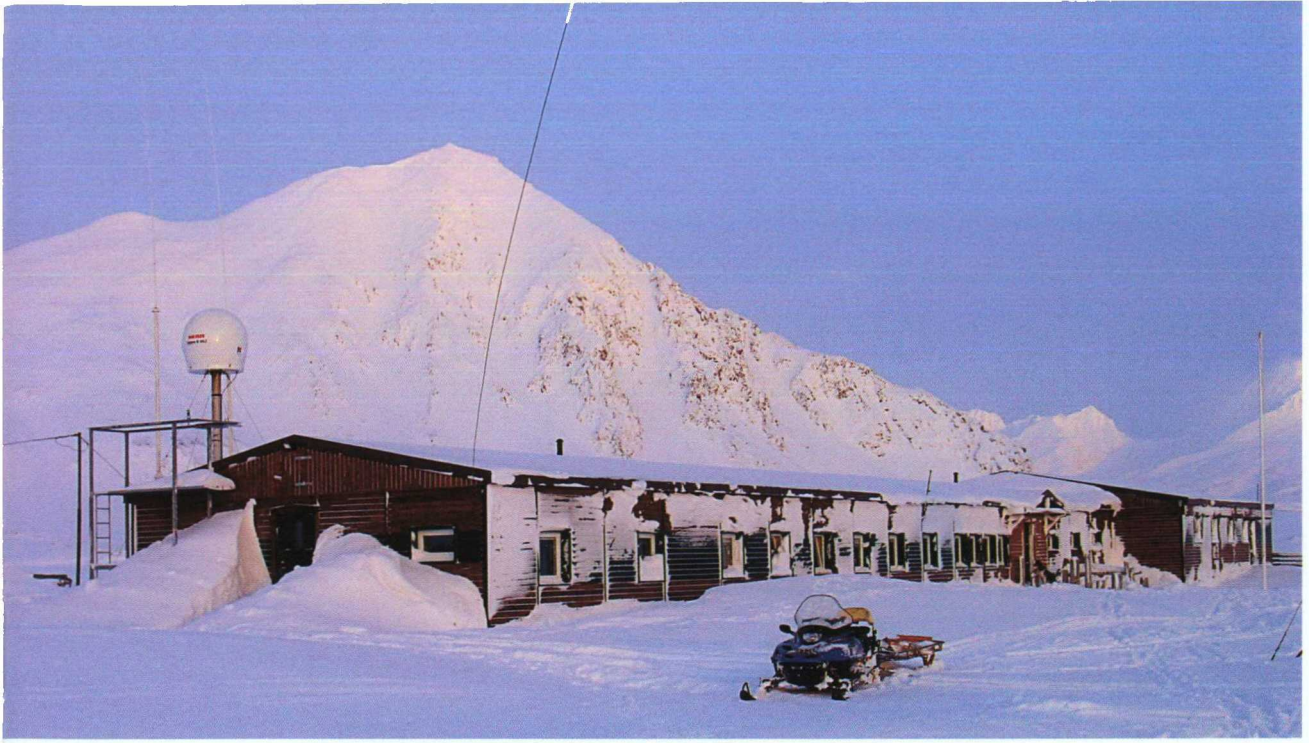
The history of the Antarctic continent began 4 billion years ago. Antarctica was not always the cold continent it is today. During the Jurassic period it formed the core of a supercontinent called Gondwana. When Gondwana broke up - a process that started some 160 million years ago - Africa, South America, India, Australia and New Zealand successively drifted away from the Antarctic core, creating the Southern Ocean as a result. These geological events are exceptionally well documented in the Mesozoic and Cenozoic terrestrial and marine rocks of the Antarctic continent. Antarctica thus plays a key role in our understanding of the history of the Earth, the origin and evolution of its fauna and flora, global paleoclimatic and paleooceanological changes, the factors involved in triggering Cenozoic glaciations, etc.

The continental Antarctic Plate is surrounded by a ring of active oceanic rifts and transform faults, rooted in the Earth's upper mantle down to a depth of 100-150 km. West Antarctica, being an agglomeration of lithospheric blocks (terranes), with its oceanic rifts and subduction zones, is key to understanding both the history of the Antarctic and the geodynamic system of the Earth.

The research carried out by numerous international teams indicates that on a global scale temperatures have risen over the past century by 0.6 ± 0.2°C. The last decade of the 20th century has been the warmest period on the instrumental record. The biggest impact of global warming can be observed in the polar regions, particularly on the lands of the northern hemisphere, most notably in the Atlantic sector of the Arctic. There are also serious concerns about the fate of the West Antarctic Ice Sheet, which is mostly grounded below the sea level and is potentially very prone to disintegration in response to warming. Generally, the cryosphere (glaciers, permafrost, sea-ice) has been shown to be the most sensitive indicator of climate change. The polar regions are thus crucial to our understanding of the complex feedback mechanisms that drive the global climate.

Polish highlights

Several geodynamical expeditions organized by Polish research institutes have led to major advances in the state of knowledge on both polar regions of the Earth. In one of the most notable experiments, Polish researchers conducted a deep seismic survey of the crust and lower lithosphere in West Antarctica. The crustal structures were determined to a depth of about 70 km, along profiles of a total length of about 4500 km, from Elephant Island to Marguerite Bay, resulting in a detailed tectonophysical model showing the Southern Pacific Ocean plate subducted beneath the continental plate of Western Antarctica, as well as the Bransfield rift - the main tectonic struc-



In April, the Arctic snow cover is thickest – here at the Polish polar station in Hornsund, Spitsbergen

Hornsund station archives

ture in Western Antarctica. In the north polar circle, Polish scientists determined the structure of the Earth's crust and lower lithosphere down to a depth of about 50 km. The profiles extended from Western Spitsbergen to the Knipovich ridge in the North Atlantic, and yielded a tectonophysical crustal model of the central part of Western Spitsbergen.

The paleoecosystem research conducted by Polish scientists in Antarctica has already provided exciting new information on the history of the region. Changes in the Antarctic environment during the Phanerozoic are reflected in detail in the fossil record. The last 65 million years of the record contain valuable information on global climate change. One of the most prominent events during this timeframe was the transition from a warm ice-free climate (greenhouse) in the Early Eocene to a colder climate and glacial regime (icehouse) at the Eocene/Oligocene boundary about 34 million years ago. This climatic event was concurrent with the final break-up of Gondwana and the opening of the Tasman and Drake passages. The timing of the initiation of the Cenozoic Antarctic glaciation is one of the most important standing questions in Antarctic science, because pinpointing this is necessary in order to understand the climatic changes and the evolution of both the fossil and the modern-day Antarctic biota.

The main base for Polish scientists in the Arctic region has been the polar station at Hornsundfjord, situated in the center of Spitsbergen, right on the boundary between the Euroasiatic and American Arctic. This favorable location has inspired many different research projects, in fields ranging from geology and oceanology, to atmospheric physics and space science. The glaciers neighboring the Station constitute an excellent research zone for interglacial processes. Seismological recording provide unique data on seismic events in South Spitsbergen and glacial seismic events. The location of Spitsbergen is optimal for studying auroras and the magnetospheric polar cusp. Many studies conducted at the Station deal with global climate change. The Hornsund Station also carries out constant monitoring in the following fields: geomagnetism, seismology, atmospheric electricity, atmospheric optics, space physics, glaciology, meteorology, biology (biodiversity of Arctic ecosystems), and geology (neotectonics).

The 4th International Polar Year 2007--2008 will provide an opportunity to undertake huge multidisciplinary research projects beyond the capabilities of any single country. The Earth's final frontier – the cold lands and waters of the polar circles – awaits international scientific teams, promising to share some of its deepest secrets that may be a key to our own future. ■

Further reading:

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