

MEMBER COUNTRY:
National Report to SCAR for year:

Republic of Korea
2008-2009

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1)						
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2)						
3)						
4)						
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NATIONAL ANTARCTIC DATA CENTRE						
SCAR DATABASE						
insert name of database for which your country has responsibility						
A BRIEF SUMMARY OF SCIENTIFIC HIGHLIGHTS (2008- Please find the attached word file.						

[Attachment File to SCAR National Report 2008-2009]

Scientific Research Highlights in 2008-2009

I. Major Research Activities

II. International Collaborations in Focus

Polar Research

Polar Policy

Events

III. Logistics & Infrastructure

Ice Breaker *Araon*

Remodelling of King Sejong Station

2nd Antarctic Station

Scientific Research Highlights in 2008-2009

I. MAJOR RESEARCH ACTIVITIES

Reconstruction of the paleoclimate and paleoceanography of the polar regions to understand the response of future global warming (2006-2010)

Principal Investigator: Dr. Jae Il LEE, KOPRI leeji@kopri.re.kr

Purpose: The research aims to reconstruct Late Quaternary climate changes using sediment cores from polar regions, to study on sedimentary processes in the Antarctic Peninsula region, and to monitor and predict ice shelf collapse in the Antarctic Peninsula region through sedimentological approaches, and geochemical and geophysical analyses.

Progress in 2008: Glacial landforms on the Barton and Weaver peninsulas of King George Island in the South Shetland Islands, West Antarctica were mapped and dated using terrestrial cosmogenic ^{36}Cl method. This provided the first quantitative terrestrial record for the Late Quaternary deglaciation in the South Shetland Islands. The analysis indicates progressive downwasting of the southwestern part of the Collins Ice Cap at a rate of ~12 mm/yr since 15.5 ka. The effects of glaciomarine sedimentary processes are recognized in variation of sedimentary facies from two deep sea cores taken in the continental rise of the Bellingshallsen Sea, West Antarctica. Two sediment cores (one gravity core and one piston core) were visually described, logged for magnetic susceptibility, and X-radiographed. Three sediment types associated with distinct sedimentary processes of last glacial, deglaciation and Holocene are identified.

Formation, evolution and neotectonics of Antarctica (2006-2010)

Principal Investigator: Dr. Moon Young CHOE, KOPRI mychoe@kopri.re.kr

Purpose: The research attempts to study the geological evolution of the Antarctic continent, to investigate the tectonic structure of the Drake Passage, and to analyze neotectonic activity in the Antarctic.

Progress in 2008: The formation and evolution of the continent are being studied through integrated use of major elements, trace elements and Sr-Nd-Pb-Hf-O isotopes. The protocols for the isotopic methods, especially for the Lu-Hf are developed for the first time in Korea. The geological age of the Mesozoic zircon near the Thiel Mountains is estimated with U-Pb and Lu-Hf isotopes in the laboratory. The anisotropic feature of the upper mantle in the Phoenix ridge, Antarctica is recognized by means of isotope components to investigate the tectonic structure of the Drake Passage. A three-dimensional boundary structure between ice and crust near King Sejong Station was identified by a heliborne and surface Ground Penetrating Radar (GPR) survey to examine Antarctic neotectonic activity. A time-varying gravity field from Gravity Recovery and Climate Experiment (GRACE) was analyzed for the purpose of ice-mass balance over the Antarctica. It is discovered that uncorrected earth tides, particularly severe in Antarctica, corrupt the gravity field measured from space.

Integrated research on the COMposition of Polar Atmosphere and Climate Change (COMPAC) (2006-2010)

Principal Investigator: Dr. Seong-Joong KIM, KOPRI seongjkim@kopri.re.kr

Purpose: The research seeks to monitor atmospheric constituents through continuous measurement of trace gases and aerosols, to observe material exchanges between surface and atmosphere using a statistical flux measurement method, to monitor the upper atmosphere in the context of climate change for a long term, and to analyze simulated climate data to assess long-term changes in the polar atmosphere-ocean-cryosphere.

Progress in 2008: The joint research project has been conducted with Stockholm University and Norwegian Polar institute to monitor variations of the Cloud Condensation Nuclei (CCN) concentration at Zeppelin Station, Ny-Alesund. It is the first attempt to have continuous CCN data in the Arctic environment for further understanding climate systems. To better examine the exchange processes between the atmosphere and the tundra ecosystem, the emission of CO₂ from the soil was quantified near Dasan Station in the Arctic in July 2008. The magnitude was estimated to be less than 20% of the net ecosystem exchange. A 10-m flux tower was established to understand the air-sea exchange of CO₂ and energy near King Sejong Station. An atmosphere observatory was built at King Sejong Station in 2009. From the fully operational observatory, continuous atmospheric composition change and meteorological and upper atmospheric data have been collected. Using a high-resolution global climate model developed at the National Center for Atmospheric Research (NCAR), and an atmosphere-ocean coupled model developed at the Canadian Center for Climate Modeling and Analysis (CCCma), climate change for the last glacial

maximum is simulated. The relation between Arctic Oscillation (AO) and the climate in East Asia has also been investigated.

Status and Changes in Polar Indicator Species and Coastal/Terrestrial Ecosystems (2006-2010)

Principal Investigator: Dr. In-Young AHN, KOPRI iahn@kopri.re.kr

Purpose: The research intends to determine the present ecosystem status of polar coastal environments, to investigate and uncover past evolution and present adaptation of representative organisms, and to identify ecosystem changes/stress responses to climate change and further predict future impacts.

Progress in 2008: The reproductive pattern of the Antarctic clam, *Laternula elliptica*, a representative species in Antarctic coastal waters, and related environmental factors have been investigated. The histology indicated that complete vitellogenic growth of *L. elliptica* takes at least a year and it spawns annually during the austral summer with spawning time coincided with algal blooming. This suggested that in the Antarctic marine environment food supply should be a crucial factor governing gonad maturation and subsequent spawning along with the water temperature. In order to elucidate molecular mechanisms that underlie the ecological and physiological functioning of Antarctic marine organism in the cold environmental condition, preliminary X-ray crystallographic experiments on -GST (Glutathione S-transferase) from *L. elliptica* have been crystalized and performed. Furthermore, the research team examines how these adaptive strategies are affected by environmental changes, and develops sensitive and reliable biomarkers to detect any stress responses at the earliest stage. In this regard, the team already isolated and characterized several stress genes present in the Antarctic clam, such as GSTs and HSPs (Heat Shock Proteins). A long-term monitoring program on the natural populations of terrestrial plants, skua and penguins around King Sejong Station has been conducted to observe any changes in relation to global warming and other environmental changes.

Studies on Characteristics of Submarine Active Tectonic Processes and Marine Environmental Change (2006-)

Principal Investigator: Dr. Minkyu PARK, KOPRI minkyu@kopri.re.kr

Purpose: The research proposes to construct and maintain a polar wide-range monitoring network using Autonomous Underwater Hydrophones (AUHs) and seismic networks, to monitor submarine tectonic activity, to detect alterations in the submarine environment to delineate characteristics of various geodynamics and evolutionary processes of regional tectonics, and to investigate the movement and

breakup of ice within the Antarctic Peninsula region using acoustic records.

Progress in 2008: In 2008, five AUHs in the Eastern Scotia Sea were deployed to detect active submarine tectonic activity along plate boundaries near the South Georgia. In 2009, AUHs were deployed again in the Bransfield Strait to monitor all the details about submarine volcanic and hydrothermal activities in the region and conducted MAPR (Miniature Autonomous Plume Recorder) survey in the water column to discover plume evidence and to locate plumes. During the 2010/2011 summer Antarctic Expedition, we will explore and sample the “extreme” hot spring environments, such as fresh lava, vent fluid, and microbial using a Remotely Operated Vehicle (ROV) and an Autonomous Underwater Vehicle (AUV). Shipboard operations will be conducted from the new Korean icebreaker R/V *Araon*.

Procurement of Polar Genetic Resources (2006-2010)

Principal Investigator: Dr. Joung Han YIM, KOPRI jhyim@kopri.re.kr

Purpose: The research aims to strengthen fundamental knowledge on polar biological research by discovering and developing biological resources based on *in vivo* evaluation systems to understand mechanisms of biological physiology and evolution in an extreme environment.

Progress in 2008: A Polar BioDB as a platform has been constructed to understand the evolution and ecology of polar organisms. It contains information on the distribution, environment, and taxonomy of more than 7,000 polar organisms including bacteria, fungi, lichen, moss, and microalgae. In 2008, more than 1,000 bacterial strains were isolated, and 11 Mb metagenomic library from seawater, freshwater, marine sediments, and terrestrial soil samples are constructed. *Sanguibacter antarcticus* was reported as a new species that has been collected from King Sejong Station. To understand adaptation mechanisms of polar organisms to low temperature, 60,000 ESTs (Expressed Sequence Tags) were analyzed. Several genetic resources were isolated: cold related genes and stress-response genes from an Antarctic plant, *Deschampsia Antarctica*; genes for cold-active chitinase and dioxygenase from polar bacteria; a highly effective antioxidant, Ramalin from an Antarctic lichen, *Ramalina terebrata*; and animal cell activity-enhancing substances from Arctic plants.

Research on Culturable Polar Organisms and their Application (2006-2010)

Principal Investigator: Dr. Sung-Ho KANG, KOPRI shkang@kopri.re.kr

Purpose: The research seeks to obtain and classify culturable polar organisms, especially microalgae and microorganisms, to establish and

maintain culture systems, to investigate adequate culture condition and protocol, and to understand cold adaptation mechanism and structure/function of antifreeze proteins.

Progress in 2008: Since 1989, various psychrophilic polar organisms, including microorganisms and microalgae have been collected near King Sejong Station, Maxwell Bay, King George Island, the Antarctic, and more recently, near Dasan Station, Ny- Alesund, Svalbard, the Arctic. From this collection, over 200 strains have been cultivated in the 2 °C culture room of the Korea Polar Research Institute (KOPRI) Culture Collection for Polar Microorganisms (KCCPM). The research has assessed the diversity of psychrophilic polar diatoms cultivated, and attempted to establish phylogenetic relationships among the diverse diatoms based on light microscopic and scanning electron microscopic observations, as well as molecular investigations. It implies a huge step towards the establishment of a database for psychrophilic polar microalgae based on morphological observations and molecular investigations for polar microorganisms. From the study on the mechanisms of cold adaptation in various psychrophilic polar microorganisms and diatoms, activities of antifreeze proteins have been screened out of the polar organisms, and the structural and functional characteristics of these purified antifreeze proteins have been analyzed. These will be in turn applied to cryobiotechnology.

IPY International Trans-Antarctic Scientific Expedition and Glaciological Fundamental Development (2006 -)

Principal Investigator: Dr. Sungmin HONG, KOPRI smhong@kopri.re.kr

Purpose: The research attempts to develop logistics and engineering skills to obtain snow and ice cores in the Antarctic continent, to construct infrastructure for ultra-clean and very sensitive analytical laboratories, and ultimately to provide valuable information on past climate and environmental conditions in timescales of decades to hundreds of thousands of years.

Progress in 2008: In 2007 and 2008, two shallow ice cores (90m and 40m in length) were retrieved from Mt. Qilian (5,350 m a.s.l.) in China and Mt. Tsambagarav (3,830 m a.s.l.) of the Altai Mountains in Mongolia, respectively as joint projects with China and Mongolia. The ice cores will be used to reconstruct a high-resolution record of the past climate and environmental changes occurred in East Asia during the last several centuries. The KOPRI research team then joined a global program, the North Greenland Eemian Ice Drilling (NEEM) (2008–2011) Project. Drawn upon experiences and know-how from international collaborative projects, KOPRI developed its independent ice drilling technology for glaciological research, and manufactured a shallow ice corer, which can be used to drill an ice core down to a depth of

200 m. The infrastructure (ultra-clean class 10 and 1000 rooms, cold room, and ultra-sensitive analytical instruments) was established to analyze ultralow inorganic components in snow and ice: inductively Coupled Plasma Sector Field Mass Spectrometry (ICP-SFMS), ion chromatography, Thermal Ionization Mass Spectrometry (TIMS), Graphite Furnace Atomic Absorption Spectrometry (GFAAS), laser diffraction particle size analyzer (Coulter counter).

Korea Expedition for Antarctic Meteorites (KOREAMET) and Operation of Meteorite Research Center (2006 -)

Principal Investigator: Dr. Jong Ik LEE, KOPRI jilee@kopri.re.kr

Purpose: The research intends to operate an Antarctic meteorite recovery team, the Korea Expedition for Antarctic Meteorites (KOREAMET), to build a meteorite research center to carry out world-class research activity, and to investigate formation processes of the solar system and the evolution of earth-like planets.

Progress in 2008: The second Korea Expedition for Antarctic Meteorites (KOREAMET) was conducted from 19 December 2007 to 6 January 2008. Sixteen meteorites (with a total mass of 10.6 kg) were recovered in the expedition: 12 at the Moulton Escarpment, one at Bermel Escarpment, two at Mt. Walcott, and one at Mt. Powell. These include 9 ordinary chondrites (OC), three carbonaceous chondrites, one enstatite chondrite, one pallasite, one eucrite and one lodranite. The research team classified all the meteorites using microscopic observation, electron microprobe analysis, and laser fluorination oxygen isotope analysis, and reported the results at the 71st Meteoritical Society Meeting, held in Matsue, Japan in July 2008. A laser fluorination oxygen isotope analysis system has been operated since July 2006 to obtain a world-class, high-technology meteorite research. The research team develops a systematic classification of meteorites using this system. A radiogenic isotope laboratory was set up in 2008 to find out the isotopic nature and ages of meteorites. The third KOREAMET will be conducted around Thiel Mountains from December 2008 to January 2009 to develop a long-term meteorite recovery program.

II. INTERNATIONAL COLLABORATIONS IN FOCUS

Inspired by the spirit of collaboration and sharing in the Antarctic Treaty, Korea has actively engaged with international collaborations in polar sciences, policy, and the related activities during 2008-2009.

POLAR RESEARCH

Hydroacoustic monitoring in the Bransfield Strait

Contact point: Dr. Minkyu Park, KOPRI minkyu@kopri.re.kr

Korea Polar Research Institute (KOPRI) and the United States National Oceanic and Atmospheric Administration's Pacific Marine Environmental Laboratory (US NOAA/PMEL) have maintained acoustic hydrophone arrays in the Bransfield Strait and Drake Passage since December 2005. During 2008-2009 austral summer expedition, KOPRI and NOAA scientists redeployed five hydrophones in the Bransfield Strait using the R/V Yuzhmorgeologiya. The research team also recovered five new hydrophones in the Scotia Sea near South Georgia Island. These hydrophones record underwater sounds originating from earthquakes, icebergs and marine mammals. These recordings are expected to help better understand tectonic events, volcanic activities, and ice breakup in the region.

Study of Antarctic oscillations and their impact on mid-latitude climate (2007-2009)

Contact point: Dr. Seong-Joong Kim, KOPRI seongjkim@kopri.re.kr

It is important to understand causes of variability in the Antarctic Oscillation (AAO), particularly low-frequency variability. This depends heavily on the availability of AAO index reconstructions. To improve the quality of low-frequency changes in the reconstructions, we need to take advantage of multiproxy data, including tree-ring and ice-core data sets. The use of ice-core and coral data would greatly improve low-frequency climate signal data and hopefully result in a much better AAO index for the past

several centuries. This is essential to understanding whether the recent trend in AAO is caused by ozone, as suggested by recent simulations. To investigate the AAO variability and its connection to mid-latitudes, KOPRI is currently collaborating with Beijing Normal University of China. KOPRI provides matching funds of 20,000 USD for proxy coral data sampled in mid-latitudes, while Beijing Normal University analyzes the AAO index using available meteorological data. This project was initiated by KOPRI to find teleconnections between Antarctica and East Asia over the long term by analyzing coral records in the northern mid-latitudes and integrating these data with modern meteorological data.

International Polar Year Project: NEEM**Contact point: Dr. Sungmin Hong, KOPRI smhong@kopri.re.kr**

In the IPY's North Greenland Eemian Ice Drilling (NEEM) (2008–2011) Project, 14 countries including Korea are involved. NEEM aims to drill deep ice core on the northwest site of the Greenland ice cap, and to obtain a reliable high-resolution northern hemisphere ice core record covering the last interglacial period, Eemian. During this period, the mean air temperature in North Atlantic was about 5°C warmer than it is today. This gives us clues on how to predict Greenland's fate in terms of global warming. Scientists and engineers at KOPRI have shared experience and know-how in deep ice core drilling technology, and conducted various research studies on ice core samples by joining the NEEM project.

International Polar Year Project: CLICOPEN**Contact point: Dr. In-Young Ahn, KOPRI iahn@kopri.re.kr**

Together with scientists from other stations including Polish Arktowski Station, Argentine-German Dallmann Laboratory on King George Island, Ukrainian Verndaski Station, and some other groups in the Peninsula Region, Korea played an active role in the IPY program, "Impact of CLimate induced glacial melting on marine and terrestrial COastal communities on a gradient along the Western Antarctic PENinsula (CLICOPEN)" (Activity ID#34). Led by Germany, the interdisciplinary CLICOPEN IPY program draws a link between changing glacier mass balance and its effects on coastal communities both on land and in the water. Korean scientists are exploring the significance of stress proteins (heat shock proteins, antioxidant proteins, etc). Tools for population genetics and for analysis of stress proteins and metabolic regulation are developed. These can be used in different locations to better understand the biogeographic background of Antarctic ectothermal tolerance to change.

POLAR POLICY

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Korea has broadened its capacity in polar science and policy through international frameworks since its first involvement in polar research activities. Upon the establishment of King Sejong Station on the Antarctic in 1988, Korea joined the Antarctic Treaty Consultative Parties as the 23rd member state in 1989, and the Scientific Committee on the Antarctic Research (SCAR) as a regular member in 1990.

KOPRI has participated as an expert delegate in the Council of Managers of National Antarctic Programs (COMNAP), the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), the Asian Forum for Polar Sciences (AFoPS), and the International Hydrographic Organization (IHO). In 2008, Korea newly joined Arctic Council as ad hoc observer, and International Hydrographic Organization (IHO).

EVENTS

15th International Symposium on Polar Sciences

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The 15th International Symposium on Polar Sciences was held in Incheon, Korea on September 24th - 26th 2008 with a theme, "Polar Ecosystems: Biodiversity and Adaptation". The symposium was divided into four main sessions: Polar ecosystems; Mechanism of Cold Adaptation; Classification of Polar Organism; and Biotechnology of Polar Organisms.

9th Asian Forum for Polar Science (AFoPs) Meeting

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The 9th Asian Forum for Polar Sciences (AFoPS) meeting was organized by KOPRI in Incheon, Korea on September 22nd - 23rd 2008. At the meeting, a review committee was set up to oversee the AFoPS functions and to address recommendations for future AFoPS' developments. The delegates gave a presentation on how climate change has caused environmental damage in their own

country, the latest domestic polar policy issues, etc.

16th International Symposium on Polar Sciences

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The 16th International Symposium on Polar Sciences took place in Incheon, Korea on June 10th - 12th 2009 with a theme, "Polar Exploration with *Araon* (아라온)" The symposium was consisted of four main sessions: Climate Change and Ocean Systems; Paleoclimate; Hydrothermal Vent Systems; and Tectonics and Magmatism at Polar Ridges.

III. LOGISTICS & INFRASTRUCTURE

Ice Breaker *Araon*

Araon - the first Korean icebreaking research vessel project has been conducted by the Korea Polar Research Institute (KOPRI). On January 4th 2007, Hanjin Heavy Inc. won the contract as a shipbuilder. Steel cutting and keel laying were held in January and May 2008 respectively. To guarantee safety and consistency of the vessel on ice, icebreaking capability test was carried out in Finland on January 22nd 2008. It will be delivered to KOPRI at the end of September 2009. *Araon* is to play an active part in both polar research and logistics in 2010.

Remodelling of King Sejong Station

KOPRI has renewed old facilities at the 20 year old King Sejong Station during 2006 - 2008. The renovation project reflects Korea's determined willingness to make King Sejong Station more environment-friendly in compliance with the Annex I to the Protocol on Environmental Protection to the Antarctic Treaty, and its national implementation, the *Korean Act on Activities and Environmental Protection in Antarctica*. A new power generating system, a high technology sewage control system, a new heat recovery system, and oil bunds were introduced at King Sejong Station to reduce environmental impacts on the Antarctic region. The new power generating system saves energy, and protects the Antarctic environment by recycling waste heat from the generator, and reusing it

to heat other buildings. This system can reduce electric consumption by 100,000 kW per year, and decrease the use of fuel oil by maximum 30%. To treat the increasing volume of sewage in a more efficient and eco-positive manner, the existing system (Capacity: 12m³/day, IMO Standards: BOD 50mg/L, SS 50mg/L) was replaced with a higher capacity system of improved standards (Capacity: 20m³/day, Treatment Standard: BOD 9.4mg/L, SS 9.4mg/L).

2nd Antarctic Station

A project of a new station on the Antarctic Continent has been conducted by Korea Polar Research Institute with Ministry of Land, Transport and Maritime Affairs. The period of the project covers six years (2006~2011). The budget amounts to 70 million USD. Five candidate sites (A and B on West Antarctica, and C, D, E on East Antarctica) were selected for the new station. Sites D (near the Mawson Station of Australia) and E (Larsemann Hills area) were surveyed in 2007. From January to February in 2008 three sites (A: Amundsen Sea area, B: Cape Burks area, site C: Oates Coast area) were surveyed by 14 Koreans using a Russian research icebreaker and a Mi-8 helicopter. Candidate site B was selected as a final candidate for the new station construction in terms of scientific research value, geographical accessibility, logistics, and international collaboration. Main research fields include climate change (glacier and atmosphere/meteorology) and space science (upper atmosphere, space and meteorite investigation). In addition, studies on tectonics, coastal and terrestrial life, and ocean will be carried out.

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