

# Full Proposals for International Polar Year 2007-2008 Activities

## Proposed IPY Activity Details

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### 1.0 PROPOSER INFORMATION

(Activity ID No: 77)

#### 1.1 Title of Activity

Plate Tectonics and Polar Gateways in Earth History

#### 1.2 Short Form Title of Proposed Activity

PLATES & GATES

#### 1.3 Activity Leader Details

Karsten Gohl

Alfred Wegener Institute for Polar and Marine Research (AWI)

Germany

#### 1.4 Lead International Organisation(s) (if applicable)

NULL

NULL

NULL

NULL

#### 1.5 Other Countries involved in the activity

Argentina

Australia

Brasil

Canada

Denmark

France

Italy

Japan

Norway

Poland

Russia

Spain

Sweden

UK

USA

NULL

#### 1.6 Expression of Intent ID #'s brought together in this proposed activity

20,90,91,151,156,174,209,246,386,407,527,568,662,696,740,829,835,878,912,937,1011

#### 1.7 Location of Field Activities

Bipolar

**1.8 Which IPY themes are addressed**

2. Change in the polar regions
3. Polar-global linkages/tele-connections
4. Exploring new frontiers

**1.9 What is the main IPY target addressed by this activity**

1. Natural or social science

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**2.0 SUMMARY OF THE ACTIVITY**

The world oceans are a major component of the Earth System, and changes in the complex global ocean current system are likely to cause global environmental changes. On geological time-scales, these water mass exchanges are controlled by the deepening and shallowing of areas of ocean floor during the tectonic opening and closing of strategic oceanic gateways and the formation of ocean basins. Establishing the detailed tectonic, geodynamic, sedimentary and paleo-topographic histories of strategic oceanic basins and gateways will provide the essential framework for modelling studies that will relate these events to paleo-climate observations collected across the globe. PLATES & GATES intends to adopt a multidisciplinary approach by addressing tectonic-magmatic, geodynamic, sedimentary and biostratigraphic processes, by utilising paleo-biological and geochemical proxies as well as past and recent oceanographic conditions in the gateways, and by using state-of-the-art geophysical techniques, sediment coring, ocean drilling and accompanying land investigations. The main objectives include (1) studies of the crust/lithosphere of the polar ocean basins and polar gateways as well as their continental margins to develop a good understanding of the past and present plate kinematics, mantle processes, margin formations, and crustal subsidence and uplift processes, (2) understanding the past ocean current systems in the basins and gateways by examining the record of change preserved in deep-ocean sediment deposits and drifts, and by undertaking seismic-stratigraphic investigations and analyses of present and paleo-oceanographic proxies to derive the evolution of deep-water circulation and climate change, (3) reconstructing detailed ocean basin and gateway opening processes and constraining the timing of shallow and deep water mass exchange between basins, (4) understanding the long-term paleo-climatic history from Mesozoic-Early Tertiary Greenhouse conditions to upper Tertiary-Quaternary Icehouse conditions, and (5) identifying and modelling the role of gateway openings/closures in the global carbon cycle, bio-evolution and the development of ice-sheets and climatic changes. Paleomagnetic, stratigraphic and petrological data from Franz Josef Land, Axel Heiberg I., Ellesmere I., the New Siberian Is. and North Greenland will be collected and analysed. Geoscientific studies including bathymetric mapping, seismic and magnetic surveying, sub-bottom profiling and sediment coring will be carried out in the Amundsen Basin, on transects across the Alpha-Mendelev Ridge, over the Lomonosov Ridge and from the North Greenland Shelf. Geological and neotectonic studies are planned for North and East Greenland, Svalbard, Bear Island, Mohns Ridge, Knipovich Ridge and the Barents Sea. The gateways between the North Atlantic and the Arctic Ocean will be investigated by a wide spectrum of geophysical and geological approaches to understand the timing and paleo-climatic consequences of water mass exchange. The Bering Strait, as the only freshwater connection between the Arctic and the Pacific, will be investigated by geophysical surveying and geological sampling (drilling). Geophysical and bathymetric surveying as well as geological and biological sampling is planned for critical regions of the Southern Ocean that formed since the break-up of Gondwana. A thorough revision of this break-up will be performed in parallel with new data acquisition giving special emphasis to the compilation and integration of existing data sets. Uncertainties about the early stages of development of the Drake Passage/Scotia Sea gateway will be resolved by studies of the tectonic and sedimentary evolution of the basins and the origin of bathymetric highs, the structure and history of relevant plate boundaries, and deformation of neighbouring land areas. Geophysical data will be collected in the Tasmanian Gateway to constrain the timing of shallow and deep-water opening between the Indian and Pacific Oceans as well as the motion between East and West Antarctica which is critical to the timing of the uplift of the Transantarctic Mountains. Other regions of interest include the passage between the southern

Kerguelen Plateau and Antarctic continent as well as major topographically outstanding transform and fracture zone systems in the Pacific. PLATES & GATES will perform Cenozoic and Mesozoic climate reconstructions using a variety of Earth system models designed to evaluate the effect of ocean gateways and basins on paleo-circulation patterns, the global carbon cycle and nature of polar ice-sheet development. These experiments will include sensitivity runs incorporating new paleo-bathymetric reconstructions arising from the new data acquisition described above. The results from these experiments will be compared with other model simulations, which include different forcing factors such as atmospheric greenhouse gasses and mountain uplift to determine the relative importance of paleo-geography on the evolution of polar and global climates over long geological timescales.

**2.1 What is the evidence of inter-disciplinarity in this activity?**

PLATES & GATES will apply a broad range of geological and geophysical methods as well as studies of the biological evolution in combination with geological sampling. PLATES & GATES will make integrated use of new and existing data for tectonic and geodynamic models as well as the integration of these models with proxies for paleo-climate modelling. The paleo-climate modelling work will provide linkages with oceanography and climatology.

**2.2 What will be the significant advances/developments from this activity? What will be the major deliverables? What are the outputs for your peers?**

PLATES & GATES will focus on data acquisition and analyses in both polar regions which are critical for understanding large time-scale paleo-climatic processes. The new data on the lithospheric and crustal structures, their ages and evolution, sedimentary formations, petrological fabrics and chemistries, as well as high-resolution bathymetry, will be integrated to provide a substantial basis for paleo-topographic and paleo-geographical grids. Existing data sets will be compiled and integrated with these new data. Dynamic models will be developed to reveal the links between tectonic evolution, sedimentary processes and paleo-oceanography. For instance, modelling will demonstrate when opening/closing of ocean gateways became effective for global paleo-oceanographic changes, and it will help understanding the biodiversity evolution. These spatially and temporally highly resolved paleo-grids provide the means for more accurate paleo-climate reconstructions using Earth system models.

Analyses and modelling results of the projects in PLATES & GATES will be presented at international science conferences and at IPY workshops/symposia and will appear in internationally peer-reviewed publications, popular scientific journals and in our website. In addition, paleo-topographic grids will be made accessible through data centres for modelling constraints of other groups working on paleo-climate processes.

**2.3 Outline the geographical location(s) for the proposed field work (approximate coordinates will be helpful if possible)**

Locations	Coordindates
central Arctic, Ellesmere I., Axel-Heiberg I., Lincoln Sea, Lomonosov Ridge, Alpha-Mendeleev Ridge	075°W, 85°N
Laptev Sea, East Siberian Sea, Bering Strait	150°E, 75°N and 165°W, 66°N
Fram Strait, Svalbard, Bear I., Barents Sea, Franz-Joseph-Land, Greenland Sea, Norwegian Sea, NE Atlantic	015°E, 80°N and 010°W, 70°N
Nares Strait, Baffin Bay, Davis Strait, Labrador Sea	060°W, 70°N
Drake Passage, Scotia Sea, Antarctic Peninsula, W Weddell Sea	050°W, 58°S
Tasmanian Gateway, NW Ross Sea	165°E, 70°S
S Indian Ocean, Kerguelen Plateau-Antarctic Passage	075°E, 65°S
S Pacific, Udintsev/Eltanin FZs	140°W, 56°S

**2.4 Define the approximate timeframe(s) for proposed field activities?**

Arctic Fieldwork time frame(s)	Antarctic Fieldwork time frame(s)
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06/07 - 09/07	12/06 - 04/07
06/08 - 09/08	12/07 - 04/08
06/09 - 09/09	12/08 - 04/09

### 2.5 What major logistic support/facilities will be required for this project?

Icebreaker  
 Ship-based drilling capability  
 Ice strengthened research ship  
 Existing field stations  
 Ship recovery of buoys etc  
 Observatories  
 Fixed wing transport aircraft  
 Fixed wing geophysical aircraft

**Further details** – other research vessels; helicopters; high-performance computing

### 2.6 How will the required logistics be supplied? Have operators been approached?

Source of logistic support	Likely potential sources	Support agreed
Consortium of national polar operators	Y	Y
Own national polar operator	Y	Y
Another national polar operator		
National agency	Y	Y
Military support		
Commercial operator	Y	
Own support		
Other		

### 2.7 If working in the Arctic regions, has there been contact with local indigenous groups or relevant authorities regarding access?

## 3.0 STRUCTURE OF THE ACTIVITY

### 3.1 Origin of the activity

This is a new activity developed for the IPY period

### 3.2 How will the activity be organised and managed? Describe the proposed management structure and means for coordinating across the cluster

PLATES & GATES is a network of individually managed projects and project groups that will operate as a coordinated effort among the participating national and/or institutional programs. An international Steering Group (SG) for general coordination has been established. At their meeting on 8-9 June 2005, the SG agreed to (1) share the tasks of project coordination, (2) to establish a central website, (3) to organise annual workshops and (4) to nominate a liaison/contact person to each of the IPY sub-committees "Data Management" and "Education & Outreach".

The central communicational and organisational tool will be a web-based forum and knowledge base where every project partner updates entries. This website will be used for information distribution and communication, downloading of newsletters, lists of planned and scheduled expeditions/cruises, listing of the individual projects in this lead/cluster project and metadata. Funding for establishing and maintaining the website will be sought from the participating institutions.

Annual workshops are intended to review the progress of the project, to present and exchange initial results of past and present surveys, investigations and modelling. The SG will help

facilitate presentations of results at international congresses and their publications, e.g. through special sessions and special publication volumes.

### **3.3 Will the activity leave a legacy of infrastructure and if so in what form?**

Temporary seismic stations and new GPS stations will be installed as part of this project. Some of these stations may become components of a permanent network of observatories (link to EoI 234 POLENET). Apart from this possibility, no infrastructure will remain in the Arctic or Antarctic from this project after the IPY. However, there will be a large data resource that will be used for future studies, in particular for geodynamic/tectonic and paleo-climate modelling studies.

### **3.4 Will the activity involve nations other than traditional polar nations? How will this be addressed?**

Non-traditional polar nations are currently not involved but are encouraged to do so.

### **3.5 Will this activity be linked with other IPY core activities? If yes please specify**

PLATES & GATES has direct links to the following IPY core activities of Cluster 3: Paleoclimate BIPOMAC (62) & ACE (37); Geophysical Observatories POLENET (234) & GOIA (536); Exploration beneath the Ice, Traverses, Earth History (no lead); Resources (no lead);

Further links exist or may be established to the following core activities: Ocean Circulation iAOOS (80) and CASO (109); CAML (83); GEOTRACES (269);

### **3.6 How will the activity manage its data? Is there a viable plan and which data management organisations/structures will be involved?**

Successful development, testing and refinement of geodynamic, tectonic, sedimentary and paleo-climate models depend on the accessibility of relevant observational data. PLATES & GATES will encourage responsible archiving of data and samples to established data centres and repositories. The data collected will be placed in national and international data banks (e.g. World Data Centre, IODP Core Repositories, PANGAEA, SCAR-SDLS, ORFEUS, IRIS, GIS Arctic Provenance Database, and other specialty data centres). The project participants will be requested to make their raw data openly available within an agreed time from the completion of the fieldwork. Through its website, PLATES & GATES will establish a directory of the relevant data centres and repositories to help researchers locate the data they need. Participants are also committed to provide metadata (i.e. a list of where, when and what kind of data/samples were collected) to the PLATES & GATES website.

### **3.7 Data Policy Agreement**

**Will this activity sign up to the IPY draft Data Policy (see website)**

Yes

### **3.8 How will the activity contribute to developing the next generation of polar scientists, logisticians, etc.?**

Individual projects are encouraged to have large numbers of undergraduate and postgraduate students involved in all stages of fieldwork, data/sample analysis and modelling. Students will be trained during the expeditions and supervised in their Honours, Master and PhD research projects relevant to this IPY theme. The network scheme of PLATES & GATES will encourage students to spend some research time in other institutions participating in this cluster project. Information about possibilities for student exchange, research projects and financial support will be regularly updated on the PLATES & GATES website.

### **3.9 How will this activity address education, outreach and communication issues outlined in the Framework document?**

As much of the work required for PLATES & GATES would take place on research vessels, a "classroom at sea" programme could be implemented to ensure outreach to schools. They involve offering a place on each research cruise to a teacher, whose role is to run a virtual classroom by operating/updating a cruise website on a daily basis, providing easy to follow explanations of shipboard activities through text, photographs and video clips. In turn, students perform exercises in their school classes based on current field experiments. This project is ideally suited for TV

documentaries as polar expeditions, visualisations/animations of geodynamics and animated climatic change models are excellent subjects to capture public imagination. Journalists of the print and TV media will be invited to join expeditions.

University and high-school students will be invited to join expeditions by announcements, e.g. on the PLATES & GATES website. Publications of maps and tools with which they were created, including references to public license software as well as ad-hoc created software, will be part of the educational component for both the undergraduate and graduate level.

Direct links will be established to large IPY Education initiatives such as the University of the Arctic (EoI 415), SVALBASE (EoI 597), and the Antarctic Institute (EoI 405).

### **3.10 What are the proposed sources of funding for this activity?**

The logistics (ship time and expeditions) and parts of the science of a number of projects are going to be funded through national polar research programs and national funding agencies or research ministries. Other projects are in the application process for funds from national funding organisations. Additional funds will be sought from the European Community (e.g. INTAS), NATO, private foundations, and special national funding schemes that support bilateral science programs.

### **3.11 Additional Comments**

PLATES & GATES is a bipolar innovative, interdisciplinary and widely internationally coordinated network-project which focuses on polar regions that are critical for changing environmental conditions. Its results will have a global relevance for understanding climatic change at long (tectonic) time-scales.

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## **4.0 CONSORTIUM INFORMATION**

### **4.1 Contact Details**

#### **Lead Contact**

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### **4.2 Other significant consortium members and their affiliation**

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