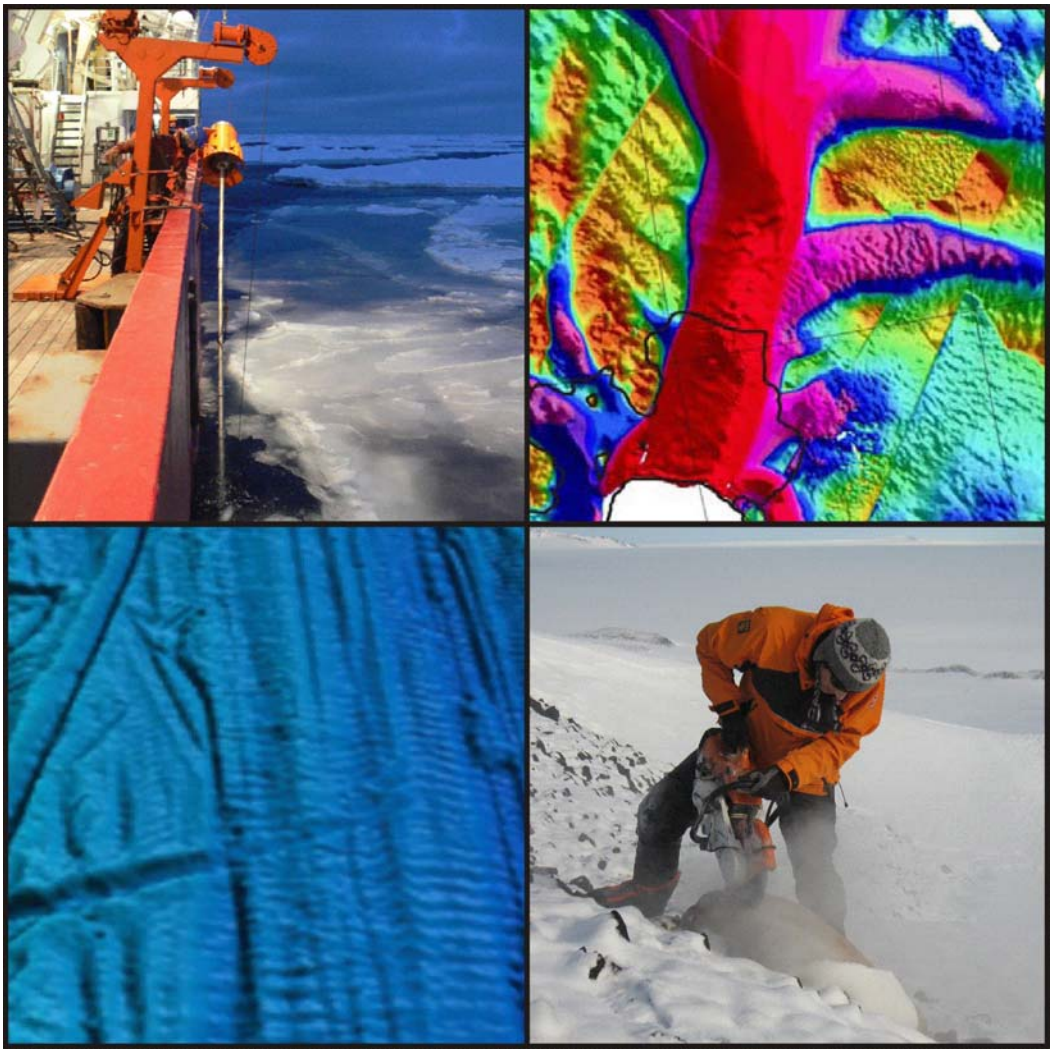
11th International Symposium on Antarctic Earth Sciences

Workshop

Amundsen Sea Embayment Tectonic and Glacial History



Edinburgh, UK 16 July 2011

Programme and Abstracts

Cover images

Top left: piston corer deployment on RRS *James Clark Ross* Cruise JR179 (2008)

Top right: Pine Island Glacier ice flow velocity from InSAR measurements (Joughin et al., Geophysical Research Letters, 30, 1706, doi:10.1029/2003GL017609, 2003)

Bottom left: view of swath bathymetry data collected in Pine Island Trough on the Swedish icebreaker *Oden* in 2010 (Jakobsson et al., Geology, 39, 691-694, doi:10.1130/G32153.1, 2011)

Bottom right: collecting samples for surface exposure age dating from an erratic boulder on Mount Maish, Hudson Mountains (photo courtesy of James Smith)

11th International Symposium on Antarctic Earth Sciences Workshop

Amundsen Sea Embayment Tectonic and Glacial History

16 July 2011

Conveners:

Rob Larter (British Antarctic Survey, UK)
Karsten Gohl (Alfred Wegener Institute for Polar and Marine Research, Germany)
Mike Bentley (Durham University, UK)
John Anderson (Rice University, Houston, TX, USA)

Overall Objective

Review existing data and identify priorities for future geoscience research (terrestrial, marine and airborne) in the Amundsen Sea embayment (ASE) region required to develop a better understanding of the past, present and future behaviour of this sector of the West Antarctic Ice Sheet (WAIS).

Background

The ASE is the most rapidly changing sector of the WAIS and contains enough ice to raise global sea level by 1.2 m. Over the past few years considerable efforts have been made to acquire new data to improve knowledge of the geological structure, subglacial topography, continental shelf bathymetry and glacial history of this remote region. In this workshop we aim to review the current state of knowledge on the tectonic and glacial evolution of the Amundsen Sea embayment. Particular emphasis will be placed on work that will improve boundary conditions for ice sheet models (e.g. subglacial topography, shelf bathymetry, palaeotopography, heat flow and substrate types) and provide palaeo-data against which model outputs can be compared. There will also be a focus on plans and targets for future scientific drilling that will reveal the history of this sector of the WAIS and its sensitivity to major climate changes.

Programme

14.00 – 14.05 Introduction, objectives and workshop schedule

14.05 – 14.35 Presentations reviewing tectonic history and framework – the geological context of West Antarctic Ice Sheet development and dynamics

- 14.05 – 14.15 Fausto Ferraccioli
  Airborne geophysical imaging helps unveil boundary conditions for the weak underbelly of the West Antarctic Ice Sheet
- 14.15 – 14.25 Karsten Gohl
  Coverage and analysis status of the geophysical database from the Amundsen Sea Embayment shelf
- 14.25 – 14.35 Cornelia Spiegel, Julia Lindow and Peter Kamp
  Exhumation and denudation history of Marie Byrd Land and the Pine Island Bay area

14.35 – 14.45 Discussion – How have tectonic history and structure influenced ice sheet development and how does this influence ice dynamics.

14.45 – 16.20 Presentations reviewing Quaternary glacial history and modern processes

- 14.45 – 14.55 Claus-Dieter Hillenbrand, Alex Kirshner, James Smith, Gerhard Kuhn, John Anderson and Rob Larter
  Timing of WAIS grounding-line retreat from the Amundsen Sea shelf since the LGM
- 14.55 – 15.05 John Anderson, Martin Jakobsson and Frank Nitsche
  Preliminary results from 2010 *Oden* Southern Ocean marine geological survey
- 15.05 – 15.10 Frank Nitsche
  An updated version of the Amundsen Sea Bathymetry grid
- 15.10 – 15.20 Mike Bentley
  Glaciation of the Amundsen Sea region: the view from the land
- 15:20 – 15:30 Mirko Scheinert
  The drawback of glacial isostatic adjustment (GIA) for the determination of ice mass changes and vertical crustal movements in West Antarctica
- 15.30 – 15.40 Andy Smith, Ed King, Julian Scott, Rob Bingham and David Vaughan
  A summary of recent data and future activities around Pine Island Glacier
- 15.40 – 15.50 Ed King and Andy Smith

Variation in bedforms beneath Pine Island Glacier from ground-based radio-echo sounding

15.50 –16.00 Dustin Schroeder, Duncan Young and Don Blankenship
The anisotropic basal boundary of Thwaites Glacier: charactarizing hydrology and morphology with coherent radar sounding

16.00 – 16.10 Duncan Young and the Operation IceBridge Land Ice Team
Operation IceBridge data, results and plans for 2011-12

16.10 – 16.20 Norbert Kaul, Karsten Gohl and Michael Schröder
West Antarctic Ice Sheet: energy fluxes through water and sea floor

16.20 – 16.40 Discussion – How can we improve boundary conditions for ice sheet models (e.g. subglacial topography, shelf bathymetry, palaeotopography, heat flow and substrate types) and provide better palaeo-data against which model outputs can be compared?

16.40 – 17.15 Presentations outlining scientific drilling initiatives

16.40 – 16.50 Karsten Gohl
Proposals to use the MeBo system and to IODP

16.50 – 17.00 Gabi Uenzelmann-Neben and Claus-Dieter Hillenbrand
Development of the WAIS right from the start: An initiative to drill sediment drifts on the Amundsen Sea continental rise

17.00 – 17.10 Tim Freudenthal
Overview of the MeBo drilling system

1710 – 17.15 Andy Smith
The WAISdrill initiative

17.15 – 17.45 Discussion – Plans and targets for future scientific drilling that will reveal the history of this sector of the WAIS and its sensitivity to climate changes

17.45 – 17.50 Summary and closing remarks

Airborne geophysical imaging helps unveil boundary conditions for the weak underbelly of the West Antarctic Ice Sheet

Fausto Ferraccioli
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The Amundsen Sea Embayment is a critical hotspot of change, where dynamic thinning of the West Antarctic Ice Sheet is both rapid and significant in terms of its contribution to accelerated global sea-level rise. Critical to predicting its dynamic behaviour and response to climate and ocean warming is an improved understanding of subglacial boundary conditions, including topography, hydrology, geology, and deeper crustal structure and processes, which also affect geothermal heat flux distributions.

Here I review some results from extensive aerogeophysical exploration conducted by the British Antarctic Survey and the University of Texas during the joint BBAS-AGASEA exploration effort over the catchments of Pine Island Glacier and Thwaites Glacier. In particular I will focus on the ongoing interpretation of potential field datasets that provide new insights into the extent, structure, and magmatic patterns of rift basins within the West Antarctic Rift System. I will also present new efforts to estimate geothermal heat flux indirectly using simple processes-oriented models of rift evolution and 1D geothermal modelling, and discuss limitations, uncertainties and potential implications. Finally, I will conclude with some suggestions for future collaborative international work, using both existing data and through new exploration efforts.

Coverage and analysis status of the geophysical database from the Amundsen Sea Embayment shelf

Karsten Gohl
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Being the third-largest outlet glacier basin of West Antarctica, the characteristics of the basement and sediments of the Amundsen Sea Embayment shelf had remained completely unknown until a steep increase of newly acquired geophysical data in the last years has provided first insights. About 2500 km of single-channel and multi-channel seismic data, collected from the inner to outer shelf by Rice University (in 1999), British Antarctic Survey (in 2006) and Alfred Wegener Institute (in 2006 and 2010), illustrate pre-glacial to glacially driven deposition and erosion. Additional seismic refraction recordings provide seismic velocity-depth control for sediments and crust. More than 35000 km of helicopter- and ship-based magnetic data provide the database for a levelled magnetic anomaly grid revealing tectonic lineaments and magmatic provinces. Marine gravity measurements from about 3000 km of ship-tracks complement the satellite-derived gravity anomaly grids for studies on crustal thickness and uplift. Heat-flow has been derived from first temperature measurements in sediment. This presentation gives an overview of the coverage and status of the geophysical database with examples of first analyses of the tectonic development, sediment stratigraphy and heat-flow.

Exhumation and denudation history of Marie Byrd Land and the Pine Island Bay area

Cornelia Spiegel[1], Julia Lindow[1] and Peter Kamp[2]
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[2]*University of Waikato, New Zealand*

The upper crustal geodynamic evolution of West Antarctica and its influence on the West Antarctic ice sheet is poorly constrained. Low-temperature thermochronology is able to monitor movements within the upper ~5 km of the earth´s crust. The goal of our study is to derive the exhumation and denudation history of Marie Byrd Land and the Pine Island Bay area. For this, we dated samples from the Kohler Range, the Mount Murphy area, and several small islands along and across Pine Island Bay by fission track and (U-Th-Sm)/He thermochronology. Our data reveal a complex thermal history. The islands of Pine Island Bay experienced mid to Late Cretaceous rapid cooling, likely related to rifting and breakup between West Antarctica and New Zealand. First (U-Th-Sm)/He data imply that the present-day exposures have already reached shallow crustal levels (<1 km) by the latest Cretaceous / early Paleocene. The Kohler Range, by contrast, cooled slowly between ~100 and 80 Ma, with exhumation rates in the order of ~0.01 km/Ma, followed by periods of more rapid exhumation at ~70 and 55 Ma. During the latter cooling period, the present-day exposures were exhumed to near-surface levels. The exhumation history of the Kohler Range is in marked contrast to that of the adjacent Mount Murphy area, which experienced rapid exhumation at 30 Ma. The different age signatures suggest that the Mount Murphy area and the Kohler Range are separated by a major fault system, which in turn suggests that the course of the Smith glacier is fault-controlled.

Timing of WAIS grounding-line retreat from the Amundsen Sea shelf since the LGM

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[3]*Alfred Wegener Institute for Polar and Marine Research, Germany*

The glacial history of the West Antarctic Ice Sheet (WAIS) in the Amundsen Sea Embayment (ASE) since the Last Glacial Maximum (LGM) can provide an urgently needed long-term context for the currently observed negative mass balance in this drainage sector. Until recently, however, this history was only poorly constrained. The timing of post-LGM WAIS retreat was based on just a handful of radiocarbon dates on marine sediment cores recovered from the ASE shelf, whilst average WAIS thinning rates since the LGM were inferred from even fewer cosmogenic surface exposure dates from the ASE hinterland.

Over the last 5 years the United Kingdom, Germany, the U.S.A. and Sweden have undertaken a comprehensive programme of marine and terrestrial geoscientific fieldwork to investigate the timing of post-LGM deglaciation of the Amundsen Sea sector. Here we present new chronological information providing minimum ages for grounded WAIS retreat from the Amundsen Sea shelf, which we obtained from marine sediment cores recovered along two palaeo-ice stream troughs: Dotson-Getz Trough in the western ASE and Pine Island Trough in the eastern ASE. The retreat histories are based on relative geomagnetic palaeointensity dating and radiocarbon dating of acid-insoluble organic matter (AIO) and calcareous (micro-)fossils, respectively. The reliability of AIO radiocarbon dates of Antarctic shelf sediments is usually compromised by significant contamination with reworked, fossil organic matter, but a thorough facies analysis of the sedimentary sequences enabled us to identify the horizon in each core that yields the most reliable AIO age for deglaciation.

In the Dotson-Getz Trough, the palaeo-ice stream retreated from the outer shelf as early as ~22.4 cal ka BP, reached the middle shelf by ~13.9 cal ka BP and the inner shelf between 12.6 and 10.1 cal ka BP. The retreat rate increased across deep basins of the inner shelf, highlighting the importance of reverse bed slopes in accelerating grounding-line retreat. The palaeo-ice stream in Pine Island Trough episodically retreated from the outer shelf between ~16-12 cal ka BP. Following which, an ice shelf was present in Pine Island Bay from ~12.3-10.6 cal ka BP. The grounding line then migrated to a location near the current ice margin by ~7 cal ka BP. A compilation of new and previously published minimum ages for grounding-line retreat from the Amundsen Sea shelf indicates that the inner shelf of the entire ASE was free of grounded ice already by the early Holocene. This finding suggests that phases of rapid grounding-line retreat (as observed for Pine Island Glacier in the mid 1990s) since then must have been short-lived.

Preliminary Results from 2010 *Oden* Southern Ocean Marine Geological Survey

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A marine geological survey of Pine Island Bay was conducted during 2010 using the Swedish icebreaker *Oden*. A virtual absence of sea ice allowed collection of swath bathymetry data and sediment cores in the central part of the bay, where limited data existed. These new data complement data from inner Pine Island Bay that was acquired during several previous expeditions, including a high-resolution seismic profile along the entire trough axis. The rugged bedrock relief of the inner trough is characterized by an organized sub-glacial drainage system that we believe was active during and immediately following the Last Glacial Maximum.

Among the more interesting features imaged in the central trough are straight, parallel aligned furrows with internal ridges that average 2 m height and have an average wave length of 100 m. The ridges occur at a more or less uniform water depth of approximately 670 meters, seaward of a prominent grounding zone wedge, which marks a period of grounding line stability. These features are over-printed by iceberg furrows with ridges (corrugated furrows) that are identical in scale to corrugated ridges. We interpret this seascape as having been formed during a major ice shelf collapse event.

Attempts to sample outcrops were successful at only one location. That core sampled siltstone with rare palynomorphs of probable late Cretaceous age, however it is not known if these are insitu or reworked.

An updated version of the Amundsen Sea bathymetry grid

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Good bathymetry data are essential for understanding tectonic settings, modeling ocean circulation, reconstructing paleo-ice streams, refining ice sheet models, and for planning expeditions. The continuous strong interest in the Amundsen Sea and especially Pine Island Bay since the publication of the first version of the Amundsen Sea in 2007 resulted in significant additions new multibeam data. I will give a brief overview of the current multibeam bathymetry coverage in the Amundsen Sea and present an updated version of the Amundsen Sea bathymetry grid. Recent cruises into the eastern Amundsen Sea benefited from unusual low ice cover, which allowed the collection of extensive and contiguous data in the area of the Pine Island - Thwaites trough system. I will discuss the implications on past ice flow in the eastern Amundsen Sea.

Glaciation of the Amundsen Sea region: the view from the land

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The Amundsen Sea region has seen relatively few onshore investigations of glacial geology. This is surprising because the region has a key role in contemporary West Antarctic Ice Sheet (WAIS) mass balance; it has been identified as a likely ‘gateway’ for past WAIS collapse; and has a history of glaciation probably extending as far back as the Miocene. I will briefly review past and ongoing studies of glaciation, focusing primarily on the last deglacial phase.

There are pressing research questions in the region that might be addressed by onshore glacial geological investigations, and I will discuss these in the context of future logistic constraints and integration with ongoing and planned future marine-based and onshore glaciological programmes.

The drawback of glacial isostatic adjustment (GIA) for the determination of ice mass changes and vertical crustal movements in West Antarctica

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Geodetic GPS measurements allow a precise determination of height changes of points marked at bedrock. The observed height change is a compound effect of the long-term adjustment to past ice-mass changes occured over the glacial cycles and of the immediate response to recent ice-mass changes. We will review the contribution of Antarctic GPS observations in this context, also with regard to the IPY project POLENET and to a planned SCAR scientific programme SERCE (Solid Earth Responses and Influences on Cryosphere Evolution).

Utilizing the gravity field satellite mission GRACE and the satellite laser altimetry mission ICESat it becomes possible to infer present-day changes of the ice mass and of the ice surface height in Antarctica, respectively. In the analysis of these satellite measurements the effect of the solid earth deformation and of the geoid deformation due to GIA play an important role. We will present a regional pattern of all these changes in the most dynamic regions, especially in West Antarctica. GPS measurements have the great potential to help to test GIA models and to discriminate between the different effects. An improved model of the GIA may help to come up with better boundary conditions for further investigations concerning the history and further development of the West Antarctic ice sheet.

A summary of recent data and future activities around Pine Island Glacier

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In 2006, the British Antarctic Survey began a programme of ground-based glaciological and geophysical research on Pine Island Glacier. Primary aims are an understanding of the glacier's dynamics, basal conditions and on-going changes. Significant campaigns were completed in the 2006-07, 2007-08 and 20010-11 field seasons. Techniques deployed included active and passive seismic, deep and shallow radar, GPS measurements of ice motion and detailed surface topography, and shallow ice coring. The geophysics programme on the glacier will be continued during the forthcoming season.

Future plans include the iSTAR Programme, which will include both on- and off-shore activities. Tractor traverses around the Pine Island Glacier drainage basin are scheduled for 2012-13 and 2013-14. Vehicles, sledges and fuel will be offloaded onto the Abbot Ice Shelf in January 2012 and deployed to the glacier in readiness for these traverses. Oceanographic moorings will be deployed in the Amundsen Sea in January 2012, followed by an oceanographic cruise in the area during January-February 2013. Scientific proposals to conduct research from the traverses and cruise are currently under review.

Variation in bedforms beneath Pine Island Glacier from ground-based radio-echo sounding

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A detailed ground radar survey of the bed of Pine Island Glacier was conducted in the 2010/11 field season at a location 100 km upstream from the grounding line. The 18 x 25 km grid reveals three styles of bed topography. About 50% of the area is relatively smooth with low amplitude (5 – 10 m)flutes, many of which are continuous for 18 km downstream. About 40 % of the bed comprises higher amplitude (10-30 m) bedforms, many of which have an elongate drumlinoid form. The remaining 10% comprises narrow zones of very low relief and very high radar backscatter amplitude. With reference to near-by seismic data, I interpret these three domains as stiff till with the ice sliding over the bed; deforming till with ice motion taken up by shear deformation within the sediment; and narrow zones with high basal melt water content which underlie areas where the internal reflecting layers (isochrones) within the ice column are strongly drawn down towards the bed. These data will facilitate the interpretation of more widely-spaced ground and airborne radar data from Pine Island Glacier and improve understanding of the basal boundary conditions.

The anisotropic basal boundary of Thwaites Glacier: Charactarizing hydrology and morphology with coherent radar sounding

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A key control on ice sheet response to climate forcing is the subglacial hydrologic boundary condition. Airborne ice penetrating radar sounding has been used with variable success to identify and characterize subglacial hydrological systems by the strength of the return from the basal interface. The specularity of the basal return can indicate the presence, extent, and configuration of subglacial water independent of temperature profile and impurity concentration of the ice column. We use multiple radar focusing windows to produce a basal specularity map from a gridded aerogeophysical survey of the Thwaites Glacier catchment using a 60 MHz coherent ice penetrating radar with a 15 MHz bandwidth LFM waveform. We find that specular returns underlie regions of low basal shear stress, correspond to modeled hydrologic pathways, and display strong anisotropy across the catchment. Notably, specular anisotropy is concentrated in regions that are isotropically smooth in the interpreted bed, indicating a basal interface that is rough on the 50 cm to 10s of meters scale in one direction and smooth on the same scale in the other. We compare the axis of symmetry of the observed anisotropy with the direction of surface velocity and subglacial hydrologic gradient across the catchment to infer the process of formation for the anisotropic bed. Using these results, we present an interpretation of the basal hydrology and morphology of Thwaites Glacier, West Antarctica in context of the hydrologic gradient, interpreted bed roughness, observed surface velocities, and inferred basal shear stress.

Operation IceBridge data, results and plans for 2011-12

D.A. Young and the Operation Ice Bridge Land Ice Team
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Operation IceBridge is a new airborne geophysics program sponsored by NASA, with the goal of bridging the elevation monitoring gap between ICESAT-1 and ICESAT-2, and provide the scientific foundations for understanding what that elevation change means for sea level. It has several elements including operations over Greenland with NASA's P-3; operations over East Antarctic with the University of Texas's ICECAP aircraft; and West Antarctic operations using NASA DC-8 aircraft. DC-8 operations have principally focused on the Antarctic Peninsula, Pine Island Glacier and Thwaites Glacier. Additional high elevation altimetry data have also been collected.

Over the 2009-10 and 2010-11 field seasons, the DC-8 has collected several thousand line kilometers of altimetry, radar and gravity data over Pine Island Glacier. Here we review the data collected to date over the Amundsen Sea Embayment and preview plans for the 2011-12 season.

West Antarctic Ice Sheet: energy fluxes through water and sea floor

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During RV Polarstern cruise ANT XXVI/3 we tried to tackle the question where the energy comes from to melt the West Antarctic glaciers, especially Thwaites and Pine Island glaciers. Can increased geothermal heat flow account for extensive bottom melting? We carried out numerous temperature measurements within the ground and the water column.

Observations revealed severe disturbances of the geothermal temperature gradients by transient effects indicating oceanographic events in the not too far past. Geothermal heat flow could be calculated from apparently undisturbed temperature gradients in some regions only. Nevertheless, we get the picture of a “geothermally normal" continental margin.

Concerning oceanography, a vigorous dynamic of the ocean currents was found, especially near the sea floor. As the sea-floor sediments retain a good memory for past temperature effects, we determined that heat flow measurements deliver valuable information for oceanographic current reconstruction.

Drill proposals for MeBo and IODP: Reconstructing West Antarctic Ice Sheet dynamics in the Amundsen Sea Embayment

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The West Antarctic Ice Sheet (WAIS), which is grounded below present sea level and, thus, is highly sensitive to climatic changes, is likely to have had a very dynamic history over the last several million years. Its collapse would result in a global sea-level rise of 3-5 m over present levels yet the world's scientific community is not able to predict how it might behave in the future, nor is much known of how it has behaved in the past. The reconstruction and quantification of partial or complete WAIS collapses in the geological past are needed in order to provide necessary constraints for ice sheet models predicting future WAIS behaviour and its potential contributions to global sea-level rise. Large uncertainties exist regarding the chronology, extent, rates, and spatial and temporal variability of past advances and retreats of the WAIS across the continental shelves. These uncertainties are mainly due to the fundamental lack of data from drill core. A series of drill sites are proposed for the Amundsen Sea Embayment shelf where seismic data reveal oceanward-dipping sedimentary sequences that span the time from the pre-glacial depositional phase to the youngest glacial periods. Our drilling strategy is to target transects from the oldest sequences close to the bedrock-basin boundary in the south to the youngest sequences in the north of the western and eastern Amundsen Sea Embayment continental shelf using the MeBo drilling rig for shallow targets and IODP deep drilling. Such transects will yield a detailed history of the glacial cycles in the Pine Island-Amundsen Sea region and allow correlations to the WAIS history known from the Ross Sea. In addition, deep-water sites on the continental rise of the embayment are selected for recovering continuous records of glacially transported sediments and the details of climatic and oceanographic changes throughout glacial-interglacial cycles.

Development of the WAIS right from the start: An initiative to drill sediment drifts on the Amundsen Sea continental rise

Gabriele Uenzelmann-Neben[1] and Claus-Dieter Hillenbrand[2]
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During the last years the West Antarctic Ice Sheet (WAIS) has been reported to undergo significant changes, especially in the area of Pine Island Bay, Amundsen Sea Embayment. There, large glaciers draining the ice sheet have shown flow acceleration, increased thinning, and, in case of Pine lsland Glacier, grounding line retreat, probably in response to oceanic melting by warm Circumpolar Deep Water (CDW) upwelling onto the shelf. In order to better understand the dynamics of the marine-based WAIS and be able to provide reliable constraints for numerical simulations of a possible future behaviour of the ice sheet, information on the glaciological long-term history of the WAIS is needed. The timing of WAIS formation and its possible collapse thereafter is still under debate. While good progress has been made over the last years in reconstructing the WAIS dynamics since the Miocene for the western Antarctic Peninsula and the Ross Sea area, little is known from the Amundsen Sea, whose continental rise is overlain by the east setting Antarctic Circumpolar Current (ACC).

Both on- and offshore studies have resulted in several contradictory hypotheses about the first appearance of mountain glaciers, ice shelves and local ice caps in West Antarctica, the build up of a large WAIS, the cooling of surface waters, the onset of bottom water circulation, and the (in-)stability of the WAIS during the Neogene. Ground truthing is difficult because the only available deep-sea drill site from the Amundsen Sea, DSDP Site 324, extends back to not more than 4 Ma. We suggest the development of an IODP proposal to address the following important objectives:

1. Develop a general age-depth model for the whole sedimentary column down to the oceanic basement, identify its basal age and reconstruct changes in depositional regimes on the continental rise in response to palaeoenvironmental changes from sedimentological analyses on the drill cores
2. Identify the first sedimentary material supplied by a large ice sheet for reconstructing WAIS formation
3. Search for indicators for WAIS collapses during the Neogene
4. Identify the oldest documented bottom current activity on the continental rise and study its relation to WAIS formation
5. Decipher the history and southward protrusions of CDW
6. Document the interaction of along-slope and down-slope sediment transport and distinguish between times with high material input from the continent and times with low material input for reconstructing ice sheet advance and retreat and changes in bed conditions (wet based vs. cold based) through time and for determining forcing mechanisms
7. Reconstruct the variability in the direction and velocity of bottom current flow in the Amundsen Sea and infer changes in bottom water production in the source areas (Ross and Weddell seas)

We invite and welcome further ideas and contributions.

Seabed drilling with the sea floor drill rig MeBo

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Sea floor drill rigs that can be deployed from standard research vessels are bridging the gap between dedicated drill ships that are used for deep drillings in the range of several hundred metres below sea floor and conventional sampling tools like gravity corers, piston corers or dredges that only scratch the surface of the sea floor. A major advantage of such robotic drill rigs is that the drilling action is conducted from a stable platform at the sea bed independent of any ship movements due to waves, wind or currents. At the Marum Center for Marine Environmental Sciences at the University of Bremen we developed the sea bed drill rig MeBo that can be deployed from standard research vessels. The drill rig is deployed on the sea floor and controlled from the vessel. Drilling tools for coring the sea floor down to 70 m can be stored on two magazines on the rig. A steel-armoured umbilical is used for lowering the rig to the sea bed in water depths up to 2000 m in the present system configuration. It was successfully operated on ten expeditions since 2005 and drilled more than 1000 m in different types of geology including hemipelagic mud, glacial till as well as sedimentary and crystalline rocks.