Magellan workshop

"Overcoming barriers to Arctic Ocean Drilling: the site survey challenge"

November 01 – 03, 2011, Denmark

Conveners
Naja Mikkelsen, Bernard Coakley, and Rudiger Stein

Sponsors
European Science Foundation (ESF) / Magellan workshop Series
International Arctic Science Committee (IASC)/ Marine Working group
European Consortium for Ocean Research Drilling (ECORD)

Abstract
The Arctic Ocean is the last unknown geologic provinces on Earth. The scientific importance of Arctic deep-sea drilling for retrieving paleoceanographic, climatic and tectonic data is well understood, but the lack of adequate site survey data hampers the development of mature drilling proposals. It is not JUST the site survey data. How many times do I have to say this? The site survey problem is slowly being solved. For the precise planning of future drilling campaigns including site selection, evaluation of proposed drill sites for safety and environmental protection aspects, etc., comprehensive site survey data are needed. The lack of good site survey data and age control for existing seismic reflection records is one of the biggest limitations for the development of Arctic Ocean scientific drilling proposals.
In order to plan the future of scientific drilling in the Arctic Ocean the international Magellan workshop *"Overcoming barriers to Arctic Ocean Drilling: the site survey challenge"* was held in Copenhagen November 1 – 3, 2011. About 33 scientists from Europe, US, Canada, Russia and Korea participated in the workshop. Funding of the workshop was provided by European Science Foundation (ESF); International Arctic Science Committee (IASC)/ Marine Working group; and the European Consortium for Ocean Research Drilling (ECORD). The workshop was successfully completed. If we claim success, it should be something more consequential than this

The focus of the workshop was to develop a site survey strategy and discuss site survey campaigns based on the existing proposals and pre-proposals that were discussed and developed during and directly after the ESF-NSF-funded Arctic Drilling Workshop held at the Alfred Wegener Institute in Bremerhaven, Germany, in November 2008 (Coakley and Stein, 2008) and information gathered during the 2003 JEODI workshop in Copenhagen, Denmark (Kristoffersen & Mikkelsen, 2004). The major objectives of the 2011-Magellan workshop were:

- to define and outline site survey investigations for specific IODP-type campaigns in Arctic Ocean key areas to be finalized in the development of drilling proposals
- to develop a scientific site survey to investigate the tectonic and paleoceanographic history of the Arctic Ocean and its role in influencing the global climate system as defined by the drilling proposals resulting from the 2008 workshop

- to summarize existing opportunities, technical needs, and limitations on drilling in the Arctic Ocean
- to bring together an international group of Arctic scientists, young scientists, and ocean drilling scientists to learn and exchange ideas and experience about the Arctic Ocean.

Introduction

The modern Arctic Ocean appears to be changing faster than any other region. To understand high latitude climate change, it is necessary to sample the history stored in the sediments filling the basins and covering the ridges of the Arctic Ocean. These sediments have been imaged with seismic reflection data, but except for the superficial piston cores, the pre-Quaternary strata have been sampled only on the Lomonosov Ridge in 2004 during IODP Expedition 302, the Arctic Coring Expedition "ACEX" (Backman et al., 2006), and during the ODP Leg 151 expedition in 1993 in the ice-free waters in the Fram Strait/Yermak Plateau area (Thiede et al., 1996).

For the precise planning of future drilling campaigns including site selection, evaluation of proposed drill sites for safety and environmental protection aspects etc., comprehensive site survey data are needed. The lack of good site survey data and age control for existing seismic reflection records is thus one of the biggest limitations for the development of Arctic Ocean scientific drilling (Kristoffersen and Mikkelsen, 2004)

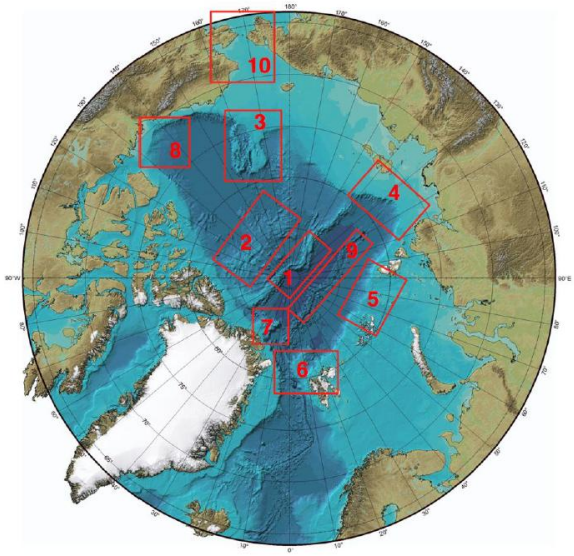

Figure 1 - *Key areas for future drilling in the Arctic Ocean: 1. Lomonosov Ridge; 2. Alpha-Mendeleev Ridge; 3. Chukchi Plateau/Northwind Ridge; 4. Laptev Sea continental margin; 5. Kara Sea continental margin; 6. Fram Strait/Yermak Plateau; 7. Morris Jessup Rise; 8. Mackenzie shelf/slope; 9. Gakkel Ridge; 10. Northerne Bering Sea / Bering Strrait area (after Coakley & Stein 2010; Stein & Coakley 2009)*

Workshop on *Arctic Ocean Drilling and the site survey challenge*

The aim of the workshop was to discuss and develop a site survey strategy to support drilling in the Arctic Ocean. The workshop was therefore divided into broad oral presentations in plenum and more detailed discussions in breakout groups. The full agenda of the workshop is presented in Annex 1.

The first day of the workshop consisted of keynote lectures and presentations related to the history of the Arctic Ocean and the legacy of high latitude ocean drilling. These presentations also summarized the existing site survey data bases. Technical needs for future site survey campaigns in the Arctic Ocean were presented and discussed in order to meet the requirement of deep ocean drilling as were different site survey campaigns aiming at other types of drilling e.g. Mebo, BGS rock drill and long piston coring. Information on techniques and possibilities presented by 3D seismic site surveys in seasonally sea-ice free Arctic regions were highlighted as was collaboration with industry and the process of developing ocean-drilling legs through IODP.

New and alternative ships available for drilling and seismic surveys in the Arctic Ocean were debated. The importance of declining ice cover, which may enable use of the JOIDES Resolution, unaided, for Arctic Ocean drilling was considered as a viable option, particularly for the Western Arctic. A new ship, Stena Drill Max , for drilling in ice infested waters was presented and might be an alternative to the three ship operation used during the IODP-ACEX- cruise in 2004 and also as an alternative for *Aurora borealis*, an European icebreaker with deep-water drilling capability, which have been pushed forward over the last years but currently awaiting funding. Also the use of a hovercraft was discussed as an alternative to larger seismic vessels for undertaking seismic surveys in the Arctic Ocean.

The next day and a half was spent in thematic and regional breakout groups discussing particular questions to be addressed by the lack of site survey data related to active and planned Arctic proposals in the IODP system. For each of the breakout groups a chair and Co-chair had been assigned prior to the meeting. The chairs had agreed to prepare an overview presentation of the topic which served as a starting point for the discussions. The co-chairs were tasked to report on the discussions. The five breakout groups were:

1. Central Arctic Ocean (Chair: W. Jokat, Co-chair: R. Stein)
2. Arctic Gateways (Chair: W. Geissler, Co-chair: M. Forwick)
3. Beaufort Sea and adjacent Canada Basin (Chair: M. O'Regan, Co-chair: J. Ortiz)
4. Chukchi and East Siberian seas (Chair: L. Polyak, Co-chair: B. Coakley)
5. Gas hydrates, permafrost, geohazards (Svalbard aera, Laptev Sea) (Chair: J. Mienert, Co-chair: C. Berndt)

The discussions were based on the eight Arctic-related drilling proposals presently listed in the IODP system. The maturity and status of the proposals were discussed and the proposals prioritized. Based on this assessment a number of key scientific questions, as well as site surveys (available and needed) and strategies were discussed and presented in plenum where they were further discussed.

Major scientific themes and hypotheses to be tested by drilling were thus identified by the breakout groups and was summarized by the following key themes: paleoceanography, tectonics and gas hydrates. The gas hydrate theme was developed into ideas of a new and Pan Arctic drilling proposal: “Arctic methane in ocean and climate systems.”

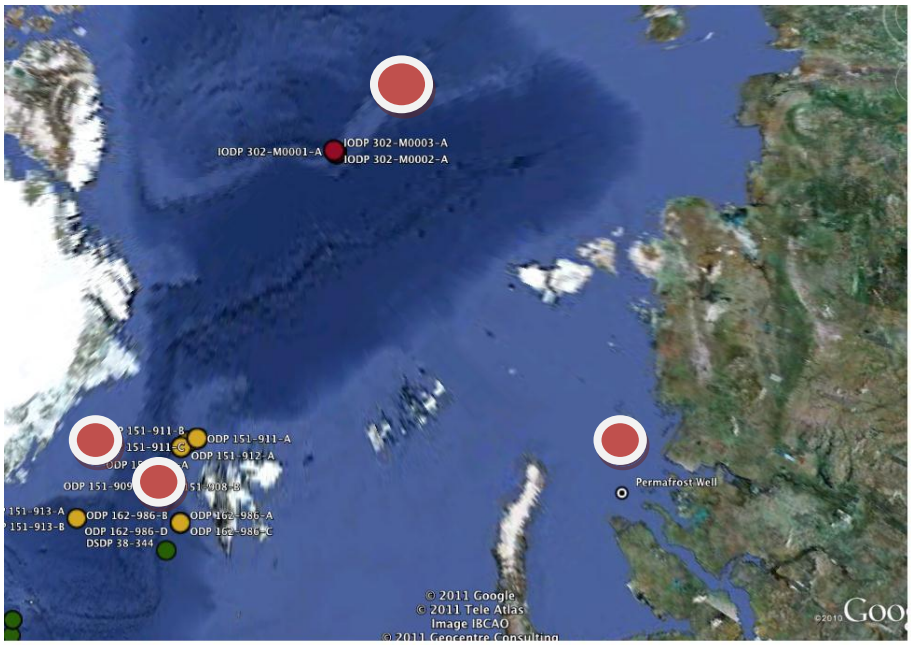

Figure 2 - Potential sites for Gas Hydrate investigation in the Eurasian Basin (red circles with white rim; East Greenland margin ; Knipovich Ridge: Kara Sea; Lomonosov Ridge). Yellow and green dots are drilled and potential IODP sites.

The site survey data base is already quite good for some of the target areas. A large number of deep penetration reflection seismic profiles have thus been acquired along the Lomonosov Ridge on icebreaker-based expeditions in 1991, 1996, 1998, and 2005 (Futterer, 1992; Kristoffersen et al., 1997; Darby et al., 2005; Jokat, 2005). However a number of crosscutting lines are required before future drill sites on the Ridge can be drilled safely.

In other key areas for future drilling, for example the Alpha-Mendeleev Ridge, site survey expeditions still have to be carried out before a detailed planning and drill site selection can start. The almost summer-ice free Beaufort Sea is the target of an upcoming IODP workshop in February 2012, and planning of a detailed site survey in the Beaufort Sea is the likely outcome of the workshop which will add data to existing seismic lines and thus facilitate scientific ocean drilling of this region.

Outlook

Sampling the Arctic Ocean has a high priority not only in the lODP Science Plan but also in the scientific community generally speaking. Work will therefore continue along the lines provided by the ideas and results from the 2011 workshop in order to facilitate the site survey campaigns which are fundamental for future Arctic deep-sea drilling.

Additional information

Sponsors

The convenors gratefully acknowledge the funding that was provided by three different sources:

- European Science Foundation (ESF) / Magellan workshop series
- International Arctic Science Committee (IASC)/ Marine Working group
- European Consortium for Ocean Research Drilling (ECORD)

Conference Venue

The original plan was to host the workshop at the premises of the Geological Survey of Denmark and Greenland. This plan, however, had to be abandoned as major repair work had to take at the institute. The workshop was therefore held at the conference centre Rungstedgaard just north of Copenhagen, where the organizers were able to obtain a very favourable price for the total arrangement.

The workshop participants did not pay a registration fee, and the sponsor money was used to cover room and board for the participants as well as travel support for some particpants .

References

Backman, J., Moran, K., Mayer, L.A., McInroy, D.B., and the Expedition 302 Scientists, 2006. Proceedings IODP, 302, College Station TX (Integrated Ocean Drilling Program Management International, Inc.). doi:10.2204/iodp.proc.302.104.2006.

Coakley, B.J., Stein, R., 2008. Workshop on “Arctic Ocean History: From Speculation to Reality”, Alfred Wegener Institute, Bremerhaven, Germany, November 3-5, 2008. Agenda and Abstract Book, 52 pp, http://www.essac.ecord.org/index.php?mod=workshop&page=workshop

Coakley, B.J., Stein, R., 2009. Arctic Ocean History: From Speculation to Reality. Alfred Wegener Institute, Bremerhaven, Germany, November 3-5, 2008. Workshop Report, ECORD Newsletter 12, p. 12.

Coakley, B. & Stein, R:, 2010. Arctic Ocean Scientific Drilling: The Next Frontier *Scientific Drilling* 9 45-9.

Darby, D.A., Jakobsson, M., Polyak, L., 2005. Icebreaker expedition collects key Arctic seafloor and ice data. Eos 86 (52), 549-552.

Fütterer, D.K. (Ed.), 1992. ARCTIC´91: The Expedition ARK-VIII/3 of RV "Polarstern" in 1991. Rep. Pol. Res. 107, 267 pp.

Jokat, W., 2005. The sedimentary structure of the Lomonosov Ridge between 88°N and 80°N: Consequences for tectonic and glacial processes. Geophys. Journ. Int. 163, 698-726.

Kristoffersen, Y., Buravtsev, V., Jokat, W., Poselov, V., 1997. Seismic reflection surveys during Arctic Ocean-96. Cruise report, Polarforskningssekretaariatets arsbok 1995/96, Stockholm, 75-77.

Kristoffersen, Y. and Mikkelsen, N. (eds.), 2004. Scientific Drilling in the Arctic Ocean and The Site Survey Challenge: Tectonic, paleoceanographic and climatic evolution of the Polar Basin. Jeodi Workshop, Copenhagen, Denmark, January 13 – 14, 2003, Geological Survey of Greenland;

Stein, R. & Coakley, B., 2009. Scientific Drilling in the Arctic Ocean: A challenge for the next decades *INVEST White Paper.* http://www.marum.de/Binaries/Binary42266/ SteinArcticOcean.pdf

Thiede, J., Myhre, A.M., Firth, J.V., Johnson, G.L., Ruddiman, W.F. (Eds.), 1996. Proc. ODP, Sci. Results, 151. College Station, Texas (Ocean Drilling Program), 685 pp.

Program

Magellan workshop

"Overcoming barriers to Arctic Ocean Drilling: the site survey Challenge"

Rungstedgård, Copenhagen, Denmark
November 01 – 03, 2011

Monday October 31:

19.00-20.00 dinner (for people arrived early)
20.00-22.00 social gathering (for people arrived early)

Tuesday November 1:

10.00 – 12.00 Registration

12.00 – 13.00 Lunch

Plenary session 1 (N. Mikkelsen)
13.00-13.15 Welcome, opening remarks, workshop agenda (N. Mikkelsen, B. Coakley, R. Stein)
13:15-14:00 Arctic Ocean Drilling and planning activities: Past, present and future (R. Stein)
14.00-14.30 Review of existing geophysical and geological data (W. Jokat)
14.30-15.00 Results of recent Arctic Ocean Expeditions (B. Coakley)

15.00-15.30 Coffee Break

Plenary session 2 (B. Coakley)
15.30-16.00 The First Deep Coring in the Central Arctic Ocean: The Drilling of the Lomonosov Ridge by the IODP (D. McInroy)
16.00-16.30 Technologies for site survey and drilling campaigns in the Arctic Ocean: Ships, Hovercraft, Mebo, etc. (Y. Kristoffersen)
16.30-16.40 The "Stena Drill Max Ice" (V. Pease)
16.40-17.10 A new versatile high-resolution 3D seismic system (C. Berndt)
17.10-17.40 Open discussion: What did we learn from ACEX except for the science?

17.40 – 18.00 Appointment of working groups (N. Mikkelsen)

19.00 – 22.00 Icebreaker and dinner/buffet

Wednesday November 2:
8.00 – 9.00 Breakfast

Plenary Session 3 (R. Stein)
09.00-09.45 Arctic Ocean geology and tectonic history: An overview (A. Grantz)
09.45-10.15 3D seismic site surveys in seasonally sea-ice free Arctic regions (J. Mienert)
10.15-10.45 Beaufort Sea Drilling: A joint IODP/ICDP approach (M. O'Regan)

10.45-11.15 Coffee Break

11.15-12.00 Break-out sessions
(1) Central Arctic Ocean (Chair: W. Jokat, Co-chair: R. Stein)
(2) Arctic Gateways (Chair: W. Geissler, Co-chair: M. Forwick)
(3) Beaufort Sea and adjacent Canada Basin (Chair: M. O'Regan, Co-chair: J. Ortiz)
(4) Chukchi and East Siberian seas (Chair: L. Polyak, Co-chair: B. Coakley)
(5) Gas hydrates, permafrost, geohazards (Svalbard aera, Laptev Sea) (Chair: J. Mienert, Co-chair: C. Berndt)

12.00-13.00 Lunch

13.00-15.00 Breakout sessions (cont.)
(1) Central Arctic Ocean (Chair: W. Jokat, Co-chair: R. Stein)
(2) Arctic Gateways (Chair: W. Geissler, Co-chair: M. Forwick)
(3) Beaufort Sea and adjacent Canada Basin (Chair: M. O'Regan, Co-chair: J. Ortiz)
(4) Chukchi and East Siberian seas (Chair: L. Polyak, Co-chair: B. Coakley)
(5) Gas hydrates, permafrost, geohazards (Svalbard aera, Laptev Sea) (Chair: J. Mienert, Co-chair: C. Berndt)

15.00-15.30 Coffee Break

Plenary session 4 (N. Mikkelsen)
15.30-16.30 Short statements of the breakout-session chairs: Where are we?

16.30-18.00 Final break-out sessions (incl. preparation of talks for Thursday morning)
(1) Central Arctic Ocean (Chair: W. Jokat, Co-chair: R. Stein)
(2) Arctic Gateways (Chair: W. Geissler, Co-chair: M. Forwick)
(3) Beaufort Sea and adjacent Canada Basin (Chair: M. O'Regan, Co-chair: J. Ortiz)
(4) Chukchi and East Siberian seas (Chair: L. Polyak, Co-chair: B. Coakley)
(5) Gas hydrates, permafrost, geohazards (Svalbard aera, Laptev Sea) (Chair: J. Mienert, Co-chair: C. Berndt)

19.00 – 20:00: Dinner

20. 00 Social gathering / work on proposals

Thursday November 3:
8.00- 9.00 Breakfast

Plenary session 5 (B. Coakley)
Presentation and discussion of results of breakout discussions
09.00-09.30 Theme1: Central Arctic Ocean (W. Jokat)
09.30-10.00 Theme 2: Arctic Gateways (W. Geissler)
10.00-10.30 Theme 3: Beaufort Sea and adjacent Canada Basin (M. O'Regan)

10.30-11.00 Coffee Break

Plenary session 6 (R. Stein)
Presentation and discussion of results of breakout discussions
11.00-11.30 Theme 4: Chukchi and East Siberian seas (L. Polyak)
11.30-12.00 Theme 5: Gas hydrates, permafrost, geohazards (J. Mienert)

Plenary session 7 (N. Mikkelsen, B. Coakley, R.Stein)
12.00-13:00 Final discussion: unsolicited ideas, informations and speculations
13.00-13.05 Closing of Workshop

13.05 – 14.00 lunch

14.00 – 15:00: Meeting of chair persons and organizing group

Departure for airport

Sponsors

European Science Foundation (ESF) / Magellan workshop Series
International Arctic Science Committee (IASC)/ Marine Working group
European Consortium for Ocean Research Drilling (ECORD)

Workshop participants

"Overcoming barriers to Arctic Ocean Drilling: the site survey Challenge"

NAME	AFFILIATION	E-MAIL ADRESS
Bazhenova, Evgenia	**Alfred Wegner Institute**	evgenia.bazhenova@awi.de
Berndt, Christian	**IFM-GEOMAR**	cberndt@ifm-geomar.de
Coakley, Bernard	**University of Alaska**	bernard.coakley@gi.alaska.edu
Cronin, Thomas M.	**US Geological Survey**	tcronin@usgs.gov
Forwick, Matthias	**University of Tromsø**	matthias.forwick@uit.no
Geissler, Wolfram H.	**Alfred Wegner Institute**	wolfram.geissler@awi.de
Grantz, Arthur	**US Geological Survey**	agrantz@usgs.gov
Hall, John	**Geological Survey of Israel**	jkh1@012.net.il
Hopper, John	**GEUS**	jrh@geus.dk
Ilhan, Ibrahim	**University of Alaska**	iilhan@alaska.edu
Jokat, Wilfried	**Alfred Wegner Institute**	wilfried.jokat@awi.de
Kristoffersen, Yngve	**University of Bergen**	yngve.kristoffersen@geo.uib.no
Lembke-Jene, Lester	**Alfred Wegner Institute**	lester.lembke-jene@awi.de

Lenniger, Marc	**University of Copenhagen**	mal@geo.ku.dk
Lucchi, Renata	**Instituto Nazionale di Oceanografia**	rglucchi@inogs.it
McInroy, David	**British Geological Survey, Edinburgh**	dbm@bgs.ac.uk
Mienert, Jurgen	**University of Tromsø**	jurgen.mienert@uit.no
Mikkelsen, Naja	**GEUS**	nm@geus.dk
Morigi, Caterina	**GEUS**	cmor@geus.dk
März, Christian	**Newcastle University**	christian.maerz@newcastle.ac.uk
Nam, Seung-Il	**Korea Polar Research Institute**	sinam@kopri.re.kr
Nørgaard-Pedersen, Niels	**GEUS**	nnp@geus.dk
O´Regan, Matt	**Cardiff University**	oreganm1@cardiff.ac.uk
Ortiz. Joseph D.	**Kent State University**	jortiz@kent.edu
Pease, Victoria	**Stockholm University**	vicky.pease@geo.su.se
Polyak, Leonid	**Ohio State University**	polyak.1@osu.edu
Rekant, Pavel	**VNIOkeangeologia**	rekant@mail.ru

Stein, Rudiger	**Alfred Wegner Institute**	ruediger.stein@awi.de
Vautravers, Maryline	**University of Cambridge**	mv217@cam.ac.uk
Vogt, Christoph	**University of Bremen**	cvogt@uni-bremen.de
Winkelmann, Daniel	**IFM-GEOMAR, Kiel**	dwinkelmann@ifm-geomar.de