Frequently Asked Questions

IODP Expedition 377
ArcOP - Arctic Ocean Paleoceanography
August – September 2022

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ArcOP briefly explained

IODP Expedition 377: Arctic Ocean Paleoceanography (ArcOP)

IODP Expedition 377 "ArcOP" is a drilling expedition of the International Ocean Discovery Program (IODP) and is focused on the Arctic Ocean – a key location in global climate change. IODP is a unique international research program involving collaboration between scientists from 23 different nations.

ArcOP stands for "Arctic Ocean Paleoceanography" and its destination is the Lomonosov Ridge located in the depths of the Arctic Ocean, where seafloor sediments provide a complete record of how Arctic climate has changed over the past 50-60 million years.

The Arctic Ocean is a very sensitive and important region for global climate change, and is unique in comparison to the other oceans on Earth. Due to complex feedback processes (collectively known as "Arctic amplification"), the Arctic is both a contributor to climate change and a region that is most affected by global warming.

The expedition will start in August 2022 and last for approximately seven weeks offshore. During this time a continuous sequence of about 900 meters of sediment cores will be collected at water depth of 800 m, using a unique combination of a scientific drillship and two ice breakers to ensure the drillship can remain at the same exact spot in the ice-covered Arctic ocean throughout the expedition.

After the expedition, an international team of scientists will analyse the cores in great detail, trying to unlock their secrets using numerous state-of-the-art methods. This will allow them to reconstruct past Arctic climate changes and to predict how the Arctic region might react to future changes in global climate. IODP Expedition 377: Arctic Ocean Paleoceanography (ArcOP) will be jointly conducted by the European Consortium for Ocean Research Drilling (ECORD), the Swedish Polar Research Secretariat (SPRS) and Arctic Marine Solutions (AMS).

Expedition website:
https://www.ecord.org/expedition377/

Expedition blog:
https://expedition377arcop.wordpress.com/

Press Release:
https://www.ecord.org/arcop-a-novel-scientific-ocean-drilling-expedition-to-be-conducted-in-2022/

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Program and generic questions

What is IODP?

The International Ocean Discovery Program (IODP), which commenced in October 2013, is an international marine research program that explores Earth's history and structure recorded in the seafloor sediments and rocks, and monitors sub-seafloor environments. IODP builds upon the earlier successes of the Deep Sea Drilling Project (DSDP), Ocean Drilling Program (ODP), and the Integrated Ocean Drilling Program (IODP), which revolutionized our view of Earth's history and global processes through ocean basin exploration. To maximise drilling capability, IODP now uses multiple drilling platforms which are operated by three Platform Providers contributing to fulfill objectives identified in the IODP Science Plan "Illuminating Earth's Past, Present, And Future: Science Plan for 2013-2023". The National Science Foundation (NSF, USA) operates the US-supplied multipurpose drillship JOIDES Resolution, the Japanese Agency for Marine-Earth Science and Technology (JAMSTEC) operate the riser-drilling-capable Chikyu, and ECORD operates mission-specific platforms (MSP).

Further information: *https://www.iodp.org*
IODP Science Plan: *https://iodp.org/about-iodp/iodp-science-plan-2013-2023*

What is ECORD

The European Consortium for Ocean Research Drilling (ECORD) is a management structure of 15 members belonging to 14 European countries and Canada in charge of scientific, operational, educational and outreach activities related to the International Ocean Discovery Program (IODP). ECORD is one of the three IODP Platform Providers and implements scientific drilling expeditions chartered on a specific project basis by the ECORD Science Operator (ESO). ECORD also supports European-based scientists by providing them access to all IODP expeditions.

Further information is available at: *https://www.ecord.org*

What is ESO

The ECORD Science Operator (ESO) is a consortium of European institutions who work together to provide the operational capabilities for ECORD-funded expeditions. The British Geological Survey (BGS) acts as the coordinator; the European Petrophysics Consortium (EPC) provides logging and petrophysical activities and the MARUM, University of Bremen, carries out all core curation and data management tasks. The ESO staff offers a wide range of operational expertise to initiate and implement drilling expeditions and have the skills that scientists require to carry out their scientific projects.

Further information:

https://www.ecord.org/about-ecord/management-structure/eso/

https://www.bgs.ac.uk/geology-projects/seafloor-scientific-ocean-drilling/

https://www.le.ac.uk/epc

https://www.marum.de/

What is SPRS?

The Swedish Polar Research Secretariat (SPRS) is a government agency that promotes and co-ordinates Swedish polar research. This includes to follow and plan research and development, as well as to organize and lead research expeditions to the Arctic and Antarctica.

Further information: *https://polar.se*

What is AMS?

Incorporated in Sweden in 2011, 'Arctic Marine Solutions' (AMS) mission lays in the quantification and operation of Ice Management for Arctic operations, as well as being a driving force for the development and deployment of technologies in support of Ice Management operations.

Further information: *https://arcticmarinesolutions.se/*

What are mission-specific platforms?

Mission-specific platforms (MSP) are unique in that they use a wide range of vessels and drilling systems to carry out scientific drilling expeditions. They are chartered on a specific project basis for drilling in technically challenging conditions, including ice-covered and shallow-water environments that are not accessible for the dedicated drilling vessels JOIDES Resolution and Chikyu. ECORD has therefore opened up new scientific topics for IODP by providing access to new drilling environments.
If needed, the ECORD Science Operator (ESO) may tailor and modify drilling vessels and systems to suit the science needs of the relevant expedition e.g., installing drilling derricks and containerised labs onboard, and sometimes even cutting a hole into the ship to pass the drillstring through!

Further information: *https://www.ecord.org/expeditions/msp/concept/*

Why are three vessels required for this expedition?

Drilling in an ice-covered region is challenging. A fleet composed of a scientific drillship supported by two icebreakers for ice protection will be used to make drilling possible in this ice-affected region. IODP Expedition 377: Arctic Ocean Paleoceanography – ArcOP - will be implemented as a joint international initiative and will greatly benefit from the experience of the Swedish Polar Research Secretariat (SPRS) and Arctic Marine Solutions (AMS) in polar regions.

Such a multi-vessel approach has been employed by ECORD for the first time during the IODP Expedition 302: Arctic Coring Expedition – ACEX - implemented by ECORD in 2004.

Where can I find out about the results of IODP mission-specific platform expeditions?

Some initial results may be publicly announced at the end of each offshore operation, but only a very small proportion of the analyses necessary will be possible at sea. The detailed scientific analyses will be carried out by a larger international group of scientists (the "Onshore Science Party") at the IODP Bremen Core Repository (BCR, https://www.marum.de/en/Research/IODP-Bremen-Core-Repository.html) at the MARUM Centre at the University of Bremen, Germany after the offshore stage of the expedition, generally a few months after the expedition. Here, they will undertake a detailed description of the cores and their properties.

Two months after this Onshore Science Party, an Expedition Preliminary Report will be publicly released on the IODP and ECORD websites. In the 12 months following the Onshore Science Party, scientists will carry out further detailed analyses on sub-samples at their own labs, before the initial expedition results are published in the freely available Expedition Proceedings (http://www.iodp.org/scientific-publications). Detailed scientific work will be published in scientific journals in the months and years following publication of the Expedition Proceedings.

The complete "shipboard" data set acquired during both offshore and onshore phases of the cruise will be publicly available on IODP and affiliated websites one year after the end of the Onshore Science Party. In addition, any interested and suitably qualified scientist from an IODP member country may sample the cores stored at the BCR for research purposes, again after the one year moratorium period.

Who is paying for the expedition?

Operational costs are funded by contributions from government science funding organisations of 14 European nations and Canada, who together form the European Consortium for Ocean Research Drilling (ECORD). ECORD's members belong to 15 countries: Austria, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom. This expedition has also benefitted from significant in-kind contributions made by the Swedish Polar Research Secretariat (SPRS), and the Federal Institute for Geosciences and Natural Resources (BGR; Hannover, Germany).

What is the difference between drilling and coring?

Drilling is the process of making a hole in the seabed. Coring involves making a hole, but also recovering the central cylinder of sediment or rock, which is brought back to the drilling vessel's deck. This can then be examined and analysed by scientists.

How can I follow the operation?

Regular updates will be provided on the expedition website and social media channels.

Expedition website: *https://www.ecord.org/expedition377/*

Twitter - @ECORD_IODP (*https://twitter.com/ECORD_IODP*)

Facebook - ECORD IODP (*https://www.facebook.com/ECORD.ORG*)

Youtube - ECORD_IODP (*https://www.youtube.com/user/ECORDESO*)

Instagram: ECORD_IODP (*https://www.instagram.com/ecord_iodp/*)

Why was the expedition cancelled for 2018 and 2021, and why is it now going ahead in 2022?

ECORD initially attempted to schedule this expedition for 2018, with ESO initiating a tender exercise for a drillship and drilling services in June 2017. In parallel, ECORD had been making significant efforts to attract in-kind contributions from other interested agencies and national governments, which were essential for providing ice management services for the expedition. This strategy was adopted to keep the expedition's cost to ECORD as low as possible. Although the tender exercise identified an affordable drillship option, the strategy ultimately failed for the 2018 attempt because the anticipated in-kind contributions for ice management did not fully materialise, leaving a significant funding shortfall.

In November 2018, ECORD approved a new ArcOP budget and provisionally rescheduled the expedition for 2021. Throughout 2019, efforts to address the affordability of ArcOP continued through discussions with potential in-kind contribution partners, and through the proponents adjusting their proposed sites. In November 2019, ECORD confirmed the rescheduling of ArcOP for 2021, and ESO initiated a new tender exercise for a drillship, drilling services, ice breakers and ice management, which closed in May 2020. The returned bids significantly exceeded ECORD's expedition budget, and was halted. Under the open tendering route chosen, it was not possible to negotiate directly with suppliers to reduce costs, as a new tendering exercise with a revised budget and/or revised specification was required to avoid falling foul of EU tendering rules. ECORD subsequently de-scheduled ArcOP for 2021.

In response to an approach by SPRS, ECORD asked ESO and SPRS to explore alternative technical and legal approaches that may allow ArcOP to be scheduled for 2022. A new approach was adopted whereby SPRS took responsibility for procuring the ArcOP fleet through a "competitive dialogue procedure" rather than the open tender route that was used previously. A "competitive dialogue procedure" carries a higher risk of legal challenge, but if handled correctly it can be useful for building complex projects. This strategy was ultimately successful, and is allowing ArcOP to be implemented in 2022.

Science related questions

What are the research questions that the ArcOP Expedition aims to address?

- Did the Arctic Ocean climate follow the global climate evolution during its course from early Cenozoic Greenhouse to late Cenozoic Icehouse conditions?
- Are the Early Eocene Climate Optimum (poor recovery in the ACEX record) and the Oligocene and Mid-Miocene warmings also reflected in Arctic Ocean records?
- Did extensive glaciations (e.g., the OI-1 and Mi-1 glaciations) develop synchronously in both the Northern and Southern Hemispheres?
- What is the timing of repeated major (Plio-)Pleistocene Arctic glaciations as postulated from sediment echosounding and multi-channel seismic reflection profiling?
- What was the variability of sea-ice in terms of frequency, extent and magnitude?
- When and how did the change from a warm, fresh-water-influenced, biosilica-rich and poorly ventilated Eocene ocean to a cold, fossil-poor, and oxygenated Neogene ocean occur?
- How critical is the exchange of water masses between the Arctic Ocean and the Atlantic and Pacific for the long-term climate evolution as well as rapid climate change?
- What is the history of Siberian river discharge and how critical is it for sea-ice formation, water mass circulation and climate change?
- How did the Arctic Ocean evolve during the Pliocene warm period and subsequent cooling? How do the ArcOP records correlate with the terrestrial record from the Siberian Lake El'gygytgyn?

The five main scientific themes are:

- To investigate whether the Arctic climate transition from Greenhouse to Icehouse conditions followed the global climate evolution;
- Explore the exchange of bottom-water masses and the significance for long-term climate evolution;
- Explore the history of Siberian river discharge and its role in sea-ice formation, climate change and water mass circulation;
- Explore the "Hiatus Problem" – was there a major hiatus or did sedimentation rates become very low (below resolution);
- Explore how the Arctic Ocean evolved during the Pliocene warm period.

Environmental questions

Does drilling into the seabed affect the local marine environment?

It does, so it needs to be managed correctly and carried out responsibly. Drilling several hundred metres into the seabed requires the use of drilling mud, a fluid mixture used to aid the coring action, cool the drill bit, clear cuttings out of the borehole, and assist with borehole stability. Drilling mud has a wide variety of compositions, with each used for specific drilling scenarios. This expedition will use an environmentally-friendly, non-toxic biodegradable mud, which will be cycled through the borehole, and will be emitted from the top of the borehole and released into the water with sedimentary cuttings. The mud/cutting mixture has the potential to blanket the seafloor in the immediate vicinity (several metres) of the borehole, with finer cuttings dispersed into the water column, potentially disturbing the local environment. Although biodegradable, the mud may have a highly localised, short-lived (a few days) effect on marine wildlife which may be attracted to the mud mixture as a food source. The area of the seabed affected is very small in size (80m2) compared to the area of similar seabed habitat along the Lomonosov Ridge (100,000 km2), and the impact is time limited.

Additionally, all precautions are taken to ensure there is no discharge of materials of any kind from the platforms. The platforms will conform to all statutory regulations. No rubbish is discarded at sea, with everything being returned to land for appropriate disposal. Any spillages on deck (e.g. low volumes of various oils and hydraulic fluids) will be addressed with absorbent materials (e.g. granules, mats etc.) solely provided for purpose of dealing with spills before they flow over the side of the vessel. Spills are more likely to flow into the vessel's moonpool, in which case they are isolated from the surrounding sea surface and will be recovered using skimming equipment.

The expedition will take place in international waters, which are largely unregulated and therefore the expedition does not need specific permission or clearances (unlike Antarctica, which has the Antarctic Treaty). However, all ships will follow the guidelines and principles of the International Maritime Organization (IMO), including the IMO's Polar Code, in addition to their own safety and pollution prevention measures.

The sites are all approved by a panel of international experts that form the IODP Environmental Protection and Safety Panel. No seabed obstacles or buried geohazards are present at the drilling locations.

Do you carry out any activities that can affect the local wildlife?

See also question above, which is related.

Yes, our activities have the potential to affect the local wildlife, and so they need to be managed correctly and carried out responsibly. The physical presence of, and noise produced by, the expedition fleet may cause some time-limited disruption to wildlife. The expedition does not include any seismic operations, or any activity that emits high amplitude sound energy into the water column. The only sound sources of note will be the vessel engines, diesel generators and the sound of breaking ice. Additionally, if ice moves across the drill sites, the fleet will manage the ice by breaking up larger floes into smaller, more manageable chunks. The icebreaking activity to protect the drillship will impact a small and local amount of ice sheet habitat, potentially used by polar bears, seals, and sea birds.

As with all marine operations, wildlife will either move away if disturbed, or move closer if curious. Wildlife displaying curious behaviour that approach the vessels will not be able to interfere with, and will therefore not be at risk from, expedition equipment.

The estimated area of ice breakage for the duration of the expedition is 240 km2, 0.006 % of the total September 2019 sea ice extent of 4,000,000 km2, which will refreeze during the oncoming winter season. [Calculation assumes an ice drift speed of 0.3 kt (0.5 km/hr), an ice management zone 2 km wide, 20 days of ice management activity, and ice being present for 50% of the time].
Additionally, our expedition sites are located on the anticipated margin of the Arctic ice pack, where ice floes are naturally broken up and spaced out by wind and current action. It is also possible that there will be no ice at all to manage at our drill site.

Are you looking for oil or gas?

No, IODP is a scientific research program.
ArcOP objectives target answering climate-related questions under the IODP Science Plan, and its Theme of Climate and Ocean Change:

- How does Earth's climate system respond to elevated levels of atmospheric CO2?
- How do ice sheets and sea level respond to a warming climate?

ArcOP will bring continuation of the science coming from IODP Expedition 302: ACEX, which results, materials and cores are still in high demand for scientists even after 16 years since ACEX took place.

Read more about IODP Science Plan: *http://iodp.org/about-iodp/iodp-science-plan-2013-2023*



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More information

About the ArcOP Expedition
https://www.ecord.org/expedition377

About the research programme IODP
http://www.iodp.org

About the European part of the programme ECORD
https://www.ecord.org

About ECORD Science Operator (ESO)
https://www.ecord.org/about-ecord/management-structure/eso/

About the Swedish Polar Research Secretariat (SPRS)
https://polar.se

About Arctic Marine Solutions (AMS)
https://arcticmarinesolutions.se

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Photo: Helicopter view of three vessels during IODP Expedition 302: Arctic Coring Expedition (ACEX) in 2004. Credits: P. Frejvall, AMS