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THE GREAT CHALLENGES IN ARCTIC OCEAN PALEOCEANOGRAPHY AND SCIENTIFC DRILLING

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Despite the importance of the Arctic Ocean in the global climate/earth system, this region is one of the last major physiographic provinces on Earth where the short- and long-term geological history is still poorly known. This lack in knowledge is mainly due to the major technological/logistical problems in operating within the permanently ice-covered Arctic region which makes it difficult to retrieve long and undisturbed sediment cores. Prior to 2004, in the central Arctic Ocean piston and gravity coring was mainly restricted to obtaining near-surface sediments, i.e., only the upper 15 m could be sampled. Thus, all studies were restricted to the late Pliocene/Quaternary time interval, with a few exceptions. These include the four short cores obtained by gravity coring from drifting ice floes over the Alpha Ridge, where older pre-Neogene organic-carbon-rich muds and laminated biosiliceous oozes were sampled. These were the only samples recording the late Cretaceous/early Cenozoic climate history and depositional environment. Continuous central Arctic Ocean sedimentary records, allowing a development of chronologic sequences of climate and environmental change through Cenozoic times and a comparison with global climate records, however, were missing prior to the IODP Expedition 302 (Arctic Ocean Coring Expedition – ACEX), the first scientific drilling in the central Arctic Ocean. By studying the unique ACEX sequence, a large number of scientific discoveries that describe previously unknown Arctic paleoenvironments, were obtained during the last decade. Key results include: Subtropical warm conditions during the Paleocene-Eocene Themal Maximum (PETM) and the early-mid Eocene, an episodic freshening of Arctic surface waters in the Eocene, black shales and euxinic conditions in the Eocene Arctic Ocean, an early onset of Arctic sea ice in the middle Eocene, among many others (see Stein et al., 2014 for review and references). While these results from ACEX were unprecedented, key questions related to the climate history of the Arctic Ocean remain unanswered, in part because of poor core recovery, and in part because of the possible presence of a major mid-Cenozoic hiatus or interval of starved sedimentation within the ACEX record. Furthermore, the ACEX sites remain the one and only drill holes in the entire central Arctic Ocean to date.

In order to fill this gap in knowledge, international, multidisciplinary expeditions and projects for scientific drilling/coring in the Arctic Ocean are needed. Key areas and approaches for drilling and recovering undisturbed and complete sedimentary sequences are depth transects across the major ocean ridge systems, i.e., the Lomonosov Ridge, the Alpha-Mendeleev Ridge, and the Chukchi Plateau/Northwind Ridge, as well as the major Arctic gateways towards the Atlantic and Pacific oceans. The new detailed climate records from the Arctic Ocean spanning time intervals from the (late Cretaceous/)Paleogene Greenhouse world to the Neogene-Quaternary Icehouse world will give new insights into our understanding of the Arctic Ocean within the global climate system and provide an opportunity to test the performance of climate models used to predict future climate change. With this, studying the Arctic Ocean is certainly one of the major challenges in climate research for the coming years.

Reference:
Stein, R. , Weller, P. , Backman, J. , Brinkhuis, H., Moran, K. , Pälike, H., 2014. Cenozoic Arctic Ocean Climate History: Some highlights from the IODP Arctic Coring Expedition (ACEX). In: Stein, R., Blackman, D. Inagaki, F., and Larsen, H.-C. (Eds.), Earth and Life Processes Discovered from Subseafloor Environment - A Decade of Science Achieved by the Integrated Ocean Drilling Program (IODP), Series Developments in Marine Geology, Vol. 7, Elsevier Amsterdam/New York, in press.