Expedition Co-chief Scientists

Professor Brandon Dugan



Brandon Dugan is a geoscientist who couples theory, experiments, and models to understand the interactions of fluids and solids in Earth's shallow crust. Brandon's research group uses this approach to study freshwater resources, natural hazards, and biochar-soil interactions. Brandon regularly participates in geophysical and geological field programs (13 total projects, five as Co-chief Scientist). His research and teaching contributions have led to Brandon being the AGU/JpGU Asahiko Taira International Scientific Ocean Drilling Research Prize recipient (2018), a Blue Key Honor Society/ Tau Beta Pi Outstanding Faculty Award winner (2017), and an Ocean Leadership Distinguished Lecturer (2022-2023). As an Earth science community member, Brandon was a member of the Environmental Protection and Safety Panel of the IODP and is an associate editor for AGU's Journal of Geophysical Research – Solid Earth.

Professor Karen Johannesson



Karen Johannesson is Professor of Geochemistry at the School for the Environment and director of the Environmental Analytical Core Facility at University of Massachusetts, Boston. She received her PhD in Hydrology and Hydrogeology at University of Nevada. Her research focuses on the chemical speciation and biogeochemical cycling of trace elements in the environment and has published over 125 peer-reviewed papers and 11 peer-reviewed book chapters. She was awarded the Clair C. Patterson Medal of the Geochemical Society in recognition of her commitment in environmental geochemistry issues related to the aqueous geochemistry of lanthanide series elements. Professor Johannesson is a fellow of the Geochemical Society, the European Association of Geochemistry, the International Society of GeoChemistry, and the Geological Society of America. She is currently Co-Editor-in-Chief of Chemical Geology.

Expedition Operator

This Mission specific platform (MSP) expedition is conducted for IODP³ by the European Consortium for Ocean Research Drilling (ECORD), which represents the ocean drilling community of 14 European countries and Canada. Operations are undertaken by the ECORD Science Operator, comprising the British Geological Survey, the University of Bremen, and the European Petrophysics Consortium, made up of the universities of Leicester (UK) and Montpellier (France).

ECORD Science Operator

During the expedition, regular updates will be posted on the webpage, through blogs and via social media:

http://www.ecord.org/expedition501

International Ocean Drilling Programme (IODP³)

The International Ocean Drilling Programme (IODP³) is an international marine research collaboration that explores Earth's history and dynamics using ocean-going research platforms to recover data recorded in seafloor sediments and rocks and to monitor subseafloor environments. IODP³ depends on facilities funded by two platform providers with financial contributions from additional partner agencies.

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INTERNATIONAL OCEAN DRILLING PROGRAMME

New England Shelf Hydrogeology

IODP³-NSF Expedition 501



Exploring coastal hydrological systems of freshwater

ECORD European Consortium for Ocean Research Drilling

www.iodp3.org
www.ecord.org

Coastal hydrological systems provide significant freshwater to coastal communities around the world, and the offshore component of these systems is poorly understood. While volumetrically significant, onshore-offshore freshened water is also susceptible to contamination due to rising sea level. To date, we know very little about the dynamics of these shoreline-crossing groundwater systems and the age of the water in these systems, and even less about their influence on cycling of nutrients and rare earth elements.

The northeast coast of the United States is perhaps the best understood example of an offshore freshwater system, and multiple studies have been undertaken to determine the origin and volume of offshore freshwater. Coring and sampling the subseafloor offshore Massachusetts, USA, will provide data for understanding the processes driving emplacement of freshwater lenses offshore New England and elsewhere globally, and lead to a better understanding of this worldwide hydrogeological phenomenon. This is essential for protection and sustainable management of offshore freshwater systems and for better understanding biogeochemical and elemental cycling in continental shelf environments.

Dedicated drilling, coring, and laboratory analyses focused on the New England shelf onshore-offshore hydrogeological system are required to fully understand emplacement processes and dynamics. We plan a three site transect to depths less than 550 meters below seafloor along the US Atlantic continental shelf south of Massachusetts, USA, to address the following key scientific questions:

1. What is the distribution of freshwater, fluid pressures, and temperatures across the New England Atlantic continental shelf?
2. How old is the groundwater, and when was it emplaced?
3. Was freshwater recharged by basal melting of ice sheets, infiltration from proglacial lakes, and/or direct recharge from precipitation?
4. Do fluid pressures reflect equilibrium conditions or are overpressuring mechanisms involved?
5. What are the current concentrations, production/consumption rates, and cycling of methane, nutrients, and rare Earth elements in shelf sediments?
6. What are the rates of decomposition of sedimentary organic matter and which redox processes/microbial communities are involved?
7. What are the magnitudes of long-term fluxes of methane and nutrients from the shelf due to periodic flushing during the Pleistocene?
8. Does the emplacement of ice sheet meltwaters in confined aquifers create a unique environment for methane?
9. What is the sea-level history along this glaciated margin?

The offshore project phase will last approximately 90 days and will include coring and in situ sampling of sub-seafloor sediments and fluids from a specialized plattform. An international team of scientists, led by the Co-chief Scientists Brandon Dugan and Karen Johannesson, will participate, and operations will be implemented by the European Consortium for Ocean Research Drilling (ECORD) and the National Science Fourndation (NSF) as part of the International Ocean Drilling Programme IODP³.

Due to the limited facilities likely available offshore, only a minimum number of measurements will be made on the vessel. For this reason, not all Expediton 501 Scientists will participate offshore. Post-expedition, the entire team will meet for an onshore phase held at the Bremen Core Repository and MARUM laboratories in Germany, planned for early 2026. Here, the core will be split into working and archive halves. The working half will be described, analysed and sampled by the Expedition Science Team. The archive half of the core will be archived at the Bremen Core Repository for future research needs by the global scientific community.

The initial results from the expedition will be published in peer-reviewed journals, the IODP³ Proceedings, and in the ICDP-IODP³ Programme Journal Scientific Drilling. One year from the end of onshore operations, the cores and all shipboard data acquired during the IODP³-NSF Expedition 501 become available for use by any scientific researcher who wishes to study them.

Background image: Cape Cod, Nantucket and Marthas Vineyard Islands, view from Space. Credits: NASA, Wikimedia Commons.