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IODP drilling and core storage facilities

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As the knowledge obtainable from ocean drilling is various and extensive, its end-users are similarly various and extensive. Scientific ocean drilling in its various forms has drilled thousands of continuously cored drill holes in all the world's oceans, and all the cores are available to scientists everywhere. It has helped prove the theory of plate tectonics and it is the key information source for past changes in global oceanography and climate. It is also a major information source for the processes that control oceanic volcanism and seabed mineralisation. It addresses the formation of continental margins, oceanic plateaus and island arcs. Ocean drilling works uniquely in investigating subduction zones that generate earthquakes and tsunamis. For example, after the enormous 2011 Japanese earthquake and tsunami, the IODP vessel *Chikyu* drilled through and instrumented the generative fault, and was able to show that nearly all stress had dissipated and that another such earthquake from that fault was unlikely for many years.

Many ocean drilling expeditions have drilled deep stratigraphic core holes in sedimentary basins on continental margins for primarily scientific reasons, but the results are widely used by petroleum exploration companies and government agencies interested in the petroleum potential of these basins. The ages and nature of the sediments, the wide set of physical and chemical data, and the industry-style wireline logs provided by IODP are part of a petroleum explorer's tools of trade.

IODP drilling facilities

IODP uses various drilling platforms to access different subseafloor environments during research expeditions (see Figure 4.1 below). Three science operators in the US, Japan and Europe manage these platforms. The main aim of these platforms is to take continuous sediment or rock cores down to varying depths below the sea floor, plus geophysical measurements *in situ* and in the recovered cores. Ancillary information comes from installing strings of observatory equipment at varying depths below the sea floor to measure, for example, the physical characteristics of the sediments or rocks and the stresses working on them, seismic activity, and the chemical composition of the pore water. A huge amount of information can be obtained from the recovered sediments, rocks and microbiological samples, and from the observatory equipment.

The US provides the *JOIDES Resolution* as IODP's workhorse, and it uses riser-less drilling technology with seawater as the primary drilling fluid, which is pumped down through the drill pipe. The seawater cleans and cools the drill bit and lifts cuttings out of the hole, leaving them in a pile around the hole. The vessel can drill in water depths of 70 to 6,000 m, and generally drills holes to less than 1,000 m below the sea floor. If it is simply drilling sediments and relatively soft sedimentary rock, it can recover 5,000 m or more of core during a two-month expedition. If it is drilling hard igneous or metamorphic rocks then that figure is greatly reduced.

Japan provides the larger and much more complex *Chikyu* to drill deeper than the *JOIDES Resolution*, often in areas where over-pressured oil or gas might be encountered. It has a marine riser system to maintain the pressure balance within the borehole, which includes an outer casing that surrounds the drill pipe to provide return-circulation of dense drilling fluid. A blowout preventer on the sea floor protects the drill works from uncontrolled pressure release. This technology is necessary for drilling several thousands of metres into the Earth.

Europe provides alternative platforms for areas that are not suitable for the other two vessels. Such areas include the Arctic and Antarctic where icebergs and floating ice require specialist vessels, and shallow water regions (e.g. among coral reefs). Such drilling has used a fleet of icebreakers including an ice-breaking drill ship, or a relatively small commercial vessel with a wireline rig, or a jackup rig, or a conventional oceanographic vessel and a seabed drill, depending on the task at hand.

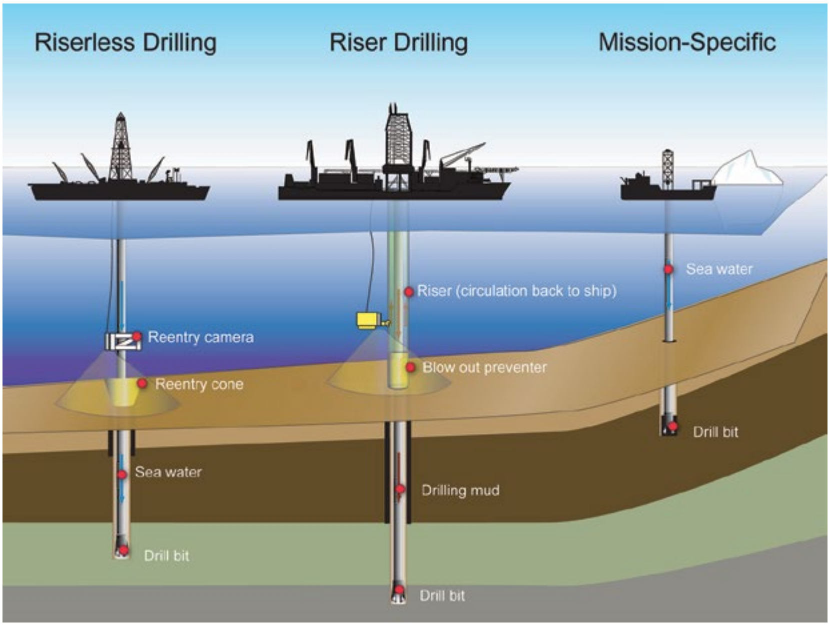

Figure 4.1. IODP vessels and their varied capabilities

JOIDES Resolution carries out standard riserless drilling, *Chikyu* can drill much deeper and uses a marine riser to help control rising fluids, and the Europeans provide a variety of vessels for non-standard activities.

Source: US Science Support Program

All ocean drilling cores (DSDP, ODP and IODP) are kept in cool conditions (4°C) in three repositories: one in the US, one in Germany, and one in Japan (www.iodp.org/resources/core-repositories). Most cores from our region are stored in Japan. A total of about 400 km of drill core, the result of 45 years of ocean drilling, are stored in these repositories, along with biological samples stored in a freezer at –20°C or in liquid nitrogen (–196°C). Members of the science party for each expedition have sole access to material for a one-year moratorium period after they obtain their samples. Once the moratorium for each expedition is over, access to core and other relevant material is provided to any bona fide scientist on the basis of a high-quality research proposal and the agreement to publish the results, assuming the proposed work does not directly clash with science party activities. People can either visit the repository to examine and/or select material, or order material on the basis of online reports and images. A curatorial advisory board makes final decisions regarding distribution of all samples.

The core repositories are:

- the Bremen Core Repository (BCR) located at MARUM at the University of Bremen, Germany
- the Gulf Coast Repository (GCR) located at Texas A&M University in College Station, Texas
- the Kochi Core Center (KCC) located at Kochi University in Kochi, Japan.

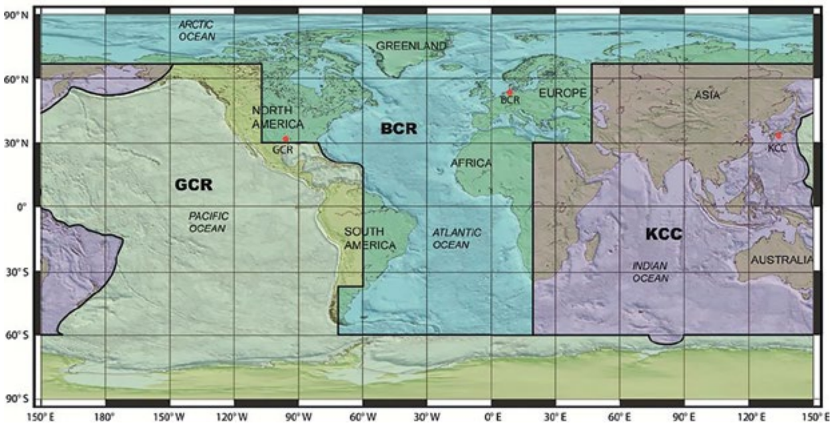

Figure 4.2. Map showing areas of responsibility for IODP core repositories

Cores are distributed largely by geographic area as shown in this map: BCR = Bremen; GCR = Gulf Coast; KCC = Kochi.

Source: Ursula Röhl, adapted from Firth, J.V., Gupta, L.P. and Röhl, U. (2009) New focus on the Tales of the Earth – Legacy Cores Redistribution Project Completed. *Scientific Drilling* 7. 31–33. doi.org/10.2204/iodp.sd.7.03.2009. [Map: 15 March, 2016]. Retrieved from marum.de/en/Cores_at_BCR.html

The BCR stores cores from the Atlantic Ocean, the Mediterranean and Black seas, and the Arctic Ocean. In 2015, the repository contained about 154 km of deep-sea cores from 87 expeditions, in about 250,000 boxes, which are sampled and analysed by national and international working groups. Around 200 scientists visit the repository annually, sometimes working on the cores in weeks-long sampling meetings. As many as 50,000 samples per year are taken by guests and by the repository staff. The repository is an important contact point for scientists from all over the world (there were more than 4,000 visitors by early 2015) and therefore significantly contributes to the exchange and transfer of marine science knowledge, leading to many international cooperations and scientific interactions.

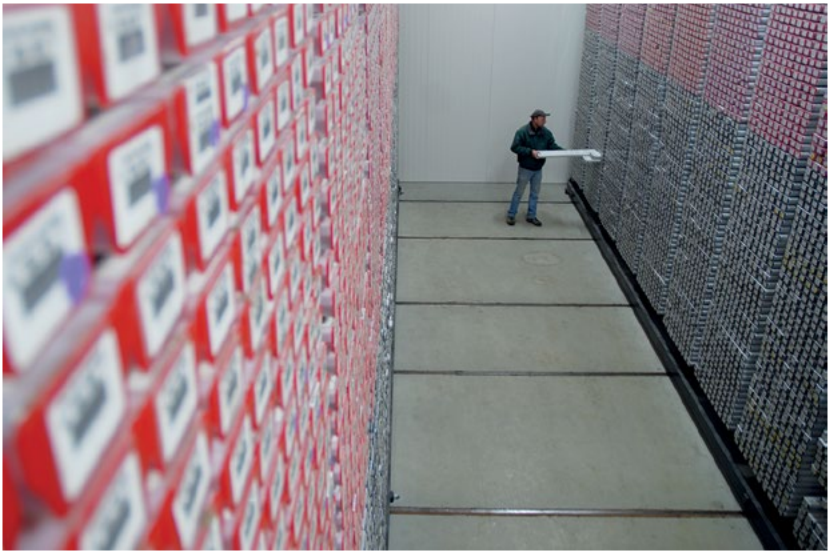

Figure 4.3. Part of the Bremen Core Repository illustrating the enormous size of these facilities

Source: MARUM, University of Bremen, Germany

Figure 4.4. Young geologist sampling at Gulf Coast Repository

Source: Courtesy of *JOIDES Resolution* Science Operator

The GCR is located on the Texas A&M University campus in College Station, Texas. This repository stores cores from the Pacific Ocean, the Caribbean Sea and Gulf of Mexico, and the Southern Ocean. A satellite repository at Rutgers University houses New Jersey/Delaware land cores 150X and 174AX. By early 2015, the GCR housed over 132 km of core in approximately 15,000 square feet of refrigerated space. In addition, the GCR stores thin section, smear slide, and residue collections, all of which are available to scientists for study.

The KCC stores cores from the Indian Ocean and the western Pacific Ocean. Cores are stored in three large reefers. These reefers are fitted with mobile core racks in order to enhance their storage capacity. Each core rack has mesh-like structures to facilitate storage of core sections in D-tubes. In early 2015, the core racks allowed storage of about 155,000 D-tubes, which provides sufficient space for storage of about 117 km of core. There is a large freezer to store biological samples at –20°C and a special facility to store samples in liquid nitrogen. Besides these, there are air-conditioned reefer containers that are used for storage of salt cores, core catcher samples and residues at room temperature and low humidity conditions. The facility was expanded in 2015.

Figure 4.5. Kochi Core Center

Source: Japan Agency for Marine-Earth Science and Technology (JAMSTEC)

This text is taken from *Exploring the Earth under the Sea: Australian and New Zealand achievements in the first phase of IODP Scientific Ocean Drilling*, edited by Neville Exon, published 2017 by ANU Press, The Australian National University, Canberra, Australia.