# IODP Operations Review Task Force Meeting

Expedition 308
Gulf of Mexico Hydrogeology

May 18th-19th, 2006
Washington, D.C.

# EXPEDITION 308 OPERATIONS REVIEW TASK FORCE PARTICIPANTS

| | |
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## Observers

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## INTRODUCTION

### Meeting Format

The IODP-MI Operations Review Task Force met on May 18th -19th at the IODP Management International office in Washington D.C. to review the operational aspects of IODP Expedition 308 (Gulf of Mexico Hydrogeology). The review concentrated on "lessons learned" from the expedition with an emphasis on "what should be done differently in the future." The committee review was based upon confidential reports submitted by the US Implementing Organization (USIO) and the Expedition 308 Co-chief scientists.

The meeting began with oral presentations by Peter Flemings and Cedric John summarizing the Co-Chief Scientist and USIO reports, respectively. Following these oral presentations, the Review Task Force identified specific pre-expedition, expedition, and post-expedition topics for discussion. The Review Task Force spent the remainder of the first day of the meeting discussing the issues and developing specific recommendations for the USIO. On the second day of the meeting, the committee reviewed the recommendations and came to a consensus on each one. These recommendations are presented in this report.

### Expedition Summary

Expedition 308, May 30th – July 8th, 2005 Mobile, AL – Porto Cristobal, Panama
*Co-Chief Scientists: Peter Flemings, Jan Behrmann*
*Staff Scientist: Cedric John*
*USIO Operations Superintendent: Ron Grout*

Integrated Ocean Drilling Program Expedition 308 was the first part of a two component program dedicated to the study of overpressure and fluid flow on the Gulf of Mexico continental slope. Expedition 308 examined how sedimentation, overpressure, flow, and deformation are coupled in passive margin settings. The goal of the expedition was to test a multi-dimensional flow model by studying how physical properties, pressure, temperature, and pore fluid composition vary within low permeability mudstones that overlie a permeable and overpressured aquifer. Expedition 308 drilled, logged and made in situ measurements in a reference location where little overpressure was deemed to be present: the Brazos Trinity IV Basin. These measurements were then contrasted with similar measurements performed in a region of very rapid Pleistocene sedimentation where overpressure is known to be present: the Ursa region of the northern Gulf of Mexico. Two key components of the experimental plan were to take substantial whole core geotechnical samples for later shore-based analysis and to deploy the T2P probe (developed jointly between MIT, Penn State, and IODP) to measure *in situ* pressure.

Expedition 308 met many of the science objectives proposed in the original IODP Proposal 589-Full3 and will provide the foundation to implement long-term *in situ* monitoring experiments in the aquifer and bounding mudstones in a future expedition to meet the full objectives of IODP Proposal 589-Full3. The Preliminary Report, which contains details of expedition scientific and operational achievements is available at http://iodp.tamu.edu/publications/PR/308PR/308PR.html.

**RECOMMENDATIONS**

The Review Task Force identified several main areas of improvement for future operations including:

- Lead-time planning
- Staffing
- Equipment/Technical
- Operations
- Miscellaneous

Many of the issues discussed during this review are inter-related and, in some sense, the above divisions are artificial. However, they help in categorizing the issues and determining key problems to solve before the start of the next phase of IODP operations.

While the primary focus of this review was on USIO (JOI Alliance) operations during Expeditions 308, many recommendations in this report are equally valuable for other IODP operators, IODP management, and to the Science Advisory Structure. As such, some recommendations are also directed to these entities.

**A) Lead-Time and Planning Issues**

Numerous pre-cruise (lead-time) planning issues were raised during the meeting. The expedition was scheduled the fall of 2004 and sailed in June 2005. As a result of this compressed schedule there was less than optimal interaction between the Implementing Organization (IO) and proponents (and later between the co-chief scientists and the IODP-TAMU operations superintendent) with respect to developing the operational plans, budgets, etc.

The IODP management, operators, and advisory structure have been slowly moving towards a 24-month lead-time process for the scheduling of expedition operations in order to alleviate most of the lead-time issues that have plagued Phase 1 operations (June 2004-Dec 2005). Once fully implemented, this extended planning process should resolve many of the planning issues identified in the Expedition 308 review (and previous reviews). However, while the lead-time has been extended, the actual implementation process (i.e., pre-expedition meetings, timelines for deliverables, etc.) is less well-defined. Of particular importance is the not only ensuring proponent and co-chief scientist input into the development of drilling plans but ensuring this communication occurs at the optimal time(s) in the planning process. Towards this end, the Expedition 308 Operation Review Task Force members made several recommendations meant to assist this implementation process.

**Recommendation 308-01**
The Expedition 308 Operations Review Task Force recommends that IODP-MI and the IOs determine the optimal communication timeframe(s) for initial (and follow-up) proponent/IO interaction to assist the IOs in preparing initial drilling plans. The Review Task Force members suggest this initial interaction should occur immediately following the annual spring Science Planning Committee (SPC) meeting (March-June timeframe). Follow-up meeting(s) should occur as necessary after the annual summer Operations Task Force meeting (but before the SPC votes on final schedules in Aug).

**Recommendation 308-02**
The Expedition 308 Operations Review Task Force recommends that the USIO and the Operations Task Force begin to define the operational plans, issues, and timelines associated with the conducting the second portion of the Gulf of Mexico Hydrogeology proposal.

## B) Staffing

The Expedition 308 Review Task Force members discussed a number of issues related to staffing, including (but not limited to) ensuring staffing in critical specialty areas (e.g., mud engineers), having enough trained/dedicated technical staff for downhole tool operations, and pre-cruise training for scientists.

### Identification of Critical Personnel

A key component of Expedition 308 success was the decision to contract an experienced mud engineer to assist with the drilling program. On the other hand, only one logging scientist was available for an intensive logging program. These examples illustrate the need to properly identify critical staffing areas far enough in advance of the expedition to ensure staffing requirements are met. The earlier these needs are identified the more flexibility the IOs and Program Member Offices have in selecting the proper mix of scientific disciplines and expertise while maintaining a long-term national/consortia staffing balance.

**Recommendation 308-03**
To ensure proper staffing levels for an expedition, the Expedition 308 Operations Review Task Force recommends that a prime deliverable from the initial pre-expedition meeting be the identification of critical scientific disciplines and engineering/technical/specialty personnel (e.g., mud engineers).

### Technical Staff Expertise/Availability

The DVTPP tool was used quite extensively on Expedition 308. However, the DVTPP is a tool that requires significant maintenance during deployment, as well as trained people with clear job responsibilities for deploying the tool and processing and archiving the data. On Expedition 308, the technical support was uneven at best. The Task Force members recommended that on expeditions such as Expedition 308 where downhole tool operations and results are critical to the success of the expedition that the IOs must have properly *trained and dedicated* staff associated with the tools.

> **Recommendation 308-04**
> Expedition 308 Operations Review Task Force recommends that the USIO supply *dedicated and trained* staff with defined roles and responsibilities for maintenance and deployment of standard downhole tools (and associated data processing and archival) for expeditions where downhole tools are expected to be run.

**Communication of Roles and Responsibilities**
All shipboard personnel, whether with the IO or scientific staff, have defined roles and responsibilities aboard the vessels. However, the communication of these responsibilities to all participants on the expeditions is not handled evenly by all IOs. The Expedition 308 Review Task Force recommends that a more formal process of supplying this information (perhaps via avenues such as the prospectus, invitation letters, supplemental expedition material, etc.) needs to be implemented.

> **Recommendation 308-05**
> Expedition 308 Operations Review Task Force recommends that IODP-MI work the IOs to develop consistent methods of communicating the roles and responsibility of IO personnel and Scientific staff to all participants prior to the expedition.

**Pre-expedition Training of Scientists**
The Expedition 308 Co-chief scientists noted the lack of experience of scientific staff in some of the core disciplines. The Expedition Review Task Force participants discussed how expeditions are staffed and the issues the IOs face with respect to maintaining national balance while ensuring proper expertise in each laboratory. Pre-expedition training by the IOs was suggested as a mechanism to increase the level of expertise of scientific staff, especially as the USIO and CDEX will have extensive shore-based analytical capabilities in Phase 2 operations. This pre-expedition training, however, has funding and personnel ramifications for the Program Member Offices (which fund scientist travel) and the IOs (which must maintain the shore-based equipment and have technicians available for training scientists).

> **Recommendation 308-06**
> Expedition 308 Operations Review Task Force recommends that IODP-MI investigate the funding, staffing, and operational issues associated with pre-expedition training of scientific personnel and work with the IOs and Program Member Offices to provide pre-expedition training in critical core disciplines.

**C) Equipment / Technical issues**
The Expedition 308 Operations Review Task Force discussed numerous analytical and drilling equipment related issues, including specific downhole tools (e.g., DVTPP and T2P), Rig Instrumentation Systems (RIS), tool calibration, and geotechnical coring tools.

**SODV equipment considerations**
Some of the analytical and drilling equipment issues discussed during this review will be addressed as part of the USIO's SODV process. The Task Force recognized that the USIO was moving forward on these particular issues but wished to reinforce the process with several specific recommendations.

> **Recommendation 308-07**
> Expedition 308 Operations Review Task Force recommends that the USIO should replace the current pycnometers with a rapid, reliable, robust system for moisture and density measurements on the SODV.

> **Recommendation 308-08**
> Expedition 308 Operations Review Task Force recommends that on the SODV the USIO should provide a Rig Instrumentation System (with accurate depth/time base), associated database(s), and appropriate infrastructure to distribute the data to the scientific party on a timely basis.

> **Recommendation 308-09**
> Expedition 308 Operations Review Task Force recommends that the USIO should provide geotechnical testing capability on the SODV for expeditions requiring these analyses to accomplish defined expedition scientific objectives. These capabilities should include, at a minimum, mini-vane shear and undrained, unconsolidated triaxial cell capabilities.

**Geotechnical coring tools**
The Review Task Force briefly discussed issues surrounding core deformation associated with 9.5-m cores (the standard in IODP-MI). Deformation found in APC/XCB cores, while normally not a problem for most scientific studies (e.g. paleoceanography), is very detrimental to geotechnical studies. Shorter cores obtained with thin-walled coring tools would generally provide less deformation. Several Task Force members also described specific (~1 m length) thin-walled coring tools routinely used by the geotechnical community that would minimize coring disturbance and that could be used by IODP in an 'off-the-shelf mode". One Task Force member (Ali Skinner) volunteered to supply IODP-MI with information on some of these geotechnical tools *(Note: This brief summary of several geotechnical coring tool options is attached as Appendix A to this report).*

**Recommendation 308-10**
The Expedition 308 Operations Review Task Force recommends IODP-MI to provide USIO with details regarding geotechnical coring tools that do not require modification for deployment from the SODV

**Colleted Delivery System**
The Colleted Delivery System (CDS) was used to deploy the DVTPP and T2P for all runs. However, a fundamental problem that plagued data acquisition and quality of these downhole tools was that the tools were not properly decoupled from the bit during deployment. In addition, the T2P probe was bent during some deployments, in part due to formation hardness but also due to the design of the flapper valve of the CDS (that tended to bend the tool during reentry). Future designs of the CDS should also address the issue of pushing/pulling tools with sensitive probes through a flapper valve in addition to properly decoupling the tools from the bit. The Review Task Force recognized the importance of addressing this issue for Phase 2 of IODP and recommended that IODP-MI determine the best way to address the issues surrounding the current CDS.

**Recommendation 308-11**
The Expedition 308 Operations Review Task Force recommends that the IODP-MI investigate (1) concepts to effectively decouple the drillstring from the DVTPP and T2P, and (2) the refurbishing of the existing CDS as possibilities toward making the CDS more efficient.

**DVTPP**
DVTPP and T2P probe deployments occurred a total of 45 times at four of the six Expedition 308 sites. The DVTPP probe was deployed a total of 20 times with only 9 deployments described as "good" or "fair", primarily because of a seawater leak in the tool. The T2P probe was deployed 25 times with only 14 deployments described as "good" or "fair". The Task Force realized that, in general, the maintenance and deployment of downhole tools on the riserless vessel need to be significantly improved and discussed a number of problem areas including, 1) tool calibration, 2) consistent maintenance and deployment of tools (addressed in **Recommendation 308-04),** 3) the lack of a systematic process to record and archive data, 4) specific problems with the DVTPP, and 5) the Colletted Delivery System **(see Recommendation 308-10**). Several additional recommendations were made regarding these tools, in particular the DVTPP.

**A) DVTPP Seawater Leaks**
The durability and usability of the DVTPP appears to be seriously compromised by a tendency to leak. A great deal of time and effort was spent on Expedition 308 diagnosing and attempting to repair the problem. The Task Force believes that the best path forward with respect to making the DVTPP a more robust tool is for the

USIO to first examine the tool in a comprehensive fashion to first determine the scale of the problem associated with the leak.

**Recommendation 308-12**
Expedition 308 Operations Review Task Force recommends that the USIO conduct a study to examine the scale of problem associated with leaks in the DVTPP and report the results of the study to Engineering Development Panel (EDP). Depending on the results of this study, EDP can make recommendations to the USIO and IODP-MI on how to proceed with a solution.

**B) DVTPP pore pressure data analysis**
During the discussion associated with the issues surrounding DVTPP use and deployment, several Task Force members commented that a major problem with the DVTPP is the lack of an analytical model to be used for interpreting the pressure data derived from the tool. With the geometry of the DVTPP, it is impractical to measure formation pressure by waiting for the long duration required for the tool insertion pressure to fully dissipate and an analytical model is required to extrapolate the measure data. Without this analytical model, it is difficult to properly analyze and interpret the data from the tool, even if it is functioning properly.

**Recommendation 308-13**
Expedition 308 Operations Review Task Force recommends that IODP-MI request the IODP Scientific Technology Panel (STP) to examine methodologies to model the DVTPP data in order to effectively use the tool in the future.

**C) Tool Calibration**
On Expedition 308, the DVTPP tools were not calibrated correctly for temperature. This is a longstanding issue, with problems reported on Leg 204 and Expedition 311. On Expedition 308, the two tools measured consistently different temperatures at equivalent depths in the same hole. The Task Force believes a more comprehensive process of shipboard and shore-based calibration of temperature and pressure is required.

**Recommendation 308-14**
Expedition 308 Operations Review Task Force recommends that the USIO investigate shore-based and shipboard pressure and temperature calibration facility/procedures as part of the SODV process.

**D) Operations**
The operational protocols developed for Expedition 308 provided a reasonable approach for delivering the science objectives of the expedition. The Review Task Force discussed aspects of the specific Expedition 308 operational protocols as well as the need for developing and archiving more generic sets of drilling and operational protocols from

expedition to expedition and from platform to platform (e.g., riser, riserless and MSP operations).

**Archiving Expedition 308 Operational Protocols**

The development and vetting of operational protocols for Expedition 308 greatly helped in achieving the scientific objectives while ensuring safety and operational efficiency. The protocols were the outcome of many lengthy discussions between the USIO personnel, EPSP members, Schlumberger, and proponents to define site locations, identify target depths, and outline operational procedures. The operational plan was fairly complex and included topics such as consistent terminology with industry standards, coring protocol for unconsolidated sand, geotechnical coring protocol, mud weights for drilling with mud at the Ursa Basin, pressure measurements, what to expect from MWD pressure logs, abandonment procedures, mud protocols, mud volumes, and usage of cement or heavy mud without fracturing the formation. Of concern to the Task Force is that these protocols, results, and suggested changes be properly archived. Proper archival of this information allows the operator, safety panels, and co-chief scientists to easily reference and learn from past experience and suggest further efficiencies based upon knowledge gained to date.

> **Recommendation 308-15**
> Expedition 308 Operations Review Task Force recommends that the USIO generate and archive a written report describing the Expedition 308 mud deployment program. The report should include operating protocols/guidelines, contingencies, changes to protocols (if any), and suggested future changes.

**Riserless Drilling and Mud deployment**

Expedition 308 was the first time in scientific ocean drilling where downhole pressure and lithology were monitored in real time, and it was the first time that weighted mud was used as a tool to drill through overpressured regimes. Expedition 308 demonstrated that drilling into overpressured formations with riserless technology can be managed using heavy mud. Fluid flow into the borehole can be controlled, and operations can be safely concluded without risk to the seafloor environment. The Review Task Force believes it is important to pursue this line of operations for future riserless operations and strongly encourages the USIO to build on the success of Expedition 308.

> **Recommendation 308-16**
> Expedition 308 Operations Review Task Force recommends that the USIO build on the experiences of Expedition 308 and actively explore future applications of drilling muds and polymers in riserless operations.

**General Operating Protocols**
Following on the discussion of specific operating protocols for Expedition 308 the Review Task Force could see significant benefits to IODP operations for developing, archiving, and distributing more generic sets of operating protocols for all IODP platforms. Many of these protocols are already developed and routinely used by each IO but are not compiled in a format (and location) that can be easily accessed by all operators and scientific staff. Utilizing laboratory information management systems (LIMS) like that proposed for the SODV to capture, update, archive, and distribute drilling and laboratory protocols would be a significant first step.

> **Recommendation 308-17**
> Expedition 308 Operations Review Task Force recommends that IODP-MI and the IOs examine and implement methods for routinely capturing updating, archiving, and distributing drilling and laboratory protocols.

**E) Miscellaneous**

**Press Releases**
The co-chief scientists and USIO noted that the process of generating and releasing a press release during Expedition 308 was not very effective. An initial press release was requested by IODP-MI and filed by the scientific staff prior to the point in the cruise when the most critical results were available. A second press release, generated by the co-chief scientists just after the expedition, apparently was not released by IODP-MI. Overall, the Expedition 308 science party and the USIO did not feel the process and goals for media interaction (press release, interviews, etc) were well-defined.

During Phase 1 of IODP operations, numerous media policy and implementation issues have arisen, such as the one described above for Expedition 308. As a result, an IODP-MI Media Task Force is being constituted to address these issues in a timely manner. The Expedition 308 Review Task Force members discussed numerous media issues with Nancy Light, IODP Director of Communications in an effort to understand the IODP media policy and made a recommendation to be forwarded to the IODP-MI Media Task Force Policy.

> **Recommendation 308-18**
> The Expedition 308 Review Task force recommends that a communications plan be generated as a deliverable from the pre-expedition planning meeting. This communication plan must clearly define and communicate the goals, processes, and roles and responsibilities for press releases, interviews, etc to each Expedition science party and the Implementing Organizations. The Review Task Force members suggests that IODP-MI (in conjunction with the IOs) produce communication kits that includes material such as answers to "Frequently Asked

Questions" regarding the expedition science, general information about IODP, etc.

**Preliminary Report Publication**

Preliminary Reports (PR) are citable documents and the Task Force heard about an outside scientist who wished to cite the document, add his own data to a PR figure containing a significant amount of lithostratigraphic and downhole logging data (including well logs) and then publish the new compilation and conclusions in the open literature before the end of the Expedition 308 moratorium. Although perfectly legitimate, the end result was that this violated the spirit of the data moratorium. This example illustrates a fundamental problem with the data policy and NSF/IO contractual obligation of publishing scientific results on the web within six weeks postcruise: IODP cannot prevent external scientists from using material readily published on the web, and if this material contains expedition specific data, it cannot protect the interests of the shipboard science party with regard to data moratorium.

The Task Force discussed the need to strike a balance between the level of science content in the Preliminary Report and the contractual obligation to publish the report. The group recommended a number of areas for the IODP-MI Publications Task Force to consider in formulating a solution to this problem.

**Recommendation 308-19**

The IODP-MI Publication Task Force should generate a consistent publications policy to address the competing demands of contractual obligation and the desire to publish highly integrated data sets in the expedition Preliminary Report. IODP-MI should request NSF to supply a clear set of metrics regarding content to fulfill contractual obligations with respect to the Preliminary Report. In addition, the IODP-MI Publications Task Force should investigate whether to return to a non-citable format for the Preliminary Report (or requesting formal written approval to re-use figures from the Preliminary Report).

# APPENDIX A

## **Adaptations of Geotechical Coring Tools to Interface with Scientific Coring**

## Adaptations of Geotechical Coring Tools to Interface with Scientific Coring

There are a variety of geotechnical sampling and coring tools available with which to carry out this work. All are designed to take short length (< 1 metre) quality cores at the required depth interval downhole. While these tools can be used exclusively during a geotechnical programme they have also been adapted to work with other percussive and rotary systems and in conjunction with wireline coring systems. In the latter application the normal coring inner barrel suite can be supplemented with these tools and a string trip avoided even though a variety of tool types are being used. An additional collection of push sampling tools with liners is also available, usually bespoke to a system and designed more for quality core collection by a push sample when rotary is not getting good samples.

### The Geotechnical Tools commonly used are:

Shelby tube – standard 2” and 3” with thin wall (~0.1”)
Split spoon sampler – collared barrel with cutting shoe, possibly catcher
Thick walled sampler – heavy duty tube basically ‘to see what’s there’
In-situ memory tools – temperature, pressure, CPT

The above is generic, and normally for geotechnical work they would be used in conjunction with a seabed template and a controlled push into the seabed by clamping the drillstring and stroking it or by clamping the drillstring and applying hydraulic pressure inside the string to progress the inner tube ahead of the main bit. In the Scientific Coring application the tools are progressed into the formation using the drillstring weight as a push force over a measured length after the inner barrel assembly has landed and locked into the outer barrel which is being held above hole bottom until the sampling tool is inserted.

### Interface to Scientific Coring Equipment

For the purposes of this review let us simply address fitting the geotechnical tools to the IODP XCB coring system. This outer barrel is compatible with both Push/Piston (APC) and Rotary (XCB) and thus is generally the main IODP choice for a wide range of scientific coring in soft and unconsolidated or semi-consolidated formations. The inner APC and XCB systems are wireline interchangeable within this same outer barrel. The critical diameter which all inner tools have to pass through is the landing ring between inner and outer barrel; as the inner core barrel is 3.5” diameter on the XCB, there is no problem with fitting any of the geotechnical tools up to the 3” size.

Note than on the existing XCB system there is a spring assembly in the head. This can be retained and in many cases is beneficial as it removes some movements due to insufficient heave compensation. However the length of compression needs to be taken into account when making up the adaptor. The spring unit can also be removed to allow full force application by insertion of another sub and this is commonly an option on other coring systems.

The XCB configuration as taken from the ODP/IODP Toolsheets is shown on page 3.

In order to fit the geotechnical tools to this XCB inner barrel system all that is required is the following:

1. Removal of XCB coring bit
2. Replacement of XCB coring bit with an adaptor head to accept the geotechnical tools and

have a ball valve assembly inside it to avoid core washing upon recovery.  The thread to connect this adaptor to the existing XCB corebarrel will be identical to the one on the existing XCB bits.  The adaptor OD will be similar to the XCB core tube OD.

a. For Shelby Tube Coring this adaptor has a shouldered seating with ‘O’ ring to seal the top of the Shelby Tube which is held on with three or four socket head screws specially arranged to remain in when the barrel is removed.  Standard Shelby tubes are either 2” (51mm) or 3” (76mm) core diameter and 1/8” wall thickness.  There is no liner and the core is extruded with appropriate Hydraulic Ram and metal pushers into a tray for immediate geotechnical testing or for foil/ cling film and wax sealing for onshore laboratory testing.  See diagram for BGS adaptor on page 4.

b. The split spoon sampler is generally used for less cohesive materials and may have a screw-on head for fitting to the adaptor and a basket type stainless steel catcher at the base for sample retention.  When the sample is recovered the core tube is opened into two halves by removing the top and bottom collars and examining the sample inside.  This is not a thinwall sampler and is used when considerable force is required to penetrate the formation e.g. when trying to obtain a sand or gravel sample.

c. The thickwall sampler is really one to use when all else has failed and you still cannot get a sample of what is down there.  Frequently it is tapered on the OD. It is also used as a percussive tool on the wireline to obtain a sample or clear a blocked bit!  A good tool to have, but the samples are not good for geotechnical testing in the main.

d. A range of push samples with liners and core retention catchers are also available, usually bespoke.  The adaptor which is generally a screw-in variety is shown on page 4 and the  illustration on Page 5 shows a push sampler used by BGS.  It is used by BGS in a number of seabed and downhole wireline applications and lengths up to 6m have been used although a push of 1 or 2m is more acceptable downhole.  This gives a quality sample between piston coring and Shelby tube sampling, but that quality is further influenced by formation type and core length attempted.

e. Finally a different adaptor can be fitted to the same XCB bit connection to allow a variety of memory probes to be used downhole.  Temperature is a routine one, pressure could be done.  Cone Penetration Testing (CPT) has now become more sophisticated but used to be done in this way and good readings can still be obtained using it.  If the CPT principles and construction is utilized the shapes and sizes of probes and their characteristic properties within various formations are well-known.

XCB

# Extended Core Barrel

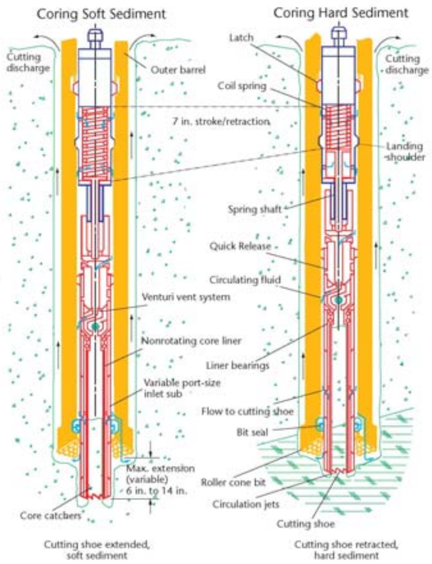
OCEAN DRILLING PROGRAM
www.oceandrilling.org

## Scientific Application

The Extended Core Barrel (XCB) coring system is used in sedimentological, climate, and paleoceanographic studies.

## XCB Operations

The XCB is used to recover 9.5 m long core samples from soft to moderately hard formations. The XCB is typically deployed when the formation becomes too stiff to piston core (i.e., upon piston coring "refusal") or when it is not hard enough to permit efficient recovery with the Rotary Core Barrel (RCB). The XCB cutting shoe extends ahead of the main bit in soft sediments but retracts into the main bit as the weight on bit increases when firm lithologies are encountered. The XCB uses the same bottom-hole assembly (BHA) as the Advanced Piston Corer (APC). The XCB relies on rotation of the drill string to advance the hole, and an integral cutting shoe trims the core sample at the same time.




**Schematic of the XCB retractable cutting shoe in standard coring mode. The XCB shoe extends 6 to 14 in. ahead of the bit in very soft formations and retracts ~7 in. (inside the main bit) as weight on bit exceeds about 12,000 lb (collapses a coil spring).**

## Design Features

**1) Cutting Shoe Trims Core**

The XCB uses an integral cutting shoe to trim the core. The shoe is positioned ahead of the main core bit, which reduces core "washing" (i.e., core damage caused by water

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jets from the shoe nozzles contacting water sensitive formations).

*Benefit:* Improves core recovery and reduces core disturbance in soft to moderately hard formations.

**2) Retractable Cutting Shoe**

A unique retraction device allows the XCB, which is normally extended ahead of the core bit, to retract inside the BHA until the cutting shoe is flush with the core bit.

*Benefit:* Cutting shoe is retracted to reduce failures when hard formations are encountered.

**3) Nonrotating Core Liner**

An inner core barrel swivel allows the core to remain stationary relative to the formation as the bit rotates, thereby reducing the transfer of rotary torque to weakly laminated formations.

*Benefit:* Reduces "discing," which is a type of core disturbance caused by transferring rotary torque to the core.

**4) Compatibility**

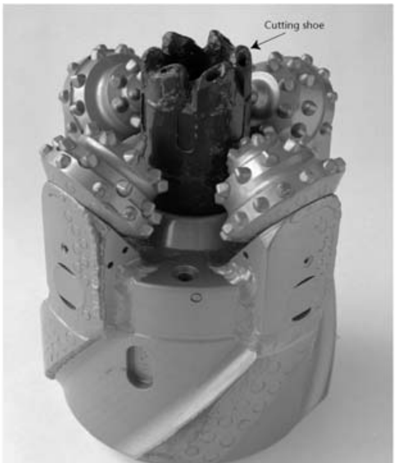
Utilizes the same BHA as the APC coring system.

*Benefit:* The APC and XCB core assemblies can be run in the same assembly, avoiding non-coring time for pipe trips.

## Cutting Shoe Options

**Soft Formations**
Steel "sawtooth" serrated cutting profile hard-faced with tungsten carbide grit.

**Hard Formations**
Polycrystalline diamond compact (PDC), diamond impregnated, surface-set diamond, and thermally stable artificial diamond.




**An $11^7/_{16}$ in. APC/XCB bit and soft formation XCB cutting shoe.**

## XCB Specifications

**Core Diameter**
2.312 in. (60 mm)

**Maximum Core Length**
9.5 m

**Cutting Shoe Extension**
7 in. beyond bit (maxium)

## Typical Operating Range

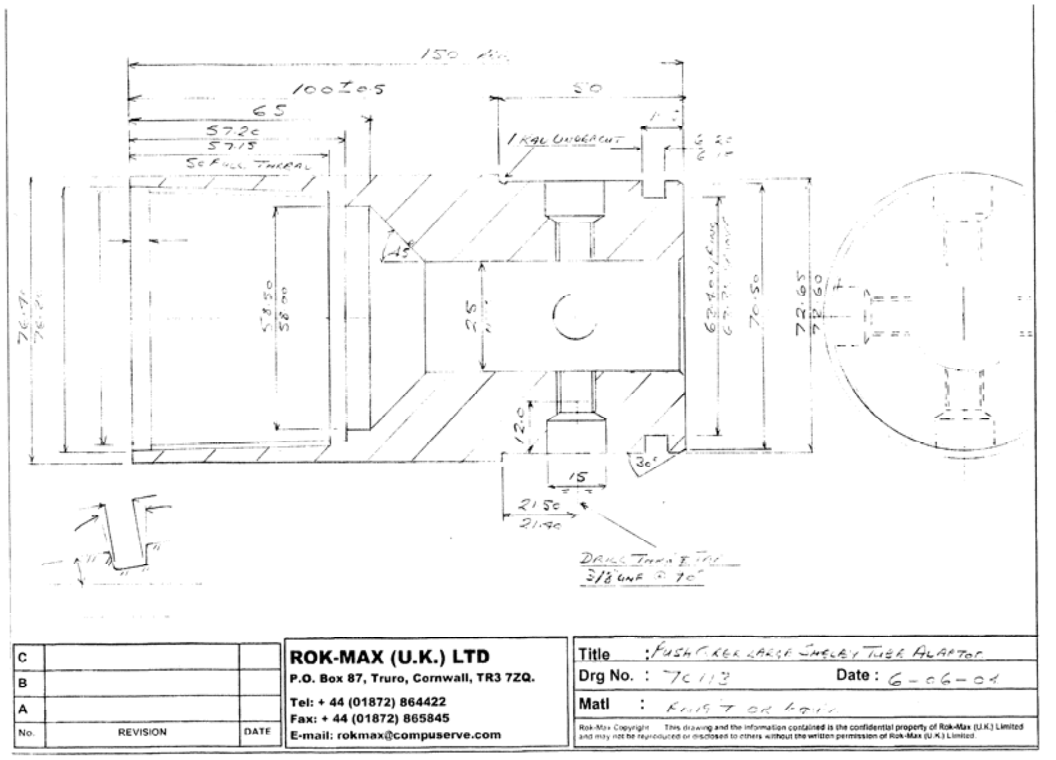
**Formation**
Soft to medium firm sediments

**Depth Range**
Typically from APC refusal to ~400 to 700 m below seafloor (mbsf) in sediments and can core top of igneous basement (destroys shoe).

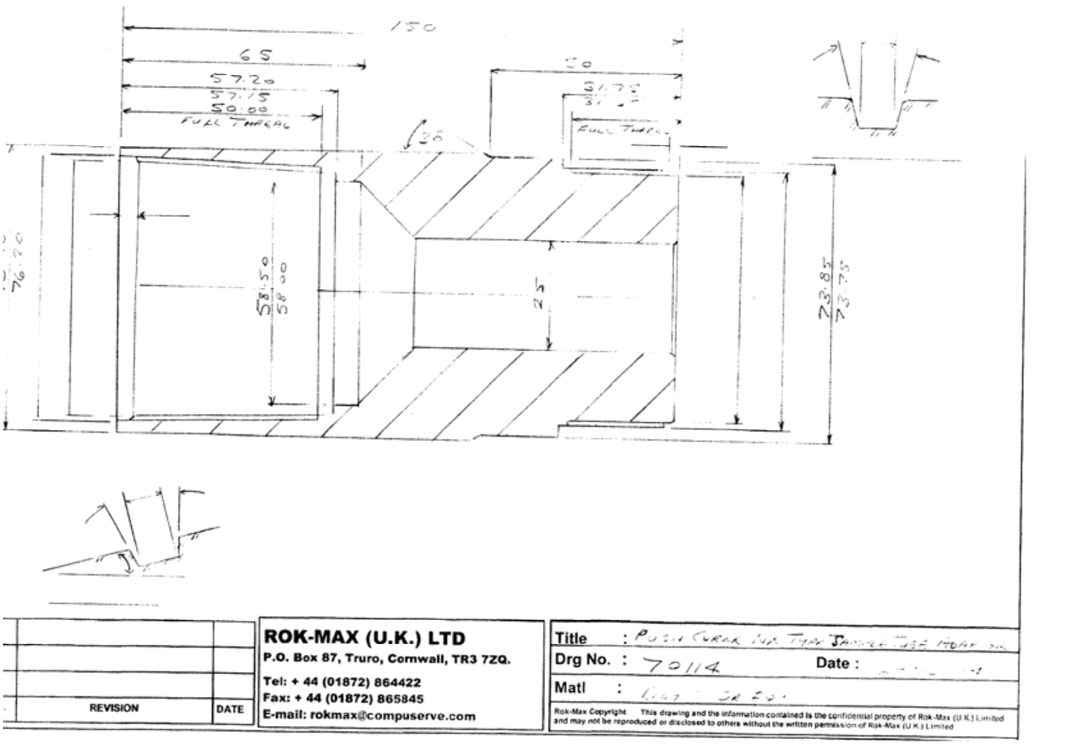
**Rate of Penetration**
Typically 30 to 12 m/hr.

## Limitations

Does not recover ooze or very soft sediments, granular formations (such as sand), fractured rock or rubble, or hard igneous formations.




**Shelby Tube  Adaptor as fitted to BGS ECB Marine Wireline Coring System ( 3” variety shown.)**




**Push Sampler Adaptor as fitted to BGS ECB Marine Wireline Coring System**

**Example of a Push Sample Assembly**

As fitted to BGS ECB Marine Wireline Corebarrel and various seabed and land coring tools. The tubes can be up to 3m long depending on the formation and danger of bending during push.  The barrels are made from mining drill rod steel, the catchers and cutting shoes are custom made.

**Concluding Remarks**

The above is not an exhaustive list of what is available to the scientific coring community.  I hope it gives an insight into what can be achieved with minor incremental effort by way of collecting specific quality cores for geotechnical purposes and as a way of emplacing memory probes at the base of the hole while conducting general scientific coring operations.  Variations of the tools described are available from any reputable drillers shelf, worldwide.