# **IODP Operations Review Task Force Meeting**

Expedition 335 Superfast Spreading Rate Crust 4

March 7<sup>th</sup> – 8<sup>th</sup>, 2011 Consortium for Ocean Leadership Washington DC, USA

### **EXPEDITION 335 OPERATIONS REVIEW TASK FORCE (ORTF)**

### PARTICIPANTS

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#### **MEETING FORMAT**

The IODP-MI Operations Review Task Force (ORTF) met on March 7<sup>th</sup> - 8<sup>th</sup> at the Consortium for Ocean Leadership (COL), Washington DC, to review operational aspects of Integrated Ocean Drilling Program (IODP) Expedition 335 Superfast Spreading Rate Crust 4. The review concentrated on "lessons learned" from the expedition with an emphasis on "what should be done differently in the future". The ORTF review was based upon confidential reports submitted by the U.S. Implementing Organization (USIO) and the Expedition 335 Co-Chief Scientists, as well as the expedition daily and weekly reports available on-line.

The meeting began with oral presentations by the Co-Chief Scientists (Damon Teagle, Benoît Ildefonse) and the Expedition Project Manager (EPM: Peter Blum), that summarized the Co-Chief Scientists' and USIO reports, respectively. The Co-Chief Scientists also presented their Co-chiefs' joint recommendations. Following the presentations, the external reviewers and IODP-MI personnel had an Executive Session to identify important issues related to this expedition and to formulate draft recommendations. On the second day of the meeting, the ORTF reviewed the draft recommendations from the Executive Session and finalized them. These recommendations are presented in this report.

#### **EXPEDITION SUMMARY**

Expedition 335: April 13<sup>th</sup> – June 3<sup>rd</sup>, 2011 Co-Chief Scientists: Damon Teagle, Benoît Ildefonse Expedition Project Managers: Peter Blum USIO Operations Superintendent (OSI): Ronald Grout

The Integrated Ocean Drilling Program (IODP) Expedition 335 was based on the IODP drilling proposal 522Full5 Superfast 4, and was officially scheduled on 25 January 2010 based on advice from IODP Science Advisory Structure (SAS). Expedition 335 was implemented to deepen ODP Hole 1256D a few hundred meters into the cumulate gabbros of the lower crust to test theoretical models of accretion of new crust at midocean ridges.

ODP Hole 1256D was drilled through the 250m thick sediment layer and ~500m into the upper crust lavas, and cased to ~269m, during ODP Leg 206 (2002). The hole was deepened 500m through lavas and into the sheeted dike complex during IODP Expedition 309 (2005) and deepened an additional ~250m during Expedition 312 (2005). The lowermost ~100m drilled during the Expedition 312 penetrated into a complex dike–gabbro transition zone. At the end of Expedition 312, Hole 1256D had a total depth of 1507.1mbsf.

The main objective of drilling into the lower crust and recovering samples of cumulate gabbro was not achieved during Expedition 335. Hole 1256D was only deepened ~14.5m to a total depth of 1521.6mbsf. About 2m of core were recovered from this interval. However, two scientific achievements are noteworthy. First, Expedition 335 had shipped

all core sections from the gabbro interval drilled during the Expedition 312 to the *JOIDES Resolution*, and the Expedition 335 scientists spent considerably more time describing those sections than was available to the Expedition 312 scientists. A coordinated sampling party was conducted at the end of the cruise to complement existing studies of those materials with new shore-based investigations. Second, hole cleaning operations using junk baskets returned a large number of rock samples. These samples consisted primarily of completely recrystallized granoblastic basalt with minor gabbroic and evolved plutonic rocks. Their size and quantity make them a unique sampling of the thermal boundary layer in the ocean crust; they reveal the intimate coupling between temporally and spatially intercalated intrusive, hydrothermal, contactmetamorphic, partial melting, and retrogressive processes. Shipboard scientists were enthusiastic about this bounty and committed to a significant post-cruise research program on both these new rocks as well as those recovered during previous expeditions.

See <u>http://iodp.tamu.edu/scienceops/expeditions/superfast\_rate\_crust.html</u> for more details regarding the background and objectives, the preliminary scientific results, and conclusions of the Expedition 335.

#### **RECOMMENDATIONS OF THE EXPEDITION 335 ORTF**

The Expedition 335 ORTF found that this expedition was one of the most difficult and technically challenging expeditions mounted by the USIO during IODP. Operational difficulties in Hole 1256D during Expedition 335 precluded progress towards the scientific objectives, and the hole was only deepened <15m. Hole 1256D now has a total depth of 1521.6mbsf. Scientists have yet to achieve the scientific objectives of the Proposal 522-Fu115 to recover samples of cumulate gabbros at the Hole 1256D. However, in a difficult context, all working teams on Expedition 335 performed remarkably well. The drilling crew of the *JOIDES Resolution* and the USIO staff did a truly exemplary job of opening, stabilizing and cleaning Hole 1256D, through a careful and prudent course of actions.

The ORTF also identified several areas for future *JOIDES Resolution* operational improvement, particularly pre-expedition planning/preparation and during-expedition operations. Specifically, the ORTF recognized that issues related to deep drilling operation in the fractured, hard formation zone of Hole 1256D were more problematic than those identified by the USIO during its operation planning. This is because the limited knowledge of Hole 1256D conditions by the USIO, a difficulty that is inherent to deep drilling in the ocean crust given the limited experience accumulated so far in very deep holes. The USIO needs a strategic planning approach for future deepening the Hole 1256D with better contingency planning to face any event, and a wide range of hard formation drilling equipment to deal with difficult conditions.

The Expedition 335 ORTF has formulated 10 recommendations and one acknowledgement. Although the primary focus of this review was on the USIO operations during the Expedition 335, many recommendations in this report are equally valuable for other IODP operators, the Science Advisory Structure (SAS), the IODP

management, IODP scientists, and some of our recommendations are also directed to those groups.

## **Recommendation 335-01: Strategic Planning Approach for Future Drilling of the Hole 1256D**

The ORTF suggests that downhole hardware best suited for drilling, reaming, hole opening and coring should be selected through the process of a formal engineering assessment using, where possible, hard rock drilling specialists from both inside and outside normal IODP domains. This assessment could be organized and directed either by IODP engineers, or by contracted outside consultants. Based on the results of that assessment, *JOIDES Resolution* should be equipped with a comprehensive inventory of hole cleaning, reaming, and drilling hardware, all selected for robust, difficult drilling conditions. However, adequate time, funding and strategic commitment is required. As a first step, the agency or agencies responsible for implementation of this plan must be determined by SIPCOM.

A similar set of recommendations also applies to improvements in tools and techniques for fishing, casing or liners, remedial cementing, and most effective use of mud.

If possible, the IODP-MI should share with the IOs any valuable outcome of an ongoing 2012 engineering assessment aimed at addressing similar drilling and coring issues for BEAM (Borehole into Earth's Mantle).

All of the above must include appropriate definition of required lead times and overall funding requirements and sources, and, of course, must be tempered with awareness of present day fiscal realities for IODP and the NSF.

#### Routing: USIO, IODP-MI, SIPCOM

Background: Drilling in Hole 1256D, IODP Expedition 335 encountered a significant thickness (>10x m) of extremely hard contact metamorphosed granoblastic basalts, and coring these rocks resulted in the absolute destruction of a C-9 RCB coring. This C-9 bit was ground to a smooth featureless stump after a maximum of only 15 hours coring/rotation. The external reviewers and Co-Chiefs pointed that if the hole was not completely clear of all junk or cavings from the hard / ultra-hard formation, a C-9 bit would have been rapidly damaged.

The Expedition 309/312 ORTF in 2006 discussed and recommended the investigation of finding ultra-hard formation drilling and coring bits but no progress has been made for the Expedition 335 planning.

The ORTF agreed with the request from Expedition 335 Co-Chiefs that future drilling operation in Hole 1256D must be prepared to battle hard/ultra-hard formations, including hard/ultra-hard formation high quality industrial tri-cone bits for hole opening, cleaning/reaming as well as a complete set of hard formation mills and junk baskets. Also the ORTF agreed with the importance of consulting with an experienced/recommended drilling engineer to evaluate the best coring plan, including the procurement (or even design and manufacture) of ultra-hard formation drill/coring bits, fishing tools and its operations, cementing strategies and casing strategies.

# Recommendation 335-02: Appropriate Personnel Involvement on Expedition Planning

The ORTF recommends that the USIO should involve appropriate personnel in preexpedition planning, especially to attend Expedition planning meetings. (Examples of such personnel might include previous Co-chief scientists, senior proponents and the *JOIDES Resolution*'s rig floor expertise.)

#### Routing: USIO

Background: During Expedition 335, Co-chiefs built an effective relationship with the drilling crew of the *JOIDES Resolution* and the USIO staff, and there was open and productive exchange of information. Also at the end of the Expedition 335 operations, the Co-chiefs organized a formal meeting (attended by Co-chiefs, past Co-chiefs and proponents, EPM, OS, OIM, Core Techs, Tool Pushers, and Driller) for an effective debrief and discussion of issues encountered during the expedition. A wide range of future operation options (casing, cementing, tools, coring, drilling bits, time on site) at the Hole 1256D was discussed, and a series of recommendations was made.

The ORTF agreed that it is very effective to have involvement of experts during the operation planning phase when specific operational difficulties may be anticipated, and different rig floor teams are used to deepen multi-expedition holes. This kind of approach should have been undertaken during the operations planning of Expedition 335.

#### **Recommendation 335-03: Post-Operation Onboard Meeting**

The ORTF considers the type of Post-Operation Onboard Meeting that the Expedition 335 had at the end of expedition has real merit and is an effective and efficient mechanism to reflect upon operational challenges during drilling expeditions. Although similar onboard meetings have taken place on some cruises (other USIO/*JOIDES Resolution* expeditions), POOMs should become standard practice and be formal, mandatory and have minutes recorded.

#### Routing: USIO

Background: The USIO is now holding the Post-Operation Onboard Meeting at the end of most expeditions, either during the return transit or after arrival in port (with attendees listed in Recommendation 335-02). The ORTF recognized that this meeting is very effective to review the operation and identify the issues while the issues on the expedition are still fresh in mind. Similar Post-Operation Onboard meetings have been held on other Expedition, but minutes have not been systematically recorded.

#### **Recommendation 335-04: Ship Schedule Flexibility**

The ORTF suggests that when clear progress is being made on a particularly difficult site near the end of expedition, serious consideration should be given to ship schedule flexibility whenever possible, including time extensions (especially where possible in conjunction with ship tie-up schedules, thereby avoiding schedule conflict with next expeditions science party and operation crew). Routing: USIO, LAs

Background: The Expedition 335 had assigned 45 operation days, which was eventually not enough to achieve its scientific goal, because most of the scheduled time was spent on the remediation of Hole 1256D. Unfortunately, Expedition 335 had to leave Site 1256 only a few hours after coring resumed.

This problem of ship schedule flexibility was already identified in the Expedition 309/312 ORTF meeting in 2006 (Recommendation 309/312-03). However, there was no progress made on this area in the IODP. The external reviewers understand that difficult target with deep drilling expedition such as the Expedition 335 might needs mechanisms for allowing more flexibility, and revising expedition schedules so that drilling can continue in deep boreholes when progress is actually being made. This may require the movement of crew, scientists and supplies to and from the rig so that drilling and hole cleaning can continue, and the temporary postponement of the immediately following expeditions.

The ORTF understands that making the ship schedule more flexible is financially difficult in the current IODP system. However, a flexible ship schedule has considerable advantages over a rigid ship schedule, for achieving some long-standing, technically challenging scientific objectives.

#### **Recommendation 335-05: Rubber Coated Centralizer Blades**

ORTF recommends to modify the rubber coated bowsprings of the logging tool centralizers so that the tool can exit the BHA into the borehole for the *JOIDES Resolution* logging operations.

#### Routing: USIO

Background: Logging operations at Expedition 335 had some difficulty and several bowsprings on the centralizer damaged during the operation. The triple combo tool which was first deployed successfully reached the bottom of Hole 1256D but tool returned with three damaged bowsprings on the upper centralizer and had to replace them. Then FMS-sonic logging tool was deployed as second logging run but was unable to exit the BHA into the borehole because of some mechanical obstruction at the bit. Once the tool returned to the surface, again they found one damaged bowspring on centralizer but this time was in lower centralizer section. USIO tried third run after replacing the damaged bowspring but was also unable to exit the BHA.

The external reviewers pointed out that the problem of this type of centralizer blades causing tools to jam in the bit throat or while passing through a float valve is not new. Past practice to solve the problem was to cut off all rubber before running any logging tool with that type of coating on the stabilizers regardless of logging engineer preferences.

### **Recommendation 335-06: Hydrodynamic Characteristics and Flow Control Planning of the Hole 1256D**

The ORTF recommends that hydrodynamic characteristics of Hole 1256D (and other problematic holes with potential scientific value by deepening) should be analyzed by a qualified drilling engineer / well planner using existing well caliper logs and downhole surveys. This should lead to recommendations for best drilling and coring procedures, predict pressure drops to be expected, and provide an estimation of how much deeper such holes can be drilled within the limits of available hydraulic horsepower on the *JOIDES Resolution*.

The USIO should re-examine the use of the quad-casing potential (include using short liner(s) and/or expandable casing) for remedial flow control of problem areas in Hole 1256D.

#### Routing: USIO

Background: The Expedition 335 found that Hole 1256D has very complex hydrodynamic characteristics because of several wide diameter sections of the hole (rat hole, washed out section). These sections greatly reduced pumping efficiencies for hole cleaning even when the *JOIDES Resolution* uses high viscosity muds.

A typical example section is located below the 16" casing section. Hole 1256D was equipped with 16" casing down to 269mbsf during the ODP Leg 206. The casing extends ~19m into basement. Below this casing section, there is a ~7m long ~23" diameter rat hole (down to 276 mbsf).

The ORTF recognized that the 23" rat hole below the 16" casing, and washed out section greatly reduced pumping efficiencies when deepening and cleaning the hole.

10-3/4" casing set in 16" casing to the bottom of the 23" rat hole, or setting short liner or expandable casing to cover existing open-hole section would improve the hydrodynamics of Hole 1256D and enable more efficient flow controlling and hole clearing

#### **Recommendation 335-07: Coring Approaches in Hole 1256D**

For deepening Hole 1256D, the ORTF recommends consideration of applying spot coring approaches or non-standard coring (conventional/non-wireline and/or thin kerf) techniques at some diameter slightly larger than 9-7/8" to penetrate the final section of the dike/gabbro transition zone, to reach underlying consistent gabbros where continuous coring could resume.

#### Routing: USIO, Superfast Scientists

Background: The Expedition 335 operation results showed that future deepening and coring operation in the dike/gabbro transition zone in Hole 1256D is feasible but remains challenging. The external reviewers advised that the USIO and the Hole 1256D Co-Chiefs should concentrate on deepening the hole to reach the scientific target depth by industrial type conventional drilling with a full-face bit (e.g. using a 9-7/8-inch tri-cone bit and adequate drill collars to present appropriate weight on bit for the specific type of bit selected). The external reviewers pointed out that using such techniques will preclude continuous coring in the difficult interval. After deepening the hole and reaching the main

scientific target, coring could resume with less operation difficulty.

Also one of external reviewer introduced that conventional/industry hard rock coring system would be an option to take cores from the dike/gabbro transition zone. This system has typically 15-30 feet long non wireline type core barrels and takes a large diameter core which is captured in a core barrel above the bit, but only removed when the entire drill string and BHA are recovered on deck. This type of system was already used in IODP on Expedition 331 by *CHIKYU*.

#### **Recommendation 335-08: Hole Cleaning**

The ORTF recommends continuing the practice of verifying and/or creating clean hole conditions on any return to Hole 1256D through a pre-planned and rigorous hole cleaning program before attempting to advance the hole with normal drill or core bits. Any debris or borehole obstructions that could damage the bits should be removed first by using appropriate tools which cause less damage to borehole wall than reverse circulation junk basket (RCJB).

#### Routing: USIO

Background: Exceedingly hard formation (granoblastic basalts) at the bottom of the hole caused the C-9 hard formation coring bit failure during Expedition 335. The USIO had to conduct number of fishing/milling operation (19 days, 13 reentries) to fish/mill junk of the destroyed C-9 bit from the bottom of hole, and to ream/clean the hole. The ORTF agreed that the USIO must ensure that the hole is completely clean of debris before attempting to deepen Hole 1256D in future.

The ORTF meeting for the Expedition 309/312 in 2006 also made similar recommendation to the USIO, to explore future applications of riserless hole cleaning and stabilization (Recommendation 309/312-12). Unfortunately there has been modest progress on these recommendations in the five years since the last ORTF.

#### **Recommendation 335-09: State of the Proposal 522-Full5**

As the Proposal 522-Full5 has already been strongly endorsed in the SAS proposal evaluation process and is now residing at the OTF, the ORTF recommends (1) that the status of the Proposal 522-Full5 be formally changed to a Multi-phase Drilling Project (MDP) without requiring new SAS review, and (2) that the appropriate IO/OTF operational planning process as outlined in the proceedings of Expedition 335 and in the ORTF recommendations be started as soon as possible.

#### Routing: SIPCOM

Background: While reviewing Expedition 335 during the ORTF meeting, the external reviewers recognized that the stated objectives of Proposal 522-Full5 and its most recent Addendum 5 submitted in July 2011 would best be achieved by a MDP drilling strategy. The external reviewers and the IODP-MI commented that, if the proposal science targets are not going to change, the SIPCOM should agree to change the Proposal 522-Full5 status to MDP without requiring new MDP proposal submission from the proponents.

#### **Recommendation 335-10: Expedition Operation Report**

The ORTF recommends that the operations reports generated during IODP expeditions be circulated in a timely manner to Co-chiefs. These reports may include the operations report written by the operations superintendent, operations information spreadsheets, core tech sheets, and any special reporting data specific to a given leg. This has happened for several expeditions already, but it could be done more consistently.

#### Routing: USIO

Background: On every USIO expedition, operation teams of the *JOIDES Resolution* archive all kind of operational related activity log into the Expedition Operation Report. However this report is an internal report in the USIO, and is not often circulated outside include Co-Chiefs. The ORTF found that operational information on this report might be highly efficient to Co-Chiefs for understanding current operational situation, and give them some answers to their questions regarding future operations.

#### Acknowledgement 335-01: Pre-planning Communication

The ORTF acknowledges that the simplified planning structure being put in place for the "new IODP" should minimize the unfortunate pre-planning communication issues highlighted by IODP Expedition 335 Co-Chiefs.

#### Routing: IODP-MI, IOs, LAs

Background: The IODP-MI held the ORTF meeting for the previous Superfast expeditions Expedition 309/312 in 2006 with the Co-Chiefs and the USIO. A wide range of issues were discussed and several recommendations were made for future Superfast expeditions. The outcomes and recommendations of that ORTF meeting were combined into a meeting report by IODP-MI and distributed to LAs, IOs, related SAS chairs and posted on IODP website. Following the Expedition 309/312 ORTF meeting, some progress on the issues and recommendations areas discussed was made by the USIO internally during planning phase of the Expedition 335. However, the Expedition 335 ORTF understands that progress was limited and not sufficient to achieve the objectives of Expedition 335. The ORTF recognized the importance of ensuring the communication and digestion of the ORTF reports among SAS, LAs, IOs, and IODP-MI. IODP-MI should follow the status of each ORTF recommendation and any actions taken by the organizations/groups to which ORTF reports are sent.