Draft Minutes

Fifth Meeting of the Engineering Development Panel (EDP) of the IODP

July 9-11, 2007

Tokyo, Japan

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IODP Engineering Development Panel
5th Meeting, 9-11 July 2007
Tokyo, Japan

Members and Guests

Engineering Development Panel – EDP Members

Alberty, Mark	USA	albertymw@bp.com	not attending
Ask, Daniel/Maria	ECORD	Maria.Ask@ltu.se	attending
Flemings, Peter*	USA	flemings@geosc.psu.edu	attending
Fukuhara, Masafumi	Japan	fukuhara1@slb.com	attending
Germaine, Jack	USA	jgermain@mit.edu	not attending
Holloway, Leon	USA	G.Leon.Holloway@conocophillips.com	attending
Miyairi, Makoto	Japan	makoto.miyairi@japex.co.jp	attending
Nakata, Haruya	Japan	nakata@gerd.co.jp	attending
Person, Roland	ECORD	Roland.person@ifremer.fr	attending
Sears, Stephen	USA	sosears@lsu.edu	attending
Suzuki, Hideyuki	Japan	suzukih@naoe.t.u-tokyo.ac.jp	not attending
Takemura, Mitsugu	Japan	mitsugu.takemura@japex.co.jp	attending
Tamura, Mitsuo	Japan	mtamura@jodco.co.jp	attending
Tezuka, Kazuhiko	Japan	kazuhiko.tezuka@japex.co.jp	attending
Thorogood, John L.	ECORD	John.Thorogood@uk.bp.com	attending
Ussler, Bill	USA	methane@mbari.org	attending
Von Herzen, Richard	USA	rvonh@whoi.edu	attending
Watanabe, Yoshiyasu	Japan	ywata@scc.u-tokai.ac.jp	alternate for Suzuki, Hideyuki
Wohlgemuth, Lothar	ECORD	wohlgem@gfz-potsdam.de	not attending
Ye, Ying	China	gsyeying@zju.edu.cn	attending

Guests, Liasons, and Observers

Asanuma, Hiroshi	Japan	asanuma@ni2.kankyo.tohoku.ac.jp	observer
Becker, Keir	SPC	kbecker@rsmas.miami.edu	attending
Eguchi, Nobuhisa	IODP-MI	science@iodp-mi-sapporo.org	attending
Grigar, Kevin	USIO	grigar@iodp.tamu.edu	attending
Higuchi, Kazutaka	CDEX		only first day
Ito, Hisao	CDEX	hisaoito@jamstec.go.jp	attending
Janecek, Tom	IODP-MI	tjanecek@iodp.org	attending
Katou, Kazumasa	CDEX		attending
Kinoshita, Masataka	JAMSTEC		attending

Kyo, Masanori	CDEX	kyom@jamstec.go.jp	attending
Meissner, Eric	USIO	meissner@ldeo.columbia.edu	attending
Miyazaki, Eigo	CDEX		attending
Myers, Gregory J.	IODP-MI	GMyers@iodp.org	attending
Nanba, Yasuhiro	CDEX		attending
Okada, Makoto	STP	okada@mx.ibaraki.ac.jp	attending
Oskvig, Kelly	IODP-MI	koskvig@iodp.org	attending
Ozaki, Masahiko	CDEX		attending
Totani, Yoko	MEXT		only first day
Wada, Kazuyasu	CDEX		attending
Umezu, Keita	AESTO		Host
Masuda, Yui	AESTO		Host

IODP Engineering Development Panel
5th Meeting, 9-11 July 2007
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EXECUTIVE SUMMARY

Overview

EDP Meeting #5 was held in Tokyo, Japan. It was hosted by JAPEX Petroleum and AESTO in JAPEX's offices adjacent to Tokyo Station. It was a superbly organized meeting and we thank the hosts.

During EDP Meeting #5, we completed our two primary goals. First, we revised the EDP Technology Roadmap and second we reviewed four IODP Technology Development Proposals. It was exciting for EDP members to see progress being made toward achieving important technology development for the IODP. EDP and IODP-MI now have a process in place to inspire and nurture technology development to better achieve the science goals of the IODP.

EDP Recommendations, Consensus Statements and Action Items

The EDP forwards the following recommendations, consensus statements, and action items to the SPC or the IODP-MI as appropriate.

EDP Consensus 0707-01: Approval of Agenda
The EDP approves the agenda for EDP Meeting #5.

EDP Consensus 0707-02: Approval of EDP Meeting #4 Minutes
The EDP approves the minutes from EDP Meeting #4.

EDP Consensus 0707-03: EDP SSEPS Liaison
One important way that EDP can learn of engineering development needs is through interaction at the SSEP meetings. In addition, EDP can provide to SSEP important insight regarding the state of engineering development and current engineering capabilities in the IOPD. EDP requests SPC modify EDP's Terms of Reference as follows:

Current wording: "The EDP chair shall be liaison to the SPC, with vice-chair as alternate. The SPC chair shall be a liaison to the EDP, with the SPC vice-chair as alternate. A science coordinator from the IODP-MI Sapporo Office shall attend each EDP meeting. Representatives from the IOs shall also be invited to attend the meetings."

Revised wording: "The EDP chair shall be liaison to the SPC, with vice-chair as alternate. The SPC chair shall be a liaison to the EDP, with the SPC vice-chair as alternate. A representative from IODP-MI shall attend each EDP meeting. Representatives from the IOs shall also be invited to attend the meetings. EDP will send a liaison to SSEP meetings.

EDP Consensus 0707-04: High Priority Engineering Developments
EDP, in closed session, discussed and debated the merits of each of the Engineering development items in the Roadmap. The EDP has formulated a list of about 10 unranked items in each of the three sub-groups (1) Sampling, Logging, Coring; 2) Drilling, Vessel Infrastructure, 3) Borehole Infrastructure) that are of high priority (Table 1.0, below). ***No effort*** has been made to establish relative priorities between sub-groups. EDP will continue to discuss the relative merit of every item in the Roadmap and it is expected that priorities will evolve over time.

Table 1.0: Unranked list of engineering developments that were deemed 'higher priority' by EDP at its July 2007 panel meeting. Refer to Technology Roadmap 2.0 for details of each engineering development. (will be replaced with top 11 from A, top 10 from B and top 10 from C.

A1) Thin Walled Geotechnical Sampler	B3) Heave Compensation	C1) High temperature electronics, sensors, and sensor systems
A2) Cone Penetrometer/Remote Vane	B5) Seabed Frame	C4) Hydrologic Isolation
A4) Hard rock re-entry system (HRRS)	B8) Improved Automatic Driller	C5) Realiable wellhead hanger seals
A11) Rotary sidewall coring	B9) Drilling Parameter Acquisition while coring	C6) Electric, optical fiber and fluid feed-throughs at wellheads and in subsurface casing completions
A12) Provide core orientation on standard coring tools - Structural Orientation of Hard Rock Cores	B10) Real Time Drilling Paramater Acquisition while coring	C9) Physical coupling of acoustic instruments to formations and decoupling from noise sources
A13) Seabed coring devices	B14) Electric/Optical Wireline	C14) Systems reliablity for LTMS
A16) Pressure coring systems (PTCS, PCS, FPC, HRC, etc.)	B19) Protocol for Proper Mud Design	C15) ROV-serviceable wellheads and submarine cable connections
A17) Pressurized Sample Transfer (autoclave)	B21) 4000 m class riser system	C17) Design standards for electrical, communications, mechanical, and fluid systems
A21) Anti-contamination system (gell core barrel)	B22) 4000 m class BOP	C18) Deployment procedures/soft-landing for borehole infrastructure and instruments
A23) Fluid samplers, temperature, and pressure measurement tools	B27) Drill pipe for ultra deep ocean drilling	C19) Managing borehole experiments
A24) Transition corers		

EDP Consensus 0707-05: EDP Technology Roadmap 2.0
EDP Technology Roadmap 2.0 will be recorded as an appendix to the EDP Meeting Minutes (Appendix # 15). This document is released as a public document. It is a second draft and it is a work in progress. EDP will continue to refine the EDP Technology Roadmap in future EDP meetings.

EDP Consensus 0707-06: IODP-MI Coring Study
EDP Supports the IODP-MI proposed coring study.

EDP Consensus 0707-07: Scoping Studies
EDP recognizes that there are many entries in the technology roadmap that address related technology challenges (Table 2). EDP recommends that IODP-MI carry out ‘analysis of options’ studies to prioritize alternative approaches. In future meetings EDP will recommend specific studies.

EDP Consensus 0707-08: Location/Time EDP Meeting #6
EDP proposes EDP Meeting #6 be held in France (Paris and Nice have been proposed as possible locations) from January 9-11, 2008 (Wednesday-Friday). The meeting will be hosted by Roland Person. EDP proposes EDP Meeting #7 be held in the United States July 14-16, 2008 (Monday-Wednesday). Washington D.C. and Monterey have been proposed as possible locations.

IODP Engineering Development Panel
5th Meeting, 9-11 July 2007
Tokyo, Japan

MINUTES

Monday, July 9, 2007

In these minutes, the Recommendations, Consensus Statements, and Action Items are not repeated in detail. Please refer to the Executive Summary for the full text of each, as indicated.

The meeting started with an introduction and review of Robert's Rules.

Agendum Item 1: Approve Agenda (by Flemings)
Consensus approval of agenda with no comments or alterations. (Appendix #1)

Agendum Item 2: Approve EDP Meeting #4 Minutes
Consensus approval of minutes from EDP Meeting Number 4.

Agendum Item 3: Quorum Discussion
Quorum for voting members is eleven. Sixteen members were present. No attendees were planning to leave before 3pm on Wednesday, so a quorum should be maintained.

Agendum Item 4: Next Meeting and Time: preliminary discussion
Meeting No 6 in Europe. Monday 14-16th January. Roland Person proposes a meeting in Paris either Total office, Ifremer Research HQ or else Nice. Possible clash with SASEC meeting.

Meeting No 7 in USA 16-18th June suggested, some concerns. 23rd – 25th June suggested as alternative. Monterey Bay or Washington possible locations, but there may be issues with hotel costs in California. This could clash with some Japanese stock-holder meeting. Probably reconsider for July 2008 instead.

Agendum Item 5: Summary of EDP Meeting #4 (Flemings)
The consensus items from the 4th meeting were reviewed with some items discussed as a reminder to existing and briefing for new members. The roadmap will be released after this meeting as a public document.

There was discussion over the disappointment on lack of ROV on the new SODV. This is a problem of needing external funding due to internal funding constraints. It can be done with minor modifications, either installed on the vessel or else a separate ROV vessel. The installation would require removal of pipe normally stored on the SODV decks reduced from 7-8000m to 4-5000m WD.

The meeting endorsed the EDP technology development process. Highlighted a request for tools unique to weighted mud operations and also overpressure prediction and detection. The meeting supported the CDEX monitoring program proposal. Reviewed the history and future plans for the DSS project and vendor selection and its relationship with the pulsed telemetry module. The lack of information on the ESO down pipe camera was noted.

Agendum Item 6: SPC Report (Becker/Flemings) (Appendix #4)

This reports on two Science Advisory Structure Executive Committee (SASEC) meetings. Major issues have arisen over budget shortfalls. There have been three meetings of the operations task force (OTF) and two major schedule adjustments. A lot of activities have happened since the January 2007 EDP meeting.

Keir reviewed the summary FY07-09 schedule as of August 2006. During January the budget was reduced and SODV start date postponed to Jan 2008. SPC approved minor changes to Chikyu. The SODV schedule revised in March was reviewed with a couple of the key high-cost operations being dropped. This appeared to be the best compromise of science objectives against budget.

At the June meeting, a combined Japanese fishing ban on NTS operations and shipyard slippage led to a re-alignment of the plan. There was also some swapping of riserless work from SODV to Chikyu. NTS riser work may be deferred and some additional work may be possible during the transit to the southern oceans. Some non-IODP operations might be inserted into the Chikyu program. Neither CDEX nor USIO have funds for full year operation of either vessel so there will be a period with segments of non-IODP funded operations of the vessels: industry, non-IODP countries. The USIO and NSF are looking at the practicalities of how non-IODP entities will access and use the vessel. Quite a lot of administrative hurdles have to be overcome. Future budgets may limit to eight months for simple expeditions or six months of costly ones.

Then, more recently the vessel for the NJ sea level MSP has been slipped into mid-2008 and the Gt Barrier Reef MSP slipped into 2009. The gap between the two MSP operations is a simple matter of organizational capability.

SPC March meeting reviewed 18 proposals. 1 was for a riser, 3 were MSP, the remainder riserless. Three were excluded. Of the remaining 15, the top 9 rankings were quite close 5.59 to 7.29 with substantially overlapping standard deviations, reflecting significant differences of opinion. Due to the budget constraints, the first 9 were to be reviewed in August for developing into options for FY09 and beyond. The group 2 proposals (10-12) were to be re-ranked if not scheduled in FY 09/10.

The SPC view of the June meeting would be to farm the vessel out to create savings for more complex operations in FY10. Meanwhile, only simple expeditions should be undertaken FY 08-09.

CDEX 14months per two years, USIO projects 7-9 months/yr. Options involve: stacked, farm-out or co-funded. MSP operations are very expensive at the moment. The situation is difficult but science principles are paramount. Rigorous science review is even more important and more selective.

Imminent August review: the forward review will be divided into three groups.

1. Half require observatories, few of which seem possible before "renewal".
2. Two are four major riser programs which SPC will review.
3. Two of the three MSP programs at OTF are very expensive.

The few remaining riserless programs are simple and relatively low cost. It is not possible simply to cancel MSP projects to fund the SODV/Chikyu platforms

Agendum Item 7: SASEC Working Group Recommendations (Becker)

Highlights of the SASEC March meeting included

- SASEC endorsed IODP-MI to explore alternative industrial use of platforms so long as the scientific integrity of the program is preserved.
- Reviewed seven proposals for workshops and prioritized for available funding (one workshop).

Highlights of the June Meeting:

- Unable to issue formal approval of the FY08 program.
- Planned to reaffirm the basic ISP themes but focus on selected subjects through phase 2.
- SASEC endorsed two proposals: complete farm-out of a hybrid model via a Complementary Project Proposal.

SASEC formed a working group to review SAS in IODP proposal process. After the budgetary shortfall came to light SASEC asked the WG to look at potential for cost savings. The WG perspective and interim recommendations honor the role of SAS in ISP. They confirm a proposal driven process.

Panel sizes and terms of membership were considered. Smaller core memberships augmented by expert advice. A possible reduction of US and Japanese members was suggested, but not ECORD. A reduction in meeting frequencies could be considered. There is no absolute mandate for twice-yearly panel meetings. An addendum to the WG report explored four further scenarios.

One scenario was of no further funding of engineering development. A suggestion was to combine STP/EDP, keeping two panels but restricting them to one meeting. There would be a further consultation with SAS. EDP might need to think ahead to consider how to operate at a reduced level. Engineering Development was one of the six implementation principles of the IODP ISP

The uncertainty is likely to continue over the next few months (Janecek). If the budget shortfall gets worse, SASEC may look at a further workgroup to consider additional savings.

Agendum Item 8: STP Report (Makoto Okada-10 minutes) (Appendix #3)

Latest STP meeting held in SF 7-9 Dec. It generated 1 recommendation, 24 consensus statements and 10 action items. Key consensus items were:

- ESO temperature tool, upgrade to an absolute accuracy of 0.01 degC and resolution of 0.001 degC before the New Jersey expedition.
- STP mandate, structure and format: suggested no change to the mandate but to continue with the three working groups. The two meeting/yr plan would allow one to be related to immediate issues and other for longer term planning matters.
- Operations review task force: STP will be involved in reviewing scientific technology aspects of programs.

The next meeting will be in Beijing in August.

Agendum Item 9: SSEP Report (Bill Ussler-10 minutes) (Appendix #4)

The SSEP panel reviewed the EDP mandate and major EDP activities in terms of the road map and the proposal review process. Tables 1 and 2 of the roadmap were reviewed and the types of engineering.

SSEP consensus on difficult drilling, and their request for EDP participation. The various factors associated with difficult drilling were reviewed:

1. Lithological: fractured basalts, chalks with hard fragments and hard-soft interlayers, including coring control. Future voyages will require the reduced core quality resulting from these features to be eliminated.
2. Thermal: high temperature conditions for equipment.
3. Fluid Overpressures: unconsolidated sediments making it difficult to get measurements.
4. Active tectonics: active faulting.
5. Contamination: getting pristine gas and water sampling due to drilling contamination as well as microbiological issues.

SSEP had to deal with 35 proposals, including 3 missions. Missions are integrated and coordinated drilling strategy, from the scientific community, a significant aspect of the IODP science plan and merits urgent promotion to meet IODP goals.

The key technical issues associated with this group of proposals. This was a perspective not previously considered by SSEP and, by beginning it early, it could improve deliverability of future programs. The Technical Roadmap does anticipate a good number of the problems identified by the SSEP program. Key issues are:

- Improved core recovery.
- Drilling into coral reefs.

- Hard rock paleo-magnetic remnance.
- Some of the holes are 7200m into basement.
- Observatory development shows up.

These are issues that are appearing a long time before EDP would normally see them. The major issue is still around heave: maintaining controlled weight on bit with improved compensation, seabed frame/template, bumper subs, motor driven core barrels, portable remotely operated drilling (PROD) is a commercial development. Two of these systems are under development: one a wireline and the other drillstring. There is also a German remote drill under development but no further information in the meeting.

As far as liaisons, it was very informative to be at the SSEP meeting and SSEP thought it would be of benefit to their future meetings. Early communications between the two groups may be of considerable value to proponents of future technologies to moderate future proposals. To review the engineering needs of these projects: run engineering developments in parallel with the scientific program, hence set long term engineering objectives.

Bill felt that it was very useful to be at the meeting and to be able to read all the confidential proposals as it enabled a much more informed review of the work than would have been possible with the information on the website. Although Bill had prepared the technology summary table, it may be that there is some overlap with the work that Greg Myers and Kelly Oskvig do.

To formalize the idea of a liaison would require a change to the EDP's terms of reference and the expenses would have to agree with the national bodies.

Agendum Item 10: Ranking Procedure (Ussler) (Appendix #14)

Bill reviewed the methods used in the past for prioritization of roadmap and proposals. At the 3rd meeting in Germany, they had three sub-groups and ranked separately. The top ten were identified in each subgroup. Votes counted H, M, L and produced a simple list. The Alberty Algorithm retained the three subgroups but ranking was weighted by expertise.

Questions for this meeting

- Maintain three separate subgroups or combine them?
- Take account of budgetary considerations.
- Consider riskiness in the proposal.

Some thoughts about time to do the development rather than cost. Steve Sears suggested that we had the roadmap and the proposal evaluation process. He questioned whether there was any value in the ranking process. Bill Ussler suggested that the EDP priority setting was not consistent with the overall science objectives. The prioritization might occur at a different level.

Tom Janacek stated that this provides a framework for getting proposals into the system. EDP can advise on cost, risk and feasibility. JLT agreed that we do not need to rank, simply advice on cost, risk, schedule and feasibility to ensure that planners of the science program can make properly informed decisions about future projects. By simply providing good information, EDP can help the program reach better decisions. This should be recognized in the process.

Agendum Item 11: Nankai Downhole Measurements Plan (M. Kinoshita-20 minutes) (Appendix #6)

This was an update on what is going on in JAMSTEC and might be considered as a case study of the technology roadmap in action. The drilling will start in September 2007. The plan is to drill a 3 km deep well to measure slips along three faults. It is planned to have shallow boreholes and seabed stations to create a real-time three dimensional monitoring system. There is a lot of technology development lead time for this project. The shallow hole is expected to be up to 100 degC with up to 170 degC for the deeper well. Measurements include: seismic deformation and strain, seismic activity and the hydrogeological properties of the formations. Studies are being carried out to determine the technological capabilities of the various sensors: tilt (10 microRad) 10 micro-strain. These will require a phased approach. The first well will incorporate ACORK behind casing pore pressure measurement. Deeper down will be a cemented in strain and seismic sensor. The proposed sensor distribution along the NT2-3 riser observatory well was described

The major technical challenges were described as:

- Monitoring at multiple intervals. Due to the expense of a single well, then the holes have to be equipped with multiple sensors. Requires behind casing monitoring technology due to feed through the wellhead, the multiple packer / clamping requirements will be difficult to satisfy.
- High temperature: initial goals are 100 degC and then leading up to 170 degC.
- Data transfer, power supply.
- Coupling to the formation.
- Shocks applied to the sensors during deployment.
- Vertical drilling and coring at he sampled interval, current instruments restricted to 3 degs maximum.
- Is there a simpler way of deploying in much shallower holes, possibly by jetting in?

There followed some considerable detailed discussion on the difficulties of multi-stage cementing to aid deployment of the external casing instrumentation. The bottom hole temperature for the second well is based on very simple basin temperature modeling. Drilling the fault will be highly problematic both due to loss of circulation and wellbore breakout.

JPFY2007 development plan:

- NT2-3 riser hole

- Land test of clamping system
- NT3 non-riser hole observatory.

<u>Agendum Item 12: Technology Roadmap—Session 1:</u>

a) Status of Roadmap (all)

Peter introduced the status of the roadmap by reminding the panel of its mandate and the purpose and scope of the roadmap, including its special attributes of being based on science goals. Proposals are assessed for cost, risk and deliverability. This is done to motivate engineering in all aspects of the program, to stimulate proposals, identify common challenges, priorities and stimulate cross communication between programs. The challenges will evolve with time. Some engineering development solutions have been identified as possible solutions. Proposals can range from innovation to increment, expensive to cheap.

By way of an example, consider data acquisition while coring. The major messages were:

- better coring tools
- drillstring g stabilization
- better coring

The idea of building a roadmap was to generate proposals. Build the roadmap and the proposals will come. The task now is to review and make additions, discuss prioritization, examine tables, agree on release of the revised roadmap with some top ranked items in each category.

Roadmap breakout group leaders

- Borehole infrastructure: Ussler
- Drilling/vessel infrastructure: Sears
- Sampling/Logging/Coring: Fukuhara

The idea would be to spend Tuesday summarizing changes, list high priorities and then spend Wednesday on grouping priorities.

Nakata's comments on the Roadmap in relation to the pathways to ED solutions:
1. There needs to be something drilling operations to counteract instability due to the stress field. Is this in the drilling or other categories?
2. Accurate estimation of downhole temperature: how is this done during planning? The prediction is critical for correctly de-risking the design of the well. How is it done during drilling? There are significant rig time delays involved in accurate temperature measurement while drilling.

b) Working Groups- Technology Roadmap (working group)

c) Reconvene: status and plans. (all).

Agendum Item 16: Operator Reports (Appendices 7, 8, 9, 10, 11, 12)

a) CDEX

i. Current F.Y. ED Projects: LTBMS -Mr.Kyo (15 min)

Progress since last EDP meeting. The long term program has the opportunity to deploy long term borehole monitoring system in 2011. Sub-systems are being developed in parallel for systems test in 2009.

The plans for the shallow borehole were described together the sensor arrays required for the three major fault zones. Details of completion design activities were described to ensure the correct completion of the wells. Significant engineering requirements will be involved to make the telemetry system to work before full system integration tests can be carried out.

ii. Shimokita Syst. Integration Test-Mr. Miyazaki(10min)

The SITS were carried out last year coincident with the first riser drilling campaign. Five items were covered: coring, casing & cementing, riser & BOP, emergency disconnect and wireline operations. More shake down operations were continued in Kenya. Two emergency disconnects were carried out. One for trial and the other due to heavy weather: 50kts wind and up to 12m heave. Some parts of the system were damaged. This led to suspension of the well.

iii. Improved downhole drilling system for mud circulation-Mr. Higuchi(10min)

The main features and advantages of riser drilling were described: borehole stability, deep penetration, well control, more logging options and better core recovery. Core line wiper testing system is to be tested during 2007. It is expected to result in a diminished frequency for replacing the coring line. They're using industry equipment and casing sizes to get experience in the technology.

iv. Detection/prediction technique for pore pressure in fault zone-Mr.Higuchi(10min)

Riser drilling enables a lot more casing strings to be set. Objectives include borehole stability and pressure protection. Pressure prediction is complicated in NTS, first in splayed fault system. No offset wells and high understand horizontal stress. They had a number of studies beforehand, using Eaton's method based on interval transit tome. Stress and borehole instability prediction is also being studied with Kyoto University. They are getting up to speed on various standard pressure detection methods while drilling. Developing skills, the stage 1 data is very valuable. Careful observation of the hole is important to the learning process.

The talk revealed a lot of progress and solid development and learning. There might be benefit from engaging a specialist pore pressure consultancy to advise on adequacy of methods.

v.   Coring System, including Gel Core-Mr.Wada (15min)
They are looking at methods to improve on the present ODP RCB coring systems by modifying inner barrel and also a small diameter RCB for 8 ½" bit. They're working on a modified tool for NTS for high temperature resistance, 150 degC operations involving conversion of Al liner and changing of a Viton seal. New RCB PDC bit designed to maximize core recovery.

They are considering future coring systems to eliminate biological and chemical contamination from the drilling mud while drilling and tripping. This will be done through use of a gel coating system. They have a land based test facility to check their work on contamination prevention. The barrel is not presently RCB compatible.

vi. 3rd Party Tool Report-Mr.Ito (10min)
Mai Lin Doan HTPF tool proposal: hydraulic tests of pre-existing fractures. Present methods are XLOT (Sh), density (Sv), breakout or core measurements (stress ration, direction). All based on the assumption that one of the principal stresses is vertical hence describing the tensor with three parameters. However, the method attempts to derive the tensor for more sophisticated interpretation of available data. The system is designed to detect natural fractures and then straddle them before taking a measurement. Current interpretation methods cannot yield enough data to get the full tensor. However, the investigators have very good experimental data from the Paris basin to support their method. Further evaluation by a NTS scientist is required. There is an operational issue involved concerning the safe use of the tool in open hole. Is any other proven tool available?

Tuesday, July 10, 2007

Meeting was convened at 0830. Minutes taken by Bill Ussler.

Flemings – discussed future EDP meeting dates.

> EDP #6 – Paris or Nice, January 9-11, 2008; Roland Person host.
> EDP #7 – Monterey, CA or Washington, DC, July 14-16, 2008; Bill Ussler host.
>
> A consensus was obtained on these meetings dates and proposed venue.

Flemings discussed slight modifications to the timing of meeting agenda items, and this was accepted by consensus.

Flemings reviewed the goal of the three Technology Roadmap working groups. He asked the panel to consider how to address TR Section 3.1, technology challenges, in light of the higher level issues faced by the IODP.

Flemings – discussed conflict of interest issues. (Appendix 14)

Flemings reviewed the COI statement. The EDP policy is a slight modification of that used by the SSEPs. Any COI is to be announced and documented in the meeting minutes. All potential COI are to be declared at either the start of the meeting, or at other appropriate times. With respect to the EDP, specific COI occurs when a panel member is a proponent of an active proposal. Proponents may participate in the discussion of all other proposals, including serving as watchdogs on other proposals. Institutional COI is common, and participation in discussion and grouping of proposals is acceptable unless the situation prevents the panel member from rendering an impartial assessment. If in doubt, inform the chair or co-chair of EDP.

Von Herzen asked how a conflicted panel member would participate in grouping exercises. Becker suggested that all conflicted proponents should be absent during proposal ranking.

There was a brief discussion of how to rank ED proposals. SSEP uses a five star grouping. Flemings pointed out that we would need a clear definition of each group. Discussion of the grouping to be used was tabled.

Potential conflicts of interest were declared at this time.

a. Flemings – proponent for the MDHDS.
b. Becker – S-CORK proponent.
c. Ussler – SCIMPI proponent.
d. Grigar – working on the MDPDS.

Flemings reminded everyone of the confidentiality of the proposals. He reviewed the procedure for the review process and the content of the panel review. Notes from discussion of each proposal do not go into the formal minutes for reasons of confidentiality.

Myers gave a presentation on the proposal process and then presented a PowerPoint presentation for each of the four engineering development proposals under consideration by the EDP.

Myers stated that ten proposals were received by the April 16th deadline. Four proposals were forwarded to EDP for their review. SOC money will be used to fund ED proposals.

A discussion of whether high level scoping issues for ED need to be resolved before supporting individual ED proposals. Myers stated that a solid plan for solving some of the ED problems highlighted in the TR needs to be achieved before throwing money at individual solutions. Ussler pointed out that Table 2 of the TR needs to be made clearer and better linked to the individual ED topics in section 3.2 of the TR. Sears emphasized that there is a need to work at a higher level and not spend more time word-smithing the detailed discussion of individual ED topics.

Myers described the steps for the proposal EDP reviews. Watchdogs prepare a written summary prior to departing from the EDP meeting. Letters will be sent to the proponents explaining the review process, and will contain technical comments and suggestions from the EDP. Based on EDP advice, IODP-MI will prepared a draft FY09 engineering development plan and prepare a funding request that will be submitted to the SPC at their annual August meeting.

Myers also discussed a coring study proposed by IODP-MI for FY08 to investigate core quality and quantity. The panel made some suggestions concerning how to collate data and potential data sources. Holloway suggested the mining industry might have core quality data. Panel members endorsed the efforts to conduct the coring study.

Myers made four proposal presentations and entertained questions. Conflicted panel members and guests were not present as appropriate.

Break for lunch at 1230

Reconvened at 1357

Flemings discussed proposal grouping schemes. He suggested using a process similar to that used by the SSEPs. There is a grouping process and the panel comes to a consensus regarding the proposal group (no voting). His initial proposal was one based on 3 stars, rather than the 5 star grouping used by the SSEPs. Makoto-san preferred a 5 star grouping. Flemings tabled this discussion for the moment. A summary of the evaluation process is presented in Appendix 14.

Agendum Item 16C: USIO status presentation (Grigar) (Appendix 12)

Grigar made an Engineering services report; described personnel reorganization at TAMU (Peter Blum is now Manager of Tools and Analytical Services); and described various engineering activities underway. His report included the status of the DSS and PTM. A full-time technician will staff the Metrology Lab (thermistor and pressure transducer calibration). Also, he described the SBTF and the desire to test the IWS before taking it out on the ship in order to identify the best tip design for water sampling. These results will also affect probe tips design for temperature and pressure tools.

Agendum Item 17: Panel Structure Terms (Flemings)
Flemings discussed panel structure and terms in light of the fiscal realities of the IODP. All US members have a 6 meeting term, and started simultaneously. He asked for volunteers for two members to rotate off after this meeting.

Myers gave a brief REVCOM review which included describing the 3^{rd} party tool pathway. Two tools, the APCT3 and HTPF are 3^{rd} party tools and are working their way through the system. EDP will be asked to review these two tools at the winter meeting.

Myers described the funding reality at IODP and the proposed reduced ship schedules. It will be a difficult fiscal climate through 2013. Novel partnerships are being proposed to fill non-operation time periods. He also proposed an engineering mini-expedition (10 days or less) to conduct comprehensive testing of engineered systems.

Break at 1515.

Reconvened at 1530.

Agendum Item 18: Technology Roadmap Session 2:
Flemings asked the TR working groups to reconvene and continue revising Section 3.2

TR working groups met for the remainder of the day.

Meeting adjourned at 1700.

Wednesday, July 10, 2007

8:30 AM: meeting started, Group Photo.

Agendum Item 27: End Executive Session
8:45 AM: Executive Session adopted by consensus.
3:00 PM: Executive Session ended by consensus.

Agendum Item 28: Close Meeting
3:05 PM: Motion to adjourn accepted by consensus.

APPENDIX 1:

EDP Meeting 5 Agenda

<u>EDP Meeting #5</u>
<u>Agenda3.0 (prepared 7/5/07)</u>

<u>MEETING GOAL:</u>

The primary goal of EDP Meeting #5 is two fold: 1) revise the EDP Technology roadmap 2) Review IODP Technology Development Proposals. The Roadmap will contain a prioritized list of important engineering developments that are needed over 2 to 5 years. The Technology Roadmap will be distributed to the Science Planning Committee in mid-July in time for their review at the SPC August Meeting.

<u>Monday: July 9, 2007</u>

<u>8:30-12:30—Morning Session</u>
<u>1:30-5:15—Afternoon Session</u>

1. Approve Agenda (Flemings)
2. Approve EDP Meeting #4 Minutes
3. Quorum Discussion
4. Next Meeting and Time: preliminary discussion
5. Summary of EDP Meeting #4 (Flemings)
6. SPC Report (Becker/Flemings)
7. SASEC Working Group Recommendations (Becker)
8. STP Report (Makoto Okada-10 minutes)
9. SSEPS Report (Bill Ussler-10 minutes)
10. Ranking Procedure (Ussler)
11. Nankai Downhole Measurements Plan (M. Kinoshita-20 minutes)
12. Technology Roadmap—Session 1:
    a. Status of Roadmap (all)
    b. Working Groups- Technology Roadmap (working group)
    c. Reconvene: status and plans. (all).
13. Conflict of Interest Discussion (Flemings/IODP-MI)
14. FY 09 Eng. Dev. Proposals Session 1
15. Revcom Review—IODPMI (IODP-MI)
16. Operator Reports
    a. CDEX
        i. Current F.Y. ED Projects: LTBMS -Mr.Kyo (15 min)
        ii. Shimokita Syst. Integration Test-Mr. Miyazaki(10min)
        iii. Improved downhole drilling system for mud circulation-Mr.Higuchi(10min)
        iv. Detection/prediction technique for pore pressure in fault zone-Mr.Higuchi(10min)
        v. Coring System, including Gel Core-Mr.Wada(15min)
        vi. 3rd Party Tool Report-Mr.Ito(10min)
    b. ESO
        i. Current F.Y. ED Projects: DownPipe Camera Feasibility (5 min)
        ii. Other related projects
        iii. 3rd Party Tool Report

c. USIO—
   i. Current F.Y. ED Projects: Pulsed Tel. Module Feasibility (5 min)
   ii. Other related projects
   iii. 3rd Party Tool Report

<u>**Tuesday: July 10, 2007**</u>

<u>8:30-12:30—Morning Session</u>
<u>1:30-5:15—Afternoon Session</u>

17. Panel Structure/Terms (Flemings/IODPMI)
18. Technology Roadmap—Session 2:
    a. Status of Roadmap Document (all)
    b. Working Groups- Technology Roadmap (working group)
    c. Reconvene: status and plans. (all).

19. FY 09 Eng. Dev. Proposals Session 2
20. Technology Roadmap Prioritization
21. Preliminary Agenda for EDP Meeting #4

<u>**Wednesday, July 11, 2007**</u>

<u>8:30-9:00 Open Session</u>

22. Next Meeting Location and Time: 2

<u>9:00-3:00 Executive Session.</u>

23. Compile Technology Roadmap
24. Review critical components of Technology Roadmap. Provide prioritized list of critical long term developments.
25. Complete Proposal Review
26. Finalize Consensus Items
27. End Executive Session
28. Close Meeting.

Responsibilities:

1. Roadmap
    a. Group Leaders:
        i. Borehole Infrastructure: **Ussler**
        ii. Drilling/Vessel Infrastructure: Sears?
        iii. Sampling/Logging/Coring: Fukahara
    b. Responsibilities
        i. All should read the Technology roadmap
        ii. Group Leaders should be prepared to lead discussion on your category.
        iii. Over the course of 3 days we need to make any edits we wish to the document. This might include adding items or refining descriptions. Also, it is key to determine if the technology is existing or will need to be developed from scratch.
        iv. Ultimately, the EDP Panel will be charged with selecting the top 10 items in each category that are deemed most important to achieve the science goals of the IODP.

2. EDP Proposals
    a. Group Leaders:

1	EDP-2009-01-B	Wellhead Interconnection System (WHIC)	Sears, Stephen	USA
			Nakata, Haruya	Japan
			Person, Roland	ECORD
			Ye, Ying	China
2	EDP-2009-02-B	Sediment Cork (SCork)	Takemura, Mitsugu	Japan
			Von Herzen, Richard	USA
			Holloway, Leon	USA
			Tamura, Mitsuo	Japan
3	EDP-2009-03-B	Decoupled Penetrometer Delivery System	Thorogood, John L.	ECORD
			Alberty, Mark	USA
			Ask, Maria	ECORD
			Ussler, Bill	USA
4	EDP-2009-10-B	SCIMPI	Fukuhara, Masafumi	Japan
			Tezuka, Kazuhiko	Japan
			Germaine, Jack	USA

    b. Responsibilities
        i. All should be familiar with each proposal
        ii. Group Leaders should be prepared to lead discussion on your proposal.
        iii. Before we leave EDP we need to have a review of each proposal completed. In addition, we need to make a formal recommendation to IODP-MI as to the importance of each proposal for achieving the goals of the IODP.

APPENDIX 2:

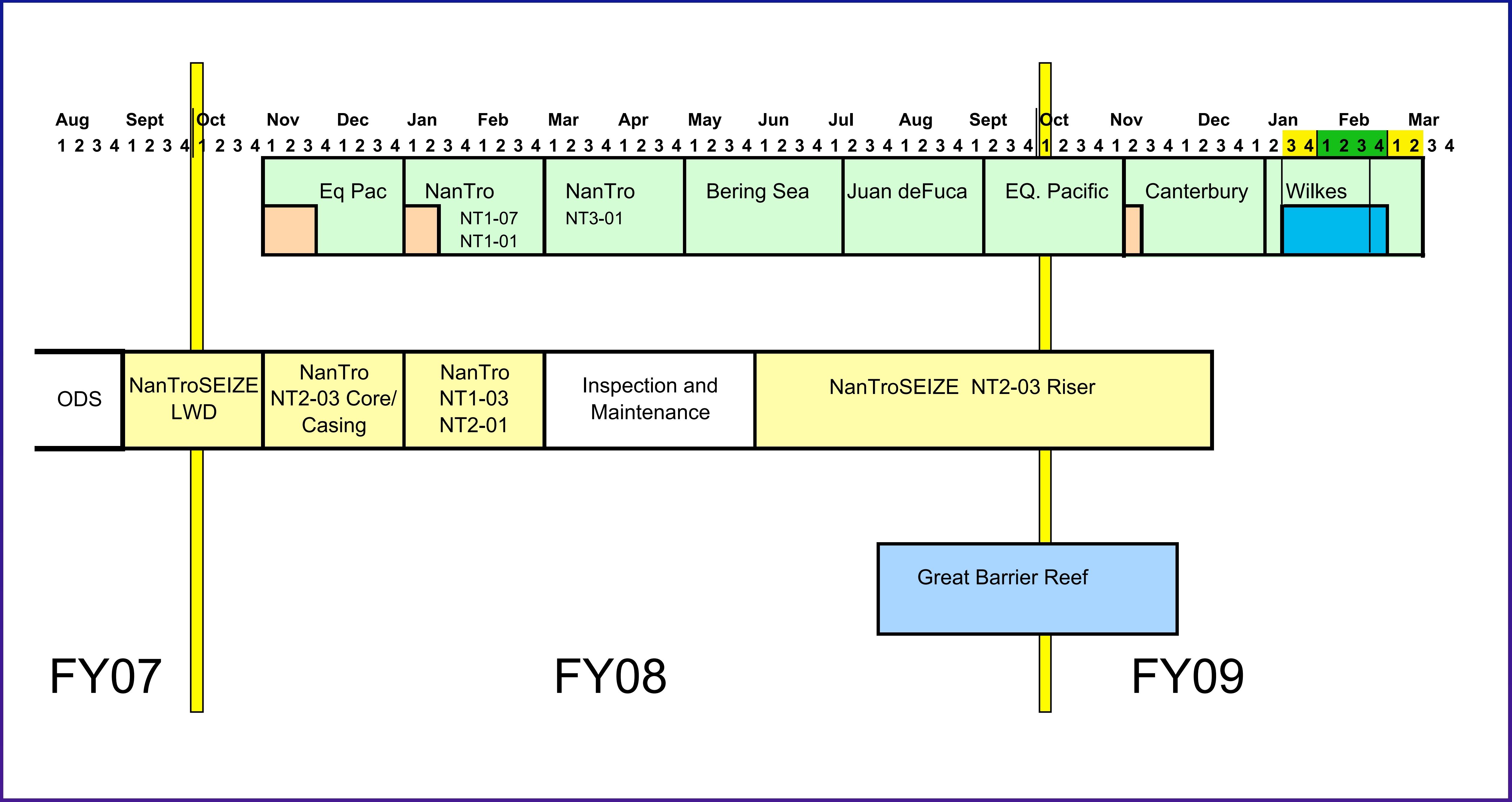
SPC/SASEC Report to EDP

SPC/SASEC Report to EDP

Tokyo, July 2007, K. Becker

1. Update on FY08-09 schedule development, in light of realistic budget projections and start date for JR IODP operations - 3 OTF meetings and 2 major schedule adjustments required since last EDP!
2. March 2007 SPC rankings for FY09 + beyond
3. Update from March and June SASEC meeting
4. Update on SAS review by SASEC WG - potential implications for EDP?

Summary FY07-09 Schedule as of August SPC



March 2007 SPC FY08 Schedule Adjustment

- In late January/early February, NSF issued FY08 budget guidance to USIO below expectations, and also specified a Jan 1 2008 earliest start date for SODV international operations.
- Operations Task Force (OTF) met Feb 22 and March 2 primarily to develop alternative SODV schedule options in response to NSF financial guidance.
- March SPC SODV schedule consensus on next 2 slides
- SPC also accepted minor schedule adjustments made by OTF to previously approved Chikyu and MSP FY08/09 operations - these are essentially the same from science perspective.

SODV Schedule Adjustment - SPC Consensus (1 of 2)

SPC Consensus 0703-15. The SPC accepts the adjustments recommended by the Operations Task Force to the FY08-09 SODV science operations schedule in response to NSF budgetary guidance for FY08 and other logistical factors. After a January 1 start date to international operations and a short transit, the approved schedule would include the following sequence:

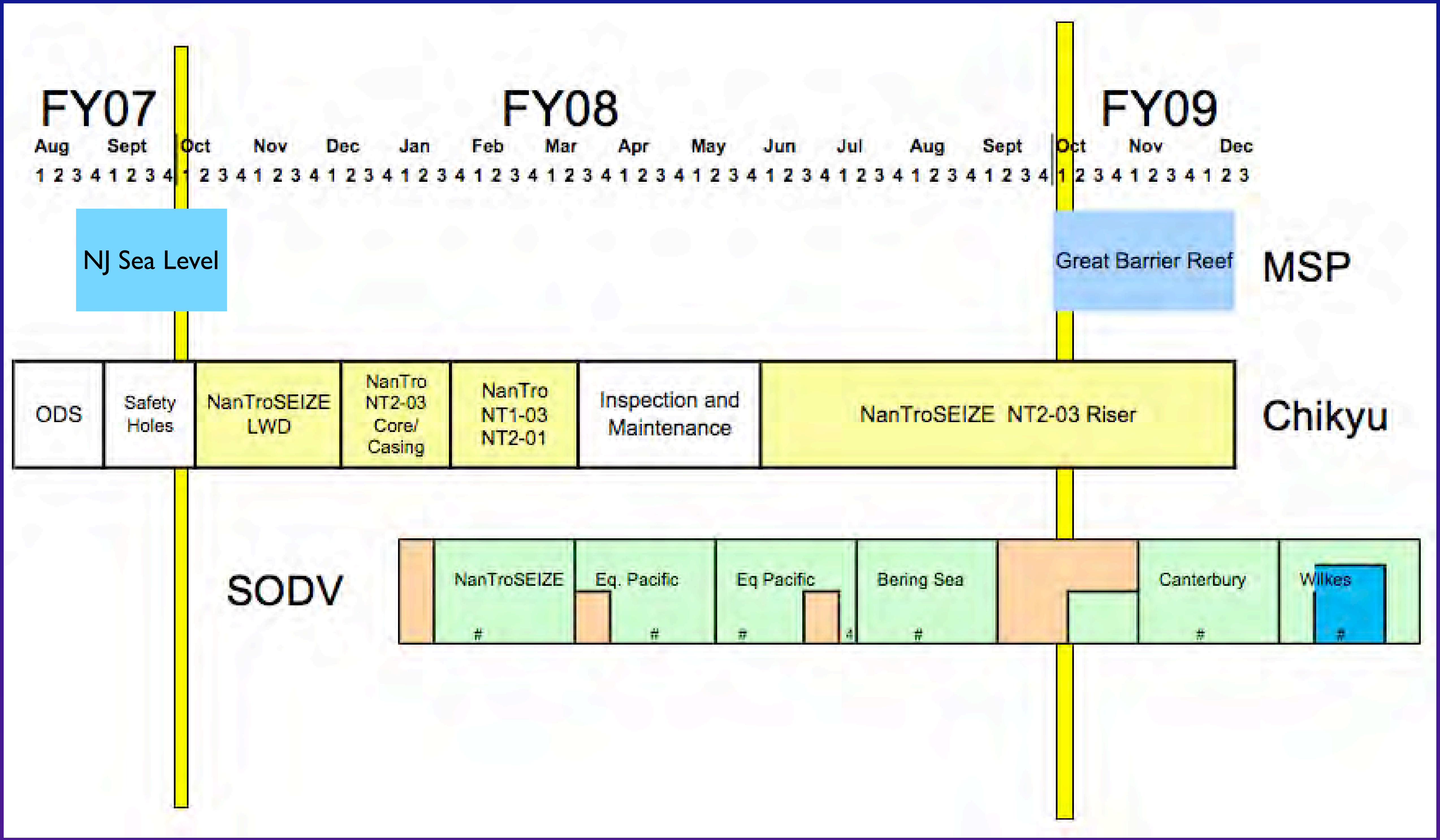
- NanTroSEIZE Stage 1 coring (Proposals 603A-Full2, 603C-Full; subduction inputs and NT3-01)
- Equatorial Pacific Paleogene Transect I (Proposal 626-Full2)
- Equatorial Pacific Paleogene Transect II, ending with remedial cementing of two Juan de Fuca CORKs installed on Expedition 301
- Bering Sea Pliocence/Pleistocene Paleoceanography (Proposal 477-Full4)
- Spanning the FY transition, a transit to the Southern Oceans with undetermined potential for brief additional science operations
- Canterbury Basin Sea Level (Proposal 600-Full)
- Wilkes Land Paleoceanography (Proposals 478-Full3, 638-APL2)

SODV Schedule Adjustment - SPC Consensus (2 of 2)

This adjusted schedule is as close as possible to the previously approved FY08-09 schedule given the budgetary and logistical constraints, except that it does not include an initial NanTroSEIZE observatory and the observatory-intensive second Juan de Fuca IODP expedition. Nevertheless, it still presents a strong mix of societally-relevant, highly-rated seismogenic zone, paleoclimate, and sea level objectives, early enough in Phase II that the results can be expected to have a significant positive impact on renewal of IODP post-2013.

In the event that NSF, IODP-MI, and the USIO cannot identify the resources to achieve the full sequence of FY08 SODV operations above, SPC recognizes that the fourth FY08 expedition (Bering Sea paleoceanography) would need to be deferred, and that a completely different model for FY09 SODV operations would need to be developed at the June 2007 Operations Task Force and August 2007 Science Planning Committee meetings.

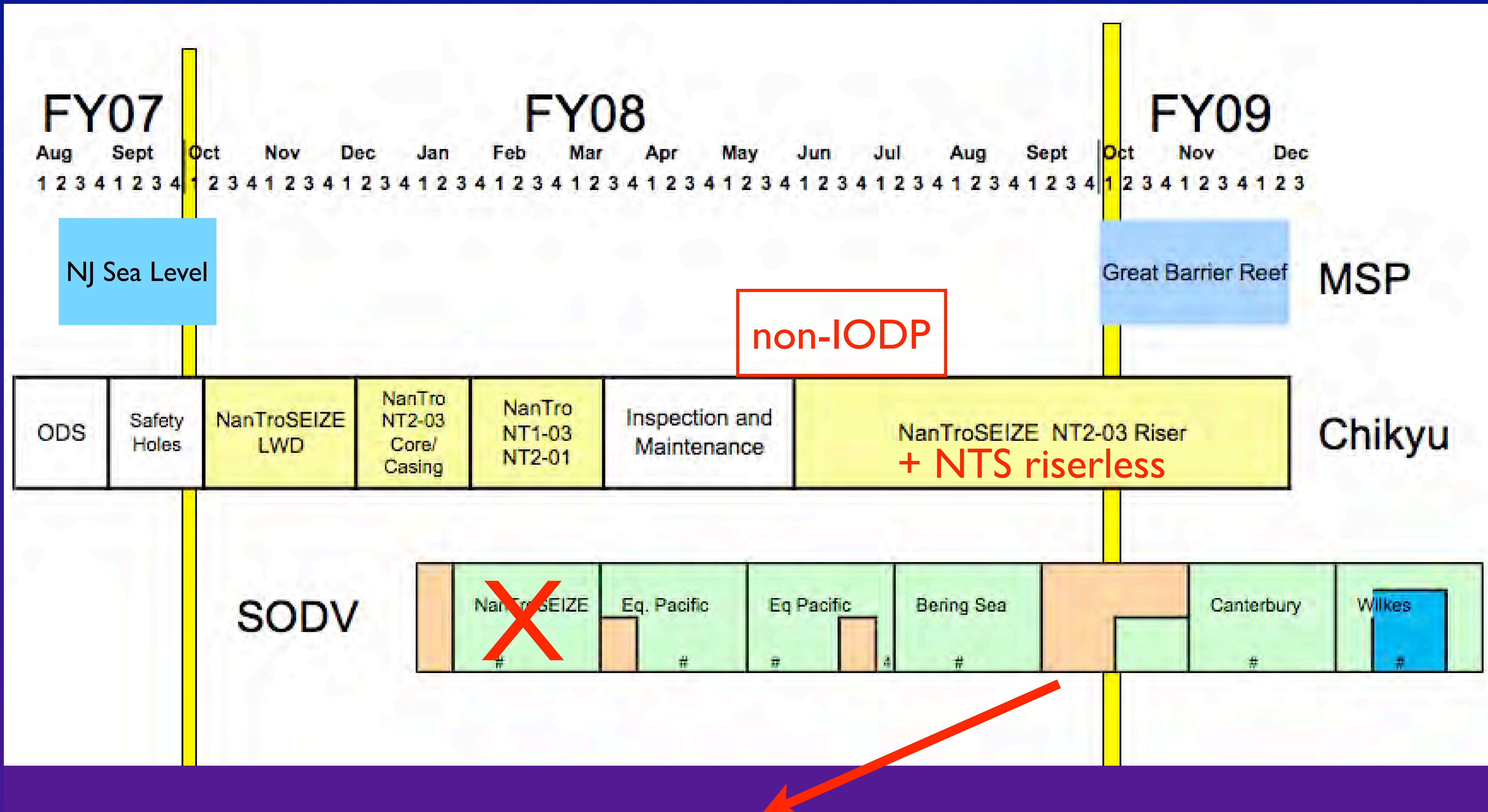
Summary FY07-09 Schedule as of March SPC



June OTF: Further FY08 Schedule Adjustments

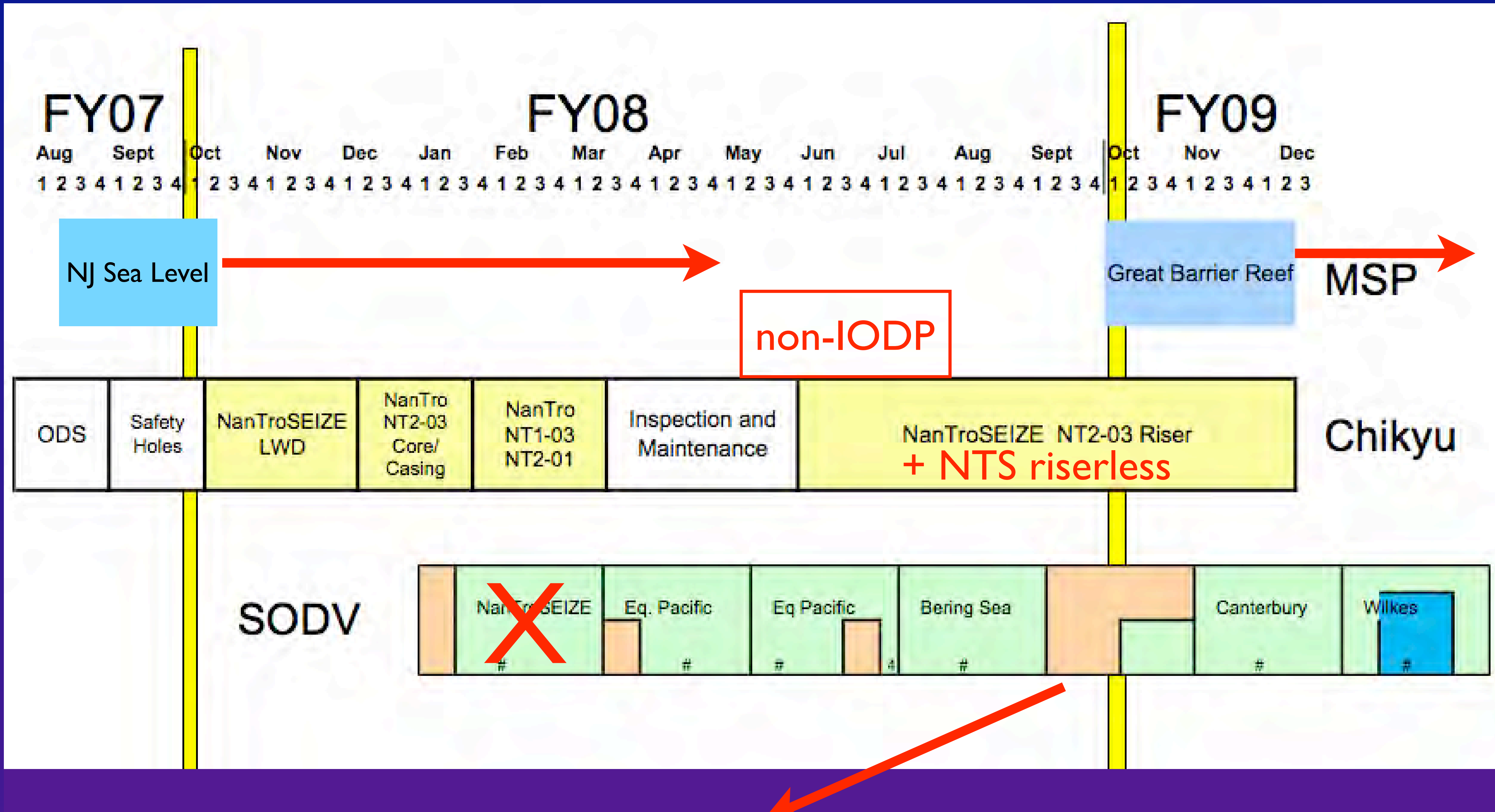
- The initial SODV NanTroSEIZE expedition cannot remain on the schedule because of combination of (a) slippage of SODV shipyard schedule and (b) Japanese fishing union ban on NanTroSEIZE operations March 1 - May 31.
- The adjusted SODV schedule recommended by OTF retains the subsequent three programs in slightly earlier slots, as well as the early FY09 Southern Ocean pair of programs, as in the previously approved schedule and APP.
- OTF agreed that a good part of the deferred NTS riserless work can be picked up by Chikyu during a 2-3 month period of riserless operations in fall of 2008, as proposed by CDEX. Subject to PMT and SPC endorsement, this could include some combination of subduction inputs coring and the Kumano Basin (NT3-01) objectives, hopefully including the initial observatory that was dropped from the SODV FY08 schedule as of March OTF and SPC meetings.
- This means that some NTS Stage 2 riser work will probably be defered to late FY09/FY10, assuming plan to continue with the NTS program as the top priority for riser work beyond FY09.
- For the August SPC, the USIO is exploring three possibilities for the potential slot on the transit between Bering Sea and Southern Oceans: NTS riserless work, Mariana fore-arc, Shatsky Rise basement.

Summary FY07-09 Schedule as of June OTF



For the August SPC, the USIO is exploring three possibilities for the potential slot on the transit between Bering Sea and Southern Oceans: NTS riserless work, Mariana fore-arc, Shatsky Rise basement. (All have potential typhoon issues.)

Summary FY07-09 Schedule as of July



For the August SPC, the USIO is exploring three possibilities for the potential slot on the transit between Bering Sea and Southern Oceans: NTS riserless work, Mariana fore-arc, Shatsky Rise basement. All have potential typhoon issues.

March 2007 SPC Proposal Review/Ranking

- 18 proposals reviewed
  - 13 from previous SPC review/ranking meetings; 5 newly forwarded from SSEP in last year
  - 1 riser program, 3 MSP, rest riserless
- 3 excluded from ranking (consensus 0703-11)
  - 2 for completion of ongoing site survey data analysis and site characterization; these are expected to be available for review and ranking at March 2008 SPC.
  - 1 for a major expansion of proposed objectives in an addendum, rendering the past reviews inadequate and raising issues of site survey data adequacy; submission of revised proposal requested, with SSEP review.

SPC March 2007 Global Rankings

(excludes 3 reviewed proposals)

Rank			Mean	Stdv
1	505-Full5	Mariana Convergent Margin	5.59	3.36
2	659-Full	Newfoundland Rifted Margin	5.76	3.80
3	633-Full2	Costa Rica Mud Mounds	6.12	3.48
4	552-Full3	Bengal Fan	6.29	4.06
5	644-Full2	Mediterranean Outflow	6.35	3.44
6	654-Full2	Shatsky Rise Origin	6.65	4.00
7	537B-Full3	Costa Rica Seismogenesis Phase B (Riser)	6.94	2.93
8	522-Full5	Superfast Spreading Crust	7.18	4.00
9	661-Full2	Newfoundland Sediment Drifts	7.29	4.13
10	548-Full2	Chixculub K-T Impact Crater (MSP)	8.18	5.04
11	612-Full3	Geodynamo	9.71	5.64
12	581-Full2	Late Pleistocene Coralgal Banks (MSP)	9.94	4.19
13	618-Full3	East Asia Margin (MSP with riser)	10.47	3.79
14	584-Full2	TAG II Hydrothermal	11.35	3.32
15	547-Full4	Oceanic Subsurface Biosphere	12.18	1.94

This is by far the most even ranking on statistical basis, ever since SCICOM began annual global ranking (1997).

SPC March 2007 Rankings - Forwarded to OTF

(blue = Group 1* for FY09 and beyond
yellow = Group 2** for FY09/10 only)

Rank			Mean	Stdv
1	505-Full5	Mariana Convergent Margin	5.59	3.36
2	659-Full	Newfoundland Rifted Margin	5.76	3.80
3	633-Full2	Costa Rica Mud Mounds	6.12	3.48
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* All Group 1 proposals from 2003-2007 to be reevaluated at Aug SPC

** Group 2 to be re-ranked at March 2008 if not scheduled in FY09/10

SPC Perspective on June 20 OTF Meeting

- In the current budget situation, it seemed clear that the best way for the USIO to afford programs with any special expenses (long casing, observatories, etc) is to conduct "off-contract" work to pay some proportion of annual fixed costs, banking the savings for the next fiscal year.
- Thus, only simple, inexpensive SODV expeditions are possible for FY08-09; FY10 is the earliest possible time for expensive observatory/casing programs, assuming that the USIO can find off-contract work in FY09.
- OTF explored a range of hypothetical scheduling approaches for coordinated scheduling of IODP and off-contract work. No single model was adopted, but there was general agreement it could be worked out on an ad hoc basis with appropriate approaches.
- Initially, the best potential for USIO off-contract work seems to be in Gulf of Mexico and Atlantic (North Sea and West Africa), possibly Indonesia or India.
- The Gulf of Mexico/Atlantic prospects are consistent with a critical mass of OTF programs in Atlantic/E. Pacific, which would allow for reasonable scheduling options to accommodate both.

So how bad is the financial situation?

- CDEX projects to be able to conduct IODP operations 14 months of every two years.
- USIO projects to be able to conduct IODP operations ~7-9 months/year (3-4 expeditions?).
- Options for remaining time include: (a) idle time in port, (b) IO-solicited "off-IODP-contract" work, or (c) co-funded work of IODP interest.
- MSP operations are very expensive in current industry climate.
- Flexibility will be required, but to what degree?
- SPC chair personal opinion: the situation is difficult, and flexibility is indeed required, but IODP science principles must remain paramount.
- SASEC and Management Forum endorsed mix of high-priority IODP economical programs and ambitious (expensive) programs, as opposed to option for scheduling only less expensive programs in order to maximize platform operating time.
- Implication: Rigorous SAS science review is even more important. The best IODP science should still be scheduled, but SAS will need to be even more selective in review process.

August SPC Review of OTF proposals

Currently at OTF are about 25 "Group 1" proposals from the 2003-2006 SPC rankings. The original plan discussed at the March SPC meeting was to review these in August on an ISP thematic basis, and then prioritize them on the same basis. However, given the difficult budget situation, we are intending instead to review them in groups according to three main issues:

1. Just over half include observatories, only a few of which seem possible before renewal. SPC will review these as a group and prioritize them, perhaps deactivating some (unless proponents raise external funding?).
2. Two are major riser programs, when at best only one more riser program besides NTS can just be started before renewal. SPC will review and prioiritize the two riser programs.
3. The MSP programs at OTF are very expensive, with one exception that will still cost >$5M. Also, there are not many MSP programs coming through SSEP, particularly inexpensive MSP programs. SPC needs to decide how to handle the very expensive proposals, and SPC/SASEC may need to do something to encourage more MSP proposals.

Highlights of March SASEC Mtg

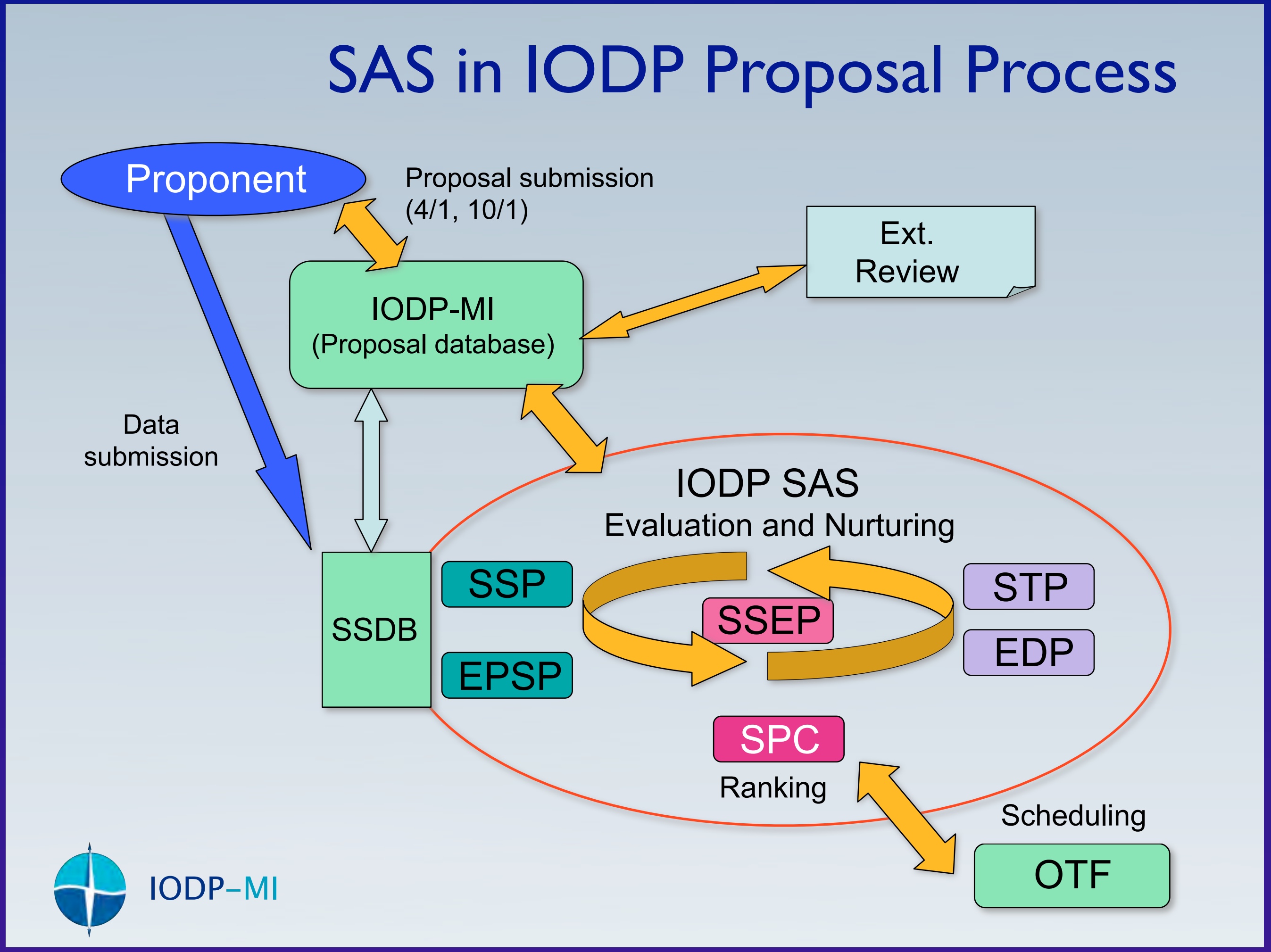
- SASEC formally approved Jim Mori as next SPC chair.
- SASEC received interim recommendations of SAS review WG and asked for final report at June 2007 SASEC meeting,including reduced SAS scenarios if required by budget situation.
- In light of IODP budget shortfalls, SASEC endorsed IODP-MI pursuit of mutually beneficial collaborative relationships with industry to utilize IODP platforms, with flexibility as long as scientific integrity of the IODP program is preserved.
- SASEC also endorsed exploration of ICDP-IODP mutual core curation and proposal evaluation efforts.
- SASEC took nominations for editorial board to update ISP, at the same time recognizing the need to prioritize among ISP objectives.
- SASEC reviewed 7 workshop proposals for FY08 and prioritized ultra-high resolution paleoclimate first. SASEC also endorsed FY07 co-sponsorship of ICDP-IODP sea level worskhop.

Highlights of June SASEC Mtg

- SASEC was unable to issue formal approval of the FY08 program plan because of the rescheduling uncertainties.
- SASEC rescoped and advanced the timeline for its plan to update the ISP. The plan is now to reaffirm the basic ISP science themes and initiatives, but focus on selected subjects through Phase 2 before 2013 IODP renewal.
- SASEC accepted the report of its WG to review SAS (later slide).
- In light of IODP budget shortfalls, SASEC endorsed two specific avenues for pursuing outside funding sources for IODP platform operations: (1) a purely non-IODP option and (2) a hybrid model with quick SAS evaluation of "Complementary Project Proposal."

SAS Working Group Report - Background

In July 2007, SASEC formed WG to review SAS and recommend "any changes to optimally configure its activities as IODP enters Phase II" or "any changes in structure necessary to integrate missions into the IODP proposal review process."



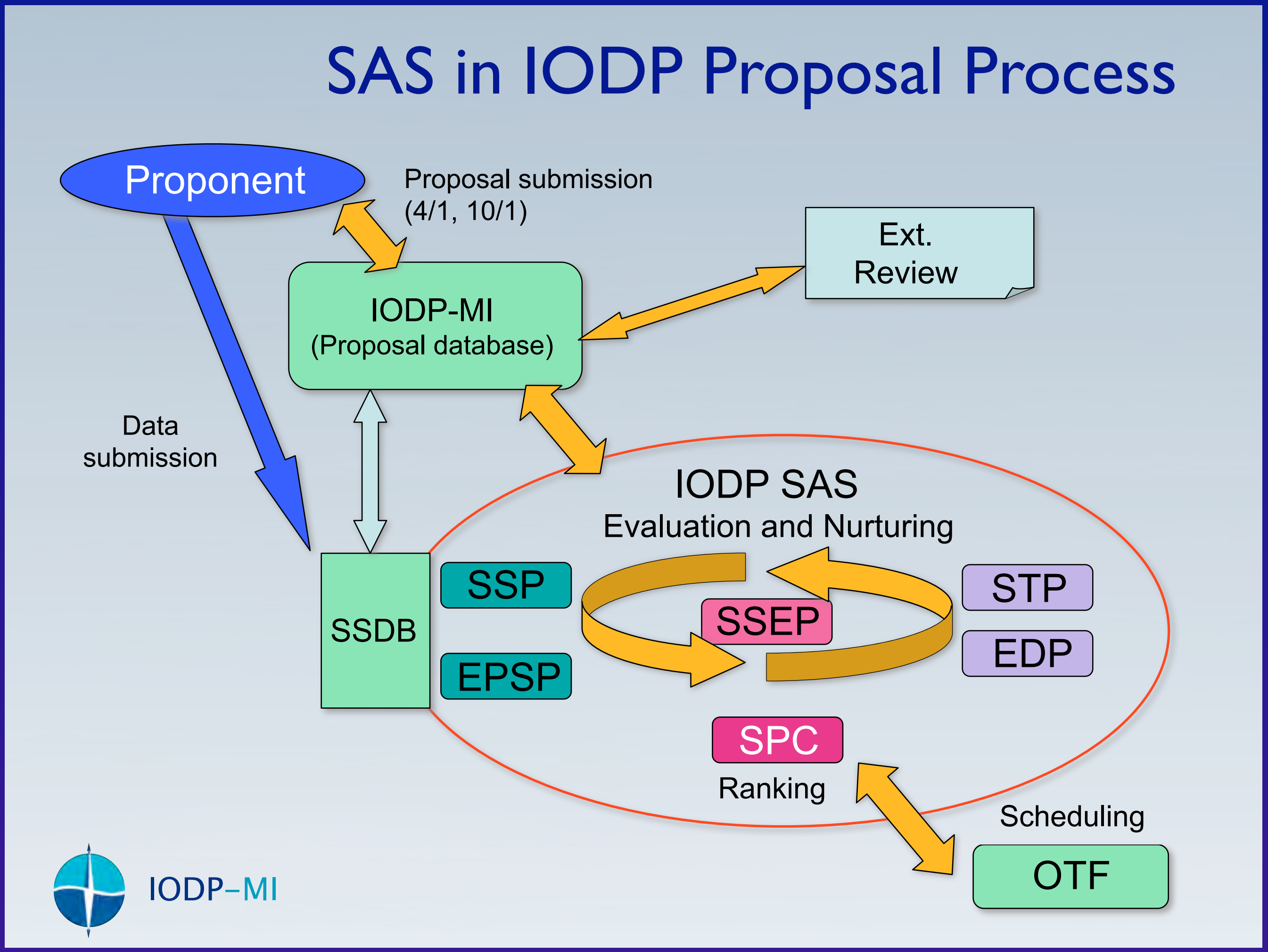
After FY08/09 budget shortfalls came to light in January, March SASEC asked WG to also look at reduced SAS for cost savings.

As discussed at Nov 2007 SASEC meeting, WG findings are based on an "internal" review, with IODP community input via responses through Feb 28 to the WG questionnaire distributed in Dec.

March 2007 SASEC

SAS Working Group Report - WG Perspective

Overall WG perspective and recommendations honor the clear statements of role of SAS in ISP (2001), IODP Principles (2002), and IODP Memoranda (2003). All three define a proposal-driven process for developing annual IODP science plans, with SAS providing the integrated proposal review and the recommended science plans to the CMO.



The interim WG recommendations preserve the core SAS proposal review process (SSEP/SPC), but identify significant efficiencies and cost savings in terms of reduced panel memberships and technical panel meeting frequencies. WG did not consider in depth the potential for joint ICDP/IODP evaluation of all IODP and ICDP proposals, but agreed that a coordinated process is needed for "amphibious" projects involving both IODP and ICDP drilling.

SAS issues raised in questionnaire responses or by WG

(✓= one key issue described in this presentation)

- ✓ Panel sizes and terms of membership - issues of (a) corporate memory vs new blood as well as (b) budget limits
- Proposal review process and SAS "corporate memory": Shortening/ simplifying the process to reduce proposal residence times and possibility of inconsistent reviews
- Focusing technical/engineering/survey advice better
- Need for more proactive long-term planning by SPC and SASEC
- SAS communication - between panels, among panels/IODP-MI/IO's, and among panels/PMO's
- Relationships between SAS panels and corresponding IODP-MI task forces
- Disconnect between site survey recommendations and funding process
- Need for earlier EPSP previews of proposals with likely safety concerns

Panel sizes and terms of membership

- WG: Voluntary reductions in technical panel membership levels (STP, EDP, SSP, maybe EPSP) - smaller "core" memberships augmented by expert advice as needed at one of two annual meetings.
  - Panel chairs agreed, assuming better interaction with PMO's for expertise and activity level of members. SPC and PMO's tentatively agreed on reductions of US and Japanese membership, but not ECORD, for 5/5/3(1)/1 model rather than current 7/7/3(1)/1 (which is not actually mandated).
- Similar reduction being implemented by PMO's for SSEP and SPC
- WG, SPC, and PMO's: standard term of 3 years but allow flexibility for 3rd and 4th years of membership at PMO discretion upon request from SAS through IODP-MI.
- Depending on implications of budget reductions for panel work loads, consider reducing service panel meeting frequencies depending on careful assessment of need for meetings, i.e., no mandate for two annual meetings.
- The reductions in membership levels, in some panel meeting frequencies, and potentially in #'s of observers should result in ~30-40% cost savings in SAS, largely for US and Japan.

If further SAS reductions are needed to save costs, what might be the effect on EDP?

- Addendum to WG report explored 4 scenarios for further reductions in SAS if demanded by budget shortfalls.... but did not recommend any of them at present.
- One of those scenarios was for the case that there is minimal or no program funding through 2012 for engineering development and shipboard technology improvements.
- In that case, it would be logical to consider two possibilities:
  - combining STP and EDP
  - keeping two panels but restricting meetings to one annual meeting
- Before adopting such a change, WG recommended first consulting with SAS itself. EDP might think ahead to envision how it thinks it could best function on a reduced basis.

APPENDIX 3:

Report from STP

Report form STP

Makoto Okada (STP)

EDP meeting held in Tokyo,
9-11 July, 2007

Results from the latest STP meeting

The latest STP meeting was held in San Francisco, USA during 7-9 Dec., 2006.

STP generated 1 recommendation, 24 consensus statements, 10 action items.

6 consensus was sent to SPC, and others ware directly sent to IODP-MI

Consensus statements sent to SPC

0612-03: ESO Temperature Tool

0612-09: STP Mandate.

0612-10: STP Working Group Reports

0612-11: Operations Review Task Force

0612-12: STP Meeting Format

0612-13: Larger Drill Pipe

Items sent to SPC

STP Consensus 0612-03: ESO Temperature Tool

STP recommends that ESO upgrades its currently used downhole push-in temperature tool to an absolute accuracy of 0.01°C and a resolution of 0.001°C. This must be accomplished before the New Jersey Expedition.

Items sent to SPC

STP Consensus 0612-09: STP Mandate.
STP discussed the panel mandate at the December 2006 STP meeting and agreed that it did not need any modification at this time. The current mandate allows STP to restructure its two meetings per year to address immediate issues at one of its yearly meetings, while dealing with future issues and planning at the other (STP Consensus Statement 0612-12). Any specific changes will be addressed after the SASEC working group on SAS Review reports its findings.

Items sent to SPC

STP Consensus 0612-10: STP Working Group Reports
STP will continue to have three working groups within its structure: Chemistry & Microbiology (CMWG); Petrophysics (including Physical Properties, logging, downhole measurements, paleomagnetism, and underway geophysics); Core Description (including Micropaleontology).

Items sent to SPC

STP Consensus 0612-11: Operations Review Task Force

STP welcomes the presentation by Thomas Janecek on how the Operations Review Task Force may proceed in future, together with the opportunity for STP to become more involved in considering Expeditions in terms of Scientific Technology. STP agrees with the proposal that the VP Science Operations will report annually on expeditions reviewed in that time frame (in line with the proposed STP Roadmap agenda), and that where appropriate IODP-MI should request specific advice from STP and participation in individual reviews.

Items sent to SPC

STP Consensus 0612-12: STP Meeting Format

STP agrees to change the format of its twice-yearly meetings in the following way: both meetings will deal with immediate issues, while one meeting will deal with regular reports (IO, IODP-MI, etc.) and the other will consider future issues and planning allowing STP to be more proactive.

APPENDIX 4:

SSEP #8 Report to the EDP

SSEP 8 Report to the EDP

Bill Ussler

July 9, 2007

SSEP 8 Presentation

- Reviewed EDP mandate
- Major EDP activities - proposal review and Technology Roadmap development
- Reviewed Tables 1 and 2 of TR
- IODP-MI Role in TR and ED
- Three types of ED Proposals
- Addressed SSEP Consensus on difficult drilling

SSEP Consensus 0611-5

The SSEP approved to include discussion on technologies for difficult drilling and request a liaison from the Engineering Development Panel to participate in the next SSEP meeting.

Difficult Drilling/Coring/Sampling

1. Lithologic
   a. Fractured lithologies - young, fractured basalts; coral reef rubble (Tahiti, Leg 310)
   b. Chalks containing hard fragments (chert) - e.g., Shatsky Rise, Leg 198
   c. Hard-soft interlayers (chert-carbonate interbeds) - e.g., Blake Nose, Leg 171B
2. Thermal
   a. Deep drilling - e.g., Nankai (603A, B, C & D); Superfast (Legs 309/312)
   b. Ridge crests/hydrothermal systems - e.g., TAG hydrothermal field (Leg 158)

3. Fluid Overpressures

a. Unconsolidated coarse sediments - e.g., New England Hydrogeology (637Full-2)

b. Sedimentary Basins - e.g., Gulf of Mexico (Leg 308)

4. Active Tectonics

a. Active strike-slip faulting - e.g., San Andreas Fault Zone (SAFOD), ICDP

b. Accretionary prisms; decollement - e.g., Barbados (Legs 78A, 110, 156; 171A); Nankai (Legs 131, 190; 196; 603A, B, C, &D)

5. Contamination

a. Fluid Chemistry - gas and water

b. Microbiology - e.g., Mid-Atlantic Ridge Microbiology (677-Full)

SSEP8 Proposals

- 35 total
- 3 Mission Proposals (new proposal category)

Mission designation based on

1. an intellectually integrated and coordinated drilling strategy
2. originating from the scientific community
3. address a significant aspect of an IODP Science Plan theme over an *extended period*
4. merits *urgent* promotion in order to achieve overall IODP program goals

Proposal #	Lead Proponent	Location	Topic	R/NR/MSP	Tech Issues
514	Droxler	Maldives	Oligocene/Neogene sea-level/carbonates	NR	limited core recovery on Leg 166; high percentage core critical for detailed strat
556	Wefer	Brazil-Malvinas	paleoceanography	NR	
567	Thomas	S. Pacific	Paleogene - paleoclimate	NR	Eocene - chert/carbonate interbeds??
601	Takai	Mid Okinawa	hydrothermal system/deep hot biosphere	NR	drilling/coring hard-rock/sulfide mounds
623	Neal	Onton Java Plateau	LIP	R/NR	3000m R drilling into basalt flows - poor recovery?
634	Barker	Antarctic circumpolar current	paleoceanography	NR	
656	Droxler	Belize Cont Mar	origin modern barrier reefs	NR/MSP	driling coral reefs
662	D'Hondt	S. Pacific gyre	deep biosphere	NR	microbial and geochemical contamination
669	Sager	Walvis Ridge	testing hot spot hypotheses - LIP	NR	drilling/coring hard rock - high resolution paleomag
671	Sacchi	Tyrrhenian Margin	active caldera	MSP	drilling hydrothermal system; high T; active tectonics; borehole observatory
683	Zheng	E. China Sea	East Asian Monsoon	R/NR	borehole observatories
686	Jaeger	S. Alaska	tectonics and climate	NR	
694	Tatsumi	IBM	arc and continental crust formation	NR/R	
695	Arculus	IBM	continental crust	NR	paleomag; drilling induced remanence; vertical core orientation
697	Tamura	IBM	rear arc crust site	NR	high T in borehole?
698	Tatsumi	IBM	continental crust/ultra deep drilling	R	8000 m borehole; 7200 m in basement
703	Brown	Costa Rica	seismic hydrologic observatories	NR/R	borehole observatories; seisCORK development
704	Goldfinger	Sumatra	rupture dynamics and forearc structure	NR	S-CORK development

706	Coffin	Kerguelen	LIP	NR	
707	Kobayashi	Sagami Bay	borehole observatories/seismicity	NR/R	3000 m boreholes; 10 sites with BH observatories (4=Riser)
709	Ohkouchi	NW Pacific	Mesozoic extremes - paleoceanography	NR	chert/shale sequences
712-APL	Davis	Nankai or JdF	Sediment-CORK	NR	new technology to be developed
713-MP	Clift	Indian/Pacific Ocean	Cenozoic Monsoon	NR/R/MSP	none explicitly identified
714-APL	Lobo	G. of Cadiz	sealevel change/sequence strat	NR	
715	Camerlenghi	Mediterranean Sea	submarine landslides	NR/MSP?	geotechnical (thin-wall) sampling; logging to mud-line; cone penetration tests (CPTU); in-situ vane shear tests
716	Webster	Hawaii	coral reefs and climate change	MSP	drilling/coring coral reefs
717	Muller	Indian Ocean/W. Australia	plume, volcanoic margin	NR	drilling/coring hard rock
718	Hirano	NW Pacific	petit hot spots	NR	deep water; recovery of volcanic sequences
719-MP	Ildefonse	E Pacific/N. Atlantic	Moho	NR/R	deep drilling/coring of ocean crust; high temperature logging and fluid/gas sampling (>200 deg C)
720-MP	Hopper	various	Continental breakup	NR/R	deep drilling/coring; high temperatures?
721-APL	Cook	Bering Sea	climate change	NR	
722	Yamamoto	Sagami Bay	tectonics and paleoseismicity	NR	
723	Kobayashi	Sagami Bay	geodetic and seismic network/observatories	NR	borehole observatories
724	deMenocal	G. of Aden	paleoenvironment and African faunal extinctions	NR	
725	Huismans	N. Atlantic	magmatism, volcanic rifted margin	NR/R	1 deep hole; recovery of volcanic sequences

Technologies for Difficult Drilling/Coring

- Problem - primarily heave, maintaining controlled weight on bit and lithology
- Heave compensation - passive & active
- Sea-bed frame/template
- Bumper sub - ODP used before heave compensation
- Motor Driven Core Barrel (MDCB) - ODP has had experience with this
- Portable Remotely Operated Drill (PROD) - commercial venture; MSP

APPENDIX 5:

Technology Roadmap Prioritization Schemes

Technology Roadmap Prioritization Schemes

Bill Ussler

July 9, 2007

Review of Past Prioritizations

- Unweighted ‘ranking’ (Windischeschenbach - EDP #3)
  - three ED subgroupings ranked independently (Sampling/Logging/Coring; Drilling/Vessel Infrastructure; Borehole Infrastructure)
  - top 10 identified in each subgroup; votes counted for H, M, or L (3, 2, or 1); no internal ranking, just a list
- Alberty algorithm proposed (New York - EDP #4)
  - ranking weighted by expertise
  - maintained three ED subgroups - not sure how to weigh across subgroups

Table 1.0: Unranked list of engineering developments that were deemed ÕhigherpriorityÕ by EDP at its June 2006 panel meeting. Refer to the Technology Roadmap for details of each engineering development.

Sampling, Logging, and Coring	*Drilling Vessel/Infrastructure*	*Borehole Infrastructure*
A-1. Thin-walled short-stroke Geotechnical Sampler	B-1. Large Diameter Pipe	C-1. High temperature electronics and sensors
A-2. Cone Penetrometer/Remote Vane	B-2. ROV Guided Logging Tools	C-2. Temperature tolerant drilling muds/drilling bits etc.
A-4. Hard rock re-entry system (HRRS)	B-3 Heave Compensation	C-5. Packer-like tech dev
A-5. Coring guidelines/operations manuals	B-5. Seabed Frame	C-7. Realiable wellhead seals and hanger seals
A-13a. provide core orientation on standard coring tools-APC	B-6. Pressure Compensated Bumper sub	C-8. Electric, optical fiber and fluid feedthroughs at wellheads
A-13b. provide core orientation on standard coring tools-rock	B-7. Rig Instrumentation System	C-13. Sampling techniques for microbiology experiments and in situ incubation systems
A-17. Pressure coring systems (PTCS, PCS, FPC, HRC)	B-10. Real time drilling parameter acquisition while coring.	C-14. Development of low power sensors - temperature, pressure, electromagnetic, seismic, chemical measurements
A-18. Pressurized Sample Transfer 4. (autoclave)	B-11. Formation logging while coring	C-16. Systems reliability for LTMS
A-22. Upgrade to XCB system	B-25 Improve expandable casing system	C-17. ROV-serviceable wellheads and submarine cable connections
A-23. Anti-contamination system (gel core barrel)		C-19. Design standards for electrical, communications, mechanical, fluid systems

Alberty Algorithm

- Two votes for each ED item:
  - Priority (P; high => low; 3, 2, or 1)
  - Expertise (E; high => low; 3, 2, or 1)
- Weighted Ranking formula:

$$R = \frac{\Sigma P_i * E_i}{\Sigma E_i}$$

Larger R, higher priority

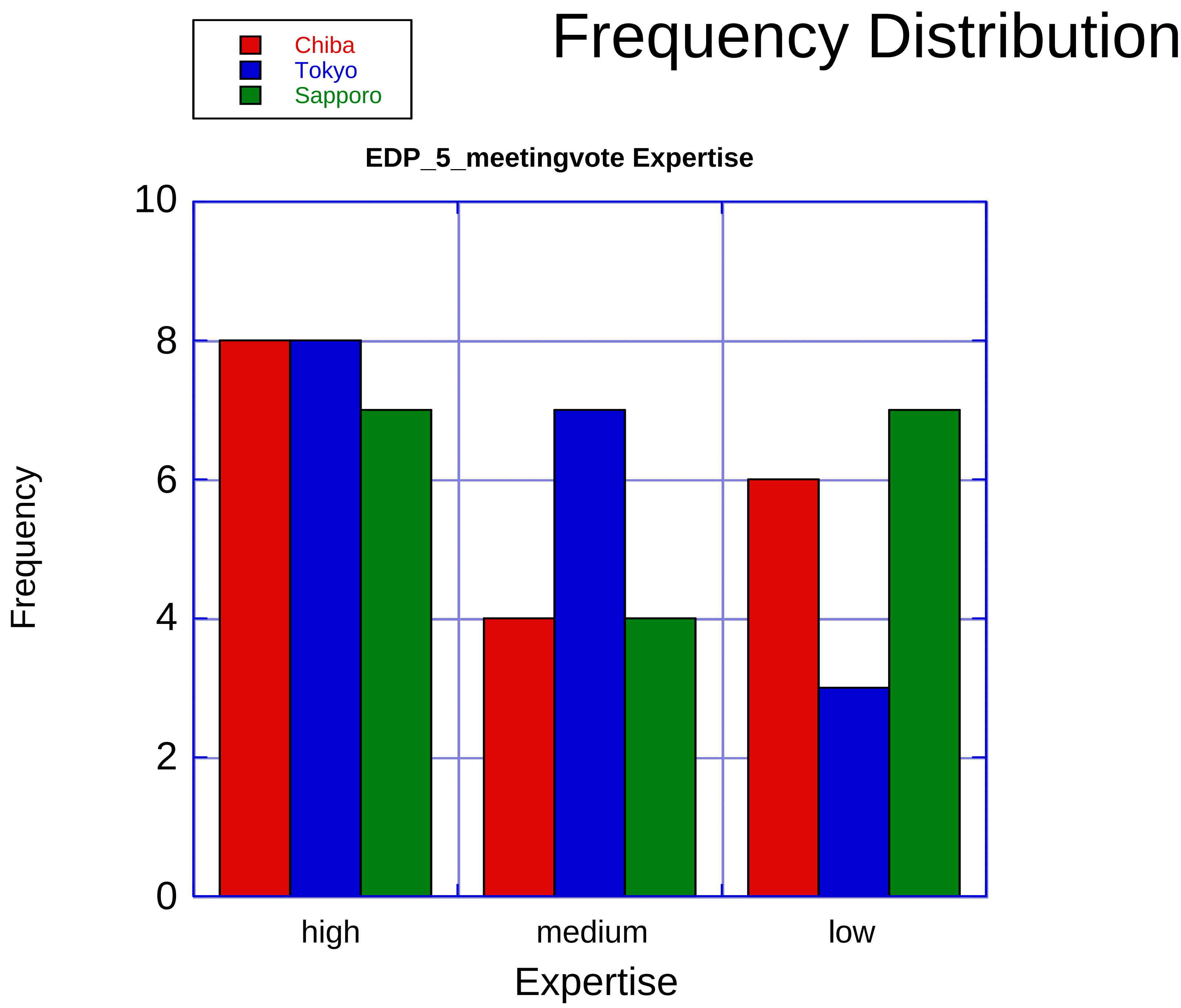
Example - choice of next EDP meeting site

	Priority	Expertise	P*E	
Chiba	2	3	6	
	3	3	9	
	2	1	2	
	2	2	4	
Each vote →	3	2	6	
	1	3	3	
	2	1	2	
	1	2	2	
	2	1	2	
	3	3	9	
	3	1	3	
	3	2	6	
	3	3	9	
	3	3	9	
	1	1	1	
	2	1	2	
	3	3	9	
	1	3	3	
sum	40	38	87	**2.29**

Weighted ranking (R)

Summary of EDP meeting site voting

	Priority	Expertise	P*E		Rank
Chiba	40	38	87	2.29	1
Sapporo	37	36	74	2.06	2
Tokyo	34	41	80	1.95	3


Chiba
Tokyo
Sapporo
Frequency Distribution
EDP_5_meetingvote Expertise
10
8
6
4
2
0
Frequency
high
medium
low
Expertise

EDP Decisions

- Maintain 3 separate subgroupings?
- How to combine them?
- ± budget considerations in ranking scheme?
- Consider difficulty in achieving ED goal

APPENDIX 6:

NanTroSEIZE Borehole Observatory Plan – Update 07

NanTroSEIZE Borehole Observatory Plan - Update 07 -

M. Kinoshita, E. Araki (IFREE)

N. Kyo, H. Ito (CDEX)

E.Davis (PGC), D. Saffer (PSU)

K. Suyehiro (JAMSTEC)

Goal of NanTroSEIZE

Understanding mechanism of M>8 earthquakes through coring, downhole mesurement and monitoring at the seismogenic fault.

Goal of NanTroSEIZE Observatory

To monitor slips and deformations at the locked portion of the M8 seismogenic plate boundary

*Drilling operation starts this September for Stage 1
*Observatory systems are now under development.

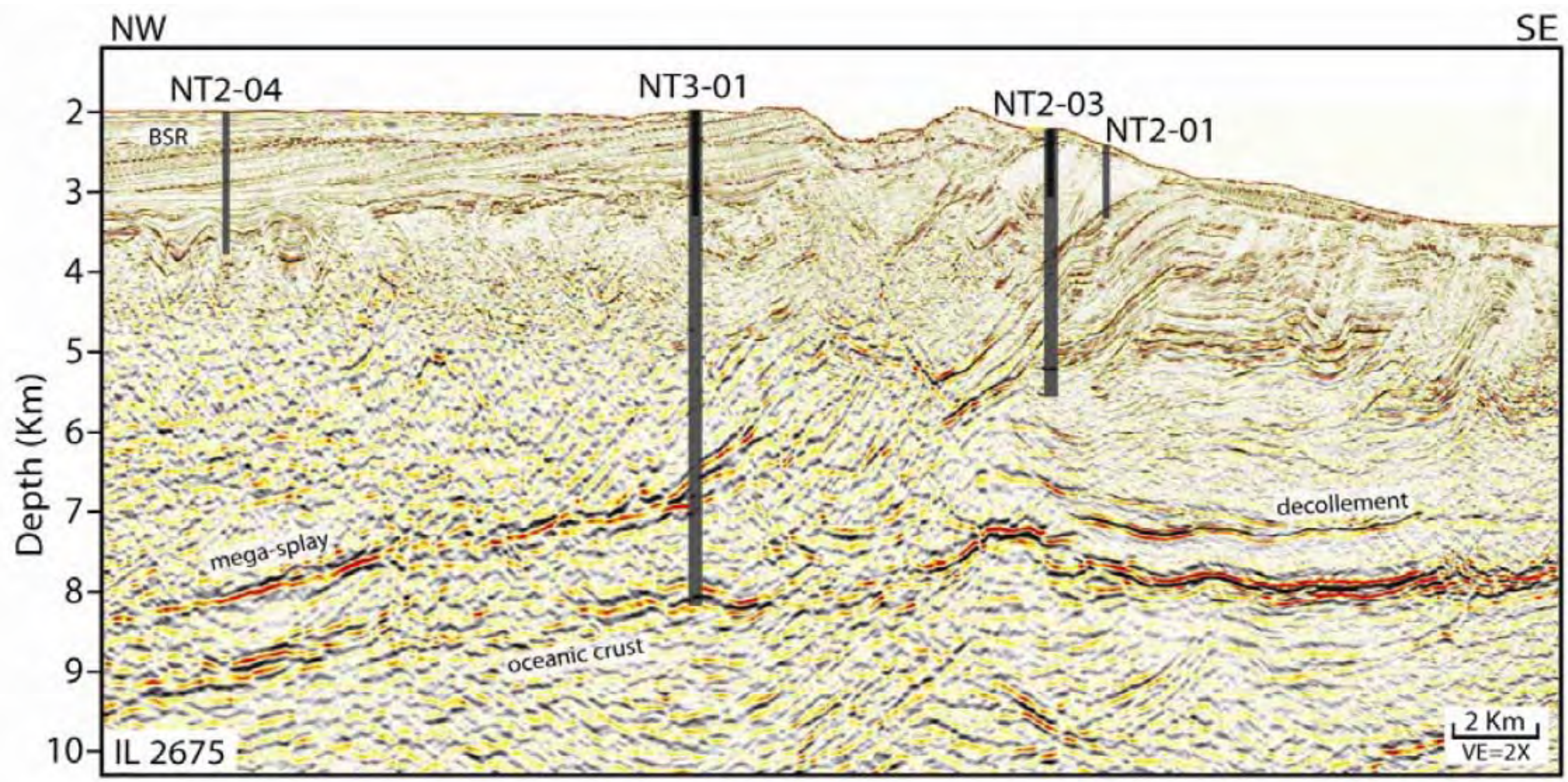
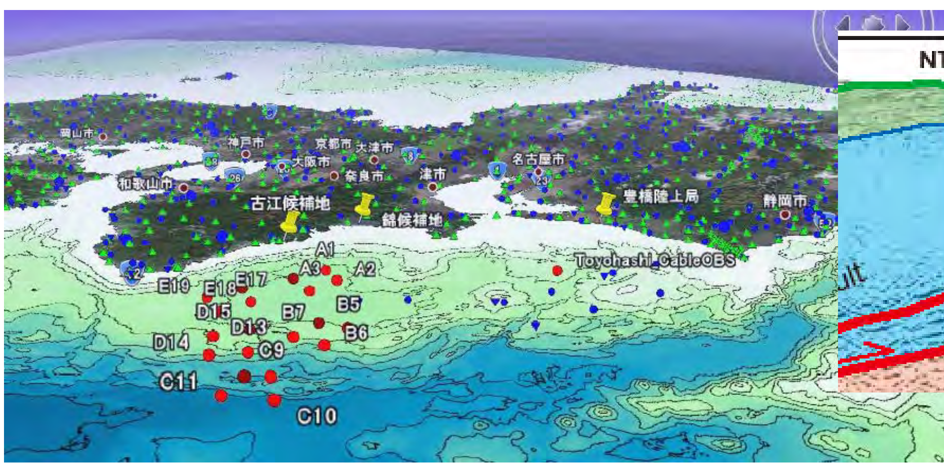
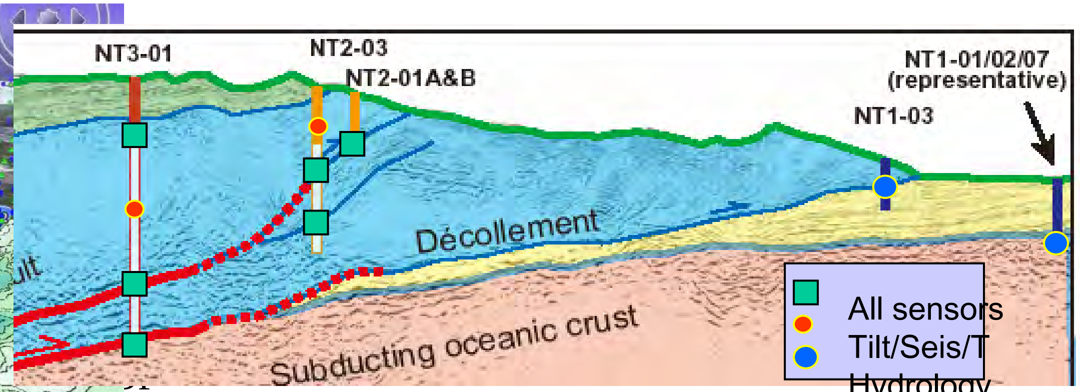


Fig. 5. CDEX 3D seismic InLine 2675 with locations of main NanTroSEIZE drill sites projected along strike. Preliminary depth converted section. Location shown in Figure 4. Note that well depths shown are potential total depths of penetration during Stages 2 and 3. Stage 1 depths ~1000-1350m.

Observatory Concept

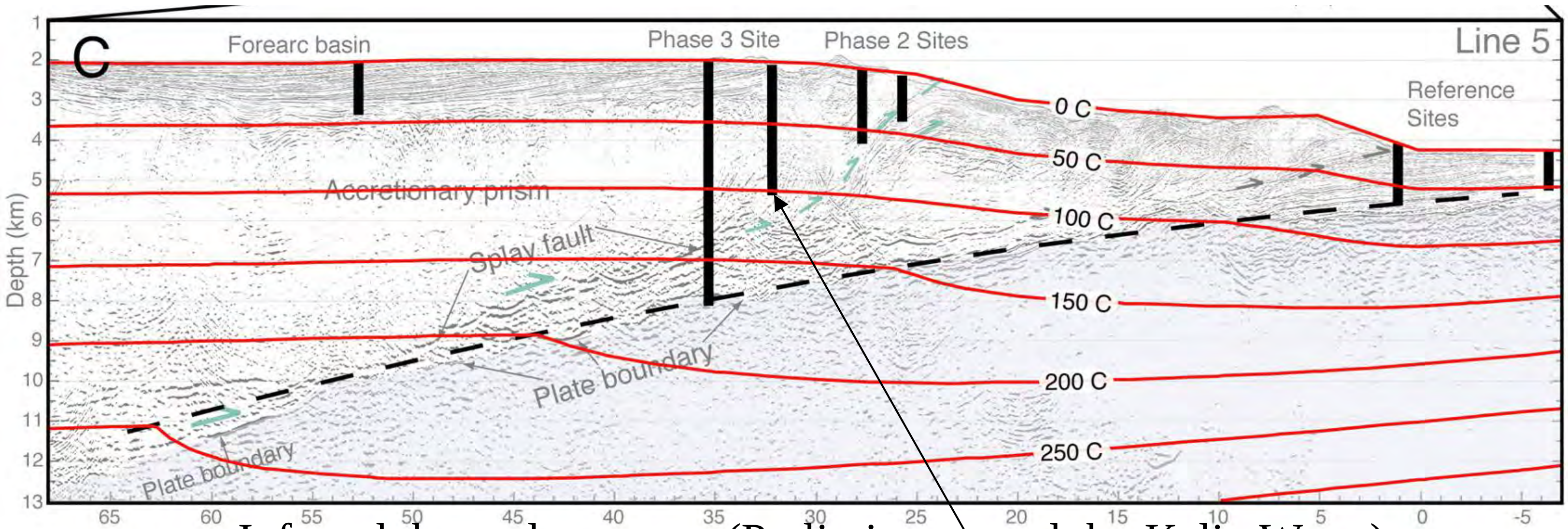
- Vertical array for near-field dynamics
  - Deep Riser boreholes
- Horizontal array for high-res. event characterization
  - Shallow boreholes
  - Seafloor stations
- Real-time, integrated system



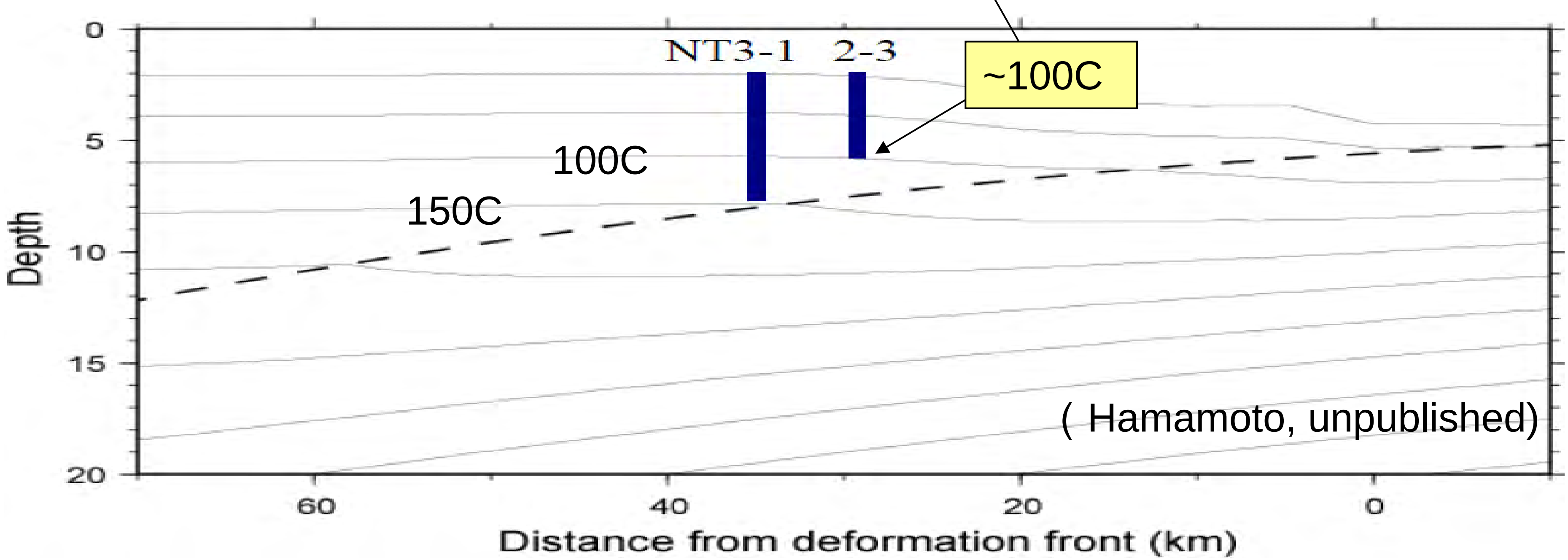


ROAD TO 4D MONITORING		2007	2008	2009	2010	2011	2012	2013		2014	2015	2016	2017
		YR	YR	YR	YR	YR	YR	YR		YR	YR	YR	YR
IODP	I	4	5	6	7	8	9	10	II	1	2	3	4
CHIKYU		1	2	3	4	5	6	7		8	9	10	11
NANTRO drilling stages		STAGE 1		STAGE 2?									
BOREHOLE OBSERVATORIES		AREAL MONITORING				VERTICAL MONITORING							
		Shallow observatories				3.5 km						6 km	
	Mid term developments												
	High T seismic												
	High T tilt												
	High T strain												
	High T cables							operational					
	High T electronics												
	Outside casing lines												
	Long term developments												
	VHigh T seismic												
	VHigh T tilt												
	VHigh T strain											operational	
	VHigh T cables												
	VHigh T electronics												
TEMPORAL ARRAY		OBS-1	OBS-2										
DONET		construction					operational						
GPS-ACOUSTIC ARRAY		construction					operational						

Thermal structure off Kumano



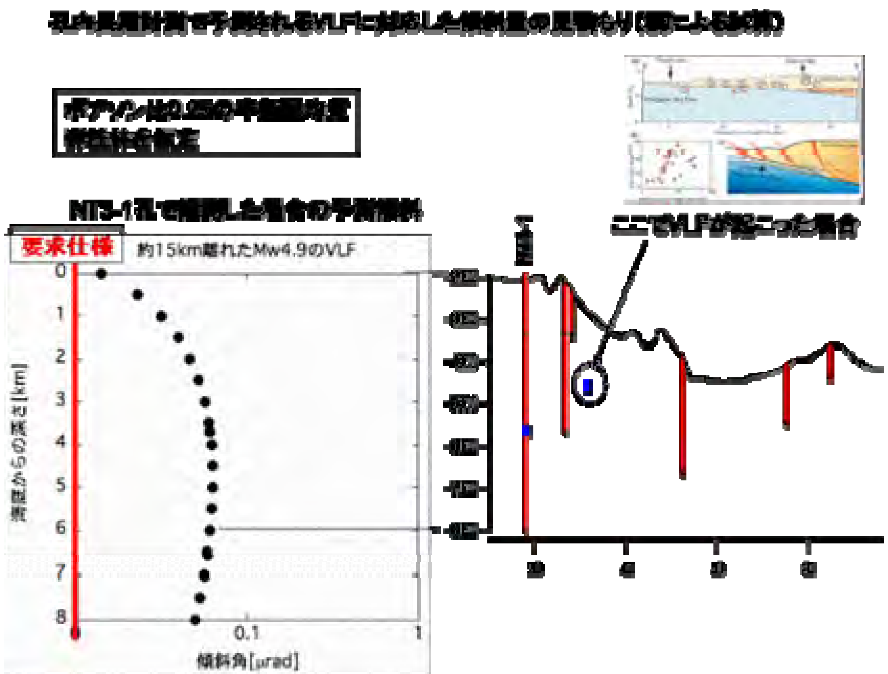
Inferred thermal structure (Preliminary result by Kelin Wang)

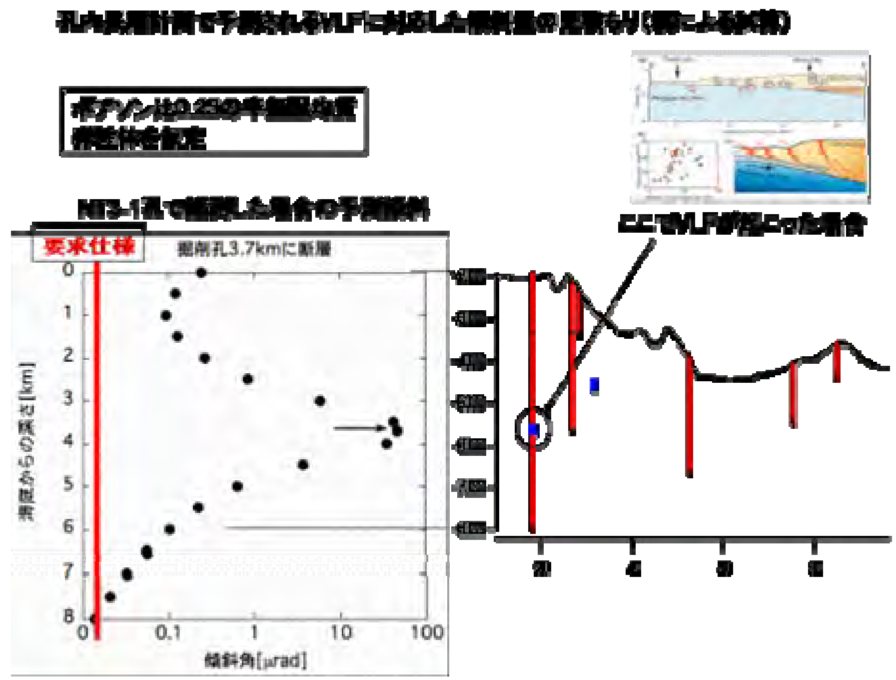


Properties to be measured

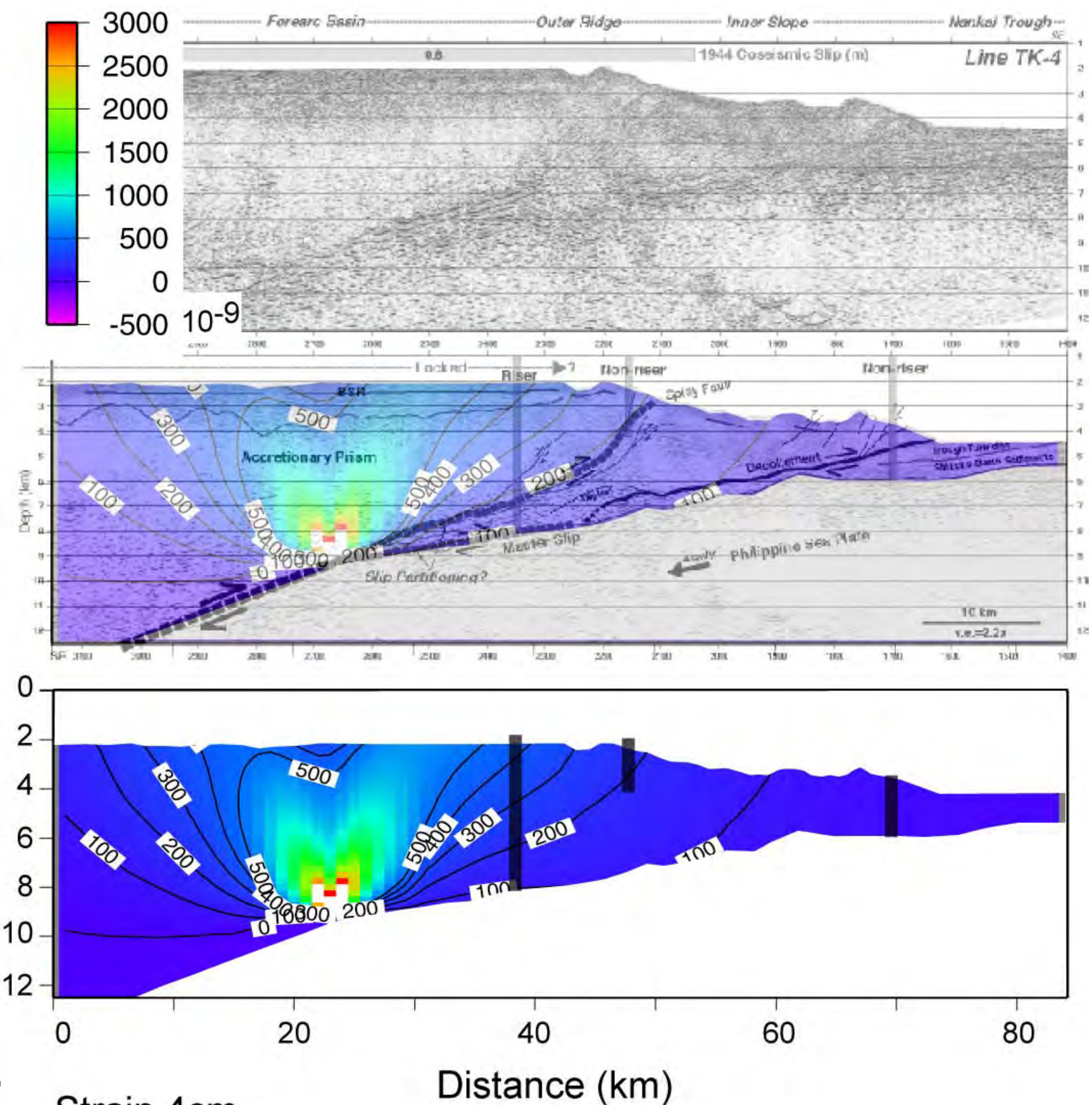
- Interseismic deformation & strain
  - Strain (Sacks), Tilt, Pore Pressure (as a proxy for strain)
- Seismic Activity (low-freq. events)
  - Broadband seismometer, Seismometer array
- Hydrological properties (overpressure)
  - Pore pressure, temperature for

Predicted tilt due to VLF event





Strain



July 09,

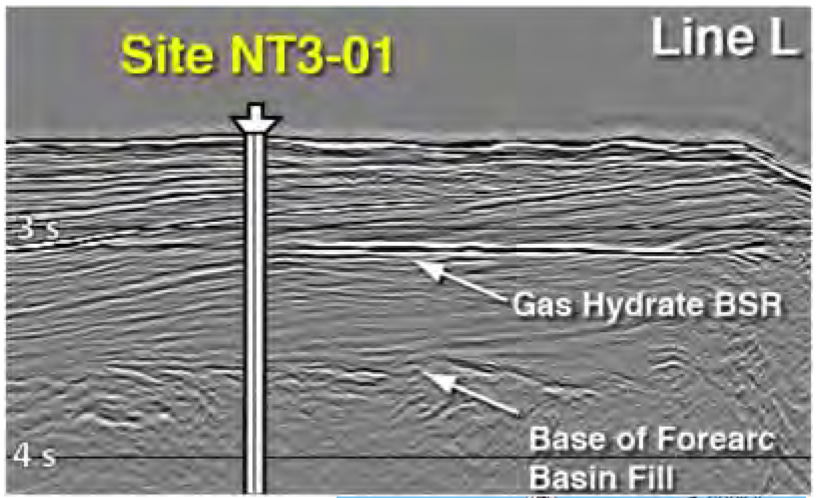
Strain 4cm

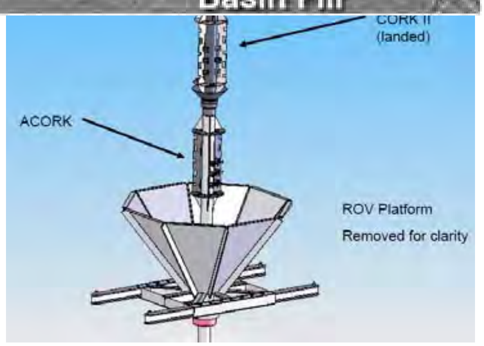
NT3-1 Non-riser Observatory - Deferred for 2008 JR Expedition

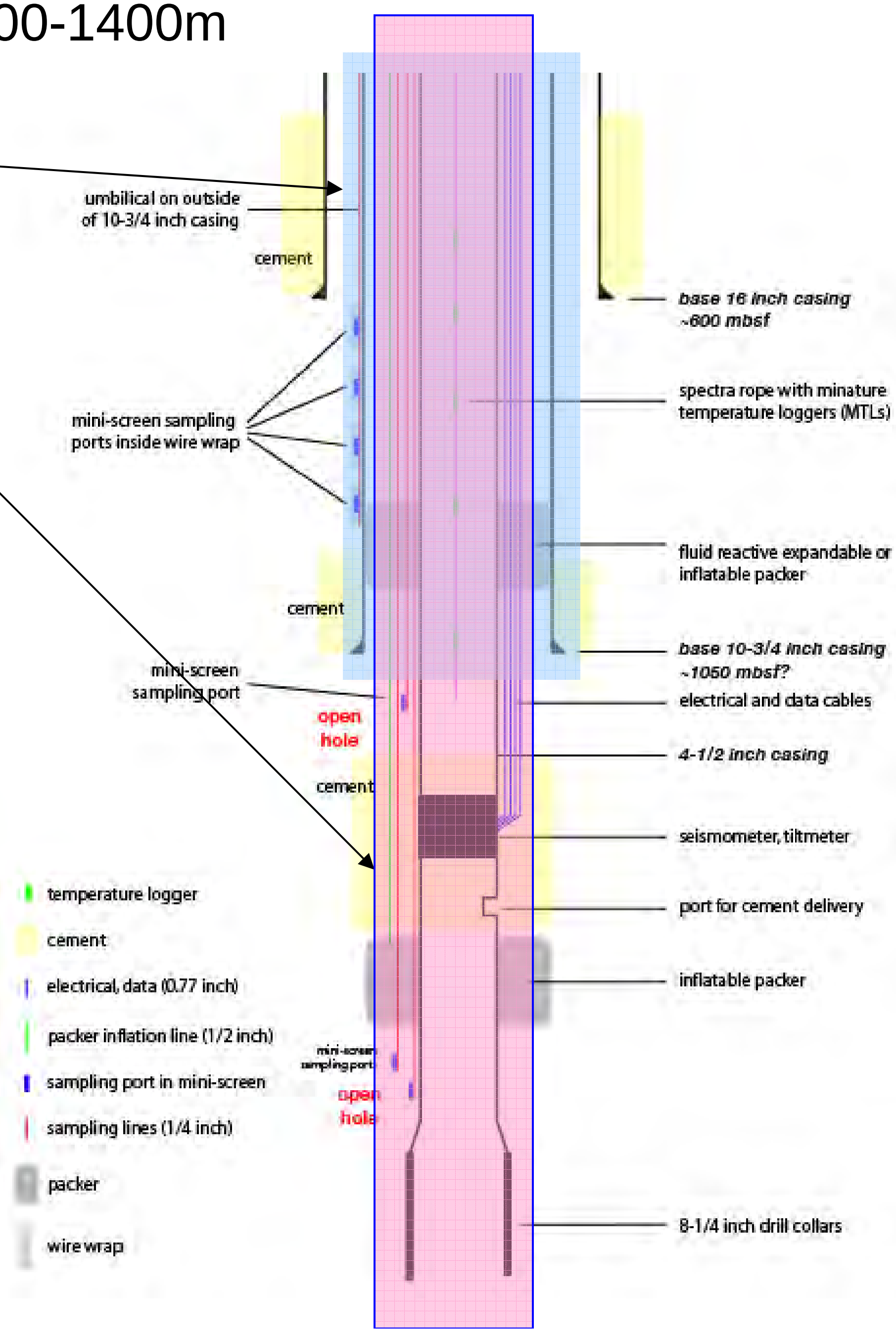
Water Depth: 2000m; Target Depth: 1300-1400m

ACORK part
behind-casing pressure

NEREID/CORK-II part
cemented strain/tilt/seis





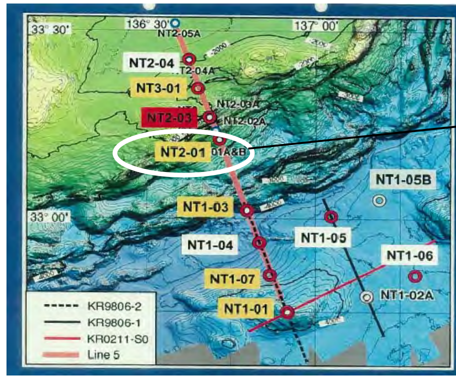


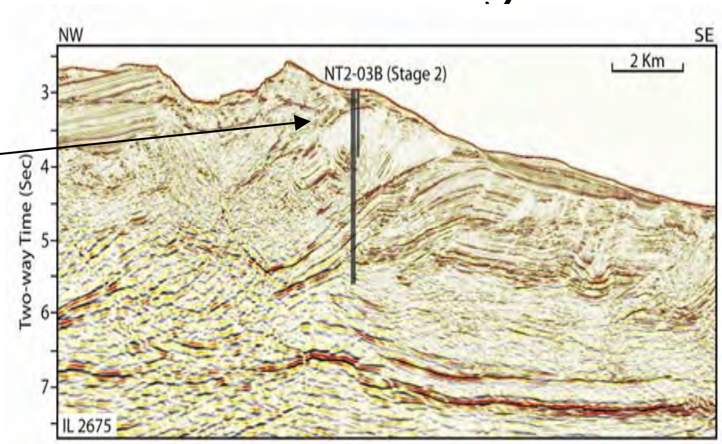
July 09, 2007

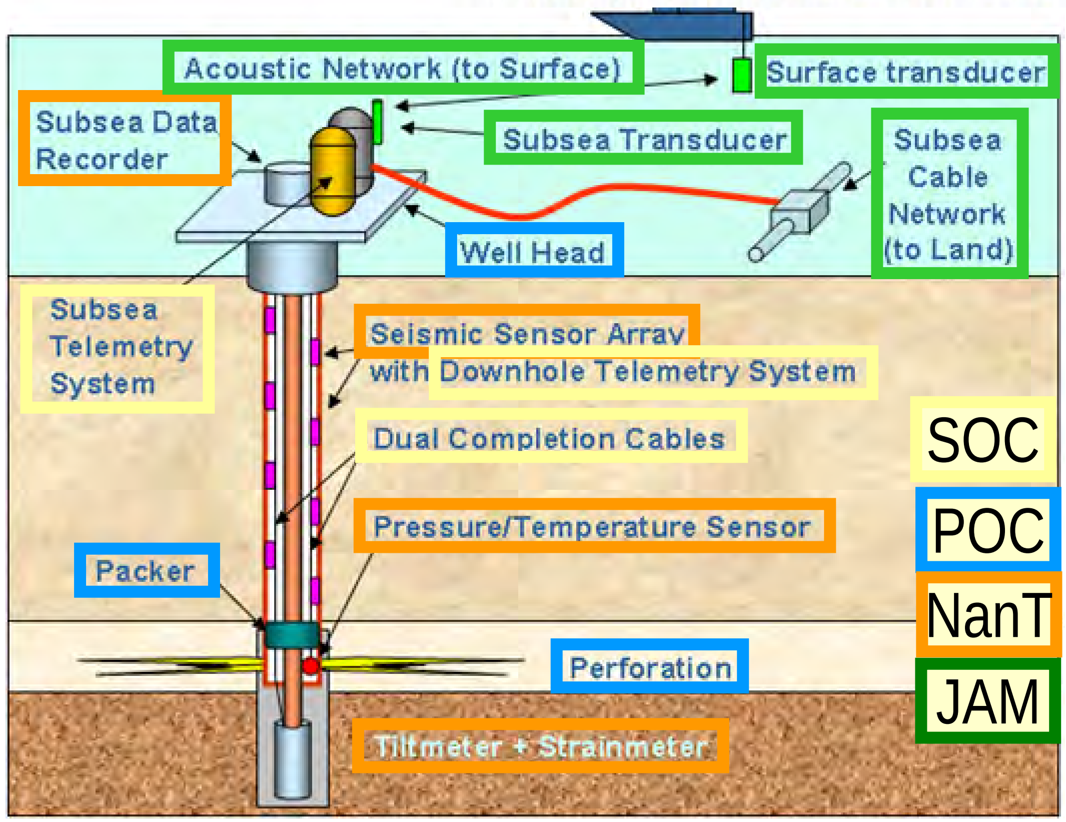
E

NT2-3 riser hole observatory

Chikyu, in 2011
WD 2178m
TD 3000-3500m
Tbottom ~90-100℃
Mega-splay

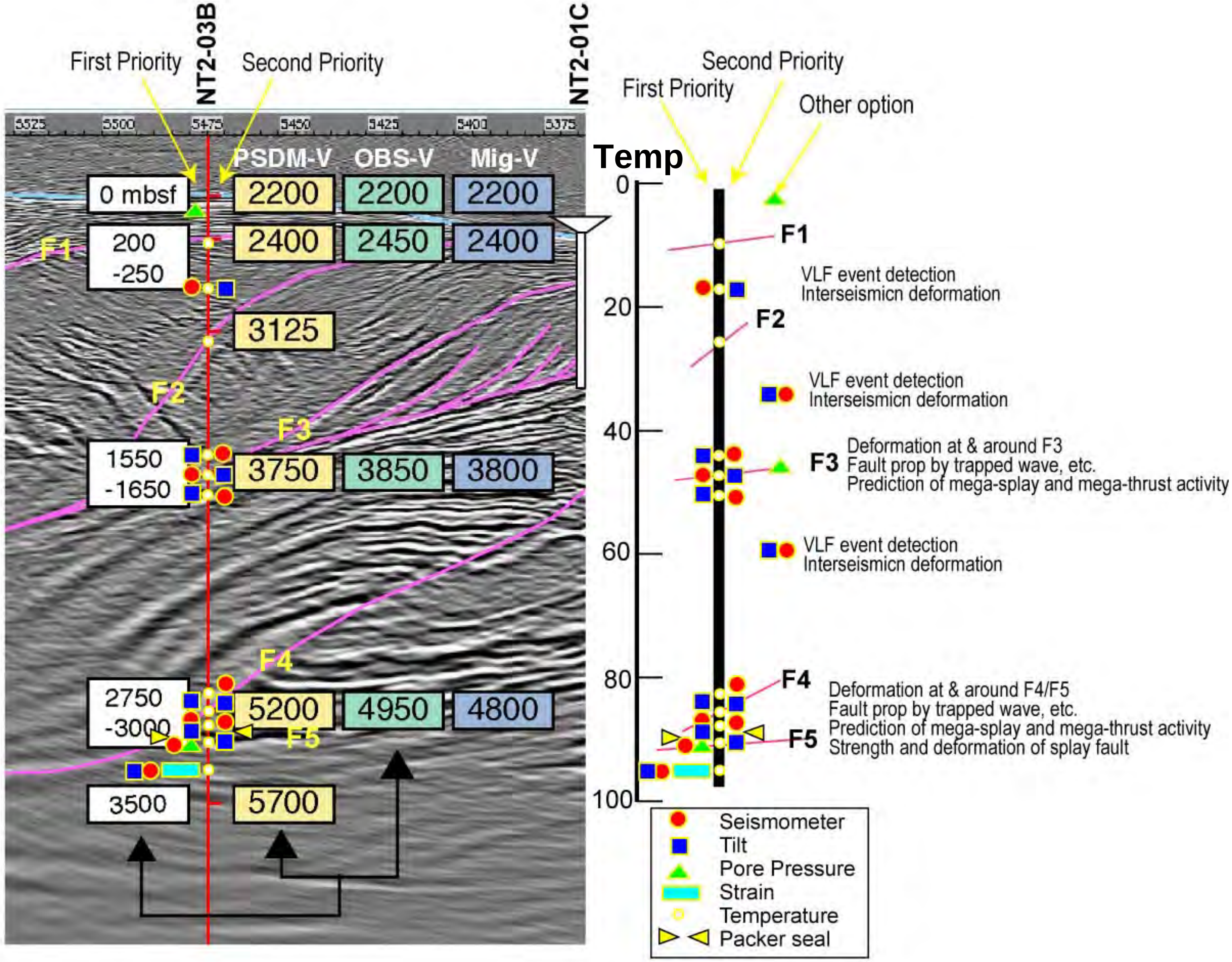




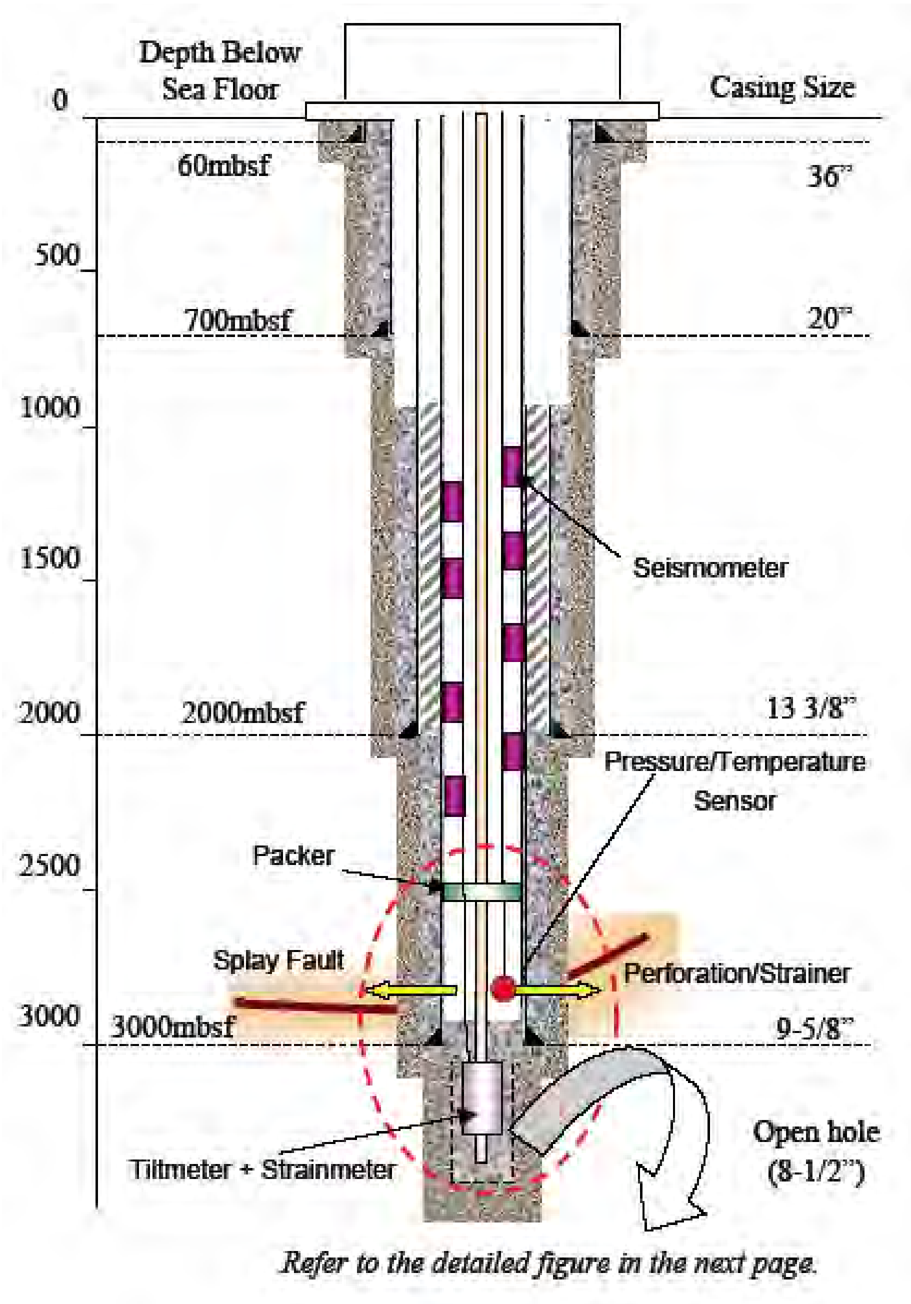


July 09, 2007

Proposed sensor distribution at NT2-03 (as of Mar.31, 2007)



Jı



NT2-3 Riser Observatory

Based on CORK-II/NEREID Type technology

Bottom-hole section:
Strain/Tilt/BBseis/PP (cemented)

Mid-hole section:
Tilt/Seis/T Array (Clampled?)

Major Technical Challenges (1)

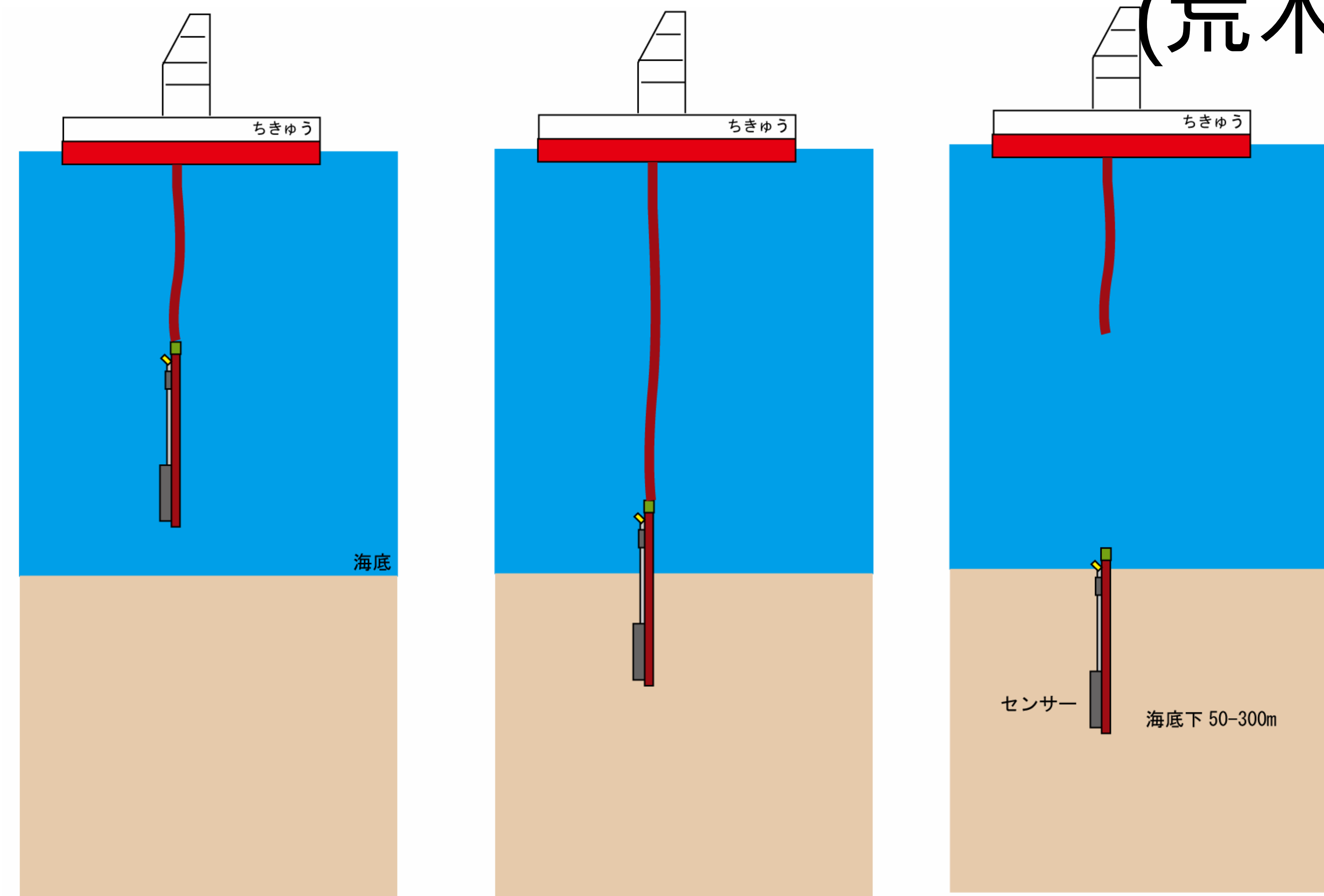
- ***Monitoring at multiple intervals***
  - Strong scientific needs for geodetic/hydrologic monitoring
  - Since a riser hole is very expensive, multiple sensors in a single hole should be considered, instead of requesting multiple holes….
  - Major technical challenges are:
    - multi-stage sub-sea cementing technique (Strain&BBseis)
    - behind-casing technology (strain/PP), which needs major technical development at the wellhead (limitation in the number of feedthrough)
    - multiple packers in casing and perforation between packers (PP)
    - reliable clamping to the casing (tilt)
  - These needs a long-term planning with international support
- ***High temperature***
  - Anticipated bottom-hole temperature for NT2-03 (3500m) and NT3-01 (6000m) holes are 100C and 170C respectively.
- ***>5 years of monitoring, potentially for-ever.***

Major Technical Challenges(2)

- *Data trannsfer*
  - Great hole depth causes attenuation of transferred signals
- *Coupling to the formation*
  - **Cementing** and **clamping** to obtain high-fidelity data
  - 10nrad for tilt, ~nstrain for strain.
- *Mechanical shock applied to sensors during deployment*
  - New strainmeter uses a soft metal to have better S/N
- *Vertical drilling AND core sampling at the fault interval*
  - Tiltmeter and seismometer currently available allow only +/-3 deg of instrument inclination.
- *Power supply and data recovery*
  - Connection to the seafloor cable network
- *Simpler deployment for shallow holes*

Jet-in installation of broadband seismometer

(荒木)



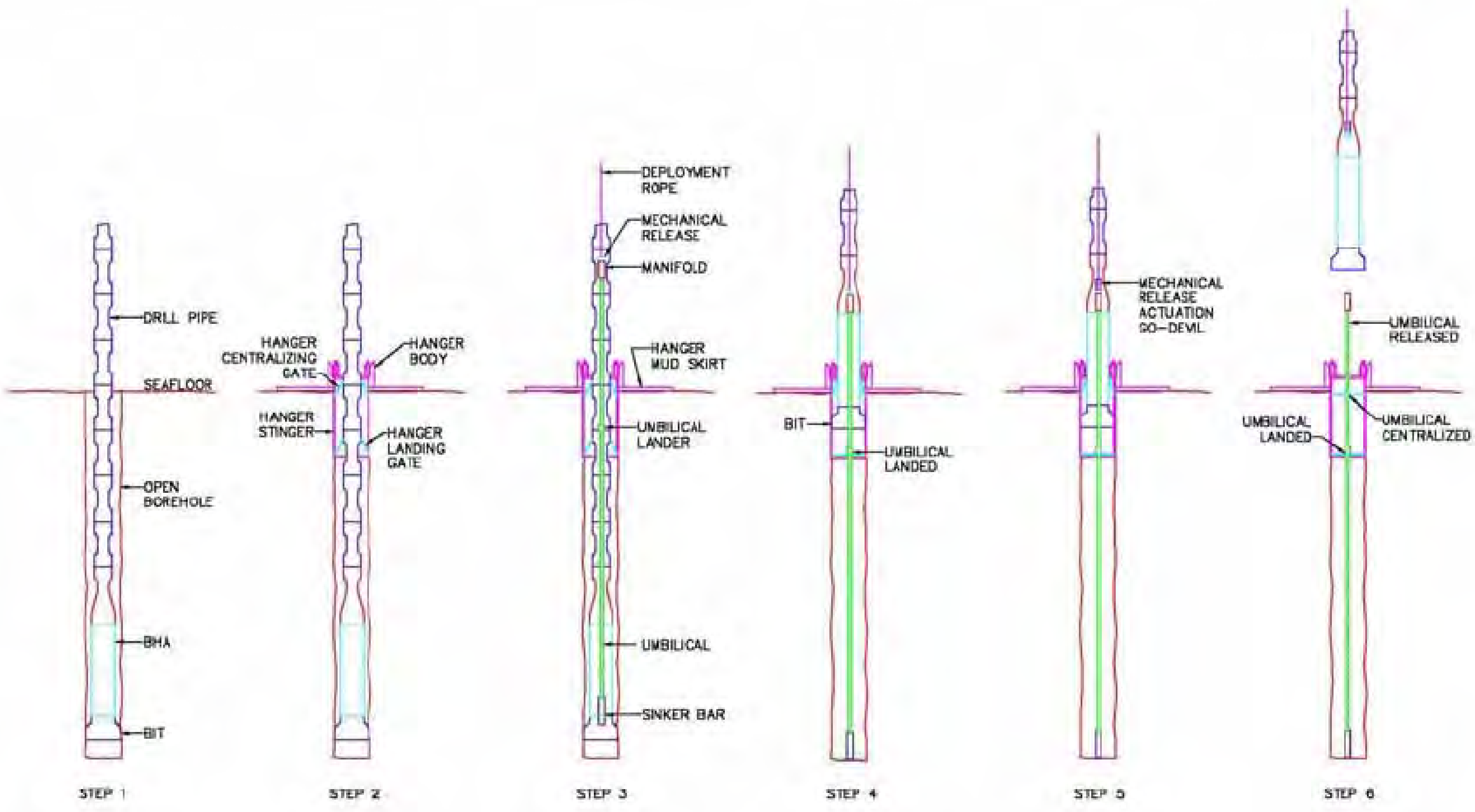
1．センサー pkg をドリルパイプの先に取り付け降下

2．Jet in

3. コネクター部分が海底に来たところで
ドリルパイプを切り離し設置完了

Sediment CORK by Earl Davis

(荒木)



P-CORK DEPLOYMENT WITH FREE FALL DEPLOYED SEAFLOOR HANGER

Development Plan in JPFY2007

- Observatory at NT2-3 riser hiole (3.5km, 90-100℃)
  - Telemetry system (CDEX) and sensors (IFREE, etc.)
- Clamping test at onland borehole
- FS for Jet-in CORK and other technical development items
- NT3-1 nonriser hole observatory (CORK-II / ACORK)
  - Deployment originally scheduled with JR but deferred.
  - Using Chikyu for deployment is being considered

END

APPENDIX 7:

Current Status on Development of Long Term Borehole Monitoring System

Current Status on Development of Long Term Borehole Monitoring System

Nori KYO

CDEX, JAMSTEC

CENTER FOR DEEP EARTH EXPLORATION
Japan Agency for Marine-Earth Science and Technology
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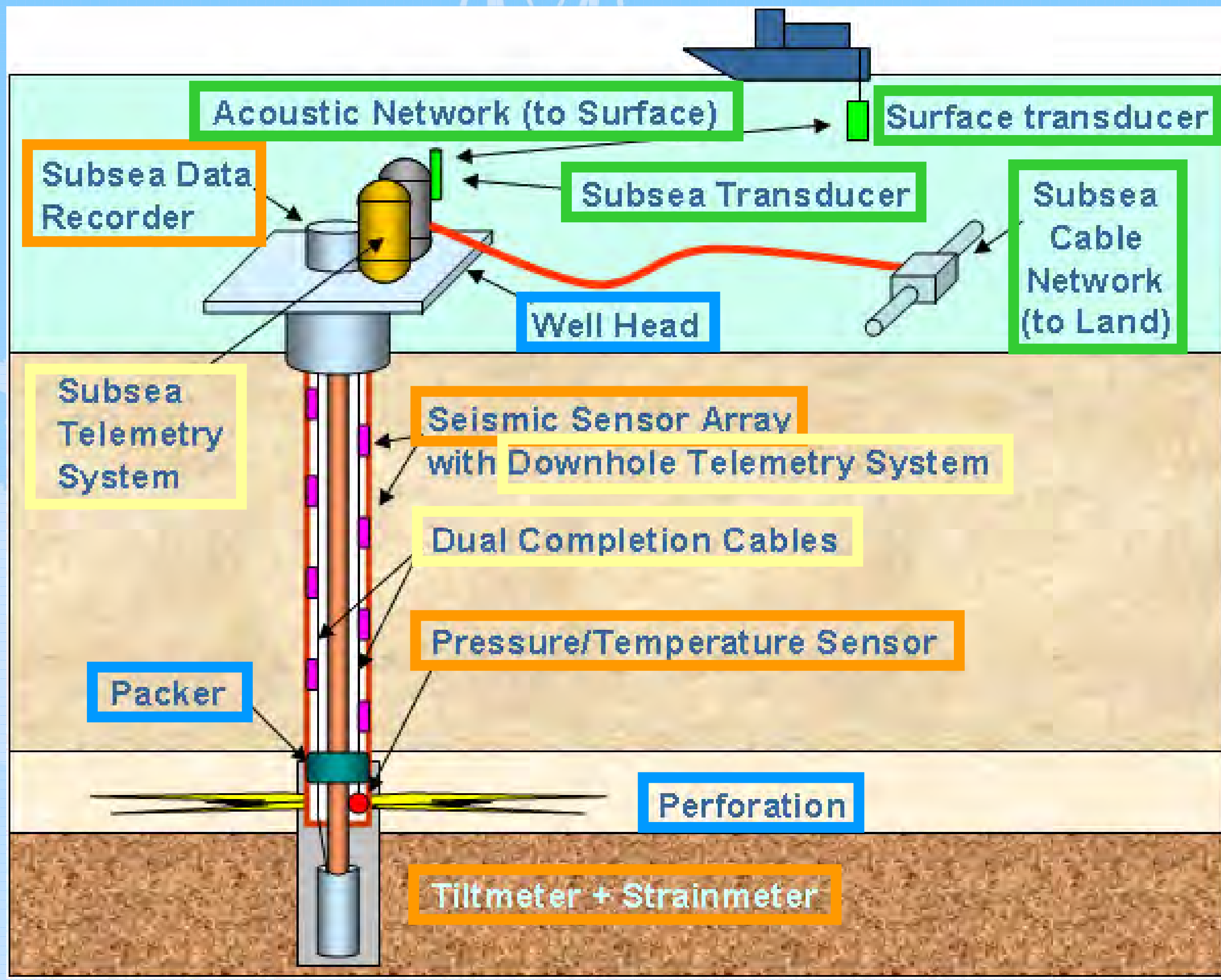
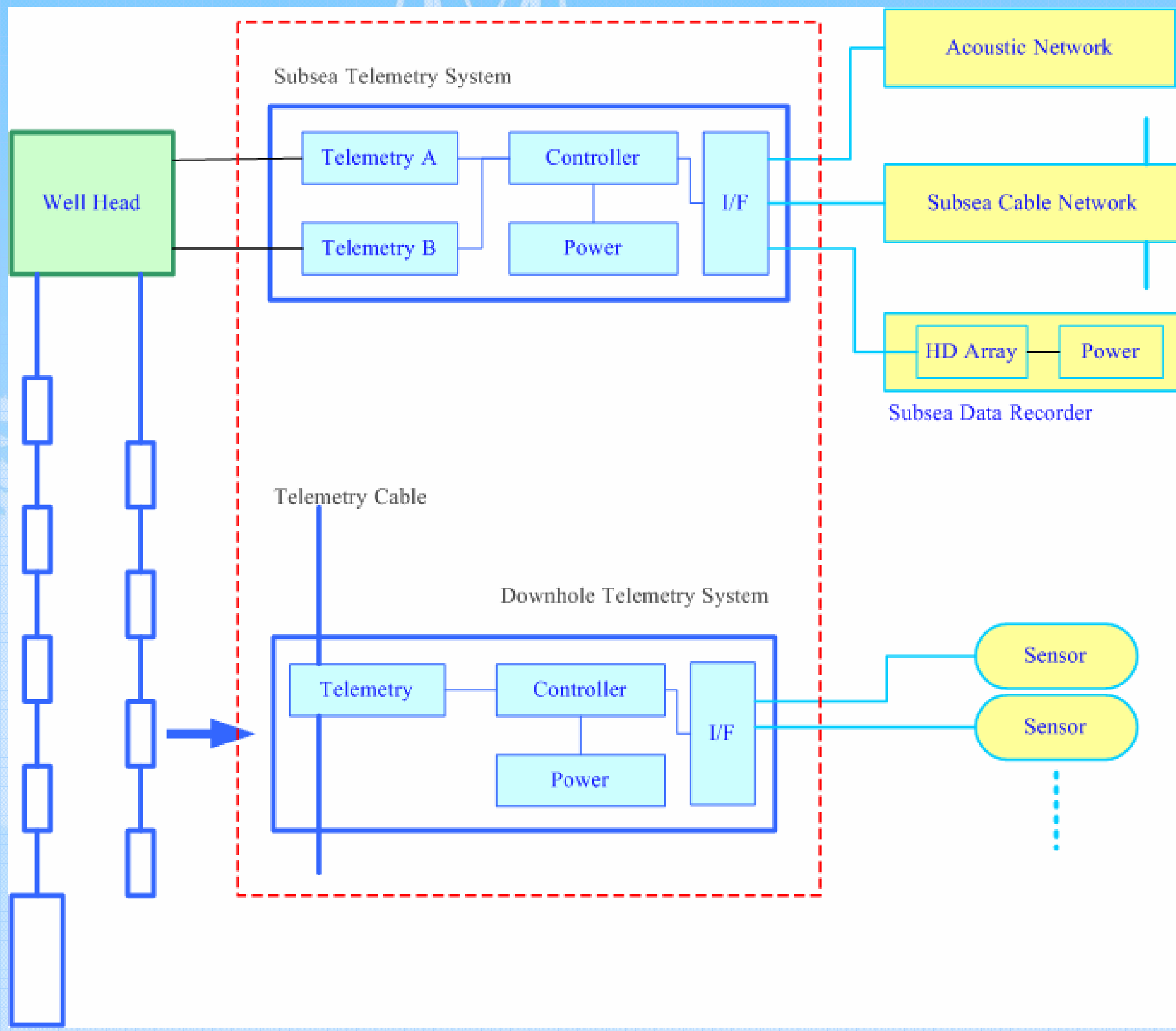
http://www.jamstec.go.jp/chikyu/ cdex@jamstec.go.jp

LTBMS Conceptual Image



Schematic Diagram of Telemetry System



CDEX Proposal for FY08-10

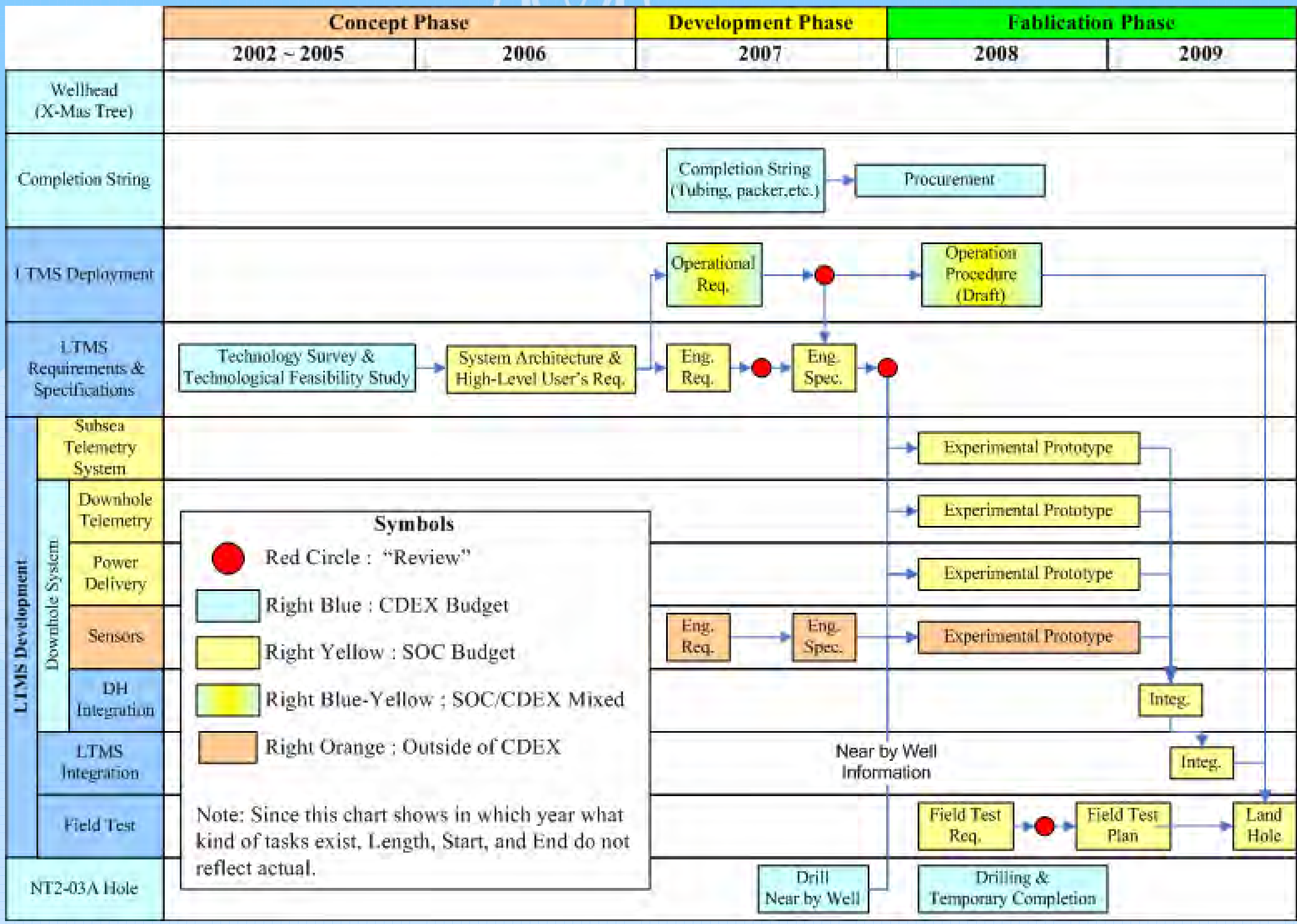
2007											
US FY07									US FY08		
JP FY H18			JP FY H19								
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
ODS (Oversea's Drilling Shakedown)							Dock		IODP:NanTroSEIZE Stage1/RL		

2008											
US FY08									US FY09		
JP FY H19			JP FY H20								
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
IODP Stage1/RL		Dock & Inspection			Non-IODP				IODP:NanTroSEIZE Stage1/RL		

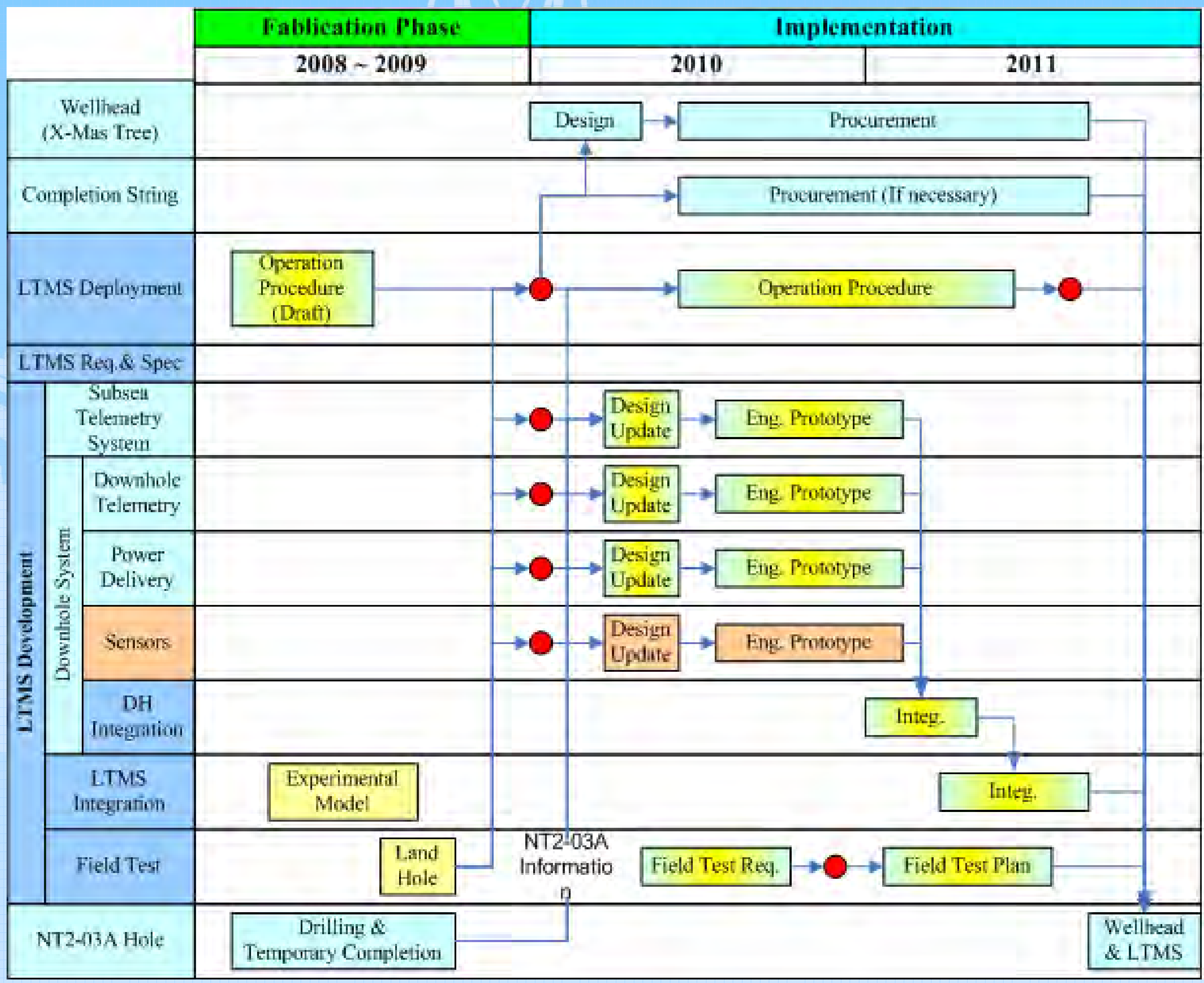
2009											
US FY09									US FY10		
JP FY H20			JP FY H21								
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
IODP:NanTro Stage2/Riser		Dock	IODP Expedition Availability (5 Months for Riser + 2 Months for Riserless) per Year								

2010											
US FY10									US FY11		
JP FY H21			JP FY H22								
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
			IODP Expedition Availability (5 Months for Riser + 2 Months for Riserless) per Year								

Development Process and Plan (1/2)



Development Process and Plan (2/2)



CENTER FOR DEEP EARTH EXPLORATION
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Scope of Work

USFY2007

- **Define Engineering Requirements**
- Define Operational Requirements
- Specify Engineering Specifications

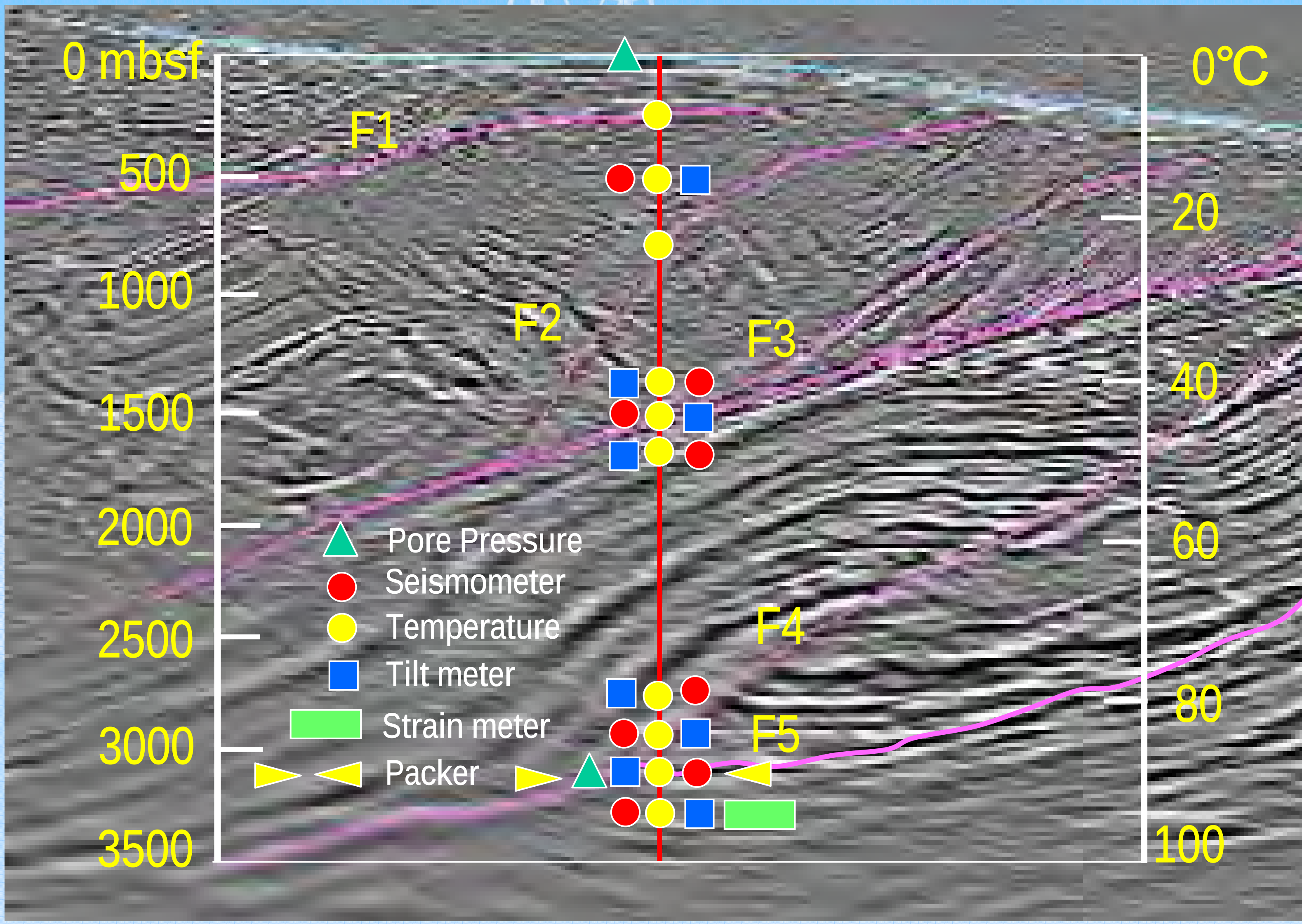
USFY2008

- Design and build EXP (Experimental Prototype)
- Define Field Test Requirements
- Prepare Field Test Plans

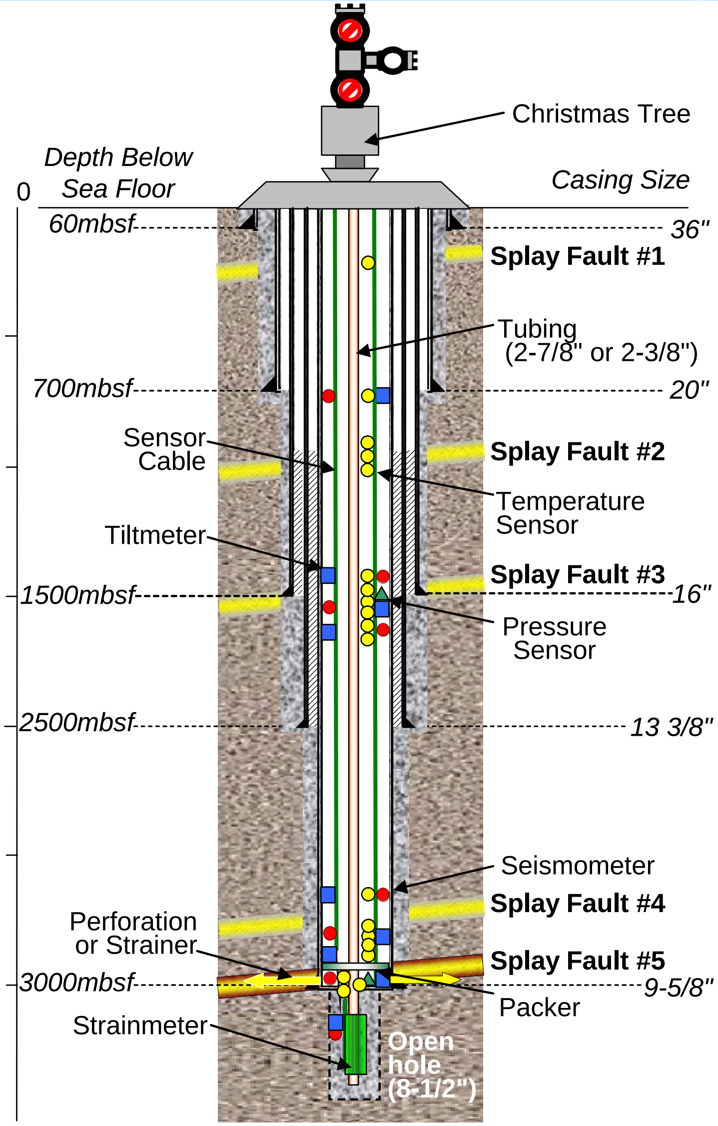
USFY2009

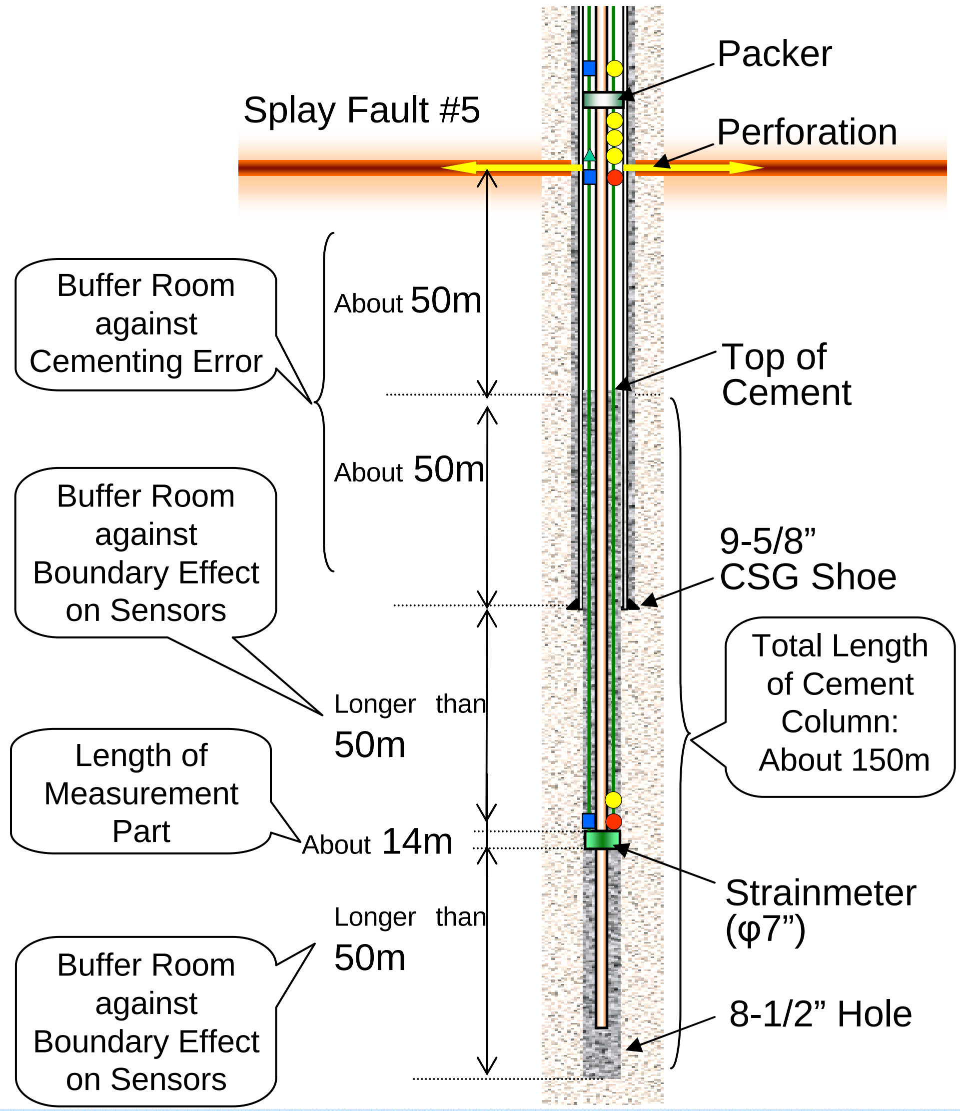
- Integration of EXP
- Field Test in the Land Hole

Proposed Borehole Observatory



Observatory plan for NT2-03 (perforation)





Engineering requirements (telemetry system 1/4)

- **Downhole telemetry**

Synchronization accuracy	<10μS (Simultaneous sampling of all channels of all modules)
Number of downhole module	*8 module (by NanTroSEIZE phase II), Be able to address up to 128
Telemetry Cable	Work with single standard completion cable System has one backup cable at least
Uplink data rate	*>512Kbps To satisfy 4mS sampling with 8 modules
Uplink bit error rate	$<10^{-9}$
Downlink data rate	*>30bps
Maximum Module distance	*1,000m Preferable target is 2,000m

Engineering requirements (telemetry system 2/4)

- **Subsea I/F**

Power supply through submarine cable network

0.15A constant current, maximum 30W

Subsea interface is able to communicate with surface through DONET, ROV and/or Acoustic transponder. This communication protocol and detail will be specified by July 2007.

Engineering requirements (telemetry system 3/4)

- **Analog input at downhole module**

High speed input (Seismic channel)	4 channels / module (Voltage proportional signal) Flat frequency response (-400Hz)
Dynamic range	24 bit ΔΣ Minimum phase, >120dB (0.01-100Hz)
Sampling rate	*Minimum of 4mS
AUX low speed input	Minimum 8 channels / module (Voltage proportional signal) Flat frequency response (-8Hz)
AUX dynamic range	>120dB (-1Hz)
AUX sampling rate	20 sample / second

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Engineering requirements (telemetry system 4/4)

- **Other Functions**

Status check

RS232 or RS485 interface with sensor

Command out (4 bit commands) for sensor control

Engineering requirements (Downhole module)

- **Environmental rating**

Temperature	-25 to 125 degC (Storage) 4 to 125 degC (Operation)
Pressure	75MPa Be able to work under 3,500mbsf deep well at 2,200m sea depth
Shock	250G Be able to deploy through casing without damage
Package size	Fit to 9-5/8” casing with tubing
Life	5 years

- **Electrical**

Power consumption	As low as possible, Target 2W without sensor power
Sensor power supply	Depend on sensor design To be specified by July 2007

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Engineering requirements (Subsea module)

- **Environmental rating**

Temperature -25 to 80 degC (Storage), -2 to 40 degC (Operation)

Pressure 35MPa, be able to work under 3,000m subsea

Shock 250G, be able to deploy by ROV

Package size Be able to deploy by ROV, to be specified by July 2007

Life 5 years, be able to do regular maintenance without shutdown

- **Electrical**

Power consumption As low as possible, target is 5W without downhole module at the telemetry power input

- **Mass Storage I/F**

System bus for data storage Be able to send data to the data storage through faster bus than downhole telemetry speed

Data redundancy Allow duplicate data storage

Device maintenance Be able to change storage media without system shutdown

Current work to specify Engineering Specifications

Performance evaluation using mock-up

- Telemetry speed performance with long cable
  - Expand feasibility mockup to evaluate full configuration
- Fault tolerant concept validation
  - Concept validation with conceptual mockup
- Power management system
  - Concept validation with conceptual mockup
- High accuracy time module combination test
  - SEASCAN, Time base module

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Current work to define Operational Requirements

- Installation sequence
  On-board handling, Tools, Monitoring while running
- X'mas-tree requirements
  Retrieval, Penetrators, Subsea data recorder, Horizontal / Conventional (Vertical)
- Pore pressure measurement at fault
  Packer, Perforation, Strainer, Cementing
- Sensor installation
  Clamping, Cementing, Orientation, Inside/Outside telemetry housing, Protector, Tubing

Current work to prepare FY08 Proposal

Planned works in FY08 and FY09

- Hardware design iteration / Concept validation[FY08]
  - Power management, Synchronization accuracy, Fault tolerant function, I/F@sea floor system
- Component evaluation[FY08]
  - High temperature, Design optimization, Cable connection
- Unit Integration Test [FY08]
  - System power consumption, Unit level anti-shock packaging design, Connectivity with down hole sensors, High temperature characteristics
- System Integration Test [FY09]
- System Life Test (Destructive Test) [FY09]
- EXP Field Test [FY09]

APPENDIX 8:

Systems Integration Tests for CHIKYU

System Integration Tests for "CHIKYU"

Eigo Miyazaki
Engineering Dept., CDEX, JAMSTEC

SITs (System Integration Tests)

- **Objective:**
  - Finding and eliminating failures and problems on the systems and equipments.
  - Function checks of systems and equipments at the same time of CHIKYU's first riser drilling operation after the construction.
- **Period： 3 months from August 2006**
- **Site： Offshore Shimokita east (Water depth: 1,180m)**

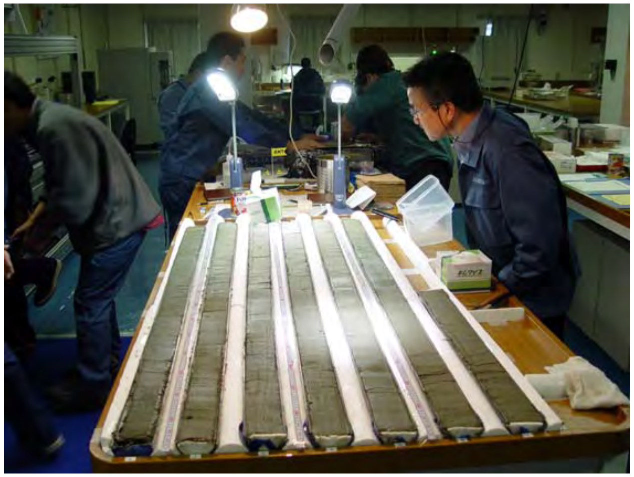
SIT Items

- Running CHIKYU coring systems
- Running casing and cementing
- Running riser and Blow out preventer (BOP)
- Emergency disconnect sequence (EDS) on LMRP/BOP
- Wireline logging operation

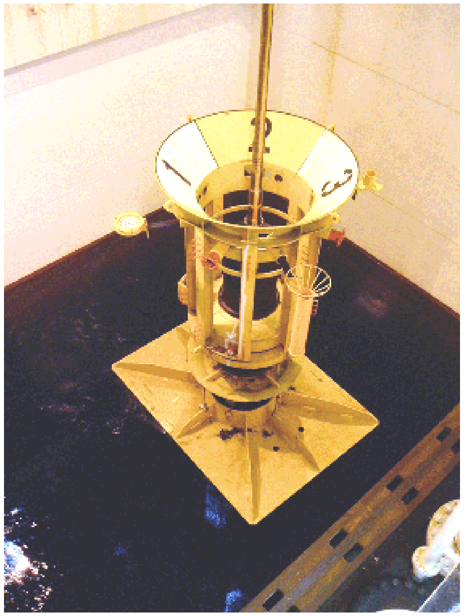
Results of SITs

- Coring
  - HPCS: 37 runs, core recovery rate: approx. 100%
  - ESCS: 4 runs, core recovery rate: approx. 80-100%
- Casing running
  - 36” conductor Jet-in (approx.56mbsf, inclination: 0.6degree）
  - Deployment of 20” casing（approx. 500m） / well head and cementing
- BOP / riser running
  - Deployment of BOP / riser on the wellhead of 1,180m W.D.
  - Relatively slow running (5 days) for riser / BOP deployment because crews were new to CHIKYU drilling equipments.
- EDS (Emergency Disconnect Sequence)
  - Simulating drift-off, EDS was activated.
  - Riser / LMRP was disconnected from Lower BOP 64 seconds after activating EDS.
  - Anti recoil system of riser tensioner, which prevent riser from colliding with the drill floor or Lower BOP, functioned properly.
- Wireline logging
  - Lowering / lifting of wireline logging tool in riser.
  - Verification of wireline route in derrick and handling of tools.

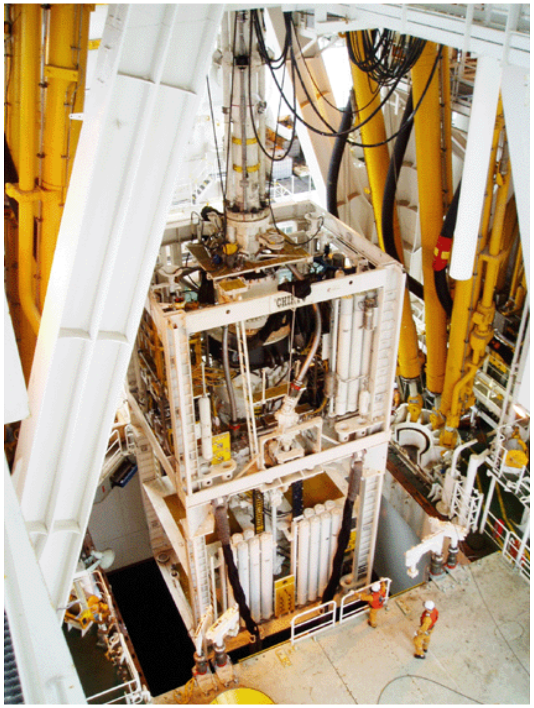
Coring



Casing running

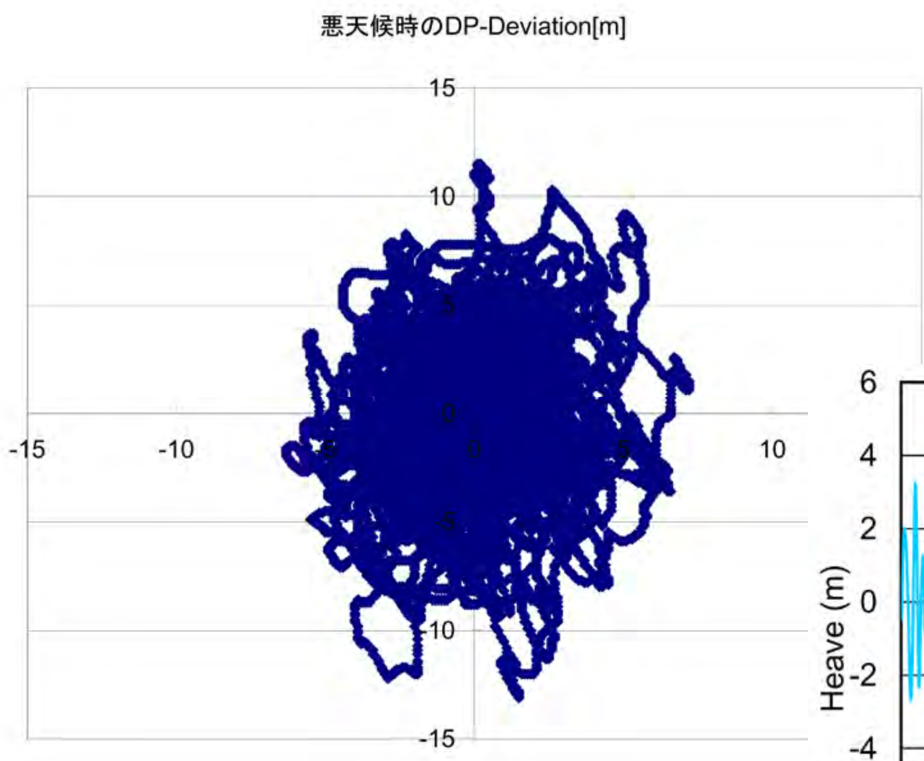


Riser / BOP Running



Other Major Checked Item

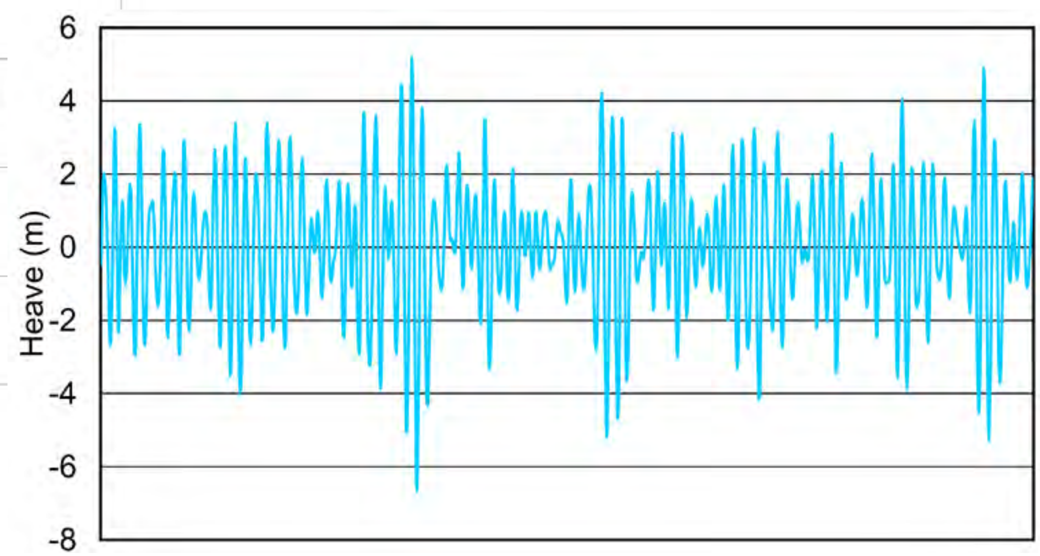
- Verification of the Dynamic Positioning System （DPS） and modification of software on DPS.



DP deviation during sever weather

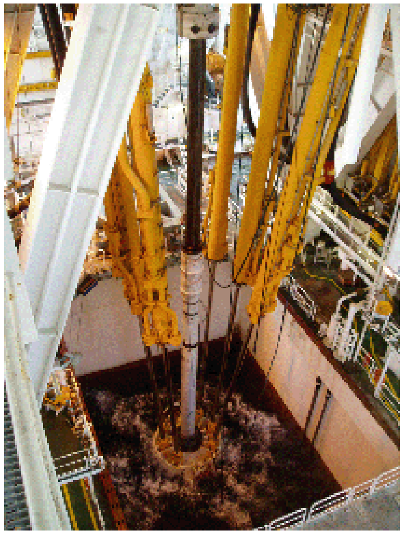
Wind: 20-30m/s

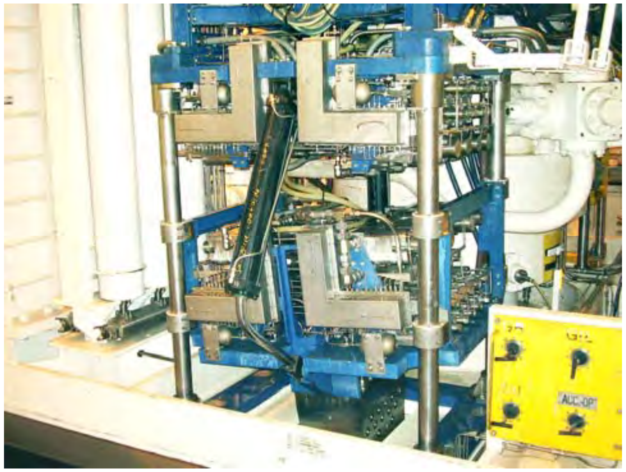
Wave Height: 6～7m

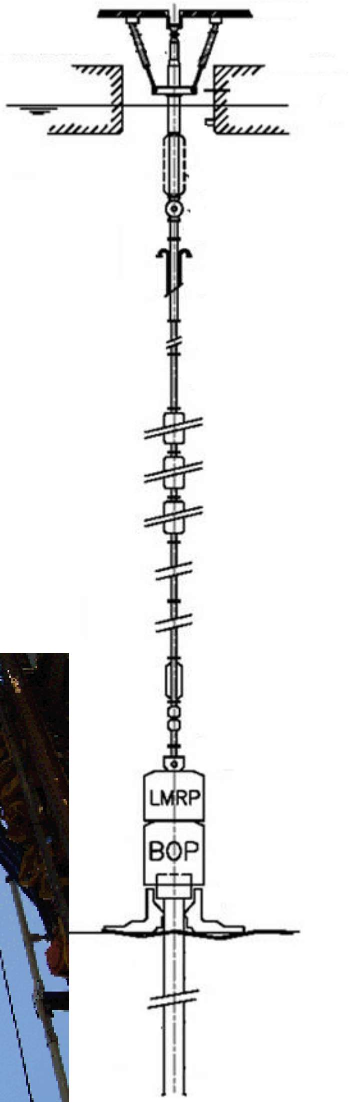


Damage due to severe weather

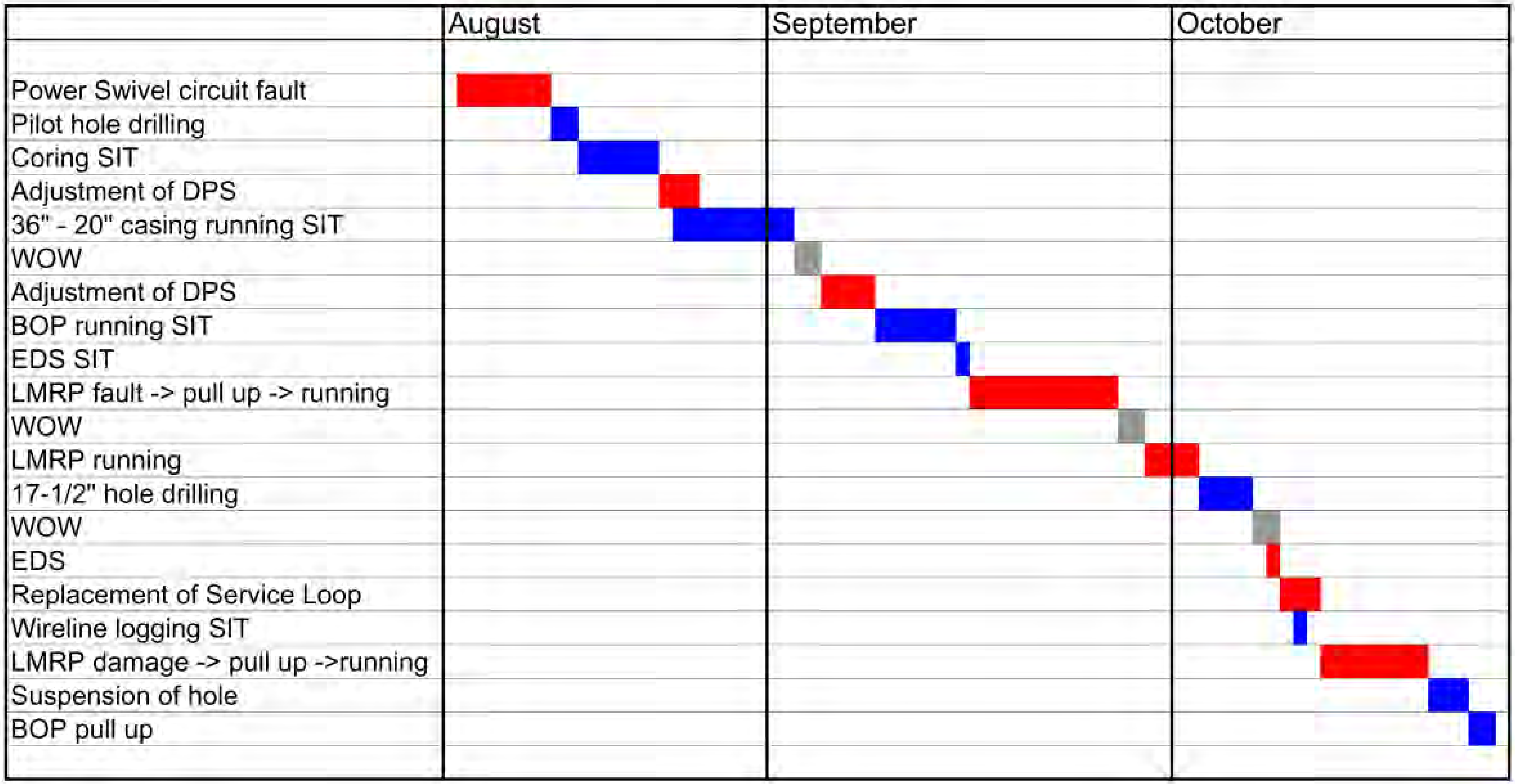
- During WOW, Anti recoil system of tensioner was activated unexpectedly, and movement of tensioner cylinders was restricted.
- EDS was carried out, however, some parts of riser/BOP were damaged.
- LMRP was pulled up on board for temporary repair.
- As a result, the hole was suspended and Shimokita operation came to an end.
- Penetration depth was 647mbsf (136m drilled with riser) .







Summary


August
September
October
Power Swivel circuit fault
Pilot hole drilling
Coring SIT
Adjustment of DPS
36" - 20" casing running SIT
WOW
Adjustment of DPS
BOP running SIT
EDS SIT
LMRP fault -> pull up -> running
WOW
LMRP running
17-1/2" hole drilling
WOW
EDS
Replacement of Service Loop
Wireline logging SIT
LMRP damage -> pull up ->running
Suspension of hole
BOP pull up

After Shimokita Operation

- After Shimokita operation, damaged equipments were repaired and some systems were modified.
- From December 2006, ODS (Offshore Drilling Shakedown) is being continued at Kenya and Australia. In ODS, riser drilling at max. W.D. 2,200m and min. W.D. 501m were carried out successfully without major problems.

APPENDIX 9:

Improvement of Downhole Tools for Mud Circulation

Improvement of Downhole Tools for Mud Circulation

CDEX / JAMSTEC

K. Higuchi

Presentation

1) The benefit of riser drilling

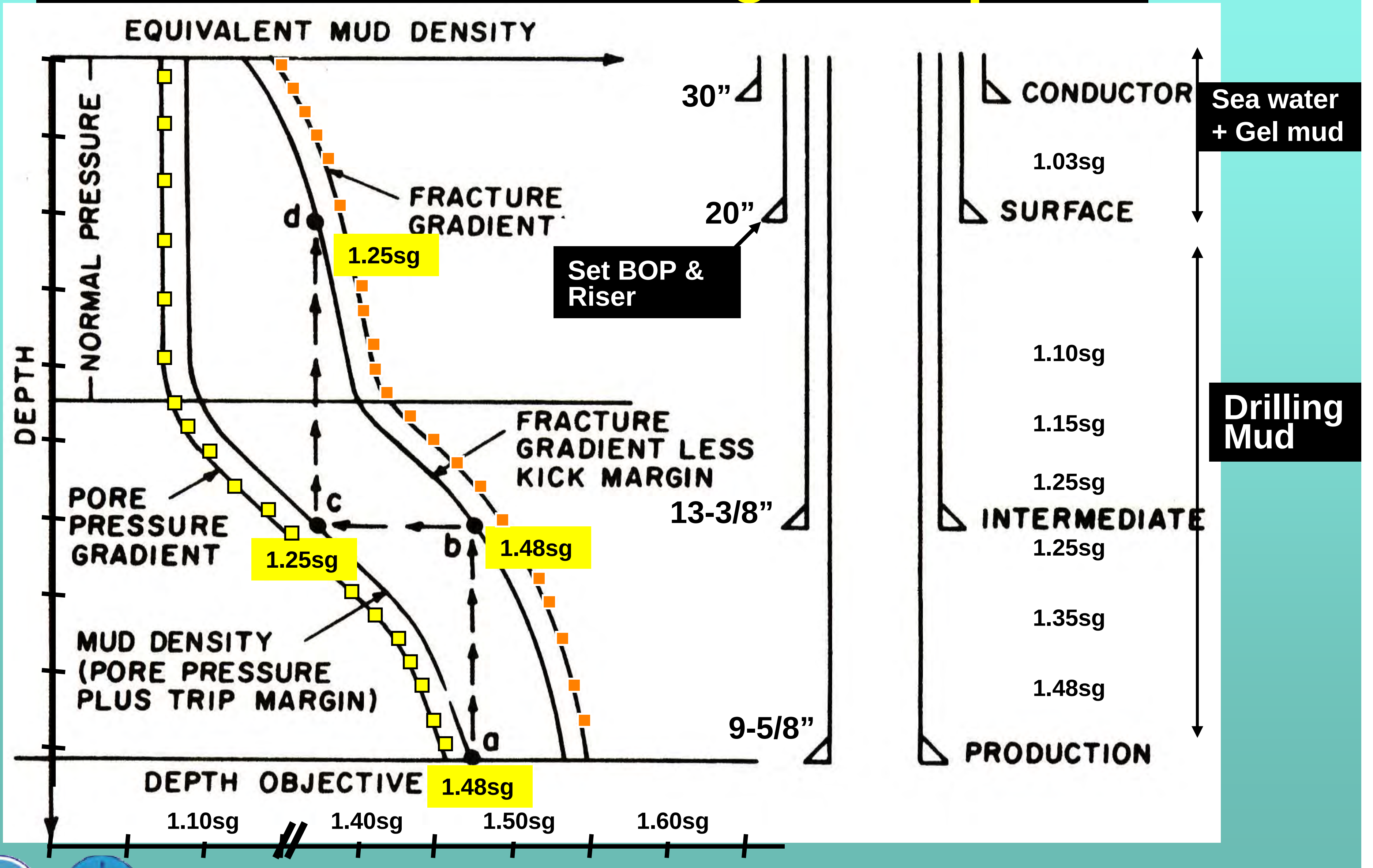
2) The importance of using mud weight and casing

3) What is done (will be done) to apply mud system
to scientific drilling

Advantages of Chikyu Riser Drilling

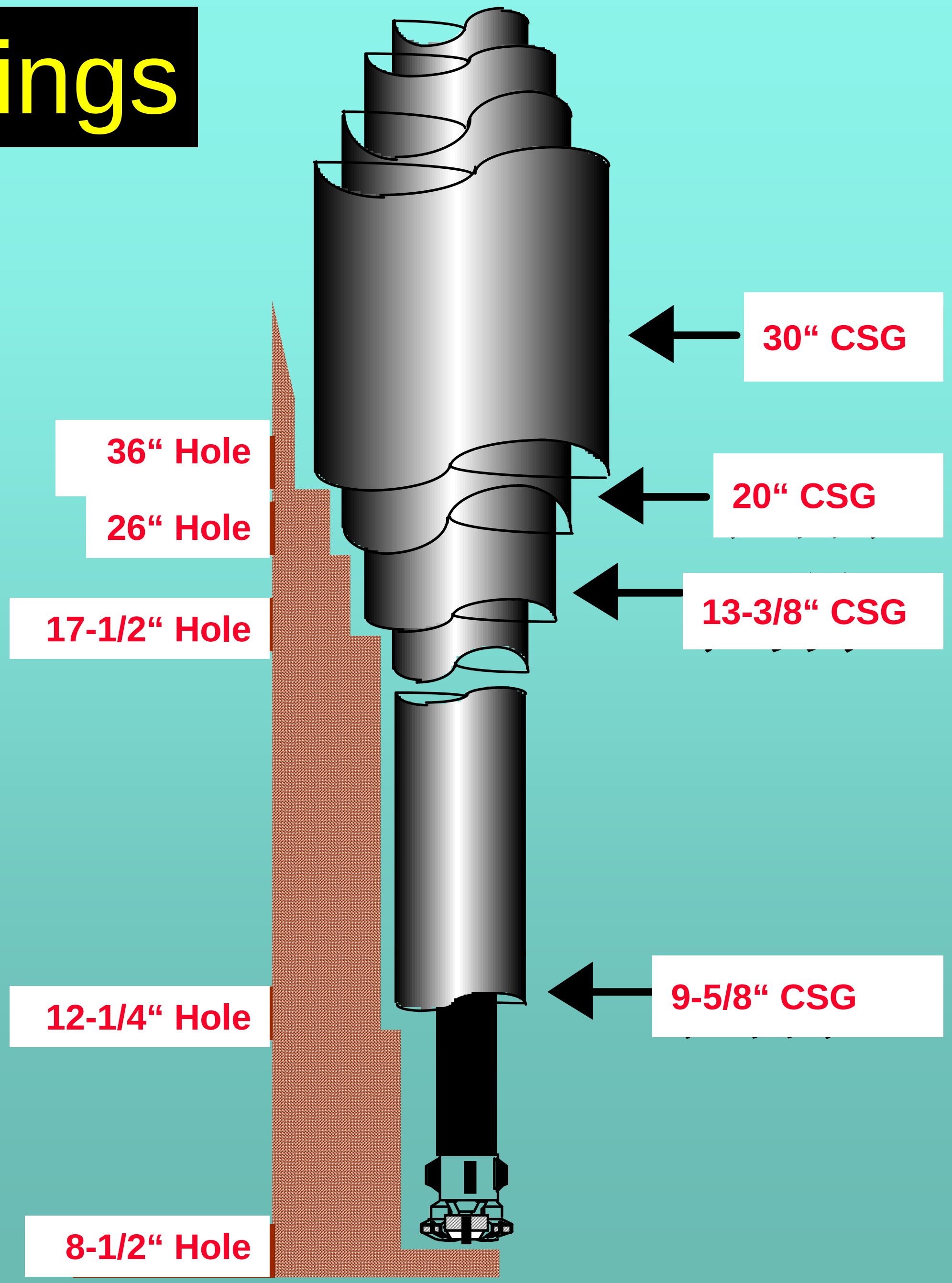
Main Features of Chikyu	*Benefit*
- BOP/Riser Pipe - Mud Circulation System - High TQ/Tension DP	▶ *Well Control* ▶ *Borehole Stability* ▶ *Deep Penetration* ▶ *Better Core Recovery* ▶ *More Logging Option*

How to decide Casing set depth



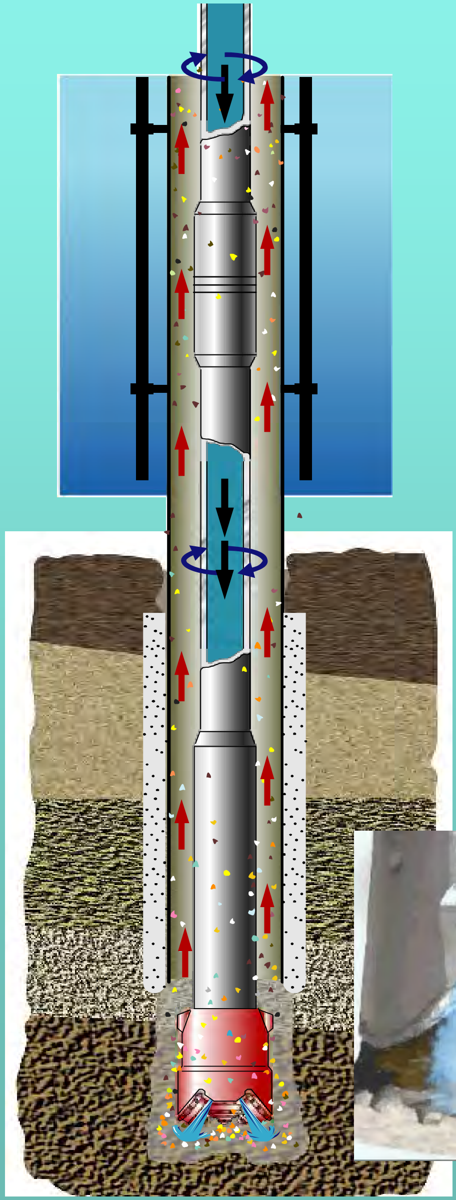
Roles of Casings

1. Structural Support
2. Solution for Drilling Problems
3. Protection of Formation
4. Pressure Isolation
5. Well Control Capability
6. Protection of Down Hole Tool



Roles of Drilling Mud

1. Removal and transportation of Cuttings
2. Provision of Hydrostatic Pressure
3. Lubrication
4. Cooling Tools
5. Provision of Hole Information
6. Supporting Hole Stability
7. Transmission of Hydrostatic Horse Power to Bit / Downhole Motor
8. Transmission of Downhole Data



Core Related Mud Circulation Issue

1) 9-7/8" RCB / 8-1/2" SD-RCB Circulation Test

Not yet tested using mud

>>> Circulation Test will be done in September 2007

(Use various weight and LCM concentration of Mud)

Core Related Mud Circulation Issue

2) Core-line Wiper Preparation

Enable mud circulation while retrieving, setting inner barrel

>>> Seal Integration, Easy/Safe-handling is important

>>> Wiper Performance Test will be done from July 2007

Core Related Mud Circulation Issue

3) Core-line Replacement

Depends on the result of test above,

Change line to smoother line

4) Drilling Jar, Shock Absorber and Bumper Sub Preparation

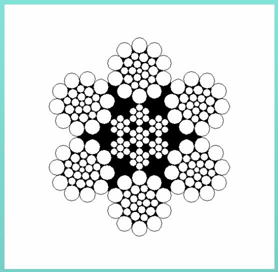
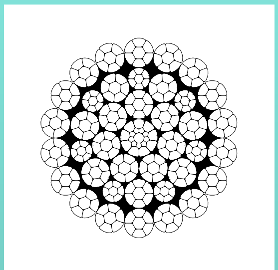
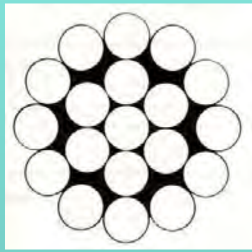
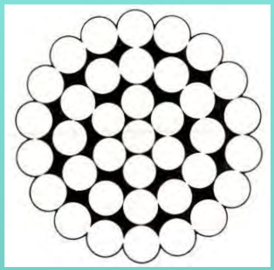
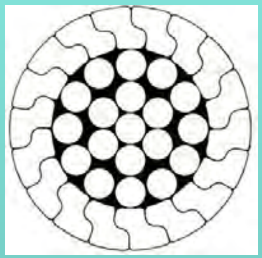
These might be required for the deeper hole in mud.

Core Related Mud Circulation Issue

3) Core-line Replacement

Depends on the result of test above,

Change line to smoother line

Others

- Casing / Hole Size

Conventional Oil Industry Casings and (Open) Holes Sizes are adopted to Chikyu drilling

This is to use oil industry experience, down- hole tools such as fishing tools and rule of thumb as much as possible.

APPENDIX 10:

Pore Pressure Prediction and Detection of NanTroSEIZE

Pore Pressure Prediction and Detection in NanTroSEIZE

CDEX / JAMSTEC

K. Higuchi

Presentation

1) Importance of pore-pressure prediction

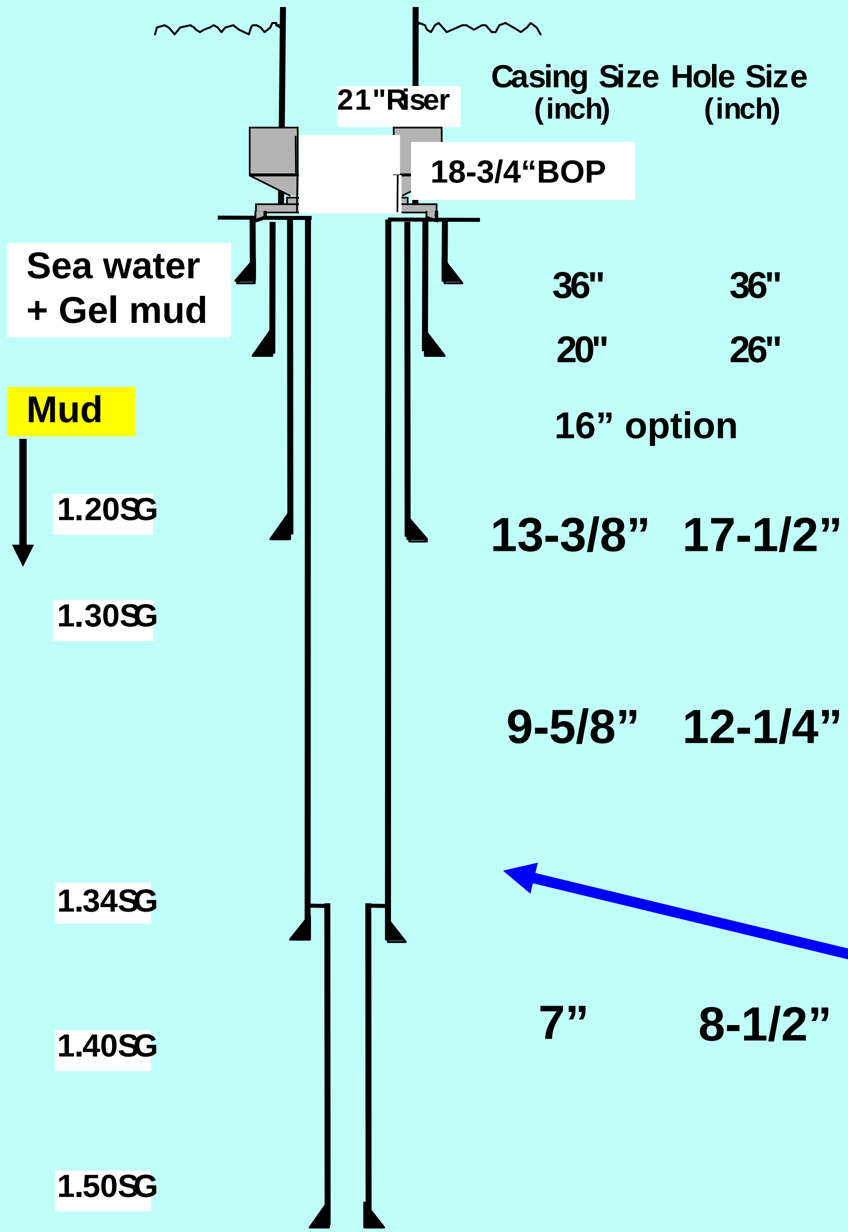
2) Difficulty in Pressure Prediction

3） CDEX approach

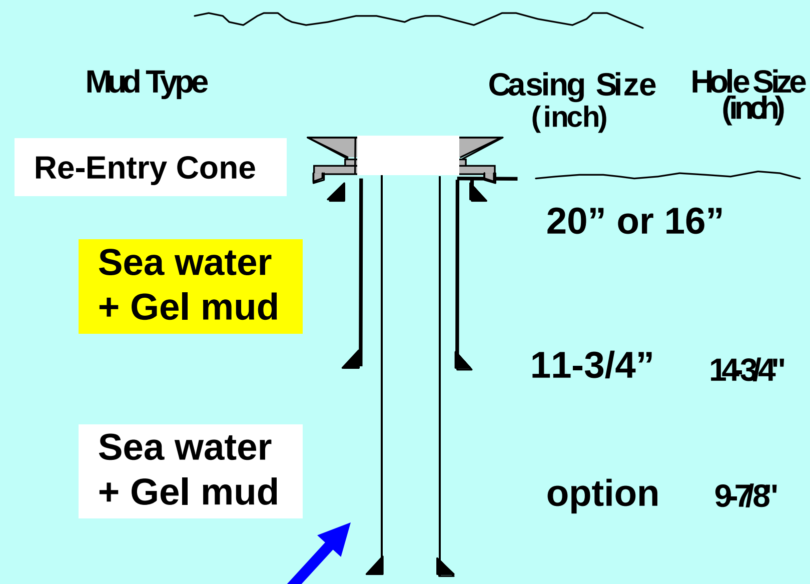
4) Prediction Method Example

5) Detection Method Example

Riser Drilling

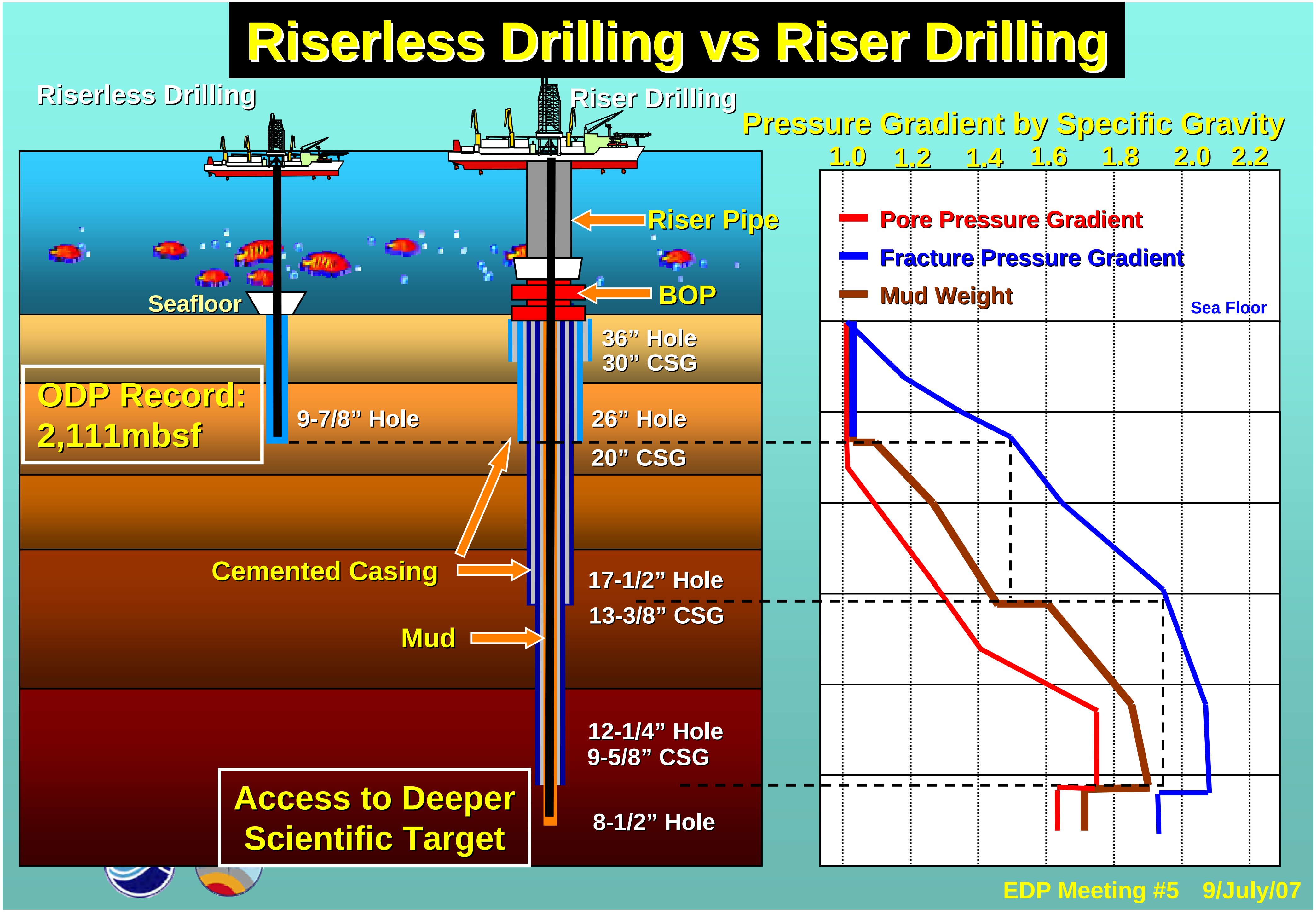


Riserless Drilling



1～2 strings of Casing

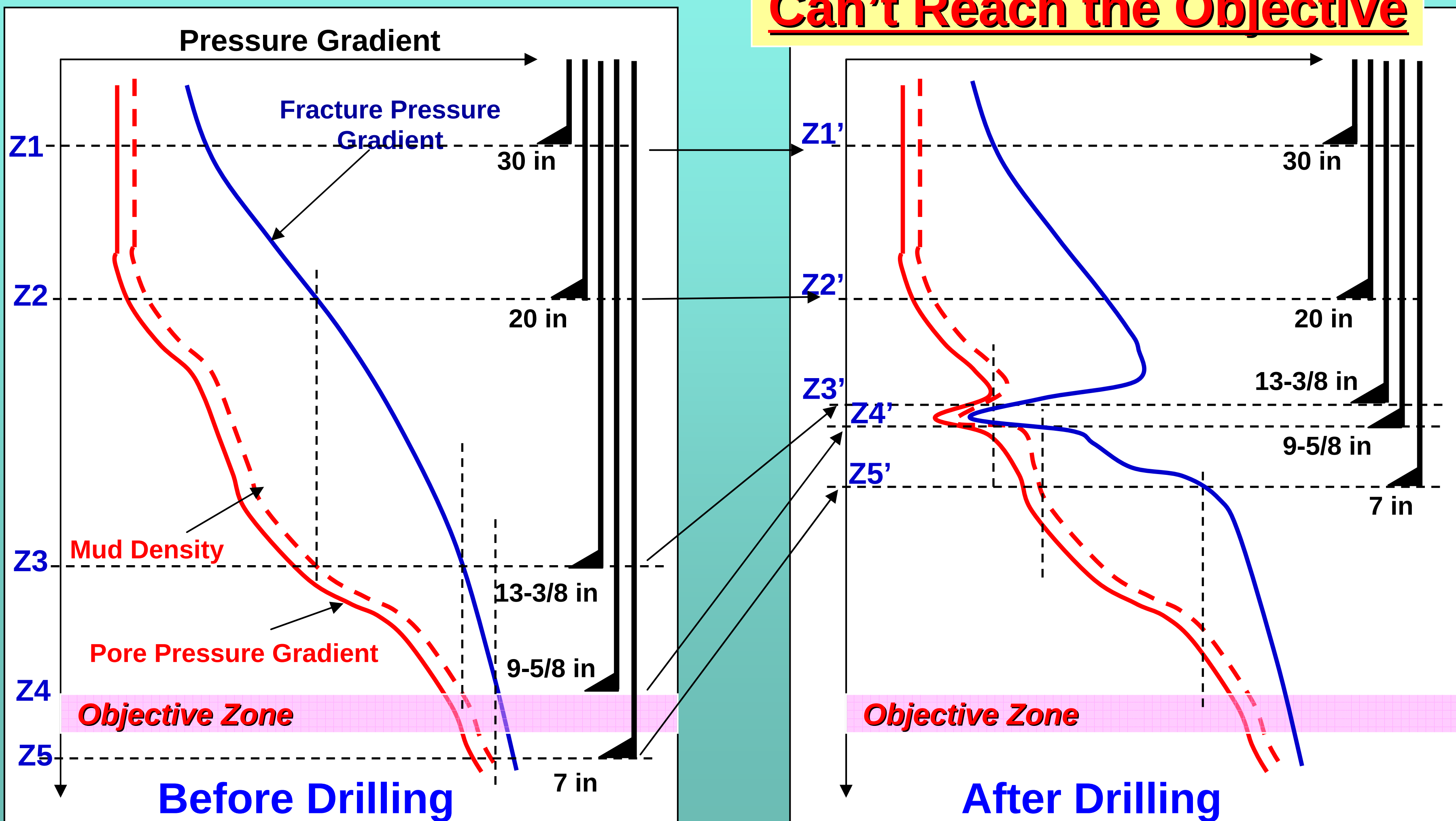
5～7 strings of Casing



Riserless Drilling vs Riser Drilling
Riserless Drilling
Riser Drilling
Seafloor
Riser Pipe
BOP
ODP Record:
2,111mbsf
9-7/8" Hole
36" Hole
30" CSG
26" Hole
20" CSG
Cemented Casing
17-1/2" Hole
13-3/8" CSG
Mud
12-1/4" Hole
9-5/8" CSG
Access to Deeper
Scientific Target
8-1/2" Hole
Pressure Gradient by Specific Gravity
1.0
1.2
1.4
1.6
1.8
2.0
2.2
Pore Pressure Gradient
Fracture Pressure Gradient
Mud Weight
Sea Floor
EDP Meeting #5 9/July/07

If the estimation is wrong....

Can't Reach the Objective



Pressure Prediction CDEX Approach

Pressure Prediction Difficulty in NanTroSEIZE

- The First Trial to the Complex Splay Fault
- Complex Stress Effects due to Tectonics
- No Offset Wells in the Same Structure
- High horizontal Stress
- Uncertainty of Fault Effect
- Depth Accuracy

Pressure Prediction CDEX Approach

1) Eaton's Method (In-house, done)

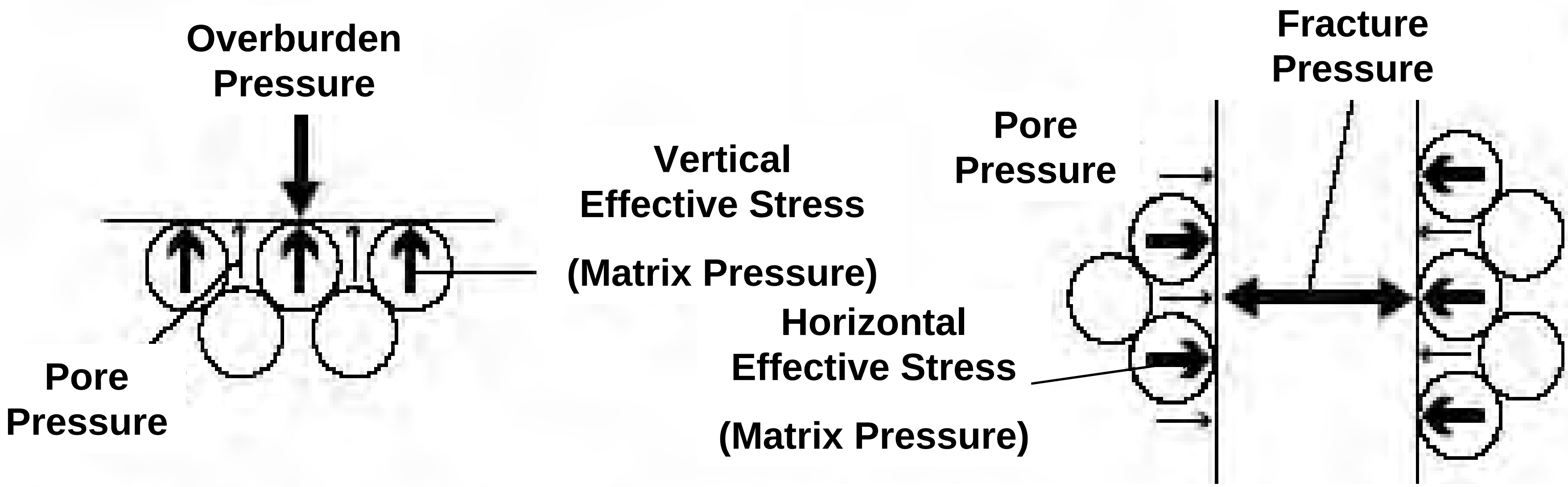
2) Stress Prediction Study (August 2007-)

3) Borehole Stability Study (August 2007-)

4) Eaton's Method Review and Further Study (September? 2007-)

Pressure Basic Relationship

Pore pressure prediction uses the pressure relationship in the simplified model.



Overburden Pressure

= Vertical Effective Stress + Pore Pressure

Horizontal Effective Stress

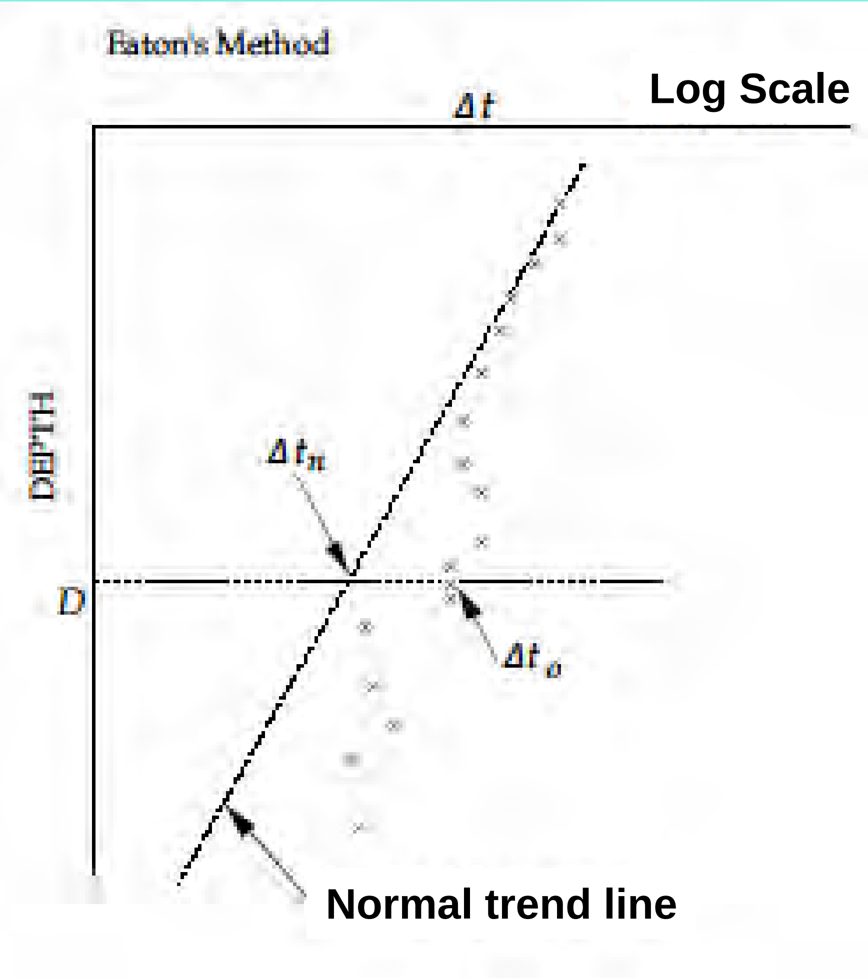
= Vertical Effective Stress x Ki

Ki : Effective Stress Coefficient

Fracture Pressure

= Horizontal Effective Stress + Pore Pressure

Basis of Eaton's Method



$P = S - \sigma_m$

P : Pore pressure

S : Overburden pressure

σ_m : Matrix stress (vertical)

Matrix stress σ_m is calculated empirically

$\sigma_m = (S - Pn) \times (\Delta t_n / \Delta t_o)^{\alpha}$

Pn : Normal Pore pressure

Δt : Interval transit time

α: Constant

$P/D = S/D - (S/D - Pn/D) \times (\Delta t_n / \Delta t_o)^{\alpha}$

Basis of Eaton's Method

$$P_{frac}=\sigma_h+P$$

P_{frac} : Fracture pressure

$\sigma_{m\,h}$: Horizontal matrix pressure

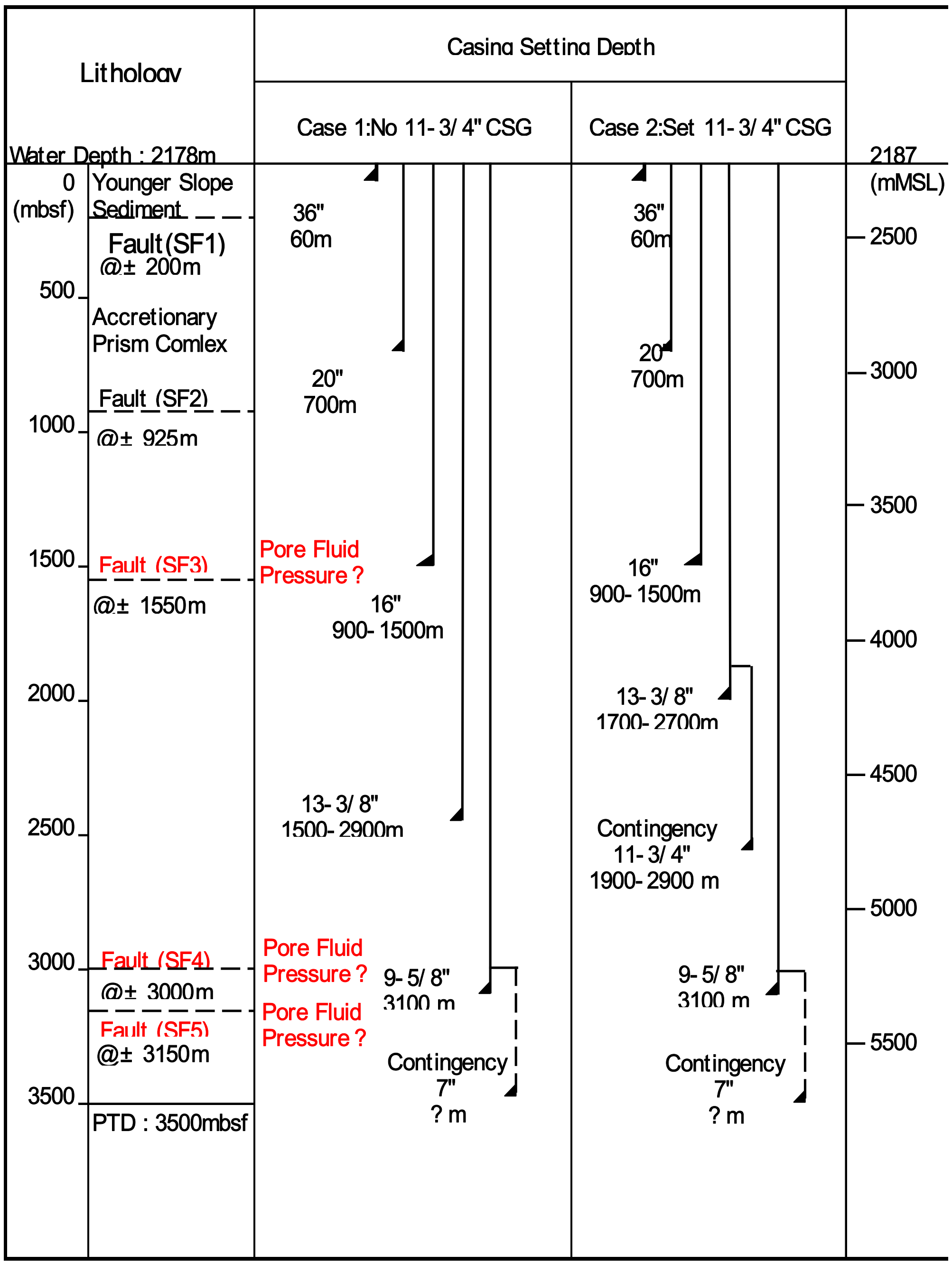
P : Pore pressure

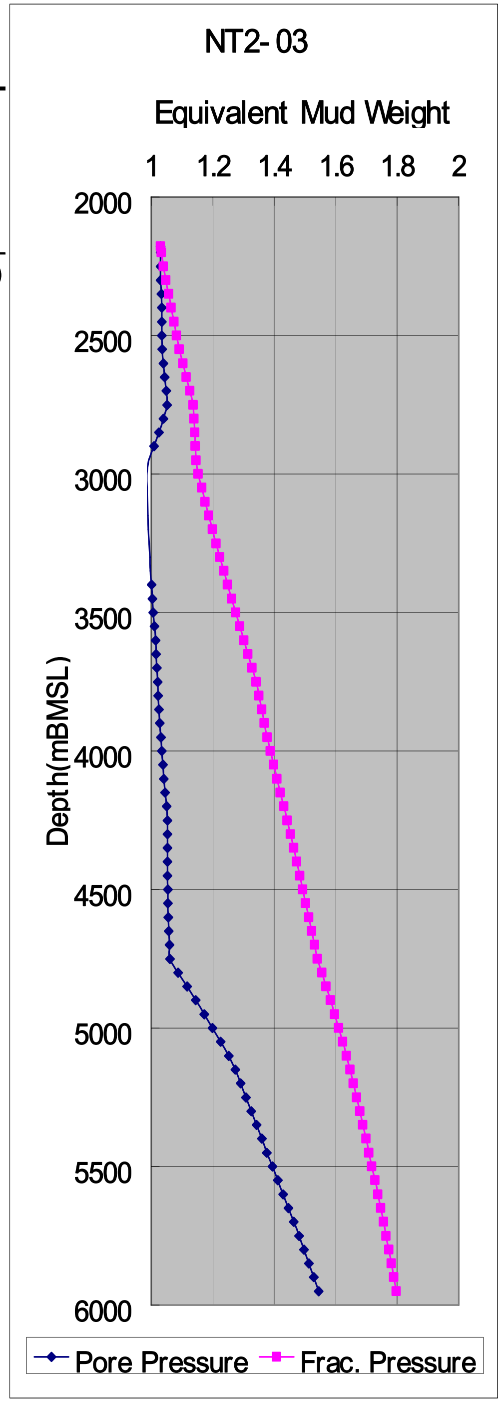
$$\sigma_h=\upsilon/(1-\upsilon) \times \sigma_v$$

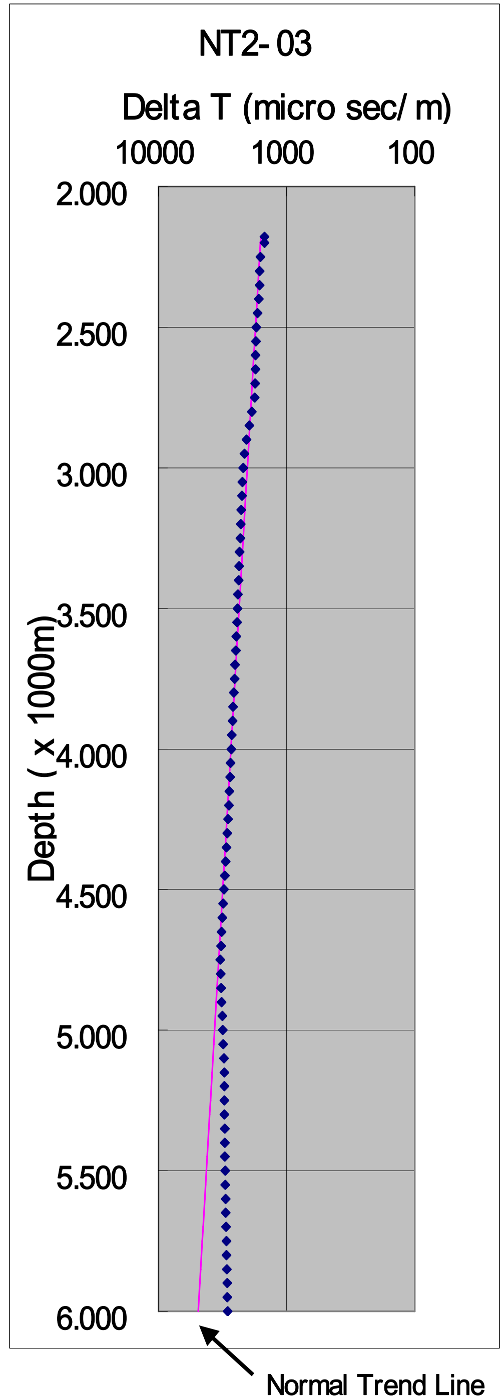
υ : Poisson's ratio

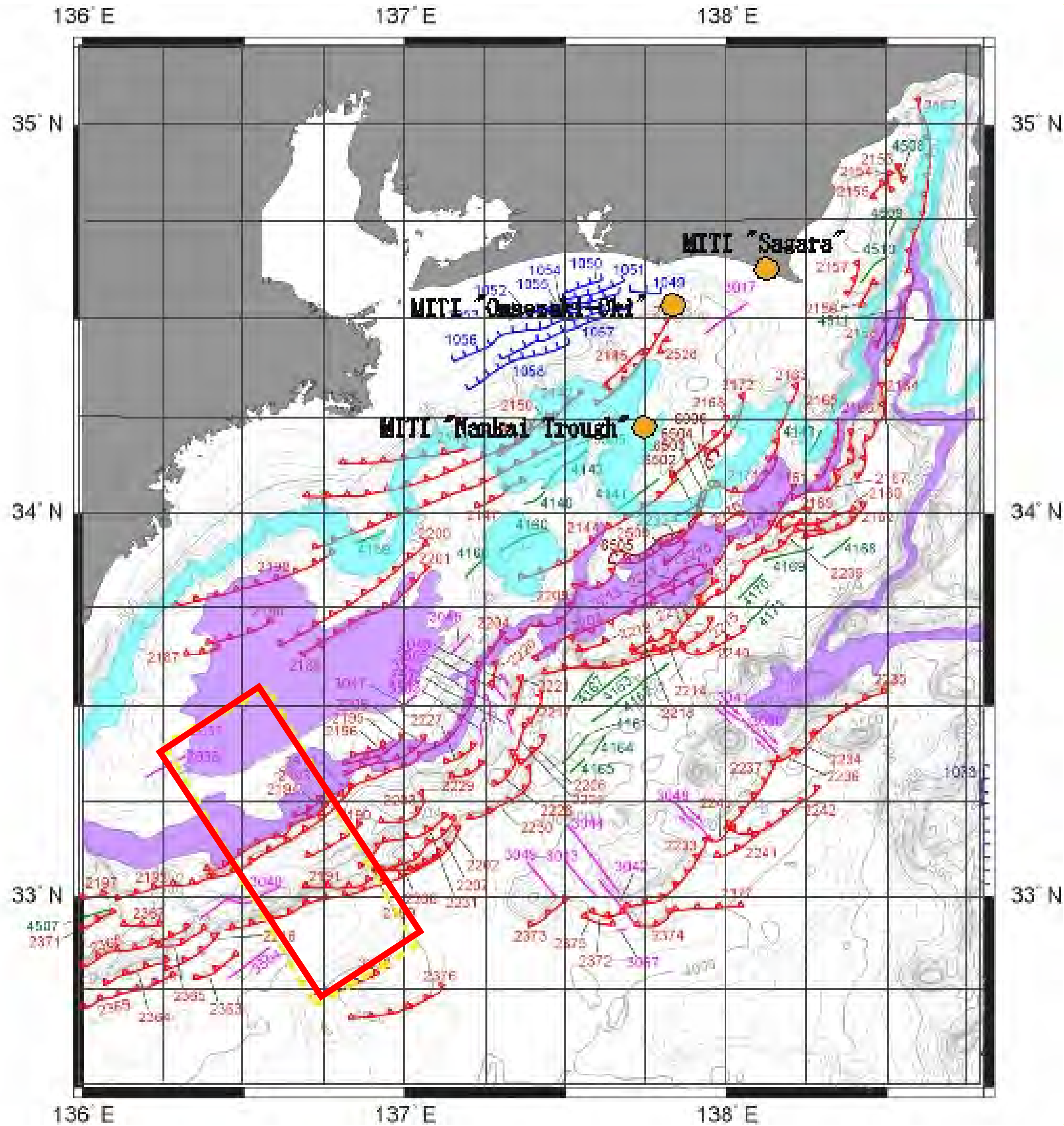
σ_v : Vertical matrix pressure

$$P_{frac}/D= \upsilon/(1-\upsilon) \times (S/D-P/D)+P/D$$


Lithology
Casing Setting Depth
Case 1:No 11-3/4" CSG
Case 2:Set 11-3/4" CSG
Water Depth : 2178m
2187 (mMSL)
0 (mbsf)
Younger Slope Sediment
Fault(SF1) @± 200m
500
Accretionary Prism Comlex
Fault (SF2) @± 925m
1000
1500
Fault (SF3) @± 1550m
2000
2500
3000
Fault (SF4) @± 3000m
Fault (SF5) @± 3150m
3500
PTD : 3500mbsf
36" 60m
20" 700m
Pore Fluid Pressure ?
16" 900-1500m
13-3/8" 1500-2900m
Pore Fluid Pressure ?
9-5/8" 3100 m
Pore Fluid Pressure ?
Contingency 7" ? m
36" 60m
20" 700m
16" 900-1500m
13-3/8" 1700-2700m
Contingency 11-3/4" 1900-2900 m
9-5/8" 3100 m
Contingency 7" ? m
2500
3000
3500
4000
4500
5000
5500


NT2-03
Equivalent Mud Weight
1
1.2
1.4
1.6
1.8
2
Depth(mBMSL)
2000
2500
3000
3500
4000
4500
5000
5500
6000
Pore Pressure
Frac. Pressure


NT2-03
Delta T (micro sec/m)
10000
1000
100
Depth (x 1000m)
2.000
2.500
3.000
3.500
4.000
4.500
5.000
5.500
6.000
Normal Trend Line


136° E
137° E
138° E
35° N
34° N
33° N
MITI "Sagara"
MITI "Omaezaki-Oki"
MITI "Nankai Trough"

Stress / Borehole Instability Prediction

Stress Prediction Study: w/ Kyoto Univ.

Earthquake Data and Velocity Data

- **>>> Estimation of Dip of Fault Plane and Slip Direction**
- **>>> Estimation of Stress Balance**
- **>>> Estimation of Stress at Specific Point**

Borehole Instability Study

Stage1. LWD data, Core, Hole Condition

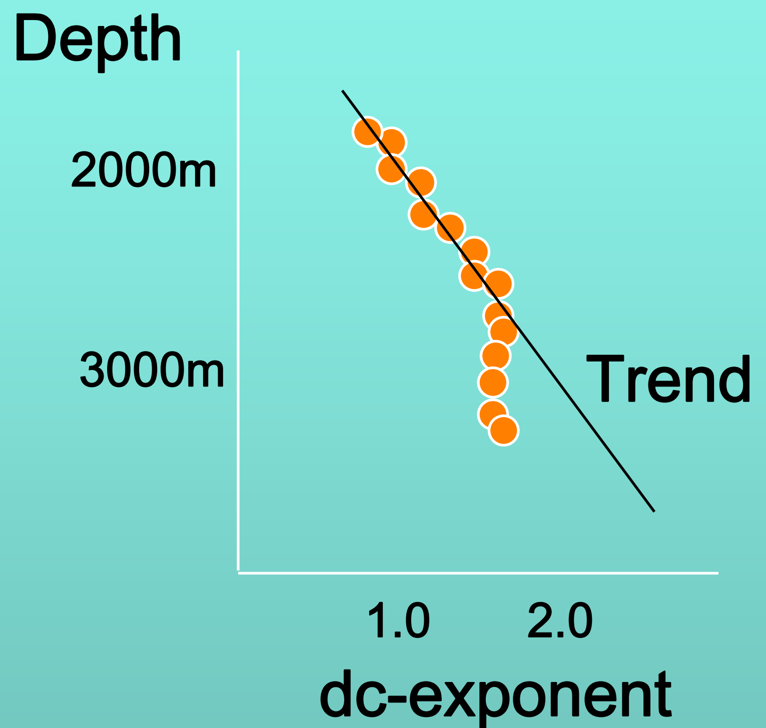
- **>>> Careful Data Analysis**
- **>>> Consideration on Stress/Pressure Balance in the Hole**
- **>>> Prediction on What May Happen in Deeper Hole**

d-exponent Method

d-Exponent

$R = K \times (W/D)^d \times N^e$

- R: Rate of Penetration (ft/hr)
- K: Constant
- W: Weight on Bit (lbs)
- D: Bit Diameter (inch)
- d: d-exponent
- N: Rotary Speed (rpm)
- e: Rotary Speed Exponent



dc-Exponent:

Calibrated "d" from mud weight variation effect

Abnormal Pressure Detection

Observation While Drilling

- Pit Level Variation
- Drilling Break (Rate of Penetration Increase)
- Caving from High Pressure Shale
  (Cuttings / Toque Drag)
- Mud Gas, Connection Gas Increase
- Mud Temperature
- Salinity of Mud
- Lower Shale Density

Conclusion

- CDEX will continue various study to predict pressure more accurate

- Stage 1 data is very valuable and should be utilized for the deeper section prediction as much as possible

- Careful observation of hole condition is very important while drilling

APPENDIX 11:

Coring System of OD21

Coring System of OD21

July 9th, 2007
JAMSTEC/CDEX

Operative Coring Tool

- Hydraulic Piston Coring System (HPCS)
- Extended Shoe Coring System(ESCS)
- 9-7/8 Rotary Core Barrel (9-7/8 RCB)
- Small Diameter Rotary Core Barrel (SD-RCB)

Hydraulic Piston Coring System (HPCS)

(ODP : Advanced Piston Corer (APC))

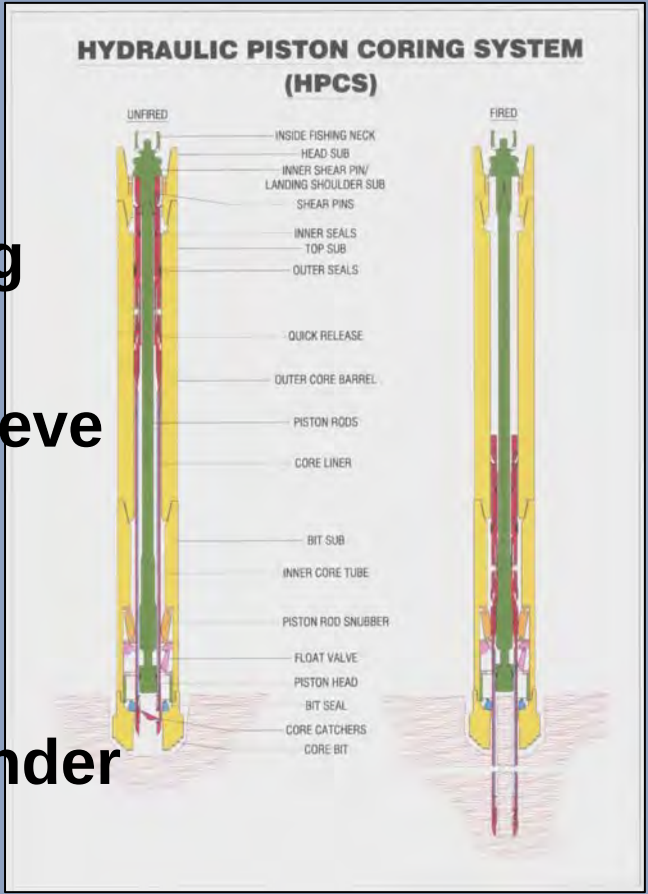
- **Improve on the ODP Core Barrels**

-Optimization of Torsion Spring Constant of Lock Open Dog

- Strength of Liner Support Sleeve

- Improve of Vent Snubber, Male Quick Release, HPCS and 3-lug

- Addition of Piston Head Extender



Extended Shoe Coring System (ESCS)

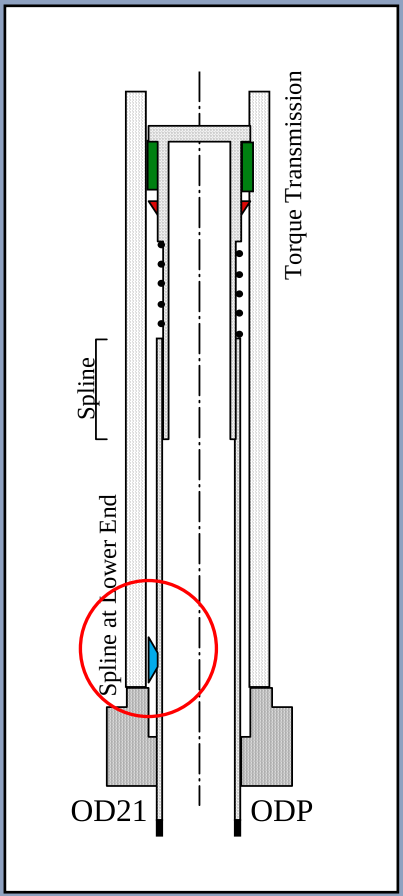
(ODP : Extended Core Barrel (XCB))

- **Improve on the ODP Core Barrels**

- Low-End Drive System

- Venturi Vent System

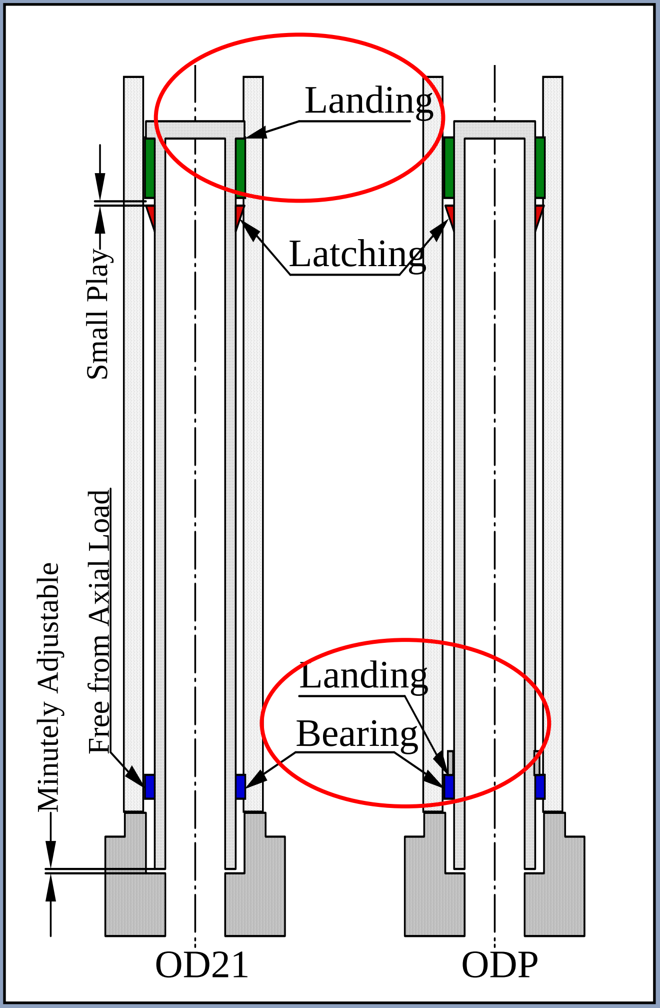
- Cutting Shoe Flow



9-7/8 Rotary Core Barrel

(ODP : Rotary Core Barrel (RCB))

- **Improve on the ODP Core Barrels**
  - Land-High/Under configuration
  -Modified Inner Barrel Length Adjuster

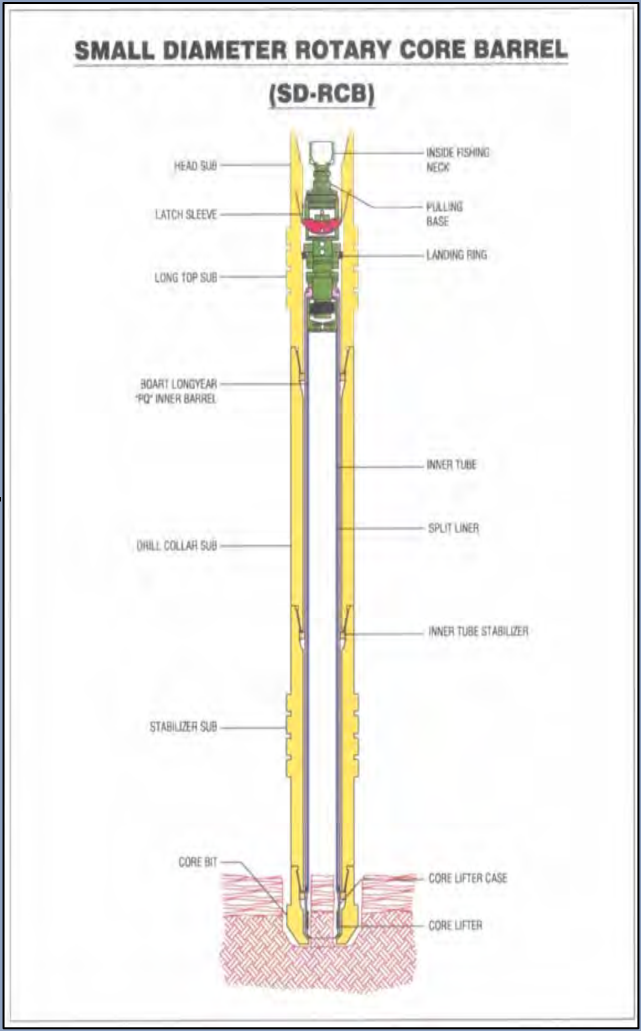


Small Diameter Rotary Core Barrel (SD-RCB)

(ODP : Advanced Diamond

Core Barrel (ADCB))

- **<u>A point of advantage</u>**
  - **High Core Recovery & High Quality**
  - **8-1/2 Core Bit**



Under Modified Coring Tool

<u>- for NanTro Riser Expedition -</u>

- Anti-heat Resistance RCB & SD-RCB
  → TD Temperature : 100℃?
- New RCB & SD-RCB PDC Bit
  → Core recovery up!

Modified Core Barrel

- **High Temperature Resistance Countermeasure**

  (150 ℃ operation)

TD temperature : 100 deg. over

→ Conversition of Aluminum Core Liner

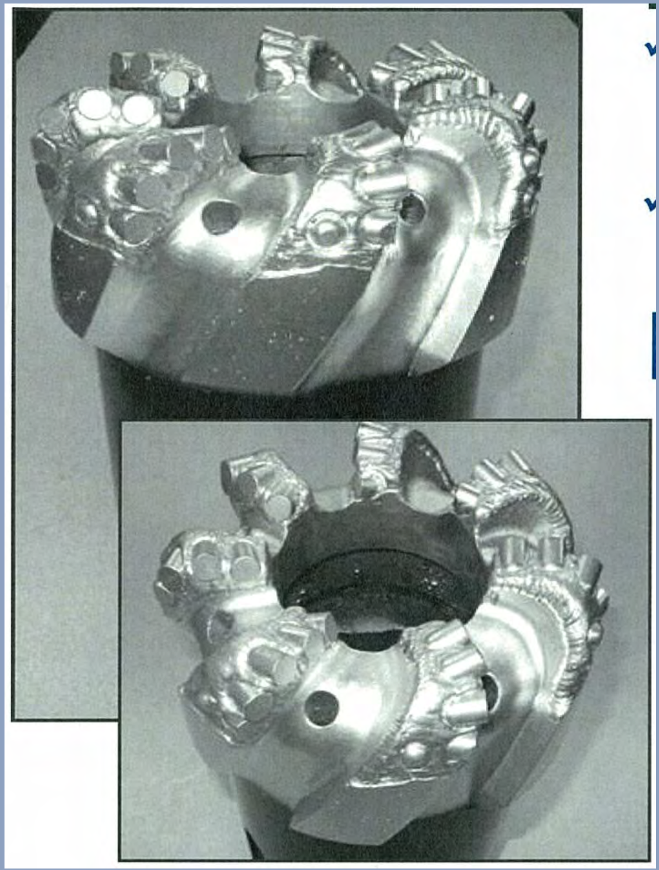
→ Conversition of Viton Seal

Under Development Core Bit

- **New RCB & SD-RCB Bit**

  → Modified Design

  PDC Bit



Future Coring System

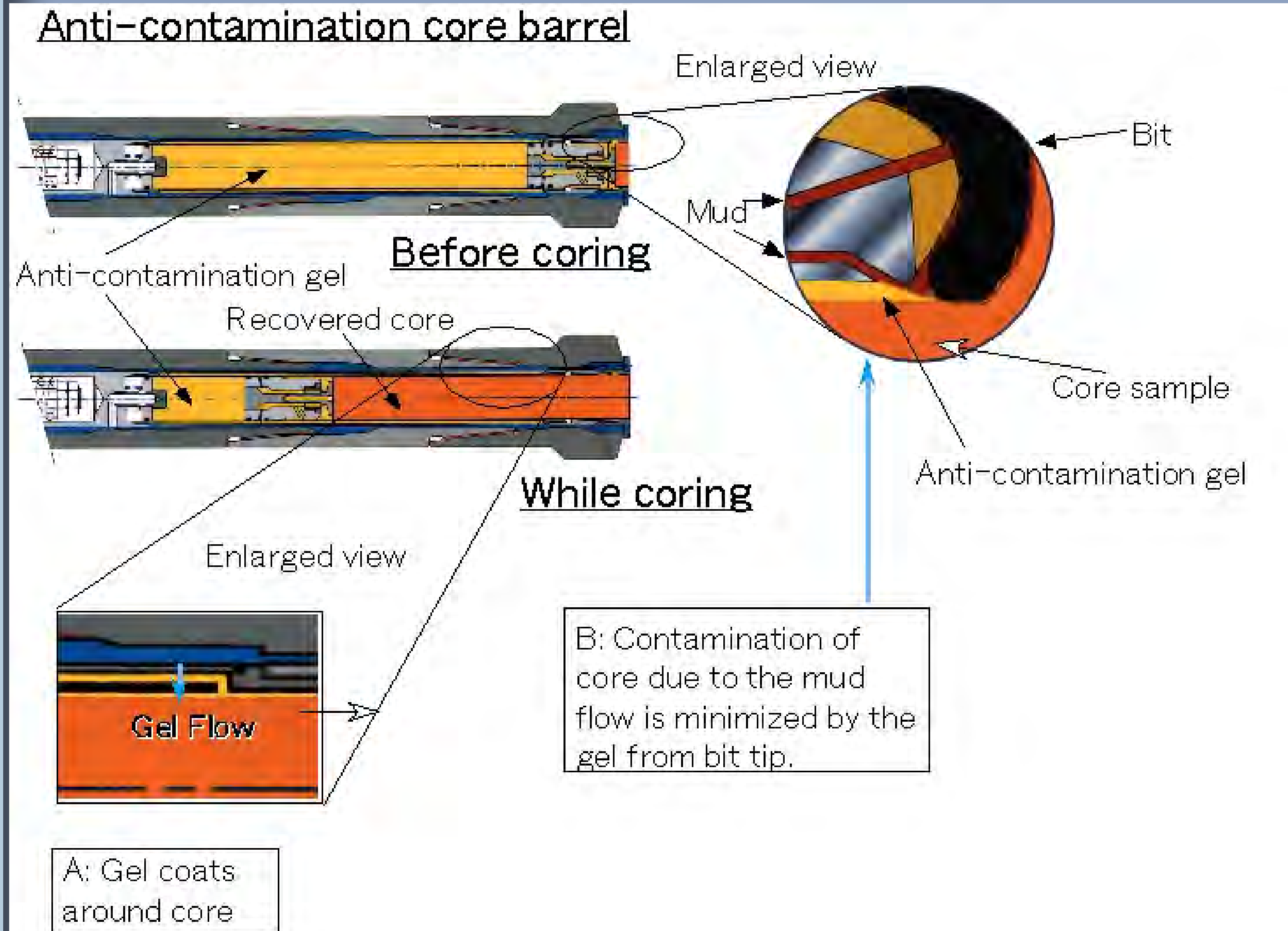
- **Anti-Contamination System**

- Biological/Chemical contamination of the core

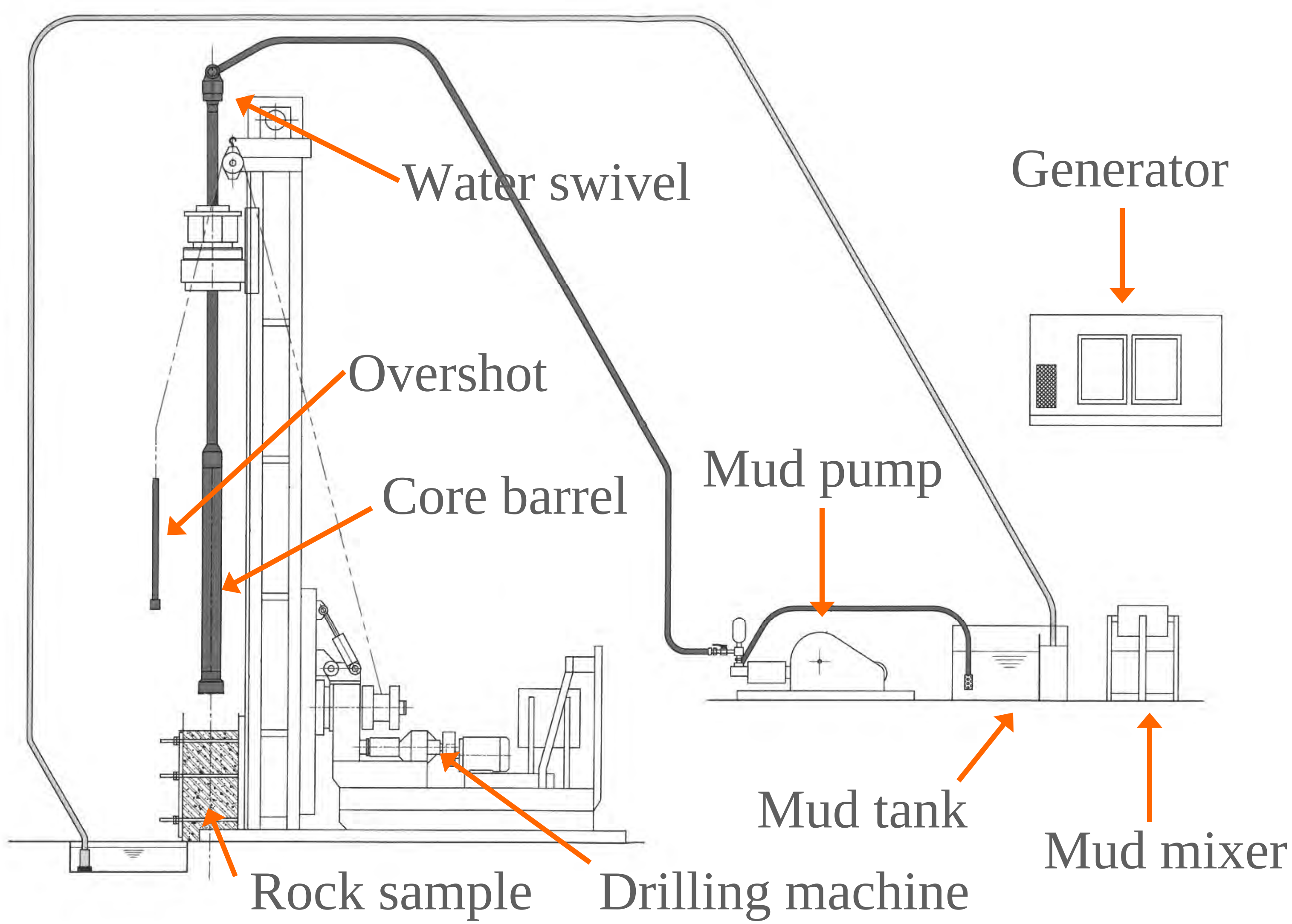
  - during coring and tripping

  - use of drilling fluid (mud)

How to Gel Coating



Equipment for Test Drilling (No.1)



Recovered core (Crystalline rock)

Recovered core with Anti-contamination gel

Recovered core without Anti-contamination gel

APPENDIX 12:

USIO-TAMU Engineering Services Report

USIO-TAMU Engineering Services Report

EDP Meeting

Tokyo

9-11 July, 2007

Engineering Services

- Management & Administration
- At Sea Operations Support
- Facilities Maintenance
- Facilities Enhancements
  - Enhancements to facilities needed to support Engineering Services
- Tools & Equipment Maintenance
- Tools & Equipment Support
- Tools & Equipment Enhancements
  - Enhance existing capabilities to meet evolving performance requirements
  - May include third party efforts to various degrees
- Development of New Capabilities
  - May include third party efforts to various degrees
- Operations Data Analysis

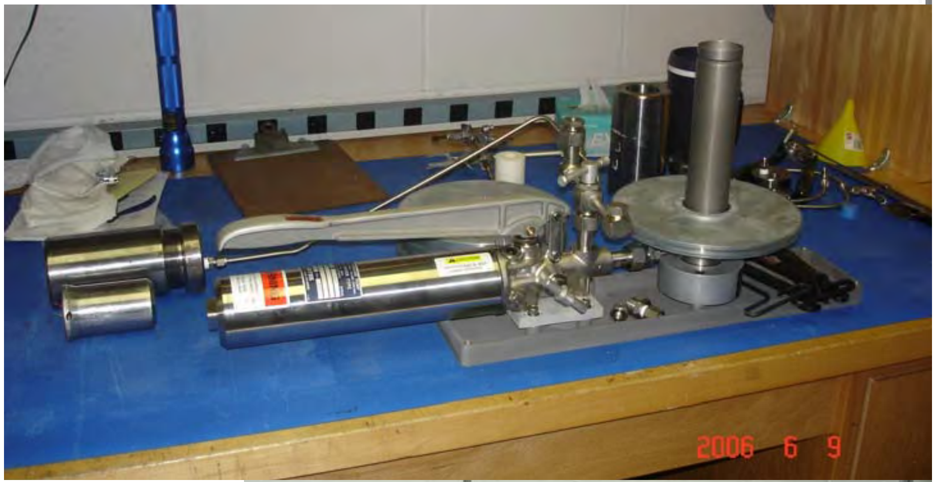
Engineering Activities for EDP

- Facilities Enhancements
  - Metrology Laboratory
  - Derrick for Tool Testing
- Tools & Equipment Enhancements
  - Advanced Piston Corer Temperature Tool Model 3 (APCT3)
  - Downhole Common Data Acquisition System (CDAQ)
  - Instrumented Water Sampler (IWS)
  - Downhole Sensor Sub/Retrievable Memory Module (DSS/RMM)
  - Heave Stroke & Hook Load Measurement (HSHL)
- Development of New Capabilities
  - Pulse Telemetry Module (PTM)
  - Simulated Borehole Test Facility (SBTF)
  - Motion Decoupled Hydraulic Delivery System (MDHDS) (Proposed)

Facilities Enhancements

Metrology Lab

- Pressure testing
  - Deadweight tester
- Temperature testing
  - Calibrations performed to NIST traceable standards
  - Temperature bath
  - Hart Scientific Black Stack unit with a Standard Platinum Restive Thermometer (SPRT) input module and a Standard Thermistor input module
  - Standardized thermistor
- Enhancements started 2005
- Expected completion date Nov 2007



Facilities Enhancements

Test Derrick

- 3 Ton Hoist in derrick repaired and renovated
  - Completion July 2007
- Modifications will be made to the derrick in order to fire SBTF in a vertical position
  - Planned for FY08

Tools & Equipment Enhancements

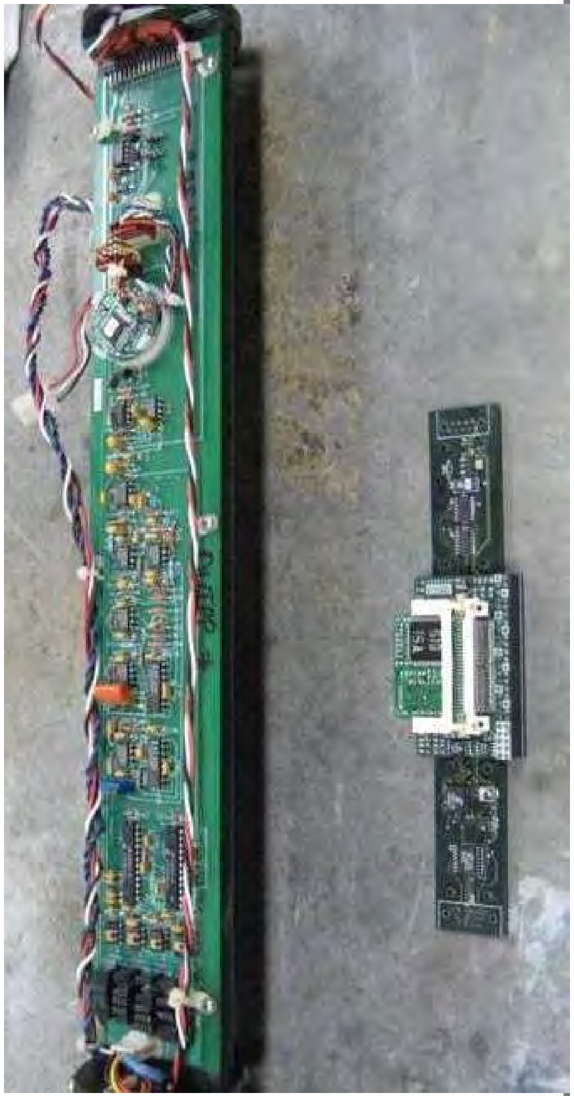
APCT3

- Electronics developed by H. Villinger (Univ. Bremen), A. Fisher (UCSC), built by ANTARES (Bremen)
- Coring shoes remain same
- Sea trials on Expedition 311 results deemed acceptable by scientific party
- Joint implementation USIO and CDEX. Similar hardware, electronics, calibration, operation routines, data storage, QA/QC, etc
- USIO will operate three owned tools and three on loan from UCSC (A. Fisher)
- CDEX will operate six owned tools
- All tools scheduled for recurring calibration/overhaul returns to USIO through lifetime
- New analysis software (TP-Fit) will be publicly available and customized for use with other tools
- Tool integration began February 2007
- Implementation projected to be complete October 2007

Tools & Equipment Enhancements

CDAQ

- Replace current data loggers in IODP downhole measurement tools (DVTP/DVTP-P, IWS, APCM and PCS)
- Support for current data loggers no longer available
- Current data loggers have come to the end of technological lifespan
- Technological advances have lead to breakthrough levels of accuracy and flexibility
- CDAQ Features
  - Surface mount components
  - Increased analog inputs
  - SPI and RS-232 serial interface
  - Increased sampling rate
  - 3 Axis digital output linear accelerometer
- Project initiated—September 2006
- Final Systems Test—October 2007



Tools & Equipment Enhancements

Instrumented Water Sampler (IWS)

- IWS developed in 2002 as in an effort to provide a more reliable tool with improved sampling capability
- A prototype tool was deployed for sea trials on ODP Leg 208
- A project has been initialized to address the issues encountered on Leg 208.
- Enhancements to the IWS will include
  - Electronics
  - Probe Tip
  - Pressure transducer bladder for tip and borehole measurement
  - Battery packaging
  - Syringe motor
  - Software interface
- Project initiated in May 2007
- Final assembly and testing in March 2008

Tools & Equipment Enhancements

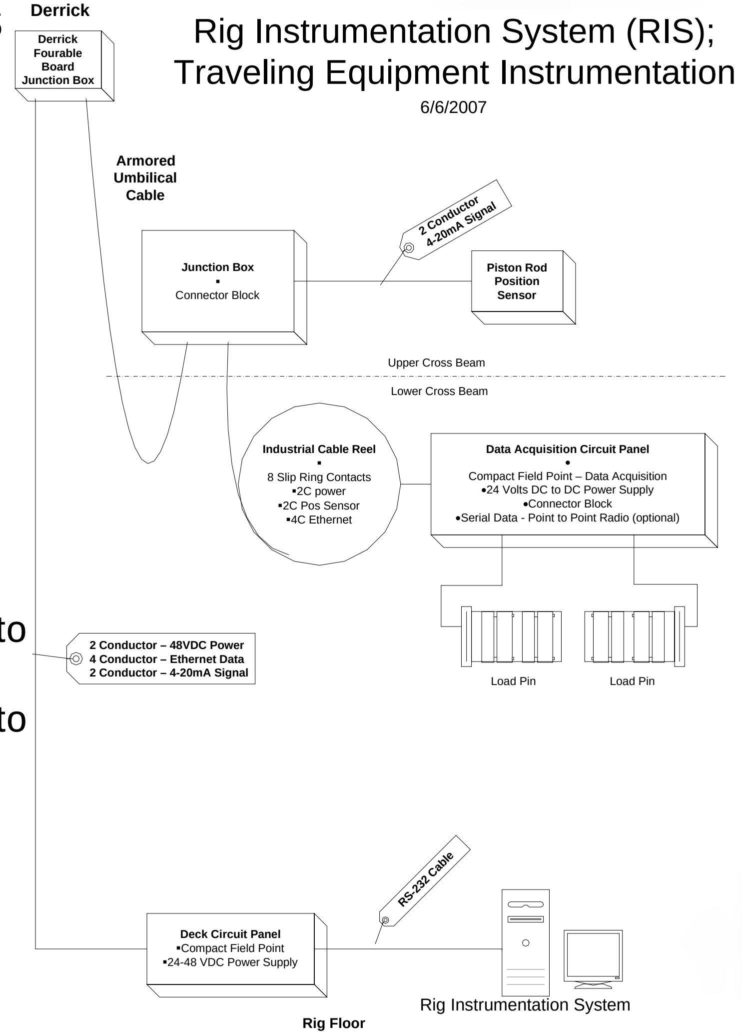
DSS/RMM

- APS Technology contracted to design and build DSS in 2001
- RMM developed by LDEO in 2003
- DSS and RMM sea trials Legs 208 & 210 in 2003
- Initial land testing in 2005
- Drilling Test in March 2007
  - Data look very good, but unable to download rig instrumentation data for verification
- Pressure Test in May 2007
  - Data from pressure transducers and thermistors looks very good
- DSS/RMM test run in June 2007
  - Data from rig instrumentation is being compared to data collected by DSS
- Pressure Test in July
  - Data to be used to verify WOB/TOB pressure and temperature correction factors
- DSS/RMM Test in Aug and Sep 2007
- Tool acceptance expected in October 2007
  - Tool will be in operational/maintenance mode
  - Will request sea trials on early JR expedition

Tools & Equipment Enhancements

Heave Stroke & Hook Load Measurements

- Stroke Position was measured off Active Heave Compensator
- Hook load received power from the AHC umbilical and transmitted data via wireless communication
- Removal of AHC requires an alternate method of collecting this information
- Proposed solution
  - Heave compensator position sensor installed on Passive Heave compensator rods
  - Data acquisition circuit panel on lower crossbeam to gather load pin data
  - Industrial cable reel installed on lower crossbeam to provide power, data transfer and electrical link between lower and upper crossbeam
  - Cables to provide data to Rig Instrumentation System
- Project initiated in June 2007
- Expected installation before first SODV expedition



Development of New Capabilities

Pulse Telemetry Module

- The Pulse Telemetry Module (PTM) would provide real time WOB/TOB and other data to the surface
- PTM Feasibility Study was initiated in January 2007
- Deliverables of feasibility study:
  - Written assessment of available off–the-shelf pulser technology
  - An estimate of engineering and development time and costs to modify off-the-shelf technology
  - An estimate of circulating fluid flow rates
  - An estimate of pulse telemetry rates depths from 5,000 to 30,000 feet
- One company out of five contacted indicated interest
- Feasibility study received by IODP on 2 July
  - Company standard pulser could be modified to fit IODP's purposes
  - Estimate of engineering development time and cost
    - ~1600 man hours to complete and test design work
    - Estimated hardware cost of $83,000 for 3 units
    - Estimated total price for 3 units is ~$250,000
  - Necessary flow rates were in the range of IODP operation
  - Net data transmission rate of ~4 8-bit words per minute
    - Note generally slow data rates of this pulser technology

Development of New Capabilities

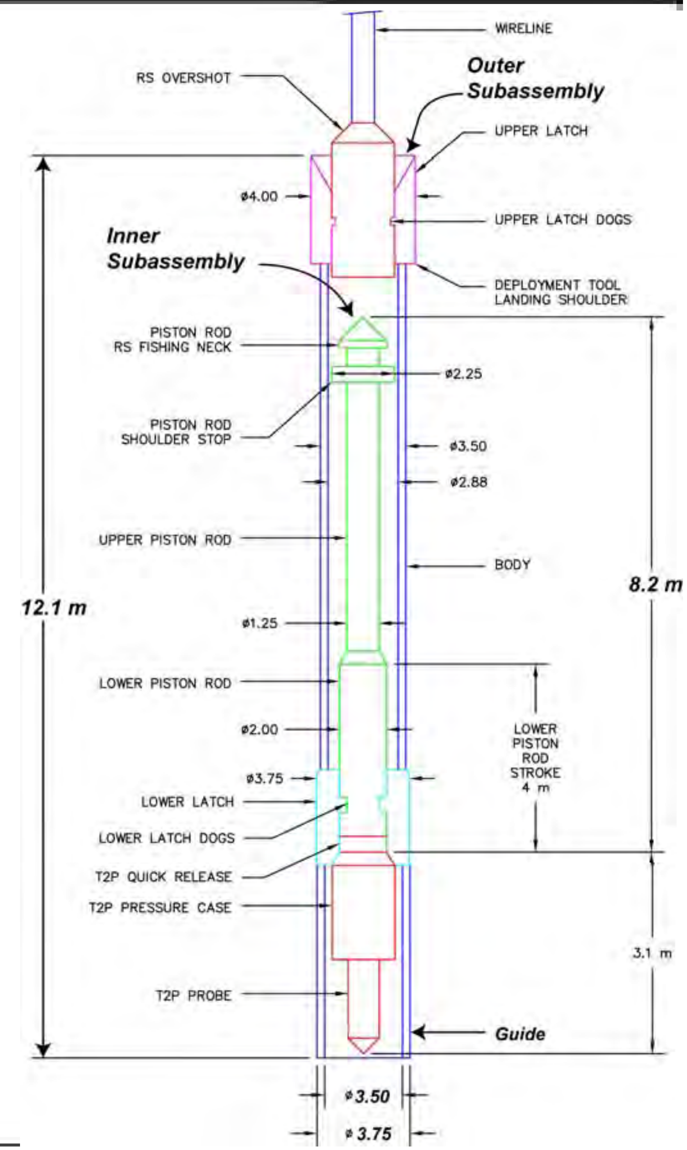
Simulated Borehole Test Facility

- Test IODP formation pressure, temperature and water sampling tools in a downhole environment
- Sediment Consolidation
  - Sediment Consolidation method developed
  - Consolidation method automated to reduce consolidation time
- Instrumentation
  - Linear encoder to measure velocity and acceleration
  - Pressure transducers in firing mechanism and sediment tank
  - Thermistors in sediment tank
- Project initiated in 2004
- Commissioning test in July 2007

Development of New Capabilities

Motion Decoupled Hydraulic Delivery System

- Proposal submitted to IODP-MI in April 2007
- Improve the delivery system of downhole measurement tools to minimize the effects of drill string motion due to heave
- New delivery system proposed to replace the colleted delivery system
- Design and fabrication by Penn State University and Mohr Engineering with USIO-TAMU participation
- Integration into IODP operations by USIO-TAMU and CDEX



APPENDIX 13:

IODP-MI Report to EDP

Engineering Development Panel Meeting

Tokyo, Japan

July 9-11, 2007

Greg Myers

IODP-MI

INTEGRATED OCEAN DRILLING PROGRAM

MANAGEMENT INTERNATIONAL

Outline

- Action Items
- Proposals
  - Review
  - Status
- Schedule
  - What's next
- Third Party Tools
- Funding
  - Current status
  - Non-IODP funding
- Other

INTEGRATED OCEAN DRILLING PROGRAM
MANAGEMENT INTERNATIONAL

Action Items

0701-06 - DSS-RMM independent review

- How does EDP recommend this proceed?

0701-09 – Engineering Development Proposal Process

- Refinements to process ongoing. Version 10 completed following the last EDP meeting.

  - For next round of proposals we will make the following changes
    - Provide more explicit details on the timing of proposal process related events. Such as when projects would be funded.
    - Ask that the proposals not assume reviewers have IODP experience.

0701-11 – Operations Review Task Force

- Any questions about the table passed around yesterday?

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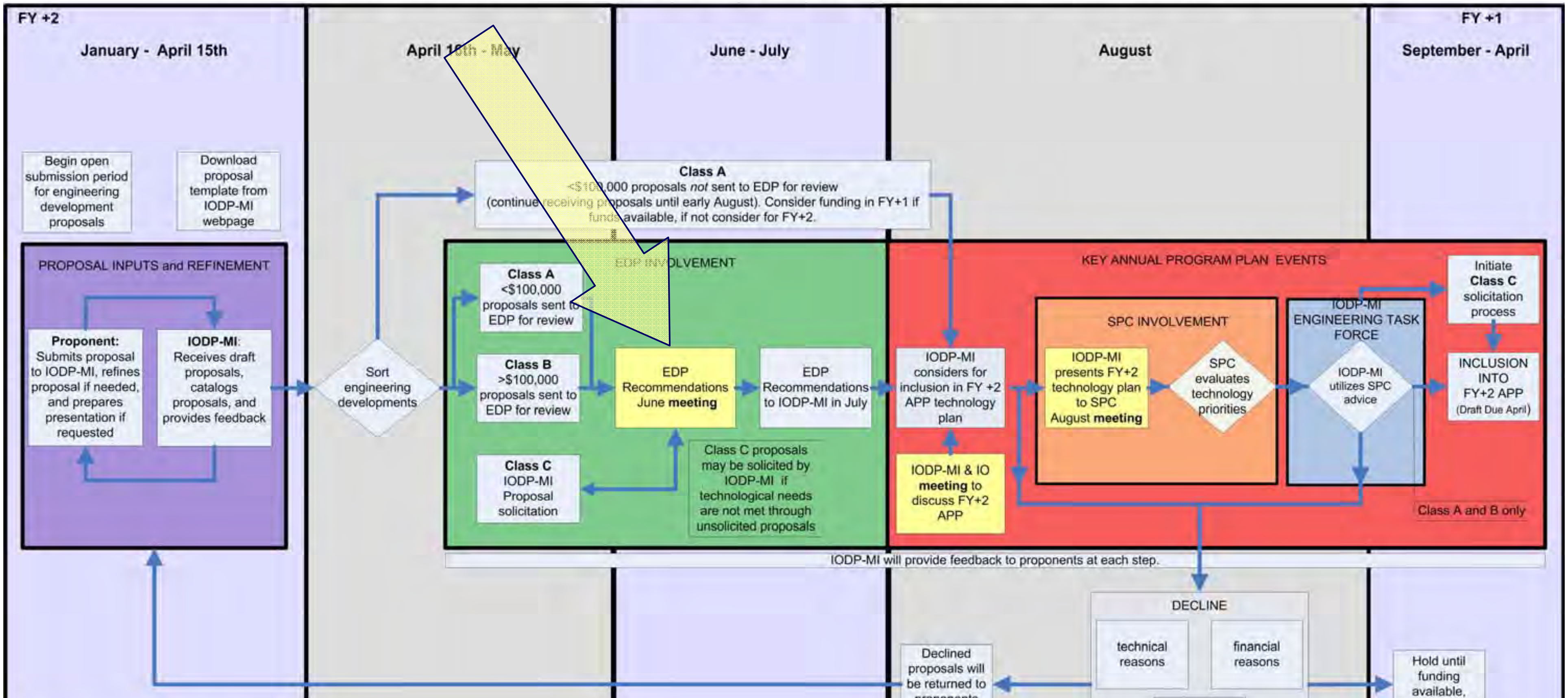
ENGINEERING DEVELOPMENT PROPOSAL SUBMISSION PROCESS FOR INCLUSION INTO THE ANNUAL PROGRAM PLAN



Sorting based on following criteria:

Class A = Unsolicited Engineering Development Projects
Proposals with total budget <$100,000 will be evaluated by IODP-MI and *may* be forwarded to EDP

Class B = Unsolicited Engineering Development Projects
All proposals with total budget ≥$100K will be forwarded to EDP

Class C = Solicited Engineering Development Projects
All potential Class C proposal solicitations will be forwarded to EDP

Proposal Summary

- 10 Proposals submitted to IODP-MI by April 15th
  - Engineering Task Force conducted preliminary review and sorting on April 16th. NSF/MEXT participated in the review
  - 4 forwarded to EDP
    - WHIC
    - Sediment Cork
    - SCIMPI
    - Motion Decoupled Penetrometer Delivery System
  - 6 not forwarded for several reasons
    - Not within purview of SAS-IODP-MI
    - Will not be funded in FY2009. At least one requires quantified scientific justification before proceeding to EDP review and grouping/ranking

ETF and Lead Agencies agreed this was outside the purview of IODP-MI. This technology exists and would likely be investigated by the platform operators. BGS already has a robotic drill thus a feasiblity study is not needed.

ETF and Lead Agencies agreed this was outside the purview of IODP-MI. This technology exists. If it were needed, it would likely be investigated by the platform operators.

This proposal is an offering of services for a robotic seafloor drilling system. The proposal was forwarded to ESO.

ETF and Lead Agencies agreed this aligns with the roadmap, but it is premature to conduct this feasibility study for a specific solution until the problem is quantitatively defined

ETF and Lead Agencies agreed that this proposal does not represent a development that can be funded with co-mingled funds since this a borehole instrumentation project for a specific borehole. This proposal will need to be funded outside of IODP.

ETF and Lead Agencies agreed this is potentially a low dollar Platform Operating Cost (POC) project and may be requested through the USIO annual program plan

Next Steps for EDP Reviewed Proposals

- Watchdogs will prepare written summary prior to departing EDP meeting and submit to IODP-MI
- Letters will be sent to proponents
  - Contains specific comments from watchdogs
- Based on EDP advice, IODP-MI will prepare a draft FY2009 plan and prepare funding request

Outline

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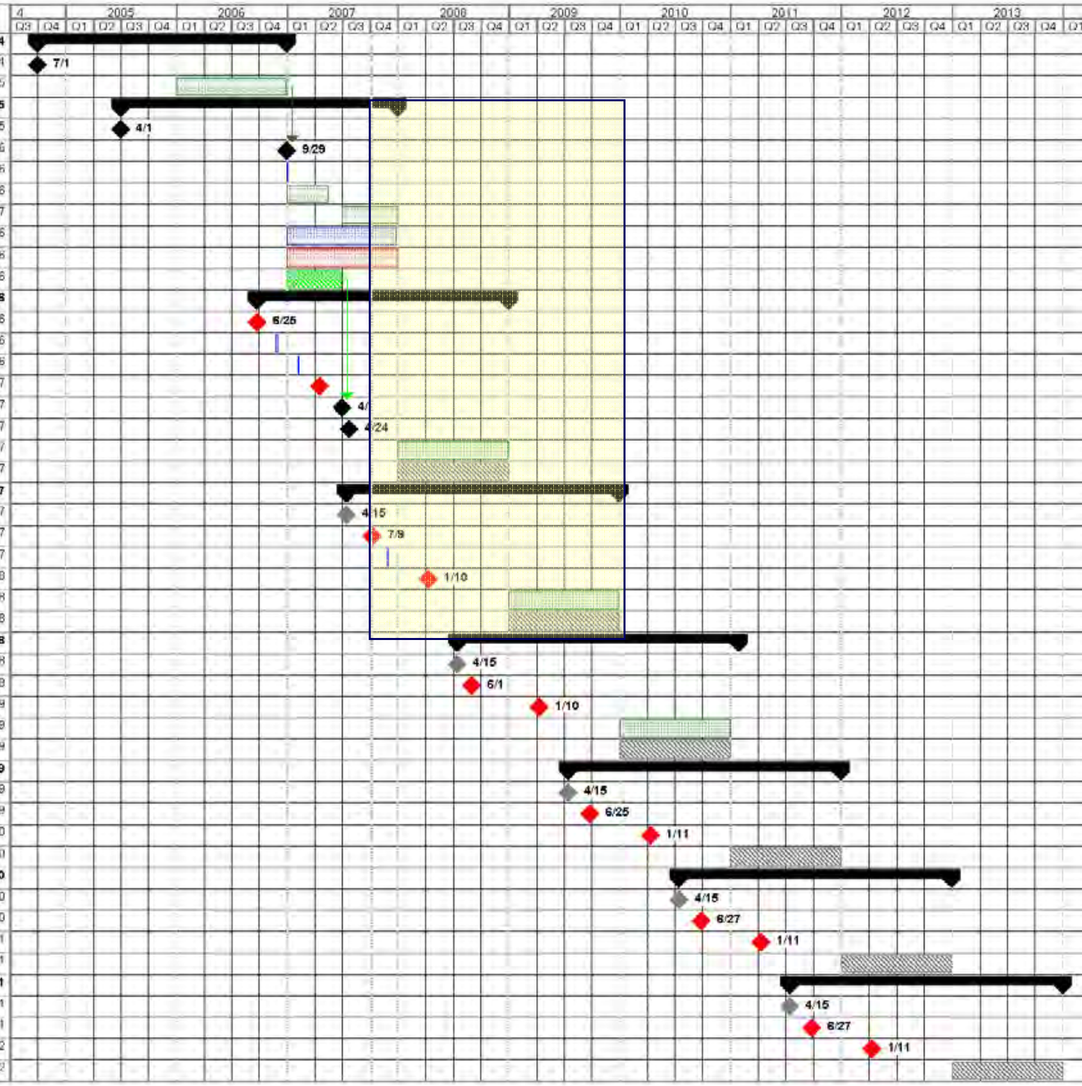
Schedule

- July 11th - receive written reviews from watchdogs
- July 17th – IODP-MI send letters to proponents
- August 10th - receive responses from proponents
- August 21st - IODP-MI will synthesize EDP advice, proponent's responses, budget realities and create a draft FY2009 engineering plan for presentation to SPC.

ID		Task Name	Duration	Start
1		**FY2006 APP**	**587 days**	**Thu 7/1/04**
2		FY 06 APP Planning	0 days	Thu 7/1/04
3		LTMS Feasibility Study	260 days	Mon 10/3/05
4		**F2007 APP**	**656 days**	**Fri 4/1/05**
5		FY 07 APP Planning	0 days	Fri 4/1/05
6		Received LTBMS feasibility Study	0 days	Fri 9/29/06
7		Engineering Task Force 1st MTG	3 days	Sun 10/1/06
8		Develop proposal for FY2007 LTBMS work	100 days	Sun 10/1/06
9		LTMS Implementation FY 07	132 days	Mon 4/2/07
10		Logging While Coring Core Barrels	262 days	Sun 10/1/06
11		PTM Feasibility Study	265 days	Sun 10/1/06
12		Thru Drill Pipe Camera Feasibility	131 days	Sun 10/1/06
13		**FY2008 APP**	**597 days?**	**Sun 6/25/06**
14		EDP June Meeting - Germany	0 days	Sun 6/25/06
15		SPC Meeting - present FY2008 plan	5 days	Fri 8/25/06
16		APP Planning Meeting	4 days	Tue 11/7/06
17		EDP - January Meeting - New York	0 days	Wed 1/17/07
18		First draft of FY 08 APP	0 days	Sun 4/1/07
19		Engineering Task Force MTG	0 days	Tue 4/24/07
20		LTBMS implementation FY 08	262 days	Mon 10/1/07
21		IODP-MI - Proposed Coring Study (<$39K)	262 days?	Mon 10/1/07
22		**FY2009 APP**	**645 days?**	**Sun 4/15/07**
23		FY +2 proposal final submission	0 days	Sun 4/15/07
24		EDP June Meeting - Japan	0 days	Mon 7/9/07
25		SPC Meeting - present FY2009 plan	5 days?	Mon 8/27/07
26		EDP January Meeting - Europe	0 days	Thu 1/10/08
27		LTBMS Implementation FY 09	261 days	Wed 10/1/08
28		Engineering Development Projects	261 days	Wed 10/1/08
29		**FY2010 APP**	**664 days**	**Tue 4/15/08**
30		FY +2 proposal final submission	0 days	Tue 4/15/08
31		EDP June Meeting	0 days	Sun 6/1/08
32		EDP January Meeting - US	0 days	Sat 1/10/09
33		LTMS Implementation FY 10	261 days	Thu 10/1/09
34		Engineering Development Projects	261 days	Thu 10/1/09
35		**FY2011 APP**	**640 days**	**Wed 4/15/09**
36		FY +2 proposal final submission	0 days	Wed 4/15/09
37		EDP June Meeting	0 days	Thu 6/25/09
38		EDP January Meeting	0 days	Mon 1/11/10
39		Engineering Development Projects	261 days	Fri 10/1/10
40		**FY2012 APP**	**643 days**	**Thu 4/15/10**
41		FY +2 proposal final submission	0 days	Thu 4/15/10
42		EDP June Meeting	0 days	Sun 6/27/10
43		EDP January Meeting	0 days	Tue 1/11/11
44		Engineering Development Projects	261 days	Mon 10/3/11
45		**FY2013 APP**	**644 days**	**Fri 4/15/11**
46		FY +2 proposal final submission	0 days	Fri 4/15/11
47		EDP June Meeting	0 days	Mon 6/27/11
48		EDP January Meeting	0 days	Wed 1/11/12
49		Engineering Development Projects	262 days	Mon 10/1/12



Project: engineering development calendar APP based-Jul
Date: Mon 7/2/07

Task		Progress		Summary		External Tasks	Deadline
Split		Milestone		Project Summary		External Milestone	

IODP-MI Core Quantity and Quality Study

- Proposed to occur in FY2008 (starting this October)
- Goal is to quantitatively define the factors that control core quality and quantity
- Deliverables will include:
  - Analysis of drilling parameters, drilling dynamics data and core quality, utilizing industry practices and standards to ascertain the source of coring problems in medium to hard rocks.
  - Provide access to proprietary industry data sets and coring techniques to assist IODP in developing possible implementation models
  - Locating industry core quality description systems and procedures. If they don't exist, a contractor will assist IODP in developing a model for scientific ocean drilling.
- Cost $29K
  - Primarily for industry consultation, data access and reporting

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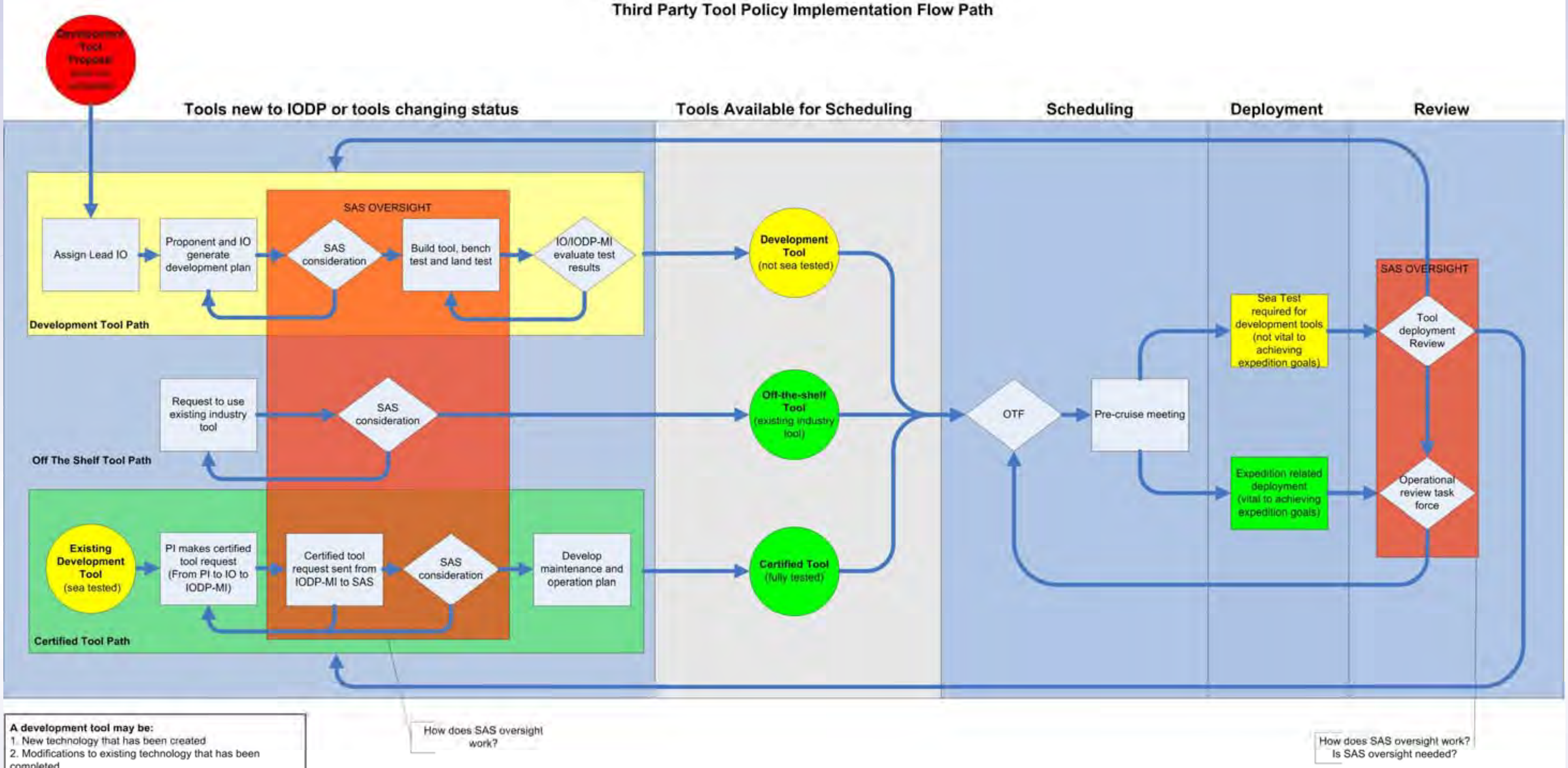
Third Party Tool Policy Implementation Flow Path



A development tool may be:
1. New technology that has been created
2. Modifications to existing technology that has been completed
3. Any existing prototype tool untested at sea

Off-the-shelf tool may be:
1. Technology new to IODP that has been utilized in other markets
2. Leased or purchased tools

A certified tool may be:
1. New technology that has been tested at sea
2. Modified, existing technology

Development

- Assign Lead IO
- Determine funding and operational requirements
- Lead IO ensure development plan has been created
- SAS is kept informed on all three tool categories

Tools available for scheduling

- These are existing, functional tools that are available for OTF consideration.

Scheduling

- Funding and operational issues have been identified and resolved
- Lead IO have provided feedback on whether third party development can move forward to OTF

Deployment

- Lead IO assists proponent in implementing testing plan

Or

- Lead IO deploys tool as integral part of science plan

Review

- Data must be archived with other shipboard data and releasable following moratorium
- Results must be made available to engineering and technology panels and operations review task force.
- Results of deployment ultimately are presented to OTF, who considers whether tool is run again.

DRAFT
December 5, 2006

INTEGRATED OCEAN DRILLING PROGRAM
MANAGEMENT INTERNATIONAL

Development Tool Request

From the Third Party Tool Implementation document…..available on the web.

Development tool request

4) **The IO will report the submission of development and deployment plans to** the STP, the **EDP**, the OTF, and IODP-MI. The STP will determine the action on these submissions in accordance with the panel mandate and will provide advice to the IO regarding further tool development. **Where engineering development is significant, the STP and EDP will designate individuals to coordinate panel input to the OTF, SPC, and IOs. The EDP may take the lead where engineering is the major focus of the development.** The IODP-MI will work in concert with the SAS, the IO's and proponents to ensure that this third-party tools policy is fully utilized.

5) Once the IO and SAS panel(s) endorse the development plan, a staff liaison will be appointed by the appropriate IO to monitor the tool's progress through the development plan. The IO's tool liaison will provide status reports on the tool's progress to the STP, EDP, OTF and IODP-MI.

Certification Request

From the Third Party Tool Implementation document…..available on the web.

5) The lead IO submits the request for certification to IODP-MI. If the tool has potential cross platform usage IODP-MI will coordinate a multi-operator agreement. IODP-MI will then seek endorsement by the STP and/or the EDP.

6) Upon STP and/or the EDP endorsement of the certification request, IODP-MI will issue a certificate confirming the satisfactory conclusion of tests and compliance with all requirements to the proponent (with copies sent to the STP and EDP chairs).

Third Party Tools on the radar

Certified Tool Request

- APCT-3 – Lead IO is USIO
  - IODP-MI has been contacted and we are expecting a request
  - IODP-MI will likely present a certification request at next EDP meeting

Deployment Tool Request

- HTPF – Lead IO is CDEX
  - IODP-MI has received a deployment request which has been forwarded to CDEX
  - CDEX and Proponent are currently discussing deployment options
  - Deployment request will be made to EDP at a future meeting

Tools being developed outside of IODP but are worth noting.

- Gel Coring Core barrel
- High Resolution Magnetic Susceptibilty tool

INTEGRATED OCEAN DRILLING PROGRAM
MANAGEMENT INTERNATIONAL

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INTEGRATED OCEAN DRILLING PROGRAM
MANAGEMENT INTERNATIONAL

Funding Status

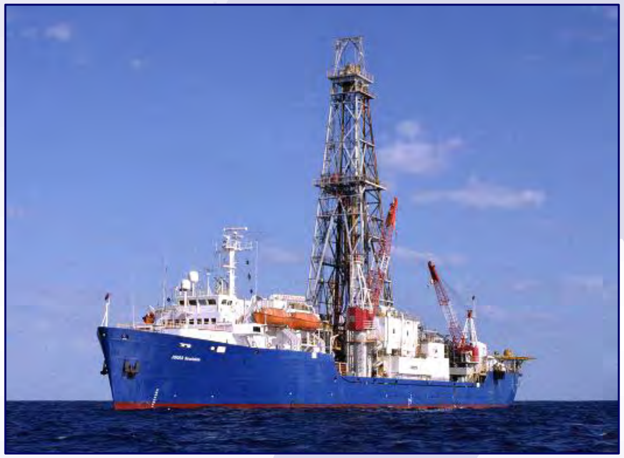
- IODP planning works on “budget request” system…which means that we put together an engineering plan, then IODP-MI requests funds to complete the plan. Lead Agencies provide guidance on how much funding will be available in the spring time frame and our request is based on the guidance amount.

- We are in a new fiscal climate through 2013. Program funds are available to run the riser and riserless platforms for approximately 6 to 8 months per year.

- IODP-MI and the USIO have been brainstorming to come up with ways of filling funding gaps. One way is for the operators to make their vessels available for non-IODP work, such as engineering testing, or technology demonstrations.

IODP has vessels and experience that can be leveraged

Riser Platform



Riserless Platform

Mission-Specific

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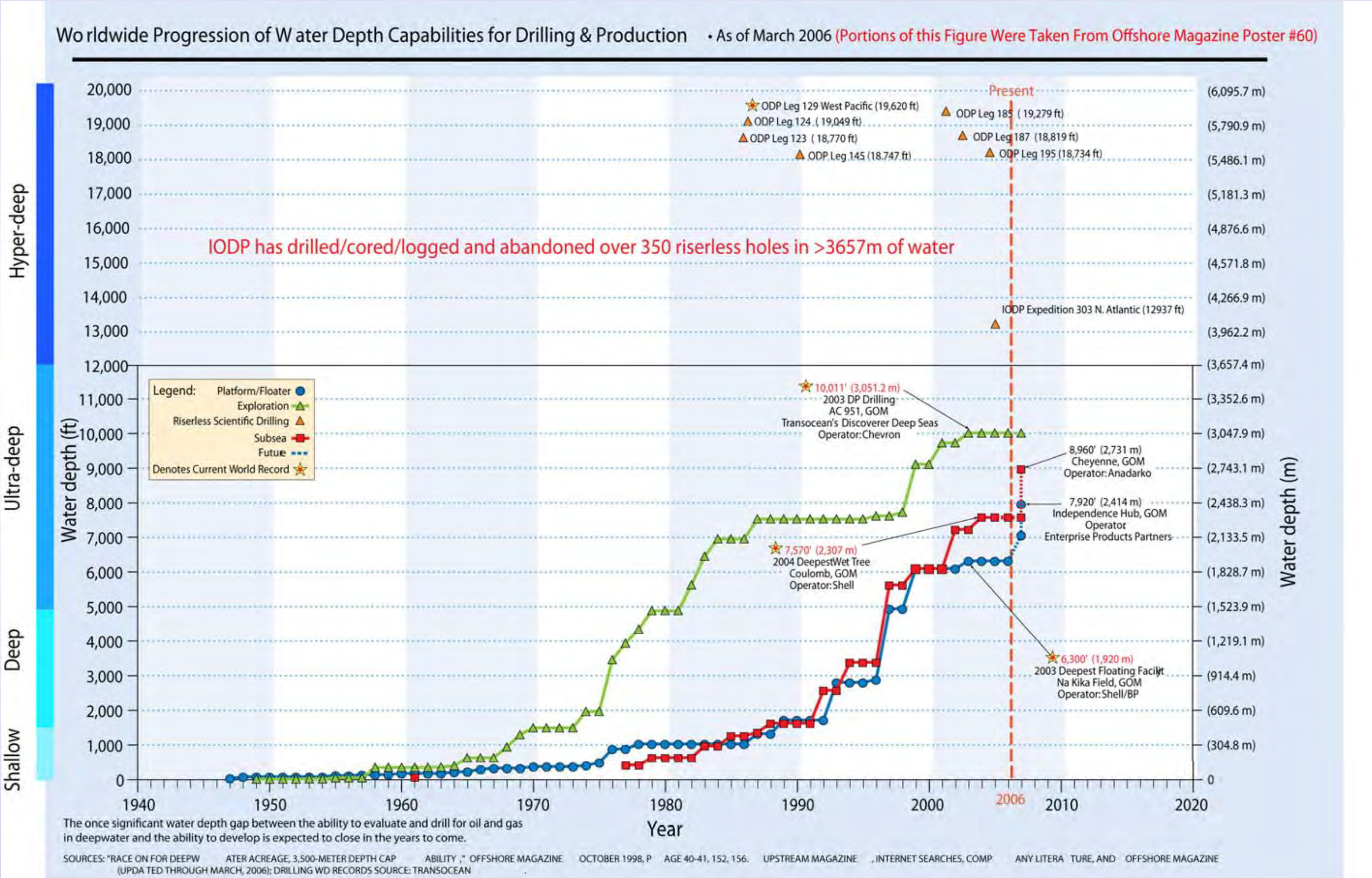
MANAGEMENT INTERNATIONAL

ODP and IODP have consistently drilled in “Hyper-deep” water

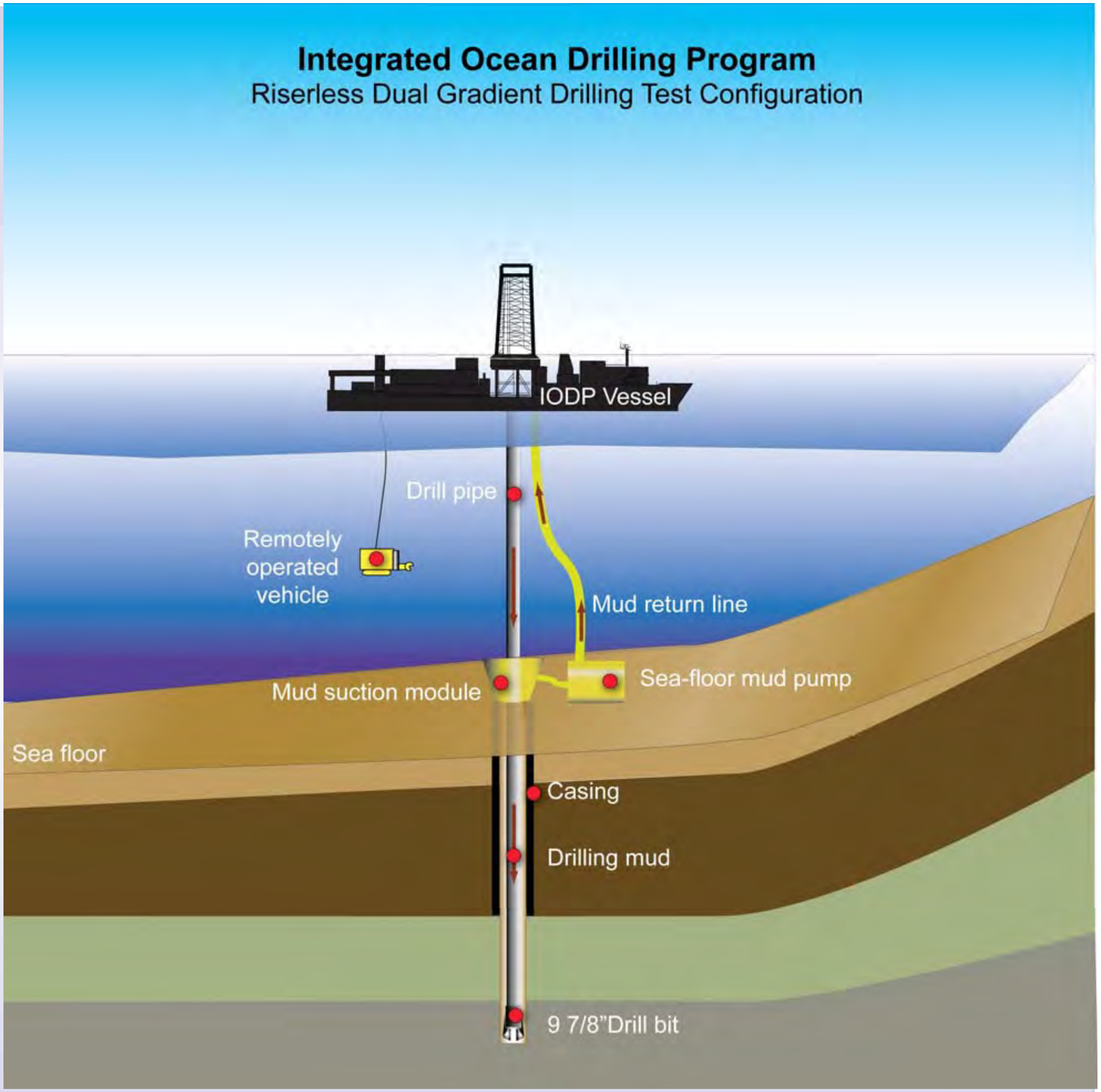


For Example…

Riserless Mud Recovery systems are presently of great interest to the ultra-deep (>1500 m) drilling programs.

Industry needs platforms for system testing.

Could a demonstration project be assembled to test riserless drilling equipment for industry while coring at sites of high interest to the IODP science community (e.g., Gulf of Mexico)?



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EDP's Role

- We are looking for other suggestions from EDP…what are your thoughts?

For example:

- Can you provide ideas for possible collaborations or projects to the IO's, IODP-MI, etc.?
- Can you review future project proposals?

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INTEGRATED OCEAN DRILLING PROGRAM
MANAGEMENT INTERNATIONAL

Other

- Develop a conceptual framework for a coordinated engineering mini-expedition (10 days or less). This could be a collection of coring equipment tests at one site. Equipment tests could include:
  - Gel Coring
  - ½ stroke APC and XCB
  - MDCB
  - DSS-RMM
  - Heave Compensation
  - Bit technologies

APPENDIX 14:

Summary of Grouping Process Used at EDP Meeting 5

Appendix #14 (version 3.0—1_4_07):
Summary of EDP Evaluation Process used at July 2007 EDP Meeting.

1. Four (4) proposals were received by the EDP from IODP-MI.

1) Wellhead Inter-connection (WHIC) system, R. Stephen et al.

2) Simple Cabled Instrumentation for Measuring Parameters In-situ (SCIMPI), by K. Moran et al.

3) Sediment CORK (SCORK), by E. Davis et al.

4) Motion Decoupled Penetrometer Delivery System (MDPDS), by P. Flemings et al.

2. Conflict of Interest

COI Overview:

A conflict of interest is a situation in which the interests (for example: personal, professional, or commercial) of an IODP SAS member or designated alternate involved in nurturing, evaluation, or assessment processes, or technological development, have a real or perceived impact, either positive or negative, on the results of the nurturing, evaluation, or assessment processes, or related contractual work.

The chair/s should clearly announce and document all potential conflicts of interest and resulting actions (included in the minutes).

In a similar fashion, members of panels who have a financial or commercial interest in tools, programs, etc, by means of their employment will be held to be in conflict of interest.

At EDP, the specific COI issue of concern is the participation of panel members and other attendees who are proponents of active proposals.

Panel members and other attendees who are proponents of active proposals are to be excluded from discussions of the specific proposal/s on which they are proponents. Proponents may participate in the discussion of all other proposals, including serving as watchdogs.

Proponents may participate in nurturing and evaluating all other proposals, with such members declaring their potential conflicts, and the chair/s keeping a record of these conflicts.

Institutional Conflicts are dealt with as follows:

- In general, this is OK.
- Does the situation prevent you from rendering an impartial (fair) assessment?
- Is there a direct supervisory role or collaboration on a larger project that includes IODP?
- Is there a personal conflict?
- If in doubt, inform Co-Chairs. Allow them to document and judge.

COI Practice at EDP Meeting #5:

Individuals with a COI on a particular proposal were excused from the room during any discussion of the proposal with which they had a COI. If a panel member was conflicted on a particular discussion, that panel member was still allowed to participate in the discussion of other proposals. The following members were determined to be in conflict with particular proposals.

Proposal #2: Ussler
Proposal #3): Becker
Proposal #4): Flemings and Grigar

3. Discussion and Grouping Process:

Prior to the meeting, lead watchdogs and at least two additional watchdogs were chosen to lead the proposal evaluation process. Watchdogs were chosen from the panel members. Panel members were to provide constructive feedback on how the proposal could be strengthened in addition to evaluating how the proposal fit into the technology goals of the IODP. The watchdogs were free to contact the proponents with questions regarding their proposal. Proposals were discussed in one session on Day 2 of the meeting.

IODP-MI (Greg Myers) made the presentations for all proposals. IODP-MI presented a comprehensive, thorough summary of proposal. Thereafter, the lead watchdog led the discussion. All watchdogs were given an opportunity to comment, then all participants were given an opportunity to comment. The goal was to reach a consensus about proposal quality, perform a complete review and deliver to IODP-MI a review letter on the last day of the meeting.

If there is no consensus, it was agreed that the differences amongst the watchdogs would be documented, described, and justified. The Lead watchdog wrote a provisional draft of panel comments, with full involvement of other watchdogs. The following issues were considered: 1) Relevance to ISP; 2) Relevance to Technology Roadmap; 3) Probability of Success; 4) General impression regarding previous reviews; 5) Strengths and challenges of final proposal.

Proposals were grouped on the last day in Executive Session. The groupings were based on a 5-star (-*) system, with 5* being the highest and 1* being the lowest. The following describes the grouping system used.

<u>5 stars: Extraordinary proposal.</u>
(ED impacts multiple aspects of the ISP and/or Tech Roadmap. Exceptional cost/benefit ratio: very high probability of success.)

<u>4 stars: Very good</u>
(Impacts the ISP and/or Tech Roadmap: good cost/benefit, high probability of success)

<u>3 stars: Good</u>
(Impacts the ISP and/or Tech Roadmap: acceptable cost/benefit, acceptable probability of success.)

<u>2 stars: Could be strengthened</u>
(Can impact ISP: contains deficiencies in organization, and/or poor cost/benefit, and/or poor probability of success.)

<u>1 star: Not Acceptable</u>
(It does not impact the ISP or contains deficiencies in organization, and/or poor cost/benefit, and/or poor probability of success.)

The results were summarized in a letter that was provided to IODP-MI. We followed the protocol of the SSEPs (Science Steering and Evaluation Panel) proposal grouping process and did not make the proposal groupings public and did not include the proposal groupings in the EDP Minutes. It was our understanding that IODP-MI would communicate the evaluation to the proponents.

4. Confidentiality:
It was communicated to EDP Members and Guests/Liasons that the engineering proposals are considered confidential, that they may contain protected intellectual property.

APPENDIX 15:

EDP Technology Roadmap 2.0

Engineering Development Panel Technology Roadmap DRAFT 2.0
November 18, 2007

Authors: EDP Panel Members (http://www.iodp.org/edp/)

History:

Engineering Development Panel Technology Roadmap 1.0 was prepared between January 2006 and July 2006. There was no previous document. It was formally ratified by the EDP Panel pending editorial revision at the June 2006 EDP Meeting in Germany.

Engineering Development Panel Technology Roadmap DRAFT 2.0 was prepared between January 2007 and November 2007. It is a modified version of EDP Technology Roadmap 1.0 based on comments made by the EDP panel at their January 2007 and July 2007 meetings. At the July 2007 meeting the technology roadmap was formally ratified by the EDP pending editorial revision.

EDP Technology Roadmap 2.0 is a public document and can be found at: http://www.iodp.org/eng-dev.

1.0 Executive Summary

The Engineering Development Panel (EDP) of the Integrated Ocean Drilling Program has developed the Technology Roadmap. The Technology Roadmap summarizes EDP roles and responsibilities. It then describes technology challenges that face the IODP as it attempts to achieve its science goals. It then details a range of developments that could contribute to achieving these science goals.

There are many more projects than can be afforded by the IODP. At its July 2007 EDP meeting, the EDP established the following unranked list of 'higher priority' engineering developments within three broad themes: Sampling/Logging/Coring, Drilling/Vessel Infrastructure, and Borehole Infrastructure.

Table 3. Unranked List of Engineering Developments

Theme 1: Sampling/Logging/Coring	***Theme 2: Drilling/Vessel Infrastructure***	***Theme 3: Borehole Infrastructure***
A1) Thin Walled Geotechnical Sampler	B3) Heave Compensation	C1) High temperature electronics, sensors, and sensor systems
A2) Cone Penetrometer/Remote Vane	B5) Seabed Frame	C4) Hydrologic Isolation
A4) Hard rock re-entry system (HRRS)	B8) Improved Automatic Driller	C5) Reliable wellhead hanger seals
A11) Rotary sidewall coring	B9) Drilling Parameter Acquisition while coring	C6) Electric, optical fiber and fluid feed-throughs
A12) Provide core orientation on standard coring tools - Structural Orientation of Hard Rock Cores	B10) Real Time Drilling Parameter Acquisition while coring	C9) Physical coupling of acoustic instruments to formations and decoupling from noise sources
A13) Seabed coring devices	B14) Electric/Optical Wireline	C14) Systems reliability for LTMS
A16) Pressure coring systems (PTCS, PCS, FPC, HRC, etc.)	B19) Protocol for Proper Mud Design	C15) ROV-serviceable wellheads and submarine cable connections
A17) Pressurized Sample Transfer (autoclave)	B21) 4000 m class riser system	C17) Design standards for electrical, communications, mechanical, and fluid systems
A21) Anti-contamination system (gell core barrel)	B22) 4000 m class BOP	C18) Deployment procedures/soft-landing for borehole infrastructure and instruments
A23) Fluid samplers, temperature, and pressure measurement tools	B27) Drill pipe for ultra deep ocean drilling	C19) Managing borehole experiments
A24) Transition corers		

EDP Technology Roadmap

2.0 Introduction and EDP Roles and Responsibilities

The Integrated Ocean Drilling Program (IODP) builds from the successes of the Deep Sea Drilling Project (DSDP) and the Ocean Drilling Program (ODP), yet it is a fundamentally more extensive and challenging multi-national endeavor. The IODP involves simultaneous use of riser, riserless, and mission-specific drilling platforms, and it will explore environments and problems that could not be addressed previously. These characteristics influence virtually all facets of planning, funding, at-sea operations, and technical development. It is particularly important to examine the role of Engineering Development (ED) because advances in these efforts are critical to IODP science, because the development and application of engineering solutions are the responsibility of the three implementing organizations (IOs) and third-party developers, and because technology advances are driving new measurement capabilities and scientific demands.

The Engineering Development Panel (EDP), a panel within the Science Advisory Structure (SAS) of IODP, is one of the key bodies charged with providing guidance on ED in the IODP. The following is extracted from the EDP mandate (http://www.iodp.org/edp/). "The panel shall provide advice on matters related to the technological needs and engineering developments necessary to meet the scientific objectives of active IODP proposals and the IODP Initial Science Plan (ISP) to the Science Planning Committee (SPC); through the SPC, to the Science Planning and Policy Oversight Committee (SPPOC) and IODP-MI; and, through IODP-MI, to the implementing organizations (IOs)…The EDP shall identify long-term (two to five year lead time) technological needs determined from active IODP proposals and the ISP, and recommend priorities for engineering developments to meet those needs, both for the annual IODP engineering plan and on a longer term."

The EDP has established the following structure at its bi-annual meetings. In its June/July meeting, EDP will provide SPC with a prioritized plan for FY+2 engineering developments for the Program Plan; EDP will also examine and define long-term ED needs (FY>2). At its January meeting, EDP will provide guidance to IODP-MI and the Implementing Organizations (IO's) by reviewing the engineering development plan within the Program Plan (FY+1); EDP will also preview long term ED needs.

The SPC will use the guidance provided by EDP's Spring meeting to prioritize the annual engineering development plan along with the annual science plan. At their summer meeting, SPC must make specific recommendations to SASEC (Science Advisory Structure Executive Comm.) for the FY+2 ED plan. Thus, the SPC must recommend the 2010 ED plan at its summer 2008 meeting. EDP is charged with providing as much detail as possible on their FY+2 engineering development recommendations. However, it will not be at the level of detail required for the formal Program Plan. That level of detail is developed by IODP-MI in the formal Program Plan. SPC must be able to map specific FY+2 developments against the long-term technology roadmap developed by EDP, and thereby envision how the ED priorities might project into future years (just as SPC tries to project science plans into years beyond a single FY).

The annual engineering plan that SPC recommends to SASEC may have many cross-linkages with the annual science plan. However, some ED recommendations could look to future programs and need not be tied to a given annual science plan. EDP input in this process will emphasize the ISP themes and initiatives, and assess the ED needs for achieving these initiatives. It should provide a first-order assessment of timelines and likely costs, and provide some sort of prioritized long-term sequence for such developments. EDP will suggest priorities, and will tie these priorities to the needs for achieving the science plan.

3.0 The Technology Roadmap

The Technology Roadmap will provide a long term vision (> 2 years) of priorities in ED that are vital to achieve the science goals of the IODP. It will be an evolving document that will undergo major review at EDP's June meeting each year. The roadmap will be founded on the scientific goals of the IODP as enunciated in the Initial Science Plan (Integrated Ocean Drilling Program, 2003) and active IODP Proposals. The Technology Roadmap will assess the ED needs for achieving these initiatives. It will provide a very rough estimate of timelines and likely costs, and provide some sort of prioritized long-term sequence for such developments. EDP will tie these priorities to the needs for achieving the science plan.

The ISP has three major scientific themes: The Deep Biosphere and Subseafloor Ocean, 2) Environmental Change, Processes and Effects, and 3) Solid Earth Cycles and Geodynamics. Within each theme there are a number of new program initiatives (Table 1). These Initiatives incorporate novel scientific approaches and require major advances in drilling platforms and technologies.

Table 1. Major Themes and Initiatives for the IODP

1	**The Deep Biosphere and the Subseafloor Ocean**
1a	Initiative: The Deep Biosphere
1b	Initiative: Gas Hydrates
2	**Environmental Change, Processes and Effects**
2a	Internal Forcing of Environmental Change
2b	Initiative: Extreme Climates
2c	External Forcing of Environmental Change
2d	Environmental Change Induced by Internal and External Processes
2e	Initiative: Rapid Climate Change
3	**Solid Earth Cycles and Geodynamics**
3a	Formation of Rifted Continental Margins, Oceanic LIPs and Oceanic Lithosphere
3b	Initiative: Continental Breakup and Sedimentary Basin Formation
3c	Initiative: Large Igneous Provinces

3d	Initiative: 21st Century Mohole
3e	Recycling of Oceanic Lithosphere Into the Deeper Mantle and Formation of Continental Crust
3f	Initiative: Seismogenic Zone

3.1 <u>Technology Challenges Facing the IODP</u>

To achieve the scientific goals identified in the ISP, there are a range of technology challenges (Table 2) that require engineering development.

Table 2. Technology Challenges for the IODP

1	Expand temperature and pressure tolerance
2	Drill/Instrument unstable lithologies and over pressured zones
3	Improve core recovery and quality
4	Improve depth control and cross-instrument depth correlations
5	Develop long-term borehole monitoring systems
6	Develop ability to perform in situ experiments
7	Improve well directional control
8	Make measurements under in-situ conditions
9	Sample at in situ conditions and transfer samples at in situ conditions shipboard
10	Improve hard-rock drilling capabilities
11	Improve remote and post-deployment capabilities
12	Improve reliability
13	Extend depth capabilities
14	Improve operability under strong currents and severe sea state

1. *Expand temperature and pressure tolerance*

We need to expand the temperature limits of drilling and measurement technology. Drilling targets are deeper than during the ODP, and the more extreme sites that have been avoided in the past are of great interest. Long-term monitoring in hot boreholes will require ED that addresses sensor reliability, robustness, and drift in hostile thermal and chemical environments.

During the ODP, the LDEO/BRG wireline Hi-T probe and the University of Miami GRC Ultra Hi-T Memory Tool were available. The LDEO/BRG Hi-T tool can be deployed in situations where temperatures do not exceed 235°C, whereas the GRC tool was used in situations where the temperatures exceed the upper limit of wireline capabilities.

Long term monitoring is a challenge because exposure to both high temperature and corrosive fluids occur over a long time frame. Significant technological developments must be made to use muds, cements, and drilling technologies for high temperature settings. Drilling muds used at high temperature cannot include standard clays, such as bentonite or sepiolite, without modifications. Additives can extend the temperature range for these materials to some degree, but investigation of more exotic materials will be essential. It will be important to use experience and knowledge of drilling high temperature wells in the geothermal and the oil and gas industry.

Material aging at high temperatures in corrosive environments is not well understood or investigated. Aging will affect the reliability and life-time of in situ experiments and long-term monitoring systems in hostile environments.

2. *Drill/Instrument unstable lithologies and over pressured zones*

Three lithologies have proven to be difficult to complete drilling:

a. Fault zones
b. Volcanic rubble in mid-ocean ridge (MOR) settings
c. Unconsolidated sands and other coarse materials

Possible approaches to drill more successfully include the development of more sophisticated drilling mud programs, approaches to case the borehole while advancing, and other techniques.

The IODP faces drilling in the Nankai Accretionary prism to considerable depths across the decollement. In this environment, the stress state is complicated and the pore pressures poorly known. Hole instability may result due to the large differences in maximum and minimum stresses along the wellbore, which can cause breakout leading to excessive hole enlargement. Possible approaches that could be used to drill more successfully include: 1) more sophisticated mud programs, 2) casing the borehole while advancing, and 3) wells could be oriented and mud weight controlled to take into account the stress condition in the borehole.

3. *Improve core recovery and quality*

Core recovery has been a significant problem in at least 5 environments in DSDP/ODP/IODP history:

a. Fault zones
b. Volcanic rubble in MOR settings
c. Unconsolidated coarse material or zones of strong rheological layering (e.g. shale-chert)
d. Igneous rocks (Hard Rock)
e. Gas Hydrates

A major goal of the IODP is to drill into fault zones (ISP Science Theme 3 and the Seismogenic Zone Initiative). In this regime, the rock is often highly deformed and core recovery is low. In intensely fractured, young lava flows, the core is often so broken up that intact pieces of core are not recovered. In shallow poorly indurated regimes (e.g. unconsolidated sands and/or layered hard-soft lithologies (e.g. chert-shale systems), core recovery is often frustratingly low. Initiation of coring (on bare and sloping seafloors) and core recovery in hard rocks have long been issues that will need to be solved. Geotechnical cores are taken to determine formation rheology, permeability, and maximum past effective stress. However, deformation caused by the Advanced Piston Corer compromises the quality of these samples. It is important to preserve the Magnetic orientation of core samples. Operational procedures for coring with mud should be developed for *Chikyu*.

4. Improve depth control and cross-instrument depth correlations

The primary reference for all coring operations is the cumulative length of the drill string below the rig floor. The actual uncertainty in drill pipe measurement and, hence, depth of an interval of core, is significantly higher, on the order of 0.2–4 m or more mainly owing to the variations of ship motion at sea. No precise estimation of error in drill pipe depth is possible. The magnitude of the error is demonstrated by the difference between precision depth recording devices and drill pipe measured depths. In addition, multiple adjacent drill pipe measurements often disagree by as much as a few meters. An additional obstacle to high-resolution depth estimation in piston coring is the requirement to lock out heave compensation before firing the advanced piston corer (APC). Accurate depth registration is fundamental to sedimentation rate calculations and any modeling based on the relationship between age and depth.

5. Develop long-term borehole monitoring systems.

A fundamental goal of the IODP is to apply long term monitoring and perform active experiments in boreholes in remote locations. These endeavors will require technological developments, robust operational/deployment plans, and post-deployment management.

Efforts to study the subsea biosphere and to perform hydrogeological and geochemical experiments rely on the ability to isolate zones within a borehole and perform experiments only within these zones. Sealing technologies that need further development include packers, multilevel seals, cementing strategies and materials, and borehole hanger sealing systems. Understanding the source of contamination and tracking potential contamination of fluids, gases, and in situ microbiological communities is essential to performing successful experiments.

Geophysical experiments and observing systems will require improvements in physical coupling to the borehole, identification and reduction of noise, and strategies for deployment of the sensors, and the conditioning/datalogging electronics.

A challenge in developing thermal measurements in boreholes is the development of thermally-neutral borehole completions that do not significantly alter the thermal properties of the borehole environment. For example, steel pipe has a significantly different thermal conductivity from sediments, thus the long-term monitoring of the thermal structure of a sedimentary section may give stable, equilibrated values, but they will be biased by the presence of the borehole infrastructure.

Reduced power consumption and optimization of seafloor and downhole instrument packages is a necessity. New low power technologies for sensor (e.g., optical sensing systems) need to be investigated and developed. If submarine cable connections become a reality for some drilling sites, this problem will be diminished to some extent, but will remain a problem for deep boreholes because of limitations in copper conductor sizes and power losses in hot and chemically-hostile environments.

A critical requirement of successful long-term monitoring systems is improved reliability and redundancy of components in the system, including cables, connectors, data systems, telemetry, and power systems. Installing long-term monitoring devices is costly. It is critical to design these systems with redundancy so that they perform over long time scales. Reliability includes not only the components and system design, it is also critical at the manufacturing level that qualified individuals assemble and test the electronics boards, fluid connection system, connector and cable mating, etc.

6. Develop ability to perform in situ experiments

We should pursue the ability to perform in situ experiments. Examples have included hydrologic experiments. However, others might include microbiologic culturing, chemical analyses, etc.

7. Improve well directional control

IODP needs to implement technology to allow the well to follow the design path (vertical or deviated). Often wells do not follow the design path due to dipping beds and stress anisotropy. In the IODP, much deeper boreholes are envisioned than previously and it will be important to be able to control the well direction. Vertically accurate boreholes are required for successful installation of tiltmeters, borehole seismometers, casing, and strain-meters. New scientific problems could be addressed and more stable well paths could be found if deviated well bores could be drilled.

8. Make measurements under in-situ conditions

Measurements in the borehole include a wide range of logging, sub-sampling, and geotechnical tools as well as hydrologic experiments. Successful measurements often depend on adequate stability of the drillstring and/or effective decoupling. The stability of long-term measurements is limited by in situ temperatures; the higher the temperture, the shorter the stable observation period.

9. Sample at in situ conditions and transfer samples at in situ conditions shipboard

There is a need to obtain samples that preserve the in-situ pressure, temperature, chemistry and biology. Integral to this process is the capability of transferring the samplers to laboratory apparatus without further compromise of integrity. This effort is critical to the Science Theme 'The Deep Biosphere and the Subseafloor Ocean' and it is also a crucial component to the Hydrate Initiative.

10. Improve hard-rock drilling capabilities

Challenges in drilling hard rock include: 1) borehole initiation on sloping sea floors or in terrains with little or no sediment cover, 2) advancing the drill bit through unstable formations, and 3) development of technologies that allow more rapid rate of penetration in homogeneous lithologies (i.e., even in the event of reduced recovery such as in sheeted dike sequences) is required for total crust penetration. Borehole advance through unstable formation continues to be a problem. A key issue is that the formation material collapses on the bottom hole assembly (BHA). This prevents drilling advancement, commonly resulting in the BHA becoming stuck and consequently lost. Expandable casing technology might offer solutions that can be deployed in stages. ODP Leg 193 and Hole 1256D (ODP Leg 206 and IODP Expeditions 309 and 312) are examples of drilling operations in hard rock that would have benefited from a technology that optimized rate of penetration even at the expense of reduced recovery. Industry has pioneered rapid penetration techniques and protocols (e.g., Exxon/Mobil's Fast Drill process) that might be adapted to achieving IODP ISP science objectives.

11. Improve remote and post-deployment capabilities

There is a need for remote manipulation of borehole infrastructure and seafloor instrument packages while the drillship is on station and afterwards. In many cases, the complexity of subsea completions requires the use of an ROV as an adjunct to the drillship deployment capabilities. The visualization capability of ROVs and their ability to manipulate equipment on the seafloor has revolutionized how science is conducted on the seafloor. Extension of this capability to boreholes has been envisioned, but not enabled for scientific ocean drilling.

Post-drilling deployment of instruments and borehole monitoring systems and their maintenance can be achieved in some cases using an ROV, but ships of opportunity and other borehole re-entry systems (e.g., the Scripps wireline re-entry vehicle) may be necessary approaches. Developing designs for wellhead completions, seafloor frames and templates that are compatible with ROV operations and non-IODP vessels is essential for enabling implementation of non-IODP platforms and re-entry tools.

There is also an emerging interest in connecting long-term borehole monitoring systems to existing or future submarine cables networks. Developing compatible ROV-serviceable, cable-connected wellheads will enable maximum use of seafloor networks. Long-term monitoring systems will require periodic visits by ROVs or other platforms for servicing and modifications to existing experiments.

12. Improve Reliability

The Engineering Development Panel recommends that IODP institute a surveillance and reliability program for both drilling and borehole monitoring operations. This program would be focused across all activities in a given type of operation, rather than attempting to increase reliability on a single project basis. Tasks would include maintaining databases on operating parameters and failure modes, root cause failure analysis on breakdowns, quality control and assurance on system components, and recommendations on operating procedures and limits. Most large offshore installations in the petroleum industry employ surveillance and reliability engineers as a dedicated job role. This is a different engineering discipline than project engineering, which has a different focus based on cost, schedule, and functionality, with reliability as one of many other priorities.

13. Extend depth capabilities

Fulfilling the ISP requires access to deep biosphere, the lower oceanic crust and upper mantle (the 21st Century Moho Initiative), and the seismogenic zone. For accomplishing these objectives, further developments will be important. The scheduled and future Seismogenic Zone drilling needs technology development to achieve deeper drilling, coring, borehole experiments etc. To achieve the goal of the 21st Century Moho Initiative, drilling technology will need to be developed for hostile environments (high temperature/pressure, high deviatoric stress), deepwater operations and deep drilling. In all cases, improved borehole stability is required.

The following list is an example of engineering developments needed to achieve this goal.

- AHC (Active Heave Compensator)
- Vertical drilling system (VDS) and rotary steerable technology to control hole trajectory
- LWD/MWD for high temperature applications
- Remote drilling

14. Improve operability under strong currents and severe sea state

To conduct riser drilling in strong current areas such as the Nankai trough while maintaining good operability, some modifications of existing systems on the *Chikyu* are required.

The stronger current force might cause the larger angles of both flex joints beyond their tolerable range. Also, larger VIV (vortex induced vibration) on the riser under strong current is recently indicated to cause the fatigue damage. To prevent these problems, it is necessary to reduce the drag coefficient of the riser pipe and the vortex around the pipe. Installing fairings onto the riser is effective for reduction of the current force. Optimal shape and arrangement of fairings needs to be studied.

Also, in order to increase operability of *Chikyu* under the severe sea conditions, more precise and efficient control for position keeping is required. Based on investigating the present abilities of *Chikyu*, the control method of DPS, RACS (Riser Angle Control System), and PMS (Power Management System) should be improved.

3.2 Pathways and Priorities in Engineering Development

The EDP identified three major categories of platform-independent ocean drilling activities that impact the types and quality of science that can be achieved: (A) Sampling, Coring and Logging; (B) Drilling Vessel Infrastructure; and (C) Borehole Infrastructure. Within each of these categories, a variety of pathways have been identified that ultimately will lead to solutions to the technology challenges identified in Section 3.1 and enable achieving the scientific goals set forth in the ISP. Each major ED task has been associated with one of the technology pathways; however in many cases these Engineering Developments will impact more than one pathway or category of drilling activity.

Each engineering development task is described below and is listed in Table 4. Each year at its summer meeting, the EDP chooses from these ED tasks developments that are high priority. At its July 2007 panel meeting, the EDP established high priority engineering developments within three themes: Sampling/Logging/Coring, Drilling/Vessel Infrastructure, and Borehole Infrastructure (Table 3).

Table 3. Unranked List of Engineering Developments

Theme 1: Sampling/Logging/Coring	***Theme 2: Drilling/Vessel Infrastructure***	***Theme 3: Borehole Infrastructure***
A1) Thin Walled Geotechnical Sampler	B3) Heave Compensation	C1) High temperature electronics, sensors, and sensor systems
A2) Cone Penetrometer/Remote Vane	B5) Seabed Frame	C4) Hydrologic Isolation
A4) Hard rock re-entry system (HRRS)	B8) Improved Automatic Driller	C5) Reliable wellhead hanger seals
A11) Rotary sidewall coring	B9) Drilling Parameter Acquisition while coring	C6) Electric, optical fiber and fluid feed-throughs at wellheads and in subsurface casing completions
A12) Provide core orientation on standard coring tools - Structural Orientation of Hard Rock Cores	B10) Real Time Drilling Parameter Acquisition while coring	C9) Physical coupling of acoustic instruments to formations and decoupling from noise sources
A13) Seabed coring devices	B14) Electric/Optical Wireline	C14) Systems reliability for LTMS
A16) Pressure coring systems (PTCS, PCS, FPC, HRC, etc.)	B19) Protocol for Proper Mud Design	C15) ROV-serviceable wellheads and submarine cable connections
A17) Pressurized Sample Transfer (autoclave)	B21) 4000 m class riser system	C17) Design standards for electrical, communications, mechanical, and fluid systems
A21) Anti-contamination system (gell core barrel)	B22) 4000 m class BOP	C18) Deployment procedures/soft-landing for borehole infrastructure and instruments
A23) Fluid samplers, temperature, and pressure measurement tools	B27) Drill pipe for ultra deep ocean drilling	C19) Managing borehole experiments
A24) Transition corers		

<u>3.2.A Engineering Developments: Sampling, Logging, and Coring</u>

ED A-1: Thin Walled Geotechnical Sampler

Develop a short length (~ 1 to 2m) geotechnical-type sampler utilizing thin walled stainless steel tubing (0.083” or 0.092”). There is considerable deformation in long stroke, thick kerf, cut cores as seen with the current version of the APC. Interpretation of pre-consolidation stress, determination of permeability, and analysis of sediment properties is dependent on obtaining high quality un-deformed core. If a piston type sampler is used it should isolate the piston upon withdrawal of the tool to eliminate any suck in from the formation upon withdrawing from the formation.

The standard tool used on the SODV and the *Chikyu* is the Advanced Piston Corer. This device strokes 9.5 meters and is composed of thick-walled material incorporating a blunt nosed cutting shoe. The net result is that the core that is taken is highly deformed.

ED A-2: Cone Penetrometer/Remote Vane

Develop the ability to deploy a piezocone penetrometer (PCPT) or remote vane (RV). This may need to be deployed with a seabed frame, which will isolate drill string movement. These industry standard tools offer in-situ measurements of shear strength as well as a means to accurately define micro strata in sediments sequences. Soil density, pore pressure and material type can also be interpreted/measured from PCPT data.

ED A-3: Upgrade to RCB System

Review status of hard-rock coring technology using Rotary Core Barrel (RCB). The RCB has been the work horse of the ODP. New work might include studies of moving the landing shoulder in the RCB away from the bit so as to decouple vibration from the bit into the inner core barrel (CDEX improvement), improved bit hydraulics, incorporation of a core anti jam device, and possible improvements in cutting structure of the bit design.

An alternative new coring system should also be studied which might offer advantages in certain formation types. This system might utilize an internal triple tube coring system run in tandem with the larger outer bit so that the existing long core guides on the RCB are eliminated and the inner tube is placed closer to the incoming core. This core barrel might resemble a type of coring system that is used within DOSECC named the Alien.

ED A-4: Hard Rock Re-entry System (HRRS)

Improve the HRRS. The HRRS is a combination re-entry/drilling system that allows a borehole to be started and cased on a sloping hard rock seafloor with limited or no initial rotation of the drill string until the hole can be started. Successful deployment results in a cased hole and re-entry funnel at the seafloor so that the hole can be re-entered for coring to be initiated. The system utilizes a down hole fluid hammer in which uses high pressure fluid to drive the hammer. While the re-entry/casing systems appears to be proven, additional work is need on bit design and hammer components to increase the longevity.

The current design of the HRRS installs a single string of casing to shallow sub seafloor depths (<30 m). This depth limitation is likely insufficient to isolate the unstable upper crust of morphologically youthful basalt flows, thus limiting the ability to attack scientific objectives focused on zero age crust. The penetration limitation is partly due to frictional drag along the casing as it follows behind the hammer bit. The ultimate theoretical design of the hammer in casing system was a dual hammer system. A hammer at the bit to create the hole, coupled to a secondary hammer at the top of the casing overcoming the frictional drag and driving the assembly into the bedrock. This development is still completely theoretical at this time.

ED A-5: Coring Guidelines/Operations Manuals

Develop coring guidelines. In order for all parties to understand the dynamics of the coring operations, a series of guidelines/manuals are needed to be prepared to familiarize the technicians/ drillers and scientific party with each type of tool and the intricacies they command in their operations as well as the cost associated with their deployment. Operating parameters, ancillary equipment requirements, and typical dimensions should also be provided so that there is a clearer understanding of what is necessary and the parameters needed to run these tools. Guidelines would be a tool for operators to use in training for drilling programs.

ED A-6 Diamond Coring System (Piggyback coring system)

A piggy back diamond system is routinely used in the offshore geotechnical industry to simulate onshore diamond coring techniques which uses thin kerf and high speed diamond bit technology. It is limited to water depths less than 1500m with current mining strings on geotechnical vessels. This concept uses a secondary coring rig located in the rooster box above the top drive. A coring string is then lowered through the API string to advance a slim hole diamond coring string. The API string is basically serving as a riser for the coring string.

ODP developed a similar version of this system called the Diamond Coring System (DCS) in the early 1990's. The DCS was rated for 4,000m water depth due to the use of a special tubing incorporating a Hydril series 503 connection. It was abandoned due issues with the passive heave compensator (PHC) on the SODV not being able to remove enough heave so that the secondary heave compensator on the DCS would function properly. It is unclear at this time whether this technology should be resurrected since the AHC compensation on the SODV is being removed and only an upgraded PHC system will be available. There may be other ways to provide this technology without the development of a piggy back coring system for the SODV. Development of such hardware is considered a long range objective and not technology to be presently pursued within the next 5 years or the program.

ED A-7: Large Diameter Diamond Coring Systems (ADCB)

During ODP Leg 193, the ADCB was the coring tool of choice in intensely fractured, young lava flows. Whole round intervals, with insufficient integrity to hold together after removed from the core liner, were recovered intact using the ADCB. This tool is similar to PQ core barrels used exclusively on many onshore applications. Based on thin kerf diamond technology, drilling with this system requires minimal weight on bit variation, thus is highly dependent on adequate heave compensation. Capturing shallow surface cores that reveal the tectonic history recorded in the uppermost section of exposed oceanic basement is likely to be one of the important contributions of this type of tool to the goals of the ISP. Further engineering developments might include operating this tool with a seabed frame for initial stabilization when spudding and/or with the HRRS to bring this system to maturity for potential applications in hydrothermal systems and zero age crust.

ED A-8: Retractable Bit Technology

Develop retractable bit technology. This technology allows the cutting structure of the bit to be removed via a wire line or wire line tool. This device can save time by preventing the need to trip the string and save money by removing hardware expenses associated with re-entry schemes and mechanical bit release. By observing the bit each time the inner core barrel is pulled or when the performance is lacking, different cutting structures or completely new bits can be replaced to optimize drilling advancement or core recovery. While current bit longevity has improved, there still might be a requirement in the not so distant future where development of this concept might be very beneficial especially in deepwater or deep hole applications.

Retractable bit technology was pursued at ODP for several years while the Diamond Coring System (DCS) was being developed as a piggyback coring system. Several versions were developed and tested. These include diamond bits from Russia, Australia and the USA as well as retractable tri-cone type bits based on the Russian technology that was developed during the deep hole Kola drilling project. Development of such hardware is considered a long range objective and not technology to be presently pursued.

ED A-9: Vibracore/Percussion Sampler

This technology was developed for shallow water sediment coring projects where lithologies are friable or weakly consolidated non-cohesive materials (i.e. sands). A vibrating mechanism, operating under hydraulic, pneumatic, mechanical or electrical power, drives a coring tube into the sediment via gravity enhanced by vibration. Vibracoring has proven effective in coring unconsolidated, heterogeneous sized or shaped sediment particles; however, it is not effective in coring clays, packed sand, or indurated materials.

A vibro-percussion corer (VPC) was developed in the early 1990's. The tool had limited testing and consequently was never developed to an operational state. The tool uses a similar technology as the fluid hammer in the HRRS. Since initial development great strides have been made in down hole fluid hammer performance and longevity as demonstrated by the Fugro Percussion Corer.

Adaptation of the new fluid hammers coupled with an APC type of deployment may offer new opportunities in recovering granular sediments without the need to rotate and/or pump fluids for advancement. "Off the shelf" industry hammers and tools (FPC) should be investigated to see which might offer the best solution and whether different frequencies might allow the tool to be tunable via fluid flow and pressure to optimize performance.

Sonic coring is a subset of vibracoring technology that uses ultrasonic vibration. This technology will enhance penetration rates in shallow environments. A sonic drill rig uses an oscillator or head with eccentric weights driven by hydraulic motors to generate high sinusoidal force in a rotating pipe drill. The frequency of vibration (generally between 50 and 120 cycles per second) of the drill bit or core barrel can be varied to allow optimum penetration. Issues that must also be overcome include drill pipe design which will withstand these resulting dynamic stresses from the high frequency vibrations in open water applications.

ED A-10: Motor Driven Core Barrel (MDCB)

The MDCB was initially developed to be compatible with the APC/XCB BHA in order to allow a single hard rock or basement core to be taken at the conclusion of sediment sampling or at the interface between two such materials. This technology used a wire line retrievable mud motor and thruster system to advance a high speed diamond bit/core barrel into the formation without rotating the main drill string. There were three main drawbacks to this system.

The first was the hole had to be reamed after the MDCB core was cut if more than one MDCB core was required, secondly the bit normally associated with the APC/XCB was larger diameter and usually not as robust as that of the RCB, thus very limited advancement could be made in reaming out the diamond cored hole with the larger bit before it became incapable of advancement. Third, configuring the thruster to produce the proper thrust/WOB was tricky. This coupled with poor heave compensation of the main drill string resulted in core jams and lack of recovery. Due to the nature of the mining-style diamond core barrel core catchers, any small vertical upward movements imposed on the system when the diamond core barrel was operating usually resulted in a core jam or stall-out of the mud motor.

While offering much promise for the future, the current MDCB has been infrequently used. Even though it uses a similar BHA as the APC and XCB, additional subs are required in the string and must be planned for in advance of starting the borehole. Because the MDCB coring assembly advances by a thruster, the outer BHA is stationary. Thus the driller cannot monitor the weight on bit (WOB) of the MDCB cutting shoe. This WOB must be pre-selected before the tool is deployed by a means of opening and closing valves in the thruster tool body. MDCB WOB is controlled by pump pressure, but since the flow is relatively low, auxiliary pressure readouts are needed on the surface to better indicate the variations in pump pressure so that the driller knows when the motor has stalled out and/or when the end of stroke is reached. Solution to this problem may include instrumentation that can track the stroke of the MDCB and transmit it up hole if other solutions such as better string isolation are not successful.

Developments in the mid to late 1990’s saw extension rods made to allow several cores to be cut before the hole had to be reamed with the larger main bit. Improvements in the thruster also provide more reliability to the tool. Issues with getting the bit back to the bottom of the hole on the next deployment and continuing problems with reaming the core hole still persisted.

With the introduction of a seabed frame to isolate all drill string motion and an outer bit (possibly coupled with a center bit combination) capable of reaming out the core hole, the MDCB should be re-examined as another means to obtain shallow surface core before casing is set or for deeper penetrations where high speed diamond technology has proven to be superior to roller cone technology in collecting core. Operation of such a system in corals might also provide high and superior core recovery than other systems currently available at IODP. Corals may also not provide the resistance in reaming out the hole with existing roller cone bits.   The possibility of interfacing with a powered sand line also offers some advantages in monitoring the status of the operation.

ED A-11: Rotary Sidewall Coring

Develop ability to take rotary sidewall cores. This sampling will be done after primary drilling and logging operations hare completed. The ability to take rock/sediment samples that are precisely located from logging after primary drilling will allow sampling of missed or absent cores. If larger drill pipe is available (i.e. 6 5/8") then existing industry tools can be used. If only existing 5.5" pipe is available then a rotary side wall corer would have to be specifically developed and may not be cost effective at this time. Thus, it is felt that this technology may be more than 5 years before funding can be found to develop such hardware if larger pipe is not available.

ED A-12: Provide Core Orientation on standard coring tools.

Develop a long-term ED pathway to enable core orientation.

a. Sediment core orientation: Current tensor tools (sediment core orientation apparatus) are no longer supported by the manufacturer. These have performed reliably for the last decade; however, maintenance and repair are problematic. Investigations into potential developments, performance enhancements, and internal support of the entire system are required. There are other systems available for diamond coring systems used in the mining industry which should be investigated to see whether they can be made compatible with existing tools.

b. Structural orientation of hard rock cores: The various components of a hard rock core orientation system (scribe, sonar target, sonic monitor, transducer, and rig instrumentation) are all necessary components of the overall system. Equipment used in the mining industry should be investigated to see if these units might be integrated before venturing into an internal development of components and testing prior to being placed into routine practice.

ED A-13: Seabed Coring Devices

Explore application of seabed coring device to capture first 100 -150 m of seafloor section. A number of shallow seabed coring devices have been developed which utilize high speed diamond coring techniques as employed in the mining/mineral exploration field. Developments in the mid to late 1990's saw the advent of several new generation seabed corers that had extended reach capabilities and were capable of obtaining deeper cores with the addition of rods behind the core barrel. Portable Remotely Operated Drill (PROD) was a second-generation seabed drill that was capable of taking core to ~ 100m below the seafloor.

Continued development of this tool into the 2000's has seen this device now become a routine tool used for geotechnical operations in collecting not only hard rock cores but CPT data and piston samples as well. Newer seafloor corers are developing wireline retrieval capabilities and operation of reveres circulation drills to capture 100 percent of the material drilled.

It is envisioned that if used in tandem with other IODP tools (HRRS/ADCB/MDCB/RCB) but on separate expeditions to collect the upper 100 -150 m of core, then IODP might NOT have to focus engineering development funds on attempts to gather shallow core and more precise heave compensation for the shallower depths, but could concentrate on using the more robust tools inside boreholes established by the HRRS or to start coring below 100mbsf. It is envisioned that this technology would not be developed or acquired, but existing systems would be used to compliment what IODP can already do.

ED A-14: Jumbo Piston Corer

Develop ability to take long piston cores. This will provide an effective means to sample the upper 30-50 m of sediment. This concept would limit or eliminate the number of triple APC cores because continuous core could be collected. Deployment could be concurrent with lowering the drill string and would be off axis from the side of the vessel. A number of other science programs now own and operate this hardware and if coordinated with other operators this might result in IODP being able to focus on deeper cores and techniques than surface sampling. With the modifications presently being made to the SODV it is doubtful whether there will be sufficient space available to handle and deploy a JPC.

ED A-15: Downhole Tools calibration and testing facility

Create down hole tools calibration facility primarily on land and secondarily on vessels, as required. Calibration of IODP downhole tools has not been a routine practice owing to the unique engineering requirements for each tool and lack of a commercial venture capable of providing routine calibration of these tools. The implementation of routine verification of tool performance will increase the tool reliability and data quality. A quality control program also needs to be incorporated into overall program. Environmental stress testing should also be a pre-requisite for all tools used in IODP either through IODP facilities or other avenues.

ED A-16: Pressure Coring systems (PTCS, PCS, FPC, HRC, etc.)

Most of the recent industry pressure coring work was performed with a seabed frame that isolated the drill string motion and enhanced the opportunity for these types of samplers to effectively work. The addition of a sea bed frame to the program may be needed to increase the recovery percentages with both current IODP and third party tools. In addition, placement of the tool with respect to the outer bit, flow paths, cutting shoe design, size, and sealing mechanism, are still some of the items that need to be re-examined with regards to the IODP tools. Further enhancements might include additional temperature and pressure measurements while coring and de-gassing. Some of the new tools and associated equipment are only pressure rated to 250 bar and hence will need upgrading to achieve all the objectives associated with samples deeper in the sediment column and in deeper water.

ED A-17: Pressurized Sample transfer (autoclave)

Sub-seafloor microbiological investigations have been enhanced now that it is possible to maintain in situ pressures when transferring cores to laboratory apparatus. A few samples have been recovered at in situ conditions, held at those conditions, and manipulated in the laboratory without significantly altering the pressure. This recent development has allowed experiments to take place investigating the barophilic nature of microorganisms. These 3rd party transfer systems are currently pressure limited to 250 bar. Consequently, further development is needed to upgrade these systems to operate at higher pressures so that similar objectives can be achieved deeper in the sediment column and at greater water depths. IODP presently does not have such a system to transfer a pressurized core.

ED A-18: Common Bottom Hole Assembly (BHA)

Current IODP practice uses the rotary core barrel (RCB) BHA for recovering core samples in medium to hard formations and the APC/(XCB) BHA for soft to medium formations. The APC/XCB BHA can also be configured to run the motor-driven core barrel (MDCB) for use in hard, fractured rock, although it is seldom used and is typically limited to only a few cores due to the inability of drilling the APC/XCB roller cone bit into harder formations. The four coring systems each have different core sizes (APC = 66 mm, XCB = 60 mm, MDCB = 57 mm, RCB = 59 mm) despite all three except the MDCB using the same size core liner.

Operational time required to round trip pipe when formations become too hard for APC/XCB coring can take as long as a day in deep water. A common BHA will save operational time as well as long-term costs and reduce inventory. The practically of combining all coring systems into one BHA makes sense but may be rather difficult to physically achieve and would require a redesign of all tools. This would be a major undertaking and may not be not attractive, especially in lieu of current budget short falls.

The downside to this plan is lies in the fact that one bit is not suitable for all formation types. Possibly a better approach may be to investigate whether some additional transitional coring tools such as those developed by DOSECC which already are designed around the same size liner might be applicable in the existing APC/XCB BHA. These transitional core barrels may offer better core recovery between APC/XCB intervals and XCB/RCB cores. Another possibility might be to investigate retractable bit technology versus redesign of all existing coring tools to be compatible with the same BHA. Based on the existing engineering development underway and the limited funds and staff, any major redesign to accommodate a single BHA most likely should be viewed as a long range project and would not be attempted within the remainder of this funding program.

ED A-19: New RCB bits

RCB bits have been improved over the years. A number of different designs are available depending upon the formation and abrasiveness of the material being cored. It is doubtful that any redesign would result in a ROP improvement. Another issue that IODP faces is that very few suppliers are interested in building a specialty bit with only small orders being placed. Presently IODP has only one roller cone bit supplier. For intermediate or softer formations materials an increased number of smaller cones bit which reduces the height of the core guides should be investigated. This improvement may increase core recovery in the transition between XCB and RCB.

ED A-20: Upgrades to XCB system

The XCB coring assembly operates very well in most cases, however improvements are needed. When coring through hard, dry clay, the face discharge waterways tend to plug, preventing circulation on the cutting face. The plugged waterways result in overheating which in turn destroys the cutting structure of these bits. This problem might be reduced by redesigning the coring shoe and providing automatic valves to maintain face discharge velocity, and/or powering the XCB shoe with a positive displacement motor independent of the XCB bit. At the very least, improvements to this system that CDEX has made to their extended core barrel should be investigated. A similar coring system developed by DOSECC should also be reviewed to see if these changes might also be incorporated to enhance the XCB.

ED A-21: Anti-Contamination System (Gel Core Barrel)

A system is required to prevent contamination of the core from circulated fluids through the application of an internal gel coating as the core is advanced into the inner barrel. Further investigation into land-based technologies should be thoroughly researched to modify this concept for offshore applications. This can provide longer core sections in a sterile environment as well as to help prevent core blocks/jams from the lubrication that the gel provides as the core is entering the core barrel. CDEX has performed some initial tests on this technology with their SD-RCD. Continued development of this work should be a joint venture to see if the RCB system could be adapted with this system

ED A-22: New In situ Sensors

Understanding in-situ chemical conditions will require the development of new devices. The possibility of implementation of new technologies such as Ion Sensitive Field Effect Transistor (ISFET), ion specific probes, and pH sensors should be investigated. These sensors while important for research and obtaining a better understanding of in situ conditions, may be more applicable as long range projects as staff and funds become more difficult for developing new tools.

ED A-23: Fluid samplers, temperature and pressure measurement tools

High temperature water samplers deployed during ODP had a poor history of performance. These were all third party tools, rarely deployed, and commonly poorly maintained between deployments. Tools deployed for measuring high borehole/formation temperatures/pressures returned useful data, but owing to design were not rugged and provided little real time feed back so that the driller could not determine if the tool was properly deployed, which in some instances leading to eventual tool failure or damage. Industry has developed hostile environment (max 200 °C) temperature/pressure measurement and water sampling tools, but most have a minimum diameter too large to fit through the current IODP drill string. Thus a new a slim line equivalent, with elevated temperature (~350 °C) is required for sampling fluids at high temperature environments.

ED A-24: Transition Corers

Additional corers should be investigated to enhance the core recovery through formation transition zones where recovery has been poor. These new samplers should be compatible with the existing APC/XCB BHA. Tools envisioned include an extended non-rotating sampler for sediments between where the APC and XCB produce good results and a triple tube diamond core barrel similar to DOSECC's Alien corer that would be deployed between the XCB and RCB initiation. Both of these tools already exist and use the existing IODP liner. Another tool which might have applications in some formation types would be a triple tube design in which the inner bit is a very thin diamond kerf bit with the non-rotating inner tube being allowed to protrude in front of both the outer bit and thin kerf diamond bit. The inner tube nose cone would more resemble an APC style shoe and allow the soil to be pushed past the nose cone into the inner barrel as the hole is advanced.

<u>3.2.B Engineering Developments: Drilling/Vessel Infrastructure</u>

Engineering development challenges for Drilling/Vessel Infrastructure are roughly categorized as follows.

- ✧ Employ industrial logging tools (ED B-1,-2).
- ✧ Eliminate bit motion/weight fluctuation (ED B-3,-4,-5,-6).
- ✧ Enhance control of drillstring during coring process (ED B-7,-8,-9,-10).
- ✧ Extend TD (total depth) of cased holes (ED B-19,-25,-26,-27,-28).
- ✧ Extend *Chikyu* capabilities (ED B-21,-22,-23,-24,-27,-29).

ED B-1: Larger Diameter Pipe

Standard and specialty large diameter logging tools can be conveyed through a conduit with an inside diameter of ~5.5 inches. The purchase or rental of pipe should be considered. This might enable development of coring tools for obtaining large diameter cores.

ED B-2: ROV Guided Logging Tools

A Feasibility Study should be completed to evaluate the possibility of using an ROV to guide logging tools into an open borehole. This system is often used in industry today and there is need for an investigation as to how this operation is carried out.

ED B-3: Heave Compensation

Poor heave compensation limits core recovery and lowers core quality. A robust, durable, drill string heave compensation system is critical to improved core recovery and quality of samples for the IODP. Improvements in this have already been made in industry with the use of heave compensated drilling platforms such as oil over air that was successfully used on Expedition 310 while piggyback drilling. Improved core recovery and core quality that was achieved during Expedition 310 should provide an impetus to advance this technology across IODP platforms.

On the riserless vessel and, if appropriate, the riser vessel, it should be determined whether procurement of a new or modified Active and/or Active/Passive Heave

Compensation system will significantly improve drill string stabilization. Approaches to improve passive heave compensation performance might include modifications to cylinders, pistons, and seals. Improved active heave compensation hardware may also be required in terms of increasing the range of operable sea states and improving system reliability.

We emphasize the need for an integrated planning and development approach. Ultimately, an integrated system (including active and/or passive heave, a pressure compensated bumper/thruster sub, and a sea bed frame utilizing a clamping system) when coupled with high quality rig and drill string instrumentation will enable the full suite of present and future down hole tools to work far more effectively in the full range of materials to be cored and tested. Computer-simulated drilling software should be utilized to enhance/configure the BHA design to reduce/eliminate vibrations when coring/drilling in different formations and water depths.

ED B-4: Heave compensation during advanced piston coring

This will reduce bit motion during piston coring. The current system requires shutting down heave compensation as the hydraulic piston core is charged and fired. During this process, the bit will respond to vertical ship motion, and ascertaining bit depth at the moment the piston fires has an error roughly equivalent to that of the bit travel. The result is poor absolute depth resolution and repeated or missing sediment sequences. A possible introduction of a seafloor frame to clamp onto BHA to isolate the heave may help elevate some of the problem described above. Thus further efforts should be investigated if this concept alone can solve the problem or whether design changes in the tool itself are required.

ED B-5: Seabed Frame

A Feasibility Study should be accomplished on the ability to deploy a seabed frame. A seabed frame is considered part of the drill string stabilization system.

Seabed frame technology, developed within the marine geotechnical industry over the past ~30 years, has two major capabilities: (a) a seafloor mass that provides stability to the drillstring for improved deployment of tools; and (b) hydraulics at the seafloor that can be used for controlled in-situ testing and some coring applications. This capability, possibly supported with a deep-water ROV or acoustically activated clamping system, would expand the non-riser capability to meet scientific objectives that require the need for:

- (a) Recovery of sand on continental margins and deep water fan systems;
- (b) Recovery of corals in shallow water environments;
- (c) Deployment of in situ tools for the measurement of pore pressure, resistivity, and temperature as well as gamma ray density, acoustic velocity and other “wireline” logging measurements in the upper 100 mbsf and in unstable borehole formations; and
- (d) Deployment of specialty tools for the measurement of in situ stress (e.g. packers).

As early as 1998, the scientific community identified the need for a “seabed frame” to meet the IODP scientific goals with the new IODP non-riser vessel (CDC, 2000). The May 2004 Downhole Tool Workshop participants re-affirmed this need (http://www.usssp-iodp.org/PDFs/DHT_Workshop_Final.pdf). Implementation of such seafloor devices may enhance recovery, allow the MDCB to initialize spudding on hard rock holes, and improve core recovery. Being able to immobilize the drill string may also improve the recovery of certain PCS-type tools.

ED B-6: Pressure Compensated Bumper/Thruster Sub

A feasibility study should be pursued on the development of a pressure-compensated Bumper/Thruster Sub to remove residual amounts of drill string motion as a means to improve core quality and quantity.

Bumper subs were used in the early days of offshore drilling to help keep the bit on the bottom of the hole due to the vertical movement of the pipe from ship motion. A bumper sub is nothing more than a drill collar sized tool that incorporates a sliding sleeve.

Due to the length and consequently the weight of the drill string typically deployed by the USIO program, even with the most advanced heave compensation system, it is doubtful that all vertical movement can be eliminated by a single device whether it is an active or passive heave compensator. Thus, there is a need to investigate whether a mechanical and/or pressure activated sub can be developed to complement whatever primary heave compensation system is selected.

A first generation shock sub was developed for the ADCB in the late 1990’s at ODP. The system was developed to reduce costs by extending bit life, increasing ROP and reducing drill string failures. The tool extends bit life by reducing impact loading on the bit. ROP is increased by reducing BHA vibration allowing optimum rotary speeds to be used. The tool was designed to operate effectively under a combination of WOB, bit pressure drop, mud weight, or hole depth. While this tool was not designed to specifically maintain a constant WOB, it does provide some damping before the load eventually finds it way to the bit.

A possible first step in any further development of such tools would be to test the existing tool in a side by side comparison while using the ADCB and the bit motion accelerometer tool developed by Lamont. Knowledge learned from such a test program would be invaluable before approaching a vendor to develop a larger version that would be of the same size as the current IODP BHA design. Reducing micro WOB fluctuations which can be offered by such a tool may be a giant step to better understand existing tools as well as improve core recovery.

ED B-7: Rig Instrumentation System

The RIS is an important tool to achieve drill string compensation. It is essential for effective drilling operations and in many situations a key component for achieving scientific objectives by providing drilling operations measurements. Rig instrumentation data should be preserved as a part of the scientific data.

The primary technology advancements in a rig instrumentation system will be increased sampling rate, integration of measurement while drilling applications, and integration of operational data into the arsenal of tools used to interpret formation characteristics. Potential improvements include accurate, continuous position recording and measuring tidal influences as they apply to true depth estimates.

ED B-8: Improved Automatic Driller

A recent development in industry is to use data from the RIS (Rig Instrumentation System) to automate some of the drilling process. The simplest systems attempt to modulate weight on bit variations and thus improve coring efficiency.

ED B-9: Drilling parameter acquisition while coring

Complete the technology development and routinely deploy the down-hole sensor sub (DSS) and remote memory module (RMM). These tools have been or are scheduled for bench testing. DSS is incorporated as part of the BHA and the DSS and RMM both store data and the RMM returns incremental data sets via coring line after each core barrel run. These instruments record weight on bit, torque on bit, annular pressure, and temperature. Down-hole pressure can be used to estimate whether there is gas or sand flow within the annulus. Knowledge of weight on bit, and torque on bit can be used to modify drilling procedures to optimize coring conditions.

ED B-10 Real time drilling parameter acquisition while coring

Transmit from down-hole sensor sub (DSS) in real time the drilling dynamics data to the surface like weight on bit, torque on bit, annular pressure and temperature. Most probable technique will be mud-pulsed telemetry to the surface. A subset of the same data acquired by the logging-while-coring system can be continuously transmitted to the rig floor. The real-time knowledge of weight on bit, and torque on bit can be used to modify drilling procedures to further optimize coring conditions.

Mud pulse telemetry is a method widely used in industry to transmit drilling data from the bit to the rig floor. This type of system is commercially available and historically reliable, with data transmission rates on the order of 12 bits per second. The digital data stream from the sensors is compressed and transmitted to the surface via pressure pulses, where each pulse is one bit of a data stream. The pressure wave travels through the pipe and is detected by sensors at the rig floor. The sensor data is decoded and displayed as down hole diagnostic parameters. If displayed in real time, the driller can make active adjustments to drilling parameters and optimize drilling stability, thus potentially improving core recovery and quality.

ED B-11 Formation logging while coring

Once the real-time logging data acquisition system has been developed and qualified in field tests, a subsequent desired development is inclusion of formation evaluation logging sensors (i.e., gamma radioactivity, resistivity, bulk density). These data can accompany real-time drilling parameter data transmission.

ED B-12: Radio Frequency ID Chip Implant in Drill Pipe

Current practice for measuring the depth of the bit below rig floor is to physically measure (strap) the length of each joint of pipe and to tally these individual lengths as each joint or stand of pipe is added. This process can be automated via the use of Radio Frequency Identification Devices (RFIDs) embedded in the tool joint of each length of pipe, pre-coded with several types of information including length. As the tool joint passes a sensor on the rig floor, the length is uploaded to an automated accounting system, thus eliminating potential operator error in pipe length determination. Additional data stored on RFID tags can potentially be used to prolong pipe utility through preventative maintenance programs.

ED B-13: Intellipipe

Several engineering developments can be applied to advancements with in situ formation characterization. These range from direct application or adaptation of off the shelf industry technology, to complete developments for unique operational environment. Intellipipe is a real time, high speed data transmission system that allows deployment of multiple sensors at or near the bit to provide drilling and formation parameter measurements (the pipe is essentially wired). In current designs the data transmission system runs inside the pipe and compatibility with coring operations is not well developed. In addition, current pipe acquisition is on a lease only basis from the sole source vendor, thus cost could be a significant issue.

ED B-14: Electric/optical wireline

A technology development that could provide enhanced data acquisition functionality while saving operational time is development of a powered fiber-optic augmented coring line (essentially combining the logging and coring lines). While it is not likely this line could be used on a routine basis (owing to excessive wear of an expensive cable), for specific applications power could be delivered to down-hole coring or measurement tools without special rigging. This could also potentially directly communicate with observatories via wet connectors and/or active overshot connectors.

ED B-15: Directional Coring

There are multiple applications of the industry-proven directional drilling technology to scientific ocean coring. Successive hole deviations in deep penetrations can save operational time and provide a three-dimensional perspective to the more routine single-dimensional view developed from a one core. Horizontal drilling may be required to develop an understanding of seafloor hydrothermal systems, and controlled directional drilling is directly applicable to characterizing three-dimensional structure and investigating tectonic problems. This technological development requires application and adaptation of proven industry tools and practices incorporate continuous coring.

Magnetic overprint

Degaussing the drill string via an AF coil mounted beneath the rig floor was attempted during DSDP. The coil was destroyed fairly quickly during operations and the analysts interpreted that inasmuch as the pipe was exposed to additional stresses on each deployment this was probably a fruitless endeavor.

Replacing drill string components with nonmagnetic materials has been tested on several expeditions. Basically the important characteristic of materials used for this purpose is magnetic permeability. Magnetic permeability of some materials is listed below.

Magnetic permeability and yield strength of materials

Material	Magnetic permeability	Approximate yield strength	Cost/cost of iron
titanium	1.00005	950 MPa	2500
monel	1.002	100-150 MPa	4000
stainless steel	1.008	500-600 MPa	700
iron	150	300-500 MPa	1
silicon iron (4% Si)	500	no data	no data

The most radical solution could be to replace the entire drill string and all components with nonmagnetic material. It is not likely a nonmagnetic drill string is readily available. Any search for nonmagnetic or low magnetic permeability materials yields only a few results. These include titanium, monel (a compound of predominantly nickel with copper, iron, and manganese), and some varieties of stainless steel. Costs of raw metal/alloys relative to iron are listed in Table 1. Considering an iron drill string will cost in excess of $1 million, none of the other nonmagnetic components are even feasible in terms of cost, even if an interested vendor could be located.

Recent studies have concluded that restricting the amount of time the core is in contact with the core barrel, as well as employing core capture components fabricated from nonmagnetic materials significantly reduces the strength of the viscous remanent magnetization induced in the core. Nonmagnetic core capture components have been fabricated for APC coring tools, however, similar technology has not been developed for XCB, RCB or alternative coring tools.

ED B-16: Non-magnetic collars

Non-magnetic drill collar material is today an accepted partial solution to address the drilling related overprinting phenomenon. Their application however is limited due to their generally weak material properties and investment cost. Suggested developments should include more robust tool joint designs and alternate “low magnetic” materials.

ED B-17: Non-magnetic core barrel

The suggested development is including the replacement of today’s normal steel core barrel with either high strength non-magnetic material or composite compound materials.

ED B-18: Magnetic shield for core barrels / anti-contamination core barrel

Similar to the effect of dynamic noise cancellation in acoustic, the feasibility of such an active electro-magnetic shield for normal steel core barrel shall be investigated. Such a system would continuously measure the magnitude and duration of a magnetic field from the surrounding steel on each section of the drilled core section and apply a reverse magnetic field to restore the virgin magnetic properties over the entire core length.

ED B-19: Protocol for Proper mud design

The riserless vessel has historically not continuously drilled with mud, but has spotted mud occasionally. The Mission Specific Platform approach generally uses some type of mud at all times. The new riser drill ship will have a full mud program. A protocol should be developed to document the basis for decisions regarding mud deployment. The protocol should take into account cost and drilling efficiency. A well designed and executed mud program is critical to drilling, logging, and coring operations with a riser, so this item is relevant to all of the ISP objectives.

ED B-20: Borehole Camera

a. Borehole camera looking downward. The borehole camera is for looking down the borehole. The justification for looking down the borehole is primarily operational, to aid decisions in drilling and coring.

b. Borehole camera looking borehole wall. The borehole camera is for imaging the borehole wall. The justification for imaging the borehole wall is primarily to obtain data about the section being drilled.

These cameras may be acoustic rather than light devices to overcome the restrictions of a non clear fluid is present in the borehole; however the development does not exclude optical devices.

ED B-21: 4,000 meter class riser system

The existing *Chikyu* riser system cannot extend beyond 3000 m with the current technology. A new riser system capable of drilling in 4000 m water depths should be developed. Several of the ISP objectives will require wells in water depths exceeding 2500m.

ED B-22: 4,000 meter class BOP

The current subsea blowout preventers on the *Chikyu* are driven by hydraulic force powered by the surface vessel and subsea nitrogen accumulators. In water depths of 4,000 meters, these accumulators will no longer work well due to changed characteristics of the extremely compressed nitrogen, and the hydraulic pressure supplied from the surface accumulator greatly decreases due to pressure loss through longer hydraulic lines between surface accumulators and blowout preventers. To drill in water depths of up to 4,000 m, a new blowout preventer based on a different technology will be required to accompany the new riser system described above.

ED B-23: Reduce Current Force on *Chikyu* Riser

While drilling under normal conditions, mean angles at both of upper flex riser joint and lower one have to be maintained within 2 degrees. Stronger current force might cause the larger angles of both flex joints beyond its tolerable range. Also, larger VIV (vortex induced vibration) on the riser under strong current is recently indicated to cause fatigue damage. In order to prevent these problems, it is necessary to reduce the drag coefficient of the riser pipe and the vortex around the pipe. Installing fairings onto the riser is effective for reduction of the current force. Optimal shape and arrangement of fairings needs to be studied.

ED B-24: Improve Dynamic Positioning Systems

In order to increase operability of *Chikyu* and other DP vessels under severe sea and current conditions, more precise and efficient control for position keeping will be required. Based on investigating the present abilities of the *Chikyu*, the control method of DPS, the Riser Angle Control and Power Management Systems should be improved. The justification will come from item 13 in the Technology Plan, and an investigation of expected sea states and currents in anticipated drilling locations is needed.

ED B-25: Improve Expandable Casing System

Develop expandable casing for ultra deep, high temperature, H_2S rich environments. The expandable casing technology developed by the petroleum industry may not meet the hostile environments that will be drilled during the IODP. Having an expandable casing option for these conditions will increase the probability of success in drilling wells in these environments.

ED B-26: Cementing protocol for deep drilling

When sealing of fluid pressure adjacent to the set casing is required, it will be necessary to develop cementing technology that is designed for severe environmental conditions. The cement slurry used in an ultra deep environment must withstand high temperatures and pressures. In addition, temperature in the hole may vary greatly. For example, there may be hours of cooling while circulating and then hours of heating when no circulation occurs. Circulation rates, the geothermal gradient, and formation properties will all play a role. The estimation of downhole temperature is key for successful cementing. The casing will experience the expansion/shrinkage which may be detrimental to the cement seal. The cement slurry must be designed with flexibility to avoid destruction of its seal to the casing.

ED B-27: Drill pipe for ultra deep ocean drilling

Chikyu is currently equipped with drill pipe that is designed to drill 10,000 m below sea level. To drill through 21st Century Mohole, a 12,000 m length drill string is required. The practical maximum drilling depth is primarily constrained by the strength-weight ratio of the drill string. In order to reach 12,000 m depth below sea level, it is necessary to develop a high strength and light-weight drill pipe that is not degraded by high temperature and H_2S.

ED B-28: High temperature High Pressure Vertical Drilling System (VDS)

A non-vertical hole may be induced when the drilling is continued without controlling the trajectory in structurally complex, high dip or high stress formations. At shallow depths, such deviation from vertical does not affect the drilling significantly, but in ultra deep holes, the deviation may bring increased drilling torque, instability of the borehole, damage to casing and other problems. We must not forget that a great effort was made to drill a nearly vertical hole for scientific objectives in the KTB project. Therefore, it is necessary to develop a vertical drilling system (VDS) for the high pressure/temperature environment. This technology is closely related to LWD/MWD technology and Downhole Motor technology, and automatic control of hole trajectory by applying rotary steerable technology used by the oil industry. The key is to improve this technology for scientific drilling objectives.

In addition, the method to drill an inclined hole intentionally while controlling its direction and inclination using advanced VDS is thought to be effective to reduce borehole instability caused by large stress differences over vertical intervals of a hole. It is expected that this technology might be necessary for penetrating the Seismogenic Zone.

ED B-29: Mud circulation drilling system over 3,000-m water depth

The limit of water depth for the current riser drilling system is approximately 3,000m. Parallel to the efforts to improve current riser drilling riser and BOP, it is important to consider a new system like flexible riser and dual-gradient drilling system (seafloor pump, SWD:Subsea Mudlift Drilling, etc.). The best approach should be taken through the comparison of pros and cons between the current riser and the new system.

ED B-30: Freestanding, remotely operated deepwater shallow hole coring system

There is a gap in core recovery for science objectives while coring in deepwater conditions with riser and non riser vessels. In some settings, core recovery is low to nonexistent from the first 50-100 meters below seafloor. Recently new remote drills have been brought onto the market that can recover this type of core, but as yet none can operate in water depths of more than 3,000 m. A feasibility study should be made into the existing remote drills to determine whether any can be upgraded to work in depths in excess of 3,000 m with core recovery depths of 50-100 meters below the seafloor.

ED B-31: Drill pipe conveyed deep water, shallow hole coring tools

Prototypes of coring tools that are designed to recover shallow cores from lithified sediment or basement exposures at the seafloor have proved promising but require engineering development. Mud motor operated systems require new bit designs to improve core recovery and internal component development to reduce maintenance and improve performance. In addition, the driller cannot monitor the weight on bit (WOB) of the MDCB cutting shoe. MDCB WOB is controlled by pump pressure, but because the flow is relatively low, variations in pump pressure do not clearly indicate WOB or even motor stalling. The solution to this problem may require instrumentation that can track the stroke of the MDBC and transmit the information uphole. In its current design, the reduced strength of the ADCB BHA precludes initiating a borehole with this system. Capturing shallow subsurface cores that reveal the tectonic history recorded in the uppermost section of exposed oceanic basement is likely to be one of the greatest contributions of a tool of this theme of the ISP. Further engineering developments in drill collar design and deployment protocols are required to bring this system to maturity for potential applications in hydrothermal systems and zero-age crust.

ED B-32: Temperature tolerant muds and drilling bits

The geothermal drilling industry has developed methods and materials appropriate for drilling hot dry rock and hot geothermal fluids. Collaboration with this industry and development of joint development partnerships would be the most beneficial approaches to identifying the technological solutions to drilling into hot, wet rocks.

In current technology, maximum temperature limits of water-based mud are 240-260 °C. In holes drilled by *Chikyu*, the bottom hole temperature are expected to reach ~300 °C. Development of the drilling mud systems that can be applied to these drilling targets is clearly necessary. Operations in other high temperature environments will also require modified mud systems and drilling bits to achieve depth targets.

3.2.C Engineering Developments: Borehole Infrastructure

ED C-1: High temperature electronics, sensors, and sensor systems

Deep drilling targets, such as the Nankai Trough, and shallow, high temperature hydrothermal systems at spreading ridges have a critical need for the development of high temperature electronics, sensors, and sensor systems. Issues include not only use of high temperature semiconductor and discrete components (>85°C, industrial grade), but the design and performance of printed-circuit boards, potting and sealing of electronics, longevity of downhole connectors, and the aging of materials in high-temperature and chemically hostile environments. Future drilling targets are above existing temperature-time curves (see Figure). Identifying appropriate sensors compatible with long-term deployment (5-10 years+) is challenging because each sensor technology has different temperature-time performance and aging characteristics. Basic types of sensors envisioned for borehole observatory use include temperature, pressure, strain, tilt, seismometers, resistivity, and specialized chemical sensors. Longer-term science objectives for drilling the Moho will require even higher temperature tolerance and reliability not presently available commercially or from academic laboratories.

Substantial efforts are underway commercially and in academic labs for creating new types of high temperature-tolerant sensors and signal conditioning electronics for high temperature borehole applications. Collaboration with these groups on specific scientific applications on IODP drilling legs would be the most beneficial approach for obtaining access to these emerging technologies. Joint development partnerships funded specifically for drilling targets would also be a suitable approach.

ED C-2: Improved cementing techniques (high temperature and hydrologic isolation)

The installation of long-term borehole monitoring systems and isolation of hydrologic zones in boreholes located in high temperature environments will require improvements to cement composition and emplacement techniques. Understanding the physical properties of cement and its temperature dependence are critical for identifying appropriate compositions that will cure and age in an acceptable manner. Cements with values of Young's Modulus higher than currently available are needed for some of the deeper observatory targets (>3,000 mbsf). Heat released during cement curing can be substantial and will affect sensors embedded in the cement. If water is used to control temperature, micro fractures will develop, changing the physical properties of the cement in potentially unacceptable ways. New techniques and technologies will be required for some sensor deployment scenarios.

Improved casing-to-formation cementing techniques are required to provide hydrologic isolation (hydrology experiments and fluid sampling) and mechanical coupling with formations (strain meters, seismology experiments). Improved cementing techniques may obviate the need for packers in some instances.

Much can be learned from the geothermal industry, and the hydrocarbon industry regarding existing technologies.

ED C-3: Corrosion tolerance

Long-term deployments and deployments in chemically hostile environments will require use of more exotic materials for pressure cases, sensor probes, etc. Investigation of the effects of strain on metal corrosion is needed for selecting appropriate materials for long-term deployments in active tectonic environments. Existing geothermal/hydrocarbon industry practices and technologies should be explored.

ED C-4: Hydrologic Isolation

Reliable hydraulic isolation of multiple horizons in open and cased boreholes, especially across a decollement, is critical for achieving IODP science goals. The reliability, temperature tolerance, and long-term integrity of existing approaches to borehole sealing (e.g., packers or cement) are inadequate. There is no established method for monitoring the integrity of borehole seals and no protocol for what to do if a seal is lost. Retrievable packers are a science requirement for some proposed drilling legs. Given the high demand for CORK technology in the drilling proposals under consideration or scheduled, an assessment of packer technology is dictated.

ED C-5: Reliable wellhead hanger seals

Although this appears to be an incremental improvement, successful long-term deployment of any borehole experiment (not just CORK deployments) relies on creating and maintaining the integrity of seals between each casing string run into a borehole. At present reliable wellhead seals have not been designed or installed for non-riser boreholes. A Feasibility/Design Study is needed to assess present sealing techniques, and to investigate design improvements. The design improvements may radically change the topside configuration of the borehole hangers, thus this study has the potential to expand beyond its initial focus in order to achieve the desired technological outcome.

ED C-6: Electric, optical fiber and fluid feed-throughs at wellheads and in subsurface casing completions

The desire to install long-term borehole monitoring systems and to conduct in situ borehole experiments requires that electrical cables, optical fibers, and fluid tubing pass through the wellheads of boreholes. The feed-through strategy must be compatible with existing shipboard deployment procedures and casing hanger geometries. The topside connections at the wellhead must be ROV-compatible and easily accessed for making and breaking connections. One challenge is accommodating the increasing number of desired feed-through connections and their types. For example, the Christmas tree used for riser-drilled boreholes presently is limited to a maximum of 8 feed-throughs, but each feed-through could accommodate multiple conductor bundles. This limitation will constrain the topology of downhole monitoring systems. Feed-through methods need to be developed for all 3 IODP platforms. The need for developing suitable feed-throughs also extends to packer zones; in most cases electrical cables cannot be spliced (for long-term reliability), thus these cables have to be passed through packers in operationally practical ways.

ED C-7: Identifying, tracking, and minimizing drilling contamination

Advances in geochemical and microbiological measurements depend on obtaining pristine samples, uncontaminated by drilling fluids and materials from selected horizons in a borehole. Some tracer methods have already been employed during the ODP (e.g., fluorescent beads in a bag), however there is need for further development of tracer techniques and better means for identifying and minimizing chemical or microbiological contamination. In particular, before starting a long-term hydrologic or microbiological borehole experiment, the presence of chemical or microbiological contamination will have to be determined. Studies of fluid movement within and between boreholes may be enhanced by the development and use of inert tracers. In the case of coupled hydrologic/microbiological pump/chase experiments, novel approaches for tracing fluid movement may be required.

Commercial products, such as the gel coating system or cleaning the well offer potential solutions to minimizing drilling fluid contamination of retrieved samples or the sidewalls. Tracer techniques suitable for identifying and tracking drilling contamination of sediment around the borehole and the return of the borehole to pre-drilling conditions need further development.

ED C-8: Casing boreholes through active fault zones

A major drilling target for the *Chikyu* is the Nankai Trough. Drilling through and successfully casing an active thrust fault for long-term monitoring has not been accomplished and is integral to the scientific objectives of this major effort. Lessons from the ICDP SAFOD project indicate both the difficulty of accomplishing this task and guidance for potential solutions. We need good strategies for drilling the hole, clearing cuttings, managing breakouts, casing, and cementing. Success with these operations requires knowing in real-time an accurate state of stress and fluid pressure conditions in the zone spanning active deformation. Adaptation of methods from academic research and industry practice to measure stress and pressure will help to achieve this goal.

ED C-9: Physical coupling of acoustic instruments to formations and decoupling from noise sources

Further development of techniques for coupling seismic and other geophysical sensor to formations is needed to conduct both active and passive acoustic experiments. The measurement of mechanical noise in boreholes to identify its source, strength, and frequency range is needed to help mitigate its effects on subsequent sensor installations in other boreholes. Techniques are needed for reducing noise, such as isolation of sensors from casing strings and other noise sources (e.g., pumps, borehole convection, and seafloor infrastructure), and for emplacing sensors in the borehole (e.g., mechanical arms, multiple clamping, motors, springs, sand/glass beads, or cementing permanently into place).

ED C-10: Accurate estimates of downhole temperatures

Accurate estimates of downhole temperatures are necessary for designing a borehole observatory, including specifications for downhole instruments, mud selection, and well completion design and cementing. Both the static formation temperature and recovery temperature are desired. Because most IODP drill sites will be located in new areas, methods for using existing drilling data, geophysical and geologic data, and site survey data are needed to predict formation temperatures.

ED C-11: Techniques for borehole microbiology incubation systems

In some cases, the return of microbiological samples to the surface is not suitable, and in situ incubation may be the best means for properly identifying and describing the community composition and understanding the physiology of these organisms. Some samples (enrichment cultures, stained samples, or archived materials) could be returned to the surface after completion of the incubation experiments. In other cases, recovery of microbiological samples at in situ conditions will be desired. Requires low contamination of borehole and surrounding sediments.

ED C-12: Development of low power sensors – temperature, pressure, electromagnetic, seismic, and chemical measurements

Each type of sensor (temperature, pressure, electromagnetic, seismic, and chemical measurements) needs development that matches science requirements. Low power consumption is an essential technological development for any long-term borehole monitoring system. The development of novel optical-based sensing systems (DTS, or optical-seismic sensors) that do not require downhole electric circuits is one approach to achieving substantial reduction in overall power requirements.

ED C-13: Cross-hole hydrologic experiments

Methods need to be developed for conducting cross-hole hydrologic experiments to determine geohydrologic properties (e.g., permeability, storativity), similar to those that are routinely conducted on land by commercial consulting companies. Monitoring techniques, sensors, inert tracers, continuous chemical measurements and sensor deployment strategies in the observation borehole are needed to optimize the outcome of these experiments. The development of borehole pumping systems or means of propagating a pressure disturbance in a borehole is also needed.

ED C-14: Systems reliability for LTMS

High reliability systems are required for successful deployment and operation of long-term monitoring systems. Manufacturing and test procedures, strategies for redundancy and fault tolerance, maintenance procedures and strategies are critical elements of maintaining high-level systems reliability. Much of these requirements are mature methods in major industries, such as the telecommunications industry (including submarine telecom cabling), and are readily available and can be easily adapted for engineered systems on and below the seafloor.

ED C-15: ROV-serviceable wellheads and submarine cable connections

With the establishment of long-term monitoring programs for boreholes, periodic maintenance will be required to change batteries, collect samples, download data, change experimental gear, make submarine cable connections, and to repair the monitoring systems. The wellheads initially deployed by the drillships will need to be designed to accommodate ROV servicing. The ROV manipulators will have to reach the interior portion of the wellheads, be able to lift and exchange instrument packages, and to plug and unplug electrical and telemetry cables, and fluid lines at the wellhead. A test borehole facility could be used for training ROV-pilots and testing procedures. This would minimize operational costs and improve efficiency and reliability of actual deployments. There is also a need for standardization of interfaces between wellheads and ROVs.

ED C-16: Efficient power systems, including distribution

Depending on the sophistication and planned lifetime for long-term monitoring systems in boreholes, efficient power systems, including power supplies, cables, connectors, and control/monitoring systems will be required to support these monitoring systems. Fault tolerance, ground fault sensing, resettable thermal breakers for isolating faulty equipment, development of observatory control systems for power load management and engineering data subsystems are necessary components of an efficient and effective power system.

ED C-17: Design standards for electrical, communications, mechanical, and fluid systems

Uniform standards need to be established for electrical, communications, mechanical, and fluid systems in borehole observatories, in coordination with observatory initiatives in the US, Japan, and Europe. Standards will enable compatibility, integration, and inter-operability between different subsystems developed independently by a variety of investigators on a more cost-effective basis. This will also reduces errors and increase reliability.

An understanding of non-IODP platform capabilities and how to interface these systems with borehole experiments and long-term borehole monitoring systems will be necessary to optimize maintenance and recovery/re-installation of borehole observatory instruments. Thus, these standards cover not only efforts by the three IODP partners, but any 3rd party engineering development or operations.

ED C-18: Deployment procedures/soft-landing for borehole infrastructure and instruments

Placement of instrument strings, CORKs, casing, seismometers, and complex borehole instrument systems into boreholes will require improved precision in depth placement and tolerance for ship heave. Reduction in ship heave would be the most beneficial technological development, however, other strategies to dampen or de-couple ship motion could be developed and employed. The use of ROV-like devices can also provide solutions for placement of instrument strings and other devices into boreholes.

ED C-19: Managing borehole experiments

Effective management of long-term borehole experiments is essential for continued success of these systems and for the provision of opportunities for multiple investigators to participate in the scientific experiments. Data policies need to be established. Procedures for instrumented systems qualification need to be established and enforced before deployment. One way to qualify instrumented systems is to test them at a borehole test facility (systems integration lab).

ED C-20: Data systems and telemetry in boreholes and on the seabed

Reliable data systems and telemetry are required for the operation of long-term borehole monitoring systems. These systems need to meet the distance/cable length and power requirements of the experiments. Metadata for the suite of borehole instruments is necessary for proper borehole management and data archiving. The telemetry system will need a system status and reporting system to monitor the engineered parts of the system.

ED C-21: Borehole instrument deployment, re-entry and servicing systems

Techniques and infrastructure will be required to allow deployment, recovery, and possible re-installation of borehole instruments (e.g., seismometers or osmosamplers) in order to perform short-duration borehole experiments, maintain long-term borehole observatories (repair and replace) and re-use existing ODP/DSDP boreholes. This may include re-designing wellhead templates and modifying operational procedures shipboard.

Successful long-term borehole observatories will require an integrated deployment plan, methods for replacing sensors and components when required, and a built-in-test (BIT) plan to monitor the status of sensors and system infrastructure over the life cycle of the experiment.

3.3: Process of Engineering Development

EDP has put a great deal of effort into developing a process to nurture, evaluate, and advance technology developments within IODP. We summarize several of the significant processes we have adopted

1. 4 Stage Development Process

Any proposed technology development should follow a 4 step process that includes the following stages: Concept, Design, Fabrication, Implementation. Every project should pass through each of these stages. Many projects many enter the Concept phase, but only a few may make the Fabrication phase.

EDP recommends that a review is performed at the end of each of the 4 stages. EDP is not the reviewer, but would like to see a summary of the review. EDP would give advice at the concept stage, and by exception give advice later in project life.

2. Open Proposal Process

Three avenues for submission of EDP proposals to allow effective implementation of the ED goals of the IODP include:

a. IO's may submit proposals to IODP-MI based on internal needs assessment.
b. Interested parties submit proposals to IODP-MI in response to RFPs issued by IODP-MI.
c. 3rd Parties submit unsolicited proposals to IODP-MI.

Proposals submitted to IODP-MI must satisfy the requirements of Stage 1 (Concept). Proposals will be identified as addressing one or more of the remaining 3 stages of engineering development: Design, Fabrication, or Implementation.

3. EDP Review

EDP will review proposals after the Concept Phase. EDP will evaluate the proposal relative to the EDP Technology Roadmap or relative to achieving the goals of the ISP if the proposed development is not yet addressed in the Roadmap. The evaluation will assess how well the proposal meets established ED needs and provide a recommended course of action to SPC. In the event an ED Proposal does not address an established need, it will be evaluated with regards to its benefit to overall IODP-MI needs.

References

Integrated Ocean Drilling Program, 2003, IODP Initial Science Plan 2003-2013: Earth, Oceans and Life, Integrated Ocean Drilling Program.

Technology Roadmap - Engineeering Development Projects (draft)
Engineering Developments-Group A -Sampling, Logging, and Coring

ED #	Engineering Development	Requirements	Science Goal	ISP Technology Challenges	Availability
	Description of develoment	**What needs to be accomplished?**	**How does it fit with ISP?** Refer to Table 1	Refer to Table 3	Existing Technology (i.e. buy off shelf) (E), Modification (M), Innovation (I)
1	Thin Walled Geotechnical Sampler	Acquire minimally disturbed geotechnical cores	all	3	M E
2	Cone Penetrometer/Remote Vane	Better characterization of in-situ strength and material properties	all	8,1	M,E
3	Upgrade to RCB system	Better core recovery through modifications to RCB	all	3,10	M
4	Hard rock re-entry system (HRRS)	Hard rock spudding - review bit and hammer performance	all	11,10,2	M
5	Coring guidelines/operations manuals	Reliable description and operation manuals of tools	all		M
6	Diamond Coring System (Piggyback Coring System)	Improved core quality and core percentage recovery through PBCS	all	3,10,2	M,I
7	Large Diameter Diamond Coring Systems (ADCB)	Improved core quality and core percentage for specific formations through bit design and lighter WOB control	all	3,10,2	M
8	Retractable Bit Technology	Improve coring efficiency and ROP in hardrock and unstabe formations	all	3,2	I
9	Vibracore/Percussion Sampler	Improve percentage of core recovery in unconsolidate sand/silt formations	all	3,2	M
10	Motor driven core barrel	Develop hardware to operate in a broader range of application for mediyn to hard rock/coral coring formations	all	3,10,2	M
11	Rotary sidewall coring	Review industry hardware to determine if it can be used in larger diameter drillpipe or whether hardware should be developed for existing IODP ID drill pipe	all	3,10	E,I
12a	Provide core orientation on standard coring tools - Sediment Core Orientation	Core orientation	all	8	I
12b	Provide core orientation on standard coring tools - Structural Orientation of Hard Rock	Core orientation	all	8	I
13	Seabed coring devices	Shallow sampling (unconsolidate sands/ corals) or high quality hard rock cores <100 to 150mbsf using existing industry hardware	all	3,10,2	E
14	Jumbo Piston corer	Long continuous sediment cores <40mbsf	all	3	E
15	Down hole Tools calibration and testing facility	Improve reliability of coring and drilling hardware through inhouse QA/QC program	all		M
16	Pressure coring systems (PTCS, PCS, FPC, HRC, etc.)	Maintain in situ sample conditions and tool relability (pressure & chemistry)	all	3,8,9,6	M

Technology Roadmap - Engineeering Development Projects (draft)

Engineering Developments-Group A -Sampling, Logging, and Coring

17	Pressurized Sample Transfer (autoclave)	Maintain in situ sample conditions (pressure & chemistry) to transfer cores into autoclave device	all	8,9,6	M,I
18	Common Bottom Hole Assembly (BHA)	Operate all coring systems in common BHA	all	3,	I
19	New RCB Bits	Improve recovery in some formations through development of new bit with shorter core guides and different con configurations	all	3,10	M
20	Upgrade to XCB system	Improved core quality and core recovery percentage	all	3	M
21	Anti-contamination system (gell core barrel)	Provide sterile and higher percentage core recovery	all	3	I,M
22	New In situ sensors	Measure selected chemicals, pH and field effect	all	~~8~~	I
23	Fluid samplers, temperature, and pressure measurement tools	improve reliability of high temperature fluid sampling, and pressure measuring tools	all	1,8,6,9	M
24	Transition corers	Improve core recovery in transition zones between existing coring systems (i.e. add additional coring/sampling tools to better capture formations between APC/XCB and XCB/RCB)	all	3,2,10	E,M

Technology Roadmap - Engineeering Development Projects (draft)
Engineering Developments-Group B - Drilling/Vessel Infrastructure

ED #	Engineering Development	Requirements	Science Goal	ISP Technology Challenges	Availability
	Description of develoment	**What needs to be accomplished?**	**How does it fit with ISP?** Refer to Table 1	Refer to Table 2	Existing Technology (i.e. buy off shelf) (E), Modification (M), Innovation (I)
1	Larger Diameter Pipe	Deploy wide diameter tools logging and sampling	all	1, 7, 8, 9, 11	E
2	ROV Guided Logging Tools	Run large diameter tools without large diameter drillpipe	all	1, 7, 8, 10,12	E
3	Heave Compensation	Improve Heave Compensation	all	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12	M
4	Heave Compensation during Advanced Piston Coring	Improve depth resolution	1a, 1b, 2a, 2b, 2c, 2d, 2e,	3, 4	I
5	Seabed Frame	Stabilize Drill String at sea floor	1a, 1b, 2a, 2b, 2c, 2d, 2e, 3f	6, 7, 8, 10, 13,	M
6	Pressure Compensated Bumper/Thruster Sub	Improve core quality and quantity	all	2, 3, 4, 9	M
7	Rig Instrumentation System	Record/communcate/store rig instrumentation data	all	2, 3, 4, 5, 7, 8, 9, 11, 12,	M
8	Improved Automatic Driller	Better Weight On Bit Control	all	3, 4, 9, 11	E
9	Drilling Parameter Acquisition while coring	Record pressure, weight on bit	all	2, 3, 4, 7, 8, 9, 10,	M
10	Real Time Drilling Paramater Acquisition while coring	pressure, weight on bit	all	2, 3, 4, 7, 8, 9, 10, 11	M
11	Formation logging while coring	Monitor At Bit Drilling Parameter and Formation Data	all	2,3, 4, 7, 8, 9, 10, 11	I
12	Radio Frequency ID Chip Implant in Drill Pipe	Reliable Depth Measurement	all	1, 4, 7, 8, 11	I
13	Intellipipe		1b,3a,3b, 3c,3d,3e,3f	2, 4, 7, 8, 9, 10, 11	E
14	Electric/Optical Wireline	Monitor and Control Observatories	1a, 1b, 3a,3b, 3c,3d,3e,3f	1, 2, 4, 5, 7, 8, 10, 11	E
15	Directional coring	Enable Directional Drilling while Coring	1b, 3a,3b, 3c,3d,3e,3f	2, 3, 6, 7, 8, 9, 11, 12	M
16	Non-magnetic collars	Reduce drilling induced Magnetic overprint	all	3, 4, 11	M
17	Non-magnetic core barrel	Reduce drilling induced Magnetic overprint	all	3, 4, 11	M
18	Magnetic shield for core barrels / anti-contamination for core barrel	Reduce drilling induced Magnetic overprint	all	3, 4, 11	I
19	Protocol for Proper Mud Design	Better Hole Cleaning, and hole stability	all	1,2,3,6,7,9,12,	E
20a	Borehole camera looking downward	Looking ahead borehole visualization	all	5,8	E
20b	Borehole camera looking borehole wall	Borehole wall visualization		5	E
21	4000 m class riser system	Deeper water riser targets	3d,3e,3f	12	M
22	4000 m class BOP	Deeper water riser targets	3d,3e,3f	12	M
23	Reduce current force on Chikyu riser	Increase operatability in currents	all	13	M
24	Improve dynamic positioning systems	Incrase operatability in severe sea states	all	13	E
25	Improve expandable casing system	Casing in deep penetration, high temperature, high pressure, hostile environments	3d,3e,3f	12	M
26	Cementing protocol for deep drilling	Casing in deep penetration, high t emperature, high pressure, hostile environments	1b, 3a,3b, 3c,3d,3e,3f	1, 5, 11, 12	M
27	Drill pipe for ultra deep ocean drilling	Drilling for deep water and deep penetration targets	3a,3b, 3c,3d,3e,3f	1, 11, 12	M
28	High temperature, high pressure vertical drilling system	Deep penetration, inclined hole targets			M
29	Mud Circulation Drilling System at over 3000m water depth.	Current drilling riser system water depth limit is approx. 3000m due to static + dynamic load caused by heaving..	3a,3b, 3c,3d,3e,3f	1, 11, 12	M
30	Freestanding remotely operated deep water shallow hole coring system	Deep water shallow hole coring	1a, 1b, 2a, 2b, 2c, 2d, 2e,	3, 10, 12	M
31	Drill pipe conveyed deep water, shallow hole coring tools	Deep water shallow hole coring	1a, 1b, 2a, 2b, 2c, 2d, 2e,	3, 12	M
32	Temperature tolerant muds/drilling bits etc.	higher temperature tolerance for longer peiods of time; market survey and state-of-the-art; establish qualification procedures	1b, 3a, 3d, 3e, 3f	1	EMI

Technology Roadmap - Engineeering Development Projects (draft)
Engineering Developments-Group C - Borehole Infrastructure

ED #	Engineering Development	Requirements	Science Goal	ISP Technology Challenges	Availability
	Description of develoment	**What needs to be accomplished?**	**How does it fit with ISP?** Refer to Table 1	Refer to Table 3	Existing Technology (i.e. buy off shelf) (E), Modification (M), Innovation (I)
1	High temperature electronics, sensors, and sensor systems	higher temperature tolerance for longer peiods of time; low drift; market survey and state-of-the-art; establish qualification procedures	1a, 3a, 3d, 3e, 3f	1	EMI
2	Improved cementing techniques (high temperature and hydrologic isolation)	higher temperature tolerance for longer peiods of time; market survey and state-of-the-art; establish qualification procedures	1a, 3a, 3d, 3e, 3f	1	EMI
3	Corrosion tolerance	higher temperature tolerance for longer peiods of time; market survey and state-of-the-art; establish qualification procedures	1a, 3a, 3d, 3e, 3f	1	EI
4	Hydrologic Isolation	need for higher reliability; means for deploying multiple levels of pakcers; development of alternative systems, packer-like techniques	1a, 1b, 3a, 3b, 3c, 3d, 3e, 3f	1, 5	EMI
5	Realiable wellhead hanger seals	need to develop sealing mechanism for existing borehole hangers used by IODP; redesign hanger sealing system for future borehole completions	1a, 1b, 3a, 3b, 3c, 3d, 3e, 3f	5	EM
6	Electric, optical fiber and fluid feed-throughs at wellheads and in subsurface casing completions	need to develop techniques for accomplishing this for all platforms	1a, 1b, 3a, 3b, 3c, 3d, 3e, 3f	5	EMI
7	Identifying, tracking, and minimizing drilling contamination	further develop contamination tracking techniques and analytical methods; identify and develop techniques for contamination control	1a, 1b, 3a, 3b, 3c, 3d, 3e, 3f	1,5	EMI
8	Casing boreholes through active fault zones	drilling and casing strategies need to be developed for actively deforming lithologies; measure pore pressures and stress field before casing; need local monitoring sensors and telemetry;	1a, 3a, 3d, 3e, 3f	5	MI
9	Physical coupling of acoustic instruments to formations and decoupling from noise sources	need to develop techniques for coupling sensors to casing or formation; need noise measurements in borehole to identify sources and strength/frequency band; need to develop techniques for reducing noise	1b, 3a, 3b, 3c, 3d, 3e, 3f	5	EMI
10	Accurate estimates of downhole temperatures	Accurate estimates of downhole temperatures are necessary for designing a borehole observatory	1a, 2d, 3a, 3b, 3c, 3d, 3e, 3f	5	EM
11	Techniques for borehole microbiology incubation systems	develop more versatile sampling techniques for microbiological samples; (get beyond contamination halo); develop downhole systems for incubation experiments, some could return samples to the surface after completion of incubation; minimize contamination; shipboard culture system comparable to borehole system	1a	5	EMI
12	Development of low power sensors - temperature, pressure, electromagnetic, seismic, chemical measurements	this is a broad spectrum of needs; each type of sensor needs development that matches science needs; low power consumption is an essential develop for LTMS; development of optical-based sensing systems that do not require downhole electrical circuits	1a, 1b, 3a, 3b, 3c, 3d, 3e, 3f	5	EMI
13	Cross-hole hydrologic experiments	need methods for conducting cross-hole hydrologic experiments; monitoring techniques and sensors; sensor deployment strategy to optimize data; develop borehole pumping systems or means of propagating a pressure disturbance	1a, 1b, 3a, 3b, 3e, 3f	5	EM
14	Systems reliablity for LTMS	high reliability systems are required for successful LTMS; methods, testing procedures; redundancy strategies; maintenance procedures and strategies	1a, 1b, 3a, 3b, 3c, 3d, 3e, 3f	5	EM
15	ROV-serviceable wellheads and submarine cable connections	re-design seafloor templates, re-entry cones, etc for ROV compatibility; provide means for making submarine cable network connections by ROV; need standardization of interfaces	1a, 1b, 3a, 3b, 3c, 3d, 3e, 3f	5, 10	EM

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16	Efficient power systems, including distribution	need well-designed power systems (batteries and submarine cables) that have fault tolerance, ground fault sensing, resettable thermal breakers; need an observatory control system for power and data subsystem control	1a, 1b, 3a, 3b, 3c, 3d, 3e, 3f	5	EMI
17	Design standards for electrical, communications, mechanical, and fluid systems	standards need to be established so that uniformity, compatibility, and inter-opererability is straightforward and cost effective	1a, 1b, 3a, 3b, 3c, 3d, 3e, 3f	5, 10	E
18	Deployment procedures/soft-landing for borehole infrastructure and instruments	need techniques to ensure that borehole instrumentation is not damaged during deployment, can be recovered in specific instances;	1a, 1b, 3a, 3b, 3c, 3d, 3e, 3f	1, 5, 10	EM
19	Managing borehole experiments	essential for LTMS and cable-connected systems that permit multiple investigators to participate in the sciencific experiments; need to establish data policies; instruement qualification procedures before deployment;	1a, 1b, 3a, 3b, 3c, 3d, 3e, 3f	5, 10	E
20	Data systems and telemetry in hole and on the seabed	reliable data systems and telemetry are required for LTMS; need to meet distance/cable length and power requirements of the experiments; include metadata; and system status reporting	1a, 1b, 3a, 3b, 3c, 3d, 3e, 3f	5	EM
21	Borehole instrument deployment, re-entry and servicing systems	techniques and infrastructure need to be developed to allow re-entry of boreholes and the removal and re-installation of borehole instruments packages and systems	1a, 1b, 3a, 3b, 3c, 3d, 3e, 3f	5, 10	EMI