JFAST (Exp. 343) External Technical Review Task Force
17 February 2012
Tel. conference

1. Meeting Participants:

Jim Mori	Kyoto University
Fred Chester	TAMU
Emily Brodsky	UCSC
Demian Saffer	PSU
Steve Hickman	USGS
Jerome Schubert	TAMU
Bob Pilko	Blade Energy Partners, Ltd
Bill Whitney	Blade Energy Partners, Ltd
Nicolas Pilisi	Blade Energy Partners, Ltd
John Thorogood	DrillingGC
Ikuo Sawada	CDEX
Sho Kataoka	CDEX
Koji Takase	CDEX
Nobu Eguchi	CDEX
Nori Kyo	CDEX
Sean Toczko	CDEX
Yoshi Kawamura	IODP-MI
Issa Kagaya	IODP-MI

2. Agenda:

    1. Borehole Stability
        - Casing size/plan
        - Drilling Mud
    2. Drill string strength
    3. The fault (scientific target) identification
        - LWD logging configuration
    4. Other issues
        - Backup wellhead and conductor systems
        - Fatigue resistance
        - Control location
        - WOB and feed rate
        - Aftershocks and post seismic slip.
        - Temperature specification of MTL rope
        - Shallow hazards
        - Preparation timeline
        - Others

3. Discussion points:

    The discussion had started based on CDEX support documents; “Drilling Program” & “Issues raised by the external technical reviewers”.

    - Hole stability is one of the main discussion point, lack of site geological information caused difficulty to pin-point mitigation plans. “Pump & Dump” may be an answer. The amount of mud and the speed of mixing mud may become critical issues.

- Thorough inspection of BHA, drill pips and surface equipment such as top drive is important.
- Sea current and VIV may cause huge problem on the operation. The real time current monitoring is essential.
- More LWD data will make fracture identification easier, even SONIC (poor performance?). Adding NMR porosity is excellent idea. ARC (induction measurement) may provide mud invasion profile and/or resistivity hole caliper.

4. Recommendations/follow-up issues:

    1. Re-search information about the problems at site 434, apparently because of hole stability uncertainty (lack of information).
    2. Clarify with drilling engineers a plan for monitoring hole stability parameters;
        - Fracture density
        - Annual pressure
    3. Conduct hydrologic calculations on U-tubing effects, while pumping weighted mud.
    4. Reconsider mud mixing process/procedure to meet sudden requirement in case of receiving the hole-instability signs.
    5. Re-clarify and reconsider possible problems to gain the robustness of the contingency plan.
    6. Inform daily operations to the External Review Task Force members, and seek advices, if need it.

5. Support document:
    - Drilling Program (by CDEX)
    - Issues raised by the external technical reviewers (by CDEX)
    - EPSP review report
    - SCP review report

Issues raised by the external technical reviewers.

16 February 2012

1. Borehole Stability issue

Casing size;

Our standard RCB core hole size is 10-5/8-inch, and we do not have a smaller-size core barrel (8-1/2-inch hole) available on hand. If the bit size is set at 9-7/8-inch, a common overshot (catch size 8-1/2-inch – our DC OD) will not be available in industry and we will have to make a special order. As noted above, the maximum OD of the outside cable protector will be 7-1/2-inch for the core hole completion. We would like to have annulus clearance for the completion as much as possible.

Borehole stability calculation will be done by the Science team.

Drilling mud;

We have considered possible courses of action to follow in case of emergency; the following mud program will be followed:

Weighted mud

Prepare 1.30 sg X 80 m^3 of weighted mud before drilling begins in case we encounter shallow gas/water flow.

Mud Formulation

- Drill water: 89 ml
- Kunigel-VO: 6.5 g
- Caustic soda: 0.1 g
- XCD polymer: 0.2 g
- Tel Bar: 34.0 g

Causes of hole instability

Use Guar Gum Mud or continuously pump Sea Water Gel slurry as a solution to Hole instability by flush Sea water Gel slurry.

Guar Gum Mud

Formulation

- Sea water: 100 ml
- Rester: 1.0 g

Sea water Gel Slurry

Formulation

- Sea water: 50 ml
- 12% Pre-hydrated Gel: 50 ml
- Caustic Soda: 0.2 g (for mud volume)
- Lime: 0.2 g (for mud volume)

2. Drill string strength

We don't have any bottom current survey data and vertical current profile data, making it difficult to estimate the drill string catenary. In our simulation study, we used the same assumptions (2 knots of surface current and 0 knots at 500 m) as were used for the initial simulation. Based on this current profile, the result of combined stress (bending and axis) was acceptable.

See also attached document <SPH_DrillPipeAnalysis.pdf>

3. Finding the fault issue

LWD configuration appears in <343_DrillingProgramReport.pdf> page 44.
Also please refer IODP Science Advisory Structure, Site Characterization Panel review <JFAST_SCP_Review.pdf>.
Regarding Tough-Logging, because of limited resources and operation schedule, we will not use it, however compare with the original LWD configuration, we had added NMR tool.

4. Other issues

Backup wellhead and conductor systems

We are now conducting a series of Stack-up Tests in Singapore for the CORK, running tool, and other wellhead components. The tests show that some minor modifications are required, but these can be resolved before the expedition is set to sail.
The following wellheads and casings are on hand (or on order) for JFAST operations:

- 2 ea. x 18-3/4-inch Wellhead with 20-inch casing joint.
- 2 ea. x 18-3/4-inch Wellhead (Tripod Wellhead)
- 13 jts. x 20-inch casing

Fatigue resistance

We are going to carry out a study of fatigue life for the drill string. On the other hand, we will be using Non-Rotating Drill Pipe Protectors to mitigate fatigue in case of slow ROP.

Control location

The capability of *Chikyu's* DPS is considerably high. *Chikyu* can keep position in sea conditions up to 7 m wave height (using 5 thrusters, with 1.5 knot current direction 80º from heading and 26 m wind direction 30º). For riserless drilling, the heading can be easily changed and *Chikyu* can maintain position even in more severe conditions. *Chikyu* can keep station within a 5 m offset, which is 0.07% of the water depth.

WOB and feed rate

We estimate that the core BHA and bit will be stabilized in the coring interval unless the ship heave unacceptably increases; this is because coring operations will begin at 500 mbsf (or more). Based on the drill string study, the operation guideline limit for wave height will be 3 m.

Aftershocks and post seismic slip

The scientists and we have been considering the possible effects of fault slippage. Weak links in MTL ropes will be placed so that even with slippage, we will be able to recover MTL sensors; at least the upper part of the MTL string may be recoverable in case the casing breaks or is crushed. Within the second hole, data will be recorded up to the point where each sensor is lost through crushing.

Temperature specification of MTL rope

As the reviewer mentioned, such characteristics of rope as strength, elongation, and abrasion are very important factors for the JFAST observatory planning. Considering these characteristics, Vectran, Spectra, Plazma are most appropriate rope among current cutting-edge products. In

IODP Exp 327, Keir Becker, et al., used Spectra rope for a similar type of deployment. However, CDEX decided on using Vectran rope for JFAST, since it has a little lower elongation factor than the others and is negatively buoyant. In addition, the melting point and critical temperature of Vectran is much higher than the others. For example, melting points of Vectran and Spectra are 329 °C and 140 °C, respectively. CDEX has conducted rope tests to confirm its strength, elongation, and abrasion at room temperature, and these results satisfied our requirements. Note that the environmental temperature at the bottom of the hole for JFAST is expected to be below 30 °C, which is close to "room temperature".

Shallow Hazards

All the site surveys have been performed by IFREE/JAMSTEC, to which one of the JFAST lead proponents, Dr. Kodaira, belongs. These surveys are also summarized in the Safety Review Report (SRR) for EPSP. They include 2D seismic dip lines with 10 km line spacing, high-resolution 2D grid seismic survey around the primary/alternate sites, and multi-narrow beam bathymetry data collection. The interpretation and hazard assessment are documented in the SRR. CDEX was involved in geological interpretation and hazard assessment with securing a basic understanding of the tectonic framework between the proponents and the operator. The Drilling Program of Exp 343 (JFAST) is being prepared by CDEX (to be printed soon), and also includes a chapter describing the same topics. If IODP-MI permits, the SRR will be supplied to you as well.

Shallow hazardous factors that can potentially affect wellhead installation and subsequent stability of the wellhead and safety drilling include: free gas (hydrocarbon) and water flow in the shallow formation, extremely soft or hard seafloor, and rough topography. The seismic profiles around the drill sites, however, show no obvious structures in the formations above the expected décollement besides the shallowest portion immediately below the seafloor. Therefore no features suggesting the presence of potential free gas, water flow, hydrocarbon trap or hydrate zones, such as high-amplitude reflectors or those with reversal polarity can be seen in the data. In the unlikely event they do exist, the impact should be minimal.

On the other hand, we have insufficient information about the seafloor condition, since no high-resolution topographic data, backscattering data nor core samples around the sites are available. The only available data regarding the seafloor hardness, the shallowest formation, shows that it is very likely to be relatively firm, according to DSDP Site 434 (similar setting to the north of JFAST, in 6000 m water depth) shear strength and bulk density data. Nevertheless, there is no data denying the presence of thick squashy mud lying on the seafloor. In addition, rough topography and/or boulders of mudstone as a result of landslides are other potential concerns. Such concerns should be minimal since the positions for spud-in will be selected through a seafloor survey via underwater TV system on site.

See also IODP Science Advisory Structure, Environmental Protection and Safety Panel Review <JFAST_EPSP_Review.pdf>.

Bottom hole assemblies

For the BHA program, please see the attached documents <BitProgram.pdf>. As for bit suppliers, we have consulted with BHI and Smith, after providing them with the lithology and the velocity data available.

Meta-ocean data

See attached document <MetaOcean_MainReport.pdf>

Procurement timeline

Please see <JFAST_Preparation.pdf>

Hydraulic seal for pressure measurement

Information from Demian Saffer, one of the lead scientist of the team.
Two recent examples that come to mind are:

1) Site C0010 (IODP Leg 319-332). This site was drilled into the splay fault at Nankai, to 555 m. Hydraulic isolation of a screened casing interval at 407 mbsf relied on sediment collapse around the casing above (from 0-400 m). Recovered pressure data indicate successful sealing. There is a clear attenuation of the tidal signal by a factor of 0.82 (approx. as expected for the sediment compressibility) - and of the ocean loading from the Feb Chile M 8.8 earthquake tsunami. So we are seeing apparent isolation of the screened interval from the overlying ocean at a couple of different frequencies. This dataset is relatively fresh, but we had a poster at AGU (Hammerschmidt et al.), and a paper in the Exp. #332 proceedings (Kopf et al.) laying out the basic observations.

2) Site 1255 (COsta Rica, Leg 205). This site included two P monitoring zones - an upper zone sealed by formation collapse of the ~150 m of sediment in the annulus above, and a lower zone sealed by cement. The upper zone is isolated from the ocean, as documented by the tidal response, and also a background overpressure of ~80 kPa (I believe it's 80 kPa...maybe 150 kPa). This is documented in a handful of papers by Davis and others (2006 EPSL, 2011 EPSL, 2008? EPS).

The alternative is simply far too risky - our track record with outside-casing packers, especially in soft sediment environments, is not very good. There is considerable added risk to installation (see Leg 196, Site 808 A-CORK), and also to the post-cruise science. As documented by Sawyer et al (2009 - JGR), the compliance of the packer and damaged formation in the outside-casing monitoring zones is not well constrained, and leads to uncertainties in interpreting the phase and amplitude of the P timeseries. Ultimately this poses problems in best design for multi-level monitoring in IODP. The overall sentiment about the A-CORK experiment is that it could/should work in theory, but is difficult to implement successfully. For that reason, most of the recent soft sediment CORKs aiming at multiple monitoring levels have simplified by going toward miniscreens or casing screens that rely on formation collapse for hydraulic isolation. We used this approach in our most recent NanTroSEIZE installation at Site C0002 as well. I suppose it may take days to weeks in some formations for collapse and to therefore establish the seal - there are indications in the P and T records at Site 1255, for example, that might indicate formation collapse "events" a couple of months after drilling.

EPSP Review 11 February 2012

A supermajority of EPSP has responded. Please forward our recommendations and comments on to the operator.

The panel has recommended approval of all sites as requested

Site	Latitude*1	Longitude*	Approved depth (m)	Recommendation
JFAST3	37° 56.3022N	143° 54.8405E	1100m	Approve as requested
JFAST4	37° 56.3528N	143° 54.5075E	1200m	Approve as requested
JFAST5	38° 39.6664N	143° 26.7087E	1000m	Approve as requested
JFAST6	37° 57.1644N	143° 34.8404E	700m	Approve as requested
JFAST7	37° 54.7748N	143° 50.8337E	1000m	Approve as requested. Dieter Strack voted not to approve based on seismic data quality
JFAST8	38° 00.6244N	144° 23.9456E	350m	Approve as requested

*Panel's recommendation assumes that this is the center-point of a circle with a 100m radius.

They do request that the operator address/be aware of the following issues:

- Sea floor condition uncertainties need to be minimized. Questions have been raised whether the seafloor camera will be sufficient. The panel suggests reprocessing the multi-beam data, conducting a new deep-tow sidescan survey, or using an ROV to conduct a radial survey.
- Detail is lacking in the shallow section. An attempt should be made to obtain additional details on the character of the shallow section. As noted by several of the panel that lack of a feature doesn't equate to no risk (i.e., have the risks of shallow water flow and shallow gas been fully addressed.
- There remains issues associated with hole stability that fall within the operator's domain.
- Potential impact of an aftershock on the drill-string.
- Expand on the details of the decision tree to include additional contingencies. At least one panel member felt that if problems develop during the drilling the 8.5 inch pilot hole at the primary and contingency site the 10-5/8 core holes should not be attempted. The panel would appreciate having the opportunity to review for information purposes the final decision tree.
- A clear understanding should be developed as to how the residual stress and afterslip may impact drilling
- Will distance between locations be maintained between holes since the panel is approving a 100 m radius from a center point.
- Requested drilling depths on the site summary sheets need to reflect the uncertainty associated with the seismic velocity.

Proposal No.	787-RRD
Short Title	Japan Trench Fast Earthquake Drilling
Lead Proponent	James Mori
SSP Watchdogs	Dan Fornari, Cara Burberry, Dhananjai Pandey
SSP Conflicts	Nakamura
Review date	1 February 2012

SSP Review:

Proposal 787-RRD (J-FAST) addresses the problem of drilling through the fault zone on which the 2011 Tokohu earthquake occurred. The key scientific objectives are listed as follows:

1) What was the stress state on the fault that controls rupture during the earthquake and was the stress completely released?

Dynamic friction during the rupture - Potentially the most significant result of this project will be a value for the dynamic coefficient of friction. Time decaying temperature measurements will be used to estimate the frictional heat produced at the time of the earthquake, which can be used to infer the level of dynamic friction.

Rupture to the toe of accretionary wedge - Past thinking was that sediments in this region are weak, so earthquake instability should not nucleate or easily propagate through this region. Measurements of current stress and stress during the earthquake can be used to explore different models to explain how slip occurred in this region.

2) What are the characteristics of large earthquakes in the fault zone, and how can we distinguish present and past events in fault zone cores?

Core Analyses – Detailed analyses of textures and small-scale structures of core samples of the fault zone will be used to infer the role of fluids and pressurization during rupture. We will look for evidence of melting from pseudotachylytes. Trace elements will be used to estimate the thermal history of the recent and past events.

Laboratory Experiments - High-speed friction and petrophysical experiments on fault material can be used to characterize the frictional behavior of the fault.

More specifically, the major goals of J-FAST are to (i) identify the fault that slipped in the Tokohu earthquake, (ii) to constrain the stress before, during and after the earthquake by a combination of observatory, geological, geochemical and geophysical observations and (iii) to identify the distinctive features of the fault zone associated with the extreme Tokohu earthquake.

The goals will be reached by a combination of core and borehole measurements, including the installation of a long-term observatory. We have never before observed slip of the magnitude of the Tohoku earthquake and are likely to have few other chances to make such a major step forward in directly observing the mechanics of earthquakes. This project requires non-standard temperature and fluid pressure monitoring of the fault zone over several years, in order to obtain estimates of fault friction.

Two drilling locations were initially proposed, J-FAST 1 (for coring of the fault zone and installation of temperature and pressure monitors) and J-FAST 2 (defined as an alternative site with the same objectives). Both drilling locations are imaged by multibeam bathymetric data and crossed by sufficient seismic lines to image the target depth adequately. The initial review expressed some concerns about these sites, however, based on the higher resolution data, new primary (JFAST 3) and secondary (JFAST4) sites have been selected. In addition, a series of potential alternate sites have been considered based on the data submitted (in Jan. 2012) to SSP in case of unexpected technical challenges. We thank the proponents for their careful review of our initial comments.

SSP Watchdog Consensus:

Data requirements have been met, per the SSP Matrix. This includes the most recent seismic and other surveys, which have now been added to the IODP DataBank database.

However, as with the SPC review, we draw the SSP members' attention to the following risks:

Scientific risks: One of the initial concerns raised by the watchdogs is the assumption of fault zone permeability. Recent shallow injection experiments near the source region of the 1995 Hanshin-Awaji earthquake showed waveform changes that are consistent with rapid rise to high permeability (10-5 m2) that endured for several days. If the Tohoku earthquake increased permeability along the fault zone, fluid flow could have advected the frictional thermal signature. Since we do not know the in-situ permeability in the Tohoku fault zone, a broader range of assumed permeabilities for the temperature decay models is warranted, including significantly higher values than included in the proposal, such as sedimentary units at ~1 km depths might achieve. The watchdogs initially requested a discussion of ways to measure or estimate the in-situ permeability during the project. This has been adequately addressed in the response to our initial comments. Although there are still some scientific risks and unknowns in this project, it is unreasonable to expect a risk-free drilling scenario and the watchdogs are satisfied that the proponents understand the complexities of the fault zone permeability issue and have sufficient methods and plans in place to tackle potential issues as they arise.

In addition, the watchdogs were initially concerned that the stress field to be estimated is at the very shallow depth of the mega-thrust (< 1000 m), which can be quite different from what we really want to know, i.e., the earthquake-triggering stress field within the seismogenic zone at much deeper depths. The rupturing fault at the targeted drilling depths could well be a passive rupture in response to stress transfer. Therefore one of the hypotheses on dynamic weakening may not be testable. However, in their response to our previous comments, the proponents have clarified the aims of the proposal in a fashion that indicates that the present drill site (JFAST 3) has a high likelihood of addressing the stated aims of the proposal.

Technological risks: Given the initial sites, SSP felt that this was a technically challenging project (e.g., water depth). With the change in primary site to JFAST 3, the concerns of the watchdogs about this challenge are allayed. In addition, the explicit statement that external drilling experts have been consulted about this project provides additional reassurance for the watchdogs that the technical challenges are being addressed as carefully as possible.

Managerial aspects: There were initial concerns from the watchdogs about the lack of clarity in the imaging of the thrust fault and the lack of precision in the location. This concern has been addressed by the acquisition of high resolution seismic lines across the region. The watchdogs felt it necessary to have the fault clearly imaged and located in order to address the technical feasibility of drilling a potentially over pressured zone and a complex structure. Drilling the sub-horizontal section of the fault as indicated for JFAST 3 & shown in the updated seismic dataset satisfies the watchdogs that the proponents are likely to be accessing a stress field close to that of the rupturing fault. Avoiding the structural complexity of JFAST 1 reduces the likelihood that this is a passive rupture and reduces the scientific risk.

The following special strategies are required and are being planned in associated with IO (CDEX):

1. Correct drill pipe on *Chikyu* to withstand anticipated load
2. Simple yet robust observatory strategy (in design)
3. Careful casing of the drill holes to allow ample clearance
4. Contingency plans for each operation suite

The drilling is not expected to induce seismicity given the near complete stress drop on the fault in the Tokohu earthquake and the low fluid and mud pressures involved in riser-less drilling.

Site Characterization Completeness and Data Adequacy Classification:

Site	Classification	Latitude	Longitude
J-FAST 1	1Bb	37° 54.2557’	143° 54.6394
J-FAST 2	1Bb	38° 04.8273’	143° 56.3412
J-FAST 3	1Aa	37.938369	143.914008
J-FAST 4	1Aa	37.939214	143.908265

Completeness: 1A – all data are in the SSDB and have been reviewed by SSP

Data Adequacy: a – data image the target drill site adequately, and scientific concerns of drill site penetration and success have been adequately addressed, with sufficient contingency plans.

For additional guidance proponents may contact the IODP-MI Science Managers <science@iodp.org>, panel watchdogs David Mallinson <mallinsond@ecu.edu>, Koji Kashihara < koji.kashihara@japex.co.jp>, Mikiya Yamashita <mikiya@jamstec.go.jp>, SSP chair Gilles Lericolais <Gilles.Lericolais@ifremer.fr> or SSP vice-chair David Mallinson <mallinsond@ecu.edu>. To submit data to the IODP Site Survey Data Bank, go to http://ssdb.iodp.org/. SSP guidelines for drill site characterization data requirements are available at http://ssdb.iodp.org/documents/IODP_Matrix_v1.pdf.