NanTroSEIZE Project Scoping Group meeting  
February 24-24, 2005  
El Dorado Hotel, Sante Fe, NM

Attendees:

**Project Scoping Core members**
Janecek, Tom     IODP-MI
Kimura, Gaku     University of Tokyo
Kinoshita, Masataka     IFREE, JAMSTEC
Kuramoto, Shin’ichi     CDEX, JAMSTEC
Tobin, Harold     New Mexico Tech
Underwood, Mike     University of Missouri

**Technical Implementation members**
Klaus, Adam     TAMU, USIO
Masago, Hideki     CDEX, JAMSTEC
Yohroh, Tamio     CDEX, JAMSTEC

**Science Advisory Structure liaisons**
Becker, Keir     RSMAS, University of Miami

**Guests**
Nathan Bangs     University of Texas Institute for Geophysics
Achim J. Kopf     University of Bremen
Randy Normann     Sandia National Laboratory  (Feb 25 only)
Location
Eldorado Hotel 
309 West San Francisco Street
Santa Fe, New Mexico 87501
Tel: (505) 988 4455
Fax: (505) 995-4555
www.eldoradohotel.com

Date and Time
Thursday, February 24, 2005  Friday, February 25, 2005
08:30 -17:00 08:30 – 17:00
Continental breakfast will be provided at 8:00 am
Lunch: Adjourn to one of the local eateries

Meeting Room in Hotel: To Be Announced

Meeting Host
Harold Tobin
Earth and Environmental Science Department
New Mexico Tech
Socorro, NM 87801
Tel: (505) 835 5920 / Email: tobin@nmt.edu

Hotel Information
Eldorado Hotel :Address above
Rooms have been set-aside for the nights of Wednesday, February 22, Thursday 23, and Friday 24 at a special rate of $94 plus tax (currently 14.3125%).

To make a reservation (Important Deadline Information)
Please telephone the reservations department directly at 800-955-4455; by faxing your reservation request to 505-995-4544; or by accessing email reservations at rez@eldoradohotel.com ON OR BEFORE Monday, February 14, 2005. Mention the IODP Management International/NanTroSEIZE when reserving, and please provide your arrival/departure dates along with a credit card number to guarantee your reservation.

Airport Transportation
Albuquerque International Airport is situated less than an hour from Santa Fe. Shuttle Service is offered by several companies, ranging in price from $20-25 per person, one way.

Sandia Shuttle Express
1-888-775-5696 (toll free)
In Albuquerque (505) 242-0302

Santa Fe Shuttle
Telephone 1-888-833-2300 (toll free)
In Albuquerque (505) 243-2300
Agenda

1. **Review Action Items from October 2004 PSG meeting**
   A watchdog has been assigned to report the status of action items generated at the previous meeting and to bring closure to that item, if possible. If the item is to be covered in more detail later in the agenda only a short update is needed.
   a. PSG Mandate (Janecek)
   b. Contingency Planning for All Sites (Tobin)
   c. Define Critical Data Sets (Tobin and Kinoshita)
   d. Define Site Survey interpretation and review procedures (Kuramoto)
   e. Develop Data Requirements worksheets for each site (Tobin, Kinoshita, Kuramoto)
   f. Develop procedures for prioritizing sites into overall drilling plan (Tobin, Kinoshita)
   g. Designate scientists to work with eng. for geo-prediction for drilling (Tobin, Kinoshita, Kuramoto)
   h. Explore task force for IODP Observatory science (Janecek)
   i. PSG Task Forces (Tobin, Kinoshita)

2. **Updates from SAS/IOs/Proponents**
   The presenters in this section should provide brief (<10 min) updates on the items as they pertain to issues (if any) related to NanTroSEIZE drilling (e.g., operations, scheduling, drilling, ship status, etc).
   a. Operations and Program Plan Updates (Janecek)
   b. Proposal 603-C, 603-D Update (Tobin and Kinoshita)
   c. SAS Update (Becker)
   d. Chikyu Update (Kuramoto)
   e. JOIDES Resolution and SODV updates (Klaus)

3. **Mandate Approval (Janecek)**
   A draft mandate will be discussed, modified, and approved by PSG core members.

4. **Site-by-Site Scoping (Tobin, Kinoshita, Underwood)**
   Review each proposed site one by one, including revisions to planned penetration depth discussed at the last PSG. *Pre-meeting preparations should include a prepared table that provides details of:*
   a. Depth of penetration
   b. Predicted geology, major targets
   c. Coring, downhole measurements plan
   d. Long-term observatory objectives as proposed
   e. Scientist prediction of possible challenges, hazards (e.g., hydrate, overpressure)
   The objective of this agenda item is to make sure that all PSG members (both engineering and science side) fully understand of what is proposed.
After this basic information is compiled, discussed and agreed upon, we can begin an initial site scoping including:
- Riser or riserless drilling requirements?
- How much casing is necessary?
- Special wellhead requirements for long-term?
- Other engineering considerations?

5. Long-term monitoring planning (Kinoshita and Tobin)
   a. Riser-less holes
   b. Riser wellhead holes
   c. Proposed task force on long-term monitoring development

The major objective of this agenda item for the PSG to agree on a way forward and designate a subset of PSG members (and other experts) to more fully develop the long-term NantroSEIZE plans. Topics might include:
- Who is responsible for which parts of observatories (IOs and scientists)?
- Are non-riser and riser hole observatories to be handled differently? How?
- How can we coordinate and target engineering efforts?
- Can we agree on task force members?
- How to integrate this NanTroSEIZE observatory group into the IODP Observatory Task Force to be started by IODP-MI?

6. 3D Seismic and Other Site Survey Activities (Kuramoto, Kinoshita, Tobin)
   The objective for this agenda item is to provide the PSG with an update on positive developments toward 3D seismic acquisition, and decide how to move forward on negotiating contract, and parameterize survey to preserve both science and engineering (hazard survey) goals of acquisition.
   a. 3D survey – parameters and coordinating negotiations (CDEX, IFREE, NSF/U.S. proponents)
   b. Other site surveys update
   c. Interaction with SSP/EPSP and site survey databank

7. Sites and Order of Drilling Operations (ALL)
   The JOIDES Resolution will be off-contract in Jan 2006 and a new riserless vessel will most likely not be on-line until mid FY07 at the earliest. Thus it appears that the first ship to the NanTroSEIZE area will be Chikyu. The goal here is to decide the operational order for drilling operations and what might be potential scheduling scenarios.

8. Other Items
9. Review Action Items
10. Adjourn
Report of the NanTroSEIZE PSG

Sante Fe, New Mexico
February 24-25, 2005
Attendees:

**Project Scoping Core members**
Janecek, Tom  
Kimura, Gaku  
Kinoshita, Masataka  
Kuramoto, Shin’ichi  
Tobin, Harold  
Underwood, Mike  

**Technical Implementation members**
Klaus, Adam  
Masago, Hideki  
Yohroh, Tamio  

**Science Advisory Structure liaisons**
Becker, Keir  

**Guests**
Bangs, Nathan  
Kopf, Achim  
Normann, Randy  

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IODP-MI
University of Tokyo
IFREE, JAMSTEC
CDEX, JAMSTEC
New Mexico Tech
University of Missouri
TAMU, USIO
CDEX, JAMSTEC
CDEX, JAMSTEC
RSMAS, University of Miami
University of Texas Institute for Geophysics
University of Bremen
Sandia National Laboratory (Feb 25 only)
Dates and Times
February 24, 2005 8:30 –17:30
February 25, 2005 8:30 –15:30

Place:
Eldorado Hotel, Sante Fe, New Mexico, USA

Original Agenda

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2. Updates from SAS/IOs/Proponents
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   c. SAS Update (Becker)
   d. Chikyu Update (Kuramoto)
   e. JOIDES Resolution and SODV updates (Klaus)

3. Mandate Approval (Janecek)

4. Site-by-Site Scoping (Tobin, Kinoshita, Underwood)

5. Long-term monitoring planning (Kinoshita and Tobin)
   a. Riser-less holes
   b. Riser wellhead holes
   c. Proposed task force on long-term monitoring development

6. 3D Seismic and Other Site Survey Activities (Kuramoto, Kinoshita, Tobin)
   a. 3D survey – parameters and coordinating negotiations (CDEX, IFREE, NSF/U.S. proponents)
   b. Other site surveys update
   c. Interaction with SSP/EPSP and site survey databank

7. Sites and Order of Drilling Operations (ALL)

8. Other Items
9. Review Action Items
10. Adjourn
Meeting Report

1. Review Action Items from October 2004 PSG meeting
   Most of the discussion regarding these action items was incorporated into specific agenda items for this (February meeting) and thus were discussed during that portion of the meeting. A few additional notes are presented below

   a. PSG Mandate
      Most of this discussion was deferred to Agenda Item 3 (below).
      The chair, however, explained that he would also like the group to consider the wording for a “generic” PSG mandate and one that was more specific to NanTroSEIZE.

   b. Contingency Planning for All Sites
      See Agenda Items 5 and 6 below

   c. Define Critical Data Sets
      - See Agenda Items 5 and 6 below

   d. Define Site Survey interpretation and review procedures
      - See …..

   e. Develop Data Requirements worksheets for each site
      - See agenda Item 9 below

   f. Develop procedures for prioritizing sites into overall drilling plan
      - See Agenda Items 5 and 6 below

   g. Designate scientists to work with eng. for geo-prediction for drilling
      - Tobin noted that has initiated discussion with a group consisting of Harold Tobin, Peter Flemings, Demian Safer, and Nakamura to provide more scientific input to CDEX well engineers

   h. Explore task force for IODP Observatory science
      - Janecek noted that IODP-MI is planning on developing a IODP-wide observatory task force in FY06 for the management of boreoles. The Task Force would have mandates related to engineering, data management, and international coordination of borehole usage.
      - The Task Force might start up a smaller effort dealing with either NanTroSEIZE or Monterey Bay issues and then use the protocols and procedures developed for these particular programs to scale up to overarching issue.
      - Also see Agenda item 7 below

   i. PSG Task Forces
      - The PSG discussed several areas that would benefit from sub-groups or Task Forces reporting to the PSG including
        1. Pore-pressure prediction
        2. Seismic data analysis and interpretation
        3. Managing borehole science
      - See also Agenda Item 7 below
2. Updates from SAS/IOs/Proponents
   PSG members provided updates to the group.
      Janecek outlined the normal plan for program development and the specific plan
      for FY07.

   b. Proposal 603-C, 603-D Update (Appendix B)
      Harold Tobin and Mike Underwood updated the PSG with the status of the
      NanTroSEIZE CDP proposals.

      - 603-C Deep plate boundary site. Single deep hole. Back from external SSEP
          review. Proponents response letter submitted. SSEPS forwarded to SPC for
          March SPC ranking meeting meeting, EPSP review coming up
      - 603-D Non-riser site observatories; SSEPs sent back to proponents for revision
          to obtain more specific information about what should get done and prioritize.
          Not previewed yet by EPSP
      - 603A- Residing at OPCOM. EPSP previewed
      - 603B- Residing at OPCOM. EPSP previewed, request for shallow seismics and
          amplitude maps, seeps, hydrate issues, velocity data

   Discussion ensued on issues surrounding site survey status and EPSP reviews and
   two action Items:

   **Action Item 0502-1:** Chair to discuss with EPSP how and when each site should be
   reviewed by EPSP.

   **Action Item 0502-2:** Chair to Contact Site Survey Data bank to determine status of
   proposals with respect to Site Survey data

   c. SAS Update
      Keir Becker updated the PSG on changes to the SAS. Of particular interest to the
      PSG is the formation for the Engineering Development Panel (formerly TAP)
      and the change of SCIMP to the Scientific Technology Panel.

      The panel was informed about the Industry Workshop led by Manik Talwani,
      which has the goal of engaging industry at the management level to investigate
      potential opportunities for IODP/industry interaction.

   d. Chikyu Update (NanTroPSG2_App_C)
      Shin’ichi Kuramoto updated the PSG about the status of Chikyu operations,
      including information about the sea trials (2 to date), duration of shakedown
      cruise, and expected delivery dates to international operations (late FY07).
The PSG expressed concerns about JAMSTEC doing “IODP” science during the shakedown and asked about locations of shakedown cruises (Kumano Basin?). The PSG encouraged CDEX to consider utilizing scientists from the international community during these operations.

e. JOIDES Resolution and SODV updates (NanTroPSG2_App_D)
   Adam Klaus updated the PSG about the status of the current non-riser schedule, including issues surrounding clearances (Monterey and Gulf of Mexico) staffing (balancing between members), and the progress towards procuring the Phase 2 non-riser vessel.

3. Mandate Approval (NanTroPSG_App_A [slides 11-19] and Appendix NanTroPSG2_App_E)
   Janecek distributed a draft of the mandate for NanTroSEIZE PSG and asked for input from PSG members by the end of the meeting. The PSG agreed that the group is probably better termed a “Project Management Group” and suggested the name be changed. The Chair indicated he would consider this request.

   Appendix E contains some suggested revisions to the Mandate. Additional modifications/mandates suggested by the PSG members include (1) providing advice on staffing and (2) linkages to funding agencies, proponents and other programs.

   Appendix E also contains a NanTroSEIZE specific mandate for use in presentations or other outreach activities.

   **Action Item 0502-3**: The Chair will incorporate all the input and finalize the generic and NanTroSEIZE specific mandates.

4. 3D Seismic and Other Site Survey Activities
   a. 3-D Survey (Appendices NanTroPSG2_App_F and G)
      Harold Tobin briefly discussed the overall international efforts toward 3-D site-survey preparations (CDEX, IFREE, NSF) and then Tomio Yohroh went into more specific details about the survey history, objectives schedule, location, and acquisition and processing parameters.

      Several issues arose that will require early PSG input, including:
      (1) determining what are the highest scientific needs [i.e., earliest priorities; Splay faults, Decollement],
      (2) how to optimize availability of pre and post STM data for drill site refinement and shallow hazard assessment by EPSP,
      (3) the need to obtain contracting guidance from companies or individuals that have conducted industry 3-D surveys,
(4) how will US (NSF) funds be integrated into the survey,
(5) who will coordinate the survey [CDEX?],
(6) the need for gravity and magnetic data?

**Action Item 0502-4:** Tamio Yohroh, Nathan Bangs, Shin’ichi Kuramoto, and Harold Tobin to discuss details regarding coordination of 3-D Survey and report back to PSG

**Action Item 0502-5:** T. Janecek to inquire at Industry Workshop about industry representatives who could provide advice with contract 3-D Survey negotiations.

b. Other site surveys update (NanTroPSG2_App_H)

Achim Kopf described the MeBo drilling & In situ-measurements in the Nankai Trough accretionary prism (MINT) cruise scheduled for April 2006 with the R/V Sonne which will involve drilling (with a PROD-type drill), gravity coring, and deployment of CPTs, heat flow probes, and CAT meters, and pore-pressure instruments (SAPPIs). Kopf requested input from the PSG on a number of issues including the staffing, conflicts with other operations (i.e., surveys, other desirable data sets, use of Kochi core repository.

5. Site-by-Site Scoping

This section is a compilation of discussion from the both the first and second day of the meeting. In particular, a discussion of hazards, challenges, and coring requirements from the second day is integrated into this site-by-site scoping summary.

Harold Tobin first presented a summary table (NanTroPSG2_App_I) for each site that provides details of parameters such as total depth, predicted geology, coring requirements, downhole measurements, hazards, etc. This table is a work-in-progress that will be refined into a package, along with such things as seismic lines, prioritized objectives, etc., for the IOs to use as a planning tool.

The individual sites were then discussed by PSG.

**Reference Sites – (NanTroPSG2_App_J)**

Mike Underwood presented details of the proposed operations at the Reference Sites including:

- NT01-01 (Basement High)
- NT01-02 (Basement Plain)
NT01-06 (Shikoku Basin)  
NT01-03 (Prism Toe)  
NT01-04 (Trench)  
NT01-05 (Trench)

Specific discussion comments/issues:
- There was general agreement that NT01-01 is the best spot for deepening basement and a target depth of 100-200 m is ideal. This site is the least likely to have sand and casing may not be required to reach Total Depth. Site 1173 could be used as an operational model. The site does not need to be cased for future re-entry.

- There was a consensus among PSG members that Lower Shikoku Basin facies in NT01-02 is not well defined and NT01-06 provides a better alternative. The disadvantage of this alternative sites is that it is farther from NT01-01 for linked hydrogeology experiments.

- NT01-04 is a channel levee complex and thus is not a prime target. NT01-05 provides a better alternate for monitoring strain transients. While deep penetration is ideal, good results could be obtained with penetration to only 500-600 mbsf.

- There are some major unresolved issues regarding seismic interpretations for NT01-03, For example, it is unclear where to place the decollement. In addition, the basement is deep (>2300m) and thus may become a lower priority to that of reaching the frontal thrust at ~500-600 mbsf. Sand could be present.

Splay Faults: (NanTroPSG2_App_K)
Masa Kinoshita presented the initial proposed operational details for the 603B Splay Fault sites including

NT02-01- Shallow branch of Splay Fault
NT02-02 – Intersection of Splay Fault at 2000 mbsf
NT02-03 – MegaSplay at 3000 mbsf
NT02-04 – Kumano basic uplift history

Specific discussion comments/issues:
- The primary objective at NT02-01 is to sample and instrument the Splay Fault; deeper penetration and pairing with other sites are lower priorities. NT02-01 is a high priority site in which 3D Seismic data would be extremely useful in determining the final site location.
• NT02-02 is poorly imaged and the proposed location of fault is based on geometric arguments rather than seismic character. 3D seismic acquisition is required before drilling. In addition, NT02-02 is a structurally complex site which could be difficult to drill in riserless mode. This is not a site for early operations and should await acquisition and interpretation of 3D seismics before determining if it should be drilled.

• NT02-03 is also poorly imaged and needs 3D seismic acquisition before proceeding. NT02-02 and NT02-03 could possibly be merged into one site.

• The lower section of NT02-04 is of lower priority as it would be sampled by NT03-01 (riser) site and thus NT02-04 could be drilled to only 1300 mbsf. Operations at this site would utilize LWD to 1300 mbsf and then emplace a P-CORK.

• Detailed seismic stratigraphic analysis throughout the Kumano Basin is essential before drilling commences.

Deep Riser Site (NanTroPSG2_App_L)
Harold Tobin presented the proposed operational details for the deep riser site NT03-01.

Specific comments:

• This is a multi-stage drilling operation with a pilot hole that will be cored/logged to 1000 m, with further deepening to ~5800-6000 mbsf and then finally initiating a sidetrack hole above the Mega Splay.

• New seismic velocity model data brings the expected Total Depth to ~5600 mbsf. Basement penetration is expected to be on the order of 200 m.

• The prioritization of information obtained from this hole is as follows:
  
  o The core/logs (geologic information),
  o Seismicity and active source seismic data recorded on a borehole array
  o Pore pressure, strain/tilt information
  o long-term fluid chemistry
  o EM-conductivity.

6. Sites and Order of Drilling Operations (NanTroPSG2_App_M)

The PSG began to address the order of operations after it analyzed the specific site-by-site operations. A series of overarching principles were discussed to help guide the discussion:
• Start with easier things, work up to bigger challenges
• Build time into schedule between operation stages to use data to adjust next stages
• Try simple observatories first and then work up to complex installations. Test technologies in simple versions
• Build in flexibility. Assume boreholes can be used for many years but instruments will fail and instruments will need to be extracted.
• Identify critical decisions that will affect later operations (casing, well-head, cemented instruments). Plan these carefully

Based upon these guidelines, a series of “Stages” were discussed. No attempt was made to determine the operational time necessary to complete a “Stage”, which could range from less than one “standard” two-month expedition to multiple expeditions.

**Stage 1: Drill and Core in riserless mode**
- NT01-01 to TD, drill and core, LWD
- NT01-02 to TD, drill and core, LWD
- NT01-03 to 1400 m
- NT03-01 upper 1000 m
- NT02-04 (1300 version) core, LWD emplace P-CORK

No other CORKing in any hole, Case only as necessary for non-riser drilling

**Stage 2: More riserless drilling, Some CORK-style installations**
- NT2-01A/B, drill core, log Hole A; case, install pore pressure and seismometer in Hole A; Drill and wireline packer test in Hole B
- NT2-02, drill, core, log, no observatory
- NT2-03, drill, log, core, upper ~1000 (preparatory for riser work)
- NT1-01, NT1-02 return for observatory installations

**Stage 3: Riser Site to 3000 mbsf**
- NT2-03, deepen to 3150 m TD, combination of coring/LWD, install casing
- Install simple retrievable observatory

**Stage 4: Riser Site to 6000 mbsf**
- NT03-01, Deepen to TD with LWD, casing
- Sidetrack to take continuous cores across faults
- Install removable “simple” observatory

THEN: Wait for a significant period to record borehole data, then complete layout of final instrument configuration for two deep observatories

**Stage 5: Install Full Deep Monitoring System**
NT2-03 and NT3-01, Deploy final monitoring systems in boreholes.
Comments/discussion on proposed stages

- Prioritization is key. It is essential to know what is to be accomplished at each stage so the future steps can be planned and executed.

- Need to think beyond concept of “standard” two-month expeditions for planning purposes.

- Will need to have operational and science reviews after each stage (and at least operational reviews after each expedition within each stage).

- Need to evaluate initial data from observatories and then refine objectives based on early monitoring. Thus it is important to have some component of observatory operations in the early stages.

- 603D proposal – determine early whether working properly, adjust/replace as required. This concept needs to be built into proposal.

- Need to develop long-term funding strategy for observatory science

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**Action Item 05-02-6:** PSG needs to develop standard presentation format of Site Scoping information that includes prioritized coring/logging/monitoring operations, seismic line (with interpretations), prioritized site science objectives.

7. **Long-term monitoring planning and infrastructure for Borehole Observatories (NantroPSG2_App_N; NantroPSG2_App_O)**

Masa Kinoshita and Harold Tobin informed the PSG of progress towards organizing a focused meeting bringing together interested persons with specific expertise in the relevant observatory components. Tobin indicated that he would approach USSSP for funding and potentially coordinate the meeting with SAFOD. Tobin and Kinoshita presented a preliminary list of names for workshop attendees (NantroPSG2_App_O) and asked the PSG members to contribute additional names (especially from Europe, ICDP, and SAFOD).

A discussion ensued on the responsibility of the IOs and proponents with respect to funding various parts of the observatory systems. It is the understanding of the PSG that casing and wellhead structures are POC expenditures. Other engineering development could be SOC. The PSG will need to request that the SAS prioritize engineering development for long-term monitoring and borehole system integration as soon as
possible. It was recognized that such prioritization is under the purview of the new Engineering Development Panel.

**Action Item 0502-7:** Chair to engage SAS on prioritizing observatory engineering development needs.

8. **Presentation: Randy Norman – Sandia Laboratories (NantroPSG2_App_P)**

Randy Norman (High-Temperature Electronics Geothermal Research Dept. Sandia National Labs) gave a presentation to the PSG members that focused on issues that need to be considered when planning instrumentation for deep-fault monitoring. Utilizing experienced gained in a variety of operations, Norman discussed laboratory and well testing protocols, evaluation criteria, and instrument components and design.

9. **Task Flow**

Shin’ichi Kuramoto handed out several charts of Work Flow and Data requirements for Riserless and Riser drilling for NanTroSEIZE and asked for comments and input from the PSG.

The PSG noted several modifications including:

1. making the responsibility of acquiring offset well data a responsibility of both the IO and proponents,
2. including the timing of SAS and OPCOM meetings,
3. better definition the mechanism/responsibility for seismic interpretation (e.g., IO? Proponent?),
4. refinement of EPSP input (current draft has too much iteration for riserless and not enough for riser drilling
5. deletion of 3D survey needs for reference sites and
6. building flow chart to include subsequent “stages”

The PSG the discussed the need to begin to integrate this flow chart with the “stages” described in Item 6 above and for the implementing organizations (USIO and JPIO) to begin to develop time estimates for the initials stages.

**Action Item 0502-8:** Chair to request time estimates for Stage 1 operations to be prepared for the June 29-30 2005 Operations Task Force meeting in Edinburgh.

10. **Next meeting**

The next meeting of the PSG will most likely be held in the early Fall of 2005 (after the June Operations Task Force meeting but prior to the Fall SPC meeting). By this time the Operations Task Force will have developed a number of scheduling scenarios for FY07
and FY08 and have gone through a series of iterations with SPC to optimize these scenarios. The PSG will then be able to meet and discuss issues that may need to be forwarded to SPC for their consideration when the vote to approve the final operations schedule.

The location is not known at this time.
Report of the NanTroSEIZE PSG

Sante Fe, New Mexico
February 24-25, 2005

Appendix A
NanoTroSEIZE PSG#2 Meeting Agenda

- Review Action Items from October 2004 PSG meeting
- Updates from SAS/IOs/Proponents
- Mandate Approval (Janecek)
- Site-by-Site Scoping (Tobin, Kinoshita, Underwood)
- Long-term monitoring planning (Kinoshita and Tobin)
- 3D Seismic and Other Site Survey Activities (Kinoshita and Tobin)
- Sites and Order of Drilling Operations
- Other Items
- Review Action Items
- Next Meeting (location, date, participants)
- Adjourn

Agenda Items (continued)

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   6. Develop procedures for prioritizing sites into overall drilling plan (Tobin, Kinoshita)
   7. Designate scientists to work with eng. for geo-prediction for drilling (Tobin, Kinoshita, Kuramoto)
   8. Explore task force for IODP Observatory science (Janecek)
   9. PSG Task Forces (Tobin, Kinoshita)

2. Updates from SAS/IOs/Proponents
   - Brief updates on the items as they pertain to issues related to NanoTroSEIZE drilling (e.g., operations, scheduling, drilling, ship status, etc.).
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     b. Proposal 603 C, 603 D Update (Tobin and Kinoshita)
     c. SAS Update (Becker)
     d. Chilly Update (Kuramoto)
     e. JOIDES Resolution and SODV updates (Klaus)

3. Mandate Approval (Janecek)
   A draft mandate will be discussed, modified, and approved by PSG core members.

4. Site-by-Site Scoping (Tobin, Kinoshita, Underwood)
   The objective of this agenda item is to make sure that all PSG members (both engineering and science side) fully understand what is proposed. Review each proposed site one by one, including revisions to planned penetration depth discussed at the last PSG. Basic information includes:
   - Depth of penetration
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   - Core, downhole measurements plan
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   After this basic information is compiled, discussed and agreed upon, we can begin an initial site scoping including:
   - Riser or riserless drilling requirements?
   - How much casing is necessary?
   - Special wellhead requirements for long-term?
   - Other engineering considerations?

5. Long-term monitoring planning (Kinoshita and Tobin)
   The major objective of this agenda item is to agree on a way forward and designate a subset of PSG members (and other experts) to more fully develop the long-term NanoTroSEIZE observatory plans.

Topics might include:
   - Who is responsible for which parts of observatories (e.g., IOs, Scientists?)
   - Are non-riser and riser hole observatories to be handled differently? How?
   - How can we coordinate and target engineering efforts?
   - Task force members?
   - How to integrate this NanoTroSEIZE observatory group into the IODP Observatory Task Force to be started by IODP-MI?
6. 3D Seismic and Other Site Survey Activities

The objective for this agenda item is to provide the PSG with an update on positive developments toward 3D seismic acquisition, and decide how to move forward on negotiating contract, and parameterize survey to preserve both science and engineering (hazard survey) goals of acquisition.

- 3D survey – parameters and coordinating negotiations (CDEX, IFREE, NSF/U.S. proponents)
- Other site surveys update
- Interaction with SSP/EPSP and site survey databank

7. Sites and Order of Drilling Operations (ALL)

The JOIDES Resolution will be off-contract in Jan 2006 and a new riserless vessel will most likely not be on-line until mid FY07 at the earliest. Thus it appears that the first ship to the NanTroSEIZE area will be Chikyu. The goal here is to decide the operational order for drilling operations and what might be potential scheduling scenarios.

8. Other Items

9. Review Action Items

10. Next meeting

Location
Date
Host
Participants

PSG Mandate

GENERAL PURPOSE

The general purpose of the Project Scoping Group (PSG) is to plan and coordinate a Complex Drilling Project (CDP) in conjunction with the Implementing Organizations (IOs) and IODP-MI and to oversee the implementation of this multi-year, multi-expedition, and (potentially) multi-platform project. The PSG ensures that the scientific objectives defined in the CDP proposal and by the Scientific Advisory Structure (SAS) are respected and works closely with IODP-MI, the IOs, and SAS to maintain maximum planning flexibility in order to respond to unfolding scientific developments in a timely and cost-efficient manner.

GENERAL PURPOSE (continued)

Specific functions of a Project Scoping Group include:

- Assisting IODP-MI, the Implementing Organizations, and expedition Co-Chief scientists in the design of detailed implementation plans for all CDP phases.
- Integrating the proposed drilling and instrumentation plan with the overall scientific effort as described in the CDP proposal and approved by the SAS.
- Defining, developing, and coordinating long-term observatory monitoring plans for the holes drilled during the project.
- Developing and overseeing critical paths and gateways to achieve scientific objectives specified in the CDP proposal and approved by the SAS.
- Coordinating data output from disparate drilling and non-drilling related activities.
- Assisting IODP-MI and IOs with Education and Outreach activities.
- Reporting progress toward implementation of the CDP to the IODP management (via the IODP-MI Operations task force) on a regular basis.
MODE OF OPERATION

A. Initiation of Scoping Group:
A Project Scoping Group is constituted by IODP-MI through its Operations Task Force (formerly known as OPCOM). IODP-MI’s Operation Task Force may implement a Project Scoping Group for any expedition at any stage of implementation it deems necessary. Normally, for CDP proposals, the Operations Task Force may initiate a PSG after the Science Planning Committee (SPC) designates a proposal to be a Complex Drilling Project and subsequently recommends that the Operations Task Force evaluate the level of scoping (if any) required for the project.

B. Reporting
A Project Scoping Group reports directly to the IODP-MI Operations Task Force. The PSG will supply reports and updates on the status of its activity at each regularly scheduled IODP-MI Operations Task Force meetings but the PSG may be requested to supply reports more frequently as deemed necessary by the Operations Task Force.

The Operations Task Force Chair will be the formal PSG liaison to the SAS. The Operations Task Force Chair, in practice, may designate specific PSG members as liaisons to SAS committees.

C. Meeting Size:
In order to keep the meetings productive, efficient, and cost effective, Project Scoping Group meeting size will generally consist of the 7-8 Core Members, 2-5 IO technical representatives, 1-2 SAS representatives and 1-3 Guests.

D. Meeting Frequency:
Meetings will be held 3-4 times/yr or as deemed necessary by the Operations Task Force.

E. Membership:
A Project Scoping Group consists of (1) Core Members, (2) Implementing Organization Technical Representatives, (3) Science Advisory Structure Representatives, and (4) Guests.

Core Members
A group of 7-8 members, consisting of 3-4 community scientists (generally proposal proponents), 1-2 Implementing Organization representatives, and IODP-MI representatives comprise the permanent members of the PSG. These Core Members provide the long-term institutional memory for the PSG and are responsible for the primary planning and coordination of the CDP and carrying it through the multi-year, multi-leg, and multi-platform project. These Core Members determine the specific agendas for each PSG meeting.

The scientists will be selected from a pool of scientists recommended by the SAS. The Chair of the PSG will be the IODP-MI Manager of Operations.
MODE OF OPERATION (cont)

Science Advisory Structure representatives
Science Advisory Structure representatives are invited to attend each PSG meeting. Normally, 1-2 SAS members attend the meetings.

Guests
Guests are invited by the Core Members (subject to approval by the PSG Chair) when the PSG needs specific technical, operational, engineering or scientific input not provided by the Core Membership, IO technical representatives, or Science Advisory Structure representative(s).

“Normal” Program Plan Development

- SPC: Ranking of Proposals
- OPCOM / SPC: Develop schedule options
- SPPOC: Approval of schedule
- Lead Agencies: Budget Guidance
- IODP-MI / IO’s: Develop APP
- SPPOC/BoG/NSF: Approval of APP

Operations Update-- FY05 Program Plan

<table>
<thead>
<tr>
<th>Date</th>
<th>Entity</th>
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<tr>
<td>Aug 02</td>
<td>IPC</td>
<td>Five MSP Programs Ranked</td>
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<tr>
<td>Sep 03</td>
<td>SPC/OPCOM</td>
<td>Global Ranking of All Programs FY05 Schedule (Oct-May)</td>
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<tr>
<td>Jan 04</td>
<td>NSF</td>
<td>Lead Agency Budget Guidance</td>
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<tr>
<td>Mar 04</td>
<td>SPC</td>
<td>Tahiti Sea Level Program sent to OPCOM</td>
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<tr>
<td>Apr 04</td>
<td>OPCOM</td>
<td>Tahiti Scheduled as FY05 MSP Minor JR schedule change</td>
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<tr>
<td>May 04</td>
<td>IODP-MI / IOs</td>
<td>FY05 Program Plan developed</td>
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<td>Jun 04</td>
<td>NSF / SPC</td>
<td>New Budget Guidance for FY05 / New Rankings to OPCOM</td>
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<tr>
<td>Jul 04</td>
<td>SPPOC</td>
<td>Approve original FY05 Program Plan</td>
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<td>Sep 04</td>
<td>OPCOM</td>
<td>New FY05 &amp; FY06 Schedule</td>
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<td>Oct 04</td>
<td>SPC</td>
<td>Approval of new FY05 Schedule/FY06 Science Program</td>
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<tr>
<td>Nov 04</td>
<td>IODP-MI</td>
<td>FY05 Program Plan Addendum</td>
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<tr>
<td>Dec 04</td>
<td>IODP-MI</td>
<td>Revised Program Plan Addendum to NSF</td>
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Operations Update-- FY05/06 Schedules

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<thead>
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<td>Juan de Fuca Ridges</td>
<td>Yubin</td>
<td>9 Apr – 31 May</td>
<td>TBN</td>
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<td>Gulf of Mexico Hydrology</td>
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<td>26 May – 6 Aug</td>
<td>TBN</td>
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<td>Demobilization</td>
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<td>Tahiti</td>
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<td>Camer, Enay</td>
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FY06 Planning-(continued)

- Jan 2005: Lead Agency Budget Guidance
- Mar: OPCOM/SPC - Schedule MSP?
- Apr: IODP-MI Develop APP
- Jun: SPPOC Approval
- Aug: NSF Approval
- Oct: Start of FY06 Operations
FY07 Planning

- Mar 05  SPC Ranking (All platforms)
- Jun 05  OPCOM develop schedule options
- Oct 05  SPC Approval of schedule options
- Dec 05  SPPOC Approval of Plan
- Jan 06  Lead Agency Budget Guidance
- Apr 06  IODP-MI Develop APP
- Jun 06  SPPOC Approval
- Aug 06  NSF Approval
- Oct 06  Start of FY07 Operations
Report of the
NanTroSEIZE PSG

Sante Fe, New Mexico
February 24-25, 2005

Appendix B
Drilling the Megathrust: The Nankai Trough Seismogenic Zone Experiment

Co-Chief Project Scientists:
Masanori Kinoshita
Harald Tobin

Subduction zone structure and interplate seismogenic zone: up-dip and down-dip limits

Why the Nankai Trough?
- Long record of frequent great earthquakes (M ~ 8.0+)
- Strongly locked
- Well-imaged faults = well-defined drilling targets
- Up-dip end of seismogenic zone within reach of Chikyu
- Proximity to Japan for monitoring, allied studies

Nankai Trough Subduction Zone: 1940s Tsunamigenic Earthquakes
- 15 Mi Philippines Sea plate subducts ~ 40 mm/yr
- Last 2 MB+ earthquakes were fairly typical
  - 1944 (Tsunami)
  - 1946 (Hankow)
- 1946 a bit larger, but complex source suggests several subevents occurred

IODP Integrated Ocean Drilling Program

NanTroSEIZE objectives:
Building a distributed observatory spanning the up-dip end of the interplate seismogenic zone

- 8 proposed drilling sites, to depths from ~500 to ~3500 m below the seafloor
- Previous ODP depth record is ~2200 m
- Allied geophysical, seafloor studies
- Sampling, logging, downhole testing, and long-term monitoring are all important
Why is drilling necessary?

- Fundamental physics of faulting remains poorly understood in many ways, especially:
  - Processes of rupture nucleation, growth, propagation, and arrest.
  - Stable vs. unstable behavior (seismic vs. aseismic slip).
  - Energy budget of fault slip (radiated energy, fracture energy, frictional heating).

- Key parameters for rate and state friction, energy budget of rupture propagation can only be measured by in situ access.
  - Pore fluid pressure, stress magnitudes and variations, thickness of slip zone.
  - Strength and elastic properties of fault zone and wall rock.

- Drilling results provide ground truth information for inferences based in remote geophysical sampling.

- Drilling provides access to make new geophysical, geochemical measurements:
  - Fault zone trapped waves, near-field seismology, seismic velocity and anisotropy variations as proxies for stress, evidence for fluid content and migration.

Seismic and tsunami waveform inversion indicates substantial up-dip slip on shallow asperity

Proposed deep drill sites are located in this high-slip zone

Seismic inversion

Tsunami inversion

Great earthquake size and effects may be governed by nature of large-slip zones, not by nucleation character

Objectives of NanTroSEIZE

- Document the material properties and state of the plate boundary fault system at several P-T and lithology conditions, testing hypotheses for stable vs. unstable frictional behavior.

- Investigate partitioning between seismic vs. aseismic processes on the main plate boundary, through monitoring of seismicity, borehole strain, and pore fluid pressure.

- Test whether there are interseismic temporal changes in state – including possible earthquake precursory signals.

- Calibrate observations in the broader geophysical volume surrounding the boreholes.

Deep Penetration MCS Depth Section

- Ongoing: Geophysical/Geologic Characterization
  - Phase I: Reference drilling, incoming section and crust, borehole observations
  - Phase II: Splay fault mechanics and slip history (to ~ 3500 m)
  - Phase III: Plate interface drilling and instrumentation (to ~ 6000 m)
Phase 1: Sites NT1-01A and -02A

Specific Objectives
- Obtain samples of faults and surrounding environment
  - Characterize lithology, structure, elastic and mechanical properties, porosity, permeability, pore fluid chemistry, microbiology
- Characterize the near-borehole environment
  - Geophysical logging
  - Active testing for pore fluid pressure, stress, hydrogeologic properties (permeability, storage)
- Monitor the borehole environment over time
  - Passive and active source seismology
  - Strain and tilt
  - Pore fluid pressure
  - Temperature
  - EM field

Mega-Splay and Plate Interface Proposed Sites

Mega-thrust Site Observatory; Fault Zone Monitoring
- Pilot Hole coring/logging 0 - 1000 m
- Deepen Hole to ~6000 m TD
- Heavy use of LWD, limited coring
- Nested casing strings from 30” to 9 5/8”
- Sidetrack above mega-splay and core 2nd crossing of faults
- Active hydrological/stress experiments (DST, MDT)
- Completion - Install Observatory (proposed)
  - Multiple perforated, packer isolated intervals
  - Multiple sensor strings
  - Long-term fluid sampling (?)

Planned 3-D Seismic Reflection Survey
- Objectives: Image splay fault and decollement zone architecture, seismic attributes across up-dip limits
- Japan - US collaboration; to be funded by MEXT (CDEX, IFREE), NSF
- Acquisition tentatively planned for March-April 2006
- To be acquired through a commercial contract, with modern industry methods
Organization of NanTroSEIZE CDP

CDP = Complex Drilling Project, a category defined by SAS

- Overview Proposal is 603-CDP
  - Lead Proponents G. Kimura and H. Tobin
- 603-A: Splay Fault Sites
  - Lead Proponents M. Underwood and J. Ashi
- 603-B: Splay Fault Sites
  - Lead Proponents M. Kinoshita, K. Brown, P. Henry, and D. Saffer
- 603-C: Deep Plate Boundary Site
  - Lead Proponents H. Tobin, K. Suyehiro
- 603-D: Non-riser site Observatories
  - Lead Proponents E. Screaton and M. Underwood

Project Scoping Group set up by OpCom on recommendation from SPC in June, 2004

Present Status of NanTroSEIZE CDP Proposals

- Most of the proposed project is now through complete IODP scientific review
- CDP, Phases 1 and 2 ranked #2 and #3 globally by SPC in 2004, Phase 3 going to March SPC for ranking
- Awaits availability of drilling ship(s)

For more information:
http://ees.nmt.edu/nantroseize

One of Chikyu’s thrusters. Kochi University undergrads for scale.
Report of the NanTroSEIZE PSG

Sante Fe, New Mexico
February 24-25, 2005

Appendix C
CDEX Statement

Shin’ichi Kuramoto
(Science Service GL)

Feb. 24-25, 2005

A Proposed New Name
Instead of PSG

PROject Management & Planning Team

PROMPT

Schedule and Status

“CHIKYU” Construction & Operations Schedule

<table>
<thead>
<tr>
<th>2003</th>
<th>2004</th>
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<th>2006</th>
<th>2007</th>
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<td>318</td>
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<td>22,572</td>
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Construction of “CHIKYU”

Dec. > Sea Trial (3-8 & 18-25)
Data Management (SIO7)
(Science Information from 7 Oceans)

- Core Data Management
  J-CORES (JAMSTEC Core Systematics)
- Site Survey Data Management
  DEXIS (Deep Earth Exploration Information Service)

Visit our web site:
http://sio7.jamstec.go.jp/

Long-Term Borehole Observatory

NanTroSEIZE
Long-Term Borehole Observatory

- Deep Hole (~7 km)
- High Temperature (~150 °C)
- Pressure Control (Wellhead)
- Many Sensors (installation, Power Supply)
- Long Term (~5 yrs)
**System Overview**

Data rate & power consumption

<table>
<thead>
<tr>
<th>Component</th>
<th>Rate (kbps)</th>
<th>Power (W)</th>
<th>Capacity (Gbytes)</th>
<th>Storage (years)</th>
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<td>Data Set 3</td>
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<td>0.24</td>
<td>7.56864</td>
<td>1</td>
</tr>
</tbody>
</table>

**Typical Monitoring System**

- **Telemetry**
  - Module: Receives data from the sensors and processes it.
  - Controller: Controls the operation of the module.
  - Battery: Supplies power to the module.
  - Seabed recorder: Records the data for later analysis.
  - Downhole module: Sends data to the surface.

**Redundant Telemetry**

- Data Set 1
  - Telemetry project in 2004

**Schedule**

- 2003: Pre-Study
- 2004: Telemetry Design & Mock-up Experiment
- 2005: Recording System, Data Transfer System
- 2006-07: System Integration and Construction

**Task Flow**

- Pre-Spud Meeting
- HSE Review & Application
- Peer Review
- PSG Review
- Final Drilling Program

**Task Flow (general)**

- Conceptual Preparation
- Tender & Procurement
- Acquisition
- Power Management
- Telemetry project in 2004
Report of the NanTroSEIZE PSG

Sante Fe, New Mexico
February 24-25, 2005

Appendix D
JOI Alliance Report
United States Implementing Organization (USIO)

TIMELINE
- 4 Feb 05: Proposals due from ship operators
- Feb-Mar: Proposal evaluation
- Apr: Ship inspection tours
- May: Begin negotiations

FUNDING
- Currently a 3-year funding model
  - FY05: $15M (allocated)
  - Proposed budget to Congress
  - FY06: $55M (requested)
  - FY07: $40M (projected)

Current Project Plan targets ship operations by end of FY07
Report of the NanTroSEIZE PSG

Sante Fe, New Mexico
February 24-25, 2005

Appendix E
PROJECT SCOPING GROUP MANAGEMENT TEAM? MANDATE

GENERAL PURPOSE

The general purpose of the Project Scoping Group Team (PSG) is to plan and coordinate a Complex Drilling Project (CDP) in conjunction with the Implementing Organizations (IOs) and IODP-MI animal of OpTAF and to oversee the implementation of this multi-year, multi-expedition, and (potentially) multi-platform project. The PSG - Project Team ensures that the scientific objectives defined in the CDP proposal and by the Scientific Advisory Structure (SAS) are respected and works closely with IODP-MI, the IOs, and SAS to maintain maximum planning flexibility in order to respond to unfolding scientific developments throughout the lifespan of the CDP in a timely and cost-efficient manner.

Specific functions of a Project Scoping Group include:

- Assisting IODP-MI, the Implementing Organizations, and expedition Co-Chief scientists in the design of detailed implementation plans for all CDP phases.
- Integrating the proposed drilling, downhole measurement, and instrumentation plan with the overall scientific effort as described in the CDP proposal package and approved by the SAS.
- Defining, developing, and coordinating long-term observatory monitoring plans for the holes drilled during the project.
- Developing and overseeing critical paths and gateways to achieve the scientific objectives specified in the CDP proposal and approved by the SAS.
- Coordinating data output from disparate drilling and non-drilling related activities.
- Assisting IODP-MI and IOs with Education and Outreach activities.
- Reporting progress toward implementation of the CDP to the IODP management (via the IODP-MI Operations task force) on a regular basis.
- Providing expedition staffing advice to national offices.

MODE OF OPERATION

A. Initiation of Scoping Group:

A Project Scoping Group is constituted by IODP-MI through its Operations Task Force (formerly known as OPCOM). IODP-MI’s Operation Task Force may implement a Project Scoping Group for any expedition at any stage of its development if deemed necessary. Normally, for CDP proposals, the Operations Task Force may initiate a PSG after the Science Planning Committee (SPC) designates a proposal to be a Complex Drilling Project and subsequently recommends that the Operations Task Force evaluate the level of scoping (if any) required for the project.
B. Reporting
A Project Scoping Group reports directly to the IODP-MI Operations Task Force. The PSG will supply reports and updates on the status of its activity at each regularly scheduled IODP-MI Operations Task Force meetings but the PSG may be requested to supply reports more frequently as deemed necessary by the Operations Task Force.

The Operations Task Force Chair will be the formal PSG liaison to the SAS. The Operations Task Force Chair, in practice, may designate specific PSG members as liaisons to SAS committees.

C. Meeting Size:
In order to keep the meetings productive, efficient, and cost effective, Project Scoping Group meeting size will generally consist of the 7-8 Core Members, 2-5 IO technical representatives, 1-2 SAS representatives and 1-3 Guests.

D. Meeting Frequency:
Meetings will be held 3-4 times/yr or as deemed necessary by the Operations Task Force.

E. Membership: (maybe put this before “Meeting Size”)
A Project Scoping Group consists of (1) Core Members, (2) Implementing Organization Technical Representatives, (3) Science Advisory Structure Representatives, and (4) Guests.

Core Members
A group of 7-8 members, consisting of 3-4 community scientists (generally proposal proponents), 1-2 Implementing Organization representatives, and IODP-MI representatives comprise the permanent members of the PSG. These Core Members provide the long-term institutional memory for the PSG and are responsible for the primary planning and coordination of the CDP and carrying it through the multi-year, multi-leg, and multi-platform project. These Core Members determine the specific agendas for each PSG meeting.

The scientists will be selected from a pool of scientists recommended by the SAS. The Chair of the PSG will be the IODP-MI Manager of Operations.

Implementing Organization Technical Representatives.
Implementing Organization representatives with specific technical, operational, or engineering expertise for the IODP platforms that will be utilized during the project will participate in the PSG. These IO representatives will provide a primary point of contact for PSG Core Members in need of specific technical or operational expertise about the IO platform capability. The number and expertise of the IO representatives attending each meeting will depend on the agenda developed by the PSG Core Members.
Science Advisory Structure representatives
Science Advisory Structure representatives are invited to attend each PSG meeting. Normally, 1-2 SAS members attend the meetings.

Guests
Guests are invited by the Core Members (subject to approval by the PSG Chair) when the PSG needs specific technical, operational, engineering or scientific input not provided by the Core Membership, IO technical representatives, or Science Advisory Structure representative(s).
NanTroSEIZE Project Management Team Mandate

The purpose of the NanTroSEIZE Project Team is to plan and coordinate the implementation of the 603-CDP Complex Drilling Project (CDP), in conjunction with the Implementing Organizations (IOs) and IODP-MI. The Project Team is tasked with ensuring that the scientific objectives, as defined in the CDP proposal and by the Scientific Advisory Structure (SAS), are respected to the fullest possible extent while responding flexibly to the changing scientific and operational conditions encountered through the lifespan of the CDP in a timely and cost-efficient manner. The NanTroSEIZE Project Team will work closely with the Operations Task Force and Implementing Organizations to develop detailed operational plans.

Specific functions of the NanTroSEIZE Project Scoping Group include:

- Assisting IODP-MI, the Implementing Organizations, and expedition Co-Chief scientists in the design of detailed implementation plans for all CDP phases.
- Integrating the proposed drilling and instrumentation plan with the overall scientific effort as described in the CDP proposal package and approved by the SAS.
- Defining, developing, and coordinating long-term observatory monitoring plans for the project.
- Developing and overseeing critical paths and gateways to achieve the scientific objectives specified in the CDP proposal and approved by the SAS.
- Coordinating data output from disparate drilling and non-drilling related activities.
- Assisting IODP-MI and IOs with Education and Outreach activities.
- Reporting progress toward implementation of the CDP to the IODP management (via the IODP-MI Operations task force) on a regular basis.
Report of the NanTroSEIZE PSG

Sante Fe, New Mexico
February 24-25, 2005

Appendix F
Kumano-Nada 3-D Survey -@NanTro SEIZE PSG#2-

T.Yohro / CDEX
Feb.24&25,2005
@Santa Fe
U.S.A.

Objectives

• 1. Better Delineation of the Splay Faults
   and Other Tectonic Frameworks.

• 2. To Acquire the High-resolution Data
   to Detect the Possible Hazards before
   Drilling.

History of the “Nankai-3D” Progress

• * June,2004  “Nankai-3D” Workshop @ Rice
  Univ., Houston
• * Oct.,2004  PSG#1  @CDEX, Jamstec,
  Yokosuka
• * Dec.,2004  SED(Survey Evaluation of Design)
  to WesternGeco ordered by CDEX
• * January, 2005  SED Presentation by Tim
  Brice/WGC @ CDEX, Yokohama
• * Jan.,2005  SED Report to IFREE, Hawaii Univ.,
  UTIG & ORI by CDEX
• * Feb.,2005  PSG#2@SantaFe

Preliminary schedule of engineering site survey

- Preparation
- Drilling
- Integration

Pre-Survey Study
Miscellaneous Preparation
Data acquisition
Data processing
Evaluation

Exploration
2D seismic survey
3D seismic survey
Single channel seismic survey
Deep tow survey
(include sampling)
Met-ocean survey
Sea current survey
Riser analysis

FY2004
FY2005
FY2006

Analysis
Wellhead/Conductor stress analysis
Analysis
Integration
Seafloor surface image by WADATSUMI

Seafloor topography of the survey area

Planned PC locations

“Kumano-nada 3-D” Parameters

Source: Kairei seabeam data
Acquisition and processing

• Acquisition parameters
  – Offset
  – Spatial sampling (streamer spacing)
  – Record length
  – Shotpoint interval
  – Migration aperture
  – Source Volume, tow depths (source, cable)

• Sampling requirements
  – Sampling in shot, receiver and CMP domains
  – Demultiple

Recommended acquisition parameters

• Sample interval 2ms
• Number of cables 8*
• Cable length 8000m**
• Group interval 12.5m(640ch.)
• Cable separation 100m
• Shotpoint interval 37.5m
• Subsurface bin size Inline 12.5m, Crossline 25m(about 106 fold)
• Record length 13 seconds
• Source Single 3147 in³ array
  – Source depth 6m, cable depth 7m
• Migration aperture 3000m***

* Or maximum operationally possible
** See Section 3.2.1 Maximum offset
*** For full imaging of the shallow section

Noise and bandwidth

Source directivity
Required Logistics

• 1. Capable 3-D Seismic Vessel
• (Hopefully Time Sharing with Other Users)
• 2. Chase Boats (2-3)
• 3. Fishery Negotiation (2 Marine Advisers onboard)
• 4. QC Personnel Onboard
• *Acquisition, Head(1-2)
• *Navigation(1-2)
• *Processing(1-2)
• *Technical Auditing at the Start of the Survey?
• 5. Insurance

Project Scheme

• 1. IFREE, NSF & CDEX
• 2. How to put NSF fund in the Project?
• *NSF→Hawaii Univ.→Jamstec(CDEX)?
• 3. Agreement with the Seismic Contractors
• 4. Who will be Operator of the 3-D Project?
• 4. Timing of Commitment to the Contractor
• *Acquisition Parameters
• *Survey Area (before start of the survey)
• 5. How to Deal with Processing & Interpretation of the Data?
• 6. Funding?

Schedule Proposed

• 1. Specs. for Internal Bidding by CDEX
• 2. Pre-commitment to a Contractor for the Usage of 3-D Vessel in early 2006 (in Summer).
• 3. Data Processing Issues.
• 4. Finalization of the Agreements between the Partners.
• 5. Contract to a Contractor
• 6. Mobilization of the 3-D Vessel

The Next Gathering Proposed in S.E. Asia to Determine 3-D Seismic Parameters before Pre-Commitment to the Seismic Contractor

END
Report of the NanTroSEIZE PSG

Sante Fe, New Mexico
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Appendix G
Kumano-Nada 3-D
Sum-up PSG#2

Present Status & Future

1. NSF, IFREE & CDEX will make funding for the 3-D project:
   - NSF         about 2.5-3.0 MM $
   - IFREE
   - CDEX                     1 + 3.5? +

2. Timing of the 3-D Survey --- early 2006
3. The most critical thing is Mob-demobilization cost
   of 3-D vessel --- We will pursue the sharing with other
   user(s) in Japan. "Academic Discount"?
4. 3-D vessel --- PGS, Veritas, WesternGeco and/or CGG
   * Contact with WesternGeco has been proceeding
   * CDEX-Jamstec will be engaged in negotiation with the contractors
     toward the agreement.
5. Data processing is another issue --- time constraint, cost(budget)
6. G & M shipboard measurement at extra cost?
7. Input from the colleagues of U.S.major oil companies?
8. Next specific gathering in Singapore, May?(organized by CDEX)
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Appendix H
MINT: MeBo drilling & In situ-measurements in the Nankai Trough accretionary prism

Achim Kopf, Heiner Villinger, Tim Freudental
Research Centre Ocean Margins (RCOM)
Bremen University — GERMANY
Masa Kinoshita, Kiyoshi Suyehiro,Juishiro Ashi
JAPAN
Kevin Brown, Annette Deyhle, Mike Tryon
USA

Study area

Approach

1) MeBo drilling (including CPT)
2) SAPPI monitoring
3) CAT Meter
4) Heat flow probes
5) Free fall-CPT
6) Gravity sensing
7) other suggestions?

MeBo: Meeresboden-Bohrgerät, or seafloor operated drill

MeBo (2): onshore drilling test & liftoff
**MeBo (3): spec’s**

- 50 cm penetration (will be 100 cm in Phase 2)
- push coring and rotary coring modes (changeable depending on subbottom sed/rock met during drilling)
- 80 mm core diameter (50 mm diameter in Phase 2)
- CPT (cone penetration testing) optional to drilling
- lithologies from soft soils to carbonate, basalt, or other hard rocks
- water depth 2000 m (4000 m in Phase 2)
- tolerable seafloor roughness 1 m (between legs)
- shipped in standard 20’ containers (one for the drill, one for the control unit, telemetry, etc.)

**MeBo targets along line 5**

<table>
<thead>
<tr>
<th>NT3-01A</th>
<th>NT3-02A</th>
<th>NT3-02A</th>
</tr>
</thead>
</table>

**SAPPI (1)**

Satellite-linked Autonomous Pore Pressure Instrument

**SAPPI (2)**

Satellite-linked Autonomous Pore Pressure Instrument

Example: Preliminary pore P/T data from a mud volcano off Gibraltar

In situ measurements during MINT:
CAT meters (SIO, K. Brown/M. Tryon)
### In situ-measurements during MINT:

**Heat flow probes**, Bremen Univ. (H. Villinger)

**3 m lance**
- Tip with a standard 15 cm onshore CPT
- 12 V power pack (autonomous)
- Data acquisition 200 Hz, Memory: SmartMedia
- Penetration depth modular from 1 m to 5 m (1 m extension rods)
- Monitored parameters: pore pressure, tip resistance and sleeve friction (as a function of sediment shear strength), temperature, tilt after deployment
- Acceleration sensor allows for 1 cm resolution and better; range up to 5 g
- Weight 40 kg (1 m penetration) up to approx. 100 kg (5 m penetration)
- Depth of penetration is controlled via the length (i.e. total number of rods and the modular weight set at the head of the lance (one weight = 15 kg)
- Present lance capable of 200 m water depth; modified pore pressure sensors and seals will be available to cope with 2500 m, and will be available in fall 2005

### Additional heat flow sites during MINT

**Marine Free fall-CPT (cone penetration testing) Lance**
- Invasive and non-invasive CPT
- Tip resistance and sleeve friction (as a function of sediment shear strength)
- Tip resistance and sleeve friction data for cone penetration and later recovery
- Depth of penetration up to approx. 500 kg (15 m)
- Depth of penetration is controlled via the length (i.e. total number of rods and the modular weight set at the head of the lance (one weight = 15 kg)
- Depth of penetration is controlled via the length (i.e. total number of rods and the modular weight set at the head of the lance (one weight = 15 kg)
- Weight 40 kg (1 m penetration) up to approx. 100 kg (5 m penetration)
- Depth of penetration is controlled via the length (i.e. total number of rods and the modular weight set at the head of the lance (one weight = 15 kg)
- Depth of penetration is controlled via the length (i.e. total number of rods and the modular weight set at the head of the lance (one weight = 15 kg)
- Depth of penetration is controlled via the length (i.e. total number of rods and the modular weight set at the head of the lance (one weight = 15 kg)

### Other devices on board R/V Sonne

- **video-guided push corer**
- **gravity cores**
- **video-guided grab**

**Multibeam**
- Deep-towed video sledge
- MST track

### Vessel: R/V Sonne

- MINT cruise scheduled for April 2006
- US or Japanese R/V will pick up CAT meters and SAPP systems 12 months later
Discussion

- multiple cores needed with Melko?
- what physical properties are required to plan casing design?
- who will do leg 1, 2, or both?
- are there conflicts with other operations in the area, e.g. the anticipated 3D seismic reflection survey
- what other data would be desirable?
- do we have to feed the Site Survey Panel with more information?

- other aspects I may have missed ???
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Appendix I
## Site-by-Site Scoping Table

<table>
<thead>
<tr>
<th>Site</th>
<th>Planned TD</th>
<th>Primary targets</th>
<th>Predicted Geology</th>
<th>Coring Requirement</th>
<th>Downhole Measurements Desired</th>
<th>Monitoring Desired</th>
<th>Potential Challenge/Hazard</th>
</tr>
</thead>
<tbody>
<tr>
<td>NT1-01</td>
<td>570 mbsf</td>
<td>1. Lower Shikoku Basin facies 2. Basement</td>
<td>0-255 mbsf: Upper Shikoku Basin facies; hemipelagic mud and volcanic ash 255-470 mbsf: Lower Shikoku Basin facies; hemipelagic mud; boundary between USB and LSB not clearly defined 470-570: basalt</td>
<td>Continuous coring to TD</td>
<td>Full-suite of LWD logs, wireline sonic log and resistivity imaging log if possible. DST, VSP, CHDT-type tests. Drillstring packer tests. DVTP-P or Piezoprobe style temperature and pressure measurements in shallow seds.</td>
<td>1A. Screen basement for P, T 1B. Screen LSB sediment for P, T 2A. Osmosampler in basement 2B. Osmosampler in LSB sediment 3. Seismometer and/or tilt meter</td>
<td>None</td>
</tr>
<tr>
<td>NT1-02</td>
<td>775-820 mbsf (depends on which seismic line is used to locate site)</td>
<td>1. Lower Shikoku Basin facies 2. Basement</td>
<td>0-290 mbsf: distal trench-wedge facies, trench-to-basin transition; fine sand to silt turbidites and hemipelagic mud 290-405 mbsf: Upper Shikoku Basin hemipelagic mud and volcanic ash 405-700 mbsf: Lower Shikoku Basin hemipelagic mud and thin turbidites 700-800 mbsf: basalt</td>
<td>Continuous coring to TD</td>
<td>Full-suite of LWD logs, wireline sonic log and resistivity imaging log if possible. DST, VSP, CHDT-type tests. Drillstring packer tests. DVTP-P or Piezoprobe style temperature and pressure measurements in shallow seds.</td>
<td>1A. Screen LSB sands for P, T 1B. Screen basement for P, T 2A. Osmosampler in LSB sands 2B. Osmosampler in basement 3. Seismometer and/or tilt meter</td>
<td>1. Possible unstable sands in LSB facies</td>
</tr>
<tr>
<td>Site</td>
<td>Planned TD</td>
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</tr>
</tbody>
</table>
| NT1-03 | 1600 mbsf (potential reduction to 800 – 1400 m??) | 1. Frontal thrust  
2. Décollement  
3. Lower Shikoku Basin facies beneath décollement | 0-250 mbsf: Upper Shikoku Basin facies; lithified hemipelagic mudstone and volcanic ash  
250 mbsf: frontal thrust  
250-550 mbsf: Axial trench-wedge facies; uncemented turbidite sand, silt, hemipelagic mud  
550-1100 mbsf: Outer trench-wedge facies, thins and fines down-section  
1100-1400 mbsf: Upper Shikoku Basin facies, hemipelagic mudstone and volcanic ash  
~1380 mbsf: Stratigraphic position of décollement, but not clearly defined  
1400-TD: Lower Shikoku Basin turbidite facies, compacted sand and hemipelagic mudstone | Continuous coring to TD | Full-suite of LWD logs, wireline sonic log and resistivity imaging log if possible. DST, VSP, CHDT-type tests. Drillstring packer tests. DVTP-P or Piezoprobe style temperature and pressure measurements in shallow seds. | 1A. Screen décollement for P, T  
1B. Screen sands in underthrust for P, T  
2A. Osmosampler in décollement  
2B. Osmosampler in sands below décollement  
3. Seismometer  
4. Basement monitoring | 1. Unstable hole conditions due to fractured and brecciated rock  
2. Unstable sands beneath frontal thrust  
3. Possible water overpressures in fault zone(s)  
4. Possible overpressured sands beneath décollement  
5. TD could be too deep to reach without casing and heavy mud |
<table>
<thead>
<tr>
<th>Site</th>
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</tr>
</thead>
</table>
| NT1-04*| To be determined | Monitoring site for strain transients; signal quality improves as lithification increases; basement not required | 0-650 mbsf: Axial to distal trench-wedge facies; un cemented sand, silt, hemipelagic mud 650-1600 mbsf: Upper to Lower Shikoku Basin deposits; facies boundary not well defined | Continuous coring to TD | Full-suite of LWD logs. Drillstring packer tests. DVTP-P or Piezoprobe style temperature and pressure measurements in shallow seds. | 1. Screen trench-wedge sands for P, T  
2. Screen LSB sands for P, T  
3. Seismometer or tilt meter | 1. Unstable sands in axial trench-wedge facies  
2. Site is within axial channel-levee complex  
3. Unstable sands in LSB turbidite facies |
| NT1-05* (alternative for NT1-04) | To be determined | Monitoring site for strain transients; signal quality improves as lithification increases; basement not required | 0-380 mbsf: Axial trench-wedge facies; un cemented sand, silt, hemipelagic mud 380-730 mbsf: Distal trench wedge and trench-to-basin transition; facies boundary not well defined 730-900 mbsf: Upper Shikoku Basin facies; hemipelagic mud and volcanic ash 900-1300 mbsf: Lower Shikoku Basin turbidite deposits; facies boundary not well defined | Continuous coring to TD | Full-suite of LWD logs. Drillstring packer tests. DVTP-P or Piezoprobe style temperature and pressure measurements in shallow seds. | 1. Screen trench-wedge sands for P, T  
2. Screen LSB sands for P, T  
3. Seismometer or tilt meter | 1. Unstable sands in axial trench-wedge facies  
2. Unstable sands in LSB turbidite facies |
<table>
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<tr>
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<th>Monitoring Desired</th>
<th>Potential Challenge/Hazard</th>
</tr>
</thead>
</table>
| NT1-06*     | 1090 mbsf  | 1. Lower Shikoku Basin facies  
2. Basement                          | 0-450 mbsf: Distal trench-wedge facies extends seaward into Shikoku Basin; basal transition not well defined  
450-600 mbsf: Upper Shikoku Basin facies; hemipelagic mud and volcanic ash; basal transition not well defined  
600-990 mbsf: Lower Shikoku Basin turbidite facies; uncemented sand and hemipelagic mud  
990-1090 mbsf: basalt basement | Continuous coring to TD | Full-suite of LWD logs, wireline sonic log and resistivity imaging log if possible. DST, VSP, CHDT-type tests. Drillstring packer tests. DVTP-P or Piezoprobe style temperature and pressure measurements in shallow sed. | 1A. Screen LSB sands for P, T  
1B. Screen basement for P, T  
2A. Osmosampler in LSB sands  
2B. Osmosampler in basement  
3. Seismometer and/or tilt meter | 1. Unstable sands in distal trench-wedge facies  
2. Unstable sands in LSB turbidite facies |
<table>
<thead>
<tr>
<th>Site</th>
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<th>Potential Challenge/Hazard</th>
</tr>
</thead>
<tbody>
<tr>
<td>NT2-01</td>
<td>1085 mbsf</td>
<td>Characterization of splay fault under shallow condition</td>
<td>0-1085m: deformed turbidite and hemipelagic sediments 0.3 sec and 1 sec: Possible intersection with fault gouge and fracture zones</td>
<td>Continuous coring at 0-1085 m</td>
<td>LWD, wireline logging of sonic and resistivity images, density, etc. DVTP-P probe, wireline packer tests, VSP Cross-hole hydrologic exp.</td>
<td>1. Pressure and Temperature at the splay fault interval at 1 sec TWT. 2. Seismometer clamped near the splay fault 3. High-res. Tiltmeter and strainmeter cemented at bottom-hole (1100m)</td>
<td>1. Possible free gas although no BSR recognized yet 2. Unstable hole conditions due to fractured and brecciated rock, possibly with water overpressure at fault zones (0.3s and 1s)</td>
</tr>
<tr>
<td>NT2-02</td>
<td>685/2140 / 2190 mbsf</td>
<td>Characterization of splay fault under intermediate depth condition</td>
<td>0-2190m: deformed turbidite and hemipelagic sediments 685m, 2140m 2190 m: Possible intersection with fault gouge and fracture zones</td>
<td>Continuous coring at 0-2190 m</td>
<td>LWD, wireline logging of sonic and resistivity images, density, etc. DVTP-P probe, wireline packer tests, VSP</td>
<td>1. Pressure and Temperature at the splay fault interval at 1 sec TWT. 2. Seismometer clamped near the splay fault 3. High-res. Tiltmeter and strainmeter cemented at bottom-hole (1100m)</td>
<td>1. Possible free gas although no BSR recognized. 2. Unstable hole conditions due to fractured and brecciated rock, possibly with water overpressure at fault zones (685/2140/2190m )</td>
</tr>
<tr>
<td>NT2-03</td>
<td>3150 mbsf</td>
<td>Characterization of splay fault under deep condition</td>
<td>0-3150m: deformed turbidite and hemipelagic sediments Splay fault zone expected near the bottom but not confirmed in MCS profile</td>
<td>1. Continuous coring at 0-3150 m, or 2. Coring near the fault zones 3000m-TD</td>
<td>LWD, wireline logging of sonic and resistivity images, density, etc. DVTP-P probe, wireline packer tests, VSP</td>
<td>1. Pressure and Temperature at the splay fault interval at 1 sec TWT. 2. Seismometer clamped near the splay fault 3. High-res. Tiltmeter and strainmeter cemented at bottom-hole (1100m)</td>
<td>1. Possible free gas although no BSR recognized, possibly at 0.3sec bsf. 2. Unstable hole conditions due to fractured and brecciated rock, possibly with water overpressure at fault zones (~3150m)</td>
</tr>
<tr>
<td>Site</td>
<td>Planned TD</td>
<td>Primary targets</td>
<td>Predicted Geology</td>
<td>Coring Requirement</td>
<td>Downhole Measurements Desired</td>
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</tr>
<tr>
<td>NT2-04</td>
<td>1300 mbsf</td>
<td>Total history of the splay fault through continuous coring the Kumano basin sediments and pilot drilling for riser platform</td>
<td>0-1300m: Poorly consolidated basinal sediments, turbidites and hemi-pelagic (sands and muds) ~500m: Unconformity</td>
<td>Continuous coring at 0-1300m</td>
<td>LWD, wireline logging of sonic and resistivity images, density, etc. DVTP-P probe, wireline packer tests, VSP</td>
<td>Observatory at this site has been proposed on 603D</td>
<td>1. Possible free gas zone associated with Gas hydrate reflector at 0.3 sec bsf.</td>
</tr>
<tr>
<td>Site</td>
<td>Planned TD</td>
<td>Primary targets</td>
<td>Predicted Geology</td>
<td>Coring Requirement</td>
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<tr>
<td>NT3-01</td>
<td>6200 mbsf (maybe closer to 5600 mbsf)</td>
<td>1. Base of Kumano Basin section 2. Mega-splay fault zone 3. Top of oceanic crust (presumed plate decollement fault zone)</td>
<td>0 – 1000 m: Poorly consolidated basinal sediments, turbidites and hemi-pelagic (sands and muds) 1000 – 3600 m: consolidated and deformed rocks of upper accretionary prism domain, mainly shales to sandstones 3600 – 6000 m: consolidated and deformed rocks of the lower accretionary prism domain, probably mostly shaly hemipelagic rock, with possible basalts, cherts, and sandstones 6000 – 6200 m: pillow basalt, volcaniclastic sediments,</td>
<td>1. Continuous coring from 0-1500 m 2. Intervals of coring TBA from 1500 - ~4000 m 3. Continuous coring from ~4000 to 5600 m. 4. Cuttings analysis throughout.</td>
<td>Full-suite of LWD logs, wireline sonic log and resistivity imaging log if possible (inside casing sonic?), DST, VSP, CHDT-type tests. Wireline packer tests after perforation. DVTP-P or Piezoprobe style temperature and pressure measurements in shallow seds.</td>
<td>1. Multi-level (up to 6) packer isolated perforated zones: basement, decollement, above decollement, beneath splay fault, splay fault, above splay fault. 2. Seismic array: 10 to 100 3 component short-period sensors clamped in borehole; 1 BroadBand at bottom of hole, cemented into place. 3. High-resolution tiltmeters at 4-5 levels spanning 2000 – 6000 mbsf. 4. Temperature measurements spanning fault zone intervals (3500? – 6000 mbsf) 5. Volumetric strainmeter cemented in outside casing at base of hole, (other levels if possible). 6. Fluid sampling over time (osmosamplers)? 6. EM conductivity/potenti</td>
<td>1. Possible free gas zone associated with Gas hydrate reflector at 0.3 sec bsf. 2. Possible unstable sands in upper 100s mbsf. 3. Unstable hole conditions due to fractured and brecciated rock, possibly with water overpressure at fault zones, at several depths 4. Sidetracking of hole for 2 or more fault crossings.</td>
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<td>all measurements?</td>
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</tbody>
</table>
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Appendix J
NanTroSEIZE: The Nankai Trough Seismogenic Zone Experiment

Phase 1. Reference Sites
- Michael Underwood (Univ. Missouri)
- Juichiro Ashi (Univ. Tokyo)

Ocean Reference Sites

- How does basement structure affect stratigraphic architecture of the NE Shikoku Basin?
- How does the physical hydrology of Shikoku Basin respond to variations in turbidite sand bodies and basement structure?
- How do fluids in igneous basement affect subduction processes?
- How have system-wide patterns of sediment dispersal affected sand-clay composition within the trench wedge and Shikoku Basin, particularly on the NE side of the fossil spreading ridge?
- How do thermal structure and primary sediment/rock composition modulate diagenesis, cementation, and fluid-rock interactions?

SITE NT01-01 (BASEMENT HIGH)

Top of LSB facies = 255 mbsf (0.3 s)
Sediment-basalt interface = 470 mbsf (0.55 s)
Basement penetration = 100 m

SITE NT01-02 (BASEMENT PLAIN)
Top of LSB facies = 405 mbsf (0.45 s)
Sediment-basalt interface = 675-720 mbsf (0.75-0.80 s)
Basement penetration = 100 m

Top of USB facies = 450 mbsf (0.5 s); top of LSB facies = 600 mbsf
Sediment-basalt interface = 990 mbsf (1.10 s)
Basement penetration = 100 m

Advantage: better LSB turbidite stratigraphy
Disadvantage: farther from NT01-01 for linked hydrogeology

Questions:
Along which stratigraphic interval does plate-boundary fault propagate?
Is frontal scarp the plate boundary or the first imbricate?
What processes govern early deformation?
Through which stratigraphic interval does the décollement propagate near the Kii deformation front?

Which factor(s) control(s) the initial position of the fault tip at the prism toe, as well as the location of ramps and flats, and mechanical behavior throughout?

Are strike-parallel changes from a "stronger" décollement to a "weaker" plate boundary influenced or controlled by inherited differences between subducting basement highs and subducting basement plains?

How do intrinsic geotechnical properties (coeff. internal friction) balance against effective stress (excess pore pressure) above, within, and below décollement?

Depth section reprocessed by Greg Moore (Hawaii)

Crossing line is close enough - if we provide structure map.

Frontal thrust = 250 mbsf
Base of trench-wedge = 1100 mbsf
Top of LSB facies = 1400 mbsf
Décollement = 1380 mbsf
Sediment-basalt interface = 1950 mbsf
Depth to basement = 1600 m
Location is within axial channel-levee complex
No specific stratigraphic target (monitoring strain transients)

Depth to basement = 1300-1400 m
No specific stratigraphic target (monitoring strain transients)

Depth to basement = 1125 m
No specific stratigraphic target
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Appendix K
Safety Package for IODP Proposal 603B-Full2: NanTroSEIZE Drilling and Observatory Phase 2
Mechanical and Hydrologic State of Mega-Splay Faults: Implications for Seismogenic Faulting and Tsunami Generation

Masa Kinoshita
Harold Tobin
Mike Underwood

Scientific Objectives and Approaches
• Goal: to characterize the magnitude and nature of strain accumulation and slip along mega-splays off the Kii peninsula
• (1) Coring of 1 site in the Kumano Basin, focused on characterizing the tectonic history of the plate above the mega-splay faults
• (2) intersection of the active mega-splay fault system at three depths at ~1, ~2 and ~3.5 km below sea-floor, for downdip evolution study of fault material properties
• Installation of long-term borehole monitoring instruments

Principal Scientific Objective of NanTroSEIZE
To acquire data bearing on and testing the following key hypotheses:
1. Systematic, progressive material and state changes control the onset of seismogenic behavior on subduction thrusts.
2. Subduction zone megathrusts are weak faults.
3. Within the seismogenic zone, relative plate motion is primarily accommodated by coseismic frictional slip in a concentrated zone.
4. Physical properties, chemistry, and state of the fault zone change with time during the earthquake cycle.
5. The mega-splay (OOST) thrust fault system slips in discrete events which may include tsunamigenic slip during great earthquakes.

Sampling and in-situ monitoring by the deep drilling is NECESSARY to test these hypotheses.

The M>8 events occur along the plate boundary fault and/or the mega-splay.
Why Line L instead of Line B?

Micro Seismicity in the Nankai Trough off Kumano (Obana et al., 2002)

Very little seismicity. Implication of 100% locked zone.

How do we test hypotheses?

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Core analysis</th>
<th>Logging DHM</th>
<th>Observatory</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. MS is locked</td>
<td>Sedimentary sequence</td>
<td></td>
<td>Slip rate</td>
</tr>
<tr>
<td></td>
<td>dating</td>
<td></td>
<td>Strain acum.</td>
</tr>
<tr>
<td>2. MS is weak</td>
<td>Microstructural analysis</td>
<td>RAB</td>
<td>Strain/Seism.</td>
</tr>
<tr>
<td></td>
<td>Multi-holes</td>
<td>DVTP-P VSP</td>
<td></td>
</tr>
<tr>
<td>3. Prop. change w/P-T,</td>
<td>Microstructural analysis</td>
<td>RAB</td>
<td>P/T</td>
</tr>
<tr>
<td>become unstable</td>
<td>Multi-holes</td>
<td>DVTP-P VSP</td>
<td></td>
</tr>
<tr>
<td>4. Hydrological connection</td>
<td>Permeability</td>
<td>Porosity VSP</td>
<td>P/T</td>
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<td>Fluid chem.</td>
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<tr>
<td>5. Prop. change with time</td>
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<td></td>
<td>All</td>
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</tbody>
</table>

Site-by-site description

Preliminary Waiting for 3D data.
NT2-01A/B: Shallow branch of splay fault

NT2-02A: Intersecting the splay fault at 2 km bsf

Interpretation at Line ODKM3-13 (by Harold Tobin)

NT2-06A/B: Shallow branch of splay fault

NT2-03A: Mega-splay at ~ 3 kilometers

NT2-04A: Kumano basin uplift history
NT2-07A: Intersecting the splay fault at 2 km bsf

Intersecting the splay fault at 2 km bsf.

MPa Peff, btm OD KM3-B and 14 Crosslines LWD/DVTP/CORK DM degC Temp, btm Full Coring 675 / 845 mbsf TD 2260 m Water Depth

NT2-08A: Mega-splay at ~ 3 kilometers

Mega-splay at ~ 3 kilometers.

MPa Peff, btm OD KM3-B and 11 Crosslines LWD/DVTP/Drill stem/RFT/Boreswell observatory DM degC Temp, btm Yes Full Coring 2910 mbsf TD 2170 m Water Depth

JAMSTEC MCS line ODKM03-L preliminary depth section. Pre-stack depth migration was conducted by CDEX, with simple velocity structure. Greg Moore (Univ. Hawaii) and Yasuyuki Nakamura (U. Tokyo) are now working on their own processing and interpretation. As of this writing, locations of the splay faults are uncertain at NT2-03A, a major reason why the 3D survey has been proposed.

Proposed 3-D Seismic Reflection Survey

- Proposed US-Japan collaboration, funded by CDEX, MEXT (IFREE), NSF, other?
- To be acquired through a commercial contract, with modern industry methods
- Goal is to collect one survey that satisfies engineering needs and science needs
  - Engineering: 3D control on high-resolution geology, velocity structure for well design
  - Science: Splay fault and decollement architecture, seismic attributes
- U.S. Proposal is pending with NSF now (Moore, Bangs, Tobin, Saffer, and Gulick are PIs), Japanese funding also under discussion
- … perhaps early 2006?

Potential Safety Issues

- Clathrate and Hydrocarbon
- Man-made Hazards
- Kuroshio current
- Typhoon / Rough weather
- Anomalous formation pore pressure

Heat Flow across the Nankai Trough off Kumano

Inferred thermal structure (Preliminary result by Kevin Wang)
Regional Clathrate and Hydrocarbon Occurrences

- Low TOC, T<100degC (NT2-03A)
  - Not probable for thermogenic gas
- Methane Hydrate – BSRs widely exist at ~400 mbsf
- MITI drilling in 1999-20

MITI Drilling

- Methane hydrate as a pore-filling form
- Saturation up to 80 %
- Methane hydrate-bearing turbiditic sand layers are less than 1 m thick, with a total thickness of 12.4 m

Potential Man-made Hazards

- Dumpsites
  - no knowledge of dumpsites in this area
- Undersea Cables
  - Cable positions are known, and all of the proposed sites are far enough from the cables

Deep-sea cables (MCS tracks also shown)
The Kuroshio Current

Three typical flow patterns of Kuroshio. 1:2 NML, 3:LM.

Typhoons and Low pressure front in winter

- Typhoons often occur in July through September. On average we encounter 11 typhoons per year within 300 km of Japanese coast. Pathways of typhoon changes with time, and in September it comes along the southern coast of Japan.
- In winter we encounter low pressure frontal lines, which cause strong wind and high wave. Thus the best time window for the drilling operations is April through August.

Overpressured fault zones or footwall blocks
Water, not gas, is expected.

Pore pressure may not be a problem….

Other specific issues for EPSP

- A slope angle (~15 deg) of the seafloor at site NT2-03A
- Potential landslides caused by an earthquake
  - In September 2004, during the cruise KY04-11 using JAMSTEC R/V "KAIYO", we observed the seafloor near the epicenter of M7.4 earthquake that occurred only two weeks before. The seafloor was so turbid and the sediment was so soft, implying the occurrence of turbidity flow after the earthquake.

Cold-seep community
Numerous surveys conducted
Submersibles
Surface ships
Cliff found during KR02-10 cruise in the Kumano forearc region
NSS Video if time allows

In order to clear these safety issues, we have to cooperate with I/O (TAMU/CDEX), with advise from EPSP.

Long-term Variation of Bottom-water Temperatures

Water Temperature Variation on the seafloor

NanTroSEIZE Phase 2 proposed sites (As of Apr 1, 2003)
The Kuroshio Current
Can be >4 knts
Largely depends on the season

Interpretation by CDEX

The Kuroshio Current
Can be >4 knts
Largely depends on the season

Interpretation by CDEX

Scientific Objectives
- Determination of evolution, long-term slip rate and strain accumulation on mega-splay faults
- Determination of systematic changes in mega-splay and wall-rock structural architecture, composition, and state with (a) increasing temperature and pressure, and (b) time.
- Quantification of hydrologic properties and source of fluids along mega-splays and wall rocks
- Defining the location of microseismicity and locked fault segments, and their relationship to plate boundary fault system architecture (i.e. on which faults and at what depths do events occur?)

Phase 2: Drilling and observatory into the mega-splay
M. Kinoshita, K. Brown, D. Saffer, P. Henry et al.
(1) Characterize the magnitude and nature of strain accumulation and slip along mega-splays off the Kii peninsula
(2) Sample and instrument the mega-splay fault system at a range of P-T conditions from ~1-3.5 km bsf.
- intersection of the active mega-splay fault system at three depths from ~1 to ~3.5 km bsf (down dip evolutionary studies from stable to unstable slip).
- coring in the Kumano Basin (evolution of the mega-splay)
- Long-term observatory of Geodesy, seismology and hydrology
- Pilot hole for phase 3
How do we test hypotheses?

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Core analysis</th>
<th>Logging</th>
<th>DHM</th>
<th>Observatory</th>
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<tr>
<td>1. MS is locked</td>
<td>Sedimentary sequence</td>
<td>High-res dating</td>
<td>Slip rate</td>
<td>Strain accum.</td>
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<tr>
<td>2. MS is weak</td>
<td>Microstructural analysis</td>
<td>Multi-holes</td>
<td>RAB DVTP-P</td>
<td>Strain/Seism.</td>
</tr>
<tr>
<td>3. Prop. change w/P-T, become unstable</td>
<td>Microstructural analysis</td>
<td>Multi-holes</td>
<td>RAB DVTP-P VSP</td>
<td>P/T</td>
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<tr>
<td>4. Hydrological connection</td>
<td>Permeability Fluid chem.</td>
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<td>P/T</td>
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<tr>
<td>5. Prop. change w/time</td>
<td>All</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Proposed plan for the borehole long-term monitoring station

Based on:
1) discussion by the scientific community
2) conceptual design by CDEX

Now being reviewed externally for its SCIENTIFIC relevance, not technical feasibility.

Drillable window: Water ≤ 2.5 km + Plate Interface ≤ 7000 m subbottom

Sample and instrument at the up-dip limit of seismogenic

Phase 0: Geophysical/Geologic Characterization
Phase 1: Incoming section and crust
Phase 2: Mega-splay fault to ~ 3500 m
Phase 3: Plate interface to ~ 6200 m
Report of the NanTroSEIZE PSG

Sante Fe, New Mexico
February 24-25, 2005

Appendix L
NT3-01: Deep 6k Site

Megathrust Site Observatory: Fault Zone Monitoring

- Pilot Hole coring/logging 0 - 1000 m
- Deepen Hole to ~6000 m TD
  - Nested casing strings back 20' to 9 5/8" heavy
  - Sidetrack above mega-splay and core 2nd crossing of faults
- Active hydrological/stress experiments (DST, MDT)
- Completion - Install Observatory (proposed): multiple perforated, packer isolated intervals, multiple sensor strings, long-term fluid sampling (?), real-time data transmission via proposed sea floor cable network

NT3-01

- Water depth 1950 m
- Planned TD ~6200 mbsf (possibly ~5600 mbsf, depends on improved velocity model)
- Major targets:
  - Bottom of Kumano basin section at 1000 mbsf
  - Mega-splay fault main strand at ~4500 mbsf
  - Top of basement and presumed decollement at 5500 - 6000 mbsf
  - 200 m of basement penetration

NT3-01

- Expected geology:
  a) 0-1000 mbsf: High porosity turbidite and hemipelagite of Kumano basin (muds and sands), poorly consolidated
  b) 1000 - 3600 mbsf: consolidated accretionary prism rocks, mostly mudstone (shale) and some sandstone, faults and veins
  c) 3600 - 6000 mbsf: consolidated sedimentary rock of lower prism, probably mostly shales, possible minor basalts, cherts
  d) 6000 - 6200 mbsf: pillow basalts, basaltic/gabbroic basement, volcanioclastic sandstone.
Coring and Logging
(to be finalized; this is from proposal)

• Coring:
  – Continuous core 0 - 1500 mbsf.
  – Some intervals of coring from 1500 - 4000 mbsf, to be determined by time available
  – Continuous coring from 4000 - 6200 mbsf, only after LWD track completed.

• Logging:
  – LWD entire site, with best available LWD suite.
  – Wireline for special logs if possible, e.g., sonic, FMI, (sonic inside casing?)

Long-term monitoring

• Multi-level (up to 6) packer isolated perforated zones: basement, decollement, above decollement, beneath splay fault, splay fault, above splay fault.
• 2. Seismic array: 10 to 100 3 component short-period sensors clamped in borehole; 1 BroadBand at bottom of hole, cemented into place.
• 3. High-resolution tiltmeters at 4-5 levels spanning 2000 – 6600 mbsf.
• 4. Temperature measurements spanning fault zone intervals (3500? – 6000 mbsf)
• 5. Volumetric strainmeter cemented in outside casing at base of hole, (other levels if possible).
• 6. Fluid sampling over time (osmosamplers)?
• 7. EM conductivity/potential measurements?

Downhole Measurements
(during operations)

• Drill Stem Test, wireline packer tests of pore fluid pressure, permeability, hydrofrac stress at several levels
• MDT or CHDT style test for pressure, fluid sample
• DVTP-P or Piezoprobe tests in shallow seds for P, T.

Megathrust Site Observatory:
Fault Zone Monitoring

• Pilot Hole coring/logging 0 - 1000 m
• Deepen Hole to ~ 9000 m TD
  – Heavy use of LWD, limited coring
  – Lateral core from 0 to 18" to 26.5" in 6 ft segments
• Sidetrack above mega-splay and core 2nd crossing of faults
• Active hydrological/stress experiments (DST, MDT)
• Completion - Install Observatory (proposed):
  – Multiple perforated, packer isolated intervals
  – Multiple sensor strings
  – Active monitoring fluid sampling (DST)
  – Long-term fluid sampling (?)
  – Real-time data transmission via proposed sea floor cable network
Report of the NanTroSEIZE PSG

Sante Fe, New Mexico
February 24-25, 2005

Appendix M
A Possible Flow of Operations

Only a rough idea, to start thinking...

Assume we begin in year 20XX.
What will we do first, second, third... etc.?

Guiding Principles

- Start with easier things, work up to bigger challenges.
- Build time into schedule between Operation Stages, to use data to adjust next stages.
- Try simple observatories first, work up to complex installations. Test technologies in simple versions.
- Build for flexibility. Assume boreholes can be used for many years, but instruments will fail.
- Identify critical decisions that will affect later operations (e.g., casing, well-head, cemented instruments). Plan these carefully.

Stage 1 -
Drill and core non-riser:

- NT1-01 to TD - core, LWD
- NT1-06 to TD - core, LWD
- NT1-03 to 550 m - (same)
- NT3-01 upper ~1000 m - Kumano basin seds plus 200 m prism unit (core + LWD)
- NT2-04 (1300 m version) - core, LWD, emplace simple CORK to measure (one-level) P and deploy temperature string.

No other CORKing, case only as necessary for non-riser drilling

Stage 2: More non-riser, Some CORK-style installations

- NT2-01 A/B:
  - Drill, core and log A hole
  - case and install basic pore pressure, 1 seismometer observatory in A hole
  - Drill, wireline packer test in B hole
- NT2-02: possible merge with NT2-03???
  - Drill, core and log (LWD?) no observatory (?)
- NT2-03:
  - Drill, log, core upper ~1000 m (prep for riser)
- NT1-01, NT1-02:
  - Return for observatory installations
Expedition 3: Riser 3000 Site
- NT2-03:
  - Deepen to 3150 m TD, combination of some coring and some LWD, casing as we go [strainmeter(s)?]
  - Install initial “simple, retrievable” observatory
    - What is it?

Expedition 4: Riser 6000 Site
- NT3-01:
  - Deepen to ~6000 m TD with LWD, casing
  - Sidetrack to take continuous core across faults (bottom - cement strainmeter?)
  - Install removable “simple” observatory

Go Away! Think about data. Record on seismic array. Wait. Think some more. Lay out final instrument. Configuration for 2 deep observatories (3.5 km and 6 km holes)

Expedition 5: Install Full Deep Monitoring System
- NT2-03 and NT3-01:
  - Deploy “final” monitoring system in boreholes.

Stage 6
- Record glorious data until we are all very old...
Report of the
NanTroSEIZE PSG

Sante Fe, New Mexico
February 24-25, 2005

Appendix N
### Long-term Observatory WG: Member Responsibility

- **Overall Design / Integration**
- Sensor configuration plan, including seafloor network (S)
- Specifications for each sensor (S)
- Integration of hydrological and geodetic/seismological observatories (IO)
- Engineering development as IODP-SOC (IMI)
- Behind-casing technique (IMI)
- Casing vs. clamping (S/IO)
- Prioritization (IMI)
- Implementation Plan (Platform, schedule, etc.) (IO)

### Hydrological observatory
- Specifications for each sensor (S)
- Integration of hydrological and geodetic/seismological observatories (IO)
- Engineering development as IODP-SOC (IMI)
- Behind-casing technique (IMI)
- Casing vs. clamping (S/IO)
- Prioritization (IMI)
- Implementation Plan (Platform, schedule, etc.) (IO)

### Geodetic observatory
- Estimation of overpressure status (S)
- Wellhead and conductor/hydraulic feed-through (IO)
- Casing and perforation (IO)
- Cementing (IO)
- Telemetry (IO)
- Strainmeter development (S)
- Tiltmeter development (S)
- Data acquisition and maintenance (S)

### Seismological observatory
- Wellhead and conductor/hydraulic feed-through (IO)
- Clamping (IO)
- Power consumption
- Number of sensors, arrangement
- Geochemical observatory
- EM observatory

### Options for infrastructure
- CORK/ACORK / ODP Geodetic holes (Phase 1)
- CDEX plan (Phase 2, not enough though)
- One observatory with composite holes (Phase 3)
- Major engineering development of the wellhead, allowing for sensor installation at many intervals
- Simple design assuming no downhole overpressure (accurate pressure estimate req.)

---

**PSG Request for prioritization of the borehole observatory engineering development**

NanTroSEIZE Long-term observatory WG

- We understand that the infrastructure of the drilled hole, including casing or wellhead, will be taken care of by the POC money of IODP. However, engineering development must be investigated as SOC. Therefore, we ask IODP-MI and SAS (EDP) to consider long-term monitoring systems and borehole system integration as a high priority for SOC engineering development.
CORK

This is an extension of current technology achieved by ODP. Basically we intend to apply this installation for a hydrogeological observatory, but potentially geodetic sensors may be added. This is to be installed at reference sites and NT02-01A. This is the simplest and easiest solution for NanTroSEIZE shallow sites (<1000m).

A-CORK

Options for infrastructure

- CORK/ACORK / ODP Geodetic holes (Phase 1)
- CDEX plan (Phase 2, not enough though)
- One observatory with composite holes (Phase 3)
- Major engineering development of the wellhead, allowing for sensor installation at many intervals
- Simple design assuming no downhole overpressure (accurate pressure estimate req.)

Borehole Strain, tilt and seismometers

Data rate & power consumption

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<tr>
<th>Component</th>
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<th>Number of levels</th>
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</table>

CDEX Plan

For Phase 2 Observatory

Hydrogeology + Seismology + Geodesy
At 0-3.5 kmbaf
Technical challenges
* Cementing
* Telemetry

→ Needs practical
Options for infrastructure

- CORK/ACORK / ODP Geodetic holes (Phase 1)
- CDEX plan (Phase 2, not enough though)
- One observatory with multiple holes (Phase 3)
- Major engineering development of the wellhead, allowing for sensor installation at many intervals
- Simple design assuming no downhole overpressure (accurate pressure estimate req.)
Proposed plan for the borehole long-term monitoring station

**Challenges**

* Geodetic sensors cemented at multi-levels (wellhead/cementing/casing)
* Hyd/Scis/Geo in the same hole (separate hole desirable if available)

---

**Options for infrastructure**

- CORK/ACORK / ODP Geodetic holes (Phase 1)
- CDEX plan (Phase 2, not enough though)
- One observatory with multiple holes (Phase 3)
- Major engineering development of the wellhead, allowing for sensor installation at many intervals
- Simple design assuming no downhole overpressure (accurate pressure estimate req.)

---

**How do we test hypotheses?**

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Core analysis</th>
<th>Logging/OHM</th>
<th>Observatory</th>
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<tr>
<td>1. MS is locked</td>
<td>Sedimentary sequence high-res dating</td>
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<td>Strain acum.</td>
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<td>2. MS is weak</td>
<td>Microstructural analysis Multi-holes</td>
<td>RAB, DVTP-P</td>
<td>Strain/Seism.</td>
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<tr>
<td>3. Prop. change w/P-T, stable/unstable transition</td>
<td>Microstructural analysis Multi-holes</td>
<td>RAB, DVTP-P</td>
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<td>4. Hydrological connection</td>
<td>Permeability Fluid chem.</td>
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<tr>
<td>5. Prop. change w/time</td>
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<td>All</td>
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</table>
What we know by now

- Seismic (MCS+OBS) Surveys, including 3D survey in early 2006
  - 3D structure of OOST
  - Muroto 3D results, effect of subducting basement topography / amplitude? (Park)
- Micro Seismicity
  - Low seismicity
  - Low very low freq. seismicity
- Crustal movement
  - Slow slip
- EM structure
  - Conductive near the updip plate boundary
- Thermal structure

What we know by now (continued)

- Detailed bathymetry and backscatter imagery (Wadatsumi)
  - Landslides?
  - Not enough resolution for fault scarp and seep community mapping? – need AUV
- Dives
- Pinpoint corings (NSS)
- Seafloor Observatory

So, what shall we do NOW.

- Site characterization
  - 3D seismic
  - Dives
  - Deedlow sidescan and SBP
  - Seafloor observatory
- Laboratory and Numerical Experiments
  - Regional stress/strain/T/P
  - Rupture nucleation/propagation process
- Development of observatory tools
- New proposals, not as NanTroSEIZE?
  - Engineering expedition (MBARI type)
  - Seismogenic Drilling at Sumatra?

Activity / Schedule

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</table>

海底電位差磁力計（長期期OBEM）

観測点分布
Deep-sea cables (MCS tracks also shown)

Inferred thermal structure (Preliminary result by Kelin Wang)

Heat flow across the Nankai Trough off Kumano

Distribution of cold seep communities

Fluid flow is confined locally along frontal thrust/OOST

Payload CAM

Ashi et al., 2003

NSS*
Cliff found during KR02-10 cruise in the Kumano forearc region

Numerous surveys conducted
Submersibles
Surface ships

CAT (Chemical and Aqueous Transport) meter
- Measurement range from 0.1mm/year to 15m/year
- Enables to measure upwelling/downwelling flux

CAT meter installation sites and process

install(KY02-03) 2002/02/25,26
recovery(KY02-05) 2002/04/14,15
Report of the
NanTroSEIZE PSG

Sante Fe, New Mexico
February 24-25, 2005

Appendix O
Proposed Monitoring Working Group

GOAL: Develop a dedicated working group to develop the long-term monitoring plan for the NanTroSEIZE project.

Possible Members:

**Seismology:**
- Ralph Stephen rstephen@whoi.edu Woods Hole OI
- Koichiro Obana obanak@jamstec.go.jp IFREE/JAMSTEC
- Kiyoshi Suyehiro* suyehiro@jamstec.go.jp JAMSTEC
- Peter Malin malin@duke.edu Duke University
- Hisao Ito hisao.itou@aist.go.jp AIST
- Ryota Hino hino@aob.geophys.tohoku.ac.jp Tohoku Univ.
- Bill Ellsworth hino@aob.geophys.tohoku.ac.jp USGS

**Hydrogeology:**
- Liz Screaton screaton@ufl.edu Un. of Florida
- Demian Saffer dsaffer@geosc.psu.edu Penn State U.
- Kevin Brown* kmbrown@ucsd.edu Scripps IO
- Earl Davis edavis@nrcan.gc.ca Pac Geoscience Ctr, Canada
- Keir Becker kbecker@rsmas.miami.edu U. Miami
- Tomochika Tokunaga tokunaga@geosys.t.u-tokyo.ac.jp Univ. Tokyo
- Masa Kinoshita

**Geodetic (Strain, Tilt):**
- Eiichi Araki araki@jamstec.go.jp JAMSTEC
- Selwyn Sacks sacks@dtm.ciw.edu Carnegie Institute
- Masanao Shinohara mshino@eri.u-tokyo.ac.jp ERI U. Tokyo
- Mark Zumberge?? mzumberge@ucsd.edu Scripps IO

**Geochemistry:**
- Tomohiro Toki toki@ori.u-tokyo.ac.jp ORI U. Tokyo
- Geoff Wheat wheat@mbari.org MBARI
- Miriam Kastner mkastner@ucsd.edu Scripps IO

**Microbiology:**
- Not sure yet who…

**EM**
- Pierre Henry
- Tadanori Goto tgoto@jamstec.go.jp IFREE/JAMSTEC
- US?

*Borehole and Sensor Engineering: needs to break down more?*
Jun Tomomoto .tomomoto@jamstec.go.jp  CDEX
Tom Pettigrew .tom.pettigrew@stress.com  Mohr Engineering
Randy Normann  ranorma@sandia.gov  Sandia National Lab
[USIO rep]
![J-DESC rep]

Integration:
Harold Tobin  tobin@nmt.edu  New Mexico Tech
Masa Kinoshita masa@jamstec.go.jp  DSR/JAMSTEC
Shinichi Kuramoto  s.kuramoto@jamstec.go.jp  CDEX

* also geodetic interest
Appendix P
General Considerations for NanTroSEIZE PSG

Santa Fe meeting Dec 2004
Randy Normann
PI High-Temperature Electronics
Geothermal Research Dept.
Sandia National Labs

Past Sandia and NEDO Relationship

Dr. Seiji Saito, Tohoku University, Dept. of Geoscience & Technology
- Very respected geothermal researcher
- Sandia supplied HT tools to support Dr. Seiji Saito projects
- Dr. Seiji Saito wrote reports on using Sandia tools in Japanese drilling projects

A Team Approach

- The operating life and the scientific needs required by deep fault monitoring require a team approach.
  - Short of placing a rock on the end of a string, well instrumentation requires a host of materials for creating pressure housings, lubricants, seals, fiber optic and/or electrical interconnects, sensors, printed wiring boards, cables, surface equipment, etc.

Suggested SAFOD Team

- Sandia National Labs
  - We are continuously well testing electronics and fiber optic sensors
  - The Geothermal Research Group has an ongoing 192.5C well monitoring project in Coso, Ca
- University of Maryland’s CALCE center is the world’s foremost authority on the physics-of-failure assessment. Currently using PoF methods for well logging tools for Schlumberger and Halliburton.
Sandia has Reliability Responsibility to the DOE and DOD

Sandia has over 200 reliability engineers and scientists

Basic HT Electronic Technology

- Commercial Industrial Grade (-20 to 85°C) electronic components
  - Have NO operating life requirements at 85°C
  - Have a nominal operating life of 18 months @ 150°C*
  - Outgas Bromide at ~175°C causing random failures in 2000hrs
- HT SOI (silicon-on-insulator) from Honeywell designs 1% failure over 20 years at 150°C (10.6 yrs at 200°C).
  - PoF is electromigration with 0.5 mA/um² current density*
  - Unfortunately, there is only a limited number of devices currently on the market.
  - Currently developing new SOI components within the Honeywell JIP.

*Reliable Electronics for High-Temperature Downhole Applications
B.L. Gingerich, SPE et al., 1999, SPE 65438

Honeywell JIP

- All of the major service companies are co-funding SOI component development
  - $8 Mil USD
- The components are needed for long-term well monitoring instrumentation
  - Improved accuracy and circuit design flexibility
- The components currently belong to the JIP members until 2007
  - Suggestion: Work with one of the JIP members to gain access

Fiber Optic Reliability

- Free hydrogen in the well has been shown to greatly reduce the operating life of fiber at temperatures of 180°C
- Manufacturers have responded with new fiber doping to reduce hydrogen effects
  - These new fiber have not been fully well tested
- Sandia is currently considering new fiber well testing at temperatures 225-320°C starting in late 2005
Fiber Optic Sensors

- DTS – Roman Backscatter great for continuously monitoring the complete well temperature profile
  - Poor resolution
  - Multi-mode fiber has limited range, a few km
- BFG – great for pipe strain
  - BFG must be mechanically isolated from each other
  - Untested for long-term drift effects in HT wells
  - Long range 10’s of km
- Fabry-Perot Interferometer – Pipe strain, temperature, pressure
  - Surface equipment complex, limited number of sensors
  - Bandwidth issues
  - Untested for long-term effects in HT wells

Current Industry Practices

- Closest commercial example: 150°C Smart Well instrumentation
  - Normally specified at 150°C-5yrs*
  - Relatively simple systems monitoring pressure, temperature, flow with the ability to control a production valve.
  - Complete systems are built metal pressure housings WITHOUT rubber seals.
  - Schlumberger’s Bernard Parmentier’s 2003 HITEN report, “No use of organic material when long-term reliability is mandatory”

Current Industry Practices, Continued

- Service companies invest millions of dollars in testing materials and components for operating temperatures and life times
  - Service companies freeze circuit design required for years of testing and production
- DTS Fibers require secondary calibration
  - Loop (twice the fiber)
  - Electronic temperature measurement
  - Testing done in the lab is good but it doesn’t really count until it is proven in the well.

Sandia has access to HT wells

- We are currently testing fibers and electronics in geothermal wells
  - Coso 193C long-term test complete with satellite data transmission
  - Navy well 58A-10D, just conducted 256C. 18 hr well log without any heat-shielding
  - Utah 220C well long-term test

*Design of High-Temperature Electronics for Well Logging Applications
**Coso Deployed System**

Funded by the Department of Energy’s National Energy Technology Laboratory (NETL)

- Uphole Electronics (Consists of data receiver/logger, transmitter, and power supply)
- Satellite Antenna

**Navy Test Well**

To date, three downhole reservoir monitoring tools have been successfully deployed.

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**Know What You Placing in the Well**

- You must allow time for lab and well testing.
  - 1 year well testing at elevated temperatures >180°C
  - Provide time to make design changes following the 1 year test
- You must not place anything in the well without knowing:
  - First and second modes of failure
  - Interaction of systems to single point failures
  - Degradation caused by hydrogen
  - Degradation caused by other potential wellbore chemicals
  - Out gassing interaction of system components

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**Evaluation Criteria for Components**

- Historical Data
  - Past applications
  - Reliability testing data
  - First & second modes of failure (PoF)
- Complete list of materials
- Assembly apprentices and QA steps
- Most evaluations will result in:
  - Suggestions for additional lab testing
  - Suggestions for production materials or assembly methods

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**Use Both Fiber and Electronic Sensors**

- Use both fiber and electronic measurements
- Different failure modes
- Different advantages/disadvantages
  - Fiber—
    - Distributed sensors
    - Normally less accuracy
    - Less downhole
  - Electronics—
    - Wide range of sensor types
    - Normally single point measurement
    - Lower power
    - Greater downhole complexity
The Future

- Oil wells are getting deeper and hotter
  - Drilling companies are looking for 225C tools for Gulf of Mexico drilling
- The Honeywell Joint Industry Partnership is creating NEW HT SOI components for commercial release in 2007
- The military is developing 350C SiC electronics and sensors
- Sandia is starting a 300C seismic sensor project in 2006 for long-term geothermal well monitoring

I have materials on well instrumentation. Please ask me for them if interested.

Thank you,
Randy