Minutes of JOIDES SEIZE Detailed Planning Group

Second Meeting; JAMSTEC Tokyo, Japan

17-18 March, 1999

SUMMARY AND MAIN CONCLUSIONS

A. The planned riser drill ship has a capability of 2,500 m maximum water depth (i.e., riser length) and 10,000 m drill string. The main technical concerns for drilling the subduction thrust seismogenic zone are (other hazards are noted in detail in the minutes below):

(a) Sites where the water depth is 2,500 m may require 5-7 km penetration to reach the seismogenic zone. 7 km drilling could take 3 to 5 years, 5 km could take much less time.

(b) The very strong Kuroshiro Ocean Current is a severe problem for most of the Nankai Trough; it is least for easternmost Nankai,

(c) Unstable formation, high formation pressures, and high temperatures.

B. Drilling of the seismogenic zone in the Japan area, with the planned drill ship capability, appears to be limited to the Nankai Trough (SW Japan). The Japan Trench and adjacent areas are too deep (a consequence of old crust being subducted).

C. A careful study is needed along the whole Nankai Trough to locate the areas of 2,500 m water depth where the subduction thrust may be reached with the minimum penetration. A 5 km hole compared to 7 km could mean half the drilling time and a higher probability of success. This study requires additional multichannel, OBS etc. seismic data. Easternmost Nankai is less subject to the Kuroshiro current, although it is more structurally and tectonically complex.

D. More accurate estimates of deep temperature and of formation pressures etc. are needed. Additional thermal data and modelling, geotechnical studies etc. are desirable.

E. An expert scientific team needs to be set up; this working team should carry through to the scientific program onboard the ship during the drilling. The team should have subgroups for each of the main scientific programs, including required site surveys. The scientific team should work closely with the JAMSTEC drilling engineering and science groups who are responsible for design, construction and operation of the ship.

DPG Members Present

R. D. Hyndman (PGC, Geol. Surv. Canada) Chair

K. Brown (Scripps Inst. Oceanog., Univ. Calif., U.S.A.)

M. Kastner (Scripps Inst. Oceanog., Univ. Calif., U.S.A.)

J. Ashi (Univ. Tokyo, Japan)

S. Peacock (Univ. Birmingham, U.K.)

S. Lallemant (Univ. Cergy Pontoise, France; for P. Huchon, Ecole Nomale)

P. Favoli (Instituto Nazionale di Geofisica, Italy)

S. Kodaira (JAMSTEC, Japan)

Visitors:

H. Kinoshita (JAMSTEC, Japan)

S. Takagawa (JAMSTEC, Japan)

H.Matsuoka (JAMSTEC, Japan)

S. Uetake (JAMSTEC, Japan)

Several others from JAMSTEC

M. Yamano (ERI, Univ. Tokyo, Japan)

M. Ando (Kyoto Univ., Japan)

C-S. Liu (National Taiwan Ocean Univ., Taiwan)

C-S. Li (National Taiwan Univ., Taiwan)

Apologies:

C. Moore (Univ. Calif., U.S.A.)

M. Zoback (Stanford Univ., U.S.A.)

P. Huchon (Ecole Normale Superieure, Paris, France)

L. Ruff (Univ. Michigan, U.S.A.)

P. Harjes (Ruhr Univ. Bochum Germany)

SEIZE Meeting Host: S. Kodaira, JAMSTEC

Minutes of Meeting:

(with many thanks to Dr. S. Peacock for most of the notes)

1. MEETING INTRODUCTIONS AND SCHEDULE

Introductions and logistics and meeting schedule.

2. MANDATE OF SEIZE DPG.

(Roy Hyndman, DPG Chairman)

Dr. Hyndman summarized the mandate of the SEIZE DPG for those not at the previous meeting. He indicated that the DPG should produce an initial report by the end of its next meeting, tentatively in May. An important part of this Tokyo meeting was to meet with JAMSTEC drilling planners and engineers for the OD21 riser drill ship. Several Japanese scientists also were invited to provide information needed on drilling in the region of Japan.

The minutes of the last meeting in San Francisco December 1999, had been circulated to the members by email and minor corrections made. Dr. Hyndman drew attention to the previous SEIZE workshop and its report (http://www.soest.hawaii.edu/margins/SEIZE_sci_plan.html), and to the San Andreas Fault drilling proposal (Zoback, Hickman, and Ellsworth; web site (http://pangea.stanford.edu/~zoback/FZD/proposaltoc.htm). For information on the Japanese OD21 Drillship proposal see the web site (http://www.jamstec.go.jp/jamstec/OD21/).

3. REPORT ON RISER DRILLSHIP AND ORGANIZATION OF OD-21

(H. Kinoshita, JAMSTEC)

Dr. Kinoshita provided the budget for the new ship:

(a) Basic design construction- $116M (US);

(b) Onboard systems- $230M;

(c) Subsea systems- $150M (at 120 Yen/US$).

Seatrials are to begin in late 2003; total completion is to be in 2005 (fiscal years, which begins in April for Japan). Planning has started for coring and long-term monitoring systems; they are to be tested on the present drillship (JOIDES Resolution) before 2004.

IODP (Integrated Ocean Drilling Program)

Management and planning for OD21-

The present ODP SCICOM (Science Committee) has formed an IODP Planning Subcommittee (IPSC); Casey Moore has sent its terms of reference. IODP will gradually replace SCICOM and in 2001, will become the IPC (International Planning Committee?) as the authority of OD21. It will initiate planning and working groups.

JAMSTEC will support OD21 as JOI at present supports the ODP. The Japanese OD21 planning committee is led by Prof. Ikuro Kushiro. Financial support is to come from STA/Monbusho. A Japanese SEIZE committee is proposed to be formed.

Dr. Kinoshita emphasized the importance of international cooperation. Three international meetings have so far taken place or are planned- CONCORD in 1998; COMPLEX this May and ICOSD in mid-2000 to plan the IODP. The new IPSC plans frequent meetings, beginning in March 1999. A time scale was presented for drilling operations to begin in 2004:

(a) Site selection, 1999-2000;

(b) Planning drilling operations and technology requirements, 2000-2002;

(c) Preparation, permission obtained to drill and site surveys, 2002-2004.

During the same period USA will develop non-riser drilling technology. Dr. Kastner asked about the time between the end of the present ODP in 2001 and availability of the OD21 ship in 2005; there appears to be no bridging mechanism to keep scientific interest in deep sea drilling. We have no information on the proposed new non-riser drill ship.

4. OD21 DRILLSHIP CONSTRUCTION SCHEDULE AND CAPABILITIES/SPECIFICATIONS

(S. Takagawa, JAMSTEC)

The planned principal specifications and overall features of the OD21 drillship were outlined and comments invited.

Dr. Hyndman asked about the operating temperature for downhole equipment. Formation temperatures could reach well over 200C. From the discussion: During drilling, the hole may be cooled by the drill mud circulation, and downhole logs and other instruments that are deployed quickly may not encounter full formation temperatures. Some short-term instruments also may be protected by insulated containers. However, long-term inhole recording instruments must be capable of withstanding formation temperatures. The German KTB well coped with 150-200C. Further research after initial construction should improve high-temperature capabilities (after 2004). Dr. Hyndman pointed out that if the riser could be made for 3,000 m, rather than the proposed initial limit of 2,500 m, the seismogenic zone could be reached from deeper water sites where the drillhole penetration required in much less, and the temperatures much lower. Dr. Kastner asked about coring facilities. They are planned to be the same as for the JOIDES Resolution and are to include a pressurized core barrel system. Coring for biological studies and coring into the mantle are included as targets.

5. HAZARDS FOR OD21 DRILLING

(S. Uetake JAMSTEC)

The drilling hazards, in order of severity, are

(a) Kuroshiro ocean current,

(b) formation overpressure,

(c) faulting and associated geological problems,

(d) typhoons,

(e) gas hydrates and gas/water flow,

(f) high downhole temperatures.

The Kuroshiro Current (KC) is specific to the Nankai Trough, SW Japan, the others are general.

(a) The KC is 100 km wide, flowing NE past the SE coast of Japan. The speed at the centre is 3-5 knots (1.5-2.6 m/s), falling to 2 kts at 50 km either side of the centre of current. The depth decay is to 1 kt at 600 m, 0.2 kt at 1000 m depth. The KC oscillates in its path over about a 2 week period, with largest oscillations in the area of the suggested drill site central, Nankai trough; >70 km movement of centre of current, with possible reversal of direction due to eddies at any site. Most of the 2,500 m water depth contour around SE coast of Japan is covered by the KC (except possibly NE end of Nankai Trough). The current can be tracked by satellite measurements of sea surface temperature (warmer than surrounding sea).

The OD21 riser drill ship is designed to operate in maximum current 1.5 kts and wind speed 30 m/s, and 2.5 kts at wind speed 23 m/s, so cannot operate continuously at the centre of the KC. The riser, rather than station keeping is the limiting factor. Excessive side force could cause damage or loss of the riser.

(b) Typhoons are defined by wind speeds greater than 17.2 m/s. There are 4-5 per year at Nankai in summer to autumn. They have diameter 100-2000 km. The maximum recorded wind speed was 70 m/s (in 1979). In Sept.-Oct. particularly, many typhoon tracks pass Nankai parallel to KC. Drilling is not recommended in the area for July-October. Coping with typhoons: need clear and firm criteria for determining when to evacuate; need enough warning for orderly evacuation (condition and plug hole, retrieve downhole pipe and equipment, and prepare ship); the minimum lost time would be about 1 week (evacuation and re-entry).

JAPEX/JNOC boreholes are planned off the Japan coast as part of the gas hydrate program. Off Sanriku in 1999 in 800-900 m water depth, planned total depth (TD) 4,000-5000 m, and at Nankai in 2000 in water depth 900-1000 m, TD 3,000 m. They anticipate temperature gradients of 3-4 C per 100 m. JAPEX has an agreement with the Japanese earthquake prediction program to make some borehole data public (not known if that includes temperatures).

The Japan Trench off NE Honshu has water depth that is too deep for the 2,500 m riser where the subduction thrust is at a practical penetration depth. This area avoids the KC, although there is a counter current rotating clockwise, originating from the north; little is know about it.

6. CAPABILITIES OF THE DRILL SHIP

(S. Takegawa, JAMSTEC)

(a) Station keeping:

The performance of the dynamic positioning system has been modelled under various combinations of current, wave height and wind speed. The system consists of six directable thrusters of which 2 are expected to be redundant. Examples were shown for 2,500 m water depth, wind speed 25 m/s, 5 m/s current and various wind directions for which four thrusters could maintain position at wave height of 2 m, and six thrusters could manage up to 4 m wave height. In the Nankai area, wave height is 5 m only after large storms. The prevailing wind is from the NW and is usually oblique to the KC.

At Nankai, the dynamic positioning system (DP) would use differential GPS from a land station on Honshu and would have a 5m positioning accuracy.

(b) Riser:

The bending limits (angle between the riser and vertical, at the ship and at the seafloor) should be less than 2 degrees for normal operations. A graph of deviation angle in a 5 kt current for various values of tension on the riser, show that tensions greater than 1100 tons are required for this current and these angle limits.

7. DOWNHOLE DRILLING CONDITIONS EXPECTED AT NANKAI

(H. Matsuoha, JAMSTEC)

The relatively little-consolidated accretionary prism sediments have a low "fracture gradient". Thus, multiple layers of casing will be required to prevent hydrofracture of the upper part of the hole by the high weight drilling mud required to match the formation pressure in the lower part of the hole. The casing will be emplaced in cycles of drill and core, then case. Two pilot holes are proposed before the main hole. The first is to test the shallow sediment conditions and need not be drilled with a riser. The second hole should be with the riser. The pilot holes should be compared with the seismic sections. Seismic- while-drilling that can see ahead of the bit is important to planning.

8. DISCUSSION WITH ENGINEERS

Takagawa concluded that the major concerns for seismogenic zone drilling at Nankai are: Kuroshiro Current, typhoon season, and sub-seafloor drilling problems. They make the project very challenging. The riser and dynamic positioning design would have to be improved to cope with the Kuroshiro Current. Drilling could not take place during the typhoon season, and pilot holes would be vital to prediction of downhole problems.

Discussion:

-The time to drill 7 km below seafloor while avoiding typhoon season is 3-5 years. We have no direct measurements of pore pressure at Nankai, although it may be estimated from critical taper of wedge (and comparison with measurements at Barbados etc.).

-Downhole temperature; the effect of cooling of formation by >100C may be to fracture formation.

-The pore pressure is probably quite close to fracture pressure; thus mud weight must be very accurately balanced.

-Toleration of riser deviation depends on physical state of seafloor; up to 25 deg. On hard seafloor, but only 2 deg. for soft seafloor.

-The proposed ODP leg(s) to Nankai include putting a CORK (packer etc. system) into previous Site 808 and to log with the Formation Micro scanner to look for ellipticity of hole (stress direction). The data should include information on temperatures and formation pressures.

-Eastern Nankai is a possible alternative site. Less site information is available because there has not yet been

ODP drilling. A French/Japanese 3-D seismic and OBS campaign is proposed for 2000; there is also a proposal for an ODP leg to drill into an out-of-sequence thrust fault. The out-of-sequence thrust is seen (by submersible) to be active recently, possibly coseismically, and make easier targets than the main seismogenic zone, which may be 7 km below the seafloor in this area. There may be areas in Eastern Nankai where the water depth is 2,500 m and the required penetration to the subduction thrust is less than for W. Nankai. However, more seismic structure data is needed to define the depth to the subduction thrust. The SEIZE DPG requested Dr. Lallemant to convey to the French committee the importance of the proposed multichannel etc. seismic surveys for evaluation of eastern Nankai as a possible SEIZE OD21 site.

-A 3000 m riser "will be available soon", the oil industry is working on it.

HEAT FLOW DATA IN THE NANKAI TROUGH

(M. Yamano, Earthquake Res. Inst., Univ. Tokyo)

Dr. Yamano presented a summary of the heat flow data available for the Nankai margin and numerical models that estimate the temperature on the subduction thrust fault. Heat flow and temperature of the subduction zone are controlled by: (a) subduction angle, (b) convergence rate, (c) age of the incoming lithosphere, (d) thickness of insulating sediments on the incoming crust, and, (e) the thickness of sediments being subducted. The amounts of frictional and radiogenic heat generation are other factors that are not well known. Advective heat transfer by wedge mantle flow, growth of the accretionary prism and hydrothermal circulation all affect heat flow and temperature. Models show that subducting cool oceanic crust and sediments beneath the margin lowers the temperatures, but strain heating and friction on the decollement could raise the temperature and heat flow.

Japan Trench compared to Nankai Trough:

-At Nankai the subducting plate is much younger and hotter. Nankai models must be time dependent, because the age of the subducting plate has increased with time. A ridge was subducted about 15 m.y. ago. The plate age has been nearly constant at the Japan Trench.

There is a plan to measure Nankai heat flow on the continental slope. The survey is supported as part of the Japan gas hydrate program, because temperature is an important control for gas hydrate vertical distribution. The survey and study will look at thermal and fluid flow regimes. The measurements will be in the region of the planned 3-D seismic survey off Muroto. It will use probe measurements calibrated with ODP drill holes, both existing and planned. There also will be long term monitoring of the temperature gradient using a 2-m seafloor probe, and a retrievable data logger. The depth to the temperature sensitive gas hydrates BSR (bottom-simulating reflector) can be used to estimate heat flow, assuming steady state. Gas hydrate BSRs are common on the Nankai continental slope.

In the area of ODP Site 808, near the toe of the accretionary prism, the probe heat flows are 107 to 200 mW/m2, i.e., high but scattered. The heat flow decreases landward, and 60 km from Site 808 it falls to about 50 mW/m2. The high heat flows in the Nankai Trough exceed that expected for the age of oceanic crust, and they indicate fluid flow. However, the required flow rates are higher than observed by bottom measurements. At DSDP sites off Ashizuri (SW of ODP Site 808), the heat flow decreases to 59-60 mW/m2. The heat flow estimated from the BSR depth falls rapidly landward. There is a gap between the landwardmost gas hydrate heat flow and the land borehole measurements. Numerical models have ben used to estimate the temperatures on the subduction thrust. The model fit to the BSR heat flow on the lower continental slope is poor, probably because the models do not include the effects of accretionary prism thickening or of fluid advection. Near the toe of the prism, the modelled 100C isotherm is almost parallel to, and 500 m above the decollement. The seismic reflection data that defines the decollement does not yet extend landward to the area of possible seismogenic zone drill sites, so the depth to the subduction thrust in that area is not well known. From the heat flow data and models, the 350C temperature (approx. maximum for crustal earthquakes) on the thrust is where the thrust is at a depth of about 25 km. At 15 km depth the model temperature is 150-200C.

The discussion concluded:

The temperature distribution along the plate interface is one of the most important factors that control the extent of the seismogenic zone, and accurate temperature estimates are essential for the subduction thrust where deep drilling is proposed (for both for drilling and downhole measurements). Existing Nankai Trough heat flow data is inadequate for accurate estimation of the thermal structure of the seismogenic zone, and new systematic and detailed heat flow surveys and more detailed thermal modelling are needed in time for planning OD21 drilling.

10. PLANNED 3-D MULTICHANNEL REFLECTION SURVEY

(S. Kodaira, JAMSTEC)

The planned joint USA-Japan survey is for an area 7-9 km by 70 km, perpendicular to the margin covering the seaward and perhaps the landward limit of the seismogenic zone. It is to be in June-August, 1999. It is hoped that images may be obtained of, the decollement, frontal thrust and the thrust where the decollement steps down to near the top of the oceanic crust. Dr. Hyndman asked whether any lines would include the area further to the west where the 2,500 m contour is further seaward and the depth to the subduction thrust may be less (because of subducted seamounts?). This appears not planned as yet, but could be considered.

As well as the 3-D multichannel survey, the experiment includes 2-D lines of ODSs from the 3-D survey area to the coast of Shikoku and land recording along a line across Shikoku. There will be 50 land stations recording two offshore shots, on at each end. There also will be a microearthquke study using the land stations and a cable-connected OBS array. Preliminary results from the cable OBSs show that previous hypocenters from land only stations, are relocated 2-10 km shallower. The earthquakes appear to have thrust mechanisms, but are located within the downgoing plate, not on the thrust.

Seismic data from the Japan Trench:

Note that the depth to seismogenic zone is about 9 km where the water depth 3-3.5 km. For water depth of 2.5 km, the seismogenic zone is some 15 km below the seafloor. Multichannel seismic reflection data show a highly faulted oceanic crust descending with steep dip, and only a small accretionary sedimentary prism. Small earthquakes occur 14-15 km below the sea surface. Heat flow is expected to be low, but greater depth to the seismogenic zone means equal or greater temperatures on the thrust (at the same landward distance?) compared to Nankai. The small earthquakes are in both subducting and overriding plates. The larger ones show normal faulting mechanisms.

11. EASTERN NANKAI FRANCE/JAPAN PROJECT

(S. Lallement, France)

The Eastern Nankia France/Japan study site is between Long. 137 and 138 where the seismogenic zone is deep because of the shallower subduction angle relative to W. Nankai. However, there may be an adjacent area of E. Nankai with much shallower dip (this needs to be examined). The most recent great earthquake rupture is 1854-5, much earlier than W. Nankai, so there is the potential for near-future great events. The heat flow from the BSR depth imaged by deep-tow seismic system is 55 mW/m2. The nearby subduction of the Isu-Bonin Ridge causes high tectonic coupling and more earthquakes within both plates than W. Nankai. The forearc basin is distorted or absent.

Geophysical surveys show an accretionary prism with a high-velocity, high magnetization backstop, of thickened crust, from which the Tokai thrust extends through the prism to the sea floor. The position of the decollement, seaward of the backstop is unclear; there are several possible candidate reflectors. The seafloor breaking faults (out-of-sequence) show recent motion and fluid venting. Seismicity is mostly related to the offshore Zenisu ridge (thrust?) system.

Lallement has proposed to IFREMER a 45x6 km 3-D multichannel seismic survey. There is also an ODP drilling proposal for a site NE of the existing seismic line. The DPG discussed this area as a seismogenic zone drilling target. Where the water depth is about 2,300 m, the structure is complex. The is a subducting seamount that probably should be avoided. A better site might be in the slope basin seaward of the anomalous backstop.

As for W. Nankai, the most important question for drilling to the seismogenic zone in E. Nankai is to locate a site where the water depth is a maximum of 2,500 m and the drilling depth to the thrust is a minimum. As noted above, E. Nankai is much less affected by the Kuroshiro Current compared to W. Nankai.

12. GEOSTAR PROJECT (Geophysical and Oceanic Station for Abyssal Research)

(in Mediterranean); P. Favoli, Italy

The Geostar observatory is designed to be deployed on the sea floor at up to 6000 m depth and gather data for 1 year. The instruments on the observatory can be varied; the test deployment included a seismometer, acoustic doppler current meter, magnetometer, electrochemical package and 2-Gbyte data store (90 days). The observatory was successfully deployed and retrieved in the Adriatic Sea in 1998. An improved version, more autonomous with real-time communication, is being designed under Phase 2 of the project and will be deployed in deep water in 2000. At present, data are retrieved by a fibre optic cable in the deployment tool or in "message capsules" released from the observatory to the sea surface for retrieval. The total cost of the project is 8-9 M Euro. The base unit and sensors cost 500 Euro.

13. UPDATES ON OTHER DEEP DRILLING PROGRAMS

The DPG members for this presentation could not attend

14. SUMMARIES OF LETTERS OF INTENT (LOI)

(C. Moore, U.S.A.)

Letters of intent (LOI) relevant to seismogenic zone drilling were solicited widely internationally before the SEIZE DPG was set up. The LOI were for a wide range of projects not all requiring deep riser drilling, including land-based studies of exhumed thrusts. S. Lallemant and colleagues submitted a proposal later for E. Nankai and it has been included. Some examples:

1. A. Trehu: "Fault Zone Guided Waves" The new ship will be able to drill deviated and forked holes to allow a "cross-hole" survey with artificial sources rather than having the uncertainty of using natural earthquakes within the seismogenic zone. The ship should be able to drill horizontal holes at 3-4 km depth.

2. Shapiro et al.: Will pumping water in and out of the seismogenic zone cause earthquakes?

3. M. Kastner: Costa Rica vs. Nicaragua chemical input/output (does not require a riser hole).

At these two sites the same incoming sedimentary section causes different styles of subduction and of volcanism. The Nicaragua part is relatively unexplored. We should see (via E. Silver) the existing ODP leg proposals for Costa Rica and proposal for seismic surveys off Nicaragua. It is unlikely that there will be enough site survey data for a ODP leg to Nicaragua before the end of the present phase of ODP.

4. K. Suyehiro; Drilling Japan Trench- An important target for the future, but cannot be drilled with OD21 system with initial 2,500 m water depth limit.

5. Gulf of Corinth- requires land and sea drilling. If the water is shallow, a jack-up or semi-submersible drilling rig rather than a ship might be more appropriate. We should encourage site surveys but riser OD21 drilling there is unlikely for some time.

There was a discussion on how to use the letters of intent and how to include some authors in science teams (along the lines of the San Andreas Fault drilling proposal).

Day 2 - 18 March

Additional visitors- Masataka Ando (Kyoto Univ., Japan) and Dr. Park (JAMSTEC).

Dr. Hyndman presented a summary of the conclusions on the riser length and depth required to reach the seismogenic zone, and on the implications for site choice.

OD21 Initial Drilling Limits

1. Water depth of 2,500 m maximum (deeper in later development)

2. Total drill string of 10,000 m, (i.e., 7,500 m hole if 2,500 m water depth).

-this depth may be difficult and would require a long time (years)

3. Pilot holes are needed with shallower penetration (could include other scientific targets)

Western Nankai-

Possible over large area off Shikoku, but:

1. Needs a very deep hole (need careful survey and study to find shallowest place)

2. Strong current problem

Eastern Nankai-

Most of area is too deep, but a small area may be much shallower

(needs more seismic structure data to determine depth to seismogenic zone)

1. Tectonically and structurally complex

2. No recent great earthquake to define rupture area but higher probability of near-future great events

3. Much less serious current problem

4. Also secondary shallower targets such as Tokai fault; could be pilot hole target?

Japan Trench:

Too deep for initial maximum riser length, but is an important future target as a major subduction type contrast to Nankai

Maximum Riser Length

A 3,000 riser (maximum water depth) would make a big difference in drilling depth required to reach seismogenic zone, i.e, possibly 5-6 km instead of 7 km (half the time?).

The difficulties of great depth of penetration and strong ocean current are severe for the seismogenic zone of the W. Nankai Trough. E. Nankai Trough has less of a current problem, but it is not yet known if a shallower seismogenic zone site can be found. An initial target might be suggested such as Tokai or similar out-of sequence thrust at much shallower depth than the seismogenic zone.

Dr. Hyndman also reviewed the primary objectives of drilling the seismogenic zone (such as described in SEIZE workshop), to guide further discussion.

Primary Objectives

1. Controls of the Great Earthquake Cycle

Changes with time; time of nucleation; precursors:

-shear stress

-pore pressure

-chemical and other physical changes

2. Controls of the Updip and Downdip Limits of Great Earthquakes

-temperature

-pressure, depth, time-dependent changes in sediments

-fault zone sediment/rock changes in composition or state; hydration

3. Low Fault Strength (stress data and heat flow)

4. "Asperities"

-weak and strong areas, continuous creep areas

5. Tsunami Earthquakes

6. Decollement Depth in Sediments (why?)

It was noted that the updip limit of the seismogenic zone is not well defined. It may be different for

(a) great earthquake rupture,

(b) aftershocks,

(c) tsunami models,

(d) geodetic models, depending upon the speed of rupture.

16. COSTA RICA PROPOSAL

By Von Huene et al. The proposal will be sent, but has not yet been received by the DPG. It should be discussed at the next meeting. The proposed site is on the flank of the subducting ridge where the target zone is 1-2 km deep. There is a proposal for a micro-earthquake study in the area.

17. REPORTS ON SEIZE SUBTOPICS

(a) Seismicity (L. Ruff who was to present on this topic was absent and M. Ando kindly made a short presentation).

The subduction thrust of Nankai is well coupled, but southward in the Hyuga-Nada area SW of Shikoku, (S. of Kyushu), there are no recorded large earthquakes rupturing the plate boundary. GPS geodetic data show that north of this zone the Pacific coasts of the Japanese islands are moving NW, whereas south of it they are moving SE. Nishimura (1999) concluded slow slip on the thrust in this zone. NW of it the plate boundary is 80-90 % locked. Some of the differences between the two regions are: To the NW, the incoming plate is younger (20 m.y. instead of 40) and the sediments on it are coarse volcaniclastics whereas they are finer to the SW. Off Kyushu almost no sediment is being subducted, whereas at Nankai, the incoming sediment thickness is about 1 km and several 100 m are subducted. Basement fault orientation is different off Kyushu because of subduction of the Kyushu Ridge.

The estimated depth of seismic coupling is 20-30 km in the Hyuga-Nada area, shallower at Nankai?

(B) Sediment Composition and State of Fluids

(M. Kastner, U.S.A.)

Miriam Kastner presented a review of evidence for a deep source of fluids found in the Nankai, Barbados, and Costa Rica accretionary complexes (and Peru and Cascadia, which have not been drilled down to the decollement). At Peru there are two sources; at 9 deg. S the source is continental basement, but at 11 deg. S (the other side of the tectonic lineament) it is mantle. Cascadia (Vancouver Is. and Oregon sites) shows a single deep source at temperatures of 100-200C.

Miriam also presented a revised hypothesis of the chloride "dilution" anomalies at the decollements. Isotopic evidence is inconsistent with simple dilution of pore water by smectite interlayer water. The chloride is not a conservative tracer but is being taken up by reactions forming biotite, serpentine and amphibole, which preferentially take up the lighter isotope, so that the isotope ratio in the fluid (35Cl/37Cl) is decreased. These mineral-forming reactions require high pressure and temperature, so the decollement fluid must come from seismogenic zone depths. The biotite forming reaction absorbs water and would affect pore fluid pressure within the seismogenic zone if it occurs to an appreciable extent there.

She also looked for a common factor in the location of the decollement within the sediment layer arriving at the three subduction zones and concluded that there was no consistency in lithological changes, fluids, clay dehydration or in temperature.

She emphasized the possible importance of organic material, which occurs at all three margins and might mature to oil at ~100C, releasing fluid in the updip part of the seismogenic zone.

(D) Seismic Structure of Subduction Thrusts-

Was discussed the previous day.

(E) Temperature Controls of Seismogenic Zones

Discussed above by Dr. Yamano and discussion

(F) Ancient Subduction Zones

Kevin Brown

Slaty cleavage begins to form at ~200C. There is uncertainty about the time scale of brittle/ductile behaviour at these temperatures; more research is needed on the effects of long-term shearing and on chemical healing of fractures. The Shimanto Belt and Sicily are possible sites.

18. FURTHER DISCUSSIONS WITH JAMSTEC ENGINEERS

(a) OD21 core recovery likely will be better than with present ODP drill ship, because of the riser, the drilling mud and the improved (active) heave compensation. The logging system also has improved active heave compensation. The core length/diameter initially will be the same as for the present ODP system. The lab space will greater and better organized than on the JOIDES Resolution.

The new ship will be 190 m long. Its derrick will be too tall for the bridge at the Panama Canal.

JAMSTEC is studying the effects of mud invasion on core (Dr. Takagawa and Prof. Shyu, Kyushu Univ.). They will use KTB expertise in drilling mud design.

The drill string will be equipped with an industry stand and blowout protector, for safety in case of drilling into hydrocarbons.

The importance of open-hole logs was emphasized and it was queried whether the drill pipe would have a larger internal diameter than on the present ship so that larger diameter logging tools can be used.

The JAMSTEC engineers were invited to the net meeting of the SEIZE DPG. Dr. Takagawa indicated that he would attend.

19. DISCUSSION ON HOW TO FORM WORKING GROUPS (SCIENTIFIC TEAMS)

A model: The San Andreas Fault drilling proposal began with a group to decide the scope and scientific needs, then invited letters of intent. The 200 letters received were sorted, then some authors were invited to write an overall proposal for each scientific subject, concentrating on how their proposal fitted the overall scheme and summarizing its budget, but not describing logistics. The three principal investigators then refined these sub-proposals and integrated them into the final proposal.

The SEIZE situation is more complicated because it depends on a combination of operations and some science via JAMSTEC, and some science, some site surveys, and some special experiments etc. by others scientists in Japan and internationally. JAMSTEC and other Japanese funding agencies will fund Japanese science proposals that have costs in addition to the primary drilling and measurements. Other individuals and groups will have to approach their own national funding agencies. The DPG must develop a science plane for SEIZE on which proposals for funding can be based. A coordinating group would maintain an overview so as to fill in gaps in science caused by lack of proposals for important aspects or failure of some funding proposals (see below).

Roy produced a description of four possible interdisciplinary science groups (based in part on the SAF proposal). Each group might have two leaders of whom one probably should be from Japan, and 4 to 8 members. The description included a initial list of leader's responsibilities. There would be a SEIZE coordinating group consisting of the leaders, for oversight of the entire program.

This proposal has to go to SCICOM and the COMPLEX meeting. A Japanese SEIZE group is being formed; first meeting in April, which could identify candidate Japanese scientific team leaders.

A list was prepared of the desirable scientific skills of the members of each of the four scientific teams (see handout), ranking them as "necessary" or "desirable". The working group may be authorized by SCICOM, although they probably would outlast the present SCICOM. Names need to be proposed soon.

Science Working Groups for Initial SEIZE Drilling

-Number: about 4

-Number of people per group: about 6

-Leaders: suggest two, one from Japan and one International Provide oversight of whole project

-Responsibilities: (a) develop a detailed science plan, including drilling requirements, sampling and measurements, (b) write or assist in writing funding proposals, (c) do science at time of drilling and after.

Types of Experts Needed

1. Site Characterization (geophysical and geological, site surveys etc.)

-seismic structure (multichannel seismic, refraction, OBS, earthquake determined structure, magnetics, gravity etc.)

-Earthquakes (great and micro earthquakes; tectonics)

-Thermal (heat flow, heat generation, heat sources and sinks; thermal modelling)

-Seafloor (morphology, faults, fluid vents; coring and dredging)

-Geodesy (land and seafloor)

2. Downhole Measurements

-Logging

-Accretionary prism hydrogeology

-temperature, fluid sampling, packers, etc.

-seismic structure data, inhole experiments

-stress and strain measurements

3. Sampling and Measurements on Core, Cuttings and Fluids

-sedimentology; paleontology

-structural geology (small scale)

-fluid chemistry, inorganic and organic chemistry, hyrate

-gas hydrate

-physical properties (velocity, resistivity, index properties; geotechnical)

-magnetics

-biology

4. Fault Zone Monitoring

-pore pressure, fluids, temperature, CORK

-downhole recording of earthquakes

-stress and strain monitoring; tectonics, engineering geophysics

-electrical transients, velocity transients note the need for high temperature instrumentation

20. REPORT OF SEIZE DPG TO SCICOM

See agenda for proposed section headings. The chairman will ask individual DPG members to write specific parts.

21. OTHER NOTES

Note, Dick Walcott apparently is responsible for SEIZE session at the COMPLEX meeting.

S. Kodaira is not able to attend next DPG meeting, but will try to find other Japanese representation (JAMSTEC) in his place.

22. NEXT MEETING OF SEIZE DPG

Proposed to be 24-25 May in Victoria, just before COMPLEX meeting in Vancouver.

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