

Seventh EPSP Meeting – January 9-10, 2007
Center for Deep Earth Exploration
Yokohama, Japan

Called to order: The seventh EPSP meeting was called to order by the chair at 9:00, on January 9, 2007 at CDEX, Yokohama, Japan. A brief explanation of the panel's conflict of interest policy was presented.

Welcome: Greg Moore meeting host welcomed attendees and explained meeting logistics.

Self introductions: Self introductions were made by all attendees.

EPSP Members Present: Bob Bruce, Michael Enachescu, Akito Furutani, Masami Hato, Hans Juvkam-Wold, Barry Katz (Chair), Philippe Lapointe, Tadashi Maruyama, Toshi Matsuoka (Vice Chair), Sumito Morita, Bramley Murton, Donald Potts, Jerome Schubert, Craig Shipp, Dieter Strack, Manabu Tanahashi, Toshiki Watanabe, Bill Winters

Guests: Dan Ahern (Safety and Risk Practice), Juichiro Ashi (Proponent 603), Jack Baldauf (USIO), Keir Becker (SPC), Neil DeSilva (TAMU Safety Panel), Earl Doyle (SSP), Craig Fulthorpe (Proponent 600), Akiko Fuse (CDEX), Gwladys Gaillot (JAMSTEC), Colin Graham (ESO), Chikara Hiramatsu (JAPEx), Martin Hovland (TAMU Safety Panel), Atsushi Ibusuki (CDEX), Thomas Janeczek (IODP-MI), Kevin Johnson (NSF), Issa Kagaya (AESTO), Toshiro Kaminishi (CDEX), Susumu Kato (JAPEx/J-DESC), Yoshi Kawamura (CDEX), Yukari Kido (CDEX), Shomi Kobayashi (CDEX), Hans Christian Larsen (IODP-MI), Jean Mascle (EPSP-retired), Dan McConnell (AOA Geophysics), Kyaw Thu Moe (CDEX), Greg Moore (Proponent 603 – Meeting Host), Toru Nagahasi (AESTO), César Ranero (Proponent 537), Hajime Saga (CDEX), Harold Tobin (Proponent 603), Takao Saito (CDEX), Uko Suzuki (CDEX), Shigenobu Uraki (CDEX), Paola Vannucchi (Proponent 537), Hirofumi Yamamoto (Safety Control Office-JAMSTEC), Barry Zelt (IODP-MI)

Approval of prior meeting minutes: Craig Shipp noted a wording change on page 10 of the minutes. With this correction the minutes from the 6th meeting are approved. **Corrected minutes will be included on the 7th meeting minutes CD.**

Agenda Review: The chair noted changes and additions to the agenda since the working agenda was distributed. A request for additional items was made. No additions were made beyond those noted by the chair.

Review of SPC activities: Keir Becker reviewed key actions of the SPC that may directly or indirectly impact EPSP activities. The working FY07-09 schedule was presented. Keir reported that SPC has approved Chikyu for NanTroSEIZE operations into early FY09 as recommended by the project management team and the Operations Task Force. SPC also approved the mission specific platform Great Barrier Reef program for FY08-09 pending the completion of the necessary site survey and a timely review by EPSP. The plans for the SODV were presented. These plans were more in flux because of the delays in the ship returning to active drilling and the outcome of EPSP's pending review of the Canterbury basin proposal. Preliminary plans are being developed for FY09-10 drilling. The activity will be focused on the Pacific basin. Two SASEC, the replacement for SPPOC, meetings were held since EPSP last met. SASEC has 1- formally approved the FY07 drilling plan; 2- initiated a review of the SAS structure; 3- decided to update the initial science plan; 4 and approved a draft mission implementation plan. As noted above a review of the SAS structure is currently underway. Panel members have been asked to provide input. Focus should be on how the process can be improved. From an EPSP standpoint items that might be considered could include when the panel enters the review the process, potential interactions with other panels as well as with mission team, etc. A single response from the panel would be preferred but individual responses would be accepted. Information is due to Keir by January 31. Panel members were reminded of an e-mail requesting that their input be sent to the chair by January 15th to permit consolidation into a single package.

Review of JOI Alliance activities: Jack Baldauf presented the JOI Alliance update. It was reported that there have been a number of management changes within the Alliance since the last EPSP meeting. The update on the SODV noted that costs have increased, while the budget for the upgrade has remained fixed. The original refit included the stretch of the ship. Alternate designs have been developed that do not include the stretch but provide for an increase in capability. The alternate design increases laboratory space, increases the number of berths, improves both the workflow and quality of life on-board. Target date for the start of operations is now November 15, 2007. First expedition will depart from Singapore. Recruiting of co-chief scientists for the scheduled legs has begun. Clearances have not yet been sought for the planned legs. It was also reported that a meeting will be organized to discuss drilling into the "Blue Sand" within the GOM.

Review of ESO activities: Colin Graham presented a summary of ESO activities. The Expedition 310 (Tahiti) report is expected to be published in March 2007. Expedition 313 (New Jersey Shallow Shelf) is expected to be drilled in May 2007 with DOSECC as drilling contractor using a lift boat as the drilling platform. The platform will have limited space and currently does not possess a drilling rig. The availability of the platform needs to be confirmed, a geotechnical survey will also have to be conducted, and necessary permits will need to be obtained prior to drilling. Because of the size of the borehole LWD/MWD will not be performed.

The current hydrocarbon monitoring plan for Expedition 313 is to use a sniffer approach similar to that used while drilling ACEX. A safe background level for hydrocarbons will be defined. Hydrocarbon indications above background will result in the termination of drilling. This background hydrocarbon level has not been determined. Some members of the panel have expressed concerns that a more rigorous monitoring approach is not being implemented. Space restrictions on MSP platforms tend to limit what measurements can be made in real time. The Great Barrier Reef drilling program will probably be the 2008 MSP activity. Several hurdles exist, including a determination as to what the GBR Marine Park Authority requirements will be and the completion of a site survey. The panel reviewed its site survey needs in light of the Tahiti drilling program. The panel recommended the acquisition of high-resolution bathymetric data, the collection of backscatter data, and a high resolution visual record of proposed sites. **Bramley Murton and Donald Potts were asked to draft a suite or preliminary recommendations for the needed EPSP site survey. (A draft version of the Murton and Potts recommendation is attached.) A proponent will be invited to the next EPSP meeting for a preview in order to understand what data are available and to transmit details on the panels needs prior to approval.** Proposal 637 – New England Hydrogeology – is a placeholder for MSP 2009. No site survey data are available. An update to the reef drilling guidelines was presented. **EPSP members are asked to review guidelines and provide recommendations so that the guidelines can be finalized before the June panel meeting.**

Review of CDEX activities: Yoshi Kawamura, CDEX's new liaison to EPSP, presented a summary of CDEX activities. He noted the completion of the shakedown cruise. The primary drilling objective of the cruise was not obtained as result of weather-related issues. High sea-state resulted in damage to the BOP during the emergency disconnect sequence. About 60% of the Shimokita test hole was non-operational time. Chikyu is currently drilling a commercial exploration well. These operations may be considered part of the crew's training at no cost to the program.

Review of SSP activities: Earl Doyle presented a review of SSP activities. He noted the change in the SSP ranking system which now addresses both the availability of data, the prior focus, and the quality of the data. A filtered version of the current proposals site surveys was presented. It was reported that the panel was happy with the new digital Site Survey Data Bank although file size and speed may be a potential issue. A contract has been issued for development of a web-based MATRIX program for providing advice to proponents on likely site survey data requirements. Dale Sawyer is the new panel chair. SSP's next meeting will be in February at Scripps.

Review of IODP-MI activities: Barry Zelt presented a brief overview of the proposal workflow and the current SAS meeting schedule. It was noted that scheduling meetings at Scripps has become complicated because of the costs associated

with hotels. The number of proposals received for the October 2006 deadline was down, only 14 submissions. Although the number of submissions was low it was not currently considered an issue of concern, but simply part of the normal ebb and flow of proposal submissions. There are currently 121 active proposals in the system. The total is lower than when last reported because several inactive proposals were officially deactivated. The “Guidelines for the EPSP Safety Review and Presentation, and Expedition Safety Panel” and “Guidelines for Drillsite Selection and Near-Surface Drilling Hazard Surveys” has been posted on the IODP website.

Review of Proposal 600-Full (Global and Local Controls on Continental Margin Stratigraphy: Canterbury Basin, Eastern South Island, New Zealand): The scientific objectives of Proposal 600 were presented by Craig Fulthorpe. The Canterbury program was developed to be a compliment of the New Jersey margin program aimed at examining the history of global sea level. Unlike the New Jersey margin there is strong local forcing resulting in the development of very large sedimentary drift packages. The specific objectives include: 1- dating of the clinoform seismic boundaries; 2- determining the paleoceanographic record and sequence stratigraphic significance of the sediment drifts; 3- establish the origin of the Marshall Paraconformity; and 4- constrain the erosional history of the Southern Alps. The program targeted drilling the sequence boundaries at a minimum of two locations. It was noted that five commercial exploration wells have been drilled in the general study area. There was little information available shallower than 750 meters. However, it was noted that no hydrocarbon shows were observed in these wells in the stratigraphic section to be penetrated by the IODP boreholes. Dan McConnell presented the results of the shallow hazards assessment for the proposed drilling program. He noted that the available data was not in full compliance with the program's Shallow Water Hazards Guidelines but that he felt they were adequate to identify any potential problems at the proposed drilling locations. The presence of shallow gas was identified in the study area and supported by the presence of bright spots showing flattening and conformance with structure. Shallow gas, however, was not seen as a significant issue at the planned drilled sites. It was generally believed that the ability to image gas was excellent. The character of the sediments also indicated that there was little risk associated with shallow water flow. Following this general overview a site-by-site summary was conducted by the panel. The results are summarized below.

Site Identification	Latitude	Longitude	Approved Depth of Penetration (m)	Comments
CB-01A	44°46.1085'S	171°40.4393'E	780	Depth extended to account for the LWD/MWD tool suite
CB-01B	44°49.2774'S	171°44.9968'E	1023	Depth extended to

Site Identification	Latitude	Longitude	Approved Depth of Penetration (m)	Comments
				account for the LWD/MWD tool suite
CB-01C	44°50.7113'S	171°42.7941'E	976	Depth extended to account for the LWD/MWD tool suite
CB-02A	44°50.8274'S	171°47.2079'E	800	Depth extended to account for the LWD/MWD tool suite
CB-02B	44°51.8507'S	171°48.6836'E	918	Depth extended to account for the LWD/MWD tool suite
CB-03A	44°53.4453'S	171°50.9851'E	1318	Depth extended to account for the LWD/MWD tool suite
CB-03B	44°53.0308'S	171°50.4059'E	1249	Depth extended to account for the LWD/MWD tool suite
CB-04A	44°56.0933'S	172°01.1532'E	1270	Depth reduced from that originally requested because of concerns associated with a package a high amplitude reflectors
CB-04B	44°56.2443'S	172°01.3629'E	1913	Depth extended to account for the LWD/MWD tool suite
CB-05A	44°40.9068'S	172°33.1125'E	---	Not approved because of concerns associated with the possibility of shallow gas
CB-05B	44°41.6069'S	172°32.1071'E	1783	Depth extended to account for the LWD/MWD tool suite
CB-05C	44°41.5230'S	172°33.9178'E	1625	Depth reduced from that originally requested because of high amplitude reflectors below the "Green" Reflector
CB-05D	44°41.6521'S	172°32.1686'E	1783	Depth extended to

Site Identification	Latitude	Longitude	Approved Depth of Penetration (m)	Comments
				account for the LWD/MWD tool suite
CB-05E	44°41.5377'S	172°32.2100'E	1789	Depth extended to account for the LWD/MWD tool suite
CB-06A	45°1.7773'S	172°3.0437'E	---	Not approved because of concerns associated with the possibility of gas. An alternate site (CB-06B) was selected.
CB-06B	45° 2.2126' S	172°3.7098'E	1106	Depth extended to account for the LWD/MWD tool suite. New site located at CDP 408 on Line 66. Approved depth is the "Green" reflector plus 50 meters – as per e-mail of 1/19/2007 – Reported lat/long also reflects a correction.

It should be noted that the "Shallow Hazards Guidelines" would suggest that at CB-03A and CB-03B BOP and well control measures are required. EPSP did not recommend or require such measures be included in the drilling program. **Final approval for Site CB-06B is contingent upon the completion of the "safety sheet" for and its delivery to the EPSP Chair and IODP-MI.**

Bob Bruce is the EPSP watchdog for this proposal.

Update on Proposal 595 (Indus Fan-Murray Ridge): Craig Shipp, as watchdog, presented an update on the Indus Fan-Murray Ridge proposal. The presentation focused on location MU-1C. Shipp noted that several of the issues raised by the panel have now been resolved including the phase of the dataset. The character of the subsurface geophysical anomalies has been examined. The available dataset does not display evidence for hydrocarbons throughout much of the section to be penetrated. There are potential issues within the sedimentary sequence immediately above basement. The data further suggest the presence of gas hydrates in the region. A BSR has been identified between 200 and 280

meters below the seafloor. The mound on which MU-1C is located has been identified as an erosional remnant associated with mass transport. Data from a well to be drilled by Shell will most probably be made available to the project providing support for the velocity and pressure assessment at MU-1C. Although no major safety risks have yet been identified Shipp recommends that considering the proposed depth of penetration (~3.8 km) and the presence of active mud diapirism in the region that a shallow hazards assessment and pre-drill pore pressure assessment be made.

Following discussion **EPSP requests that OTF work with the appropriate IO(s) to initiate a shallow hazards survey and contract for an independent pore pressure prognosis.**

Review of Proposal 537A (Costa Rica Seismogenesis Project CRISP Program A):

Paola Vannucchi presented a brief overview of the scientific objectives of CRISP. The program was developed to sample and quantify input into a seismogenic zone along an erosive margin and specifically penetrate the rupture area. The drilling program is divided into two parts a non-riser program, which includes five sites along a transect, and a riser program that focuses on decollement drilling. The specific objectives of Part A, the focus of this review, are: 1- the characterization of the subducting oceanic sediment and oceanic basement; 2- constraining the fluid/rock interaction along the plate boundary; 3- the estimation of the character of the upper plate material entering the subduction channel; and 4-the measurement of the stress field across the seismogenic zone to determine the degree of locking.

Meeting was recessed: 17:20

Meeting called back to order: January 10 at 9:00

Housekeeping reminders: The chair reminded panel members of the reply dates for the requested input on Keir Becker's request for input on the SAS structure and the need to review the updated reef drilling guidelines before the next panel meeting. The chair also recommended that ESO consider using the geotechnical cores as a means to establish the background hydrocarbon level for the hydrocarbon monitoring program to be used during the New Jersey margin. **Colin Graham stated that he will provide to the panel plans on how they plan on using the "sniffer" as a hydrocarbon monitoring tool.**

Continuation of Review of Proposal 537A (Costa Rica Seismogenesis Project CRISP Program A):

César Ranero presented a geophysical overview of the study area. This review included a summary of the acquisition and processing parameters. It was noted that along the margin there have been approximately 125 mounds representing fluid escape structures identified, but no such features were identified in the immediate vicinity of the drilling sites. It was also noted that within the study area very little stratigraphy could be traced from one line to the

next. Following the overview a site-by-site review was conducted. The results are presented below.

Site Identification	Latitude	Longitude	Approved Depth of Penetration (m)	Comments
CRIS-1A	8° 25.71474'N	84° 9.47028'W	350	Depth extended to account for the LWD/MWD tool suite
CRIS-5A	8° 27.633'N	84°7.482'W	350	Depth extended to account for the LWD/MWD tool suite
CRIS-2B	8° 29.02044'N	84°7.8405'W	800	Depth extended to account for the LWD/MWD tool suite Borehole will penetrate a BSR Panel has requested that LWD/MWD operations take place prior to coring operations
CRIS-3A	8°35.23956'N	84°4.7785'2W	---	Not approved. Panel was concerned with a series of undefined bright reflections that would have been penetrated by the borehole. It was also noted that the position of the borehole presented on page 29 of the Safety Package was not correct. The cited latitude and longitude is correct EPSP relocated the site
CRIS-3B	8°35.54136'N	84°4.63062'W	1000	Alternate for CRIS-3A. Located at shotpoint 2500 on line BGR99-7 Approved penetration accounts for the

Site Identification	Latitude	Longitude	Approved Depth of Penetration (m)	Comments
				greater depth required to reach objective and to accommodate the LWD/MWD tool suite
CRIS-4A	8°40.84962'N	84°2.0169'W	1050	Depth extended to account for the LWD/MWD tool suite Also note that the depth approved represents that included in the presentation rather than that included in the Safety Sheet

Final approval for CRIS-3B is contingent upon submission by the proponents of a completed set of safety sheets, including latitude/longitudes. The panel also strongly recommended that the proponents prepare and submit a suite of alternate and contingency locations. It was agreed that they will attempt to prepare such locations for submission to the panel for review prior to the meeting's adjournment.

Bramley Murton is the EPSP watchdog for this proposal.

Review of Proposal 603 NanTroSEIZE Stage 1 (Nankai Trough Seismogenic Zone Experiment): Greg Moore presented the scientific justification for the program and a site-by-site review. The program represents the culmination of a number of interdisciplinary studies aimed at the quantification of lateral changes along the subduction thrustsheet. The region selected has a long history of great (8+) earthquakes, has been well-imaged, and is located in a position that long-term monitoring is possible. Stage 1 includes five expeditions using both the Chikyu and the SODV. Stage 1 activities call for LWD/MWD of all sites prior to coring. Prior DSDP and ODP drilling results were briefly reviewed. Moore also reviewed possible safety issues that the proponents have identified. The panel recommends that they check on cable positions. The site-by-site review will focus on the stage 1 drilling program. If, however, there are potential issues identified in the deeper section they will be noted. The results are presented below.

Site Identification	Latitude	Longitude	Approved Depth of Penetration (m)	Comments
NT2-01B	33°13.320'N	136°42.200'E	1200	Approved as requested
NT2-01C	33°13.7035'N	136°43.0353'E	1200	Approved as requested
NT2-03B	33°14.300'N	136°42.650'E	1250	Approved as requested No issues identified in the deeper sequence Velocity analysis should be completed to improve depth estimation for the deeper section
NT2-03C	33°13.9075'N	136°41.811'E	1250	Approved as requested No issues identified in the deeper sequence Velocity analysis should be completed to improve depth estimation for the deeper section
NT3-01B	33°18.020'N	136°38.180'E	1400	Approved as requested A BSR was identified. Velocity analysis should be completed to improve depth estimation for the deeper section
NT3-01C	33°18.650'N	136°40.120'E	1400	Approved as requested Velocity analysis should be completed to improve depth estimation for the deeper section
NT2-04B	33°23.050'N	136°36.460'E	1400	Approved as requested
NT1-04C	32°54.000'N	136°51.110'E	1500	Approved as requested
NT1-01A	32°44.8878'N	136°55.0236'E	800	Request to deepen the previously

Site Identification	Latitude	Longitude	Approved Depth of Penetration (m)	Comments
				approved location was approved
NT1-07A	32°49.730'N	136°52.890'E	1400	Request to deepen the previously approved location was approved Panel requested that LWD/MWD be performed as part of deepening of the hole from the originally approved 1120m
NT1-03A	33°1.23258'N	136°47.94852'E	1800	Approved to deepen to 1800 meters The request was to deepen to 2700m from the originally approved 700m EPSP expressed concerns whether the site was actually drillable because of surface slope Recommended that alternate sites be selected
NT1-03B	33°1.635'N	136°47.639'E	1800	Added site Approved as requested
NT1-03C	33°2.000'N	136°47.403'E	1800	Added site Approved as requested

Final approval for sites NT1-03B and NT1-03C is contingent upon submitting the safety sheets to the EPSP chair and IODP-MI.

Sumito Morita is the EPSP watchdog for this proposal.

Discussion on CDEX Safety Review and Communication Protocols: Yoshi Kawamura presented the current working view of the safety process for Chikyu. It was noted that it was very different from that employed by either ESO or USIO but that it not need be identical. The discussion that followed suggested that there is a need for commonality for non-riser approvals. It was also suggested that there was a need for earlier engagement with EPSP than proposed for riser

operations. EPSP is currently previewing potential riser programs without the benefit of CDEX participation. It was also noted that EPSP provides only recommendations rather than final approvals. Kawamura suggested that this should be considered the beginning of a dialog on this topic and that additional discussion should follow at future meetings.

Review of additional sites proposed by Proposal 537A proponents: César Ranero presented a site-by-site review of the alternate/contingency locations.

Site Identification	Latitude	Longitude	Approved Depth of Penetration (m)	Comments
CRIS-7A	8°25.38186'N	84°9.63408'W	310	Alternate for CRIS-1A Approved as requested at CDP 5850 on Line 7
CRIS-8A	8°25.35666'N	84°8.60154'W	370	Alternate for CRIS-5A Approved as requested at CDP 5700 on Line 9
CRIS-9A	8°29.3274'N	84°7.69308'W	980	Alternate for CRIS-2B Approved as requested at CDP 4550 on Line 7
CRIS-10A	8°35.99802'N	84°4.4037'W	800	Alternate for CRIS-3B Approved as requested at CDP 2350 on Line 7
CRIS-11A	8°39.94296'N	84°2.46624'W	1120	Alternate for CRIS-11A Approved as requested at CDP 1050 on Line 7

Final approval for sites CRIS-7A, CRIS-8A, CRIS-9A, CRIS-10A, and CRIS-11A is contingent upon submitting the safety sheets to the EPSP chair and IODP-MI.

Next Meetings: The date for the 8th EPSP meeting was set for June 18-19, in Houston, TX. The meeting host will be Barry Katz. The agenda will tentatively include previews of Great Barrier Reef, Indus Fan/Murray Ridge, and Santa Barbara. Additional agenda items may be added based on the discussions at the upcoming SPC meeting. The dates for 9th EPSP meeting were tentatively set for November 29-30. Meeting host will be Dieter Strack and the meeting will be held in Germany.

Update on LWD/MWD operational templates: Kyaw Thu Moe presented an update on the LWD/MWD operational template. A preliminary template has been developed by CDEX and USIO and will be circulated to ESO. It is currently being viewed as an evergreen document that will continue to be revised as experience is gained during operations. It was noted that there would be different templates for riser and non-riser operations.

Update on operational protocol for NanTroSeize: Kyaw Thu Moe presented the update for the two operators. Among the key revisions was the change in the number of pilot holes and the defining of the monitoring program during their drilling. Further updates will be presented at future panel meetings.

Other new business: The request from Michael Riedel for a contribution on EPSP's perspective on hydrate drilling to an AGU volume on hydrates was discussed. Toshi Matsuoka and Sumito Morita volunteered to develop a first draft if there was sufficient time, with Bob Bruce and Craig Shipp volunteering to aid in revising the first draft. Barry Katz said that he would advise Michael Riedel and ask that he coordinate with the authors.

Craig Shipp noted the quality of the safety packages and presentations and made the job of the panel significantly easier.

Dieter Strack noted that he found the electronic flipping between datasets during the shallow hazards review of Proposal 600 was less than ideal. It was suggested that we might consider either multiple projectors/screens or that the presentations be multimedia, including paper copies to place the data into a more regional perspective.

Acknowledgements: EPSP thanks Greg Moore and the CDEX for acting as host.

Adjournment: Meeting was adjourned at 16:45.

RECOMMENDATIONS BY BRAMLEY MURTON AND DONALD POTTS FOR GREAT BARRIER REEF SITE SURVEY

Consider potential (and relevant) hazards:

Geohazards?

Risks to biological/ecological systems?

Corals

Mammals?

Benthic communities (algal, microbial, infauna ...

Other (e.g. issues from Tahiti experience)?

Noise/vibration?

Desirable information for assessing risk (cf. IODP Reef Drilling Guidelines)

Location- shelf, shelf-slope break, slope...

Setting - reef, non-reef...

Surface = soft, consolidated, structural ...

Water depth

Geomorphology

Structural model, basement ...

Biological communities & scale of patchiness

Indicators of fluid discharges (physical, biological, chemical ...

Transport indicators (currents, waves, tides, erosion, slumping sedimentation ...

Summarize and evaluate relevance/quality of existing data?

Seismic

Bathymetry

Biological surveys

Oceanographic (currents, upwelling ...

Sedimentary ...

Evaluate Available/Feasible technologies

High resolution seismic (3D?)

Casing and plugging (cf. IODP Reef Drilling Guidelines)

Suggested Approach

EPSP is aware that even the best available seismic data from shallow reef and sedimentary carbonates may not be very informative about sub-surface structures. Therefore interpretations based on visualization of the seafloor are likely to be critical. For evaluation of proposed drilling sites, we suggest an approach based on integration of at least three data types:

1. High spatial (decimetric) & vertical resolution multibeam

→ 3D Digital Bathymetric Model (DBM) 10% overlapping lines; 100% coverage (SNIPPET backscatter data from multibeam at higher spatial resolution resolution than bathymetry)

2. High resolution sidescan

→ backscatter imagery co-located with multibeam at similar resolution to multibeam (e.g. 300-500kHz) fully processed (beam pattern, shading, georeferencing)

→ drape over DBM

60% Overlapping lines for probable targets (eliminate track line anomalies)

3. High resolution bottom imaging (paired lasers for scale)

Photographic imaging at high-resolution (at least some at millimetric scale for species identification). Mosaics of photos to cover each proposed site before and after drilling: 100% cover for a radius of 5-10 m around hole; partial cover to >50m. Crossing line traverses of photos both parallel and perpendicular to the reef margin over a distance of 200m, centred on proposed site. Suggested imaging systems: Towed camera, ROV, UAV

4. Scuba examination (of shallowest sites)

N.B. Photographic/Scuba design should include provision for pre- and post-drilling monitoring.