SCIMP Appendix 99-1-9

Borehole Research Group Operator Report

Cruise Highlights:

Leg 179 revisited Site 735 to conduct experiments with the Hammer-In drill casing and other operations as time permitted. After reaching a depth of 158 meters below seafloor at Hole 1105A, four toolstrings were deployed. The FMS acquired exceptionally high quality data. FMS images of Hole 1105A show layers of resistive rock with 1 to 6 m thick conductive material occurring at irregular intervals. The conductive areas correlate quite well with the oxide and olivine oxide gabbro lithologic units defined in the core, and the resistive intervals correspond to gabbro and olivine-bearing gabbro.

The first Seismic-While-Drilling pilot sensor experiments were conducted at Site 735 and NERO. Preliminary data analysis shows considerable success in recording the drill pipe acceleration signal under various drilling conditions. Post-cruise analysis of the data will be done to correlate with the seafloor OBS data and to evaluate future technology developments for active heave compensation and measurement-while-coring.

During Leg 180, four sites were logged with Triple Combo and FMS/Sonic toolstrings, and vertical seismic profiles were obtained at three sites, making this one of the most successful ODP logging legs to date. The logs offer significant aid in the effort to correlate the drilled sequences between holes. For instance, layers identified in Hole 1118A showing low gamma ray, low porosity, and high sonic velocity appear as thinner (compacted) intervals in Hole 1109D, and can be correlated with a prominent seismic reflector. Clay indicators in the corresponding sedimentary units may explain these differences.

During Leg 181, four holes (1119C; 1123B; 1124C; 1125B) were logged using the Triple Combo; the FMS/Sonic, and the GHMT toolstrings despite very rough weather and a shortened drilling and logging program. Pronounced sediment cyclicity, relating to glacial/interglacial climate change, was observed in the gamma and magnetic susceptibility logs from each hole and a critical correlation was made between core and log-based magnetic susceptibility to position missing sections of core. Sonic velocity data were used to calculate the depth to major seismic reflectors and identify target horizons.

Engineering and Software Developments:

The Drill String Acceleration tool (DSA) is being developed to measure and record the drill bit acceleration and vibration signals by instrumenting a core barrel with accelerometers and other sensors. The design will provide for enough internal memory to continuously record high volumes of data for at least 1-2 hr. per deployment. Future expansion of this design is under discussion. DSA target deployment is Leg 185.

A meeting between LDEO and TAMU engineers was held November 12th at LDEO to conduct a design review of the DSA and to discuss new developments in FY 99 plans for active heave and measurement while coring. Measuring uphole and downhole acceleration during Leg 185 in a joint experiment were set in motion, and utilizing off-the-shelf MWD tools to measure weight-on-bit during 1999 was discussed. These short- and medium-term development plans were presented to TEDCOM on November 19-20.

The dipole shear sonic imager (DSI) was shipped to Wellington for standard and routine use in the wireline logging operation. The DSI will be deployed as part of the FMS-Sonic toolstring.

I. MANAGEMENT

Meetings and Events

The Scientific Measurements Panel (SciMP) met at LDEO from June 29 through July 10. Gerardo Iturrino hosted, Dave Goldberg and Mary Reagan also attended the meeting.

Pat Williams (JOI) was updated on recent activities with regard to the Year 2000 effort.

The FY 00 Logging Prospectus was reviewed by ODP Logging services personnel prior to submission to the JOIDES office for SCICOM. A qualitative list of logging costs for the outyear proposals was revised for SCICOM as well.

The dipole shear sonic imager (DSI) was shipped to Wellington for standard and routine use in the wireline logging operation. The DSI will be deployed as part of the FMS-Sonic toolstring.

Personnel

Walt Masterson from IRIS was hired to fill the vacant Engineering Assistant position at BRG.

Ulysses Ninnemann from SIO was selected for the open Logging Scientist position at BRG.

Ted Baker was hired to fill the open Database/Systems administrator position at BRG.

Florence Einaudi replaced André Revil as a logging scientists at Aix-en-Provence.

II. STANDARD LOGGING OPERATIONS

Leg 179 -NERO/Hammer Drilling

Leg 179 revisited the SWIR Site 735 to conduct experiments with the Hammer-In drill casing and other operations as time permitted. With several additional days on site, Hole 1105A was drilled and logged. After reaching a depth of 158 meters below seafloor at Hole 1105A, four toolstrings were deployed. The FMS acquired exceptionally high quality data. FMS images of Hole 1105A show layers of resistive rock with 1 to 6 m thick conductive material occurring at irregular intervals. The conductive areas correlate quite well with the oxide and olivine oxide gabbro lithologic units defined in the core description. Conversely, the resistive intervals correspond to gabbro and olivine-bearing gabbro.

The log data were particularly useful in identifying in situ features. Temperature measurements indicate an increasing hydrothermal gradient of 1˚C/100 m with perturbations likely occurring as a result of drilling mud pumped downhole. As the borehole equilibrated to hydrostatic pressure and normalized temperature, water flowing from zones of secondary porosity (fractures) may have altered the temperature of the borehole fluid. The most notable example occurs over a 2-m thick zone at 102-104 mbsf which represents a 0.6˚C increase in borehole fluid temperature. Other in-situ measurements at this interval confirm the existence of an enlarged borehole, increased porosity, lower velocity zone. The FMS log indicates fractures and only pebble or gravel-sized material was recovered in this interval.

Leg 179 also occupied the NERO site to drill and establish a long term borehole observatory. Time constraints precluded logging or other downhole experiments before leaving the site for Darwin.

The first Seismic-While-Drilling pilot sensor experiments were conducted at Site 735 and at NERO. Preliminary data analysis shows considerable success in recording the drill pipe acceleration signal under various drilling conditions. Post-cruise analysis of the data will be done to correlate with the seafloor OBS data recorded at both sites and to evaluate future technology developments for active heave compensation and measurement-while-coring.

Leg 180 -Woodlark Basin

The objectives of Leg 180 were to determine the sedimentology, biostratigraphy, and vertical motion history of the syn-rift sediments on the hanging wall margin to the Moresby low-angle normal fault. The nature of the forearc basin sequence beneath the rift onset angular unconformity was thwarted by the unexpected presence of an undrillable conglomerate of dolerite and basalt cobbles in an altered clayey silty matrix.

Sites 1109, 1114, 1115, and 1118 were all logged with Triple Combo and FMS/Sonic toolstrings, and vertical seismic profiles were obtained at Sites 1118 (complete), 1109 and 1115 (partial), making this one of the most successful ODP logging legs to date. The logs offer significant aid in the effort to correlate the drilled sequences between holes. For instance, layers identified in Hole 1118A showing low gamma ray, low porosity, and high sonic velocity appear as thinner (compacted) intervals in Hole 1109D, and can be correlated with a prominent seismic reflector. Clay indicators in the corresponding sedimentary units may explain these differences.

Hole 1115C was successfully logged above 784 mbsf with Triple Combo and FMS/Sonic toolstrings across a major regional unconformity that is also observed in Hole 1109D. The well seismic tool was used to record check shots near the base of the hole, allowing depth correlation with seismic reflection lines and better migrate existing multichannel seismic data

Leg 181 - SW Pacific Gateways

The scientific objectives of Leg 181 were to investigate the Cenozoic evolution of the Deep Western Boundary Current (DWBC) and the Antarctic Circumpolar Current (ACC), through the Southwest Pacific Gateway, to the east and southeast of New Zealand.

Four holes (1119C; 1123B; 1124C; 1125B) were logged using the Triple Combo; the FMS/Sonic, and the GHMT toolstrings despite very rough weather and a shortened drilling and logging program. Pronounced sediment cyclicity, relating to glacial/interglacial climate change, was observed in the gamma and magnetic susceptibility logs from each hole and a critical correlation was made between core and log-based magnetic susceptibility to position missing sections of core. Sonic velocity data were used to calculate the depth to major seismic reflectors and identify target horizons.

Distinct lithologic boundaries were recognizable in the logs, in particular, the K/T boundary, which was marked by a pronounced high in resistivity and a concomitant drop in magnetic susceptibility. The logs at this hole are vital for filling in a 17-m interval just with zero recovery.

Leg 182 Great Australian Bight

Leg 182 was designed to drill a transect of holes across the western Great Australian Bight margin, from shelf edge to the continental rise to establish a basic stratigraphy for these Cenozoic sequences.

Hole 1126D was logged and the data have bee useful for correlating the part of the section measured through pipe (upper 116 mbsf) with core measurements. A check shot survey allowed the time-depth curves derived from seismic stacking velocities to be correlated with confidence between sites

Site 1128 was successfully logged with the Triple-Combo and FMS/Sonic toolstrings to distinguish nannofossil ooze interbedded with variably indurated sandstone turbidite beds. These interbedded sediments are reflected as alternations of low gamma ray, high density, and resistive intervals corresponding to calcite-rich layers and high gamma-ray, low density, and conductive intervals corresponding to sandstones.

III. SPECIALTY TOOLS AND ENGINEERING DEVELOPMENTS

Temperature and Acceleration Pressure Tool (TAP)

Pressure testing of two TAP tools built to replace the TLT tools was successfully completed at WHOI. One tool was shipped to Wellington for deployment on Leg 182. Final machining of parts for the second tool will be completed and assembled at LDEO by December 1998.

DSA - Drill String Acceleration/Active Heave Compensation

The Drill String Acceleration tool (DSA) is being developed to measure the effectiveness of the passive heave compensator and evaluate future active heave compensation developments in ODP. The primary purpose of the tool will be to measure and record the drill bit acceleration and vibration signals by instrumenting a core barrel with accelerometers and other sensors. The design will provide for enough internal memory to continuously record high volumes of data for at least 1-2 hr. per deployment. Future expansion of this design is under discussion. DSA target deployment is Leg 185.

A meeting between LDEO and TAMU engineers was held November 12th at LDEO to conduct a design review of the DSA and to discuss new developments in FY 99 plans for active heave and measurement while coring. Measuring uphole and downhole acceleration during Leg 185 in a joint experiment were set in motion, and utilizing off-the-shelf MWD tools to measure weight-on-bit during 1999 was discussed. These short- and medium-term development plans were presented to TEDCOM on November 19-20.

Dry Dock Operations

During Leg 179, multiple measurements and specifications were acquired for the August 1999 dry dock. Plans are underway to install a fan-coil air-conditioner, upgrade the existing workspace in the DHML, instrument the rig-floor to record drilling parameters, and to replace the Schlumberger MAXIS system with the latest-generation data acquisition cab. Vendor selection is currently in progress.

IV. SHIPBOARD LOG ANALYSIS

Core Log Integration Platform (CLIP)

CLIP efforts during this period focused on preparation of the Sagan software module for deployment during Leg 182. Efforts also concentrated on the training of logging scientists for upcoming legs in the use of Sagan.

Coding efforts developed the ability to link core and log depths at decimeter resolution. Sagan can now perform all three of the main core-log correlation options: (1) raw core mbsf to mld; (2) composite (Splicer output) core to mld; and (3) single spliced core record to mld. An optimal correlation can be defined using multiple datasets from multiple holes. The result is a color coded “map” showing stretch/compression and log offset values where the core-log correlations are highest.

V. SHOREBASED LOG ANALYSIS

ODP Conventional Data:
The following holes were processed and prepared for inclusion in the database at LDEO-BRG:
Leg 179: Hole 1105A
Leg 180: Holes 1108B, 1109D, 1114A, 1115C, and 1118A
Leg 181: Holes 1119B, 1123B, 1124C, 1125B
Leg 182: Holes 1126D, 1127B, 1128B, 1129D, 1130C, 1131A, 1132C, 1134A

FMS processing:
The following holes were processed at the Aix-en Provence (France) processing center:
Leg 178: Hole 1103A
Leg 179: Hole 1105A
Leg 180: Holes 1109D, 1114A, 1115C, 1118A
Leg 181: Holes 1119D, 1123B, 1124C
Leg 182: in progress

GHMT processing:
The following holes were processed at the Aix-en Provence (France) processing center:
Leg 178: Holes 1096C, 1103A
Leg 181: Holes 1119C, 1123B, 1124C
Leg 182: Holes 1126D, 1127B

Temperature processing:
The following holes were processed at LDEO-BRG:
Leg 174B: Hole 395A
Leg 175: Holes 1077A, 1081A, 1082A, 1084A, 1085A
Leg 176: Hole 735B
Leg 177: Hole 1093D
Leg 178: Holes 1095B, 1096C, 1103A
Leg 179: Hole 1105A
Leg 180: Holes 1108B, 1109D, 1114A, 1115C 1118A

Historic data processing

All processed GHMT data and relative documentation are currently being formatted for inclusion in the on-line database. Legs 160-178 (total of 23 holes) have been reviewed and formatted. Legs 160, 162, and 165 (8 holes) need partial processing or revision; Leg 134, 145, 154, and 155 (7 holes) require processing.

Training

Alex Isern visited LDEO for additional training prior to her participation as JOIDES Logger on Leg 182 and to use GeoFrame to continue her analysis of Leg 166 log data.

Patrick Fothergill (LUBR), Guy Spence (LUBR), Andre Revil (LMF), Mads Huuse (Denmark), and Dave Handwerger (Utah) visited LDEO for training in preparation for their participation as Lamont Loggers on Legs 181-183.

Christine Lauer and Qingmou Li received training at LDEO in preparation for sailing on Leg 184.

Software training was provided to David Mallinson (Univ. South Florida) on Sagan and Splicer, Steve Clemens (Brown University) on Splicer, and Alexandra Isern (Univ. of Sydney) on Sagan.

VI. DATABASE

The ODP Log Database has been updated through Leg 182, including Schlumberger original and processed data (conventional, geochemical, and FMS), specialty tools (borehole televiewer, multichannel sonic, and temperature), borehole images, and sonic waveforms.

On-line Database Development Project

On-line conventional data for both wireline and Logging-While-Drilling (LWD) now exists for all legs, along with any available *Initial Reports* plots, processing documentation, and file dictionary relative to each hole. Proprietary data now include Legs 177 through 182.

ODP Logging Services personnel worked with David Divins (NGDC) to develop a plan for insuring that the NGDC archive of ODP log data contained complete and up-to-date information.

Post-Cruise Distribution of Log Data

Composite logs of the processed data of Legs 179 through 182 were made available to the shipboard party.

The log data CD-ROMs for Legs 172-175 have completed and sent to Friesen Printers for distribution.

APPENDIX 99-1-10

SciMP Jan. 1999 Curation Report

1) Curatorial Statistics

See attached tables/figures.

Samples issued and # Requests completed reflect the large amount of sampling party activity at the BCR in FY98, where most new FY98 cores were stored, and also reflects the effort to minimize shipboard sampling on high recovery cruises. The GCR and ECR (which has more recent ODP cores as well as DSDP cores) stayed at a 'base' level of about 9-11,000 samples per year , which is indicative of a repository that didnt receive new core. Only the WCR, which only has DSDP cores and no ODP cores, had a very low level of sampling acitivity.

Visitors to each repository reflects the large amount of sampling party activity at the BCR, leaving little time to accomodate educational groups and tour groups. On the other hand, the WCR had very little sampling activity, and has ample time to accomodate large groups of (mostly) students from regional schools and colleges. Both the ECR and WCR have regularly scheduled open houses/school visits each year.

Days to complete post moratorium sample requests shows that 50% of requests are filled within 3 weeks of the date of the request, 75% are filled within 6 weeks, and 88% are filled within two months. The long tail on the curve that stretches out to 284 days is explained mainly by three scenarios: (a) scientists who wish to visit repositories to view and sample cores themselves often send in their requests months before they schedule their visits. (b) 3 large sampling parties at BCR, which took >50,000 samples, required several months of dedicated work from the BCR staff. For several weeks before and after each sampling party last year, requests not associated with the sampling parties (i.e., post moratorium requests) were put on hold. This caused a delay in completing these other requests. (c) Both the ECR staff and WCR staff were called upon to sail on the ship much more than usual in FY98, because one of the shipboard curatorial reps has been onshore due to an injury. Therefore, both of these repositories were understaffed for several months during the FY, resulting in a delay in completing some requests.

2) Permanent Archive Sampling

5 PA requests since new policy allows them. All have been approved by CAB. Only one required significant revision/reduction in size and number of samples before approval. Total # samples taken: 117 for 4 requests. Most samples <2cc vol. 5th request not sampled yet.

3) Museum Displays/Conference Displays

Museum loans:

a) Smithsonian (#15010): several igneous rocks - long term display.
b) Smithsonian (#15948A): K/T boundary core - approved for 2 year extension till 2001.
c) American Museum of Natural History (#16325A): one Miocene core and one Quaternary core for display on climate change - long term display (up to 30 years).

Conference Displays:

2 requests in FY98: both showing Leg 139/169 sulfide cores.

4) Personnel

One new FTE position approved for GCR for FY99. interviews in progress.
One FTE position at WCR cut in FY99 because of low sampling activity
One vacant FTE position at ECR filled.

Repository Staff sailed on 5 ODP legs in FY98, either as additional curatorial staff on heavy coring legs (175, 176, 177) or to fill shipboard curatorial position (178, 180).

5) Reprint Collection/Bibliography DB

Since the ODP reorganization in Dec. 1996, upkeep of the Curatorial Bibliographic Database has been of low priority because of many other more pressing database projects. All outside journal reprints received, which are related to sample requests, have been updated in the database through summer, 1997. However, only ODP papers up to SR Vol. 145 (up to Dec., 1996) have been entered into the database, an additional 590 papers have been published in SR volumes 146-160, to fulfill sample request obligations, and these papers will be added into the bibliographic database in FY99. In order to compare # of ODP requests versus # of papers published to fulfill obligations, the following numbers are based on data from 1985 to Dec. 1, 1996.

Requests: 5245

Publications linked to sample requests: 3277 (of these 1866 are in ODP SR volumes, and 1411 are in outside journals).

Requests that do not have publications linked to them yet: 1968 (of these many will be in the ODP SR vols. 146-160, but not entered into the database yet).

It is important to note that it is common for one request to produce several papers, and in a few cases one paper may be linked to 2 or more requests because of collaboration between scientists. So there is not a 1-1 correspondance between # requests and # publications.

6) Core Wrapping Project

In FY98, 3717 core sections (mostly archive halves) were wrapped with plastic wrap. Most of these were done at the ECR where summer student support was used. Since then, the ECR has not yet been able to find a student assistant to hire. As soon as someone is hired, they will continue this project at the ECR.

In FY98, the BCR was too busy with sampling parties to begin this project. As of October 1998, the BCR has hired student support and is actively wrapping their colleciton, beginning with the most recent legs (178 and working backwards.

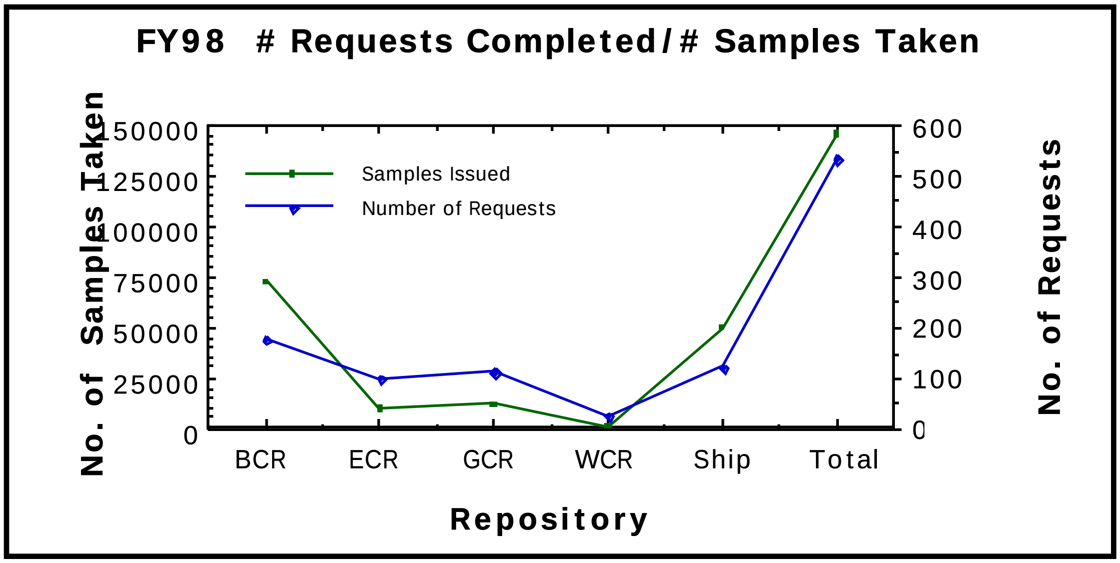
The GCR had some student support in spring 1998, but was unable to find student support in the summer to work on this project. Beginning in October 1998, a dedicated student has been hired to work on this project.

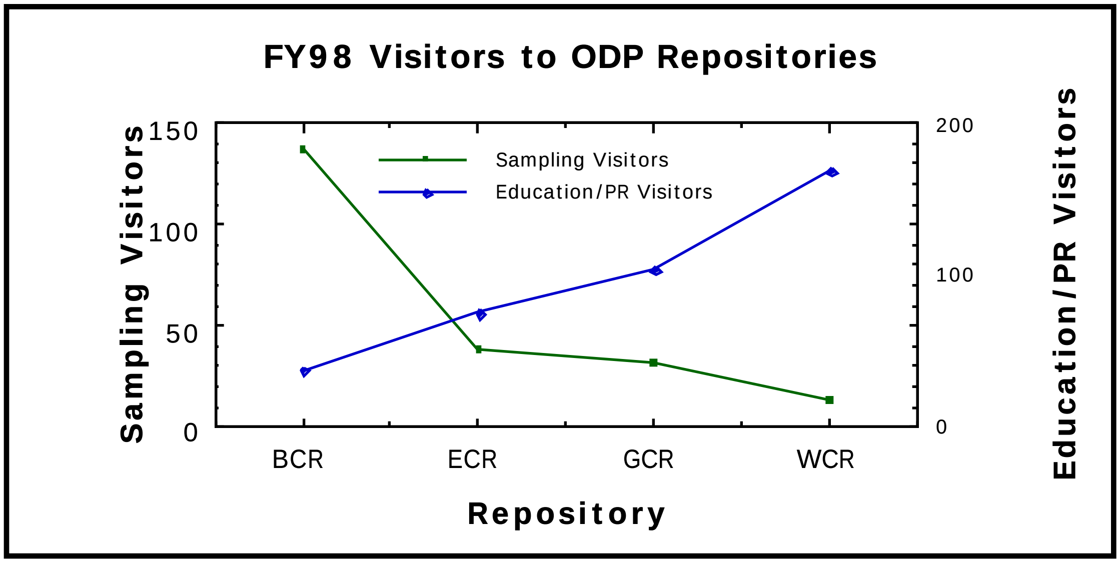
The ODP Curator decided to put the WCR on hold for this project because of questions about effectively wrapping old, drier cores. These questions were answered at a Core Curators Conference in Oct. 1998. The WCR will begin this project in Jan. 1999, with a student assistant.

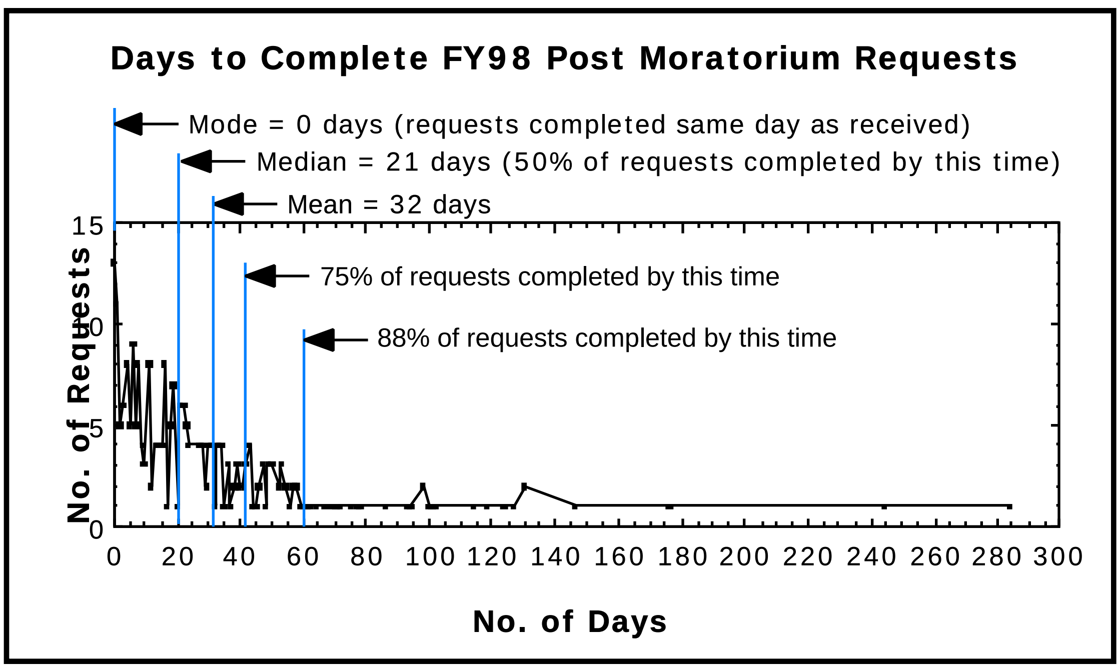
As of Jan. 1, 1999, ODP has wrapped a total of 8343 sections. BCR is concentrating on wrapping archive halves, form younger to older legs, and is curently working on Leg 177 cores. GCR is concentrating on wrapping new legs as they come in, and is currently on Leg 180. They will work no 181, 182, etc. as they come in. ECR will concentrate on wrapping APC archive cores form the youngest ODP legs, working towards older legs, and has already wrapped Legs 174 and most of 150. WCR will concentrate on wrapping APC archive cores from its youngest cores and work backwards.

7) GCR Building Expansion

The GCR has had an 11,000 ft2 addition completed as of mid-January, 1999. This new refridgerated and warehouse space should accomodate new ODP cores for up to 10 years, depending on the ships operational area.


FY98 # Requests Completed/# Samples Taken
No. of Samples Taken
No. of Requests
Samples Issued
Number of Requests
150000
125000
100000
75000
50000
25000
0
600
500
400
300
200
100
0
BCR
ECR
GCR
WCR
Ship
Total
Repository


FY98 Visitors to ODP Repositories
Sampling Visitors
Education/PR Visitors
150
100
50
0
200
100
0
BCR
ECR
GCR
WCR
Repository


Days to Complete FY98 Post Moratorium Requests
Mode = 0 days (requests completed same day as received)
Median = 21 days (50% of requests completed by this time)
Mean = 32 days
75% of requests completed by this time
88% of requests completed by this time
No. of Requests
15
10
5
0
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
No. of Days

FY1998 REQUESTS	COUNTRY
18	AUSTRALIA
2	BELGIUM
1	BRAZIL
10	CANADA
5	CHINA
3	DENMARK
17	FRANCE
54	GERMANY
1	INDIA
14	ITALY
25	JAPAN
1	KOREA
1	MEXICO
11	NETHERLANDS
6	NEW ZEALAND
16	NORWAY
2	PAPUA NEW GUINEA
1	PORTUGAL
3	RUSSIA
1	SOUTH AFRICA
5	SPAIN
7	SWEDEN
9	SWITZERLAND
2	TAIWAN
3	TURKEY
54	UNITED KINGDOM
260	USA
532	TOTAL

FY98 Curatorial Activity

BCR	Oct/Nov	Dec/Jan	Feb/Mar	Apr/May	June/July	Aug/Sept	Total
Archive 1/2 viewed	0	184	70	0	80	220	554
Samples Issued	2602	14329	8089	24918	9584	13715	73237
Residues issued	0	0	0	0	0	0	0
TS issued	127	0	0	10	0	0	137
Smear Slides Issued	0	105	0	0	0	0	105
Number of Requests	19	44	18	18	38	42	179
Visitors							
Sampling Visitors	10	36	26	39	17	9	137
Tour Visits	1 radio interview	17	1	03 tour groups			4 tours from Feb-Sept. 18 visitors from Oct.-Jan.
Projects							
Personnel							

GCR	Oct/Nov	Dec/Jan	Feb/Mar	Apr/May	June/July	Aug/Sept	Total
Archive 1/2 viewed	63	53	414	20	0	149	699
Samples Issued	2675	1867	1375	373	2320	2845	11455
Residues issued	0	90	2	0	0	75	167
TS issued	0	0	0	0	0	243	243
Smear Slides Issued	0	0	0	0	0	0	0
Number of Requests Completed	16	18	31	8	22	16	111
Visitors							
Sampling Visitors	9	6	9	2	0	5	31
Tour Visits	35	03 tour groups, 1 film crew		4 tour groups	4 tour groups	2 tour groups	13 tours 1 film crew from Feb-Sept. 35 visitors from Oct.-Jan.
Projects							917 sections wrapped
Personnel							

ECR	Oct/Nov	Dec/Jan	Feb/Mar	Apr/May	June/July	Aug/Sept	Total
Archive 1/2 viewed	126	270	103	341	36	0	876
Samples Issued	725	3910	1720	921	1295	1194	9765
Residues issued	0	0	0	0	0	0	0
TS issued	0	0	0	0	29	0	29
Smear Slides Issued	0	0	0	0	0	0	0
Number of Requests Visitors	13	27	23	13	16	8	100
Sampling Visitors	10	8	8	6	4	2	38
Tour Visits	36	0	2 tours, 1 film crew	3 tours	2 tours		7 tour groups, 1 film crew from Feb-Sept. 36 visitors in tour groups from Oct.-Jan.
Projects							2,800 core sections were wrapped
Personnel	sailed 1 leg		sailed 1 leg		sailed 1 leg		sailed 3 legs

WCR	Oct/Nov	Dec/Jan	Feb/Mar	Apr/May	June/July	Aug/Sept	Total
Archive 1/2 viewed	0	45	0	0	0	0	45
Samples Issued	54	780	105	96	20	286	1341
Residues issued	0	0	0	0	0	0	0
TS issued	0	0	0	0	0	0	0
Smear Slides Issued	0	0	0	0	0	0	0
Number of Requests Visitors	1	6	6	3	1	8	25
Sampling Visitors		6	2	2	0	3	13
Tour Visits	66	39	2 tour groups	4 tour groups	0	8 groups	13 tour groups in Feb-Sept. 105 visitors in tour groups from Oct.-Jan.
Projects							
Personnel	sailed 1 leg	sailed 1 leg					sailed 2 legs

Total Repositories	Oct/Nov	Dec/Jan	Feb/Mar	Apr/May	June/July	Aug/Sept	Total
Archive 1/2 viewed	189	552	587	361	116	369	2174
Samples Issued	6056	20886	11289	26308	13219	18040	95798
Residues issued	0	90	2	0	0	75	167
TS issued	127	0	0	10	29	243	409
Smear Slides Issued	0	105	0	0	0	0	105
Number of Requests Completed	49	95	78	42	77	74	415
Visitors							
Sampling Visitors	29	56	45	49	21	19	219
Tour Visits	138	5	68 tours/2 film crews	11 tours	9 tours	2 tours	30 tour groups, 2 film crews, 1 radio interview from Feb-Sept. 194 visitors in tour groups between Oct. and Jan.
Projects							3717 sections wrapped
Personnel	sailed 2 legs	sailed 1 leg	sailed 1 leg		sailed 1 leg		sailed 5 legs

Ship Sampling	Leg 176	Leg 177	Leg 178	Leg 179	Leg 180	Leg 181	Total
Number of Requests Completed	30	14	21	5	26	24	120
Samples Issued	3164	10737	9040	476	10674	15385	49476

Total FY98 sampling	BCR	ECR	GCR	WCR	Ship		Total
	179	100	111	25	120		535
Samples Issued	73237	9765	11455	1341	49476		145274

SCIMP APPENDIX 99-1-11

PUBLICATION ISSUES FOR JANUARY 1999 Meeting

Outside literature extension policy

The following rules should apply to both SR and journal submissions.

Rules for Considering Submission Extensions

- Can only be granted by the Publication Services Manager.
- Only consider extensions greater than one-week to initial deadlines if:
  - extenuating circumstances (e.g., death or severe illness in the family; long-term, unavoidable, equipment failure, etc.), and
  - ERB feel authors can still meet the set revision deadline.
- Only grant extensions to revision deadlines if they won't impact closing deadline.
- If the author does not meet the revised deadline they are considered a nonperformer.

Format of Leg Summary Chapter

- The Preliminary Report (PRT) and the *Initial Reports* (IR) volume must be completed by the end of the leg.
- One chapter must be written for use as both the PRT and the "Leg Summary" chapter of the IR volume.
- The goal of the "Leg Summary" chapter is to provide readers with:
  (1) a summary of the principal cruise results, and
  (2) an overview of the contents of the IR volume.
- The Co-chiefs and the Staff Scientist will coordinate production of the chapter and authorship will be Shipboard Scientific Party.
- The chapter should be written in the format of a scientific paper:

Abstract

Introduction: Background and objectives.

Methods: Drilling and sampling strategies.

Results: Discussion of how results were achieved; traditional site summaries or more evolved format.

Discussion/Conclusion: Discussion of how the objectives outlined in the Scientific Prospectus were achieved.

References

Figures: Include as appropriate to illustrate site locations, lithologies, ages, and other pertinent information.

Tables: Include new "Hole Summary" table and others as appropriate.

Guidelines for plates and data submissions to electronic volumes

- TAMU recommends holding off on issuing new guidelines because:
  (a) we should encourage scientists to try using new publication formats in the electronic medium;
  (b) we have never run out of space on a CD-ROM; and
  (c) the number of volume contributions are decreasing so there will be more space available per submission.

- Image size and quality should be reviewed by the ERB to make sure they are acceptable for print.

- Publication Services should:
  - ♦ monitor how many authors submit large files or poor-quality plates, and
  - ♦ work with authors on a case-by-case basis at the earliest stage possible to determine how to handle manuscript submissions.

· Questions Publication Services Considered:

Plates

♦ Should we maintain the current limits on the number of plates we allow for free per manuscript (2 complex, or 5 simple)?

♦ Should we allow authors to prepare their own plates when we quit printing chapters?

♦ Should we impose image resolution limits for electronic images (close-up photos; plates)?

♦ Should we establish a maximum file size per manuscript for images?

♦ Should we only accept plates in electronic form, or continue to accept photos that we scan?

Papers and Data

♦ Should we impose a maximum file size for data sets published in the *Proceedings*?

♦ Should we impose author fees if files are over a specific size (e.g, if inclusion of data would run volume from one to two CDs)?

♦ Should guidelines be set up to determine when large data sets should be published within a publication and when they should be housed with the ODP data librarian with a sample table included in the publication?

Current Plate Rules

· Each chapter is allowed five free simple plates or any combination of simple and complex plates, for a total cost allowance of $250.

· For any chapter with plates whose preparation costs exceed $250, the author must pay for all additional plates, whether simple or complex.

Plate definitions

A plate is a photographic figure that fills a full page including caption. It is usually made up of a number of small photographs, which come in the following varieties:

Simple plates: Photographs with right-angle corners, square or rectangular in shape. The entire photograph will be reproduced as a unit. Price: $50 each.

Complex plates: Photographs with free-form, irregular edges, usually printed against a solid white or solid black background. Price: $125 each.

SR Artwork Fees

Charges apply only to changes made by ODP to author-supplied figures for the *Scientific Results* volume. Price: $22.50 per hour.

Mirror Site Update

United States: Texas A&M University Electronic Library

- Interested in accepting the ODP electronic publications archive.
- Commitment to keep the files in a accessible format.

Germany: University of Breman

- Plans underway to mirror ODP/Publications material this year and JANUS next year.
- Will supply the server and supply the staff to maintain the site at no cost.

United Kingdom: Natural History Museum (London)

- Offered to mirror all of the ODP site except JANUS.
- Waiting to receive permission from ODP to buy a 20 GB hard drive to loan to the museum for use on their server.

Australia:

- Alexander Isern queried and replied: “My feeling is that the best place would be at the Australian Geological Survey Organsation (AGSO). They have a dedicated computer staff whereas many of the Universities would not. I will pass it by Chris Pigram, head of the marine division today.”
- TAMU has not heard from Chris yet.
- TAMU has a minor concern whether AGSO is the best place to house a mirror site, given that funding is often cut at Surveys.

Unix/PC/Mac Compatibility for Electronic Volumes

Since 1995, Publication Services has operated under a mandate that electronic publication products must be Mac, PC, and Unix compatible.

- Our 9/97 questionnaire showed that out of 256 responses:
  11% used Unix
  38% used PC
  52% used Mac

- Unix users can’t read Excel files on volume CDs.
- Buttons are not viewable in Acrobat from a Unix.

Do we still need to follow/heed to this requirement?

SCIMP APPENDIX 99-1-12

Most Recent Version of **<u>ODP Sample Distribution, Data Distribution, and Publications Policy</u>**

2/1/99

Frank:

I have entered all the corrections and changes we agreed to last Monday. Now that you have opened the envelope containing this file, the ball is officially back in your court.

Also, I've got two more questions.

1) This one was mentioned at USSAC and I've just had a real case where it occurred. The new policy does not address how we should handle the situation when an author who chooses to submit a manuscript to a journal gets rejected and then decides he/she would like to rework the paper and submit it to another journal. In the case where this happened recently, the author realized upon receiving the rejection notice that he had not selected the most appropriate venue when he initially submitted the paper. Under the new policy, will authors be allowed the option of submitting their paper to second journal if they receive a rejection, or will we require that they submit their MS to the SR as a paper or data report after one rejection? If you decide on the first option, which makes sense to me, we need to modify the wording in the policy.

2) Do you have a summary of the USSAC funding obligation fulfillment guidelines? If such a list exists do you want to have a link to the USSAC guidelines from the policy section where we state "Note: Investigators may have other data obligations under the U.S. National Science Foundation's Ocean Science Data Policy or under relevant policies of other funding agencies that require submission of data to national data centers."?
   Also, since the USSAC guidelines are not identical to those outlined in this policy I think it would be helpful for others and me at TAMU to have a copy of them so we can be aware of the differences.

Here is the key to the highlighted areas in this document:
   Light shading = outstanding issues for Frank to resolve.
   Dark shading = corrections made based on 1/25 meeting.

The enclosed file is a Word 97 PC file. If you can't read it let me know and I'll convert it to be Mac-readable and send it again. I'm also sending Tom and Rick copies of the document.

Let me know if you have any questions and what your timeline is on wrapping this up and making it official. It would be ideal if we could initiate the new policy on Leg 184. I've informed Peter Blum of the new components outlined within this policy so that he will be prepared to disseminate the information to the scientific party if you complete the policy during the leg.

Regards,

Ann

1/25/99 Draft Version

ODP Sample Distribution, Data Distribution, and Publications Policy

This document outlines the policy and the procedures for distributing samples and data from the Ocean Drilling Program and the Deep Sea Drilling Project to research scientists, curators, and educators. It also describes the associated obligations recipients incur.

This policy replaces the ODP Publications Policy (dated 16 July 1996; amended 12 February 1997) and the ODP Sample Distribution Policy (dated 1 July 1998). This new policy contains new publication rules that begin with Leg 169 and Leg 175. See Appendix A for a summary of the new rules and when they take effect.

ON WEB PAGE, BUTTONS WOULD SAY:
How to obtain samples
How to obtain data
Checklist for fulfilling obligation
Deadlines for fulfilling obligation
Advisory Board and other contact information
Leg-specific sampling strategy guidelines
Sample Request Form [**1/26:** CHECK IF SAYS DATA AND SAMPLE- need data form.
2/1: The form on the WWW is called "ODP SAMPLE REQUEST FORM."]

1. Introduction

The Ocean Drilling Program (ODP) is an international geoscience program that collects and analyzes marine cores of rocks and sediments recovered by the research vessel *JOIDES Resolution* from the seafloor. Three repositories in the Unites States (Texas A&M University, LDEO/Columbia University, and University of California at San Diego) and one in Germany (Bremen University) house these cores, as well as those from the Deep Sea Drilling Project (DSDP). Shipboard samples and residues thin sections, and smear slides also reside in these repositories. Core photographs, hand-written data sheets, and electronic core analysis data are curated at the Texas A&M University location. Downhole logging data is managed by the Borehole Research Group at LDEO.

Everyone who is invited to sail on an ODP cruise and anyone who obtains samples after a cruise incurs an obligation to ODP as defined in this policy. They are required to fulfill specific obligations associated with conducting research, publishing results, and providing ODP with associated data. If the procedures outlined in this policy are not met, recipients will be restricted from obtaining future samples and may not be allowed to participate on future cruise legs.

2. Overview of Policy

This document outlines the policy and the procedures for distributing ODP and DSDP samples and data to research scientists, curators, and educators. It also defines the obligations recipients incur.

The specific objectives of the ODP policy are to: (1) insure availability of samples and data to scientific party members so that they can fulfill the objectives of the drilling leg and their responsibilities to the ODP; (2) encourage scientific analyses over a wide range of research disciplines by providing samples to the scientific community; (3) [**FRANK** CHECK IF THIS WAS WORDING IN ORIGINAL VERSION: preserve core material as an archive for future description and observations, for non-destructive analyses, and for sampling;] and (4) to disseminate scientific results from postcruise research.

2.1 Sample Distribution

ODP and DSDP samples are generally distributed for research projects that can be accomplished within two to three years. Samples are given or loaned to persons in the following four categories. See Section 4 and Section 5 for details on requirements associated with receiving samples for individuals in each of these categories.

(1) scientists who participate on specific drilling legs as shipboard or shorebased members of a “scientific party” that has been formally approved by the ODP, and whose requests have been approved by the Sample Allocation Committee:
(2) scientists who wish to conduct research on ODP or DSDP materials, and publish the results, but who are not necessarily associated with a specific leg;
(3) curators of museums and collections; and
(4) educators.

Within the “moratorium” of each leg, which extends from the time the leg begins (i.e., the ship sails) to 12 months after it ends (i.e., the ship returns to port), only members of the scientific party (including approved shorebased researchers) are permitted to receive core samples and associated data (also see Section 4. Moratorium Sampling). Sample requests from scientists not formally associated with the scientific party will be considered after the moratorium has expired (also see Section 5. Post-moratorium Sampling).

2.2 Data Distribution

Data produced from samples taken for routine shipboard analyses are available to the entire shipboard party and approved shorebased participants during the moratorium. After the moratorium expires, all cruise data are made available to everyone. Data from all Deep Sea Drilling Project and Ocean Drilling Program cruises are available through the ODP Data Librarian. Data from ODP Leg 171B and beyond are also available on the Internet (http://www-odp.tamu.edu/database/), or from the ODP Data Librarian.

2.3 Publication Distribution

At the end of each drilling leg, the ODP publishes a set of two volumes known as the *Proceedings of the Ocean Drilling Program*, which consist of an *Initial Reports* (IR) volume and a *Scientific Results* (SR) volume. The *Initial Reports* (IR) volume is prepared by the shipboard scientific party and contains the scientific and engineering results from each ODP leg. This volume is distributed approximately one-year postcruise. The *Scientific Results* (SR) volume contains peer-reviewed papers prepared by individual scientists that present the results of their postcruise scientific research from a drilling leg. This volume is distributed approximately four-years postcruise. In order to fulfill their obligation to ODP, scientists are given the option of publishing their postcruise results in either the *Scientific Results* volume, or in an appropriate peer-reviewed scientific journal that publishes in English. See Appendix G for details on steps to follow to fulfil the ODP obligation.

3. Program Responsibilities

3.1 Curatorial Responsibilities

The responsibility and authority for making decisions regarding the distribution of DSDP/ODP samples, as per this policy, lies with the Sample Allocation Committee (SAC), the Curatorial Advisory Board (CAB), and the ODP Curator.

3.1.a. Sample Allocation Committee

For each drilling leg, a Sample Allocation Committee (SAC) is constituted, comprising the Co-chief Scientists, the ODP Staff Scientist, and the ODP Curator. During the leg, the Curator's authority and responsibilities to the SAC may be ceded to the shipboard Curatorial Representative.

Because the Sample Allocation Committee (SAC) best understands the scientific needs of their leg, this group establishes a leg-specific sampling policy and makes decisions on leg-specific sample requests received before the leg sails, during the leg, and within the moratorium, but not after. Approval of such sample requests requires endorsement by a majority of the SAC. In the event of an evenly divided vote, the ODP Curator will make a decision. If so desired, the sample requester may choose to appeal the SAC's decision to the Curatorial Advisory Board (CAB).

3.1.b. Curatorial Advisory Board

The Curatorial Advisory Board (CAB) is a standing body that consists of the ODP Deputy Director, the Manager of Science Services, and two members of the scientific community (selected by the JOIDES Scientific Measurements Panel) who will serve four-year terms that overlap by two years. Every effort will be made to insure that CAB membership represents a variety of scientific disciplines.

The Curatorial Advisory Board (CAB) has two main functions. It acts as an "appeal board" vested with the authority to make final decisions regarding sample distribution if and when conflicts or differences of opinion arise among any combination of the sample requester, ODP Curator, and the Sample Allocation Committee (SAC). In the case of an equally split vote among the four CAB members, the final authority rests with the JOI Office. [**FRANK** SHOULD THIS BE A SPECIFIC TITLE AT THE JOI OFFICE?] The CAB is also responsible for reviewing and approving requests to sample the "permanent archive" and requests for loans of core material for public display. (See Appendix B: Core Curation Terms and Definitions.) To insure prompt decisions, CAB members will communicate via teleconferencing or e-mail. The existing Curatorial Advisory Board members are listed in Appendix C.

A person appealing the CAB may contract any member of the board directly (See Appendix C for contact information).

3.1.c. ODP Curator

The ODP Curator maintains a record of all distributed samples, both on board the ship and from the repositories. This record, which includes the recipients, the nature of the proposed research, volume of samples taken, and the status of the request, is available to investigators upon request.

3.2 Publication Responsibilities

The responsibility and authority for making decisions regarding the publication of postcruise research to fulfill the ODP obligation, as per this policy, lies with the Manager of Publication Services and the Editorial Review Board for each leg.

3.2.a. Editorial Review Board (ERB)

An Editorial Review Board (ERB) is established for every leg and remains active for 42 months postcruise. The primary purpose of the ERB is to maintain an independent and effective peer-review system for the publication of leg results. The Board is comprised of up to four persons: two Co-chief Scientists for the leg, the ODP Staff Scientist, and an external scientist/specialist. The external scientist/specialist is selected by the other members of the ERB. Effective with Leg 160, the need for external ERB members will be determined on a leg-by-leg basis, based on the leg workload and Co-chiefs' and Staff Scientist's expertise.

The board members' responsibilities include the following.
The Co-chief Scientist(s) will:
(i) Write, or coordinate, a Leg Synthesis paper to be published in the *Scientific Results* (SR) volume.

The ODP Staff Scientist will:
(i) Ensure that all *Scientific Results* manuscripts are of reviewable quality before they are sent out for review. Upon submission, the ODP Staff Scientist will check manuscripts to ensure that they are complete and of reviewable quality. Manuscripts that do not meet ODP's standards will be returned to the author and will not go through the review process unless they are revised to meet ODP standards before the submission deadline.
(ii) Document the status of the scientific party members' actions to fulfill their obligation requirements.
(iii) Effective with Leg 169, coordinate the handling of additional contributions to the *Scientific Results* (SR) volume after 42 months postcruise. (See Section 4.4 for details).

The entire ERB will:
(i) Review all proposed publication titles related to the leg (*Scientific Results* volume, journal, or book), approve all papers that fulfill ODP obligations, and approve the final table of contents for the *Scientific Results* volume.
(ii) Review each journal or book submission for proper citation of site summaries and site chapters and for proper use of data and conclusions from other members of the scientific party.
(iii) Coordinate the peer-review process for each *Scientific Results* manuscript, collect *Scientific Results* manuscript reviews, and make the final decision on manuscript acceptance or rejection.

4. Requestor Responsibilities—Moratorium Sampling

4.1 Leg-specific Sampling Strategy

Leg-specific sampling, both shipboard and shorebased, will follow the Sampling Strategy established by the Sample Allocation Committee (see Appendix D). The strategy will integrate and coordinate the programs for drilling, sampling, and downhole measurement in order to best meet scientific needs. By necessity, the strategy will evolve over the course of leg planning and operations, and during the postcruise moratorium. All sampling plans will be carefully considered in the strategy.

Whenever possible, sampling should be deferred to a coordinated shorebased sampling effort (commonly referred to as a "sampling party") in order to sample more efficiently, and with the perspective gained from having completed the leg. This will insure the best possible use of the core and distribution of samples. Shorebased sampling will be particularly appropriate for legs where many samples will be needed, such as those focusing on paleoceanographic objectives. Travel funds have been specifically allocated for this purpose by some ODP member countries.

4.2 Requests from Scientific Party Members

Only scientific party members can receive samples and data during the moratorium period.

4.2.a. Requests for Samples

Scientific party members are requested to submit sample requests to the ODP Curator three months prior to the start of the leg. (For contact information, see Appendix C.) This will provide sufficient lead-time for planning. Sample requests submitted during a leg or during the moratorium will also be considered.

An electronic version of the ODP Sample Request Form is available at http://www-odp.tamu.edu/curation/subsfrm.htm. Individuals who can not easily access this form on the Internet should contact the ODP Curator for a printed copy. Appendix F contains guidelines to assist the requester in estimating sample volumes.

The Sample Allocation Committee (SAC) will review the sample requests and approval will be based on compatibility with the Sampling Strategy. Sample requests are approved if a majority of the SAC endorses the requests. In cases where a sample request is considered incompatible, the SAC may: (1) recommend modifications to the request, (2) modify the Sampling Strategy, or (3) reject the request if the other options are inappropriate. . In the event of an evenly divided vote, the ODP Curator will make a decision. If so desired, the sample requester may choose to appeal any decision to the CAB. If a conflict arises over the allocation of samples, shipboard scientific party members have priority over shorebased members.

4.2.b. Requests for Data

Data produced from samples taken for routine shipboard analyses (e.g., index properties, interstitial (pore) water whole rounds, thin sections, smear slides, X-ray diffraction and X-ray fluorescence samples, paleontology core-catcher samples) are available to the entire shipboard party and approved shorebased participants during the moratorium. Data from Legs 171B and beyond are made available on the Internet at: http://www-odp.tamu.edu/database/. During the moratorium the data is password protected and can only be accessed by members of the scientific party. Individuals who can not easily access the Internet may submit data requests to the ODP Data Librarian (see Appendix C).

4.3 Samples for Routine Shipboard Analyses

Unless requested, samples used for routine shipboard analyses, and/or their residues, are shipped to the appropriate core repository at the end of the cruise. If scientific party members want these materials for postcruise research, they are available through the normal sample request procedure (see Section 4.2.a. and Appendix E). Thin sections and smear slides prepared during a cruise are archived at the repository where the core from that leg is stored. **[IS THIS NECESSARY TO SAY?:** "They are catalogued before being made available for short-term (less than one year) loan to scientific party members upon request." WHY NOT SAY "and are available for short-term (less than one year) loan to scientific party members upon request through the regular sample request procedures (Appendix E)."]

An electronic version of the ODP Sample Request Form is available at http://www-odp.tamu.edu/curation/subsfrm.htm. Individuals who can not easily access this form on the Internet should contact the ODP Curator for a printed copy. Appendix F contains guidelines to assist the requester in estimating sample volumes.

4.4 Sample- and Data-recipient Responsibilities

This section details the ODP obligation fulfillment requirements associated with this policy. To see, at a glance, when specific new policy rules go into effect see Appendix A.

4.4.a. Rules for Legs 160–168

Scientific party members of Legs 160 through 174 are still required to follow the guidelines outlined the "ODP Publications Policy" dated 16 July 1996 and amended 12 February 1997. This policy is available on the Internet at http://www-odp.tamu.edu/publications/PUBPOL.HTML. Individuals who can not easily access this policy on the Internet should contact the Manager of Publication Services for a printed copy.

4.4.b. Rules for Legs 169–174

With the exception of the two rules outlined below in this section, all scientific party members of Legs 169 through 174 are required to follow the guidelines outlined the "ODP Publications Policy" dated 16 July 1996 and amended 12 February 1997. This policy is available on the Internet at: http://www-odp.tamu.edu/publications/PUBPOL.HTML. Individuals who can not easily access this policy on Internet should contact the Manager of Publication Services for a printed copy.

(1) The deadlines for submissions to the *Scientific Results* (SR) volume are:

Papers and Data Reports	
Initial submission:	28 months postcruise
Revised submission:	34 months postcruise
Synthesis Papers	
Initial submission:	35 months postcruise
Revised submission:	40 months postcruise

(2) Papers may be submitted to the *Scientific Results* volume for peer review between 13 and 28 months postcruise. The Editorial Review Board will be responsible for coordinating the manuscript peer-review process as soon as the Staff Scientist approves the papers. Upon acceptance and revision, *Scientific Results* volume papers will be processed for publication on the Internet. In addition, all leg-related citations will be listed on the ODP Publications web site. The *Scientific Results* volume contents will be reprinted on CD-ROM four-years postcruise.

4.4.c. Rules for Legs 175 and beyond

Beginning with Leg 175, all scientific party members who are invited to sail on ODP cruises and all shorebased participants included in the scientific party incur an obligation to ODP that must be fulfilled by conducting postcruise research and by publishing associated results. [WE HAD DISCUSSED ADDING A NOTE HERE THAT EXPLAINED WHAT TO DO IF YOU DIDN'T GET RESEARCH RESULTS. THERE WAS ALREADY A PARAGRAPH ON THIS AT THE END OF THIS SECTION, SO I MOVED IT UP HERE AND REWORDED IT SLIGHTLY: If a scientific party member is unable to produce research results, and thus fulfill ODP's obligation requirements, because appropriate sample or data were not retrieved during the cruise, or because data could not be obtained during postcruise analyses, a letter of explanation must be submitted to] [the ODP Curator. FRANK REVISE WORDING: ANN HAS A PROBLEM WITH THIS BECAUSE IT IMPLIES IF AN AUTHOR MISSES A DEADLINE HE DOESN'T NEED TO CONTACT PUBS OR THE ERB, JUST THE CURATOR WHICH IS NOT RIGHT. ESPECIALLY SINCE PUBS AND THE STAFF SCIENTIST ARE RESPONSIBLE FOR TRACKING WHO HAS FULFILLED OBLIGATION REQUIREMENTS.] Failure to meet these responsibilities will result in the rejection of future sample requests and may influence participation on future legs.

For a summary of the obligation fulfillment requirements see Appendix G.

The obligation fulfillment requirements for all scientific party members are:

(1) Comply with all written collaborative agreements identified in the leg-sampling plan.

(2) Submit all manuscripts by 28-months postcruise.

(3) Publish a paper in:
   (a) a peer-reviewed scientific journal or book that is published in English, or
   (b) a paper or a data report in the *Scientific Results* (SR) volume.

(4) Acknowledge the Ocean Drilling Program (ODP) in all publications that result from the use of data collected from ODP samples.

(5) Submit one reprinted copy of all published works derived from the ODP samples to the ODP Curator.

(6) Submit all final analytical and/or descriptive data obtained from the samples to the ODP Curator as soon as the data have been published. Whenever available, data should be submitted in electronic format.

(Note: Investigators may have other data obligations under the U.S. National Science Foundation's Ocean Science Data Policy or under relevant policies of other funding agencies that require submission of data to national data centers.)

(7) Return all unused samples to the appropriate core repository no later than five years postcruise. Residues from processed samples need not be returned.

Additional obligation fulfillment requirements for authors who submit to journals or books are:

(1) For all papers that fulfill ODP obligations, at time of submission, simultaneously submit a copy of each manuscript to the ODP Publications Coordinator. The ERB must check each manuscript within three months of receipt. If the ERB determines that there is improper usage of the data and conclusions of other members of the scientific party, or failure to properly cite the *Initial Reports* volume, the ERB will contact the author, and when necessary the journal or book editor, with a recommendation that the manuscript be withdrawn or suitably modified. The Manager of Publication Services and the Curatorial Advisory Board (CAB) will address any disputes arising from this activity.

(2) If manuscripts are rejected, authors must contribute manuscripts or data reports to the *Scientific Results* (SR) volume no later than six months after receiving the rejection notice and follow fulfillment requirements for authors who submit to the SR volume (below).

Additional obligation fulfillment requirements for authors who submit to the *Scientific Results* (SR) volume are:

(1) The deadlines for submissions to the *Scientific Results* (SR) volume are:

Papers and Data Reports	
Initial submission:	28 months postcruise
Revised submission:	34 months postcruise
Synthesis Papers	
Initial submission:	35 months postcruise
Revised submission:	40 months postcruise

(2) Papers may be submitted to the *Scientific Results* volume for peer review between 13 and 28 months postcruise. The Editorial Review Board will be responsible for coordinating the manuscript peer-review process as soon as the Staff Scientist approves the papers. Upon acceptance and revision, *Scientific Results* volume papers will be published on the Internet. A leg-related citation list will also be published on the Internet. The *Scientific Results* volume contents will be reprinted on CD-ROM four-years postcruise.

5. Requestor Responsibilities—Post-moratorium Sampling

5.1 Scientific Sampling

5.1.a. Sampling Strategy [OR Sample Request Procedure]

Beginning 12 months after a cruise has ended, samples will be provided to any scientist, curator, or educator who has the resources to complete a scientific investigation, or prepare materials for curatorial or educational purposes. Requests for samples should be submitted using the Sample Request Form (see Appendix E) to the ODP Curator.

The ODP Curator and the Curatorial Advisory Board (CAB) supervise post-moratorium sampling. The ODP Curator will receive post-moratorium sample requests and will evaluate them for completeness and for adherence to the provisions in this policy. If questions arise, the ODP Curator will consult with the requester.

An electronic version of the ODP Sample Request Form is available at http://www-odp.tamu.edu/curation/subsfrm.htm. Individuals who can not easily access this form on the Internet should contact the ODP Curator for a printed copy of the form. Appendix F contains guidelines to assist the requester in estimating sample volumes.

When considering a sample request, the ODP Curator will ascertain whether the requested material is available in the working half or the temporary archive half of the core (see Appendix B for definitions). If not available, the ODP Curator will consult with the requester to determine if the range of the sought interval(s) or the sample spacing within the interval(s) may be modified. If the request cannot be modified because of scientific requirements, a request to sample the permanent archive can be considered. (See Appendix B: Core Curation Terms and Definitions.)

Approval of sample requests will also be based on the availability of material and the length of time it will take the investigator to complete the proposed project. Typical studies will take two to three years, but a longer duration will be considered under certain circumstances. If a sample requester disagrees with the ODP Curator's final decision on a sample request, the sample requester may choose to appeal any decision to the Curatorial Advisory Board (CAB).

To assist the sample requester, the ODP Curator can provide relevant information on previous sample requests and resultant studies on the core interval in question. The ODP Curator can also provide advice and guidance to the requester when considering sample volumes and frequencies (see Appendix F).

The sample requester must independently secure funds for sample-related research activities.

5.1.b. Archive Sampling

Requests to sample archive material should be sent to the ODP Curator, who will forward them to the Curatorial Advisory Board (CAB) after preliminary review. The CAB will evaluate the request based on its scientific merit and on the extent to which the working half is depleted. If necessary, the CAB may also consult with members of the original Sample Allocation Committee (SAC) who were responsible for establishing the permanent archive being considered for sampling. The CAB will strive to maintain a representative continuous section of core material for archival purposes whenever possible.

5.1.c. Sample-recipient Responsibilities

5.1.c.i. Requests for Samples

This section details the ODP obligation fulfillment requirements associated with this policy for Scientists who receive samples or conduct non-destructive analyses after the 12-month moratorium.

The obligation fulfillment requirements are as follows:

(1) Publish a paper in a peer-reviewed scientific journal or book that publishes in English, or submit a progress report to the ODP Curator outlining the status of the samples and/or the data no later than 36 months after receiving them.
(2) Acknowledge the ODP, DSDP, and/or others as appropriate, in all publications that use data collected from ODP or DSDP samples.
(3) Submit one reprinted copy of all published works derived from the ODP samples to the ODP Curator.
(4) Submit all final analytical and/or descriptive data obtained from the samples to the ODP Curator, as soon as the data have been published, or within five years after receiving samples, whichever comes first. Data, preferably in electronic format, should also be submitted to the ODP Curator. Investigators should be aware that they may have other data obligations under the U.S. National Science Foundation's Ocean Science Data Policy or under relevant policies of other funding agencies that require submission of data to national data centers.
(5) Return all unused samples to the appropriate core repository no later than five years postcruise. Residues from processed samples need not be returned.
(6) If the sample recipient is unable to produce research results, and thus fulfill ODP's obligation requirements, because data could not be obtained during postcruise analyses, a letter of explanation must be submitted to the ODP Curator.

Failure to meet these responsibilities will result in the rejection of future sample requests and may influence participation on future legs.

All leg-related citations will be published on the ODP Publications web site.

5.1.c.i. Requests for Data

Data produced from samples taken for routine shipboard analyses (e.g., index properties, interstitial (pore) water whole rounds, thin sections, smear slides, X-ray diffraction and X-ray fluorescence samples, paleontology core-catcher samples) are available after the moratorium has ended (13 months postcruise). Data from Legs 171B and beyond are made available on the Internet at: http://www-odp.tamu.edu/database/. Individuals who can not access the Internet may submit data request to the ODP Data Librarian (see Appendix C).

Individuals who use ODP or DSDP data after the moratorium period has expired to not do not incur the same obligations to publish their results, but should submit final analytical and/or descriptive data to the ODP Curator. [FRANK DECIDE IF THIS IS CORRECT TO ASK THEM TO SUBMIT DATA. DOES IT NEED TO BE REWORDED??]

5.2 Requests for Educational Material

Cores can be viewed, described, and sampled for teaching and educational purposes. Core materials that are abundant in the collection, and thus not in demand for research purposes, are available to educators for sampling.

Sample requests must be made using the Sample Request Form (See Appendix E). The ODP Curator will approve requests if they do not deplete the working and/or the temporary archive halves of the core.

Educators who receive samples or conduct non-destructive analyses do not incur the same obligations as researchers to publish or provide data to ODP.

5.3 Requests for Public Display Material

Core material is available for public display, such as in museums or at professional scientific meetings. Requests to borrow cores may be submitted to the ODP Curator (see Appendix C). They should:
(1) include a description of the public display, including the location and purpose;
(2) (2) indicate the duration of the display and how the curatorial state of the cores will be maintained; and
(3) identify the person(s) responsible for overseeing the cores. Requests will be reviewed by the ODP Curator and possibly the Curatorial Advisory Board (CAB), and will be forwarded to Joint Oceanographic Institutions, Inc. (JOI) for final approval as appropriate. A loan agreement will be required for long-term loans (two weeks or more). The Curator will provide details about the loan agreement upon request.

All public displays of ODP/DSDP material will include a notice that properly credits the Ocean Drilling Program and support by the National Science Foundation and its international partners.

Appendix A: Summary of New Publications-related Policy Components

This table summarizes the new publications rules and when each rule goes into effect. (See Section 4.4 for complete policy text.)

Policy Component	**Leg when rule goes into effect**
The other members of the ERB select the external member of the Editorial Review Board (ERB). The need for external ERB members should be determined on a leg-by-leg basis, based on the leg workload and Co-chiefs' and Staff Scientist's expertise.	Leg 169
The Editorial Review Board (ERB) will remain active for 42 months postcruise. The ODP Staff Scientist for the leg will coordinate the handling of additional contributions to the *Scientific Results* (SR) volume after 42 months postcruise.	Leg 169
It is the responsibility of the Co-chief Scientist(s) from each leg to write, or coordinate, a Leg Synthesis paper to be published in the *Scientific Results* (SR) volume.	Note: This has always been outlined in the "Co-chief Agreement," as a Program requirement. It is included in the Policy beginning with Leg 169.
All scientific party members who are invited to sail on ODP cruises and all shorebased participants included in the scientific party incur an obligation to ODP that must be fulfilled by conducting postcruise research and by publishing associated results. If a scientific party member is unable to produce research results, and thus fulfill ODP's obligation requirements, because appropriate sample or data were not retrieved during the cruise, or because data could not be obtained during postcruise analyses, a letter of explanation must be submitted to [the ODP Curator. FRANK SEE COMMENT IN TEXT ABOUT THIS (Section 4.4.c.)]	Leg 175
All collaborative agreements must be identified in the leg-sampling plan and approved by the SAC before samples are distributed. Scientific party members are required to comply with all collaborative agreements.	Leg 184 [FRANK WE TALKED ABOUT CREATING THIS REQUIREMENT AFTER THE MALPAS ISSUE CAME UP IN 2/96. THIS WAS DURING 166 BUT IT WAS NEVER WRITTEN AS A FORMAL PART OF THE POLICY SO I THINK IT SHOULD BEGIN WITH EITHER 169 OR 184]
Authors must publish a paper in (a) a peer-reviewed scientific journal or book that is published in English, or (b) a paper or a data report in the *Scientific Results* volume.	Leg 175
All journal and book manuscripts must be submitted by 28 months postcruise.	Leg 175
If journal or book manuscripts are rejected, authors must contribute papers or data reports to the *Scientific Results* (SR) volume no later than six months after receiving the rejection notice and follow fulfillment requirements for authors who submit to the SR volume.	Leg 175
The *Scientific Results* volume paper and data report revision deadline and all synthesis paper deadlines have been extended by two weeks. The new deadline schedule is: Papers and Data Reports—Initial submission: 28 months postcruise Revised submission: 34 months postcruise Synthesis Papers—Initial submission: 35 months postcruise Revised submission: 40 months postcruise	Leg 169
Papers may be submitted to the *Scientific Results* volume for peer review between 13 and 28 months postcruise. The Editorial Review Board will be responsible for coordinating the manuscript peer-review process as soon as the Staff Scientist approves the papers. Upon acceptance and revision, *Scientific Results* volume papers will be processed for publication on the Internet. The *Scientific Results* volume contents will be reprinted on CD-ROM four-years postcruise.	Leg 169

Appendix B: Core Curation Terms and Definitions

In this appendix, ODP-related curatorial terms, concepts and requirements are defined and explained.

B.1. Scientific Party

The "scientific party" includes all scientists who sail on the leg, as well as any shorebased scientists who were granted permission from the Sample Allocation Committee (SAC) to receive samples or data from the leg within the moratorium.

B.2. Moratorium

The period from the beginning of a leg through one year after the end of a leg is designated as the "moratorium" period for a leg. During this moratorium, certain restrictions are applied to cores and data generated during the leg. The purpose of the moratorium is to ensure adequate time is allotted for scientific party members to conduct leg-related research before the cores and data are made available to the general scientific community. This requirement was established to enable the scientific party members to fulfill their obligations to ODP without competition from the general science community.

B.3. Unique and Non-unique Intervals

A cored interval is designated "unique" if it has been recovered only once at a drill site. The most common occurrence of a unique interval is one that results when only one hole is drilled at a site. If the cored interval is recovered from two or more holes, then the interval is considered "non-unique".

A critical exception to this definition occurs when drilling into igneous basement rocks, metamorphic rocks, or metalliferous deposits. Every hole drilled into these lithologies is considered unique because of their inherent lateral heterogeneity.

Lithostratigraphic analysis of advanced piston cores from multiple holes drilled at one site may reveal that short (generally less than two meter) sedimentary intervals are commonly missing between successive cores from any one drill hole, even where nominal recovery approaches 100%. These missing intervals can be ignored when considering whether or not an interval is unique.

B.4. Composite Splice

[TOM NEEDS TO CHECK WORDING OF THIS SECTION]

A technique commonly used on paleoceanographic cruises which core multiple APC/ XCB holes at each site is the production of a composite section that correlates depths between sections in all holes where there is coring overlap. This composite section is based primarily on comparison of multisensor track data to determine the most complete overall section in a site. A splice is then composed of discrete core sections from multiple holes. Once the data are correlated between holes, new depths values (meters composite depth, or mcd) are assigned to all core sections, which are different from drillstring depths (mbsf). The purpose of this splice is to provide a complete sedimentary section for high-resolution scientific analysis. This affects the way sampling is conducted on some legs, as scientists will prefer to sample along this splice rather than down one single hole at a site. This also affects the permanent archive collection, as the archive halves of the splice are usually preferred for sampling (temporary archives) rather than for archiving (permanent archives).

B.5. Archive and Working Halves

Cores are split into halves for shipboard analysis to uniquely identify split-core halves for measurements and sampling. The halves are referred to as "working half" and "archive half." The entire working half is available for sampling. The concept and definition of an archive half (see below) is aimed to enhance scientific flexibility and to enable greater access to important material. In certain circumstances the archive is available for sampling (see below).

Before 1997, the archive was preserved (unsampled) and conserved in the repository, available only for non-destructive examination and analysis. Samples for destructive analyses were taken exclusively from the working half. Since 1997, the entire core has been available for sampling. The procedure of splitting cores into working and archive halves will continue, for practical and database purposes, but the concept and definition of an archive half has now been expanded and modified. This will enhance scientific flexibility by enabling greater access to important and often coveted material.

B.6. Permanent Archive

A "minimum permanent archive" will be established for each ODP drill site. Archive core earmarked "permanent" is material that is initially preserved unsampled and is conserved in the core repositories for subsequent non-destructive examination and analysis. In "unique intervals", this minimum permanent archive will consist of at least one half of each core, excluding whole-round samples (e.g., for interstitial pore water analysis). If so desired, the Sample Allocation Committee (SAC) may choose to designate more, but not less than this amount as the permanent archive. In "non-unique intervals", the permanent archive will consist of at least one half of one set of cores that span the entire drilled sequence, again, excluding whole-round samples. The permanent archive is intended for science needs that may arise five years or more after drilling is completed.

In practice, if holes are cored continuously, the minimum permanent archive may consist of one half of each core taken from the deepest hole drilled at a site. As such, the archive halves of cores from additional holes drilled to equal or shallower depths, which contain replicate copies of stratigraphic intervals constituting the minimum permanent archive, need not be designated as permanent archive, but can be, if so desired by the SAC. If not deemed permanent archive, they are "temporary archive". If a spliced section is constructed and sampling demand exceeds the working half, an alternative scenario may be required to make sure all samples can be taken from the spliced section. In this case, the permanent archive can be defined from cores that are not part of the splice (e.g., from cores from different holes.

Sampling of the permanent archive is feasible five years postcruise if the working and/or the temporary archive halves of the core have been depleted, as judged by the ODP Curator and the Curatorial Advisory Board (CAB).

B.7. Temporary Archive

Cores taken from non-unique intervals that are not part of the "minimum permanent archive" will be considered "temporary archives," unless stipulated otherwise by the Sample Allocation Committee (SAC) in the Sample Strategy. If required for special shorebased analysis, some cores may be left unsplit onboard and shipped to the laboratory as whole-core. If split (the common scenario), the temporary archive may be sampled just like working halves when either the working halves have been depleted by sampling, or when pristine, undisturbed material is needed for special sampling needs, such as U-channels or slab samples.

B.8. Critical Intervals

Critical intervals are defined as lithologic spans that are of such scientific interest that there is extremely high sampling demand for them. These intervals may vary from thin, discrete horizons to thick units, extending over an entire core or more. Examples include, but are not limited to: décollements, sediment-basement contacts, igneous contacts, impact/tektite horizons, gas hydrates, marker ash horizons, scaly fabric, magnetic reversals, and particular biostratigraphic levels. The Sample Allocation Committee (SAC) is responsible for anticipating the recovery of critical intervals and for developing a strategy for sampling and/or conserving them. For post-moratorium sampling, the ODP Curator will work with investigators to ensure that previously defined critical intervals are sampled only when necessary.

B.9. Non-destructive Analyses

Requests to perform non-destructive analyses on cores (e.g., descriptions, imaging, X-ray) should be submitted to the ODP Curator after completing the ODP Sample Request Form. Investigators who carry out non-destructive analyses incur the same obligations as those who request samples (see Section 4 and Section 5 of this policy).

Appendix C: Contact Information—Curation Advisory Board and Policy Overseers

	Name	Contact Information
ODP Curator	Dr. John Firth	E-mail: John_Firth@odp.tamu.edu Phone: (409)845-0507 Fax: (409)845-1303 Mailing address: Ocean Drilling Program 1000 Discovery Drive College Station, TX 77845 U.S.A.
Curatorial Advisory Board Members (CAB)	Dr. Christopher MacLeod	E-mail: macleod@cardiff.ac.uk Phone: 44(1222)874 830, ext. 5181 Fax: 44(1222)874 326 Department of Earth Sciences University of Wales of Cardiff P.O. Box 914 Cardiff CF1 3YE, United Kingdom
	Dr. Richard W. Murray	E-mail: rickm@bu.edu **Phone: (617)353-6532** **Fax: (617)353-3290** Department of Earth Sciences Boston University 675 Commonwealth Avenue Boston, MA 02215 U.S.A.
	Dr. Jack Baldauf, ODP Deputy Director	E-mail: Jack_Baldauf@odp.tamu.edu Phone: (409)845-9297 Fax: (409)845-1026 Mailing address: Ocean Drilling Program 1000 Discovery Drive College Station, TX 77845 U.S.A.
	Dr. Tom Davies, ODP Manager of Science Services	E-mail: Tom_Davies@odp.tamu.edu Phone: (409)862-2283 Fax: (409)845-0876 Mailing address: Ocean Drilling Program 1000 Discovery Drive College Station, TX 77845 U.S.A.
Sample Allocation Committee (SAC)	For each leg, this committee is comprised of the Co-chief Scientists and Staff Scientist, and the ODP Curator.	Contact information for the Co-chief Scientists and Staff Scientist of each leg can be found on the title page of the Scientific Prospectus or the Preliminary Report publications. See above for ODP Curator contact information.
Editorial Review Board (ERB)	For each drilling leg, this board is comprised of the Co-chief Scientists and Staff Scientist, and one external scientist.	Contact information for the Co-chief Scientists and Staff Scientist of each leg can be found on the title page of the Scientific Prospectus or the Preliminary Report publications.
ODP Publication Services Manager	Ann Klaus	E-mail: Ann_Klaus@odp.tamu.edu Phone: (409)845-2729 Fax: (409)862-3527 Mailing address: Ocean Drilling Program 1000 Discovery Drive College Station, TX 77845 U.S.A.

ODP Publications Coordinator	Gigi Delgado	E-mail: Gigi_Delgado@odp.tamu.edu Phone: (409)845-1909 Fax: (409)862-3527 Mailing address: Ocean Drilling Program 1000 Discovery Drive College Station, TX 77845 U.S.A.
ODP Data Librarian	Vasudha Chavali	E-mail: Vasudha_Chavali@odp.tamu.edu Phone: (409)845-8495 Fax: (409)862-4857 Mailing address: Ocean Drilling Program 1000 Discovery Drive College Station, TX 77845 U.S.A.
Scientific Measurements Panel	Tom Janecek, Chair	Member list and e-mail links can be found at: http://www.whoi.edu/joides/PanelDir.html#anchorscimp
JOI Office	FRANK ADD CONTACT NAME AND INFO	E-mail: ________@brook.edu Phone: (202)232-________ Fax: (202)________ Mailing address: Joint Oceanographic Institutions 1755 Massachusetts Avenue, N.W., Suite 800 Washington, DC 20036-2102 U.S.A.
JOIDES Office	Jeff Schuffert	E-mail: jschuffert@geomar.de Phone: +49 (431) 600-2834 Fax: +49 (431) 600-2947 URL: www.joides.geomar.de Mailing address: JOIDES Office GEOMAR Research Center Wischhofstr. 1-3, Buildg. 4 D-24148 Kiel, Germany

Appendix D: Leg-specific Sampling Strategy Guidelines

Development of the leg-specific Sampling Strategy begins in the initial stages of leg planning, when ODP drilling proposals are written and submitted to the Joint Oceanographic Institutions for Deep Earth Sampling (JOIDES) Office. At this stage, proponents will develop a draft Sampling Strategy that will fulfill the scientific objectives of the leg.

Once a proposal has been scheduled for drilling by JOIDES and Co-chiefs have been selected, the Sample Allocation Committee (SAC) will write a formal, leg-specific Sampling Strategy for publication in the ODP Scientific Prospectus series. The ODP Director and the Deputy Director will review the Scientific Prospectus before it is published. This will give them an opportunity to advise on sampling issues pertaining to the broader (non-leg-specific) community.

The Sampling Strategy will meet the specific objectives of the leg. The Sampling Strategy will define the minimum permanent archive and any supplements to it that the Sample Allocation Committee (SAC) deems necessary. The Sampling Strategy will also become the basis of the shipboard and moratorium "sampling plan."

A successful Strategy will:

(1) define the amount of core material available to the scientific party for sampling by deciding if (and when) more than a minimum permanent archive is needed;
(2) anticipate and possibly define limits on the volume and frequency of shipboard sampling for routine analyses, pilot studies, and low-resolution studies;
(3) estimate the sampling volume and frequency that is needed to meet the objectives of the leg, as per scientific sub-discipline and request type;
(4) anticipate the recovery of critical intervals and develop a protocol for sampling and/or preserving them;
(5) decide where and when sampling will occur. SACs are strongly encouraged to defer large-volume and high-frequency sampling to postcruise "sampling parties" at ODP core repositories; [FRANK, CONSIDER REWORDING BECAUSE A STRATEGY CAN'T REALLY "DECIDE" ANYTHING]
(6) determine special sampling methods and needs (e.g., Pressure Core Sampler, microbiology, whole rounds);
(7) consider any special core storage or shipping needs (e.g., plastic wrap, freezing sections); and
(8) identify disciplines/personnel needed for shorebased sampling.

The Sampling Strategy should be formatted using the following categories. For examples, see recent copies of leg-specific sampling strategies from previous legs in the Scientific Prospectus series. (See also, Appendix B: Core Curation Terms and Definitions.)

Needs
Sampling Timetable
General Sampling Procedures
Critical Intervals
Permanent Archive
Temporary Archive

Appendix E: ODP Sample Request Form

An electronic version of the ODP Sample Request Form is available at http://www-odp.tamu.edu/curation/subsfrm.htm. Individuals who can not easily access this form on the Internet should contact the ODP Curator for a printed copy.

Appendix F: Typical Sample Volumes

The following volumes are guidelines, not limits.

Thin-section billets	10 cm^3 up to 50 cm^3 for large-grained plutonic rocks
Alkenone (U_k^{37})	5 cm^3
X-ray diffraction	5 cm^3
X-ray fluorescence	20 cm^3 (sediments), 20–50 cm^3 (igneous/sulfides - varies depending on grain size and homogeneity of rock)
Carbonate	2 cm^3
Paleomagnetism	7 cm^3 cubes, 12cc minicores, 600 cm^3 U-channels
Moisture and density	10–20 cm^3
Grain size	10–20 cm^3 depending upon coarseness
Planktonic foraminifers	10 cm^3
Benthic foraminifers	10–20 cm^3
Nannofossils	2 cm^3
Diatoms	5–10 cm^3
Radiolarians	10 cm^3
Palynology	10–15 cm^3
Organic samples	20 cm^3
Interstitial porewaters	5 cm whole rounds, up to 10–20 cm, based on water content
Inorganic geochemistry	10 cm^3
Organic geochemistry	10 cm^3
Sedimentology	10–20 cm^3
Slabs (for laminae studies)	25–50 cm^3, depending on slab length
Slabs (large grained plutonic rocks)	50–100 cm^3, often shared by scientists for multiple analyses
Stable isotopes (C, O)	10–20 cm^3

Appendix G: Checklists for Fulfilling the ODP Obligation

The following lists summarize the steps investigators need to follow to fulfill the ODP obligation if they sailed on a leg or received samples. Failure to meet all of these responsibilities will result in the rejection of future sample requests and may influence participation on future legs.

A. All Scientific Party Members

A.1. Publishing in a scientific journal or book

		Notes
1.	Comply with all written collaborative agreements identified in the sampling plan.	
2.	At the second postcruise meeting, submit final titles to the Editorial Review Board (ERB) for all papers that fulfill your ODP obligation and any supplementary publications you plan to publish.	
3.	Acknowledge in all publications the receipt of data or samples from ODP and the funding agency that supported the research.	
4.	Submit manuscript to the journal or book no later than 28 months postcruise.	This rule takes effect with Leg 175.
5.	Submit a copy of each manuscript to the ODP Publications Coordinator at the time of submission to the journal or book. Include a cover letter that includes publication venue and date of submission.	The ERB has three months from time of receipt to check submissions for proper citation of site summaries and site chapters and for proper use of data and conclusions from other members of the scientific party.
6.	If the paper is accepted for publication, submit an electronic copy of the following to the ODP Publications Coordinator: Final citation Abstract Keyword list	If this information is not submitted to ODP you could be classified as a not performer.
7.	Send one reprint to the ODP Curator.	
8.	If the paper is rejected, submit a data report for the *Scientific Results* volume to the ODP Publications Coordinator within six months of the rejection and follow the guidelines outlined in Section 4.4.c.	This rules goes into effect with Leg 175.
9.	Submit all final analytical and/or descriptive data obtained from the samples to the ODP Curator.	
10.	Return all unused samples to the appropriate core repository no later than five years postcruise.	

A.2. Publishing in the *Scientific Results* volume

		Notes
1.	Comply with all written collaborative agreements identified in the sampling plan.	
2.	At the second postcruise meeting, submit final title(s) to the Editorial Review Board (ERB) for paper(s) that fulfill your ODP obligation and any supplementary publications you plan to publish.	
3.	Acknowledge in all publications the receipt of data or samples from ODP and the funding agency that supported the research.	
4.	Submit manuscript(s) for peer review to the ODP Publications Coordinator by ODP deadline: Regular papers and data reports: 28* months postcruise Synthesis papers: 35* months postcruise * For authors whose journal or book submissions were rejected, their *Scientific Result* submission deadline is 6 months after rejection receipt.	Submissions must be of reviewable quality and meet ODP's standards as outlined in the Publication Instructions for ODP Scientists guide. Manuscripts that do not meet the ODP standards will be returned to the author and will not go through the review process unless they are revised

		to meet ODP standards before the submission deadline.
5.	Submit revised manuscript(s) by: Regular papers and data reports*: 34 months postcruise Synthesis papers: 40 months postcruise * For individuals whose journal or book submissions were rejected, the Editorial Review Board will determine their revision deadline.	
6.	Submit all final analytical and/or descriptive data obtained from the samples to the ODP Curator.	
7.	Return all unused samples to the appropriate core repository no later than five years postcruise.	

B. Investigators who receive samples after the 12-month moratorium.

1.	Submit manuscript to a journal or book based on research results.	
2.	No later than 36 months after receipt of samples send to ODP Curator either: (a) a reprint of published manuscript , or (b) a progress report outlining status of research.	Submissions must be of reviewable quality and meet ODP's standards as outlined in the Publication Instructions for ODP Scientists guide. Manuscripts that do not meet the ODP standards will be returned to the author and will not go through the review process unless they are revised to meet ODP standards before the submission deadline.
3.	Submit all final analytical and/or descriptive data obtained from the samples to the ODP Curator.	
4.	Submit all final analytical and/or descriptive data obtained from the samples to the ODP Curator, as soon as the data have been published, or within five years after receiving samples, whichever comes first.	

APPENDIX 99-1-13

Tomorrow's Technology Today

A survey of emerging trends in non-destructive measurements for the geosciences.

Interim report of the IMAGES standing committee on
"New Technologies in Sediment Imaging"

by

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NOTE: The material contained in this report is being provided to the IMAGES Science Steering Committee for informational purposes only and does not represent an endorsement or recommendation of any particular system or technology. Wherever possible, a reference to the original source of the information or a suitable point of contact (e.g., name or webpage URL) is provided to assist the reader in obtaining more detailed information.

Introduction

The IMAGES SciCom created a technical standing committee to investigate "New Technologies for Sediment Imaging" (NTSI) at their December, 1996 meeting in San Francisco, CA. At this meeting of the IMAGES SciCOM, Dr. Laurent Labeyrie articulated the proposed mission of this new committee:

"The need for developing the capability to rapidly perform ultra-high resolution studies of long sedimentary sequences on a very large number of cores will require new approaches with respect to data acquisition tools and relationships with proxies. It will be necessary to quantify continuously the perturbations introduced by bioturbation and sampling; to develop secondary proxies for interpolating changes between the more quantitative proxies which require sampling large volumes of sediments (e.g., isotope studies, micropaleontological transfer functions, geochemical parameters, etc.). The one-dimensional continuous records obtained by tools such as the GEOTEK multi-parameter system (multi-sensor core logger, MSCL) are a step in the right direction, but not sufficient for our purpose. Tools must now be developed for 2D and 3D imaging with at least millimeter resolution, and acting on a large array of physical characteristics (to multiply the number of proxies which may be independently estimated). There already exists expensive X-ray video digital systems, and much too primitive color reflectance video imaging. Why not, for example, excite the fluorescence of in-situ bacteria or adapt microwave imaging to sediment study?"

This report, which is intended to respond in the broadest context to the mission of the NTSI committee, has three main purposes. The first is to provide a general overview of the available instruments, including those which are either being used now to make non-destructive measurements on marine sediment samples, or which have the potential to be used for this purpose in the future (Part I). The second purpose of the report is to provide preliminary recommendations that can be used to gain insight into how to most effectively promote the rapid development and implementation of new technologies, or how to re-engineer technologies found in other fields (Part II). The final purpose of this report is to present a future strategy and agenda for the IMAGES New Technologies for Sediment Imaging (NTSI) standing committee (Part III). Most of the effort has been put into the first part, so the second two parts should be considered a work in progress.

PART I.

Background

The design and use of a wide-array of rapid, non-destructive logging instruments and imaging techniques has led to fundamental advances in basic research capabilities and in some cases, to the transfer of these remote-sensing technologies to the private sector for commercialization. More and more, we find non-destructive measurements providing the "road map" for subsequent sampling and directed studies in paleoceanography, and in other unrelated scientific fields. We are combining point measurements and discrete sample analyses with images, and sometimes with additional multispectral and volumetric data as well, to provide a mosaic of "nested" data and observations — from microscopic to macroscopic fields of view, and from two-dimensional (2-D) surfaces to three-dimensional (3-D) volumes of observational data. These are both quantitative and qualitative in nature.

Existing Logging and Imaging Systems

The "standard" set of techniques that have traditionally been employed by marine sedimentologists include, for example, visual core and smear slide descriptions, grain size analyses, and geochemical determinations of sedimentary components. These tools have gradually been augmented by suites of non-destructive, semi-continuous measurements of sediment physical properties and rock magnetic properties. These measurements are made by computer-controlled sensors deployed on so-called multi-sensor tracks (MST) or multi-sensor core loggers (MSCL), respectively. The measurements provided by the typical sensors on whole-core logging systems include: (1) gamma density, (2) magnetic susceptibility, (3) sound velocity, and (4) natural gamma activity (where available). Each of these techniques assumes that the volume of rock or sediment contained in the core liner is effectively held constant (i.e., there are no voids, gas pockets, or incompletely recovered intervals along the length of the core section) and that the sensors are well calibrated to reference samples.

These new techniques, which gained more vocal support over the past five to ten years, are now considered "standard". They provide quantitative measurements of sedimentary parameters (which are used as paleoceanographic and paleoclimatic proxies) at the centimeter-scales that are needed to investigate millenial-scale climatic variability in marine cores from regions of the seafloor having high sediment accumulation rates. The "standard" whole-core techniques are now being supplemented by split-core techniques using the same types of sensors as well as additional instruments and probes that provide measurements at closer sample spacing (i.e., higher resolution). In addition, digital imaging systems and other sensors, which provide data from various regions of the electromagnetic spectrum (Fig. 1; Table 1), are being used as prototypes mounted on track systems or as independently-deployed instruments. The available optical systems are diverse, and include for example, color reflectance systems, digital RGB cameras, line-scan cameras, video imaging systems, and laser-scanning microscopic techniques. Other prototype or limited production systems include X-ray fluorescence (XRF) core scanners (Jansen et al., in press), full-waveform ultrasonic logging systems (Breitzke and Spiess, 1993; Breitzke et al., 1996), and u-channel magnetometer systems (Kissel, 1997; von Dobenneck et al., 1996), among others (see Table 2; also see appendices, this report).

Emerging Logging and Imaging Systems

Up to this point this report has mentioned instruments and sensor applications which are probably familiar to almost all of the readers. The next sections will introduce a broad range of 2-D and 3-D technologies (Table 3). Some of these “emerging” technologies are being widely embraced by international researchers, but others still require significant developmental work to attain their full analytical potential. Potential issues involved in the deployment and use of these “emerging” systems may involve the proprietary nature of their particular data acquisition and analysis software, the selection of appropriate standards and calibration protocols, and/or the training needs of the scientists and technicians who operate them and who will ultimately interpret the data.

Some technologies that have been used by geoscientists in analog format for many years (e.g., film-based X-ray images) are "emerging" as digital applications. Others have been developed for specialized bio-medical, material science, and/or industrial imaging markets and have not been used extensively, if at all, in marine geological studies. As these instruments evolve toward potentially new applications and/or gain more widespread acceptance by a communitee of users, a new opportunities and problems may arise which will require innovative and creative solutions.

This report itself has been continually evolving over the past year as the scale of the task became apparent. At this point, the goal is to describe the potential for technology transfer (e.g., from academic, industrial, medical, or government laboratories to practical field situations) or modification to existing technologies for IMAGES activities. This report is intended to provide at least a minimal reference for establishing a technological baseline describing what is available to our community. Following this survey, it will be important to evaluate the strengths and limitations of each of these technologies and to assess the potential improvements they offer over existing systems, as well as how they satisfy a set of clearly-defined measurement needs for the IMAGES activity. Future activities will require clear, quantitative statements of performance and cost specifications for the development of new instruments and/or for the modification of existing systems. The goal is to identify the building blocks, design the fundamental structure, and describe the plan that can be used to transform science fiction into science fact.

Biomedical Imaging Modalities Applied to Geological Studies:

Biomedical imaging methods, including both analog and digital techniques, have a wide range of possible uses beyond the medical field. These techniques have found niche markets in material sciences research, petroleum exploration, and non-destructive testing applications, although financial considerations have limited their broad application in other areas. The demand to achieve sediment imaging at millimeter or smaller scales of spatial resolution naturally leads to the investigation of biomedical methods.

Film-based X-ray imaging methods have been widely used for investigations of laminated sediment sequences, bioturbation, sedimentary structures, and deformation features. Indirect digital X-ray imaging systems, which transform the light produced by X-rays hitting a scintillating screen or image intensifier into digital data, using a combination of CCD arrays, A/D converters, and digital cameras or digital video systems to convert the analog signal into a digital one, are also now available. These X-ray systems can be designed for either radiography (static image acquisition) or fluoroscopy (dynamic image acquisition), and can be used to image cores moving along a track (Algeo, 1994; Migeon et al., 1997), or propelled by a vertical screw (Rack et al., 1996). In addition, direct-digital acquisition techniques, which utilize large-area, flat-panel imaging arrays formed by thin-films of amorphous silicon or amorphous selenium integrated with field-effect transistors (FETs) or photodiodes, are the subject of intensive research activities and commercial activities (Antonuk, 1995; Hofmeister, 1995; Blouke, 1995; Rowlands and Kasap, 1997).

Computerized tomographic imaging methods, including X-ray computed tomography (CT) and magnetic resonance imaging (MRI), are ideally suited for examining the fine-scale structure and behavior of a wide variety of materials using a multitude of image acquisition strategies. X-ray CT and MRI are complementary techniques that can be used to produce planar (2-D) and 3-D images from selected regions of an object or fluid-filled volume. X-ray CT can image electron density and atomic number in solids, which have been quantitatively compared to measurements of bulk density, while MRI can image nuclear spin density, MR relaxation times (i.e., T1, T2, T2*), chemical shifts, and fluid flow velocities. Petrographic applications of NMR include well logging and laboratory measurements of free-fluid index, residual oil saturation, the distribution of pore sizes, and the macroscopic fluid flow properties of rocks and other types of porous media.

X-ray CT methods have recently been used in the analysis of marine sediments and marine sedimentary structures, the characterization of soils, and the study of ice cores. Geologic applications of NMR and MRI techniques have emphasized their use in petrophysical applications, and in the study of fluid flow in porous solids.

Data standards for biomedical imaging devices are based on a concept requiring the interconnection of devices on standard networks, the Digital Imaging and Communications in Medicine (DICOM) standard (http://www.xray.hmc.psu.edu/dicom/dicom-home.html). One potential challenge regarding the transfer of these technologies to other fields of science may be the need to integrate with these standards, or to work with medical instrument manufactures to alter them for non-conventional uses of these instruments.

Digital X-Ray Technologies:

X-radiographs of sediment samples and cores are a standard part of many geologic investigations, especially those oriented toward the study of annual or seasonal laminations. The traditional methods have been film-based with digitization sometimes employed as a secondary step, following an analog to digital signal conversion process. We are entering a transitional period where direct digital x-ray conversion is becoming possible due to the commercial availability of large-area detector arrays (imaging sensors) coated with thin films of amorphous silicon or amorphous selenium combined with other digital electronics and computer (software) interfaces. Most of the products that are emerging into the public domain are either in the research stage or are being marketed for biomedical systems and applications. It will take an unknown amount of effort to define how to incorporate these digital sensors into non-medical research instruments that are afordable, and that meet the needs of individual applications.A sampling of the research groups and commercial ventures incorporating digital X-ray technologies includes the following (this selection is not meant to be exhaustive, nor is it prioritized in any way, it is simply meant to show the existing range of activities):

(1) Two medical research groups at the Sunnybrook Health Science Center in Toronto, Canada, one headed by Dr. John Rowlands of the University of Toronto, Department of Medical Biophysics and one headed by Dr. Martin Yaffe of the Digital Mammography Project, Imaging Research Program, have developed active research programs using amorphous selenium for medical imaging applications.
http://www.sunnybrook.utoronto.ca:8080
http://medbio.utoronto.ca
http://www.sunnybrook.utoronto.ca:8080/~selenium/valley.html
http://wwwresearch.sunnybrook.on.ca/~yaffe/DIGMAM.html

(2) Sterling Diagnostic Imaging, Inc., formerly DuPont Diagnostic Imaging, has begun marketing their DirectRay™ technology, which uses “an amorphous selenium-coated thin-film-transistor (TFT) array to provide “a full field 14 x 17-inch imaging area using 2560 x 3072 matrix of detector elements”.
http://www.sterlingdi.com/pages/product/dray/tech1.html

(3) Swissray International has begun marketing their AddOn-Multi-System product line, which provides direct digital radiography capabilities.
http://www.swissray.com

(4) Varian Imaging Products (VIP) has announced a product that is not yet commercially available, called LAST™ (Large Area Sensing Technology), which is a fusion of "large-area amorphous silicon imaging sensors, radiation-converting materials, low-noise analog and real-time digital electronics, and application-specific packaged interfaces". A technical brief, "Sensor Panel Imaging" in .pdf format is also available at their website.
http://www.varian.com/hcs/ip/index.html

(5) Philips Medical Systems, Thomson Tubes Electroniques, and Siemens Medical Engineering have formed a jointly-owned company to develop, manufacture and market a new generation of flat digital detectors dedicated to (medical) x-ray imaging systems. The new company, called TRIXELL and registered in France, is based in Moirans, near Grenoble according to press releases from 1997.
http://www.news.philips.com/archief/199703041.html
http://www.devicelink.com/emdm/archive/97/11/ind.html

(6) A National Institute of Standards and Technology (NIST), Advanced Technology Program (ATP), project was announced recently which involves Xerox's Palo Alto Research Center, working with Thermotrex Corporation and TPL, Inc., to develop the next generation of large-area digital image sensors based on thin-film silicon technology with potential applications to digital x-ray mammography, high-resolution document scanning, and non-destructive testing.
http://www.atp.nist.gov/www/comps/briefs/96010257.htm

(7) LIXI, Inc., markets a system called the Lixiscope, which was originally developed by NASA at the Goddard Space Flight Center, as well as other products. http://www.lixi.com

(8) Digiray® X-ray Systems, provides high-contrast digital X-ray imaging for a variety of applications using a patented Reverse Geometry X-ray (RGX®) machine. They have also developed a system called Motionless CT™, which uses multiple detectors and a single X-ray source to view one layer at a time within an object. http://www.digiray.com

3-D Microfocal Computed Tomography Imaging Systems

Non-destructive 3D examinations of the internal structures of objects can be obtained using microfocus x-ray tubes incorporated into imaging systems. These instruments provide imaging resolutions on the order of a few microns. The potential application of these instruments in geological studies of unconsolidated sediments is largely in its infancy, but some interesting work has been done. The reference list at the end of this report contains a number of the significant publications related to the use of these instruments. Other examples are included in the appendices of this report. A web survey was done in order to identify some of the commercially available products and the university groups conducting active research of this nature. These include the following:

(1) Bio-Imaging Research, Inc., have a wide range of different X-ray CT and microfocal CT systems (e.g., ACTIS) for imaging small to very large objects (see appendices).
http://www.bio-imaging.com

(2) Micro Photonics, Inc., markets the Skyscan 1072 X-ray Microtomograph system, which provides a spatial resolution of up to 8 µm (see appendices).
http://www.microphotonics.com

(3) A research group at the High-Resolution X-Ray Computed Tomography Facility, Department of Geological Sciences, University of Texas at Austin, are using a microfocal X-ray CT system for the analysis of metamorphic rocks and other geologic and archeologic specimens. Email contact: ctlab@maestro.geo.utexas.edu
http://www.ctlab.geo.utexas.edu

(4) Another research group at the Katholieke University Leuven in Belgium have been using the combination of microfocal X-ray computed microtomography (CMT) and color image analysis to

quantitatively characterize coal samples (see appendices; Simons, et al., 1997; Verhlst et al., 1996). Email contact: Rudy.Swennen@geo.kuleuven.ac.be
http://cwisdb.cc.kuleuven.ac.be

(5) Scientific Measurement Systems markets a system called SMARTSCAN™, which can be used for industrial digital radiography, computed tomography and digital laminography. They have also integrated X-ray CT with computer-aided design software.
http://www.sms-ct.com/company.html

(6) Kevex X-ray, offer a full range of microfocus and integrated X-ray products. http://www.kevex-x-ray.com

(7) North American Imaging, Inc., supply image intensifiers, and X-ray and CT tubes.
http://www.tubenet.com/Copg.html

(8) High-resolution Synchrotron X-ray techniques are being used to study earth materials at micron and sub-micron scales of spatial resolution. These pages describe emerging research into this emerging technology by several different researchers. These techniques are useful for pursuing basic research question relating to the scale-dependence of transport properties through pore networks, reservoir characterization in petroleum geology, fracture processes in cement-based materials, and many other research activities.
http://www.lbl.gov/Publications/LDRD/1996/Schlueter.html
http://www.lbl.gov/Publications/LDRD/1996/Binnall.html
http://www.rpi.edu/~kaluka2/XTM.html
http://www.rpi.edu/~kaluka2/nanno.html
http://www.umeciv.maine.edu/cd/research/xmt/

Nuclear Magnetic Resonance Imaging (NMR and MRI):

In porous media, the internal magnetic field gradients are caused by the different susceptibility values of the solid grains and the pore fluid, the form of the gradient depending on the geometry of the pore structure, and the magnitude being directly proportional to the applied magnetic field strength (Kleinberg and Horsfield, 1990). Because NMR lifetimes are related to the lengths that characterize the pore space, magnetic resonance is a valuable, non-invasive technnique for estimating the permeability of a porous medium. In conventional NMR of porous media, the fluid's bulk relaxation processes are overwhelmed by the influence of the pore-grain interface, where the proton magnetization decays rapidly due either to the presence of paramagnetic impurities or to the hindered rotation of H_2O molecules (Straley et al., 1987).

T_1 is the symbol used to represent the longitudinal, or spin-lattice relaxation time constant, T_2 is the symbol for the transverse, or spin-spin relaxation time constant, and T_2* is the symbol for the free induction decay rate observed due to the combination of spin-spin relaxation and main field inhomogeneities (eg., represented by an exponentially damped sine wave). A spin-echo sequence is a set of radiofrequency (RF) pulses (and for imaging, field gradient pulses) of defined timing and amplitude which is usually repeated many times, each time resulting in the collection of an MR signal.

Measuring the spin-lattice relaxation time (T_1) of a fluid contained in the pore space of a solid allows the determination of pore structure information without pore shape assumptions, thus yielding the "true" pore volume to surface area ratio in a wet solid. The T_1 relaxation time is a function of the fluid, proton frequency, temperature, pore surface chemistry, and pore size (Gallegos and Smith, 1988). In solid materials, T_2 relaxation times are on the order of tens of μs while T_1 relaxation times are typically many hundreds of seconds long (Attard et al., 1991).

The multiexponential character of the NMR decays is correlated with the heterogeneities in pore sizes which characterize most rocks; the heterogeneity length scale is larger than the diffusion length associated with NMR relaxation times. The most important relaxation mechanism arises from hyperfine interactions with paramagnetic ions such as Mn^{2+} and Fe^{3+} at the grain surfaces (Kleinberg et al., 1994).

Potter et al. (1996), have recently presented an NMR technique which is capable of detecting bacterial cells (using high concentrations of cells) and of measuring the cell density in suspension and in porous media. Their study is based on the pulsed-field gradient spin-echo (PGSE) technique and relies on the fact that extracellular water diffuses freely while intracellular water is completely restricted by the relatively impermeable cell wall of the bacterium; thereby allowing a diffusion filter to be used to eliminate the signal from extracellular water. Diffusion-weighted imaging can be used to spatially map the distribution of bacteria within water-saturated quartz sand packs. The ability to monitor microbial biomass growth and distribution within laboratory columns and flow cells will possibly provide a critical link to scaling microbial processes to field scale, using NMR well-logging equipment.

MRI Study of a Sediment Core from Lake Winnipeg, Canada:

Non-destructive measurements of sediment samples from Core Namao 94-900-122a from Lake Winnipeg have been made using a Magnetic Resonance Imaging technique known as SPRITE (Single-Point, Ramped Imaging with T_1 Enhancement) developed at the University of New Brunswick (Balcom et al., 1996b; Rack et al., in press). This is the first time that lake sediments, or any other kind of highly-porous sediment for that matter, have been imaged using this technique. The SPRITE images are primarily used to identify changes in mm-scale sedimentary structures and to infer fine-scale variations in sediment porosity from 330 to 465 cm in Section 4 of this core. Future work will provide more quantitative analyses of these intervals and a better understanding of the full potential of this method of imaging.

Fluorescence and Reflectance Spectroscopy

Spectral data are used to facilitate the identification of materials based on how they absorb and reflect light. As in planetary observations systems, the fusion of imaging and spectroscopy provides a powerful new tool for the remote sensing of sediments and other types of materials. The most important test of any methodology is the ability to link remote measurements to the familiar frame of reference of the observer, both in the field and in the laboratory. One of the most important issues is how to process, validate and interpret the data that are now possible to retrieve and archive. An extensive list of references are included in this report regarding mineral spectra and reflectance spectroscopy, colorimetry, fluorescence spectroscopy, optical and chemical sensors and probes, and related methods.

Fluorescence spectroscopy is widely used in the medical field and in biological research. The literature is so voluminous that no attempts have been made at this time to review these techniques. The interested reader is directed to the articles contained in a series of books on the subject by Lakowicz.

Some of the interesting geologic applications of reflectance spectroscopy are: (1) the mapping and remote identification of minerals and mineral associations, (2) the mapping and remote identification of bacteria, and other biological-related compounds, and (3) the mapping and identification of geochemical compounds. There is a wealth of data currently available on these remote sensing topics. In particular, the U.S. Geological Survey (USGS) Spectroscopy Lab has an excellent website describing a wide range of spectroscopic techniques and software related to rocks and minerals. One of the many outstanding contributions of this site is an article written by Roger N. Clark, which is entitled “Spectroscopy of Rocks and Minerals, and Principles of Spectroscopy”. This article is derived from a chapter by Roger Clark in the forthcoming “Manual of Remote Sensing” (1998). The homepage URL is: http://speclab.cr.usgs.gov

The SCAT (Split Core Analysis Track) system, developed by Alan Mix and others at Oregon State University, measures diffuse reflectance spectra from the surface of split sediment cores. This system utilizes a broad spectral bandwidth that extends from the ultaviolet into the near infra-red portion of the electomagnetic spectrum (250 to 950 nm wavelengths), with spectral resolution of 0.68 nm. This system has been successfully deployed on several high-recovery Ocean Drilling Program coring cruises (Harris and Mix, in press; Mix et al., 1992, 1995; Ortiz et al, in press; also see the appendices of this report for more information).

A visible wavelength sensor used by the Ocean Drilling Program and other researchers for discrete colorimetric and spectra measurements is the Minolta spectrophotometer system. Other optical systems are also being developed and deployed on split-core multi-sensor track systems. These include the Dalsa Line Scan Camera being considered for the ODP split-core track, and the GEOSCAN line camera system marketed by GEOTEK, Ltd. (UK). Some of the available web-based information about these specific systems includes the following:

(1) Information about Minolta colorimetric system can be found at the following URL address: http://www.minoltausa.com/productlinelist-cat=cm.htm

(2) Information about the Dalsa Color Line Scan Camera and other digital cameras can be found on the website of Graftek Imaging, Inc., at the following URL address: http://www.graftek.com/prices.htm

(3) Information about the GEOTEK GEOSCAN line camera system can be found at the following URL address: http://www.users.dircon.co.uk/~geotek/geoscan.html

Chemical Fossils (Biomarkers) and Molecular Stratigraphy:

Biological marker compounds (or biomarkers) are geologically occuring organic compounds with chemical structures that can be unambiguously linked to natural product precursors (Eglington and Calvin, 1967; Rosell-Melé and Koç, 1997). It is possible to identify tetrapyrrole types (porphyrins vs. chlorins) using visible spectrophotometry (Rosell-Melé and Koç, 1997). With few exceptions, chlorins, free base phorbides, and porphyrins have electronic spectra with maxima in the near-UV and visible range (i.e., 350-850 nm). The Soret band is the wavelength region with the highest extinction in the near-UV range (i.e., 360-420 nm), but it disappears almost completely if the tetrapyrrolic ring is broken, or if its aromatic conjugation is interrupted in any other way.

Sedimentary chlorins and porphyrins are diagenetic products of chlorophyll molecules and are considered to be chemical fossils or biomarkers of phototrophic organisms. Chlorophyll-derived pigments (chlorins and geoporphyrins) include the red metalloporphyrin pigments, which occur widely in ancient sedimentary rocks and petroleum, and the green chlorin pigments, which result from structural modifications of the chlorophyll molecules produced by photosynthetic organisms in the water column and which are preserved in Recent sediments. Downhole trends in the total abundance of chlorin pigments in sediments, in common with all biomarkers, depends on changes in primary (export) productivity and preservational efficiency.

The Confocal Laser-Scanning MACROscope/microscope (CLSM/m)

The Confocal Scanning-Laser MACROscope/microscope (CSLMm) is an instrument developed by researchers in the Department of Physics at the University of Waterloo, Ontario, Canada, which is now being tested for geologic applications. Systematic investigations are underway to evaluate its potential for imaging lake and ocean sediments, both as discrete samples and as split-cores (see Rack, et al., 1998; also see Appendix G). A commercial version of the CSLMm is being marketed by Biomedical Photometrics, Inc. (BPI). Their homepage URL is: http://www.confocal.com

The Confocal Laser-Scanning MACROscope/microscope provides digital images at user specified fields-of-view using the appropriate light sources and detectors. It is envisioned that the instrument can be used to collect registered digital imagery at nested spatial-scales from centimeters to microns using reflected-light and fluorescence emission. These digital datasets will allow researchers to conduct routine quantitative surveys along the surface of sediment cores (and/or discrete samples), and to supplement these general surveys with close-up, microscopic investigations. In addition to these tasks, it is believed that the system can be used to rapidly collect three-dimensional images of dispersed particles on slides for pollen and microfossil identifications, conduct systematic digital micro-facies analysis of Heinrich layers and event-deposits in marine cores, and identify material suitable for dating in terrestrial and marine samples.

Important advantages of this system over conventional confocal microscopes, are (1) the ability to rapidly image very large specimens and (2) the ability to image samples using an extremely wide range of magnification (e.g., from a 7.5 cm x 7.5 cm field of view (FOV) in the MACROscope mode, to a 25 µm x 25 µm FOV at the highest microscope magnification). In confocal imaging, light from above and below the focal plane is rejected by the (confocal) detector pinhole, resulting in a digital image where individual pixels are either in-focus or dark. Confocal optical slices are obtained at a series of focus positions in the z-direction (depth) to assemble a three-dimensional image. The thickness of an optical slice is determined by the axial (depth) resolution of the instrument.

A "proof-of-concept" study has already been initiated using approximately 30 samples requested from the Ocean Drilling Program's collection of globally-distributed sediment cores, which are representative of the wide range of compositional and textural variation found in typical marine sediments (e.g., biosiliceous and calcareous oozes, glacial diamicts, volcanic ash, organic-rich sediments, sands, silts, clays, etc.). Early results with the system have demonstrated that it is possible to measure the thickness of mm-scale sedimentary layers using the acquired images, to examine contacts between layers, and to zoom-in to identify interesting features. The system can be used with a fluorescence spectrometer to make single point spectral measurements within the field of view.

Geotechnical and Geochemical Applications

There are many laboratory and field instruments that are used in the geotechnical and environmental sectors for non-destructive measurements or remote observations. One of the instruments that has been used to make rapid, non-destructive and precisely located measurements of fluid flow through porous media has been the probe permeameter (Bourke, 1993; Halvorsen, 1993; Sutherland et al., 1993). This instrument can measure gas flow into porous media using a probe that is pressed against the sample surface. Some of these systems have been automated and used on laminated rocks (Halvorsen, 1993).

An extensive literature has developed around the use of the cone penetrometer test (CPT), which is being used for environmental surveys, geotechnical characterization, and hazards mapping. More information is provided in the following section.

The US Department of Energy sponsor a Characterization, Monitoring, & Sensor Technology - Crosscutting Program (CMST) that deals with technology transfer and research, primarily related to environmental remediation projects. One of the reports from this program is entitled "Recommendations on the Development of Chemical Sensors and Field Deployable Instruments for DOE Needs". This report provides an informed overview of technologies to meet the needs for environmental characterization and monitoring, including reviews of (1) piezoelectric mass sensors, (2) fiber and optical waveguide sensors, (3) electrochemical sensors, and (4) optical sensors, among others. The URL for obtaining this report is: http://www.cmst.org/cmst/NewServer/rp.html

The Cone Penetrometer Test (CPT):

Cone penetrometer-deployed sensors are being used in the geotechnical and environmental sectors for many routine and advanced applications. A key factor in the potential development and use of penetrometer-based sensors is to understand the component technologies which have been developed for cone penetrometer tests on land, and then re-engineer these systems to fullfill our needs offshore.

Much of the information about cone penetrometer-based sensors and probes that is presented in the following section was obtained during a series of searches on the World Wide Web (WWW), beginning with an excellent sites created by Dr. Richard S. Olsen:

Cone Penetrometer Test website:
http://www.liquefaction.com

and Dr. R. G. Campanella, In-Situ Testing Group, UBC Civil Engineering
http://www.civi..ubc.ca/home/in-situ

Another interesting site is the homepage of Dr. Paul Mayne, Civil and Environmental Engineering, Georgia Institute of Technology, which provides links to information about piezocone tests and instruments in publications and research summaries.
http://geosystems.gatech.edu/Faculty/Mayne/mayne.html

Examples of research studies that are currently underway using penetrometer-based systems include: (1) a Seismic Piezocone Pressuremeter (SPP), which will permit the in-situ measurement of 8 separate parameters from a single sounding. This instrument will provide the necessary data for a complete characterization of in-situ (G/Gmax) modulus degredation relationships; (2) a Vibrocone Penetrometer (VP) for use in detecting liquefiable zones in highly seismic areas. Fugro Geosciences has provided a triple-element piezocone for the measurement of tip, sleeve, and multiple porewater pressures in this system; (3) a Gamma-Ray Cone Penetrometer (GRCP) which can be used in delineating the natural radioactivity of a sediment (K, U, Th) and can also be used to make a discrimination between clay and sand.

In addition, a penetrometer instrumented with an accelerometer may provide information about both the shearing strength and the geoacoustic properties of the sediment. When the probe first impacts the

sediment there is a rapid deceleration controlled by the shear strength, followed by a period of damped oscillation with frequency dependent on the geoacoustic properties. A very brief 1994 research summary by T. Akal (SACLANT) and R. D. Stoll (Lamont-Doherty) describes laboratory and field tests "with a probe similar to the expendable bathythermograph (XBT)", wherein the thermistor used to measure temperature is replaced by an accelerometer. This work was supported by ONR.
http://sound.media.mit.edu/~dpwe/AUDITORY/asamtgs/asa94aus/1aAO/1aAO11.html

Commercial websites dealing with this technology include, for example:

(1) Kessler Soils Engineering Products, Inc., who describe a Dynamic Cone Penetrometer (KesslerDCP), which consists of a 5/8 inch-diameter steel rod with cone attached to one end. Disposable cones are available. http://www.kesslerdcp.com

(2) VERTEK Manufacturing, who describe a geotechnical and environmental system called the Automated Dynamic Cone Penetrometer (ADCP).
http://www.ara.com/division/vertek/images/ADCP.htm

(3) Applied Research Associates, who have developed a Combined Electrical Resistivity and Dielectric Probe based on cone penetrometer test specifications.
http://www.ara.com/techno/CPT.htm

(4) There are two systems that are now being widely-used for environmental investigations, these are: (1) the Site Characterization and Analysis Penetrometer System (SCAPS), which uses a Laser-Induced Fluorescence sensor (LIF), and the Rapid Optical Screening Tool (ROST), both of which can be used for the in-situ detection of petroleum (aromatic) hydrocarbons. These tools use a laser (e.g., pulsed nitrogen laser; wavelength tunable ultraviolet laser source) coupled with an optical detector to measure fluorescence (via optical fibers) through a sapphire window on a probe that is pushed into the ground. The TriService Group (U.S. Army, Navy, and Air Force) in conjunction with the US Department of Energy and the EPA were instrumental in developing these systems.
(For more information see the CPT website: http://www.liquefaction.com).

(5) Fugro Geosciences has developed and/or acquired specialized cone penetrometer test (CPT) sensors and sampling tools, which include: (1) Standard Cone Penetrometer - identifies statigraphy; (2) Piezocone - identifies statigraphy and measures saturated pore pressure. Allows identification of the water table and estimation of hydraulic conductivity and refined interpretation of fine-grained soils; (3) Conductivity Cone - identifies stratigraphy and soil/groundwater conductivity; (4) Supercone - combined standard, piezo, and conductivity cone; (5) Natural gamma probe; and (6) Seismic probe. CPT installed piezometers are available in diameters from 1/2 inch to 2-inch.

Fugro Geosciences acquired the (ROST) technology from Loral (now Lockheed Martin) in May 1996. Fugro now provides ROST worldwide directly to consultants and site owners as an integrated service with their direct push capabilities.

Dakota Technologies, Inc. (DTI), a small business formed by researchers from North Dakota State University, co-developers of ROST, provide research and development and technical support to Fugro. DTI has developed a ROST upgrade that will allow simultaneous monitoring of fluorescence versus depth at four separate wavelengths during a push. The systems will be upgraded to the multi-wavelength function in the near future. This feature will allow detection of a wider range of contaminants simultaneously and will provide continuous product differentiation.

Fugro and DTI will continue to evaluate and upgrade the ROST system to make it as robust as possible. Fugro is currently an active participant in the development of the next generation of laser-induced fluorescence in-situ technology under the Advanced Applied Technology Demonstration Facility sponsored by the US Department of Defense in partnership with Tufts University and Rice University. Fugro is also pursuing development of new sensors including probes for in-situ metals and chlorinated hydrocarbon screening.

Note: The information presented about the activities of Fugro Geosciences and Dakota Technologies, Inc. has been extracted from: Bujewski, G., and Rutherford, B. (Sandia National Laboratories), 1996. The Rapid Optical Screening Tool (ROST™) Laser-Induced Fluorescence (LIF) System for Screening of Petroleum Hydrocarbons in Subsurface Soils. Innovative Technology Verification Report, National Exposure Research Laboratory, U.S. EPA Report.

Digital Imaging and Digital Color Management, Image File Formats, and Compression Algorithms

This section of the report should probably be included in the activities of the IMAGES Data Advisory Committee, but is included here for completeness. There are a large number of potential issues that relate to the ultimate goal of selecting an image file format and compression algorithm for imaging systems, ranging from data acquisition issues through those related to data storage, analysis, and archiving.

These issues go well beyond simply selecting a file format/compression scheme. It is important that we define the community needs for scientific activities both before and after image capture (and archiving). It is also important to identify the differences between (1) acquisition systems requirements, arising from the use of various digital imaging devices, for example: frame cameras, line-scan cameras, and spectral imaging systems referenced to digital images; (2) database systems requirements; and (3) output system requirements, which allow us to transfer images to devices such as printers, monitors, CD-ROMs, and other systems. There are lots of trade-offs in this area of cross-platform data exchange using color images, or images linked to spectral data.

It is important that researchers are educated about how such subjects as "digital image formats" and "digital color management" are integrated into a systems view. It will take some time to absorb all of this knowledge, but in order to define the specifications for new instruments which allow them to be compatible with the overall database, it might be necessary to reach a better understanding of the variables involved.

A very interesting, recently published book explores the methods for color encoding and color interchange used between a wide range of input and output systems, and one that is written in a tutorial manner that is very useful and informative. It is written by the imaging scientists who developed the Kodak Photo-CD system and presents a description of a Unified Color-Management Paradigm for "open systems", based on advanced color-encoding methods that go well beyond standard color measurement techniques. This book provides a holistic framework for working with digital color images and data.

Edward J. Giorgianni and Thomas E. Madden, 1997. Digital Color Management. Addison Wesley, Reading, MA. ISBN: 0-201-63426-0 (TA1637.G56 1997).
http://www.awl.com/cseng/titles/0-201-63426-0

These pages by Chales Poynton are very informative and lead to many other sites:
http://www.inforamp.net/%7Epoynton/Poynton-colour.html *note the spelling of colour!
http://www.inforamp.net/%7Epoynton/notes/links/color-links.html

Poynton also has FAQs about Color Science and Gamma corrections.
http://www.inforamp.net/~poynton/GammaFAQ.html
http://www.inforamp.net/~poynton/ColorFAQ.html

Also see the International Color Consortium site for more information on color management:
http://www.color.org

Compression Schemes:

Many of the formal specifications, for both various image compression schemes and various image file formats, are available on-line. Here are a few examples:

The compression FAQ (in three parts):
http://www.cis.ohio-state.edu/hypertext/faq/usenet/compression-faq/part1/faq-doc-1.html

The FBI Fingerprint Image Compression Standard
http://www.c3.lanl.gov/~brislawn/FBI/FBI.html

The CREW method (Compression with Reversible Embedded Wavelets):
http://www.crc.ricoh.com/CREW/CREW.summary.html

SPIHT image compression (Set Partitioning in Hierarchical Trees):
http://ipl.rpi.edu/SPIHT/spiht1.html

FocusWave/SPIHT image compression technology:
http://www.focusweb.com/imagetech

LOCO-I/JPEG-LS lossless/near-lossless compression:
http://www.hpl.hp.com/loco

Waterloo BragZone - a site comparing different image compression programs:
http://links.uwaterloo.ca/bragzone.base.html

and focusing on fractal-based methods:
http://links.uwaterloo.ca/fractals.home.html

These sites provide an introduction to the realm of compression algorithms using DCT-based (discrete cosine transform), wavelet-based, fractal-based, fractal-wavelet hybrids, and pyramid-based schemes. There are many others in this group.

A potentially interesting book is: "The Data Compression Book", 2nd ed. 1995
http://web2.airmail.net/markn/tdcb/tdcb.htm

A book dealing with multiscale methods in image analysis using wavelets is:
Jean-Luc Starck, Fionn Murtagh, and Albert Bijaoui, 1998. Image and Data Analysis: The Multiscale Approach. Cambridge ISBN: 0-521-59914-8 (paper), 0-521-59084-1 (hard).
http://www.cup.org/Titles/59/0521590841.html
http://ourworld.compuserve.com/homepages/multires

The following pages review different data and image file formats and provide links to more detailed sources of information:
http://www.lib.virginia.edu/dic/info/formats.html
http://www.dcs.ed.ac.uk/~mxr/gfx/2d-hi.html
http://www.cobb.com/tma/9508/tma89501.htm

For more information about the BMP format, see:
http://www.dcs.ed.ac.uk/~mxr/gfx/2d/BMP.txt

This only scratches the surface of the available information, so keep searching.

PART II. Review and Preliminary Recommendations

The NTSI Standing Committee - Progress to date

In the eighteen months since the initiation of this committee, most of the activities have been undertaken by the chairman in consultation with the other committee members and with interested individuals within the IMAGES and marine geoscientific community. The primary activity of this committee has been (1) to research both traditional sources of published literature and the wealth of on-line, web-based information sources, and (2) to identify those instruments and/or techniques which either have proven relevance to the study of marine sediments, or which could be adapted to the study of these materials in the near-term. This search was necessarily both broadly-defined and interdisciplinary in nature, since it was unclear where and at what level of development, suitable new techniques and/or technologies might be found. The research to date has focused on investigating established, non-invasive technologies (eg., X-radiography, X-ray CT scanning, MRI) and exploring newly-emerging techniques, such as using nuclear magnetic resonance (NMR), optical sensors and probes, photoelectric sensors, optical reflectance and/or fluorescence spectroscopy, confocal scanning laser microscopy (CSLM), and other potential methods for geologic investigations. In addition, the chairman has approached a number of interested scientists about contributing their expertise to this committee and as a result, some of their contribuions are included in the appendices to this report.

The CORSAIRES Core Logging Workshop (European Union-sponsored), which was held last year (July 24-25, 1997), was an activity that largely complemented the objectives of the international NTSI standing committee and thus provide a unique opportunity to “jump-start” the activities of the NTSI group and to promote these activities to a core group of interested marine scientists in Europe. The CORSAIRES Workshop provided the opportunity for cross-pollination between research groups, both through the plenary lectures and through the series of workshop practicals. The workshop practicals focused on: (1) demonstration of a new core splitting system (IFREMER), (2) the use of GEOTEK multi-sensor core logger, (3) demonstration of a video imaging system (IFREMER-EPSHOM), and (4) demonstration of the CORTEX X-ray fluorescence system (NIOZ, Texel). This interaction resulted in a proposal submitted to the EU in 1998 as a concerted effort for a European Core Lab Network (EUCLAN).

What is needed now is a more formal gathering of the IMAGES NTSI committee members, possibly together with a core group of technically-oriented ODP researchers, to critically evaluate some of the information contained in this report and the associated reference materials. The agenda for this meeting would be developed in the coming months, after everyone has a chance to absorb the material contained in this overview, and the important issues are defined in more detail. There is a meeting entitled "Technology for Deep-Sea Geological Investigations: Developments, Applications and Results", which is planned for November 11-12, 1998 at the Geological Society in London, which may provide an intermediate venue for initiating these discussions, depending on the list of possible attendees. Other possibilites should be discussed. There is also the possibility that the IMAGES group would like to submit a white paper to the upcoming meeting to discuss the future of scientific ocean drilling, if this is considered an appropriate way to integrate IMAGES needs with those of the Ocean Drilling Program.

PART III. Future Agenda of the NTSI Standing Committee

Where do we go from here?

The work of the NTSI standing committee has only just begun at the end of eighteen months. The activities of the past year have been limited to web-based surveys and email correspondence between a small group of interested participants. This situation is not likely to change without some allocation of funds to this activity. It is essential that the mission of this committee be reviewed by the IMAGES SciCom and that they provide some guidance on what this committee is tasked to accomplish. Everything done to date has been a free-form attempt to set the stage to address some of the important questions and issues that pertain to the identification, promotion, and deployment of new sensor systems. The following list of "strawman" topics might be a place to start.

Next-Generation Core Logging and Imaging Systems

- What are the enabling technologies?
- How can we promote the development of new systems?
- How can we make these systems affordable?
- Where do we find the resources?

Design and Implementation of Future Systems

- Definition of Needs
- Quality Assurance and Groundtruthing of Measurements
- Standards and Calibration Procedures

- Transfer Functions for Paleoenvironmental Proxies
- Correlation between Data and Images
- "Nested" Scales of Resolution

Digital Imaging - Storage and Archiving of Images

- Digital Color Management
- Digital Image Formats
- Digital Image Compression Algorithms
- Display, Analysis, and Publication of Images
- Image Database - Storage, Retreival and Search Capabilities

In addition, the following process-oriented framework (taken from Yacobi and Holt, 1994), was developed for evaluating new measurement technologies in the microanalysis of solids. This type of formal approach might help to provide some guidelines for the activities of the NTSI standing committee in the future. The first topic of this outline has been largely addressed by the material contained in this report. The key is to find answers to the rest of these questions.

(1) Identify various potential instruments and techniques and gather appropriate information in order to evaluate each technique or technology.

(2) Questions to be addressed during evaluation might include:

a.) What type of information is available?
b.) What is the sensitivity of the analysis?
c.) What is the depth of analysis (ie., surface, subsurface, bulk analysis)?
d.) What is the spatial resolution (x,y)?
e.) What is the depth resolution (z)?
f.) Is the analysis quantifiable?
g.) What are the data acquisition and processing times?
h.) Is the method destructive or non-destructive?
i.) Does the measurement yield information about physical, structural, or compositional properties of the material?
j.) What is the excitation source (ie., electrons, ions, photons, positrons, neutrons, acoustic waves)?
k.) What effects, or response, carries the desired information or signal (ie., backscattered and secondary particles and photons, diffracted waves, interactions between excitation probe and bulk solid)?
l.) What kind of detectors are required to capture this signal?
m.) What is the cost of each analysis?
n.) What kind of sample preparation is required?
o.) What is the throughput of the analysis?

Finally, Figure 2 illustrates a flowchart that can be used to evaluate technology development needs. This chart was modified from the CMST report mentioned earlier. The potential for commercialization of some of these technologies may make it possible to arrange partnerships with government agencies and/or private corporations to develop new tools. This potential is unknown, but should be assessed. There are a lot of things that can be done, the question that needs to be addressed now is: What should be done?

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Table 1. The Electromagnetic (EM) Spectrum

Gamma rays (shorter than 0.3 Å)

X-rays (0.3 Å to 300 Å)

Ultraviolet (0.3 µm to 0.4 µm)

Visible (0.4 µm to 0.7 µm)

Infrared:
- Near infrared (0.7 µm to 1 µm)
- Short wavelength infrared (1 µm to 3 µm)
- Mid infrared (3 µm to 15 µm)
- Thermal infrared (10 µm to 15 µm)
- Far infrared (15 µm to 1 mm)

Microwave (1 mm to 0.3 m; 300 GHz to 1 GHz):
- EHF (1 mm to 10 mm; 300 to 30 GHz)
- SHF (10 mm to 0.1 m; 30 GHz to 3 GHz)

Radiometer and Radar:
- Bands = I, G, P, L, S, C, X, Ku, K, Ka, O, V, W
- nominal SAR frequency range (30 mm to 0.3 m; 10 GHz to 1 GHz)

Radio (Broadcast, Communication, Navigation)
- UHF (0.1 m to 1 m; 3 GHz to 300 MHz)
- VHF (1 m to 10 m; 300 MHz to 30 MHz)
- HF (10 m to 0.1 km; 30 MHz to 3 MHz)
- MF (0.1 km to 1 km; 3 MHz to 300 kHz)
- LF (1 km to 10 km; 300 kHz to 30 kHz)
- VLF (10 km to 100 km; 30 kHz to 3 kHz)
- ULF (> 100 km; longer than 3 kHz)

Table 2. Existing Core Logging and Imaging Systems

Ocean Drilling Program (ODP)

Whole-Core Multi-Sensor Track (MST)

ODP Split-Core A-Logger

ODP Split-Core W-Logger

* For more information see: ODP Technical Note #26 - Blum, 1997.
http://www.odp-tamu.edu/publications/tnotes/tn26/INDEX.HTM

GEOTEK Whole Core Multi-Sensor Core Logger (MSCL)

GEOTEK Split Core Logger
* For more information see the GEOTEK Ltd. (United Kingdom) website at:
http://www.users.dircon.co.uk/~geotek/

Oregon State University SCAT system
* For more information see appendices of this report:

Automated Full-Waveform Logging System
University of Bremen, Department of Earth Sciences, Germany
* For more information see appendices of this report:

XRF Core-Scanner - for shipboard element analyses.
CORTEX (Corescanner Texel), second system delivered to University of Bremen
* For more information see appendices of this report:

U-Channel Cryogenic Magnetometer Systems

- CNRS, Gif-sur-Yvette - contact Dr. Carlo Laj
- University of Florida - contact Dr. James Channell
- University of California, Davis - contact Dr. Ken Verosub

Table 3. Emerging Technologies and 3-D Imaging Systems

X-Ray Systems: (2-D and 3-D)

Digital X-Ray Imaging Systems
- Radiography
- Fluoroscopy

X-Ray Computed Tomography (CT) Systems
- Medical systems
- Industrial systems

Microfocal X-Ray Computed Microtomography (CMT)

Nuclear Magnetic Resonance (NMR) and Magnetic Resonance Imaging (MRI) Systems and Methods:

NMR Mouse - Mobile Universal Surface Explorer

SPRITE - Single Point Ramped Imaging with T1 Enhancement

Advanced Optical Systems and Methods:

Digital Camera Systems

Colorimetry and Color Management

Optically-Stimulated Luminescence

Confocal Scanning-Laser MACROscope/Microscope
- Fluorescence Spectroscopy
- Imaging Spectroscopy

Fiber-Optic Spectroscopy Systems
- Raman
- Fourier Transform Infra-Red
- Multi-Wavelength

Geotechnical and Downhole Applications:

- Probe (mini) Permeameter
- Cone Penetrometer-based Sensor Systems
- Electrical Conductivity and Dielectric Imaging

List of Appendices

SCIMP APPENDIX 99-1-14

The role of seismic data in ODP

PRESENTATION BY SVERRE PLANKE--

Seismic data are essential to achieve the goals of the ODP LRP.
- •particularly for deep (riser) holes - post 2003
- •unique core data in ODP which additionally can be utilized to study seismic wave phenomena

Currently the responsibilities of seismic data are divided between several contractors and institutions.
- •many aspects under SciMP responsibilities

Suggest to focus, strengthen, and coordinate activities related to seismic data acquisition, processing and interpretation.
- • core/log/seismic integration
- •assure industry standard data quality

Short overview of current status of seismic data in ODP

Physical properties (ODP)

Vp, Vs	Vs not in hard-rocks. Atmospheric conditions. Measurements should be done quickly after recovery to avoid relaxation cracking and alteration.
Density	GRAPE (MST). Pycnometer.
In-situ	Unknown status.

Wireline logging (LDEO-BRG)

Velocity (Dipole Shear Imager, DSI; Sonic Digital Tool, SDT).	Limited facilities available for slowness-time coherency (STC) processing.
Density	

Downhole seismic experiments (LDEO-BRG)

Vertical seismic profiling (VSP) Well seismic tool (WST)	Frequently not undertaken. Limited processing facilities.

Seismic reflection data (ODP, other)

Single-channel (JR underway lab)	Limited use for leg-specific scientific purposes. Few laboratory specialists.
Multi-channel	Greatly varying standard. No processing or interpretation facilities. Limited QC (Site survey panel).
Other seismic data (wide-angle data etc.)	Greatly varying standard. No processing or interpretation facilities. Limited QC.

Ideas for reorganization

(1) Seismic laboratory on JR

Use and maintenance of hardware and software for seismic data acquisition, processing and interpretation.

Incorporate underway geophysics laboratory. Include responsibilities for aspects of multi-channel data processing and interpretation, downhole measurements (well seismic surveys, sonic logs), and physical property measurements.

Staffing requirements:

* Trained laboratory technician.
* Shipboard scientist with main responsibility for seismic data interpretation and integration.

(2) Introduce contractor responsible for leg-specific seismic data acquisition and processing

* Time-depth conversion for each site.
* Upgrade and maintenance of ship- and shore-based seismic laboratory.

(3) Provide shore-based facility for MCS data processing and interpretation

* Pre-cruise QC of data.
* Provided facility in collaboration with other scientific programs (i.e. separate funding).

SciMP actions/recommendations

* Organize task groups / work shops to come up with specific recommendations.
* Assure increased quality, usefulness and availability of leg-related seismic data.
* Opportunity for ODP to be in the lead in the process of reorganizing marine geosciences.

SCIMP APPENDIX 99-1-15

Specific BISOPHERE LAB needs for Leg 185 relative to PPG requirements

FAX   8 December, 1998

From:

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To:
Richard Murray
Guest - Powell Hotel

Rick,

Here is a preliminary list of equipment for the ODP microbiology lab. Most of the items are general use equipment (shakers, centrifuge, anaerobic chamber, laminar flow hood, luminometer, pipettes, refrigerator, shaker, sonicator, spectrophotometer, sterilizer, vacuum pumps, vortex mixer and water baths). These items should be of use to the majority of microbiologists on ODP Legs.

The Leg 185 specific section is made up of supplies that will either consumed on board or contains samples that will be shipped back to the home institution.

The microscope upgrade section assumes that the Zeiss Axiophot microscope will be on board and available for use by the microbiologists. It also assumes that the scope is outfitted with epifluorescence illumination via a mercury bulb.

The radioisotope section is for the possible outfitting of the ship for radioisotope work. It is possible to replace the liquid scintillation counter listed with a less expensive machine at a saving of approximately $5,000. I do not have experience with the alternative machine but I plan to check into it.

In addition to the microscope, other equipment already on board that will be necessary for the microbiologists include the ultra-low freezer, the lyophilizer and the water purification system. I presume that these items are already in use by ODP scientists, which makes it imperative to determine whether the items can accommodate the increased demand by the microbiologists or whether duplication is necessary.

Executive Summary

The list of proposed equipment will allow microbiologists to work with recovered cores using complementary strategies. On one hand, some equipment (anaerobic chamber, water baths, shaker etc.) will allow manipulations onboard in order to culture microorganisms at sea. This will result in estimates of their in situ abundance as well as bring microorganisms into pure culture for future studies. Other onboard equipment (microscope, camera, sonicator etc.) will permit the quantification, and documentation, of the microorganisms, which will be useful in targeting samples for detailed experimentation at sea.

Other equipment (laminar flow hood, dry-ice maker) will be used to preserve subsamples for subsequent analyses in land-based operations. The hood will allow for subsamples to be taken with little risk of contamination and quick-freezing will preserve the microbial

community composition which can be analyzed, at the molecular level, at shore-based facilities.

The addition of radioisotope facilities onboard will open up new possibilities for processoriented studies with microorganisms recovered from the deep sediments. A scintillation counter on board, while expensive, will allow both the quantification of these processes as well as for routine surveys for contamination, which are necessary for shipboard radioisotope work.

Supplies for ODP Microbiology Laboratory

Item	Price
General Equipment	
Anaerobic chamber	$5,500
Centrifuge (refrigerated)	$8,300
Dry-bath incubator	$1,000
Dry ice maker & accessories	$1,000
Filtration rig, bottle-top (5)	$500
Freezer	$500
Gas bottles/regulators	$1,500
General Glassware	$5,000
Homogenizer	$2,400
Hot/Stir plate	$350
Incubator (2)	$3,600
Laminar Flow hood	$2,400
Luminometer	$4,000
Mortar/Pest	$200
Pipetes	$1,700
Refrigerator	$700
Shaker	$1,400
Sonicator	$1,450
Spectrophotometer	$3,000
Sterilizer	$750
Vacuum pump (2)	$600
Vortex mixer	$300
Water bath (2)	$2,000
Subtotal $48,150	
Leg 185 specific	
Consumables	$5,000
Culture Tubes (I *500)*	$600
Misc. items	$4,500
Racks (3 cs)	$300
Syringes	$250
Subtotal $10,650	
Upgrades for microscope	
Camera for microscope	$11,300
Filter cubes for microscope	$800
Radioisotope work	
liquid scintillation counter	$23,000
Survey meter	$600
Shielding	$500
Subtotal $24,100	

SCIMP APPENDIX 99-1-16

NOTE:CONTACT RICK MURRAY OR TOM JANECEK FOR THE FIGURES AND TABLES OF THIS REPORT.

GROUND TRUTHING IN-SITU METHANE HYDRATES: INNOVATIVE METHODS FOR SAMPLING, MONITORING, AND VALIDATED MODELLING

JNOC - TRC, Chiba City, Japan, 20/22 Oct. 1998

Hans Amann, TU-Berlin, Germany, Section Marine Technology

1. Abstract

HYACE, an acronym for,, Gas Hydrate Aufoclave Coring Equipment System", is a comprehensive research and development project sponsored by the European Union's Marine Science and Technology Program MAST. The project started in the fourth quarter of 1997 and if shall last until the year 2000, after having performed scientific deepwater prototype tests. There are eight partners involved from six European countries, and it is coordinated by Technische Universitdt Berlin, Section Marine Technology. The other partners are BGS, British Geological Survey, Marine Geology Group from Edinburgh, the Spanish Instituto de Ciencas del Mar from Barcelona, companies Fugro Engineers from Leidschendam in the Netherland and Geotek from the UK, the French Ocean development institution Ifremer from Paris/Toulon, IGME, the Greek Geological Survey from Athens, and the Institute for Petroleum Engineering at Technische Universitat Clausthal in Germany.

Development and prototype testing of alternative and innovative down-hole controlled autoclave coring systems constitute one central activity. The coring systems are being designed to sample marine sediments at down-hole conditions and to bring cores on board while maintaining as many down-hole parameters as possible. Particular geological targets are sediments on the deepwater covered continental slopes containing gas hydrates and deep biophere strata. Autoclave sampling tools will include push, percussion and rotary corers. The different concepts of push and rotary corers will be driven by downhole actuators instead of top drives on-board of the research vessels/drillships. The transfer of valuable downhole samples to pressurized and low temperature core analysis and other laboratory facilities for measurement and evaluation constitutes another major task. Data obtained will be used to adapt and to validate reservoir models of methane hydrates and their kinetics, esp. the dissociation, flow and storage processes. The general goal of the project is to contribute to systematic ground truthing of this ephemeral phenomenon of growing global significance: knowing and predicting the in-situ performance of volatile methane hydrates.

Complementary downhole measurement while coring are therefore important. Temperature, pressure and tool performance monitoring had been selected upon request by the geoscientific community as the initial parameters.

2. Introduction : the need for ground truthing

Knowing quantitative in-situ properties of remote parameters for understanding and reliable prediction of events is the gist of geoscience, and, hence, the goal of all related technical methods and equipment. This is even more relevant for marine geoscience and technology, where remote locations, difficult logistics and hostile oceanic conditions have to be met. The study of ephemeral marine phenomena, intimately linked with far offshore, deepwater and deeply buried sediments, such as the methane hydrates, their genesis and significance for man and global change, result in most complex and extreme technical system requirements.

Remote sensing, increasingly used for the far distant conditions of the open ocean and its deep underground, must be calibrated on samples representing as much as feasible the in-situ conditions. There can be no meaningful methane hydrate exploration without geofechnically meaningful sampling. This was recently demonstrated in connection with the remotely sensed BSR, the bottom simulating reflector, and gas hydrate occurence. There are strong BSRs offshore central Norway but no methane hydrates were found so far. Was it due to the lack of appropriate sampling methods ? Sampling, furthermore, changes the geological conditions and can thus only give indications of the true in-situ. Necessarily there will be always a gap between sampling, measurement and inference to the in-situ reality. This gap must be bridged by modelling, model validation and hindcasfing tests. Part of this effort is also the everlasting geotechnical and engineering research task to have the sample(s) represent the true environment, its location, the time of sampling and environmental and technical data of the sampling method. Preservation of the sediment and of the hydrate structure in the sediment downhole, therefore, and of pressure and temperature, mechanical, chemical, mineralogical and biological conditions of clathrate occurrences are thus basic requirements for ground trufhing oriented sampling methods. Complementary measurements while drilling and while sampling, e.g. measurements of thermal conductivity and of acoustic wave propagation in the clafhrates, contribute to infer to in-situ parameters.

In addition to the geoscientific rationale for ground truthing the eventual industrial and economic use of geoscience in general and of marine methane hydrates in particular should be considered. We need systematic and mulfiparameter studies and understanding of the occurence, of the genesis and of the development of marine methane hydrates in the Earth cycles. Only upon this knowledge can we reliably extrapolate the basic laws and the design methods of their environmental control and eventual economic utilization.

The same holds for the climate and geohazard roles of marine methane hydrates. Are the hydrates truly linked and in which quantitative way are they linked to rapid climatic changes as witnessed in global warming periods by the Dansgaar-Oschgar events? What are the sediment-mechanical causes and consequences of marine slope instabilities in combination with marine hydrates in the continental slopes? Well designed ground truthing methods contribute to answer those questions. As a logical consequence geoscience as the user and technology as the supplier should work closely together. Although quite commonsense I know from almost three decades in ocean oriented technology research and development that such close cooperation must always be revitalized. This symposium on marine methane hydrates, in which I have the honour and the pleasure to participate, constitutes such an important endeavour.

3. Occurence and properties of marine methane hydrates

The phase stability diagrams of methane clathrates as being represented by the one example given in Fig. (11.1) show the pressure and temperature regime in which marine hydrates may occur: low temperature of -270 °K to 285 °K and high pressures of more than 70/100 bar are necessary. Those conditions are given outside of permafrost regions only in the far offshore on and in the continental slopes at more than 700/1000 m of waterdepth. Marine biomass production for biogenic methane generation (or other sources of methane) and appropriate sedimentary conditions are further sets of natural factors for the genesis, occurence and characterization of marine methane hydrate.

Many different kinds of host sediments have been encountered. Fine grained clays and oozes with soft to semiconsolidated characteristics at the upper 200-400m below seabed (mbsb) have been encountered before and during ODP Leg 164 in late 1995. At greater penetration depth on the Blake Outer Ridge, deeper than 200-400 mbsb, consolidated clays have been found, also containing methane hydrates. Sampling and coring became more difficult, albeit impossible, in those deeper layers. Those sediments on the Blake Outer Ridge contain methane hydrate in such amount, to mention this dimension here, that the demand for natural gas in the United States could possibly be satisfied for 100 years, Dickens et al. 1997.

A sequence of fine grained sandy layers, even containing pebbles, were found to contain methane hydrates offshore the Pacific Costa Rica coast during DSDP Leg 84. Fine grained ashes and muds from mud volcanos have been reported from the Mediterranean, the Black Sea, the Barents Sea and South East Asian sites, Makogon, 1997. Fine grained vulcanite and carbonate sediments may consolidate to hard and very hard sedimentary layers.

The depth of burial of methane hydrates depends on sea level (changes), the geothermal gradient and sea water temperatures. Methane hydrates occur from the seabed surface (e.g. on the Cascadia Range) to 500/700 mbsf, Paull/ODP 1996. The sedimentary cover of marine gas hydrates is usually not as thick and consolidated as in the case of terrestrial gas hydrate deposits in permafrost regions, Makogon, 1997.

Despite the many different forms of sediments in which marine methane hydrates have been encountered by sampling it seems that fine grained sediments with a larger percentage of cohesive material (clay) dominate. This tentative generalization goes along with the more frequent occurrence of marine methane hydrates at farther offshore and deepwater locations or in the vicinity of mud volcanoes. Hydrates in those fine grained sediments may generate cementing effects resulting in hard and very hard layers to be cut during drilling and coring, Clennell 1996. A mixture of fine grained sand, watered and mildly frozen (270 °K) was therefore selected for the HYACE drillability and cutting/coring tests at ITE in 1998.

Marine methane hydrates have been found in many different combinations with the host sediment: disseminated and vein type hydrates in sediment pores and crevices, Fig. (11.2), in lumps and in nodular aggregations, and even in layers up to some meters thick, Makogon 1997. Pure hydrates may be compared, in their mechanical properties, with permafrost ice.

Some mechanical, thermal and electrical properties of marine methane hydrates, which are important for cutting/coring and for ground truthing, are listed in the table hereunder. The difference and the similarity with ice should be noted. The high acoustic impedance and thermal capacity and the low thermal conductivity are of particular interest beside the mechanical properties. The heating effects from cutting cores in hydrate sequences, which necessarily produces friction and heat, may be restricted to a thin layer in the vicinity of the cutting edge, leaving the rest of the core thermally less or not disturbed.

Properties of methane hydrates and ice (adapted from SLOAN, MAKAGON 1997)

(Table not included here ---contact Rick Murray or SCIMP Chair Thomas Janecek for a copy of the table).

4. Ground truthing of logging data by sampling and coring methods

Undisturbed samples, i.e. "least disturbed", are a basic geoscientific requirement for approximations of ground truthing of in-situ properties. Samples allow the determination, inter alia, of the (downhole) parameters:

* mechanical sedimentary structure, including density, porosity, permeability, (undrained shear) strength, elasticity, compaction and grain sizes,
* pressure and temperature (p/T) phase stability conditions of the clathrates,
* other physical parameters, such as the heat and heat transfer capacity, the electrical and sonic impedances,
* chemistry, gas content and composition, water and salt contents, in the water, in the gas and in the clathrate phases.

Samples need to be precisely positioned, their x,y and z coordinates with a (relative) precision of cm/dm and their attitudes (north, inclination/verticality) with a precision of 1-3°. Time of sampling is important too. Sampling must be repeatable but should be statistically independent, including all methods of sample evaluation. Sampling should provide for ancillary parameter measurement,,while sampling", in order to locate, coordinate and constantly monitor other in-situ/downhole conditions. Samples should be obtained and retrieved in a form and using methods that they can be readily and ,,truly" analyzed in the ship laboratory after sampling. Those requirements amount to the well experienced fact that coring constitutes the most appropriate way to satisfy those sampling and ground truthing requirements, see also Zuidberg et al., 1998.

Different soils and sediments require different coring methods. Soft to consolidated clays as they were encountered in the upper 100-200 m of sediments on the Blake Outer Ridge during ODP Leg 164 were penetrated and cored by push coring with the push-in version of the PCS, ODP's pressure core sampler. Despite good results, the performance could still be improved, e.g. during downhole controlled sampling/coring and, hence, core quality. Retrieval of the core/sample into the autoclave pressure chamber of the PCS and closing the chamber with a ball valve usually worked well. Occasional malfunctions of the autoclave were due to clogging and jamming effects. Within the scope of HYACE the push core method will be adapted to be used in combination with the downhole thruster telescope, Fig. (11.4). Shorter tool length, better motion control, less bending and jamming and less clogging are expected.

More consolidated and harder sediments in deeper layers, > 300/400 mbsb, could not be properly penetrated and cored by push coring during Leg 164. Rotary drilling and cutting became necessary but didn't work satisfactorily. One reason is seen in the top drive of traditional offshore drilling, Amann, 1 998,

A moyno motor was therefore selected as downhole controllable actuator. The low rpm (50-100) should generate higher torque in stiff and hard sediments and, at the same time, produce less friction heat than a comparable but fast rotating turbine drive. The downhole moyno motor is driven by seawater used as drilling fluid. Furthermore, cutting of sediments will be effected by a slim curve cutter, not with a thick Auger. The cutting shoe should have a stepped profile: a slim internal cutter, a transport section for cuttings and optimized inlet nozzles for the drilling fluid to transport solids and heat from the cutting area to the annulus, finally a thicker outer part to warrant mechanical stability.

Profiled cutting shoes with indurated cutting inserts from tungsten carbide or diamonds in a high temperature resistant matrix are being investigated for hard layers of sediments and hydrates. Those sediments are indurated carbonate or mud layers or hydrate cemented sand, cemented silt or siltstone. Such harder layers have been sampled already, but in a nonrepresentative way, close to the seabed surface, by large and powerful grab samplers offshore Oregon, Suess et al., 1997, and in volcanic ashes in the Mediterranean, Ivanov and Woodside, 1996. They should be cut by the downhole controlled combined action of rotary cutting, hammering with chainsaw effects and optimized fluid transport.

The basic requirement to have a large core diameter for least disturbed core qualities asks for an eventual adaptation of an active flap valve design to close (and open) the autoclave pressure vessel instead of closing with the standard ball valve. The gain in core diameter in the predetermined outer diameter range of the 5" drillpipe/bottom hole assembly may be up to 25 %. A final decision on the closing, sealing and reopening mechanism will be taken at the beginning of 1999 when detailed design and procurement should start.

Granular, hard and well consolidated sediments such as coarse quartzite sand, hard gravel and pebble layers are characterized as ,,hard to core" stuff. Neither push nor rotary coring will work here. Percussion and vibration hammering may result in satisfactory coring. Percussion will also be generated by the drilling mud/seawater which is pumped to the downhole area from the drillship through the drill string. Development of the percussion autoclave corer is performed by FUGRO Engineers, see also Zuidberg et al. in this Symposium.

The core is retrieved in all three coring alternatives into the autoclave pressure chamber of the tool. The tool with the core is delivered at downhole pressure conditions via wireline winching to the rig floor for further laboratory analysis, cf. Chapter 7 hereunder. Sufficiently low temperatures during coring and retrieval after coring can be supported, if necessary, by pumping cold deep sea water at about 278-285 °K as drilling fluid. Retrieval time of the tool, after sampling and until its autoclave pressure chamber can be delivered onboard ship for further use or cold storage, must be shortened, so that no (significant) deviation of the downhole p/T conditions occur in the downhole autoclave.

5. Core analysis at downhole conditions

Analysis of cores from scientific deep sea drilling, and the measurement of their basic physical properties such as density, porosity or water content are increasingly performed, already on board of the research ships, by automatic core logging equipment. Such core logging is done on open split cores, where the preservation of downhole conditions, especially of all pressure related conditions, are not possible.

Samples from high pressure downhole sites, containing the actual core but also water, sediment debris and gas, all contained in the autoclave high pressure core barrel, must be analyzed by adapted core logging equipment. This can be achieved either by sensors placed inside the autoclave core barrel- as it is already done with the HYACE downhole monitoring system, cf. Chapter 7 hereunder- and/or by outside remote sensing. The latter method requires core logging equipment with the core in a pressure vessel. The material of the pressure vessel must permit the use of remote sensing such as y-ray, x-ray, acoustic and electromagnetic methods.

Steel cannot be used as it interferes with electromagnetic radiation. An amagnetic light metal alloy, e.g. on the basis of aluminium or titanium, avoids this shortcoming. The best material for the pressure vessel is fiber reinforced high strength plastic, as it interferes least with all remote sensing/logging methods. The radiation intensity of the core logging sources will be increased for penetration through the pressure vessel walls as well as the monitoring period. Last but not least, the calibration process will be adapted, from open split core logging to core logging in pressure housing.

The contents of the autoclave pressure chamber in the downhole tool of the HYACE system will be transferred to the laboratory storage and logging chamber or chambers. Such transfer will be effected by pressure compensated locking of the two (or three) chambers and by magnetic piston actuation. Such adapted core logging, to be developed by the HYACE partner Geotek, will eventually allow the onboard scientific analysis of expensive methane hydrate samples and cores at preserved downhole conditions. The rather awkward bleeding off of free gas from the autoclave and its subsequent analysis with the „headspace method" , the only analytical methods used so far, should thus be complemented by important analytical tools.

Further measurements on the sample/core within the outoclave core barrel, during coring and core retrieval, are being attempted as well, beyond the necessarily limited scope, time frame and budget of HYACE.

6.Complementary measurements while drilling and coring

Typical services of logging while drilling, which should be complementary to coring, are provided within the ODP system by the Lamont Borehole Research Group. Typical logs were performed during Leg 164 with the Schlumberger Quad-combo tool which includes the:

- electrical resistivity log (DITE-SFL), giving electrical resistivity porosity;
- acoustic velocity log (LSS/SDT);
- bulk density log (H LDT);
- natural gamma-ray log (NGT), stratigraphic layers;
- neutron porosity log (CNT-G), neutron porosity; and others.

They gave further data, especially porosity at dowhole conditions (with gas hydrates) and indications of sedimentary sequences, lithology and stratigraphy, of methane hydrates, of free water and of free gas in the dual porosity sediments with changing and interdependent porosity-permeability relations as a consequence of hydrate dissociation.

Precise vertical location of the core position is an essential requirement and in practice more difficult than one might believe from theory. Measuring the pipe length, including heave compensation, and the wireline length need to be complemented by control of the verticality, deviations from it and the shape of hole. Such controls are usually not done so far so that an exact depth and geometry control of the drill hole, the coring process and the core cannot be achieved. A comprehensive control of those parameters and its dynamic development including the changing shape of the hole is thus an essential requirement for future ,,measurement while coring". This sevice is requested by scientists since many years but it is only sporadically achieved due to a lack of interest from the logging service industry. Measurement while coring will eventually improve scientific drilling as it provides for important complementary data for ground truthing: downhole p/T conditions at the cutting shoe and during the coring process, position and attitude of the drilling/coring tool, stratigraphy by natural gamma ray with a cm/dm resolution, sediment mechanical properties such as (undrained) shear strength, density, porosity and grain size and chemical data: contents of methane hydrates, free and pore water, free gas and chloride content, indicating the freshening of pore water, and, hence, the methane hydrate dissociation process.

Within the scope and budget of HYACE we have selected, upon request by geoscientific users, to measure pressure, temperature and tool performance. Those parameters are measured in the tool, and the measurements represent downhole conditions. Temperature sensing at three spots of the core barrel while pulling the core into the core barrel/pressure vessel should give quantitative correlation data of temperatures during coring ahead of the drillbit. A temperature sensing cutting shoe is being developed by ODP and may become an in-situ temperature probe. All those methods and their data.
generation will eventually help to correlate from conditions in the laboratory, from downhole and from cutting shoe conditions to the in-situ properties.

A promising opportunity for additional measurement while coring is penetrometer sounding below the borehole, giving (almost) in-situ properties of the mechanical sedimentary/hydrate structure and indicating even the presence of methane hydrates, Lunne 1996, Zuidberg 1998. One alternatives is the standard cone penetrometer sounding used by the offshore geotechnical industry. Penetrometer sounding ahead of the drillbit could eventually be achieved without equipment change by using a properly instrumented (piezo transducers) pushing, cutting or percussion tube, a ,tube penetrometer".

7. Handling, research plafforms and scientific drilling equipment

Dynamically positioned drillships of various sizes are being used or are planned, Figs. (11), such as the concept of the large Japanese scientific drilling platform for dedicated scientific drilling with a riser in all waterdepths of the world oceans. Scientific drilling means basically (continuous) coring and logging while drilling. It includes all tasks of gas hydrate research as outlined above. Dimenions of the ships and their handling and drilling equipment do have a significant influence on how to best perform deepwater and deep coring research, where to do it and on which targets. Unsatisfactory or no coring result in many strata, not just in ,,difficult to core" sediments and rocks, are unfortunately fairly frequent outcomes of the operation of the RV ,,Joides Resolution" of ODP. Lack of sea state endurance and water depth limitations are often encountered by small drilling vessels such as the RV ,,Bucentaur". Sufficient size, seakeeping abilities and deepwater drilling equipment are thus basic requirements. The deepsea marine riser, furthermore, is often requested as the key to future efficient and safe scientific drilling. It should be borne in mind, however, that a 4000 m marine riser system with all auxiliaries will constitute a very massive, expensive and complex subsystem to build and even more so to operate.

Interface requirements of the drilling platform for handling of HYACE are

* Handling height less than 12 m for the HYACE tool (9m), plus the wireline fishing tool (2m), plus 1 m of motion reserve. This length should be available vertically and horizontally for installation and dismantling incl. exchange of the actual autoclave coring tools. Deepwater drillships, handling usually threbles stands of 27m length, can easily handle the required tool length. Intermediate storage and maintenance of the tool will be done in a separate rathole facility.
* Lifting facilities of the drawworks or the hydraulic-automatic driller should be at 3000 kN plus, capable to handle at least 6000 m of 5" drillpipe or larger diameters and 3-5 drill collars / bottom hole assemblies.
* Pump facilities for pumping drilling fluid (seawater) at min 60 bars and 35 I/sec.

* Large drillpipe (e.g. 9 5/8" , or even 13 3/8" standard size) would be advantageous for better drilling and coring if no marine riser with blowout prevention, kill and choke and circulation control would be used. Such larger drillpipe, if made of steel, would again require much larger handling structures and facilities. The use of aluminium alloys, as being succesfully applied in Russian scientific drilling, should therefore be tested for larger diameter drillpipe (>100 mm internal diameter). Larger diameters give automatically better cores, more space for improved logging while drilling and coring and permit better heave compensation (piggy back).
* Heave compensation should be such that no vertical motion of the downhole assembly, including the subs and the coring tools, take place, at least +/- 4m. Load variations should be reduced to +/- 25ON in order to provide for improved cutting/coring in hard rack. This is a particularly stringent requirement which was only partly achieved sofar by the piggy back method for the ODP diamond coring system, which is a double heave compensating system, see also Fig.(l 1.2).
* Pumping of cold deep seawater (500 - 1000 m of waterdepth) to the drillship to be used as drilling fluid can be achieved by a separately installed hose or pipe system. Positive experience with a similar system have been made by the author.
* The different sizes of ships, handling equipment and drillpipe require an adaptable and modular design of a tool family like HYACE to be used in all conditions and on most platforms.

8. Correlation of in-situ conditions and processes

Description, analysis and prediction of geoscientific phenomena always use models. Numerical models, simulating reality to an ever greater degree of reliability, need ground truthed assumptions and data. Those data from coring, remote sensing, logging while drilling and proxy data (which I couldn't deal with here due to shortage of time and text) may show quantitatively represented trends towards in-situ conditions.

The needs for modelling, for data to validate and, finally, the use of those models for prediction should shape the technical methods to obtain the data. The preservation of downhole p/T condition for methane hydrate sampling, as outline above, and complementary p and T measurements while drilling/coring are examples. The establishment of a p/T stability diagram for a specific sedimentary oceanographic situation is one important goal. Dissociation of the methane hydrates in changing p/T conditions, Fig. (11.3), development of free gas and water and their storage and flow in dual porosity situations would be a further task. Porosity with and without hydrate and/or water, permeability and their changes in a dissociation process are very important parameters for all kind of (reservoir) performance forecasts. Predictions of slope stability and of gas reservoir formations will be deductions from those (and still other, e.g. sediment mechanical) model simulations.

Within the HYACE Project our partner ITE (the Reservoir Engineering Group) are contributing an adaptation of a methane dissociation model derived from coal bed methane modelling. Physical bonds of methane and coal are assumed in a monolayer structure satisfying the same formal rules, where ,,adsorbtion/desorbtion" are being replaced by ,,enclathration/ declathration", Sloan 1997. Langmuir isotherms are thus an appropriate assumption to quantitatively represent the dissociation of methane from its clathrate bonds. The model adaptation from coal bed methane to methane hydrates will result in basically similar but also different dissociation, diffusion, dual porosity flow and concentration constants. Validation of the model will be done first with experimental data from laboratory experiments with technical and artificial sedimentary gas hydrates. The second and more important step, at the end of the project, will be the validation with and for true marine hydrate data, obtained from down-hole samples and measurements.

Technical requirements to achieve this task in autoclave sampling will be:

- cutting and retrieval methods for least disturbance of the mechanical structure of the sediment-hydrate structures,
- no (least possible) warming of hydrates by friction and impacts of the coring/core cutting process, prevention of ,,melting" of the hydrates/clathrates beyond the actual cutting area,
- Withholding direct influences of seawater as drilling mud from the coring/core cutting process in order to preserve chemical (salinity, water) and temperature conditions ahead of the drill bit.

9. Conclusions

Ground truthing remains a most important geoscientific and technological task. HYACE will contribute to it. Specific contributions will be made by:

I . Mechanically least distributed sampling/coring through sediment specific cutting, coring and core retrieval methods,
2. Preservation of downhole p/T conditions in an autoclave core barrel,
3. Complementary logging while drilling, and, even more important, by measurement while coring,
4. Adapted core logging in an autoclave core logger,
5. Correlation of parameters obtained in laboratory and in-situ testing, in core logging and in numerical models, to infer to the in-situ conditions.

Those different tasks will be necessarily achieved to different levels of geoscientific confidence and technical and organizational perfection. Scientific pilot testing on ODP, on European and on other platforms are suggested for the HYACE tool in the year 2000. General use should be offered thereafter. Further tasks will come up to be tackled thereon, e.g. specific insitu testing methods, ahead of the drill bit, use of a fully instrumented bottom hole assembly, drill string seismics or further developped autoclave core logging units with inside and outside sensor systems.

Last but not least, the EU-Commission, DG XII, Programme Marine Science and Technology, MAST 111, should be gratefully acknowledged. The EUCommission sponsors the project under the research contract MAS3-CT970102

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Summary of the Management Report Iune 1 - Nov. 30, 1998

The project which had to be reorganized very shortly before its delayed start in December 1997 due to the last minute withdrawal of two of the original partners- took some more efforts in 1998 to get off the ground. This take-off has now been successfully achieved, despite some usual and some other, unforeseen and additional loads, coordination and teething problems. One major system, the downhole rotary corer, and its derivative system, the downhole actuated push corer, were redesigned upon initial discussions on redesign in Lisbon in May, 1998, during the M2 Meeting. Conceptual and basic design and testing (of components) of the percussion corer were done as well. The effort in correlation analysis as contribution to ground truthing, small and preparation of large scale testing are progressing. The international interest in the project and its emerging prototype products: the three HYACE tools and onboard evaluation methods, is growing. This was witnessed by requests from US scientific groups and invitations to possibly join the ODP system. Such opportunity would ideally fit the HYACE project plans. There is, in addition, interest from the Japanese side, to eventually have an offspring development from HYACE for the Japanese gas hydrate exploration and technology program. Those and other interests emerged in the second half of 1998. In order to achieve a successful match of those demands tight schedules and performance requirements need to be met: technical feasibility tests on RV "Joides Resolution" in July/August 2000 (ODP Leg 191 as a candidate) and on RV "Bucentaur" later on, in Sept/Oct, scientific prototype uses in ODP gas hydrate legs in 2001 and beyond.

When looking at the project progress in a critical and constructive way one should not forget the much wider scope of the project as adopted by the partners and the sponsor in 1998, although no additional budget nor time were requested:

- there are now three different types of downhole controlled principles for coring in different sediments: push, rotary and percussion autoclave coring instead of one originally planned type,

- much more attention and efforts are now given to the core evaluation method onboard ship,

- in addition to the eventual use of HYACE tools onboard of the RV "Joides Resolution" efforts are being made to have the tools also ready for smaller European ocean research platforms, e.g. MS "Bucentaur".

In order to meet the target of the technical feasibility tests in Summer of 2000 the HYACE group needs to establish and comply with the following (slightly) amended schedule:

- 1st /4 - 1999: finalization of the basic and commencement of the detailed design of the finally chosen rotary (and push) coring versions, as discussed on the M3 meeting in Dec. 1998 and finally evaluated by Fugro and the partners in Dec. 1998, Jan. 1999, patent application,

- 2nd /4 - 1999: further detailed design, procurement, manufacturing, start assembly, testing of an initial 1: I scale test system without autoclave function, possible interest and demonstration to Japanese client.

- 3rd/4 - 1999: continue assembly, testing, redesigning, add valves/ autoclaves, instrumentation (p,T),

- 4th/4 - 1999: dto,

- 1st /4 - 2000: complete large scale tests onshore, comparison of systems,

- 2nd /4 2000: finalization large scale test, shipment to Japan,

- 3rd /4 2000: July/August Leg 191, Tokyo Gyam, technical feasibility tests on RV "Joides Resolution"; MS "Bucentaur", evaluation, reporting.

It was already suggested by the M1 Meeting in Dec. 1997, to extend the final date of the project. Such prolongation to Dec. 31, 2000 will be applied for in Jan. 1999 by the Coordinator TUB-MAT. Finalizationof the Consortium Agreement is also urgent.

SCIMP APPENDIX 99-1-17

•X-RAY REQUEST FROM EUGENE DOMACK

From: John_Firth@odp.tamu.edu
Date: Mon, 21 Dec 98 00:56:45 CST
To: edomack@hamilton.edu (eugene domack)
Cc: Gary_Acton@odp.tamu.edu, frack@brook.edu, ftaylor@hamilton.edu
Subject: Re: An x-ray machine for sale! 2nd notice
Mime-Version: 1.0

Dear Eugene:

I have forwarded your message on to various people in ODP to discuss.
We are discussing it. I need to know some specifics: does it record images
digitally or is it a plain film x-ray unit? How big is it (dimensions, weight)?
Can you send us some spec sheets on it (presumably you got some material like this
before or when you ordered it) that you can fax to me (our FAX is
409-845-0876).
If we were to have an x-ray unit, it would ideally record digital images and
could be connected to our database and could be automated.

We wont have an answer to you till after the holidays, and after you can
give us this specific info.

Thanks,

John
>>

Subject: An x-ray machine for sale! 2nd notice
From: edomack@hamilton.edu (eugene domack) at #Internet
Date: 12/21/98 12:44 PM

Dear John:

We have just retaken delivery of the x-ray machine that was is in Bremen for the Leg 178 sampling party. The last of the x-rays were just completed late last month. As you may be aware the JOI/USSP award for ship based work on the Palmer Deep (here at Hamilton College) did not allow us to charge the cost of the machine, as it was permanent equipment. I had intended on covering the cost of the unit on the overhead on one of my upcoming NSF awards but our business office is running a deficit so that option is out.

In some of the correspondence from ODP it was suggested that ODP repository and the Resolution could make use of such a unit. It is portable, can be set up in any room with adequate shielding, and can be sent to any lab or reserach location where U-channels are being used.

I therefore would like to inquire as to whether your facilities could and would support such an acquisition. I would be willing to complete all the appropriate requests and justify the equipment to the appropriate oversight panel. Please let me know if you are interested in pursuing these

options, so that I might begin to clear my books.
In the mean time I am sending the x-ray machine to Ellen Cowan at ASU for her use on the Leg 178 drift cores.

Cheers,
and thanks in advance for your reply,

Eugene W. Domack
Professor
Department of Geology
Hamilton College
198 College Hill Road
Clinton New York, 13323
(315) 859-4711
859-4807 (fax)
edomack@hamilton.edu

>>

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•X-RAY REQUEST FROM PETER BARKER

Date: Fri, 15 Jan 1999 16:19:03 +0000
From: "Peter Barker" <pfba@pcmail.nerc-bas.ac.uk>
To: janecek@quartz.gly.fsu.edu
Cc: acamerlenghi@ogs.trieste.it
Subject: Shipboard X-ray

Tom

I append the text of our proposal to SciMP, which Angelo and I have now discussed. It is unchanged from the mailed version: there were additional details we might have added, but the key thing, we decided, is to make the central point. Decisions on exactly how such a facility might be implemented are for later.

Regards

Peter

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A Modern Shipboard Pre-Splitting X-Ray Facility

P F Barker and A Camerlenghi, co-chief scientists, ODP Leg 178.

ODP Leg 178 sampled glacigenic sediments, including subglacial tills and a wide range of other sediments that contained IRD, were laminated, showed small-scale structures etc. We tried to arrange for an X-ray system to be made available on board, primarily to examine cores before they were split. We found 2 systems; the offer of the first (from the Cape Roberts Project at McMurdo Stn, Antarctica) was later withdrawn because of a clash of use, and the second (from Kate Moran*s then lab at BIO), which had to be containerised, eventually could not be put on board because of considerations of loading, space, and convenient access. Neither system would have been ideal.

We (Leg 178 co-chiefs and sedimentologists) remain convinced of the value of a shipboard X-ray facility. Many of the split cores from Leg 178 have been or are being X-rayed on a variety of shore-based systems, in some cases at considerable cost and inconvenience (and risk to the cores). However, the opportunity has been lost to examine cores routinely on board before they are split, which has additional advantages. We consider that these advantages extend to other types of core besides those with a glacial influence, and that many perceived difficulties and disadvantages of X-radiography no longer exist if a modern system is used.

We wish the SCIMP to consider including a pre-splitting digital X-ray facility within the shipboard core-lab upgrade, as part of the imminent refit. The style of machine we have in mind is that of the airport hand-carried luggage X-ray: small, flexible, instant-view and video- or digitally recording, a full generation beyond what has been used historically in Geoscience. Such machines are now commercially available at moderate cost (see attached sample quotation).

1. General Specification. The airport, carry-on luggage X-ray concept has already been mentioned. Essentially, however, the machine is tailored to core examination, floor- or bench-mounted with shielded horizontal arms 1.5 m long for core section input/output. Typically 8 cm of core is imaged at a time, with the core moved along manually or automatically between shots: a 1.5 m core section takes about 2 minutes. Zoom focussing is possible, and recording on video cassette is standard, with digital image processing available. Images are text-identified and time/date stamped. A sample quotation (US$82k for a high-end spec) is attached: in practice there would be overlap in several respects in what could be done by the manufacturer and what (with their considerable experience with tracks and data logging) by ODP-TAMU, that would govern cost. Power requirements are modest (600 VA), weights are of the order of 300-400 kg. The basic cabinet is of standard width and depth, but the 1.5 m extension arms and required access to one end limit where it can be stationed.

2. Advantages. We describe below a few advantages of core X-ray examination before splitting. We know that many other uses are possible, and would soon be exploited routinely on board. The X-ray describes fabric. Fabric occurs in

i. glacial sediments - shear fabric, clast position and orientation, flow fabric
ii. clastic sediments - dip, lamination, faulting, veining, grain size/porosity
iii. biogenic sediments - lamination, diagenetic horizons, bioturbation, free gas
iv. basement rocks - vesicularity, veining, faulting

2.1. The core fabric is known before splitting (the core may be rotated in the machine). It would be possible to choose the orientation of the split to best display the geology, to minimise the destructive effects of splitting hard/soft alternations, to identify and protect key intervals of core (eg a K-T boundary section). If there is a discrepancy between the position of a feature in the logged hole, the MST data and/or the split core, these data will help resolve it.

2.2. The core fabric is examined ROUTINELY. A record is built up of pre-split digital X-ray images of an additional physical parameter (like colour, MS, GRAPE etc) whose variation down-core can be examined, and compared with other such measurements and with logs.

2.3. An instant, pre-splitting measurement of core properties could be a considerable aid to shipboard decision-making: co-chiefs often must make decisions on what to do next, that depend on what has been recovered, and there may be delay because nothing is known of a core until it is examined routinely after the warm-up period OR the core may be examined earlier but only by splitting before the core is properly equilibrated. Ship time may well be saved.

2.4. The equipment can be used for follow-up measurements as needed - on split cores or selected slabs or U-channels, at higher resolution - when not in routine use. Everything that the old system could do, but faster and cheaper, and much more besides.

2.5. The X-ray measurement could be made during the warm-up period, before the core is offered to the MST, so that no time would be lost. Measurement would take about 2 minutes per section. For some studies (eg of exsolving gas), it may be desirable to repeat the measurement at intervals during the warm-up period - this would be possible.

2.6 Digital statistical analysis of the core image would be possible, with a range of appropriate objectives.

3. Disadvantages of old system ODP have stated that they had an X-ray system on board originally, but it had first been relegated to the *second-look lab* and then removed completely. It was an old, wet-film processing system, expensive and slow to use, therefore confined to the study of specific small intervals of core, usually as prepared slabs, off-line. The machine now proposed is completely different in construction, capability and intended use.

4. Comments.

4.1. Long-Range Plan. A major concern in evaluating any new (or existing) equipment should be its contribution towards ODP*s fulfilling the requirements of its Long Range Plan. In the case of a modern shipboard X-ray system as proposed here, the question is simple to answer. The scope of benefit from such an instrument is so broad that almost all aspects of the attempt to fulfil the LRP are affected. Thus, it is not a particularly useful question if the answer is intended to point to one specific branch of science. However, the question is valid, and the answer, in that there will be significant benefit over a wide range of relevant activity.

4.2. Developments. We are aware (Rack, 1998) that many variants on x-radiography are under development - X-ray computed tomography, magnetic resonance imaging for example. These developments are some way from commercial availability at moderate cost. While they undoubtedly represent interesting, potentially very useful developments for imaging cores, we see a gap in the shipboard provision NOW, that a relatively simple, modern, commercially available system will fill.

4.3. Purchase. We have contacted Tronix and Geotek: doubtless other sources exist. We assume that others would organise precise specification and purchase, but would be happy to assist if necessary.

Rack, F. R. 1998. Tomorrow*s Technology Today. Report of IMAGES Standing Committee on *New Technologies in Sediment Imaging*. Unpublished.