JOIDES LITHOSPHERE PANEL MEETING
August 29-30, 1985
at Universite Louis Pasteur, Institut de Geologie
Strasbourg, France

SUMMARY

1. Considerable concern over the availability of only two bare rock guidebases that causes major review of Atlantic and Pacific priorities. Recommend that two guidebases be used in the Atlantic only if needed to get one good hole. If a guidebase is available for 111, either left over from 106-109 or because more funds could be found, then 111 should be EPR drilling. 504B and EPR have equal science priority but there is a need to start tackling the technical problems associated with EPR as soon as possible.

2. Excellent MARK site survey work defines ideal drill sites for 106 and 109. Kane Fracture Zone drilling is back-up for 106 but recommend that final decisions on 109 back-ups (if needed) be delayed to January LITHP meeting before PCOM but after 106.

3. EPR drilling site should have three characteristics: seismically defined magma chamber, full photo coverage, and active hydrothermal activity but locate first site in downflow zone. Consensus was 'French' 13°N area probably best meets these requirements at this time.

4. Unique opportunity exists for sampling upper mantle stratigraphy by drilling SW Indian Ridge fracture zones. This proposal combines aspects of both upper mantle geochemistry and fracture zone tectonics, both high priority COSOD objectives. Full panel support for this drilling. Recommend three basement penetrations in Kerguelen and strong support for 90-E ridge program but still would like strengthened proposal and other relevant principals involved in the deliberations.

1. PCOM REPORT

Jose Honnorez reviewed the highlights of the Hanover PCOM meeting in June. The major issue was the cancellation of the EPR drilling caused by the lack of bare rock guidebases (resulting from funding shortages). Sufficient funds for only two guidebases are available as opposed to the four that were required by the previous drilling plans. Because LITHP so strongly supported the 'two hole' scenario at MARK then both these guidebases would be used in the Atlantic and EPR drilling would have to be replaced by 504B. Detailed discussions ensued regarding the budgetary background to these unfortunate events. Four points resulted from these discussions:

a)The panel felt strongly that the availability of only two guidebases changes the lithosphere drilling options so dramatically that a fresh review of our Atlantic and Pacific priorities is needed.

b) Longer term, it is clear that LITHP objectives are in jeopardy because of lack of funds for application and development of innovative engineering.

c) Priorities that are produced after great effort by the JOIDES panel structure are apparently ignored by the budgeteers and policy makers thus eroding both the credibility of the program and the interest of the panel members.

d) COSOD objectives are not being achieved and will not be achieved in the foreseeable future given present funding and planning priorities.

LITHP requested that the Chairman write a letter to the PCOM Chairman to emphasize our concern over both the fact of the removal of two guidebases from the program as well as the inference that the JOIDES panel priorities are being ignored and the drilling plans are in the hands of the budgeteers.

2. TAMU REPORT

Andy Adamson reported that guidebase construction will be completed by September 15. A brief description of the drill pipe TV system resulted in major concerns with regard to its effectiveness because of field-of-view, control and lighting limitations. Andy reported that the Mesotech drill pipe sonar had been tested. It worked, but data interpretation (in terms of guidebase siting aid) in rough igneous environment was difficult, if not impossible. Brief reviews of legs 103 and 104 were presented. Andy reported that TAMU is doing all in its power to protect engineering development from the funding problems discussed earlier.

3. ATLANTIC DRILLING

a. MARK Site Survey. As had been discussed at our last meeting in February, delays and rescheduling of the MARK site survey work did not make practical a detailed presentation of all data to the full panel. Purdy reported on an informal meeting between himself, the Site Survey Team (Detrick, Fox, Ryan, Mayer), 106 and 109 Cochiefs (Bryan and Detrick) and TAMU representative, Garrison in Woods Hole on August 21. The combined SEABEAM and SEAMARC datasets represent an exceptionally high quality site survey that well defines three excellent drilling targets that meet the engineering specifications. Of these three, two are considered preferable because they are 'centrally' located within the median valley on what is a close as possible to zero age crust (i) Near Beacon #2 at 22°55.45'N 44°56.8'W on a beautifully imaged axial volcano atop the along axis high ii) Near Beacon #3 at 23°22.15'N 44°57.15'W about 25 km south of the Kane Fracture Zone on a linear ridge that is the present day neovolcanic zone. The latter is the freshest site with photographic evidence of hydrothermal activity. Both sites are considered prime targets of equal science priority. The Beacon 2 site is suggested as the first location to try the guidebase only because it is a more easily locatable site (if beacon has failed) and the area of 'flat' seafloor is larger. Only engineering simplicity influences the choice. Clearly both sites need to be drilled at some point.

b. 106 and 109 Plans. Because of the restriction to two guidebases, the first point of discussion here was whether LITHP would remain with its previous recommendation that two guidebases be emplaced in the MARK area. The choice now seemed to be between 2 shallow zero age holes in the Atlantic and none in the Pacific versus (the possibility of) one zero age hole in the Atlantic and one in the Pacific. There was a strong Panel consensus to take the second option i.e., one in each ocean. An important point is that LITHP still recommends that should two guidebases be required in the Atlantic to get a good hole started, then they should be used. In this case EPR would be replaced by 504B.

In discussing specific scenarios and back-ups for 109 it became clear that an infinity of possibilities exists: LITHP judged it more constructive to schedule our next meeting in early January (immediately after 106 but before PCOM) so the experiences and accomplishments of 106 can be input to our decision making. The desire to log 395 during 109 was reaffirmed. The question of 106 back-up remains and a lively discussion ensued on this topic. The major points raised were i) why not drill off-axis to look at age related changes rather than drilling a fracture zone? ii) the nodal basin seems a high risk target given lack of knowledge of sediment thickness: is it a good idea to have a 'high-risk' back-up to a 'high-risk' leg?

The outcome of this discussion was reaffirmation of the importance of understanding fracture zones to the understanding of accretion at slow spreading ridges and the restatement of the fact that the Kane Fracture Zone has always been considered a crucial component of our slow spreading 'natural laboratory'. Jim Hawkins and Nicolai Petersen did not support fracture zone drilling. The nodal basin site versus other fracture zone sites was a trickier problem given our lack of nodal basin sediment thickness data. The rubble problem will be bad in the nodal basin but probably no worse than elsewhere in the trough: it must be left as a judgement call for the Co-chiefs but also we urged reexamination of site survey data to determine if any sediment thickness inferences can be made. Also we request the site survey team to suggest additional fracture zone sites besides those in the Karson proposal to provide Cochiefs with more flexibility. LITHP understands a third reentry cone will be on board and available for use on the Kane Fracture Zone.

Honnorez suggested that in order to achieve some penetration on 106 given the large investment in time in guidebase work, no logging at all should be carried out. Although LITHP sympathized with 106's problem, little support existed for cutting out logging completely, although we specifically recommend that any 'special' downhole experiments take place on 109. A minimum logging effort is needed on 106 especially if fracture zone drilling is accomplished.

c) Miscellaneous. i) Langmuir made the point that received broad support that in his experience igneous rock samples were not efficiently utilized from previous DSDP legs specifically because 'no' samples all had the same analyses carried out on them. Langmuir was commissioned to write a policy statement on this for LITHP to review and pass on to JOIDES. ii) Yet again, LITHP requested that Becker be appointed to the panel, and voiced its disappointment that, after a year, PCOM had still not acted on this request.

4. PACIFIC DRILLING

Following the Atlantic discussions, there was fast and unanimous agreement that should a guidebase be available, then Leg 111 should be EPR. If not, then 504B should be deepened as far as possible. The panel rejected arguments against EPR on the basis of technical problems due to high temperatures because i) we need to start somewhere and cannot 'wait until 1991' to tackle these problems, ii) anyway we have high temperature problems in 504B (though obviously to a lesser degree), iii) we would plan as far as possible to choose a downflow zone to drill on EPR and iv) Salisbury and DMP report significant progress in this area.

The discussion then turned to the choice of a drill site on the EPR. A consensus was reached that the ideal EPR drill site region should have four characteristics: i) located hydrothermal activity, ii) seismically defined magma chamber, iii) geochemical signature of offset edge effects, iv) 'interesting chemistry (definable in an infinity of ways). Langmuir presented an excellent review of the options: the three general areas being i) 12°37'-12°54'N: an unusually short ridge segment, full submersible and photo coverage, includes 2 small overlappers. iii) North of Clipperton: includes good overlapper and, of course, a large offset fracture zone and has simple chemistry but with more variability than south of the Clipperton Fracture Zone. Discrete step occurs across 11°45' overlapper. iii) South of Clipperton: includes off axis seamounts and a classic magma chamber signature in the bathymetry; very homogeneous chemistry also suggestive of large steady state magma chamber. The qualitative but useful overview of these primary characteristics presented by Langmuir is included in tabular form below:

EPR Location Summary

	12°50'N	N. of Clipperton	S. of Clipperton
Hydrothermal	√√	??	? Yes says MacDonald
Seamounts	√√	√	√√
Fractionation edge effects	Highest MgO	√	No
Chemical Discontinuity	Yes but hetero	Yes across 1145	Marginal
'Interesting' Chemistry	Too interesting	Interesting not as noisy	Boring but most normal
Magma Chamber	Cannot be large and well mixed	Not just one	Most obvious
SUMMARY	Best Hydrothermal	Best Edge Effect	Least Complicated

A general discussion of EPR objectives and targets ensued in which guests Bougault, Fouquet and Albarede played an active role. Bougault was supportive of the basalt chemistry-bathymetry correlations but made the point that they need to be studied with time requiring off-axis flow line drilling. Fouquet presented the case for drilling a massive sulphide deposit near 13°N, the largest known on the EPR, 5 km off axis and known from electrical measurements to be more than 10m thick. Albarede emphasized the importance of the mass balance problem and the need for the kind of detailed water chemistry data that exists at 13°N. Again, the problem of the wide variety of scales at which the parameters of importance to us vary led again to the restatement of our need for more holes and more drilling time.

504B Co-chiefs: Nominations were Becker, Kinoshita, Bougault, Natland, Emmerman (in no order). Need for strong downhole expertise was emphasized.

A summary of Pacific deliberations is as follows:

i) If a guidebase is available, 111 should be EPR. EPR and 504B are equal science priority but for technical reasons we judge it important to drill EPR now to learn of problems etc. that can be tackled before return in 1990-91. If EPR is not drilled now, momentum for engineering development and high temperature tool development will be seriously damaged. Guidebase for 111 could come as a result of success in Atlantic or as a result of finding additional funds. <u>If new funds appear, third guidebase for EPR should be top priority</u>.

ii) EPR drilling site should have three characteristics: seismically defined magma chamber, full photo coverage, active hydrothermal activity but locate first site in downflow zone. Consensus was 'French' 13°N area probably best meet these requirements at this time.

5. WESTERN PACIFIC

Margaret Leinen reviewed the thinking of the Western Pacific Regional panel describing their five process-oriented themes as Arc Magmatism; Subduction Processes, Collision Tectonics, Passive Margin Tectonics and Miocene Events.

However, the major portion of the Western Pacific discussion was built around the Planning Conference (Western Pacific Arc-Trench-Backarc Basins Systems) organized by Jim Hawkins at Scripps on 25-27 June 1985. An extensive and detailed report was made available to the panel and a summary was circulated which is included in these minutes as an Appendix. Much discussion ensued but no hard conclusions reached. The Chairman noted that many Western Pacific proposals had been received in recent weeks and they would be mailed to the Panel for review at our next meeting. No consensus on a Western Pacific drilling strategy was reached but the four primary areas of LITHP interest were briefly described as (in no order of priority) the ophiolite comparison; global mass problem (input at trenches versus output in arc volcanism); magma processes and their comparison with mid-ocean ridges; evolution of fore arcs.

Much more discussion is needed within LITHP on these issues and the review of the many pending proposals will be used as our starting point at the next meeting.

6. INDIAN OCEAN

The primary task for the Panel here was to respond to Larson's letter of July 9 in which we were presented with PCOM's Hannover drilling schedule and requested to prioritize our objectives on the legs of LITHP interest. Those are:

i) May-June, SW Indian Ridge (Dick and Natland proposal)

This is a unique opportunity to drill mantle peridotites close to a plate boundary and determine shallow mantle stratigraphy. Compelling evidence exists that peridotites outcrop on the fracture zone walls in this region much more pervasively than at other known fracture zones: this may well be the best place to drill peridotite. The proposed drilling plan combines aspects of both upper mantle geochemistry and fracture zone tectonics, both high priority COSOD objectives. It is the peridotite drilling that LITHP supports most strongly because it is taking advantage of the drill ship's presence at what may be the optimal location. Some of the fracture zone objectives could be met at more accessible locations but these are a powerful and important spin-off.

This is a new idea; this is the best location to do it and the objectives are of the highest priority.

ii) Red Sea

Theirry Juteau reviewed the deliberations of the Red Sea Working Group and LITHP reaffirmed the high priority placed on the study of the hydrothermal systems there.

iii) Kerguelen

Schlich reviewed the Kerguelen drilling options and LITHP, recognizing the multidisciplinary nature of the objectives and large sediment thicknesses that would prevent significant basement penetrations, recommend simply that at least three of the Kerguelen holes should reach basement and penetrate to bit destruction.

iv) 90°E Ridge

These discussions centered around the new proposal generated (with the encouragement of LITHP) by Fry and Sclater. LITHP restated the high priority placed on hot spot trace drilling in the Indian Ocean. The 90°E Ridge was compared as a target with the Duncan et al. Chagos-Laccadive proposal (#88B). There was strong preference for 90°E ridge as the primary target but also the wish to retain the possibility of drilling Chagos-Laccadive on a 'hole of opportunity' basis. Although the Fry-Sclater proposal was supported LITHP would like to see it strengthened and other relevant principals (specifically Duncan) included in its resubmittal.

v) Indian Ocean Proposal Reviews:

Indian Ocean Proposal reviews. The following proposals had been circulated to LITHP in advance of the meeting and were formally reviewed:

a) 88/B: Chagos-Laccadive: Duncan et al.: Strong support in principal but prefer the 90°E target. Get Duncan involved in 90°E drilling; drill Chagos-Laccadive if opportunity arises.

b) 89/B: SW Indian Ridge: Dick and Natland: see earlier these minutes.

c) 137/B: Fossil Ridges: Schlich et al.: Strong support, good target but little support for drilling both the Mascarene and the Wharton. Three holes are the absolute minimum needed to attack the problem in a reasonable manner.

d) 138/B: Rodriguez: Schlich et al.: Almost no support: little motivation for drilling. Much more could be done simply with dredging.

e) 140/B: Red Sea: Pautot and Guennoc: Deferred to RSWG.

f) 133/F: Fluid Samplers: McDuff and Barnes: Deferred to next meeting.

g) An informal proposal from Natland with a modified fracture zone drilling plan was presented by Hawkins. LITHP hoped Dick and Natland could assemble a single coherent plan containing the best of both the original proposal and these new ideas.

h) LITHP reaffirms the high priority previously placed on the Langmuir Cold Spot proposal and urges PCOM to reconsider. Also the Brocher Crozet Basin proposal should remain under consideration while ever there is a chance the technical problems can be solved.

7. NEXT MEETING

Tentatively scheduled for 15-16 January preferably in Hawaii.

ATTENDEES

G.M. Purdy, Chairman
J.R. Delaney
T. Fujii
J.W. Hawkins
T. Juteau
C.H. Langmuir
M. Leinen
K.C. MacDonald
N. Petersen
J.C. Sclater
J. Sinton

Liaison

J. Honnorez
R.E. McDuff
A. Adamson

Guests

F. Albarede
H. Bougault
Y. Fouquet
R. Schlich

APPENDIX

REPORT OF PLANNING CONFERENCE-WESTERN PACIFIC ARC-TRENCH-BACKARC BASIN SYSTEMS

I. INTRODUCTION

A planning conference was convened at Scripps Institution of Oceanography on 25-27 June 1985 to develop a science plan for the study of the active arc - trench - backarc systems of the Western Pacific. The meeting was advertised in EOS and was open to all interested in attending. In addition to about 35 US participants, there were guests from France, Japan and New Zealand who had expressed an interest in the meeting. The purpose of the meeting was to consider scientific objectives, and to propose possible study sites, that could be addressed by the Ocean Drilling Program.

The conference proceeded in three phases; first, we discussed the general nature of the geological evolution of intra-oceanic arc - trench - backarc systems and drew up a list of problems that need further study in order to improve our understanding of crustal evolution in these systems. Models for the tectonic - petrologic development of arc - trench - backarc systems, most of them developed by the participants as a result of previous work, were summarized, new problems and concepts were discussed, and important unsolved problems were identified. Some specific problems were also discussed such as the significance and origin of the uplifted blocks of oceanic crust, and the diapirs of serpentinized peridotite, found in the forearcs of the Mariana and Bonin systems. Other specific topics included the petrologic charavteristics of backarc basin basalts and their similarities/differences to MORB or to arc magmas; the nature of the Valu Fa ridge (Tonga Arc) "magma chamber", and sedimentologic - tectonic problems related to accretion and vertical tectonism in forearcs. The ophiolite problem was reviewed and we discussed the importance of developing a better understanding of the structure, composition, and physical properties of the crust/upper mantle in intra-oceanic arc - trench - backarc systems in order to be able to distinguish between ophiolites derived from deepsea oceanic lithosphere versus lithosphere originally formed in other settings such as backarc basins. The conferees agreed that there is good evidence in support of the long-standing assumption that ophiolites are fragments of oceanic lithosphere but there was considerable doubt among participants at this meeting that the rocks of ophiolites necessarily represent lithosphere formed at mid-ocean ridge spreading centers. Other settings such as backarc basins or even island arcs may have been the site of formation of many of the ophiolites. The difficulty in recognizing petrologic-geochemical signatures sufficient to distinguish between mid-ocean ridge basalts and some backarc basin basalts requires data more extensive than can be obtained by dredging of seafloor exposures.

The second phase of the meeting was devoted to considering various regions where the major problems could be studied. Four regions were selected as being the most promising in terms of the problems needing further study and in view of the extensive geologic data that exists. These were the Izu-Bonin, Mariana, Lau-Tonga, and Banda-Sulu arc systems. At this time we did not attempt to rank any of these in terms of priority; each has special merits and offers insight to different aspects of the common theme of crustal evolution at convergent plate margins in intra-oceanic settings.

The final phase of the meeting resulted in compilation of a list of proposed drill sites, in each of the four regions, that would provide very important data to help answer some of the fundamental problems we discussed. The conferees also agreed that the proposed ODP drill sites would be important not only in retrieving the stratigraphic record at these sites but would be important for long term studies involving logging of physical properties, study of hydrothermal circulation, pore fluid chemistry and its changes with time, and seismic experiments. We recognized that drilling is but one part of what should be a continuing multi-disciplinary project. We endorse the continued survey of arc systems <u>both on land and at sea</u> using "conventional" geologic and geophysical techniques, the use of manned and remote controlled undersea vehicles and platforms, and the drilling of deep crustal holes on islands of the forearc such as Guam, Saipan, Eua or in the Bonins.

II. The Backarc Basin - Island Arc Ophiolite Analog: A Problem for Deep Drilling?

Although ophiolites have traditionally been regarded as <u>the</u> model of typical oceanic crust recent detailed chemical and mineralogical studies of both ophiolite and island-arc rocks strongly suggest that many classic ophiolites are more closely related to an arc or near-arc setting rather than to a typical ocean ridge spreading center. The latter vary typically from "normal" depleted or "tholeiitic" MORB, to relatively alkaline basalts, approaching typical ocean island basalt in composition. In contrast, many ophiolites may include some MORB-like tholeiitic pillow lavas, but these grade into mildly calc-alkaline to highly calcic andesitic, arc tholeiitic, or boninitic rocks typical of intra-oceanic island arcs such as Tonga or the Marianas. These arc affinities were recognized in the Troodos ophiolite by Miyashiro (1973) mainly in terms of major element characteristics of the pillow lavas, but he also noted that the overall structure ans stratigraphy of Troodos could be equated with an island-arc setting. Ewart and Bryan (1972) emphasized the geochemical similarity of the early-stage basaltic andesites of the Tonga island arc to some ocean-ridge basalts, as well as to pillow lavas reported from some ophiolites. They interpreted the pillow lava/sheeted dike/gabbro complex exposed on Eua Island as the top of an underlying ophiolite complex, which was presumed also to be the source of periodotites dredged from the lower forearc slope. Studies of the Zambales Range ophiolite (Philippines) led Hawkins and Evans (1983) to propose that it compresses remnants of arc and backarc basin crust. Bloomer and Hawkins (1983) proposed that rocks exposed on the slopes and forearc of the Mariana Trench constituted an ophiolite suite although most of the rocks indicate an origin in an arc setting. Recent studies of peridotites from ophiolites and oceanic fracture zones confirm that there are consistent differences in spinel and pyroxene compositions between typical abyssal peridotites and those of many ophiolites (Dick and Bullen, 1984; Dick and Fisher, 1984). Hickey and Frey (1982) demonstrated that similarity in rare earth patterns between boninites from several west Pacific island arcs and the lower pillow lavas from the Betts Cove ophiolite complex; similar relations are seen in the arch-derived ophiolite of the Zambales Range (Hawkins and Evans, 1983). Much more detailed analysis of fresh, glassy pillow rims from the Troodos Ophiolite (Robinson et al, 1983) have confirmed the earlier suspicions that these are island-arc related; specifically, it is suggested that all of the Troodos ophiolite was created in a setting similar to the Bonin or Marianas arc.

Although the chemical and mineralogical evidence are persuasive, the classic ophiolite definition is based on stratigraphy and overall lithologic associations. To date, these are not well-defined either in the deep ocean basins or the island-arc environment. Hopefully, one or more deep holes in oceanic crust will be successfully completed during the ODP program. Similar consideration should be given to one or more deep holes in a island arc setting, for comparison both to the oceanic crustal section and to typical ophiolite stratigraphy.

Compared to deep ocean crust, the site selection for this hole (or holes) poses greater problems in the arc environment. "Arc-ophiolites" may well be composite sections made up of fragments of oceanic crust, fore-arc crust, and back arc basin crust which have been tectonically shuffled and superimposed on one another. Hopefully, the "oceanic" part of any such composite ophiolite can be deduced from drilling already planned on or near the mid-ocean ridges. Remaining questions which must be addressed, then, seem to be the following:

1. What portion of the island arc stratigraphic section can be deduced from field studies on land?

2. To what extent can deep drilling in the forearc clarify relations between "tholeiitic" arc basals, sheeted dikes, andesitic or boninitic lavas, and ultramafic rocks?

3. What elements of "arc-ophiolite" stratigraphy may be defined by drilling on or near a back-arc spreading center?

4. Can any details of tectonic evolution of the arc be deduced from deep drilling in fore-arc or back-arc regions?

5. What down-hole experiments can be used to help define major stratigraphic units, structural boundaries, and the lateral continuity of these features?