Architecture of the Oceanic Lithosphere Program Planning Group

Revelle Conference Room, IGPP, SIO, La Jolla, CA, 8-10 May, 1998

Meeting Minutes

Summary

The PPG on the Architecture of the Oceanic Lithosphere had a very successful first meeting at Scripps from 8 to 10 May. We had been given a very difficult series of decisions to take, and the discussions were not always easy, but we arrived at a set of recommendations which we feel are simple and coherent. In the period up until 2003, we recommend two main thrusts for lithospheric drilling:
(a) A start should be made on the drilling of an intact section of ocean crust (our preferred wording equivalent to "complete penetration of the oceanic crust" in our mandate). By 2003 we would like to see significant progress towards this target, which we see as taking place in three stages, a preliminary stage of pilot drilling, perhaps making a start on a deep hole, a second stage using current technology that would drill to about 3000m penetration, and a third stage using riser technology which would complete the task. Because of the need for a rapid start if these targets are to be met, we considered three proposals already in the system against a list of 11 essential and 6 desirable criteria, 11 of which can be evaluated on the basis of existing data. The H2O site (proposal 500) was rejected because the water depth is too great for the 4000m riser planned for the second stage of the riser ship, and of the Ultrafast West site (proposal 499) and the Guatemala Basin site (proposal 522), we preferred the Guatemala Basin site since that site is shallower, and is more easily revisited since it is closer to likely ship tracks. Both the Ultrafast West site and the Guatemala Basin site have the disadvantage that the crust was formed at a very low latitude, which adds significant problems for palaeomagnetics. We therefore sought, with the assistance of Peter Lonsdale, a further site formed at higher latitudes. We identified the best alternative as a site at 23º 30" N, 116º W, off the coast of Baja California, outside Mexican waters, and south of the Alijos Rocks. This fulfills the criterion for latitude, but was formed at a significantly slower spreading rate than the Guatemala Basin site (130 mm/yr rather than 200 mm/yr). A site survey has been proposed for the Guatemala Basin site, and we recommend that this be extended, or an additional survey planned, for the Alijos Rocks site so that the two can be compared on the basis of a full MCS survey, and the better one selected for further work.
(b) In parallel with this we recommend that a major thrust be made before 2003 to develop further our understanding of the dynamics of the plutonic foundations of the oceanic lithosphere. The processes that shape this region are crucial in the dynamics of the lithosphere, and are subject to great controversy at present. Drilling can provide a critical contribution to the resolution of this debate. At present there are five proposals which are relevant to this question. In fast spread crust, the plutonic foundations are rarely brought by later tectonics close to the surface. We recognise three possible sites at present, the Hess Deep, the Pito Deep and the Nova Canton Trough. Of these, the only site under active consideration for drilling is the Hess Deep, and this must have a high priority. In slow spread crust there are several important proposals: the area close to 15º N in the MAR, where peridotite seems to make up a large part of the surface layers (proposal 525), the detachment faults close to the Kane and Atlantis transforms in the MAR (proposals 512 and 532), and the area around site 735B in the SW Indian Ocean Ridge (proposal 535). All of these proposals except 535 are preliminary proposals, and we would like to see full proposals for all of these sites before October, so that we can evaluate them further at our next meeting. We understand that some of the proponents are awaiting site surveys before submitting a full proposal, but we feel thatif we are to prioritise further we will need the further information in a

full proposal based on all of the data at present available. We will not want to evaluate specific drill sites; generic drill sites will be fine. At present we wish to go no further with prioritisation than to say that this is a critical area of oceanic dynamics that requires urgent investigation. We discussed technical questions at length, and decided that there are two areas of great importance for the success of this drilling and for that of further drilling beyond 2003. One is the active heave compensation system, and the other is the development of hammer drill-in casing and casing hammers,. We recommend very strongly that both of these should be fully developed and tested before the end of 2000, so that both are available for drilling plutonic foundation sites, and active heave compensation for the intact crustal section site. We discussed priorities beyond 2003 only in outline, but it was clear that if a capability for zero age drilling could be developed, then that would have great potential for some very exciting science, and would give a strong link to ridge crest observatories. Again, for this both active heave compensation and hammer in casing would be a great advantage, and measurement while coring would give important advances in capability. Other targets include the architecture of a slow-spreading segment, further investigation of hydrothermal systems, and drilling to study long-term variation in the crustal accretion process. A second meeting should take place late in this year, at about the time of AGU, to discuss some of the questions raised here and develop them further.

Attending
Rodey Batiza (co-Chair), Joe Cann (co-Chair), Mathilde Cannat, Colin Devey (replacing Ingo Grevemeyer), Don Forsyth, Peter Kelemen, Graham Kent, Eiichi Kikawa, Charles Langmuir, Philippe Pezard. Jamie Allan (representing NSF), Emily Klein (SCICOM liaison), Gene Pollard (TAMU Engineering Group), Fred Spiess (liaison with Observatories PPG).

Regrets
Jeff Gee, Kathy Gillis and Rolf Pedersen.

Agenda

1. Hear a presentation from Gene Pollard on new and future technological developments and the timing of their implementation, and discuss how to use this information to schedule our plans.

2. Discuss how to implement the objective of complete crustal penetration, the nature of preparation required for such an effort, and hence its timing.

3. Hear a presentation from Fred Spiess and discuss how to relate our work to that of the Long Term Observatory PPG, reviewing the different aims of flank observatories and ridge crest observatories.

4. Discuss how to integrate hydrothermal system science with igneous and structural aspects of lithospheric drilling.

5. Review the Woods Hole document, identify its highest scientific priorities, discuss our views on the current status of these priorities in the light of recent advances in knowledge, ask how these priorities might best be met, and what problems may lie in the way of meeting them.

6. Discuss developments in mid-ocean ridge science since the Woods Hole meeting, and new targets that might have reached a high priority since then.

7. Review the proposals already in the system for lithospheric drilling.

8. Decide on a provisional priority rating for high priority targets in the period up to 2003 and the number of legs required by each target, as well as the need to develop new drilling and site survey proposals.

Addendum

9. Review the long-term framework beyond 2003.

10. Review priorities for engineering and technical development.

11. Key links to other Geoscience Initiatives.

12. Next meeting.

Item 1. Engineering Report. Gene Pollard of the TAMU Engineering Group gave a presentation on engineering developments in progress with an emphasis on those with potential benefit to hard-rock and crustal drilling. In general, these are aimed at improved hard-rock coring, deeper hard-rock drilling, improved downhole measurements, and items needed for seafloor observatories. A wide array of specific engineering improvements were discussed, with a focus on: 1) Active heave compensation, 2) Measurement while coring (MWC), 3) Hammer drill-in casing and the auxiliary casing hammer, and 4) the diamond core barrel (DCB). Active heave compensation should allow weight on bit control to within 1000psi, needed for improved drilling and coring in hard rock, and for prolonged bit life, especially with narrow kerf diamond bits. Operational active heave compensation systems already exist and installation on the JOIDES Resolution (JR) is expected to be reasonably routine. Installation is planned for 1999. The PPG strongly supported this development, which should greatly improve the chances of drilling in difficult formations. MWC is aimed at making real-time (via acoustic telemetry) measurements of weight on bit, torque, vibration, stick-slip, BHA whirl, penetration rate, temperature, depth, RPM, shock, and other important drilling parameters in order to improve drilling and core recovery. In industry, measurement while drilling systems already exist, however adapting these to coring will require some complex repackaging. Sea tests of a new system are expected in 2001. The PPG feels that the MWC system is an important addition for improved core recovery and deeper penetration in hard rock. We strongly support continued development of MWC. Hammer drill-in casing (HDC) and casing hammers offer a great advantage over conventional drill-in casing and are potentially a great improvement for starting holes in rubbly formations such as submarine lava flows. The HDC and under reamers have recently been successfully tested, and will continue to be improved. The auxiliary casing hammer, needed to apply a downward force to the top of the casing, is under development. The PPG strongly supports continued development of HDC and casing hammers for improved ability to start holes (to 30-40m) in zero-age crust and rubbly formations on ridge flanks. The diamond core barrel is an existing tool that has been very effective in a variety of difficult formations. Its continued development is important for future hard-rock drilling. Pollard emphasized the fact that drilling deep holes into oceanic crust poses a difficult challenge, particularly when continuous coring is required. New tool development is an important component of a strategy to drill deep (3-6 km) holes, but it is equally important to provide adequate time for testing these tools in a phased development scheme. Pollard described a number of scenarios for possible successful drilling of holes up to 3-3.5 km deep into ocean crust. The JR is designed to work with drill strings up to ~8500m under ideal conditions and ~7500m under difficult weather conditions. Thus in 4000m water depth, it is possible to drill a

hole up to ~3500m deep in any weather, provided the formations cooperate. Pollard emphasized the need to start with the largest possible casing (20" or 26" if possible), and to extend each successive casing liner to the greatest possible depth. As an example, 20" casing to 60-100m, 16" casing to 300-500m, 13 3/8" casing to 1200-1300m, and 10 3/4" casing to 2200-2500m, could allow continued drilling of an uncased hole to (aluminum) if the JR were to be used, or riser drilling, possibly with the new OD-21 after 2003.

Item 2. Penetration of a complete section of intact ocean crust. This discussion began with a consideration of the criteria for choosing a site for an intact section of ocean crust. As this goal eventually became the PPG's highest priority, these criteria were refined throughout the meeting, and were divided into essential criteria and desirable criteria. They are as follows: Essential Criteria:
1. Fast-spreading (>100 mm/yr full rate)
2. Age of crust >10 Ma
3. >50-100m of sediment
4. Water depth < 4000m
5. Simple tectonic setting
6. Sharp Moho reflection seismic boundary
7. Fast layer 2A velocities and thin low velocity surface layer
8. Crustal thickness between 5-6 km
9. Present location <30º latitude N or S
10. Within a reasonable distance to adequate port facilities
11. Excellent site surveys especially including magnetics and detailed MCS seismic studies

Rationale
A total crustal penetration in fast rather than slow-spread crust is desirable because of the apparent geologic simplicity of fast-spread crust and because fast-spread crust represents the largest amount of present-day ocean crust. Choosing relatively old, cold and thickly sedimented crust is important to maximize the chances of hydrothermal sealing of the upper crust, with improved drillability and core recovery, and to minimize the difficulties caused by high temperatures in the hole (described in a presentation by Philippe Pezard). These requirements plays off against the need for modest water depths to reach deeper crustal levels with the JR, and the even more stringent requirement imposed by the reported limit of 4000m for the riser of the next generation drill ship. In order that the site can be drilled during a multi-leg program, it is important that the site have good weather year around and be close to ports to minimize losses to transit. An adequate site survey is especially important, including detailed seismic studies in excess of the minimal ODP requirements. These are essential to ensure normal crustal thickness, to avoid local tectonic complications like OSCs and other small offsets, and to pick sites with enhanced drillability (i.e. thin or absent upper rubble layer; low porosity in layer 2A). Desirable Criteria:
1. Super-fast spreading (>130-150 mm/yr full rate)
2. Age of crust 20-30 Ma (but generally conflicts with 4 and 5 above)
3. >200m of overlying sediment
4. Near a deep-sea cable and/or flank observatory
5. Within an ION/OSN tile indicating a gap in global seismic coverage
6. Formation at a latitude >15º N or S

Rationale
Super-fast spreading is desirable because such crust may be tectonically simpler than fast-spread crust and because available data indicates that the depth to the AMC, and thus perhaps to layer 3,

is systematically smaller at super-fast rates. Location of the site near cables and observatories is also highly desirable, and if so, then it would be desirable to case as many as possible of the pilot holes drilled prior to starting the deep hole. Having several cased holes is important for wireline reentry to deploy and recover borehole instrument packages, and for doing cross-hole experiments in an observatory environment. Formation at a magnetic latitude >15° is important because good signals of magnetic inclination are needed to detect magnetic reversals in the crustal section and possible rotation of crustal blocks, an essential component of crustal architecture. In addition, magnetic inclination changes can provide evidence of the original dips of lava flows, with important implications for inferring the original geometry of eruptive conduits, flow runout distances, and other variables.

Additional Considerations
1. Strategy should include an array of shallow holes to provide a local to regional tectonic, structural, and geochemical context.
2. This array of holes should be positioned to increase their potential for cross-hole experiments.
3. Adequate shallow and deep water testing of vital engineering components is necessary prior to actual attempted drilling.
4. If possible, the strategy should aim to reduce the number of separate holes drilled, especially to depths greater than 1 km.

Strategy
In order to achieve complete crustal penetration of fast-spread crust after 2003, we envision a general strategy as follows:
a) Conduct site surveys (see more on this topic later)
b) Identify the best site
c) Conduct a leg of drilling to drill one to three pilot holes, the best of which would be planned as the deep hole. The final goal of this first leg would be to have the designated hole drilled and cased to 300-500m with large-diameter (20") casing.
d) Additional legs of drilling using current technology to deepen the hole to ~3000-3500m. Leg 2 would drill and case (13 3/8") to ~1500m, and would investigate the layer 2A/2B boundary, the layer 2/3 boundary, and the top of the gabbro section; leg 3 would drill and case (10 3/8") to ~3000m, and leg 4 would drill ahead as far as possible without casing.
e) Use a riser-capable platform either to deepen the existing hole or to drill a new hole nearby, with continued drilling to pass beyond the Moho. The PPG strongly endorses continued support of the required engineering developments. We also wish to see a significant start to this enterprise before 2003.

Item 3. Observatories PPG. Fred Spiess described progress of the Observatories PPG, which has had two meetings and a couple small workshops so far. This PPG is considering four main types of observatories:
1) Global Seismology (OSN, ION sites),
2) crustal hydrology sites (like site 504B),
3) convergent margins hydrology and tectonics observatory sites, and
4) Ridge crest hydrology, tectonics, and deep biosphere observatories.
The PPG has developed a series of general and special requirements for these observatories, including the important need to service the observatories without having to use the drill ship. Because of this, and the degradation of uncased holes, Spiess emphasized the importance of casing as many as possible future ODP holes. Ideally, the casing should be cemented-in and perforated to allow detailed packer experiments. An important conclusion of this discussion is that the array of planned observatory sites will make an important contribution to scientific

questions of central interest to the Architecture of Ocean Lithosphere PPG and vice-versa. Our PPG is strongly in favor of continued close liaison with the Observatories PPG in order to help accomplish shared scientific goals.

Item 4. Hydrothermal systems. We discussed the importance of integrating the study of hydrothermal systems with the igneous and structural aspects of crustal architecture. It is well known that hydrothermal processes exert important controls on the architecture of oceanic crust and lithosphere directly and via a variety of causal and feedback loops. Future meetings will consider in detail how best to integrate specific key questions about the nature of active hydrothermal systems with architecture drilling.

Item 5. Woods Hole Report. Under sponsorship of ODP, JOI/USSSP, IAVCEI, and InterRidge, a meeting held at Woods Hole, 26-28 May, 1996 considered a wide variety of scientific questions related to crustal drilling, some of which overlap with the concerns of our PPG. We culled the Woods Hole report "The Ocean Lithosphere and Scientific Drilling Into the 21st Century" and discussed which of the major questions they considered also fall within the area of our PPG. After discussion, the following general questions emerged as relevant: - Complete crustal drilling of intact ocean crust at fast spreading rates - 4D architecture of a slow spreading ridge segment - Offset drilling of deep crust/mantle - Zero age drilling - Ridge axis and flanks observatories - Hydrothermal system in an arc environment - Fore arc analog for ophiolite genesis These were all discussed in depth at different points in the meeting, and formed the principal basis on which we arrived at priorities.

Item 6. Developments since the Woods Hole report. The principal new target for drilling that has emerged since the Woods Hole meeting has been the recognition of major detachment fault surfaces in a number of slow and intermediate spreading ridges. These large detachments, whose existence has been postulated for many years, appear to bring plutonic rocks up to the sea floor, juxtaposed against upper crustal rocks during major extension. Drilling the detachment faults may present an exciting opportunity to address a variety of exciting structural and petrologic problems, and might recover long sections of lower crustal and mantle rocks.

Item 7. Review of existing proposals. Next, we discussed the drilling and site survey proposals presently in the mill at JOIDES, NSF, and other agencies. We initially considered a quite large group of proposals as potentially relevant to our PPG. However, many of these are in areas that already have strong and organized constituencies, or else are not directly related to the architecture of the oceanic lithosphere. We eventually focused our discussion on the following major topics: - Complete penetration of intact crustal section at fast spreading rates (discussed above) - Offset drilling of fast-spread crust. True offset drilling can be carried out in Hess Deep, Pito Deep, and possibly the Nova Canton trough, because prior to tectonic disruption, the ocean crust at these locations was intact. Of these, Hess Deep is by far the most mature site from the standpoint of ODP. There is a pending site survey proposal for Hess Deep (D. Smith et al.), but no drilling proposal has been submitted for additional ODP drilling. - Drilling of the plutonic foundations of slow-spread crust. This general theme of drilling tectonic windows into the deep crust and upper mantle is an important component of investigating the architecture of slow spreading segments Additional Drilling at Site 735B (JOIDES proposal 535 =46ull). There is presently a site survey cruise underway in the vicinity of 735B, a Shinkai 6500 dive program is planned for fall 1998, and additional work is planned in 1999. Drilling of the recently-recognized detachment faults in the vicinity of the Atlantis Transform (proposal 512-Pre and 512-Add), and the Kane Transform (proposal 532-Pre) of the Mid-Atlantic Ridge. There are presently site survey cruises pending or funded to investigate the detachments in the vicinity of Atlantis (Blackman et

al. funded) and Kane (MacLeod et al. funded, Tucholke et al. pending) transforms. Drilling of peridotite units at 15º 20'N at the Mid-Atlantic Ridge (proposal 525-Pre). This program was strongly endorsed in the Woods Hole Report. Further site survey work will be completed this summer. Another proposal to drill peridotite at the medium spreading Central Indian Ridge (proposal 531) is part of the general theme of the plutonic foundation of the oceanic lithosphere. It was noted in discussion that scientific thinking on the architecture of a single slow-spreading segment is in a state of flux, and that the drilling strategy for this objective outlined in the Woods Hole report may need to be reconsidered. Accordingly, we recognise the above three initiatives as the first logical steps towards understanding the 4D architecture of slow-spread crust.

Item 8. Prioritisation for the period up until 2003. After extensive discussion and a secret ballot that revealed a remarkable degree of unity within the PPG, we decided upon a two-pronged strategy to approach the Architecture of Ocean Lithosphere at fast and slow spreading rates. The first major thrust is to make a significant start on penetration of an intact section of fast-spread crust. The second thrust is to investigate the plutonic foundations of the oceanic lithosphere at both fast and slow spreading rates through offset drilling of sections exposed by later tectonics, and through drilling of sections that have been exposed by the tectonic processes associated with rifting. We discuss each of these separately. Penetration of an intact section of fast spread crust In this area, the top priority in the short term is to select and adequately survey a site and to make a significant start on drilling. Because this represents a very tight schedule, we considered three sites at the meeting for which proposals had already been submitted, against the lists of essential and desirable criteria listed under Item 2 above, for which the sites could be assessed without further survey work. The four sites are:
1) The Hawaii-2 Observatory (H2O) site (proposal 500-Full2),
2) a site in the equatorial Pacific (proposal 499-Rev) which we call the Ultrafast West site,
3) A site in the Guatemala basin (EEQ-2, Leg 138- proposal 522-Pre). The H2O site meets many of the essential criteria, but it is too deep (~4500m), is relatively remote and has a thin sediment cover (50-75m). It fulfills several of the desirable criteria, and is the only site close to a cable, but because of its failure to meet some essential criteria, it was rejected for a major effort at deep crustal penetration. The Ultrafast West site meets the essential criteria, though it is rather far from port; it fulfills many of the desirable criteria too, except that the crust was formed at an very low magnetic latitude. The Guatemala basin site meets all of the essential criteria, but was formed at the same very low latitude as the Ultrafast West site. These three sites were all formed at spreading rates of 140 mm/yr or greater (though H2O is slower than the others), two of them are high-priority ION/OSN sites, and one is near an abandoned deep sea phone cable. However none of these three sites meets all the criteria identified by the PPG. Thus, after the PPG meeting was over, a subset of members (J. Cann, E. Kikawa, and G. Kent) met to seek an additional site with the help of Peter Lonsdale. They were able to rule out all of the potential areas south of the Equator because of tectonic complication at the appropriate time in the past, but identified a possible fourth site at 23º 30'N, 116º W, about 300 nm west of Baja California and south of the Alijos Rocks. This Alijos Rocks site formed at a fast spreading rate (~130 mm/yr), has at least 150m of sediment, is in 3800m water depth and formed at a latitude of 15º N or greater. This site fulfills the latitude criterion, as well as all of the essential criteria. It was, however, formed at a spreading rate considerably lower than that of the Guatemala Basin and Ultrafast West sites (200 mm/yr). On the basis of the information available at present, the PPG felt that it could identify the Guatemala Basin and Alijos Rocks sites as the most promising sites for the major investment that this target would eventually consume. PPG thus recommends a high quality site survey for both of those sites as soon as possible, so that the results can be evaluated in time for a significant start to be made on drilling before 2003. PPG also recommends preparing full drilling proposals, with the target of deep drilling clearly in view, for both of these sites. Drilling the plutonic foundations

of the oceanic lithosphere This target comprises offset drilling of lower crustal and mantle rocks in a variety of environments, possibly including a return to 735B, detachments at Atlantis and Kane transforms, peridotites at 15º N, and plutonic exposure in the Hess Deep. Prioritisation of these is presently premature, as there are numerous field programs that are pending, funded but yet not scheduled, and in progress. At our next meeting, we will consider progress on all these fronts and will prioritize them when there is enough information about each to make meaningful choices. Critical to developing a tighter list of priorities will be development of the proposals that have so far been submitted. - At present we have a full proposal for a return to a site close to 735B, but new survey data are being collected, and that proposal can be brought up to date in the next few months. - We have a pre-proposal for drilling peridotites at 15º N on the MAR (525-Pre), but this needs to be developed into a full proposal, and to incorporate the results of cruises planned for this summer. - Pre-proposals have been submitted for drilling detachment faults at the Kane (532-Pre) and Atlantis (512) transforms, and these need to be developed into full proposals in the near future. Further site survey work has been funded, but not scheduled in both areas, but full proposals will be required before that work can be complete. - Though we identify offset drilling of the plutonic foundations of fast-spread crust at Hess Deep as an important component in our plans, there is no current proposal in the system for drilling there, though a proposal for further site survey work there is pending. We recommend that a full proposal be developed for this area on the basis of available information in the near future. PPG thus recommends that a high priority be given to site survey work and development of full proposals for drilling the plutonic foundations of the oceanic lithosphere.

Item 9. Long-term priorities beyond 2003. In addition to the complete penetration of intact fast-spread crust, and investigations of the deep crust and upper mantle at slow and fast spreading rates, the PPG identified additional long-term priorities: --Zero-age drilling of volcanic and hydrothermal systems -- Ridge crest observatories -- Anatomy of a slow-spreading segment -- Long-term variation in the crustal accretion process These topics and possible drilling strategies will be considered at the next PPG meeting. In relation to these targets, PPG encourages the submission of proposals aimed at understanding the architecture of single slow-spreading segments, and especially at drilling a strike section on crust about 10 Myr old. An announcement to this effect will be circulated through the InterRidge mailing list.

Item 10. Engineering priorities. The PPG strongly endorses continued development, testing, and implementation of active heave compensation, measurement while coring (MWC) capability, hammer drill-in casing and casing hammers, and the diamond core barrel. All these capabilities will be invaluable to a successfully penetration of intact ocean crust, with good core recovery. In the shorter term, PPG recommends giving a high priority to development and testing of active heave compensation and hammer drill-in casing and casing hammers which promise significantly to improve the quality of drilling of plutonic rocks. These sites will also allow development of these techniques to the stage where they can be tested on zero-age crust, which will be a very high priority if these technical developments prove successful. It is important to note that an excellent start on both of our goals, with first-order scientific return, can be made with available technology. However it is also clear that continued technical development has the promise of substantially improving both the success of drilling and the quality of the results obtained.

Item 11. Links to other Initiatives. The PPG reaffirms the importance of maintaining communication links with other geoscience initiatives with common and related goals. These presently include: the JOIDES Observatories PPG, InterRidge, ION/OSN, the US Ridge and Margins programs and similar organizations in other countries, The JOIDES Deep Biosphere

PPG. It is especially important for the PPG to keep abreast of developments and plans related to the OD-21, and drilling capabilities beyond 2003.

Item 12. Next Meeting. One suggestion was for the next meeting to occur just after the AGU Fall meeting. Possible meeting places include Hawaii and San Francisco. Action Items-
1. Report to Tarduno and others regarding priorities, proposal upgrades, new proposals, and other matters in these minutes
2. Communicate with PIs of drilling proposals and site surveys intact crust- Doug Wilson Atlantis detachment- Donna Blackman Kane detachment- Brian Tucholke 15=B0N MAR- Jack Casey Hess Deep- Debbie Smith et al. 735B- Henry Dick
3. follow-up with all PI's in late summer regarding drilling proposals by October