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PART 4

ROUND-TABLE SESSION

1.0 NOGAP Regional Studies

1.1 Introduction

Neil MacLeod: In the first session today, we want to review the NOGAP granular resource projects that were reported on yesterday, think about where they fit with the geological models that Steve Blasco presented yesterday and try to identify any changes that should be made to the interpretation of those areas from a geological or inventory perspective.

Those who know something about geophysics might be able to recommend equipment and techniques that are being used today would be better than that used to evaluate the area in question. Those with engineering, surveys, or the operator's perspective may want to consider how the data was or should be collected and how the information could be used.

1.2 Yukon Shelf

John Lewis: Over the past 7 or 8 years, there has been very little new data added to the Yukon shelf geophysical data sets or geotechnical data sets as far, as I am aware. So there isn't a lot we can do to update granular resource inventory on that basis. There are a number of questions as to the local small shoal features and the thickness of the lag deposits in the off shore region. I suggest it would be possible to mount some new data acquisition programs in that region, with sampling to confirm the thickness of features. In general, I think there is a reasonably good regional overview of the granular resource in the Yukon Shelf area and I can't see a lot that we can add to that with the existing data set.

Steve Blasco: You are saying that we need new data to actually get at the thickness.

John Lewis: I think so. The geophysical data that we collected out there didn't really give us an idea of the thickness. I think we may have to go back with some kind of vibrocoring program or something along that line to get a better idea of the nature of those off-shore lag deposits. Are they recoverable if they are only 10 cm thick? Is there a dredging mechanism to get at these gravels?

Bill Scott: If they area only a few centimetres, you can't really dredge too effectively.

Kevin Hewitt: If the seabed was flat and you struck off 6 to 8 inches each time, it might be possible. But then even if it was 8 inches thick it would not be much good because you can't guarantee you will not go back over where you just stripped off.

John Lewis: But there are 1,400 km^2 of area so you could put your dredge down and steam for a 100 km without re-crossing the lines.

Kevin Hewitt: I would say a practical minimum thickness would be 1 to 2 m.

John Lewis: At this stage, the geophysics are not showing us any significant thickness of gravel at all. All we have are grab samples throughout much of that Shelf area.

Steve Blasco: What you are really saying is that for the 20 prospects you identified, you need to go back and do two things. You need some high res advanced geophysics using new equipment and you need to go back and sample it.

John Lewis: Then you could do some serious delineation of granular resource.

Steve Blasco: From the geologic model standpoint, we can't do much more to enhance the inventory data. In this area the model works pretty good.

John Lewis: I feel fairly confident in the regional geology that we have developed with the data that we had. It is really just the lag gravels that are in question.

Neil MacLeod: Does that include your interpretation that it is a lag deposit that it is not a reworked till?

Steve Blasco: Sometime we intend to go back and focus on these deposits like we did at Issigak, to try to get at the site geology. As for as regional geology, I think we have a framework in place. When sampling, you would try to differentiate, I suppose, between ice rafted deposits and those that are lag deposits. That is those that come out of Unit L, on the shoal. The regional geology really constrains you in terms of roughly where to look and what kind of deposits to look for. John Lewis has 20 of them to go look at. You just need the site geology.

John Lewis: Would it be worthwhile setting up a project to go look at a couple of these shoals on the Yukon shelf, the mid shelf shoals and the outer shoals? I think we are fairly confident that the alluvial deposits along shore are reasonably good quality granular resource. It is the off-shore ones that are questionable in nature because we have very little ground proofing information on these.

Steve Blasco: When the data was collected on the Yukon Shelf, both geological and bathymetric, it was not with any kind of sand or gravel inventory purpose in mind. We could put a different suite of gear on now, basically focusing on the upper few metres. We might be moving in to some of the new digital seismic systems, chirps and things like that.

Neil MacLeod: Is there enough information on gravel on the Yukon Shelf to justify going there rather than say to Banks Island or Issigak?

John Lewis: Well I think there is a higher gravel content in the region, whether those gravels are thick enough to be recoverable is still in question. Look at the alluvial deposits near shore where you can actually walk along the shore and sample them to get a kind of a quality factor. Why wouldn't you go recover the near shore deposits? There are possibly 400 to 800 million cubic metres of shallow gravel. If you are going to steam all the way over to the Yukon Shelf, whether you go on the outer shelf or the inner shelf makes no difference.

Steve Blasco: The problem in the inner shelf is you get into water depths that dredges don't like. Some of the resources you want to recover are in water depths less than 10 m and the dredges don't like to go in there.

John Lewis: Well we have 400 million cubic metres estimated in water depths between 10 - 20 m and another 400 million in-shore of that in the 0 - 10 m.

Bill Scott: What happens to shoreline stability if you start dredging major volumes from that water depth? I would guess that would be a serious problem.

John Lewis: I wouldn't think it would be much of a problem. If you were out beyond the 10 m contour, you will not be taking armour off the beaches.

Steve Blasco: There is also the strip along the edge of the Yukon Shelf where there are migrating sand wedges. There is stuff all along the edge as you go down the Mackenzie Trough and it is not as far to travel.

John Lewis: Yeah and it is potentially thicker. If you are getting mega-ripples and sand wedges, you are definitely into a thicker surficial material.

Bob Gowan: Was there side scan involved in that?

John Lewis: There was. Actually, we didn't look at it in our program but Jim Shearer did a summary of it for us. He was looking at it from an ice scour point of view and he mapped out surficial features like mega-ripples and what he interpreted as granular or gravels and ripples marks throughout the area. These should be tested further.

Kevin Hewitt: I don't think that the industry or operators are likely to want granular materials in the Yukon Coast area because the SSDC mat has already been used just west of there on the U.S. side. They put it on the seabed and it worked well. There is likely not any reason to drill another hole near there.

1.3 Herschel Island

Neil MacLeod: Can we move on to Rick Quinn and the Herschel Island area?

Rick Quinn: Well, in the area from Herschel Island down to Cape Point, there is a lot of geophysical coverage. Particularly in the deeper water areas where a survey boat can traverse. There is a fair amount of geophysical coverage from the Norweta and various cruises that the operators have had and the Banksland cruise that GSC had. Unfortunately, there are the inherent limitations of the acoustic techniques that were used on some of the most prospective areas for borrow like on the Herschel Sill. The capping of the coarser material tends to preclude the definition of the deeper underlying layers using geophysics.

There are a couple of areas that need more exploration, someday. Between Kay Point and Herschel Sill, there is a vast area that has not been looked at. Collinson Head, off Herschel Island, has not been delineated very tightly. There could be some more material up on that northern tip or the eastern side of Herschel. There are also prospective areas near the Yukon Shelf where you have outwash deposits on-shore that really haven't been looked at to any great extent in a submarine environment. So, in my mind, there is certainly a need for some way of physically sampling to try to delineate the areas that are termed as prospective. We would see what really is on the sea floor and if there is any way of determining some of the thicknesses and the granular nature of the deposits. I wonder too if some of the techniques such as electrical methods could be looked at to help complement the geophysics that is known already.

Another thought crossed my mind for that area too. I think it was Steve who was saying there are actually some very large boulders sitting up on the Sill. These have caused problems to suction dredges in some other areas like off Kay Point. They may be due to either re-working of the sediments or could be due to terrestrial outwash plain glacial deposits. Something like a towed video system may provide a technique of giving some aerial coverage as well as a real world look at the nature of the sediments that are on the

sea floor. I hesitate to recommend using the video because the Beaufort is not known to be the clearest water area of the world but nevertheless if it can be towed and contour fly over the sea floor, it could give more information on the nature and size of the aggregates and provide ground truthing for environmental concerns.

John Lewis: When I have been in along the Yukon coast in that area, usually the water is quite clear. I don't know what the bottom water would be like. It could be a turbid zone.

Rick Quinn: The areas that we are primarily interested in is the Sill and the area with potentially course grained material off Stokes Point and between Roland Bay and up to Catton Point.

Steve Blasco: When Gulf was looking for permanent residence sites for the Tarsiut caissons and for Molikpaq, they did quite a study all along that coast to look for a sand seabed as a resting nest. I do not believe they were very successful except for two sites. Gulf did quite a bit of work in there and I don't think we have ever looked at that data. I'm not sure which ship did it but they did eventually find a suitable site. They did move a ship over there and so there is a data set along that coastline that has not been analyzed.

Neil MacLeod: It seems there are a few things to be done in the Herschel Island area to tie up some loose ends. There is a need to confirm the origin of the deposits on the Sill and the origin of the sill to get a better grasp of prospects in the Herschel area.

Rick Quinn: Yeah and also to confirm the spatial distribution of the material. Sometimes you may be in less than 12 m of water.

1.4 Issigak

Neil MacLeod: The next site to the east is Issigak. We have a lot of borehole data from Issigak and I think that we know a fair bit about the physical features of the Issigak deposit. But there are a couple of remaining issues such as the geological interpretation that ties the Tarsiut biostratigraphy back to Issigak. There are ways of confirming this interpretation. In fact, at one time we had data by ESSO that would confirm it, but that data was lost.

A second issue is the question of a source. It is my interpretation that Issigak is a fluvial or fluvial deltaic deposit comprised of sediment reworked from a nearby source some place off the south or southwest end of it. The source has never been identified because it is in an area of shallow water where not much exploration has been done. The problems have always been that the seabed in that area is quite shallow, the bottom is quite soft and the

always been that the seabed in that area is quite shallow, the bottom is quite soft and the water is quite muddy. The geophysical guys will have to come up with a new way of sneaking into that area which is maybe only 5 or 6 m deep at the most.

Steve, you have a somewhat different opinion on its origin and I know Guy Fortin has really different ideas on the geology of that deposit. Perhaps you can suggest ways of testing his theories?

Steve Blasco: We definitely need more regional information to link Issigak back into Tarsiut and some other areas so we can map reflectors in and out of the area. We need that kind of regional framework to determine whether Guy's approach, your approach, our approach or whichever is appropriate. I also agree with you, that we need to tie down the origin as an actual fluvial deposit, to find the source of the gravel. If, in fact, it has all been reworked and now shows up as some kind of shoreline, those water depths further to the east need to be explored more thoroughly. If it is some kind of lag deposit, we may find more Issigaks along the same old shoreline.

We have never done much research about old shoreline stands on the Beaufort. We did some work with Pelletier, when he was trying to look at still stands years ago but there wasn't enough information. It would be nice to have that kind of information then we could actually sit down and decide which model is appropriate.

Another thing was, Muharrem Gajtani's hypothesis was that any kind of a shoal element was worth investigating too because it was exposed to higher energy conditions for a longer period of time. So any shoals in the area of an exploration prospect were looked at.

Kevin Hewitt: That is how Muharrem found Issigak. They saw that high there on the bathymetry and just came in to test it.

Neil MacLeod: Guy, do you have any comments about Issigak?

Guy Fortin: Maybe one. I think that a lot of our interpretation is based on one date at Tarsiut. Should we trust that date 100% or is Issigak also based on some other dates on the eastern side?

Neil MacLeod: Well there are a fair number of dates on the Tarsiut samples. The biostratigraphic information has been compiled and there are several different dates on that. If there is an error in the interpretation it is with the correlation of the information at Tarsiut and back to Issigak. I think that the Tarsiut dates are probably your type sections

for the Beaufort. That hole is dated and tied down about as well as it will be and probably about as well anything in the Kringalik Plateau will be for the next ten years. Steve, I don't know of anything else you are doing in that area?

Steve Blasco: There are between 20 and 25 industry dates on the Tarsiut section that all tie together nicely. They were done in the early years by Muharrem. But the real weak link is the tie-in to Issigak. If we find that the Issigak area is not linked to Tarsiut or the stratigraphy is changing in there that would require a significant re-thinking of our local model.

I don't think we can really dispute the Tarsiut data. It is a question of whether it is appropriate beyond Tarsiut.

1.5 Isserk

Neil MacLeod: I guess our next stop on our voyage eastward is Isserk. Mr. Lewis will you lead off?

John Lewis: For the study of the Isserk site, we were unable to locate quite a considerable amount of data. In particular, Gulf's data from 1982, 1984 and 1985 couldn't be found. There were boomer and 3.5 kilohertz data but most available seismic data over the shallow upper sand deposit at Isserk was not of particularly good quality. So we ended up doing most of that inter-pretation from the relatively large number of boreholes that were available in the area. It would be interesting, if this earlier data could be found, to re-evaluate some of it. Alternately we should go up and do some re-survey over the area with say the IKB Seistec or a dual boomer system maybe, to try for better penetration and stratigraphic delineation through that upper sand body.

Another objective would be to extend our data to the area of the lower sand body in the southwest corner of the block. We have virtually no quality information on this large area. If there is a chance to put some boreholes in that region, it might be worthwhile. That area does extend further southeast beyond the edge of the Isserk block site. So it may be worth extending the search a little bit further to the south.

When Laughie Meagher and I were originally writing this report, he suggested about 60 more boreholes would be required to delineate it accurately. I think that is probably a ridiculous number to consider at this time. We had a lot of uncertainty in the assessment of the deposits at that point, particularly the qualities of the lower deposit and there was

no information on the upper deposit. We felt that some improved geophysical surveying techniques which may have been actually used in these missing data sets from '84 and '85, were needed.

I think most of the seismic data that was available over the Isserk site was somewhat marginal because of weather conditions at the time of the survey. There were a couple of good lines but the majority of them were seriously affected by heave motion. Some re-survey over that site area would really help. You can either plan on good weather or you should make some improvements by providing active heave compensations systems, or data acquisition systems that were not available or were not used at the time.

Neil MacLeod: You might justify re-surveying it if the work was focused on the gravel part of that deposit. You did show that in the lower sand body there was an area with gravel in it. Could more work be done to trace that further?

John Lewis: Unfortunately most of the geophysical data that we had was over the shallow sand body and you couldn't see the bottom of the shallow sand on the seismic records. It typically masked the lower sand reflector because coarser grained material on the seabed really limits your penetration and resolution definition with high- res, particularly with a 3.5 kilo-Hertz profiler and the boomer is often significantly reduced in its effectiveness. So you could have gravel hidden under the first layer of sand.

Neil MacLeod: Kevin, as an operator, do you agree that the prospects of gravel at Isserk might drive further research.

Kevin Hewitt: Yes. There is enough sand there. Gravel is what will be scarce resource.

Bill Scott: Scarce enough to justify several metres of stripping because if I understand it right, the lower gravel is a fair way down in this thing.

John Lewis: We only really saw it in one borehole which turns out to be the common point of all three profiles I showed.

Neil MacLeod: I guess, you have to evaluate that. If it turns out that this is the only high spot with gravel on it and everything else is 15 m down obviously you wouldn't chase it. But we don't know that yet. There is probably some justification for further work at Isserk. It would be much greater if someone was proposing to develop there but it isn't far from Amauligak to go for gravel.

John Lewis: That is my feeling. There were extensive recommendations made at the end of our study that could not be justified now. I could see possibly going back and doing a couple of test lines with new geophysical technique whether it be resistivity or a better seismic profiling system. In fact you might want to go out to an area like Isserk or Issigak to test it there because you have a well known area. So those two areas may become test areas to look at new processing and new techniques in the future.

1.6 Erksak

Neil MacLeod: John, do you want to move on to Erksak?

John Lewis: O.K. The Erksak area study was very much a broad brush regional evaluation. It is a very large area to start with. Throughout the southeastern portion of the area there was very little geophysical data or geotechnical data. Most geotechnical data is grouped in a number of small regions for site studies.

The prospect zones were particularly lacking in boreholes. I think there were two boreholes within the Erksak Channel that, if I remember correctly, both had marginal quality granular resource. The Erksak Channel looked like old braided river streams, sandbars, etc. A few more boreholes or additional work in that region is required to delineate these prospects.

You would have to do some very detailed delineation work before you would actually try and use any of the resources outlined in these prospects. I'm not sure how much effort should go into that area. It tends to be all fine-grained sand and very little gravel was observed.

Neil MacLeod: Can you put some sort of quality assessment on the resource prospects?

John Lewis: We did try to do that by looking at the seismics and the nearby boreholes and estimating the quality. We still ended up with something like 7 billion cubic metres of potential granular sediments. It is a huge area and there is a lot of sand exposed on the seabed. Quality would have to be looked for each area. You would only do that if you wanted to go in and look at a very specific area.

Steve Blasco: Do you have enough of an understanding of the geology there to be able to say that we have identified all of the potential targets in there? I would hate to discover that there are some gravel deposits that were missed.

Bob Gowan: Yeah. Is there anything to suggest that the proven areas are the best areas in terms of likely gravel targets?

John Lewis: The only reason those were classified as 'proven' was because they were the only ones that had any borehole data.

Bob Gowan: Have you considered whether there are better prospects for gravel based on the physiography or landform? Perhaps these bars that you have shown in the channels or a terrace on the edge of the Issigak high or something.

John Lewis: There certainly might be areas where some borehole work would be interesting. We do have a few very good seismic records showing these pro-grading beds on the edges of the channel features. You have a very good indication that it was probably well washed out and reasonably clean material. But we don't have much to confirm that.

Steve Blasco: Are you talking about that in general terms or about the edge of the Kugmallit Channel on the Tingmiark Plain?

John Lewis: I think along that whole edge there is a relatively high probability for reasonably good quality resources. But we have virtually no boreholes there. We found working on this large an area extremely difficult. As a geologist or geophysicist, you look at the Beaufort as a stratigraphic collection of 8 units (A, B,C, etc.) and your mapping is stratigraphically oriented. In this case, we had to impose engineering considerations on it. It became very complex to deal with this.

Steve Blasco: Ground truthing seems to be a bigger concern here than is more geophysical work. The questions we usually get are "where is the coarser grained material" and "where is the sand with the lower fines content." Most of the Unit C sand there has a fines content of 6, 8, or 10%. Yet if it has been re-worked at all, it could be as low as 2 or 3%.

John Lewis: Well I'm certain that our understanding of the area would benefit from higher quality seismic data including the data that we couldn't locate. The majority of the lines in that region I think were Gulf '80 and '81 data sets. There were a few Dome lines and a few Esso lines. I know that the whole area of the Uviluk high was all surveyed by Dome in '81 cause I did it. Unfortunately we couldn't find any of that data set.

Now you could evaluate some of the site survey data to find answers to your detailed questions. For our study we wanted to get a regional perspective and we didn't go in and look at them in the detail that you are asking for now. You could go in and look at all the data from the Kogyuk site or the West Tingmiark site or if you could find the Uviluk data

set from the perspective of trying to delineate gravel from sand and consider it from a quality factor. We couldn't do that because the area of our study was just too big to look at it in that detail.

Steve Blasco: Was there any potential in the James Shoal area?

John Lewis: Oh yes. There is quite a large potential, although the James Shoal area does appear to have a veneer of clay overlying it. There are some sand areas down the southern portion of the shoal and around the Alerk site as well. There were a lot of boreholes there and there was some dredging.

Steve Blasco: What about the whole Kaglulik Plain. We never really looked at the area which is further to the east. We start to get more inter-bedded sequences as you go further east.

John Lewis: And there is a lot more permafrost, if I remember correctly.

Neil MacLeod: We did a couple of holes out that way for Chevron at the north end of Tuktoyaktuk Peninsula, both on the west side and the east side. To my knowledge there is no shallow seismic out that way other than some of the regional lines that Dome did initially.

Steve Blasco: And we have some regional lines. They have never been looked at from the sand and gravel perspective though.

Kevin Hewitt: We did a couple of boreholes initially in '80 out there and encountered very fine and very dense sand.

John Lewis: In the Baillie Island area you tend to get better penetration with the acoustic methods than you do through that Tingmiark Plain area. That always implied to me that you are getting a fining or less sand content and less permafrost.

Steve Blasco: But that is a very general picture. I wonder, in fact, if there are areas within the Kaglulik Plain which may contain potential granular resources. It is a question of whether there is a more appropriate way to do some regional work there.

John Lewis: Again, it comes down to a question of whether that is likely to be an area where there they will need granular resource?

Steve Blasco: Well, it may be easier to bring material in from there than it is from Herschel or Banks (Island). I don't think we have enough information to categorically state that we can neglect the Kaglulik Plain as a source of sand and gravel. I wouldn't want to make that statement. So it is a question of how to put ourselves in a position to either say there is or is not a source there.

1.7 Banks Island

John Lewis: Guy, do you want to say anything about the Banks Island area?

Guy Fortin: Banks Island is very far east and there is very little data. We have one regional line along the coast, no boreholes and only a few samples from a grab sampler. This makes interpreting the geology very difficult. I don't know much about dredging but I wouldn't send a dredge out there without a good map of the pockets of sand and gravel.

A lot of mapping must be done if there is some interest there. If the pockets are wide enough to be dredgeable, we need almost complete coverage with side scan sonar and some resistivity or seismic tools. I don't think a 3.50 kiloHertz would do the job. Maybe a system like a boomer with a minimum penetration of 3 or 4 m in coarse sand and gravel with a resolution of about half a metre. I don't think it's worth it to core all of the pockets. Maybe we should think about doing some coring and establishing correlation curves which may help to interpret either the resistivity or the refraction data.

There are in fact three settings to consider. At the mouth of the Masik River, there may be a fluvial glacial terrace. I think we have to drop the off-shore extension of Carpenter Till because I don't think a dredge can work where the sea bed has a relief of maybe 10 m. That leaves the Sachs Till extension which is flat and should be a good source for high quality material. In fact, all the area between the Masik River and Sachs Harbour has a good potential but there is almost no data there.

John Lewis: There were some dredge tests in there, weren't there? They found quite large boulders.

Guy Fortin: Yes. I don't know if the boulders represent problems for dredging. Is there is a way to filter a seabed boulder of a half metre when sucking up sand and gravel? And I don't know if those pockets are too small or not wide enough for the dredges.

Neil MacLeod: The biggest problem Dome had with the dredges was that they couldn't re-locate an area where they found good material, because of their accuracy of their positioning equipment, the sea state conditions or because it was so close to the shore. When you start going into small pockets, you really have to know what you are doing. If someone was going to get serious about dredging over there, better positioning is essential.

It is my opinion that dredging in those small pockets is pretty inefficient. There are a thousand complications to dredging at Banks Island like the ship time to get there, these small pockets are hard to hit and the closeness to the shore. I think the operators would have to be very desperate before they would ever make too many trips back there. I think Banks Island is your source of last resort. If it looks like there are other options and I think they will explore those pretty far before they go back to Banks Island.

Kevin Hewitt: As I said before, we would like to know where gravel is. We already know where the sand is. If you ask yourself why we would need the gravel, we will probably need it for erosion protection. There will be a lot less demand in the future than it was at that time because we had major erosion problems with the shallow draft structures then. With the SSDC/MAT we don't need any erosion protection. The Molikpaq has 20 m draft, but only needs a little erosion protection around the base. I think if you are looking at production structures you will probably need some but they will probably be designed such that you don't need large boulders. If you did, there would be something wrong with your design.

I'm just trying to put Banks Island in perspective. Previously we had a serious problem with erosion because of the draft of those structures. We were willing to go across to Banks Island because it seemed like the most viable prospect. It worked to a degree but it is not likely to be an effective prospect for the future. I say not likely.

Rick Quinn: What would be the advantage of having a detailed bathymetric map of the area between Masik River and Sachs Harbour apart from navigation concerns?

Guy Fortin: We have to think about a system which combines both GIS and GPS to have a map on shipboard and an update of the positioning to be able to dredge those pockets. It would be necessary to have good bathymetric maps for dredging because of the high seabed relief. Besides that, I think it would also help to mark the off-shore outcrops of till because I think they have a small relief. It could be a way to map the outcrops and the pockets instead of seismic. It would be easy to map the narrow shoreline with maybe one pass.

2.0 Technology and Techniques

2.1 Introduction

Neil MacLeod: I think we can move on to the next part of our planned discussions. We should be trying to focus on ways for developing and applying new technology in the exploration or assessment of granular prospects in the Beaufort. First I suggest we look at seismic techniques. Consider the application of newer techniques for mapping granular resources in the Beaufort Sea. John, is there anything that has come on the market or about to come on the market that would revolutionize our ability to predict where granular resources might be found?

2.2 Seismic Methods

2.2.1 Equipment

John Lewis: Well I suggest that from an acoustics point of view there are ways to improve the quality of data by adding heave compensation and using the line and cone array systems that have been developed over the last couple of years. We have obtained quite good data with that. I still think using acoustics for stratigraphic mapping will be severely restricted in areas of coarse granular material. Therefore, you would probably have to move on to resistivity techniques or borehole confirmation to get your stratigraphy through those regions. You can't usually determine the thickness of a deposit very well from acoustics. You can usually see the top of the deposit but it is very difficult to delineate the bottom of the deposit with acoustics.

Rick Quinn: Something that we haven't fully talked about is the resolution aspect of acoustics. That is things like pulse width and power output but we might want to look at the frequency spectrums to help us delineate gravel deposits. If you are in an area that requires penetration, hitting it with a bigger hammer often creates more problems. Perhaps if you could use some of the digital techniques or signal processing techniques and look at frequency bands that may be best tuned to look at more deep-lying gravel deposits, you might get more dividends. Use the frequency spectrums that will give you penetration and then try to fine tune the resolution component of it. That is digital processing.

John Lewis: The chirp system does that.

Rick Quinn: Yeah. But there is also a big band width in the line cone survey. You have a big dynamic range there as well and it is probably at a lower frequency than the chirp.

John Lewis: Not particularly, the line cone acts as a natural filter and cuts out almost everything below about 1800 hertz. But I can still get, often 40 or 50 m penetration in clays.

Rick Quinn: Yeah, but we are not looking for penetration in clays. What we want is to get better penetration and enhance the resolution in the gravels.

John Lewis: But that frequency cut off is also a function of the size of the cone. If you make the cone bigger that frequency goes lower.

Rick Quinn: I think the component you want to enhance is the low frequency component, if you want to get deeper down to look at some of these.

Bill Scott: You run into wavelength problems though at lower frequencies. If you are looking for a layer that is a couple of metres thick, the wave length gets to be comparable to the layer size or bigger. If you blink you miss the layer.

John Peters: How important is heave compensation relative to all of these other fine tuning things? I mean, will you get tremendous improvement just by having heave compensation.

John Lewis: If you are looking at high resolution systems it is extremely important.

George Eaton: I think that is an easy problem to solve compared to some of these other things you have been talking about.

Steve Blasco: The question is how to import heave compensation into our system or should it be corrected outside it.

John Lewis: Most seismic systems have a separate source and receiver. You have one going up and the other going down and they are not going up and down in conjunction with the vessel.

Steve Blasco: George, what is the stage of development that the Hydrographic Service has achieved with the heave compensator?

George Eaton: Well there are a number that you can buy that will work reasonably well these days. We ran one in '89 on the Tully that showed remarkably good results. Most cost in the neighbourhood of $20,000 but I think realistically the problem could be solved with GPS.

Steve Blasco: On the acoustics side, there are also refraction methods.

Guy Fortin: Refractions can help to distinguish between sand and gravel. If anything there is no sub-bottom penetration with a refraction systems. It is good when you use both methods to help interpret the layers.

Steve Blasco: There are changes from a reflection side too. One big change is the switch to digital acquisition systems which should be experimented with. The new digital acquisition systems in the GSC is the new ORE systems. An idea would be to try and focus some of the new digital equipment as opposed to analog on the gravel problems. You mentioned line and cone but there is also the Datasonic chirp system. I am concerned from what I have seen of the chirp system about its ability to penetrate sand and gravel but maybe from the digital processing standpoint there some possibility. We are planning to get back into digital processing where you can start enhancing digital data and manipulate the weaker signal from below the hard return.

John Lewis: You still have to be concerned about the actual source/receiver combination to do that.

Steve Blasco: Yeah. That doesn't destroy the system. It is just to give you an option for playing around more with the data.

John Lewis: A lot of the older data that was collected out here was recorded on analog tape. That could be digitized.

Steve Blasco: In fact, Gulf went through quite a study. They took a series of boomer data and had it digitized by A-Cubed of Toronto. It was a $22,000 project. The digitizing of the analog data chewed up $19,000 and the processing and interpretation chewed up the other $3,000. The answer was that the analog data wasn't that good to start with and you can't make something better than what you started with. So there was no point in the high cost of digitizing for that project. But the whole process was there and they certainly demonstrated that if you had very good analog data at the start, you could do something with it.

Neil MacLeod: But I think the point here has to be that there isn't anything strikingly new on the market. There are no startlingly new processing or data storage techniques that will revolutionize anything we are doing. There has been general progress but there is no reason to go back to any particular site now with new equipment because now there is a way of seeing something that we couldn't see before.

Steve Blasco: Well, it is a little more than that. There is also equipment, like sleeve guns. We could get out of air guns and into sleeve guns. No I believe it is a little more than what you are saying. There are in fact enhancements in equipment and enhancements in signal processing that are appropriate and worth testing. You could select a suite of equipment and focus it specifically for gravel.

But Neil raised a valid question. Is equipment substantially improved enough that we can go back and re-do Issigak or Isserk and nail it down for all time? I don't think it has reached that level. Although, it has probably reached a level where we can add to what we know.

John Lewis: Another aspect of the seismic techniques is to try and do things like heave compensation so that you can really look at that fine scaled stratigraphy. Because that is in the shallow zone and particularly in Unit B when you are looking for reworked units trying to determine if there is any gravel in there. What you need is very good quality data that is heave compensated to the point that you can look at it like a drawn seismic section. If you have a system that will give you 6 cm or 10 cm resolution but it is going up and down 50 cm, you can't make much sense out of it.

It is my impression that we need to focus on ways to improve on the resolution and interpretability of Unit B. If you are going to get into the stratigraphic definitions of reworked thin sand bars and deposits and try and make sense out of them, you have to have the heave compensation. You have to have the highest possible quality seismic information that you can get. And we have a couple of examples which were collected over the years because they happen to be out there on a day when it was just flat calm. The amount of stratigraphy that can be interpreted out of those few records is phenomenal. But that is one out of ten lines and you can't interpret a whole region based on one out of ten lines. I think that technology is around and can probably be put together to work with more consistency than we have had in the past.

Neil MacLeod: Guy, have you any ideas? You have worked with different equipment and you are working with some new equipment now. Can any of that be applied to the Beaufort?

Guy Fortin: I think the problems are a bit different. We are looking for very soft sediment. But in the Beaufort we are looking for sand and gravel. So I cannot disagree with John about the need for higher resolution. The only problem is it is very difficult to resolve those thin layers of dense sand and gravel.

John Lewis: I think your ability to penetrate and interpret the depths of the sand will improve if you can get the heave compensation and you can get the finer detail on your stratigraphy. Now, a lot of time you can't interpret stratigraphy other than on a very broad sense. You might know you have your 'C' Unconformity, a major reflector. But when you have half a metre of heave on the data that is about all you can get out of it.

Steve Blasco: That brings another point to mind. One of the ways to improve the quality of seismic data is to cut your speed in half. We don't get as many lines. Instead of running at 6 knots, we run at 3 and we do get a better spatial resolution. Those are some of the things we need to do, just be satisfied with fewer lines and better quality and solve the problem, rather than going after huge volumes of data.

2.2.2 Storing Geophysical Data

Neil MacLeod: I have a question for the geophysical operators. Are there new techniques for electronically storing data that would make it more feasible to keep some of this stuff than the older methods where everything was kept on paper? Certainly we are just a generation away from disks and things like that for storing that stuff. But where is the industry going now?

Steve Blasco: You can actually take a seismic section and scan it and passively record it. You may have trouble interacting with it and it is not all that good because you don't get the original dynamic range. All the subtleties have disappeared from the scanning.

John Lewis: There are new recording techniques out there, new digital recording systems and that sort of thing. But a lot of those are still pretty rough. When you try and store the information that is in a seismic record or side scan record you have to store one hell of a lot of data. You can acquire up into the Gigabyte range of the data within a few days of surveying. So, the techniques are still a little difficult to deal with and I'm not entirely convinced that when you have to go back and run all the stuff through a system to get a display wether it ever really gets looked at in detail again. It is one thing to pull out a record and hold it up and you can say within a few seconds if there is something on it that you want to get. But if I have to go and fiddle around with computers and disks and wait for ten minutes for it to regenerate a profile, I probably will not even look at it.

Neil MacLeod: That means the paper records are very valuable because without them we don't have an easy method of re-examining the data.

A bad practice that some operators had was to run their budgets for their seismic work to the last nickel while at sea. They did not budget for putting together a report on the project with any interpreted sections, or whatever. I know Rick Quinn's firm did some for Gulf and those are very valuable reports when the data is lost.

If all the operators had just taken 5% of their ship budget and used it for an end of project report, we at least would have our basic interpretation and sections some place in a library. It would not likely be shredded if it was in a report format.

Rick Quinn: In the fall, I had a call from a fellow at Gulf who had been asked to go through a lot of Gulf's high resolution surveys to create some kind of an inventory and to get it organized. He wanted to know if we had a copy of an Operations Report for Gulf work done '81. Sure enough, we had a copy. The good news was that Gulf was putting all this together so there may be some chance of finding it.

Steve Blasco: I expect Chris Burquist has taken over all of that. We have a current project at Amauligak and we have been accessing seismic data, borehole data and all that through him. He seems to be quite aware of what is there and not there.

2.2.3 Shallow Water Surveys

Bill Scott: Well, there is likely to be some near shore work because Steve Solomon is planning a drilling program in a year's time to keep us honest in all the predictions on the survey.

Steve Blasco: But that is all in less than 5 m water depth. I don't think any of it was to be deeper than that.

John Lewis: That brings up a thought. For the Issigak area, you said it would be worth doing more work in-shore to try and see if there is a source for that gravel. Using the Arktos vehicle it might be possible to set up a program to survey in the real shallow water between the deposit and Pelly Island.

Bob Gowan: How shallow can it work?

John Lewis: You can run it right up on shore.

Neil MacLeod: What you could do there is to run off Garry Island or Pelly Island and some of the spits. It would help us understand the morphology of some of these other

deposits. Is what we are seeing at Issigak typical of a spit or similar secondary deposit like the Immerk Pit or is it more like a channel deposit? It sure would be an interesting exercise.

John Lewis: I'm pretty sure we could access the area using an Arktos type vehicle and work in water depths that we haven't been able to survey in the past.

Steve Blasco: Are these areas too shallow for dredging?

John Lewis: We are looking at it from a geology point of view to try to sort out the models for the Issigak area.

Kevin Hewitt: To answer that question, I think there was a limit for dredging before because of the specific equipment we had up there. There is no dredging equipment there right now. If we had a deposit, we could bring equipment out specifically for it.

John Lewis: Well the Arktos won't be there this year. Apparently it is to be repaired.

Steve Blasco: It went to the Coast Guard last week and they are putting up practically a quarter million dollars to refit and refurbish it. The engines and everything are supposed to be completed by late fall. It should be available next year. However, we have to request it to make sure it stays in the Beaufort.

Bill Scott: Some of this work could be done off the ice too. You know, there are lots of areas where the ice is good enough that you could do a winter program. A lot of the problems go away if you work off the ice. I don't know about acoustically but electrically you can get some very high grade data off the ice.

John Lewis: Well there are a lot of problems with acoustics through the ice. Plus the production rates on winter programs tend to be considerably slower than conventional marine work.

Bill Scott: You are trying to resolve a detailed situation of multi-layers in a relatively confined area. You don't need 100 km of line per day.

Bob Gowan: Is Steve Solomon's winter program set for next year? Is it off North Head?

Steve Blasco: I think they haven't decided yet but it is definitely in that region. He wants to ground truth the stuff he has.

Bill Scott: We could certainly find some winter electives to that. We might nip around the corner and look at this strand line that I was talking about too. Throughout most of that area, the ice is pretty good.

Bob Gowan: The logistics have been looked at to Isserk?

Neil MacLeod: All through there you can work on the ice. You can get out to Isserk some years. We had trouble in about 1 year in 5 getting out to the Isserk area. But anything inside Isserk is quite accessible over the ice. We got to Issigak over the ice 2 years out of 3. That was getting to the limit, though. You should not count on it.

Bill Scott: Well certainly all of Kugmallit Bay will have solid ice. ESSO have worked in winter all through there.

John Lewis: It might be worth taking the new hydrographic data and re-evaluating it and looking for new targets as well as going out and doing some ground truthing on targets that are already known.

2.3 Resistivity

Neil MacLeod: It seems to me that seismic methods are unable to give us information about the thickness of granular deposits or about the nature of inter-bedded granular deposits. Bill, I understand that resistivity may be able to complement seismic work in these areas.

Bill Scott: I think there is some hope for using resistivity for mapping the thickness of granular deposits particularly in areas where we have a bit of control. You need to tie it at some places so you have the confidence of interpretation through the areas where you can't confirm it. But there certainly is a reasonable possibility that you can do quite detailed mapping of near surface layers.

With resistivity you can resolve layers of thicknesses comparable to their depth of burial. As you get deeper, the interpretation has to be broader brush. But certainly if you are talking about, say the top 10 m, you can get quite nice resolution and very detailed. If you are looking at the top of permafrost at 150 m, you will be plus or minus 10 or 15 m and you are not going to find thin layers at any depth.

Neil MacLeod: Bill, would the marine resistivity techniques see through the upper sand layer at Isserk better?

Bill Scott: Yeah. You would have a chance of separating the two layers, particularly if there was a clay layer in between.

John Lewis: There is a clay there between the two sand bodies at Isserk.

Neil MacLeod: Could you pick up a gravel layer between two sand layers? There would have to be some minimum thickness, I know, but what are the capabilities?

Bill Scott: You could resolve fairly thin layers provided they are electrically different enough. It is easier to answer the question if I have samples and can actually measure the resistivities and see what the differences were. But, generally you can tell sand from gravel. If there were some stuff in between with a bigger contrast, like clay, you would certainly be able to separate that into layers. For that sort of thing, I would really go to a bottom towed system which I am looking at trying to develop now anyway for work in Lake Ontario.

John Peters: Do you need to make your resistivity measurements in situ or can you use the existing samples to get a realistic model.

Bill Scott: If there were existing samples and I could reconstitute them with the right salinity of water it would give me a very good idea. Then I could do some predictive modelling before the field work and set up a system to enhance the thicknesses we are looking for. Your vertical resolution depends on the separation between electrodes. So if you know you are only going to try and resolve the top 6 m then you build an array that does just that. But if at the same time you want to look at permafrost, then wherever it is, your array has to be very different.

Neil MacLeod: We should be putting some thought into getting that kind of calibration information whenever we are doing geotechnical work in the Beaufort. If resistivity is to be a widely used tool, we all should think about getting samples for calibration.

Bill, you have some good ideas for the next stages in the development of resistivity methods. Will you review them for us?

Bill Scott: What I'm really interested in now is getting continuous information that starts in 3 m water depth and ends up on dry land. This year we got one profile with the electric using Arktos. It started in the water and ended on-shore. We learned there are a lot of easier ways to do it than the way we did it the first time. But I would like to look now

at streamlining that and adding seismic to it. I have some preliminary ideas to get a continuous seismic profile through that shallow water zone and up on the land as well. I am going after some money for that independently.

Neil MacLeod: Well, it is an interesting problem that you are trying to solve. It is also very important because anything that is developed in the Beaufort Sea will either go out by ship or go out by pipeline. All those pipelines have to cross that shoreline. I think that transition zone is where we will find the key design issue of a marine pipeline. Ice scour is something we can handle. But the changes in the permafrost front, at the shoreline transition, may be very difficult for pipeline design.

Bill Scott: Part of assessing coastal stability in trying to find a place where you can bring a line ashore where it would last for thirty years without having major problems. I think that is why this is such an interesting area technically. I'm really keen to work on this.

Steve Blasco: The last two years were the first years we actually have any seismic data other than Jim Hunter's for our refraction information. We actually can run a profile from the off-shore to the on-shore and see the permafrost. Off the Tuktoyaktuk Peninsula we can see the permafrost at 49 m coming up right to the shoreline.

Bill Scott: I picked up a lot of information on the deeper permafrost with the electric there and I'm pretty confident about the depths with that. That is the easiest thing to find because it is such an enormous contrast.

John Lewis: I don't really see much point in trying to push the seismics on-shore if you are going to hit permafrost which is down a metre or so. You won't get anything you don't already know. With Arktos, we can get to within about a half a metre of water when the whole frame system starts lifting out of the water and then you have to shut it off. I think that is pretty good. Particularly off the Tuktoyaktuk Peninsula, we could walk in because the water depth was about 2 m until you were right into the beach and then it just kind of popped up. At Richards Island, the shore isn't much different. So you might be a couple hundred yards from the beach when you actually stop profiling.

Bill Scott: There were some areas where we went over spits that were just sort of breaking the water. It would have been very interesting to keep the seismic going through those. Another reason to do this from my point of view is that interface is also of real interest in mineral prospecting. Generally speaking, when you do electrical methods in lakes, you do it in the winter time. You can't do it on-shore in winter or you do it in the summertime

on-shore. And you can't get at the water until you get far enough out that you can float something, so the transition zone is an area really to focus on in terms of equipment development.

John Lewis: Well, for most coastal areas of the world, that is a surf zone. You can't get through it anyway, because your equipment is getting beat up on the bottom.

Bill Scott: That is not true in the Beaufort and it is not true in a lot of inland water. There are a lot of inland waters problems that are comparable. This kind of approach has never been offered before and yet would be very useful. Any time you do sewage outfall design for example, that area is the actual focus of the design.

Another thing we have already started to look at is getting a system on the bottom for deeper water. Right now the practical limit is about 20 m of water depth. Until we get a bottom-towed system, we can't go farther out than 20 m of water depth and still count on much resolution of shallow bottom layers. I have already undertaken to have a bottom-towed system for next summer, so it better not be a difficult problem. But I think it will be a while before that set up is routinely deployable with confidence.

Neil MacLeod: Are there any problems with speed of traverse with resistivity? How does it compare with acoustics?

Bill Scott: We ran it at 3 to 4 knots this time around without real problems with resistivity. At the moment it is not technically feasible to do the polarization measurements at that speed. But you can run resistivity at any speed that you can comfortably run good acoustics.

John Lewis: In shallow water and those kind of environments, you are limited to about 3 knots, in general.

2.4 Geology

Neil MacLeod: Steve, let's go into the geological stuff. Is there anything else we should be doing?

Steve Blasco: Most of our work has really just been a wider application of things we have been using all along. We are starting to put together what we call sandwiches of pollen that we find in Holocene sediments like Wisconsin sediments. There are now certain assemblages or characteristics that we can identify when we see them. For example, there

is a wet tundra assemblage. Now that we know that it is wet, we have a much better idea of its age. We now have a link between depositional environments and age that is becoming understood much better.

It is a case of using the tools we have been using all along. We are still using standard things like forams and pollen and other dating techniques. We tried a whole series of them. We tried thermal luminescence, we tried uranium dating, we have tried amino acid dating, none of them turned out to be very exact. We even tried lead 210 dating for recent stuff but there isn't enough lead 210 for the measuring equipment to detect in a lot of cases. We have tried a lot of stuff without a great deal of results. Biostratigraphy and radium carbon dating are still the focal point of geologic information.

Neil MacLeod: Yesterday you presented 14 variations of geologic models. Some are more right than others for each area. What is happening to refine these?

Steve Blasco: A fair bit of work has been done on the geological models of the surficial sediments in the Beaufort but there is a need for additional geological work to constrain the models to constrain the inventory. The gross stratigraphic framework for the shelf is in place, but the models suffer from this big problem about the correlation between on-shore, off-shore and shallow water. More work in shallow water should provide the answer now that we have the technology for work in shallow water.

John Lewis has shown us that Arktos can do the geophysics and we can also put cones on it and do some geotechnical work too. I would be inclined to do the geophysics first and then go back and ground truth it.

Obviously whenever you come up with datable material we still want to date it. This chronology gap between land and seabed is a serious concern and it is not just a concern in the Beaufort Sea. There are other areas, like the East Coast, where it has become a huge problem.

The answer to this key question appears to be in the area north of Richards Island. The question carries with it major implications to sand and gravel inventory. If we do have Toker Point sediments indicating a relatively recent glacial advance out there, they could be a source of material like the hidden source of Issigak gravel. It would show that our geologic models are wrong.

Neil MacLeod: That whole range of issues has to be sorted out, because I think there are a lot of us headed in the wrong direction because of the geological models.

Guy, you have looked at the geology too. You have your ideas which don't always agree with Steve's. Where do you think we should look for the key to resolve this and what work do you think is necessary?

Guy Fortin: I agree with Steve that we have to find out what is happening between Isserk and the shore because that is where the two models are contradictory. Some of my interpretations, in the last couple of years before I left the Beaufort, were based on the feeling that there is a glacial limit out there. We have little evidence for it but I think we should search for that evidence.

My interpretation comes from one set of data which combined refraction and reflection data. The only way to explain the channels and the geology is by having an ice sheet there as a source of melting water. I think there is gravel to be found very close to that limit and probably not much off-shore of that limit. I think we should look closer to shore particularly southeast of Isserk. I think there are a couple of highs in that area which could be a source of good gravel.

John Lewis: That is right along the pipeline route.

Guy Fortin: Yeah. I think if you draw a line from the limit of Toker Point till on-shore out to the highs near Isserk, you define the glacial limit there. That limit looks good at Issigak too. Maybe all those are related. I think that because only an ice tongue could bring boulders of the size we get at Issigak, that far off-shore. There must have been some highs sitting there as recently as 30,000 years ago.

Steve Blasco: That is where the problem is. You end up with all those deformed layers which seem to sit on stuff that is younger. If you imply that it is caused by glaciation, you are putting ice in the area at 6,000 years ago. If that is true, then everything on-shore is in error and it will be hard to convince Terrain Sciences of that.

The problem becomes even more complex when you try to invoke the model. So there is either something major wrong with the chronology or with the stratigraphy. Perhaps we have inliers and outliers and we are not recognizing the fact that the stratigraphy is not continuous. Again, we are talking about two end members of the model.

2.5 Grab Sampler

Bill Scott: What is the state of grab samplers? We have been working on a hydraulically operated grab for getting coarse-grained samples. We are using it in placer deposits. It picks up cobble sized samples and still gets 30 cm into the bottom. The design is such that

it pulls itself down while it is closing so instead of bumping across the hard top it actually sucks in and pulls up. It works like a couple of backhoes and they operate against each other as they pull down and in. It strikes me that if you have any kind of gravel, your standard light weight samplers don't really give you a return. Would there be some interest in a system like that?

Steve Blasco: Certainly, would be worth trying in terms of sampling technology. I have always had trouble even with vibrocoring. What is the size of it?

Bill Scott: Well, the one we have is 20 litres but we are building a 50 litre version as well. One of the problems with most sampling tools for coarse grained materials is that the fines wash out on the way up. That way you don't really have an idea of what the soil is. It is one of the reasons for building this thing so that there is no wash-out in the design. All it needs is a winch and a hydraulic pump. We are using the power pack off a log splitter. It closes in less than 15 seconds.

Rick Quinn: I would like to have a look at the hydraulic sampler out in the Fraser Delta before taking it up north.

Steve Blasco: Well actually I was going to try it off the end of the dock in Halifax sometime towards the end of March.

Bill Scott: Gordie is going to get a launch and we will do the testing in places he has found difficult. It is not so much an unproven quantity; we are using it regularly. I'm prepared to offer it to take off head-sized boulders and the stuff in between.

Steve Blasco: Also I would be interested in how disturbed the sample is.

Bill Scott: When the next scour experiment is done in the tank, we will put down a very thin layer of black every centimetre and then we will dig holes in the corners. To see how much distortion there is, we will core through what comes up in the sampler.

2.6 Bathymetric Techniques

Neil MacLeod: George, CHS has its own budget and works in its own way. I expect you have probably heard today where your work ties in with the needs of this group. Is there anything in particular that needs some sort of commitment or support from this group to help you?

George Eaton: Well, I think there is a trend in the Hydrographic Service at the moment to turn more inwards than out. I think the days of data acquisition are over, although some work is still possible. I think you will find that we will be mucking more and more with the data we have already. If we get that into order it will become more accessible to you people. I don't think there will be any big acquisition programs for awhile.

Neil MacLeod: George, could you review recent developments in the bathymetric trade?

George Eaton: Well there are a number of techniques that might be of use. Perhaps the one showing the greatest promise is the Through Ice Bathymetric System (TIBS). It is being used in its first production survey this year in Pelly Bay. Depending on the results of that, it will be used again next year off the Garry - Hooper Island area I think. That is all subject to change of course and on funding. GPS will have an affect on all of this too. It means that we can get better position than we have ever had before anywhere in the Beaufort at any time.

I think you people should all make your acoustic requirements better known to us before we go out to do an area. We can help you out more than we have in the past with things like swath sonars. We can also survey in more detailed fashion for you than we ever have before simply because of GPS and some better acoustic techniques. You should consider that some of this data is available in a digital form which has not necessarily been so in the past.

Bill Scott: Would you be amenable to offers to put other equipment on at the same time?

George Eaton: Yeah. There is an accord that was signed years ago between Fisheries and Oceans and EMR that allows some co-operation that goes back and forth.

The Tully will not be in the Beaufort Sea this coming year but that is not to say it won't be there in future years. Depends on how loud you request it and the validity of it. I wouldn't be afraid to make your requests well known and well in advance, strongly.

Steve Blasco: Actually we were asked to put in a 3 to 4 year long term plan for ships on the west coast. We did that and never heard anything back.

George Eaton: Well I think it is important to follow it up. Who knows what did happen to it? Talk to Don Garrett.

Steve Blasco: What about things like Rick mentioned yesterday. Systems that penetrate where you have suspended sediments. Are there advances being made there and systems that will ultimately be able to see through the fog?

Rick Quinn: I wouldn't hold much hope there. You could get a bigger more powerful laser but there is only marginal return on the more powerful laser. It's like using an axe to cut flowers. It's the wrong way to go for murky waters. You might as well go to swath sonars and potentially TIBS.

That is interesting because sonar may give you the water bottom. I know the resolution of that is directly dependent on the water depth but you know there is more information in that electromagnetic signal that could very well help you to pull out more sub-water information. It is of no interest to the hydrographers what is happening below the water/mud line; however, it is for gravel exploration purposes. That is an area worth more consideration. The initial use of the electromagnetic system was on land to find mineral deposits. It was suppose to look through the sub-surface to find conductivity or resistivity changes. Using electromagnetics from the air over water, who knows, it something that is a question.

Steve Blasco: But you are also running a multi-spectral scanner with your LARSEN-LIDAR stuff.

Rick Quinn: Well we had good success with that in Lake Huron last year. It gave a good complement to the laser but it is dependent on the blue/green component of the light. You need some clear water to use it effectively. You need the blue/green backscatter to tie on to. Where it does shine is in an environmental approach where you are looking at pollution plumes. It will give you values of sediment content in the water column through the near-surface water.

Bill Scott: Sure but what comes out of it is the water plus a bottom layer. That is one of the things they have. They don't offer it necessarily but they do have the bottom resistivity. It is just a bulk number but certainly if you were flying over a granular area that would be a larger number than if you were in a clay area. That is part of your digital file isn't it George? Or don't you even record it?

George Eaton: No. It will probably not even be recorded.

Bill Scott: Why not consider recording it because right there, you could contour bottom resistivities and that would be a significant advantage in an area that wasn't well known.

I speak as a geophysicist. There are so many imponderables that I would be astounded if we have acoustic precision. On the other hand because different bottoms alter the depth you get, unless you can model that, you cannot be accurate with the bathymetry. I would be interested to see it from that point of view because it would indeed be a way of getting a first estimate of the bottom resistivity.

2.7 Positioning

Neil MacLeod: Dave Thompson, hydrographic and positioning are your part of the business. Do you have some suggestions for more work on any of these issues?

Dave Thompson: Well GPS is the big thing that our industry does. It is affected by things like bathymetry equipment, swath systems and Lidar. Those things are progressing quite rapidly and before we see any sizeable amount of work in the Beaufort Sea, I think those systems will develop substantially to support what you guys do. That should make it a lot easier than has been in the past.

One big problem I see is focusing on all of the data you now have. That to me is the big challenge. Like you say, some of it already has been shredded and lost.

Steve Blasco: A couple of logistics questions, for Dave. If we were considering running an off-shore program in the central Beaufort, can you get by with using differential GPS? Do you need just one reference station on-shore?

Dave Thompson: I would think so. You need a reference station, at the airport or handy to the airport where it is easily supported. You could probably even do one in Inuvik.

John Lewis: Radio communications through Beaufort tends to get little goofy at times.

Dave Thompson: It's hard, yeah. It is not a good area for propagation of HF stuff, but you can still do it. An HF system seems to be the best for that sort of thing.

John Lewis: Well, with the HF system on the Nahidik you can't even talk to Polar Shelf in Tuktoyaktuk from the Yukon Shelf area which is not that far away.

Steve Blasco: You would probably have to use one of the DEW line sites then as a reference point. Say Komakuk or Stokes Point or somewhere like that wouldn't you?

Dave Thompson: Something with an airstrip. Something that is easy to support with a fixed wing aircraft.

George Eaton: What sort of accuracy do you need in real time? I think the best you could get would be 10 m.

John Lewis: Yes, I think 10 m is OK.

George Eaton: Do you want to post-process the stuff or do you want know in real time?

John Lewis: I think you want to know in real time because you want to be able to run adjacent lines with, say, 50 m line spacing.

Rita Olthof: The more receivers you have, the more accurate you can get your position. Is that how it works? Or is that a different system? I know Parks Canada uses a system like that to determine positions. They need at least two receivers, but if they have more they can narrow it down.

Dave Thompson: The statistics might bring it down but not significantly.

Steve Blasco: GPS is important to us because it allows us for the first time to actually operate independently of industry. Over the years, all our work has been tied into the navigation network of the operators or Hydrographic. If there was no network, we didn't have a program. Now we can operate where we want to with a differential GPS system.

John Lewis: A differential GPS system has to be linked via radio or satellite or something out to your vessel. The communications problem in the Beaufort with the HF transmissions through there is it fairly crucial. I believe you have to have a continuous link.

Dave Thompson: If you are going to deal within 5 m, it has to be continuous.

John Lewis: The radio link can be through another communication satellite or through an HF or an SSB or whatever. It has to be kind of a modem link where this data is being transferred back up to the ship all the time. My concern is that HF is not very reliable in the Beaufort.

George Eaton: HF is a problem in the Beaufort, always has been. If a number of people were working up there, another thing would be to campaign with the Coast Guard to get one of their 2 - 400 kilohertz low frequency radios, like on every other coast in the world. Get them to modulate one of those with GPS.

Dave Thompson: Theoretically, you can punch data through where you can't get voice. But there isn't a system operating right now.

Steve Blasco: But there has been in the past? You know of any, George?

George Eaton: Well we have done it with the Lidar airplane.

Rick Quinn: Yeah, we had it in Dolphin and Union Strait.

Dave Thompson: If you are travelling all over the Beaufort you don't necessarily need real time positioning all the time either. If you look at it like that it is a luxury. If you are just going to shoot some regional lines or something, well post-process it later.

Steve Blasco: Still most of our problem comes in when we go over and take on a regional line which we want to go through 2 boreholes. That is a constraint and we don't like to be off more than a few metres.

John Lewis: Often we want to go over glory holes which we have those mapped with side scan and you go over them and confirm that everything is working.

2.8 Data Management

2.8.1 Data Base Systems

Neil MacLeod: John, in your presentation yesterday, you gave us some ideas of what could be done with your firm's software. Where else should we be looking, or how else should we be applying these concepts? What does GIS mean to Beaufort Sea workers?

John Peters: Well, we have always had the best success in building these sorts of applications when the client has been able to define very clearly what they want to see, how they would like to use the system and what problems they would like to solve with it. Before answering your question, it would be nice to briefly discuss how people perceive getting the best advantage out of a data entering system that has an inventory such as this is.

Steve Blasco: One of the things that seems to be coming out is that there are two elements of our system: one is the borehole and geophysical data base itself and the other is the

tools for manipulation of the data base and even working with it in a mapping sense. Is it true that you are now putting a union together between the ESEBase data base and the InFocus mapping set up?

John Peters: What you will have shortly is a geotechnical logging capability, a mapping capability and a general data base management capability all rolled into one. You know, it really doesn't matter whether it is ESEBase or that it is InFocus.

Steve Blasco: Call it ESEFocus. Will I be able to call upon ESEFocus to produce a section that goes from the northwest to the southeast across Issigak that will include both the seismic section and 27 boreholes in that zone? I'm sure the borehole information will come out but will I get a seismic section superimposed or a line drawing? I know it is not the interpretive section superimposed. How close are we to something like that?

John Peters: At this stage, we haven't a section capability from the seismic point of view. There is a section capability from a borehole point of view.

John Lewis: There has to be a mandate saying you want to get to that level. At the moment, you are putting interpretive maps and data sets into the system but I don't think anyone has thoughts of trying to put in all the seismic data in profile sections.

Neil MacLeod: It is a large problem to handle. All you could practically do is go along each seismic section and pick every tenth shot point and put in typical section or something, based on somebody's interpretation. Even that would be a huge task.

Steve Blasco: Well that is definitely where we want to go. I know what happened when we tried to do it. We experimented two years ago with some data from the pipeline area. We spent a lot of time. One line was 700 kilobytes of data and it was not that big a line.

Bill Scott: It would be much trickier, however, to produce a section on an arbitrary profile line because that will mean interpolation from lines that were not necessarily parallel to the direction you are asking for.

Steve Blasco: But he is asking me what ultimately we may want. That is where I'm heading.

John Peters: Alright now, I have another question that relates to the seismic track line information. We have put in all of the regional information, plus quite a lot of site survey

track data. Is there any reason why we should continue to build it up at the level of the site surveys? I mean, we have already a study catalogue which essentially provides you an outline with the position of the site survey but no track information.

Bob Gowan: You get the number of lines and the spacings of it.

John Peters: Yeah. Exactly. It tells you the statistics on the site but it doesn't actually show the layout. Is there any reason why you would want to continue to build the actual layout of the tracks? Given that it is not a navigation data base.

Neil MacLeod: Probably for 95% of the sites there is no justification for it. But if you are talking about Amauligak, there probably is a need because that is likely where some development will occur.

John Lewis: It also comes back to the question of how much of that data can be found. There is certainly no point in putting in any lines if the data has already been shredded.

Neil MacLeod: I disagree. I think you should show where it is or where it was because some day somebody may come along with a copy of the records. You should code it in such a way that when you call up you can tell that it is a missing line.

Steve Blasco: We have come full cycle now. We are back to the very first thing you started with: the priority is to QC the data bases that exist. Those missing track lines need to be identified and the rest should be all earmarked to tell where the data is.

2.8.2 G.I.S. Applications

John Peters: Where I was leading to with that question was what other sort of data do you want in the system. When you are planning activities in the Beaufort, are you satisfied having seismic coverage and borehole coverage and a few geological maps or do you also want logistical information? Do you want interpretative maps of ice conditions on a seasonal or yearly basis? Do you want transportation stuff, port facilities and these sorts of things? I mean all these additional layers of information are just an extension of what we have now.

Steve Blasco: Now that is where it gets sticky, because the ice people already have that. It is all on MacGraphics with Dickens and Associates. Now our question is how do we import all of that which exists on a digital atlas for ice in a MacIntosh environment into your ESEFocus environment so you can do the things we want.

John Peters: That is not your problem. What you have to say to the programmer is this is what I want. If I'm operating up there, I will need more than the resource information. I also need all of this other environmental or logistical stuff. Go out and get it for me. Then the programmer has the problem of overcoming the technical aspect.

Steve Blasco: What you are saying, John, is you are not technologically limited any more. You are resource limited. It is just a matter of having sufficient money to do the tasks. The software and hardware technology are there to make it work.

John Peters: Yeah. I'm against the notion of populating the data base management system with a whole bunch of data without having some focus on how it will be used at the end of the day.

Bob Gowan: But certainly from a planning point of view, if you are working in the Beaufort, you have to have some kind of a line on where the ice is.

Kevin Hewitt: We have a system that could be used for ice management or whatever.

John Peters: If you were going up there next year to start doing stuff, would you use this very tidy granular data base?

Kevin Hewitt: Well, let's face it, whatever is done in the next year or two should not be driven by operators' needs because we don't have any. We don't have to find gravel right now. But if you want a typical problem, it would be to find out what exists along a pipeline profile and have a cross section for that. I see that as being the most logical use of your program.

Program development for this type of application should not necessarily be funded with granular resource money. The same applies to correlating ice scour with soil strengths, etc. It should not to be funded with NOGAP's granular resource money.

Neil MacLeod: Kevin, how would industry use a granular resource data base?

Kevin Hewitt: The most likely scenario for any work is around the Gulf discovery, Amauligak. We have a unit that can sit in 23 m of water, beyond that we need to build a sub-base for it. Therefore, we are likely to require some site preparation and the use of some granular materials. The last time we did that was in 1983. So we would have to re-evaluate where to get those materials from to make sure that we get the base quality that we need. We will be potentially using this data base.

John Peters: O.K. That is good. That is what we wanted to hear.

Kevin Hewitt: We have our own group that has data on ice and the likelihood of open water in any location in any one year. I don't know what system they use but we don't need another one like it that is built into a granular resources GIS.

John Peters: From an overall planning point of view it is quite nice to consolidate all the different sources of data which will be used to make planning decisions. If you have a system which has the potential for bringing that in or summarizing information in comparison with other aspects, your planning may be very easy. That is the point I'm getting at. I'm sort of opening up the possibility here. Is there any sense in trying to identify data sets in addition to the ones we already have that would make sense for planning purposes?

I look at things like lease information both the exploration leases and dredge site leases, having those in a graphical form overlaid on your other information would be quite useful I would think. And to be able to actually access this status of your dredging leases whether they have expired and that sort of stuff.

Kevin Hewitt: They are all nice things to have but they are not cost effective things to do right now. When you get down to it, there is a lot of critical data that we don't have available to us to make those decisions. For example, where we place our unit is very dependent on the micro-bathymetry at that site. We don't have that information.

Neil MacLeod: There is a factor of scale here too. Think of all the data that exists for the Beaufort Sea. It is a huge area. When someone actually gets down to looking at developing that island structure, the site is very small and you need a lot of very specific information. All that background information is just background information. When you get to detailed engineering, you have to have site-specific information. But it is like a geological map, you just can't plan it for every end user. When you put the geological map together you don't know who will use it or for what purpose.

Bill Scott: The message is you guess what they want, but you would better be right.

Neil MacLeod: The answer is to incorporate the different layers of data as they are available and as people identify a need. You may look at it now and think there is no justification for including the ice data, but ten years from now perhaps ship transportation becomes the mode of removing oil from the Beaufort. Then someone will say we better put that in and they may be willing to pay for it.

John Lewis: But you put it in ten years from now. You don't put it in now.

Rita Olthof: And hopefully they haven't shredded it by then.

2.8.3 Bathymetric Data

John Peters: One of the items missing from the resource data base is bathymetry, at least on the small scale. Is this something we should look at putting together?

Steve Blasco: It is something that we are definitely using. We have a detailed bathymetry map on a one metre interval for the Beaufort on ArcInfo files. All our ice scour information is categorized on a per kilometre per one metre incremental water depth. We didn't develop it but we use it.

John Lewis: Was it developed from the most recent data available?

Steve Blasco: No. It used a Resource Series Map because we have agreed the Natural Resource Series is the basic map we will use for all work. That way everything has a standard base. We have actually digitized that map series.

John Lewis: For the Erksak area, we digitized the 1986 bathymetric data set. That produced a significantly different physiographic interpretation of the seabed. The newer data set has a higher line density and provides a lot more detail.

Steve Blasco: That is true. It is a real conundrum as to when do you transfer to a new datums. So that we could all talk the same language, the three operators and ourselves agreed to all use the Natural Resource Series base until Hydrographic came up with a new one.

John Lewis: CHS, typically doesn't go in and do a one metre contour map of the site area except for navigation. Will they change that?

George Eaton: No. Not unless there is a specific question or request. Then we might do it.

Steve Blasco: Again, it is a question of what basis to use. Bathymetry is a key issue. But then what do you use as the base. Right now we are using the Natural Resource Series because it is one that everyone can access. In fact, there are lots of problems with it.

Bob Gowan: But you have interpreted that, though.

Steve Blasco: Canadian Seabed Research took the 2 m Resource Series Map and interpreted it to 1 m and sent it on to us. I don't think it is really that big a task to actually digitize it.

George Eaton: I think you would look at four or five thousand bucks a chart to do that.

John Peters: I take it that bathymetry is a priority?

Steve Blasco: I would say so because it is really the basis for everything we do.

2.8.4 Computer Generated Cross-Sections

Neil MacLeod: What I think John Peters was asking initially was, what kind of applications do you see for the system. It is a generic question. "How do you think you will use the data or the program?" By "you", I mean Steve, Bob, Kevin, anyone else. Where do you see that you will use the data? What are your problems today that should drive the way the system is put together.

Steve Blasco: Well, ten years ago I pretty well knew in my mind who had what seismic data and the hundred boreholes that were in the system. If somebody asked me about the geology between the middle of the Kringalik Plateau on the 50 m contour over to Kaglulik, I could put that together. I would get the seismic line. I could get the two boreholes and I could compile them. It was quite straight-forward. Now, I can't do that, because there are 2800 boreholes and, god knows, 20000 km of seismic data.

In the long term, I really would like to be able to go to the data base and answer that question. What I want is a section. Hypothetically, I have all the seismic lines in there, so it should be able to give me a seismic section. Now please superimpose on that any borehole that comes within 50 m on either side of that line, plus any in situ tests. Unless we have the data base, it will be impossible to do because:

a) at least the data will be in there and it won't be lost, and

b) there is no way I can remember that there are 42 boreholes which straddled that line.

The next question is whether there is one metre of clay or half a metre? The questions are much more sophisticated now. In the future, the sections we have to produce will be much more detailed.

We have been experimenting on that a bit. Actually we used the Gulf pipeline because it was a big application of SuperTech. We superimposed everything we knew on that line. It demonstrated to me that technology isn't the limitation. It is just a matter of how to compress our data to make it work. It is driven by two things: the need for more detailed information and an inability of our minds to retain or cope with the amount of information that is available. Plus the new one we have added here: stuff disappears with time. But if it is on somebody's disk and Rita is still around, we will have it all. That is what drives us.

John Peters: Would there be support for building a section creating capability?

Steve Blasco: There would be support for that. I would say if we were on a five year program to produce from Amauligak or Isserk the resources would be there to create that. Right now, I think it will be much slower, because the resources are not available. So how do we work at it bit by bit? When we get to the stage where production is approved we don't want to be scrambling like we were ten years ago.

John Peters: Well right now, the query would be to give us all the data in a corridor. We can do that for you, immediately. At that point you take over and you start adding in more data.

John Lewis: You can develop the technique for pulling that section out with the data set you have now. Once you have that, it becomes a question of the effort to put together this humongous data base that is out there at the level of detail that you need to extract any chosen section line.

John Peters: When you said humongous data base, you are talking about the seismic data?

Steve Blasco: Yes and there are smaller data bases like radiocarbon dates which we talked about this morning. There are about 23 or 24 of them at Tarsiut and maybe there are a total of 60 in the Beaufort Sea or even other kinds of data, such as thermal luminescence dates. If you asked me to lay my hands on them, I couldn't do that. I know that we have a variety of reports and I know where I would go to start looking. I think it would take a month of somebody's time to find it all. It would be interesting to have that in the Beaufort data base. There are some things we can do that are manageable and not costly on the computer side. But it sure is costly in terms of someone's time to find the data.

Bob Gowan: Steve, you said earlier that you were not putting any requirements on a GIS system for maps that you are creating yourself. Are you requiring now that they be produced with a digital copy?

Steve Blasco: No. We haven't put any money into developing GIS. The reason for that is, if I tried to take GSC money out of my shop right now to develop GIS there would be disagreement about which system to use.

Bob Gowan: But do you require your contractors to provide a digital copy of data that they are using to produce a map as well as a report or paper copies of the map?

Steve Blasco: I cannot ask a contractor to give me a digital map if it is something he has totally paid for. But, for example, I paid for the scour data base so, I will get a print-out of it and I will get a floppy disk of it too.

Bob Gowan: So eventually will things like maps of seabed sediments or something like that will become available throughout the whole Beaufort.

Steve Blasco: We have a series of eight maps that are all done by hand and the first one is the geotechnical zonation or the physiographic regions. They exist as a series of 1:250,000 maps which were prepared in 1986. They are available for anybody who wants to digitize them for me. I have a project coming up and the digitizing might fit in when we do it. I have been reluctant to digitize some of them because we are actually trying to get them updated.

John Lewis: They can be scanned and converted?

Rick Quinn: Yes but the maps are interpretations of some original data. You still have to input the data, I would think. Your map might change down the road with some new data.

Steve Blasco: You are right. But, in fact, consider the enormous volume of data we have; more so with seismic lines. When we started working with SuperTech, they digitized everything. The next thing you know, we have filled up every disk in the neighbourhood and we haven't even started manipulating it. So we only put in interpreted information. Ultimately, you have to have the data base in there that you use to create the map, but I haven't the resources to do that now.

Bob Gowan: It is the same approach that you use for the SPANS system to classify point data or something like that to overlay on other information to make interpretative maps. They need that system to do that type of function. There is no reason that you can't use the map as one layer in the system. That is a snapshot of one time. It may be updated, but if it is the best we have right now, then that is what I want to use.

Neil MacLeod: Maybe the answer is to have the facilities within the data base management system to incorporate the seismic data in an interpreted form. You need to identify that there are seismic lines crossing or near to the section you want to interpret and you need to be able to bring in the portions of those lines that are in the window that you have identified for your section. The next step is to provide an interpretation of the seismic line where it crosses the section or at one or more points along a line that is adjacent to your section. Then there may be some extrapolation to correct for the fact that the seismic line is not directly on the section that you are trying to interpret.

Interpreting geology from a seismic section is a very judgemental process. Even skilled interpreters need to incorporate much more than a short section of records to make an interpretation. I think the problem of interpreting geology from seismic is bigger than the problem of importing an interpreted section or shot point into the data base from which your section can be drawn. These problems need to be looked at separately. First, we need an ability to draw sections from the data base. Second, we need to create an ability or doorway to bring interpreted shot points from another source into the data base. Third, the software must be developed to interpret short sections of seismic data.

At this time, you couldn't put all the seismic data in a data base. But with another generation of data storage modules or cubes or whatever it may be, perhaps it will become feasible. The same applies to some of George Eaton's stuff. Right now, you couldn't justify putting in every data point CHS has in the Beaufort Sea. But you should put in the interfaces that would allow you to take a disk of digitized bathymetric data for a particular area and use at the time that you are working in that area.

John Peters: Yes and that is quite a simple process, because you have the track line which has an ID and then you have your data which has the same ID so it is just a relational linkage. So you can have a seismic data display or profile display system which can be initiated through plugging onto the actual tracking, today. The package with ESEBase works with exactly the same principle.

Steve Blasco: My strategy for the next couple of years would be to put together a Beaufort Shelf Atlas. There are key seismic lines that are probably the best we will have for some time. In the central geology report, which we are putting together now, there are half a dozen key cross-sections. I would take and digitize only those. Over the next couple of years I would do that for each area. Slowly over time more sections would be added just like we have with the pipeline. That is my strategy.

John Lewis: You have that for the Central Beaufort. You have seven or eight of them.

Steve Blasco: That's right and that is the way I intend to work it for now. I think there are big strides coming up in technology in terms of data compression that will allow us to work with the data in ways we can't now. We are seeing some of it happening now.

2.8.5 Material Gradation

Bob Gowan: An issue that Brian Rogers brought up yesterday, is that most of our studies have only really considered stratigraphy rather than details such as better or poorer qualities of materials or gradation.

John Lewis: We can do that to some extent in the areas where there is significant borehole control, but in other areas all we have to work with is this seismo-stratigraphy so we can't do anything about that. We tried to do it for Isserk in the central proven zone. You know that is where I had the twelve zones with different dredgability codes. But for Erksak, it was a bit of a guess. There was just one hole for control and then the next hole might be 5 km away.

Neil MacLeod: I interpreted Brian Rogers to ask if we can regionally identify the average D50. Can we interpret the limit for exploration on the basis of regional trends in gradation?

John Lewis: That is something we should be able to work out with the data base and with GIS. Go in and dig that out and plot it out, anything with the D50 greater than whatever.

Neil MacLeod: I doubt we have enough data to do that with any confidence.

Steve Blasco: We have a huge report on that and that is where we got the trends. But you are right. There just isn't enough data to push it very far.

John Lewis: Rita was talking about having 2800 samples or boreholes.

Steve Blasco: If you want to see what is happening in Unit C, then you need 50 boreholes that go from the Tuktoyaktuk Peninsula across Tingmiark Plain down to 50 m. We don't have them. We already know there is a trend; it gets finer off-shore. But if you want to know the D50 at exactly 35 m of water, we couldn't say. It is a good concept, we will just have to keep adding more boreholes.

2.9 Environmental Impact

John Peters: What is the climate for environmental impact regulations?

Steve Blasco: At one time, Fisheries and Oceans and Environment Canada became very concerned about dredging on the sea floor. We believe that the dredging process is far less environmentally significant than is ice scouring. You know, in a 100 years, 90% of the sea floor in much of the Beaufort is torn up by ice scour. In comparison, dredging is a very localized operation and the disturbance on the sea floor caused by dredging is considerably less than what is done by nature itself.

A greater concern which was never dealt with is that there may be only a certain number of gravel niches in the Beaufort. If you go suck them all up, the little critters that like to live on gravel niches will not be too impressed. But you are not actually doing that by the relatively small volume of material that they will be moving. The biggest concern was whether the dredging itself was causing an environmental impact. All the critters on the bottom have to get out of the way of the ice keel and getting out of the way of a suction head is not much different.

Kevin Hewitt: When Dome was dredging, we did our own environmental assessment of the borrow site prior to and after dredging. No one came after us and put pressure on us to do it. But I'm sure there would be that pressure now.

3.0 Priorities for Future Work

3.1 Introduction

Neil MacLeod: This is where we want to start looking at targets and defining specific goals for future work. Maybe before we talk about priorities we should consider how fast we should be working in the Beaufort Sea. The operators don't seem to be interested any more. No boreholes have been drilled up there in the last two or three years. Gulf is gone and ESSO has pulled out. The way you have to read it is, we are at least five years from any serious work in the Beaufort and probably longer than that. Chevron is the only major operator to show any new interest of development up there and they are tied up with Hibernia. Until Hibernia is built, they are not likely to get serious about anything in the Canadian Beaufort, unless they find a real hot prospect. Perhaps if Shell was successful with its on-shore stuff and started talking seriously about the infrastructure to tie the delta back to the Norman Wells Oil pipeline things might occur sooner.

Bill Scott: If that happened, there would be a lot of pressure to find gravel along the delta channels.

Steve Blasco: It will be interesting to see what happens with the off-shore. It is still the best area in North America where a major oil company with its big infrastructure might make a profit.

The other interesting thing is that NEB will be releasing more lease blocks. They only released the one block in the recent off-shore bidding, thinking there would be no bids at all, on either the on-shore or the off-shore.

Both ESSO and Gulf have made it known to the federal government that they have financial problems but if they were on a sound footing they would not leave the frontier. Both companies have made it plain that it is their financial woes that has caused them to withdraw from the Beaufort.

Bob Gowan: The question really is what should be the priority of the Beaufort relative to the priority of Mackenzie Valley in terms of spending money on research and for granular resources.

Steve Blasco: The bottom line is that there will not be development in the off-shore until the on-shore is developed. The Delta will go ahead of the off-shore. It has to, unless there

is a find comparable to Amauligak that is on the other side of the fault. But I would still bet you that some phased development will pick up something in the Delta before the off-shore.

Bill Scott: The fact is there won't be a huge find in the Beaufort right now because nobody is actually doing enough.

Steve Blasco: Although nobody is drilling, there are a lot of seismic things to do.

John Lewis: Also, there are new commitments by Amoco and by Chevron from the latest lease sales. There will be something going on in the Beaufort and it will probably be more seismic work.

Steve Blasco: Some of it will be for engineering. They want to get their price of production down and they can't do it without some engineering. I think that is the purpose of Amoco's new R & D committee. How do you get the price of oil transportation and productions costs down? You have to do some research.

Neil MacLeod: If there is a future for the Beaufort, significant operations are not likely for the next three or four years. The time frame is probably four to twelve years.

John Lewis: Certainly that is the kind of time frame for production. I would think that some exploration activities will be still going on even though on a small scale.

Steve Blasco: In the meantime, we will try to pick up on the geophysical stuff and when the operators put a coring vessel in the Beaufort, to do a couple of sites, we will take advantage of it and add on to the program for the borehole information we need.

3.2 Operator's Priorities

Neil MacLeod: Kevin, as the only industry representative here, what can you tell us about the future of the Beaufort? If it does have one, where should we focus our efforts in the search for granular resources?

Kevin Hewitt: I think you have to consider the importance of the Beaufort from the interest of the operators over the last two days. We know that Gulf is basically out of the picture. After all, they just pulled out of Hibernia. Beaudril is up for sale, or should I say they are looking for someone to manage those assets and although we are in ESSO's building, they don't have anyone here.

From an industry standpoint, what we expect in the next few years, is to drill in the area around Amauligak. We may need to use some granular materials there because the water depth is a little deep for the SSDC mat system without a berm. That is the only project that I see which may require granular materials in the near term.

Secondly, there are no dredges in the Beaufort now. Before anything could happen, it would require a dredge. Therefore, I don't think that we should be looking at an industry project to be driving what we do here. It is my view that we should be trying to fill in gaps in the models that have been identified here and not try to be too site specific.

Bill Scott: I have some questions for Kevin. What is the shallowest you can put an SSDC with a mat? And what is the deepest water for an ice island?

Kevin Hewitt: The SSDC and mat need 7 m to float it in and an ice island, I think, can be used out to about 8 m.

Bill Scott: So in fact there is no need for gravels in general for exploration. But there would be at the time that production came up. Would you consider an SSDC mat set up for production?

Kevin Hewitt: Yes. We are actually looking at that option for a small scale production operation.

Bill Scott: So, in fact with that around, the demand for sand and/or gravel is much diminished over what it used to be.

Kevin Hewitt: It is diminished. But for something around the Kogyuk or Amauligak areas where there are 20 to 30 m of water, we may need several metres of sand or gravel to bring it up to where we can use the SSDC and mat.

Bill Scott: So there is still a reason to talk about granular resources? That is all I was interested in. From the way you were talking yesterday, it seemed as if the demand would be so sharply reduced that maybe there is no need for identifying new areas.

Neil MacLeod: You will get different opinions on that too. Jeff Weaver has suggested that Esso's concepts are for a much reduced need for sand. In fact, they will probably try and design ways around having to use dredges. On the other hand, there are needs for gravel such as for erosion protection for pipelines and structures.

John Lewis: Well ESSO have been getting some flak from the Coast Guard now about having to clean up those artificial islands.

Neil MacLeod: I think that is true for exploration structures, but for long term production facilities, you could justify those clean-up costs. It sounds like ESSO would prefer some alternatives to dredged facilities whether it is a mat or some sort of a conical drilling unit perhaps something like the Molikpaq. They are aiming at minimizing the need for sand and gravel. Obviously if they were sitting some place where there was lots of good sand they might alter their plans. Jeff indicated their first generation concept is based around something in the Amauligak area. They would like to tie Issungnak into that for a local network.

Kevin Hewitt: My personal opinion is that there is still a need for some granular materials. I think that the technology of building off-shore structures has changed dramatically in the last ten years. Hence there has been a change in the need for granular materials. There is still a need but it may be an order of magnitude less than it was once.

We cannot predict the future but a benefit to some of the things we do here is that the technology that is being created for the Arctic off-shore environment is very marketable for Canada to sell into Russia. Most of Russia's oil prospects are in the Arctic and a pretty good portion are in the off-shore.

3.3 Data Archives

John Lewis: I am concerned about all the lost data. When we came out to Calgary in 1988 to collect the data for the central Beaufort area, a fairly large amount of it couldn't be found within a month's searching. I'm sure it is still around somewhere. Dome had a very good data storage system and the people who were there in 1981 knew exactly how to get everything. But in '88 when we came back, we couldn't find it. I recommend that someone should be charged with putting in some serious effort to try and locate as much as possible of this data and get it centralized and organized.

Steve Blasco: We can support that. What he simply means is that somebody in Calgary will have to do it.

Neil MacLeod: In a sense, the data catalogue and geophysical data base identify most of the programs and that is the first step. Someone has to go through that listing and find as many of them as they can. Whether you could find someone now who knows when it was

done and what it looks like, is pretty iffy. I went looking for Esso data from Issigak only three years after it was collected. They had hundreds of kilometres of seismic data between Issigak and Tarsiut. It was gone.

Steve Blasco: We know that data was mistakenly shredded because of a screw up when Cathy Nelson left.

John Lewis: Would their tapes still be around somewhere?

Steve Blasco: They may be in a couple of boxes of multi-channel we were given but I don't know because I persisted in trying to figure out where the paper traces had gone.

Neil MacLeod: It seems that a very strong case can be made for an archive for the shallow marine seismic data.

Steve Blasco: There are 3 years of Gulf data missing.

John Lewis: I know the '81 Dome data went missing and I remember specifically boxing all that up, labelling it all very nicely and sending it back.

Steve Blasco: The data collected by Huntec in '74, is still the best data collected north of Richards Island. I would like to get my hands on it but I don't know where it is. It has completely disappeared. It shows all the deformation and internal structure of Unit B and the deformation there was marvellous stuff.

George Eaton: From an outsider's point of view, it sounds like a pretty deplorable condition. Any money you spend trying to get that stuff together now could certainly save you money in the future. The cost of going out and getting it again is just astronomical compared to looking in the basement for 2 or 3 months.

Bob Gowan: This would be the time to do it wouldn't it?

John Lewis: Especially since we should have done it 5 years ago. I recommend some kind of a program where the government or someone becomes a depository for all of this data and organizes a central clearing house or library.

Steve Blasco: We sometimes forget that the National Energy Board has a repository of data as well. It is not quite as complete as industry's, because industry only files what they need to, but we can also find some data through NEB. I believe they have a couple of copies of each site survey. That would be with Laura Richards and her group.

Neil MacLeod: Ray Smith was telling me yesterday they actually have had operators coming to them to find stuff that has been lost.

John Lewis: In '88 we photocopied as much as we could find of the data for the central Beaufort. That all resides at AGC now. That was all done under our projects.

John Peters: This issue of the central repository is critical to the whole Beaufort data base. I think you are just wasting your effort if you leave the data records dispersed.

Steve Blasco: Well GSC has already agreed we would do it. Repetitive mapping with side scan data is really important to us for our ice scour studies. So we are basically the repository for all of that. Our biggest problem is trying to keep track of it. We use it and others use it for something else and it is cycled around a lot. NEB is definitely a possible repository, maybe we should discuss it with them. It may be more appropriate to store the data here in Calgary.

Bill Scott: It has to be a maintained collection. You can't just store it. There is a possibility that a lot of this stuff might be put on microfilm and you actually lend out the microfilm and not the original record.

Steve Blasco: Well, we looked into that some time ago but it would cost a few hundred thousand dollars to microfilm all this data. The question is who pays? The problem is if you raise all those issues now, you would never get to do the first step of data archiving. Another problem is with the ultimate fate of NEB. I suspect a decade from now, you may find that all the northern data is somewhere in Yellowknife and NEB doesn't exist as an organization.

Neil MacLeod: What about ISPG? It is here in Calgary.

Steve Blasco: Well ISPG already defaulted all the Beaufort stuff to us as it is. ISPG is GSC and it could do it, you know. ISPG is here and so are the operators.

John Peters: Within AGC or ISPG there is already person-time and expertise that would be able to maintain a catalogue.

Steve Blasco: That is right. We have a full-time curation staff.

John Lewis: What should also be considered is what formats to use to store it in so it could be accessed.

Rick Quinn: You don't want to re-invent the wheel with all this high-risk type of stuff. They are doing it in deep seismic.

Steve Blasco: I'm sure there are standard procedure. In actual fact, we have exceeded the volume of data collected for deep seismic stuff because our sample rates are so high. You are operating at 2 - 4 milliseconds. We want to save 2 to 4 kilohertz of data and so our data volume is huge.

Rick Quinn: Yes, but, in many cases when you go through the interpretation and you are delineating your reflectors would you digitize the particular horizon?

John Lewis: That is the way SuperTech was developed, the old software.

Rick Quinn: You are talking about a tremendous volume of just the field data. It is sitting in raw form. Then you have the mish-mash of digitized reflectors going on and then you have the final maps.

John Lewis: That aspect becomes very difficult. There were certainly enough paper rolls to more than fill this room. If you could get 50% of them now I think you would be doing very well. It would probably take you a couple of months of data search, chasing things around to find it.

Bill Scott: I think that is being awful optimistic. I think it would take a year. It is not a trivial problem any more to get this stuff. You will have to identify what it is you are looking for, track down who did it, interview them, find out exactly where it was and what was done with it initially and follow the trail of where it has been. All that will take real time and money but it is still cheaper than doing it again.

Steve Blasco: I would look at it from another way. I would simply go to Gulf and ask where do you store all your data. Then we simply go through all of that. That is what will take time.

John Lewis: That may be sort of mind boggling because they may have several warehouses full of boxes. It will all be seismic data. Most of it for deep exploration. They will all look the same and the ones we want won't be well marked.

Bill Scott: Another problem is you get say 6 boxes and they are full of records. When you starting working through them, you figure out it is an area of interest. But you will not find the track plots with it. You will have to go somewhere else to get those.

Steve Blasco: We have that on the data bases that McElhanney and EBA have put together. Most of the stuff we have all worked with and it is stored reasonably well. It is finding it.

Bill Scott: Well, in fact there is more value to keeping the interpretation available than the raw data. As long as the raw data can be found. The interpretation is a value-added effort. Steve was talking about these eight maps. They are worth much more than just the raw data because somebody has given some thought to how they correlate and those correlations are part of the maps. So if you want a product that you will use, it is probably better to take the map on which somebody has already done the correlation and use it to build your thinking. I don't know that we want all the raw data to be part of the data base.

John Lewis: The raw data should be indexed.

Bill Scott: You should know where the raw data is so that if you don't trust a piece of it or if something else comes up you can go check.

Steve Blasco: Now that we have these geophysical data bases I'm not interested in one that shows track plots of data that is lost. I would sooner get those lines off the system because it creates a misunderstanding. I would really support John's recommendation to confirm what we have, where it is and how it is stored. The Geological Survey has offered to be an ultimate repository or NEB if it is to be stored here. Either one can curate it.

John Peters: This data never seems to stay in one place. You can find all the data and take a snapshot today but in a year's time you can't go back and find it.

Bill Scott: We would know that if it is in a repository because then there is a record of where it went and an active curator will chase people after a reasonable length of time.

3.4 Geological Studies

Neil MacLeod: Steve, will you go back through your many bright ideas and clearly identify your goals for geological work in the next short while?

Steve Blasco: I would say in the next phase, we need to collect some additional geophysical data in each of the prospect areas such as Isserk and we need regional data related to Issigak. We should focus on the central region and as a lesser priority on Herschel Island and the Yukon Shelf. I would, in fact, put a little slightly higher priority on establishing the geology of the Kaglulik Plains so we could categorically state it is not an area where we have much hope of finding sand and/or gravel.

Neil MacLeod: There was a fair bit of work done in the Amauligak area which was presented in Scott Dallimore's report. Is there anything which came out of that report that needs to be looked at?

Steve Blasco: We identified one area earlier when we talked about recognition of some possible shorelines and some gravels in the southern Akpak area. It is a key area because it is close to Amauligak.

I do believe this whole question of the on-shore/off-shore geologic correlation should have a high priority, because it is a factor in understanding the geology of all the different prospects. It would be great to geophysically and geologically cover the area from Issigak right across to Amauligak. My next priority would then probably be Kaglulik because it is largely an unknown area.

Bob Gowan: How about Nerlerk?

Steve Blasco: Well, that is further out. We do know that the sand plains that we are drawing on, including Erksak, get finer and finer and more interbated and more distal at the north end of the Tingmiark Plain and Akpak Plateau. On that basis, we can eliminated the Nerlerk area for now. That may or may not be correct.

Neil MacLeod: I think for practical purposes, it is unlikely that anything will be built in deeper water until something is built in shallow water. You must be very optimistic to think that there is not a lot of time to adjust to a deeper water scenario.

John Lewis: At some point there may be some exploration work done in the deeper water. Would they go back to the drill ship technology and summer-only drilling?

Kevin Hewitt: That would be the most cost effective method.

John Lewis: So there would be no real requirement to come up for granular resource out there.

Steve Blasco: One thing that has to come out of our PERD meetings is just what Neil said. The assumption is that development will occur progressively northwards. First they will develop in the Delta and then they will be looking to the near shore and they will slowly work their way off-shore. Maybe Amauligak is the key point, but if they find a big deposit in closer to the shore, then it will become the focus. I would just as soon concentrate our

efforts on the near shore and mid-water depths and not spread our efforts too thinly. If we only have a little bit of information in a thousand places, we won't have the information that will make development cost effective.

Neil MacLeod: Steve, are there other aspects of the geology to consider?

Steve Blasco: The Megatransect was a series of five deep boreholes that Terrain Sciences did. They put together the stratigraphy and geology for that transect and it is built into our draft of the central geology report. So any implications that has on the models would directly relate to the granular resource. It suggests that Units D and E and other units underlying Unit C, have continuity with the on-shore and the underlying clay. Unit D appears as the Hooper Clay on-shore. That is a key stratigraphic link.

John Lewis: We are still left with the Toker Point unit.

Steve Blasco: Yes. We are still left with that issue. It has to be sorted out because that unit is a potentially significant source of granular resources.

John Lewis: Well it is also the age aspect of that because if we do push the stratigraphy straight through underneath all that, then that makes the Toker Point tills very young.

Steve Blasco: Well we have talked to people outside Terrain Sciences such as Wayne Pollard, Fred Michel and even more recently Ross Mckay. There is a thought that the Toker Point till is Late Wisconsin in age. That would correlate with our off-shore stratigraphy. We might argue the chronology question for years and I don't know at this point, if it is really solving this problem about granular resources. It is the stratigraphy that is a key to the resource, hopefully chronology will come along. The idea is to use the geology to find more sand and gravel. We can't lose sight of that.

Neil MacLeod: I think you have to solve the chronology question before you can identify the origin of a lot these gravel deposits. We have proven many times there is more sand out there than you can ever use, but there is not enough gravel. If there is a key to finding the gravel, it will be in solving that till sheet problem. My feeling is if someone could resolve that question in a positive way, it could have a very big impact on where you conduct exploration for gravel.

Steve Blasco: There are some other concerns in all this. When you talk to Jean-Serge Vincent about the issue, he says that you may not get enough gravel out of Toker Point till to make gravel deposits. The till is a very clayey deposit. And we also have glacial sequences on Hooper and Pelly Islands. We have no idea where they sit in time.

That brings you right back to where we were a few minutes ago. You have to focus on that triangle that bounds Issigak over to Amauligak and everything south of that right to the shoreline. We are working with Megatransect right now, looking at biostratigraphy to try and tie the two together. The big thing will be actually dating material that both Terrain Sciences and ourselves agree is datable. Then whatever date comes out, we don't argue about.

John Lewis: The area you just outlined is also the area that likely will be most important for finding more gravels. You see, it is all tied together. That is certainly the area where we want to get the most recent bathymetry and update the bathymetry maps and look at them from a detailed geologic point of view. Any kind of little shoal feature that may have been missed on the earlier map sheets could be important.

Neil MacLeod: Steve, if you had abundant funds, how would you go about solving the debate? You are talking a small area needing some critical data.

Steve Blasco: The only way to solve it is to run seismic right from the on-shore to the off-shore to put a seismo-stratigraphy in place, first. Then you run a series of boreholes that are 20 to 50 m deep in a series of lines from the on-shore to the off-shore. Megatransect is one and the other end line would be in the Ikit Trough. It would have to sort out your problem. That is basically where we are headed as resources become available.

In fact, most of our PERD awards will focus in the next few years on the central Beaufort. Which brings another point to mind. It is not just Indian and Northern Affairs NOGAP resources that can be dealt with here. There may be geological resources and PERD resources that can be linked to make this all work better, so we can finally research the resources.

3.5 Evaluation of Equipment

Bill Scott: It would be worth perhaps looking at a 2 week experiment with all of the presently available new technology over 1 or 2 of these areas where there really is good control. That would be a way of examining the potential of new equipment or techniques. I don't think there is any sense in talking about major regional surveys because there isn't a driving economic force.

Guy Fortin: Is there no southern site where we can do a test like that? Perhaps off Halifax harbour. Somewhere with a gravel bed. We can have a number of companies try their system and select the best one before we go up north.

Bill Scott: It is hard to find a wide expanse of shallow water with the same kind of geology. In fact, parts of the B.C. coast around Vancouver Harbour are better. Those areas have comparable features but it is really hard to find an area with the same geology. Or even something close.

Rick Quinn: We discussed many ideas for fine tuning different technologies, resistivities, seismics, line-cone effects, chirp sonars and so on. That is all well and good but the money is pretty tight these days and to go up to the Beaufort Sea and do a lot of things that have never been tried before is expensive. It is cheap to mobilize to the Fraser Delta. It is a deltaic environment, where we can try some of these things and see if you can really run a boomer and a resistivity system together. Maybe you don't have the permafrost and you can always say you don't have this and you don't that, but guys like John who have been in the business long enough, know that if you test some of these systems, either they work in a gross sense or they are totally incompatible. You don't want to be testing those things up in the real shallow water of the Beaufort where you have logistics against you and a tremendous cost. With the Fraser Delta, there may be other money you could tap into because there are other interests in the Delta; like B.C. Hydro, or PGC and Arktos isn't very far away, either.

Steve Blasco: There is a GSC program to study the Fraser Delta underway now. It is being done under Dave Prior. We could consider some advantage of that. One of the things we are doing in that program is to evaluate a shear wave source that Angela Davis will be bringing over from England. She has been working with shear waves for the last ten years and has developed a deep-towed sled. It is to be tested at Hibernia and in Fraser Delta and if that goes well, in two years we will use the shear wave source in the Beaufort to get around shallow gas problems.

Rick Quinn: Well in the Fraser Delta you have more of a season to work in. You can do it in the off season when it is less expensive and you get more time to play around. There is certainly merit in a test program which is dovetailed on to some of the ongoing work in the Fraser Delta.

Steve Blasco: I'm working the same route with Russ Parrott's digital initiative. We have it slated for the Beaufort but definitely we will look at the programs that he is already working on. We don't want to take a system up north that is still temperamental and not operational. It will be tested in the Fraser Delta and east coast before it goes north.

Bill Scott: In that case it would be all worthwhile to look at getting some control for somewhere in the Fraser Delta that would make it a useful test area. There is a certain

amount of borehole data there for other reasons. I mean people have done geotechnical investigations so it should be worth trying to compile some of that and find an area where the geology is known where one could do tests.

Neil MacLeod: I take it is not just a matter of picking a site that has data. It is picking a site that is representative of the Beaufort.

Steve Blasco: The counter point of that is we have done a hell of a lot of work in the Beaufort. We have a lot of ground truth in an area that you won't have in the Fraser Delta. You have to make sure you can have something.

Neil MacLeod: So maybe, the broad task for John should be to develop a data base for the Fraser Delta first. From that we will figure out where the right section is.

Bill Scott: It is possible that other money might be available to fund that. I mean that it would be logical thing for the Fraser Delta people to be looking at anyway and maybe that is already underway.

3.6 Data Management Systems

Neil MacLeod: We discussed the applications for the data base programs and GIS earlier. John, will you review the main objectives that came out of that.

John Peters: Well, I will recap on the priorities. We are not looking at the technology issue here; we are looking at data. And, it looks like, as far as I can gather, the main priority will be to provide some Quality Control of the data. That could be quite a substantive task. We have recognized that bathymetry is important. So we should be trying to include the existing bathymetry including the areas where Glen Gilbert has digitized the bathymetry. In order of priority after that, we have radiocarbon dates and there is the set of 1:250,000 geological maps that we may also decide to bring in. I think the main thing is to cycle back to this QC and get the actual inventory straightened out.

Bob Gowan: One of the projects that I had planned and which was caught in the freeze (on government spending) was to look at marrying the existing InFocus system with a Raster based system. Clarke University has developed a real cheap version of a Raster based system that can handle quite a number of problems in terms of correlation of the data between layers and actually overlaying layers, rather than over-plotting as you end up doing with InFocus. It was to be done through a pilot project to try to relate some of these other factors like existing ice cover, existing environmental constraints and that sort of thing as a tool that could be used for planning purposes. It could be used in something as simple

as planning a field program when we are working with limited funds and trying to determine physical environmental and operational priorities. That is certainly a candidate for carrying on with future work.

John Peters: It is a very interesting system actually and there is very good potential. You might have heard of it, Bill. Program called "IDRISI". It does a lot of things that a system like SPANS would do. It is a spatial analysis system. It is quite simple to take one cover sheet and overlay it with another one to produce a new map.

John Lewis: This could be an easier way of incorporating the maps that currently exist by scanning them or something in Raster.

John Peters: You would bastardize an existing coverage in some way. I think it has to be a pilot project because there is not enough data to sustain such a thing right now, as a production sort of tool. Blasco's eight maps would be wonderful.

Bob Gowan: It is the type of tool you would use regionally, rather than searching on a point basis, or borehole grid type of basis. You could put in the depth to the granular material, a certain quality level and a certain water depth or whatever and it would only display those various things that met the criteria. So it is an exact overlay where it creates a product from the various layers you are using with it.

Steve Blasco: An addendum to all that is the continued development of computer techniques, GIS and data bases, etc., as the basis on which we work in future. Somehow we have to incorporate that into the resources of a project. When we are doing bathymetry, we don't just do a series of maps but we also put it into the data base. Somehow we have to try and work that way.

I have concern in the long term about having another reference map for the Beaufort and replacing the Natural Resource Series which we are using. Maybe Indian Affairs needs to write a letter to the Hydrographic Survey and say "Look we need a new data base map and we would like an electronic map of the Beaufort and need it for..." Does that carry any impact? We definitely have a need which I don't think will go away.

Bob Gowan: I think we start by approaching CHS about the recent data. That is an immediate requirement. There will be future ones for new base maps.

3.7 Granular Resource Prospects

Neil MacLeod: We have talked about quite a few exploration prospects and keyed on the well explored deposits. During the last couple of days, we have talked about quite a few other areas where we would like to see some work done. I think we have covered them all, now it is just a matter now of bringing them back out to establish priorities. I think the central Beaufort area around Amauligak probably has to be the first priority based on where development is likely to occur. I think there is information that suggests there might be gravel in the Isserk area and that is something we need to explore. What other deposits, prospects can you think of that fit that category now.

Steve Blasco: Well again, someone should look and see if there are other deposits like Issigak in that area. You follow along that contour and back towards Issigak's source. And we should do something in the area to the east of Amauligak, in the Kaglulik plain area, before we go back and further explore Herschel or Yukon. You are trapped between trying to further delineate what is known versus looking at an area we don't anything about it at all. It has to come down to the logistics. Which is the closest area to potential production sites? Banks Island is now a lower priority until you find out that there are no resources elsewhere and we have to go there.

I haven't heard any other new areas come to light. At the north end of the Akpak Plateau, for example, is a huge delta that is in deep water. There are some delta fans that were built out towards the shelf edge, when the sea water level was lower. The fans are much like the alluvial fans that you have on the Yukon Coast.

John Lewis: But again you have to transport the coarse material all away across the shelf before you get it there and I wonder if that is likely.

Steve Blasco: I think it is when you consider where did the sediments go that were in Kugmallit Trough and the Niglit Channels in the Erksak Trough. That stuff is somewhere. Unfortunately it is out beyond 35 m water depth so it may not be practical. I don't know of any other site. Perhaps in the Baillie Island area. Gravel has been reported north of Baillie Island.

Neil MacLeod: We have poked around out there several years ago for Dome and we didn't find anything.

Bill Scott: I think that you can't really make a case for doing anything very far from Amauligak until you have proven that there is no gravel there. It is really interesting to look at all the other places in terms of long term gravel potential. But until you can

demonstrate there isn't available gravel around the south end of Akpak Plateau, then there is really no call to go anywhere else. I don't see anybody developing anything off-shore in the next 4 or 5 years except in the Amauligak region right now. Nobody else has anything of obvious production value like Amauligak.

Neil MacLeod: Any suggestions of where you would look first?

Bill Scott: There is a lot of evidence for old strand lines along the west of the Kugmallit Channel and I believe there is coarse gravel in places. We found that some of those sediments had very high resistivities when we were working for ESSO in the Arnak area east of Richards Island. The deposits we were tracing were open ended. It was going off to the northwest and out of the survey area. The old Huntec data had outlined the strand lines and that is why we were looking there initially.

When they built the last Arnak, a lot of the fill was actually gravel. It was the same stuff that we had been mapping with the resistivity. I don't think anybody has ever looked in that area very much.

Neil MacLeod: From the Amauligak development point of view having gravel in that area would be pretty attractive.

Steve Blasco: Yeah. Because the features tend to be linear we think they must have something to do with an old shoreline. It is the only thing we could think of that would generate that kind of linear form. A bar or channels all the other landforms tend to have limited extent and less linear character. The problem with old shorelines is that if the shelf was tilted due to ice loading, the shoreline won't always follow a bathymetric line.

Bill Scott: For a lot of this area, the water depth is only 8 to 9 m. We never tested some of the better areas and I don't think we looked west of the island that was being built. There was certainly some better looking stuff on that side that we never tested.

Neil MacLeod: I recall some interesting features of similar type that are on the west side of the Akpak Plateau. On some of Muharrem's old data there were some pretty nice delta and terrace-type deposits that seemed to be built by streams flowing off the Akpak into the Ikit Trough.

3.8 Re-Interpreting Bathymetry

John Lewis: I suggest that we take the newest version of the CHS data and re-contour it to re-assess those areas. I can see a project developed to identify geologic features from detailed bathymetric maps. We should look at those details to outline new targets.

Steve Blasco: That would be a first step.

John Lewis: You might consider some detailed interpretation on the newest bathymetry for Issigak and Isserk regions. When we were doing the Erksak area, we managed to get the newer hydrographic survey data and contour it. An awful lot of small shoal features showed up through the Erksak area. I think there was a considerable amount of newer hydrographic survey done on the shelf area certainly a lot of the areas were outside the Erksak region. No one has pulled out the work sheets and re-contoured them at a one metre contour interval or as small as you possibly can with a geologic framework in mind. It might be worth some effort to do that on a broader basis.

George Eaton: Go ahead and request the data. It is an obvious thing that is an obstacle. It has been in the past. This stuff should be presentable in digital form. The original soundings are at 100 m line spacing but the final sheets we have on record are reduced to 100,000 scale with 500 m line spacing. But the raw stuff is around.

John Lewis: Yeah, but what we want is the work sheets which are 20,000 or 30,000 scale maps.

George Eaton: Yeah, anything since '85 there shouldn't be any great difficult in getting that out.

John Lewis: I think it is worth the effort on looking at most of the Beaufort shelf with the newer data set where you do have the higher volume density of 100 and 200 m line spacings and things like that. From this point of view and I think you may find an awful lot of features similar to Issigak. Things will start popping up at you.

Steve Blasco: Is there any way that some of the things that are of interest can be added on to the next Canadian Hydrographic Service program or is your program fixed.

George Eaton: If you have a request certainly make it known to Tony O'Connor.

3.9 Summary of Priorities

Neil MacLeod: It seems the first off-shore development work will be around Amauligak. That is something that has come out a dozen times today. Gravel deposits near Amauligak must be the first priority. From a technology point of view, Steve, you made some comments on different systems and how they might be used. Rick, I like your idea for taking stuff out to the west coast and doing some trials in reasonable conditions before we hit the big expenses of mobilizing to the Beaufort are quite valid. That is where some of the equipment will fall by the way.

The major recommendations that have been made today are summarized in the next section of this report.

Steve Blasco: The other thing that should drive our priorities is opportunity based options. If something is going on in the Beaufort, we should piggyback on it to maximize the impact to granular resource. We have our priorities from A to Z, but in actual fact, we do them when the opportunity presents itself. When a coring vessel is there or a seismic vessel, we do what we can. We may have a survey vessel next year. It will be there and probably for the last time. Because we won't have to pay huge ship costs, we will do a geophysical survey next year. Thereafter we will have hellishly large ship costs.

3.10 Closing

Neil MacLeod: Well we have come to the time when we must think about wrapping this up. We covered the issues, we covered the issues again and talked about them again. I appreciate everyone's comments. I think it has been a very successful workshop meeting. I hope you all agree. It has been fun to get together with good old friends and to compare ideas.

We owe ESSO a vote of thanks for these facilities and their help. We have not suffered in these accommodations by any means. I would also like to thank Bob for sponsoring us and encouraging us. I hope when the final reports are put together, we have provided him with the information that he is after. Thank you Bob. Thank you gentlemen and Rita. That is it.

4.0 Editor's Summary of Recommendations

4.1 NOGAP Study Areas

4.1.1 Yukon Shelf

- Sampling of the prospects identified in the NOGAP study is needed to confirm interpretations of thickness.
- Most of the data available for this area was not collected for granular resource exploration. Therefore, geophysical work with more appropriate tools might help to improve the understanding of the granular deposits.
- Additional exploration should focus on the area of mega-ripples along the edge of the Shelf at the Mackenzie Trough and in the shallow to mid-depth water range.

4.1.2 Herschel Island

- There are several areas along the coast where gravel is suspected but which have not been explored.
- The thickness of most deposits in this area has not been determined. Some boreholes or resistivity might be considered.
- Gulf collected some seabed data when looking for set down areas for the Molikpaq. These have not been reviewed for evidence of granular deposits or their geological value.

4.1.3 Issigak

- The stratigraphic link between Issigak and Tarsiut should be confirmed because it is fundamental to the interpretation of age.
- The morphology of Issigak should be tested by on site examination.
- The results of that examination should be used to direct further investigation of either an upstream source (fluvial model) or bathometrically similar deposit (strand line model).
- The Arktos set-up might be appropriate for exploring in the shallow water between Issigak and Pelly Island.

- Steve Blasco may have a couple of boxes containing multi-channel data from ESSO's lost data set for the area between Issigak and Tarsiut. This data should be reviewed to confirm or revise thelocal geologic model.

- Bathymetric work sheets at CHS may provide details of local relief that indicate similar deposits or help to interpret the origin of the deposit.

4.1.4 Isserk

- Delineation of granular resources has been hampered by a thin upper sand layer which seismically obscures a lower sand which includes some gravel rich facies. New seismic methods, including heave compensation or resistivity methods could be used to improve our understanding of the deposit.

- Borehole control is needed in the southwest corner of the block.

- More exploration is needed on the tail of the deposit which extends to the southeast outside the block.

- Detailed look at CHS bathymetric work sheets may provide new exploration prospects in the area.

4.1.5 Erksak

Borehole control for seismic interpretation is incomplete. Good prospects have been identified in Erksak Channel and along the edge of Kugmallit Channel, but these need borehole confirmation.

4.1.6 Banks Island

- Dredging in this area will comprise selective development of small pockets of till in rock. The use of correlation curves based on a few boreholes to help interpret seismic data would simplify the exploration process.

- Accurate bathymetric mapping is needed for navigation of dredges and would help to identify pockets of till.

4.1.7 Amauligak Area

- This should be the focal point of granular resource exploration during next few years. More distant potential sources should be de-emphasized.

- Gravel prospects near the Amauligak area are much more valuable than sand prospects.

4.1.8 Arnak/Akpak

Old strand line features identified in the Arnak area should be delineated and evaluated. There is evidence of gravel in these.

4.2 Geological Objectives (for Granular Resource Application)

- The stratigraphic schism between on-shore and off-shore has resulted in geological models that may be overlooking gravel deposits. Detailed work on the area between Amauligak, Issigak and Richards Island is needed to resolve.

- The geo-chronology and the marine limit of Toker Point tills is disputed by many. Mapping and dating to confirm or modify the models are needed.

- The gradational character and variation of Toker Point till should be assessed for its potential as a source of granular materials after re-working. Perhaps it is too fine grained to worry about.

- Similarly, the geologic and gradational character of tills on Hooper Island and Pelly Island need to be correlated with Toker Point eposits and possible granular deposits.

- The geological models suggest the first priority for granular resources exploration should be in the Amauligak/Issigak/North Head triangle. The second priority is the Kaglulik Plain, including Erksak, if only to prove there is not any viable sources out there. The third priority is the Yukon/Herschel area.

4.3 Data Archives

- A thorough search for seismic records of shallow marine deposits should be undertaken to retrieve valuable data, identify lost and destroyed records and establish an archive.

- The database of geophysical track plots should be modified to show lost, destroyed, archived, good, bad, etc., quality assessment information.

- A government agency should be selected to archive all marine seismic data. The Atlantic Geoscience Centre, National Energy Board and Institute of Sedimentary and Petroleum Geology were suggested as acceptable curators.

4.4 Data Base/G.I.S.

- Engineering and geological applications of borehole data base require capabilities to generate cross-section incorporating borehole data. Some facilities to incorporate seismic data into the section will be needed in the long term.

- Methods of incorporating seismic data into cross-sections generated by the data base should be developed in stages.

- NOGAP funding should not be used for developing cross-section generating capabilities. Perhaps PERD and GSC money should be used.

- GIS development incorporating data available in other specialty data bases should proceed slowly, as required at present.

- GIS should incorporate bathymetric base maps, modified bathymetric data (CSR's data) and the facility to input new digital data from CHS.

- GIS should incorporate radio carbon dates and 1:250,000 geological maps.

- NOGAP funding should be reserved for GIS development relating directly to granular resource applications. It should not be used for engineering, geological, logistical or infrastructure input.

4.5 New Technology

- The concept of a towed video system that is able to contour fly over the bottom was advanced to study/document bottom features such as boulders, ripples and gravel deposits.

- The need to develop and incorporate heave compensation on seismic equipment systems was raised many times.

- The incorporation of GPS techniques for navigation and heave compensation post-processing was identified as a significant technological advance.

- The Coast Guard should be asked to provide low frequency modulated radio beacons for GPS applications in the Beaufort.

- Resistivity techniques offer the ability to see into and through granular deposits which seismic methods cannot do. Continued development of resistivity should be promoted and complementary seismic/resistivity programs should be tried.

- Seabed sediments and pore water should be routinely sampled and tested for resistivity and salinity to establish an atlas of resistivity calibration data for the Beaufort.

- Research of sonar/bathymetric data already collected should be conducted to assess whether that data can provide an indication of seabed resistivities hence sediment type on a first approximation basis. Further CHS bathymetric work should be modified to record seabed resistivity data for this purpose.

- The use of resistivity from the ice (winter program) is a feasible method of investigating bathymetric anomalies which may be identified by a re-examination of the CHS work sheets.

- It is recommend that field trials be held in the Fraser Delta area to perfect suites of geophysical equipment, bathymetric techniques and sampling tools before taking them to the Beaufort Sea.