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DRILLER'S FIELD NOTES SUBSEA PERMAFROST PROGRAM.(U)
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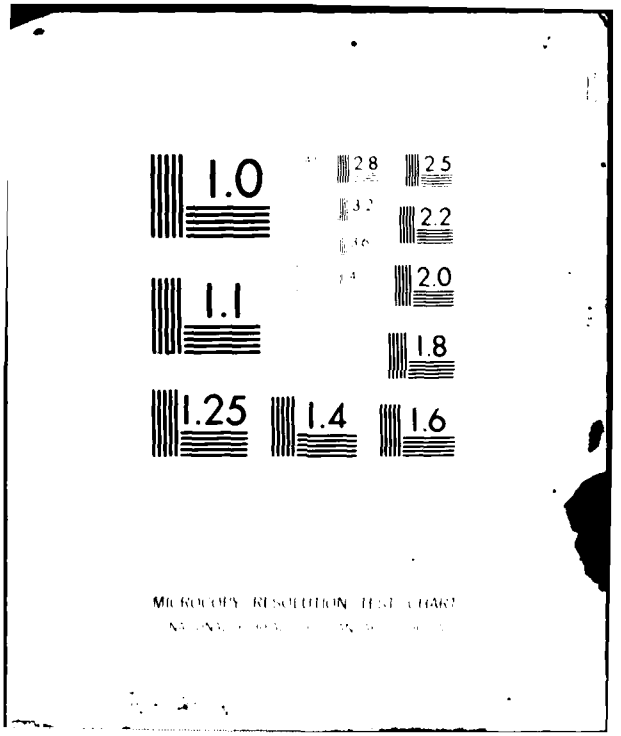
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DRILLER'S FIELD NOTES
SUBSEA PERMAFROST PROGRAM,

Prudhoe Bay, Alaska
March-May 1977
Outer Continental Shelf Program

(11) May '77

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27 March, 1977

Left Fairbanks at 6:40 PM. Arrived VE Surfcote at Prudhoe Bay at 8:40 PM.

28 March

Up at 4:45 AM, to work by 6:30 AM. Paul Sellmann earlier this week had the drill sleds moved from VE NORCON over to VE Surfcote and unloaded and sorted out the equipment, drill rod and casing. We went to CATCO Rolligon to check out the TD 25 tractor. Went to bed about 7:00 PM.

29 March

Up at 5:00 AM. We left VE Surfcote about 8:30 AM with D6 tractor, TD 25 and the drilling equipment. We almost reached the old Arco dock when a hydraulic line blew on the D6 Cat and we were down just before lunch until late afternoon. The hydraulic line was repaired and we were able to move the equipment out onto the ice near the old Arco dock by evening.

30 March

Hitched onto the equipment and moved out on the Gull Island Road. We were approximately one mile away from Gull Island when we headed due north for approximately one mile. We had to plow a road from the Gull Island Road to the drill location. We parked the drilling equipment and rigged-up for drilling shallow holes.

Bore Hole PB-5

Three piston samples were taken off the bottom and one Washington drive sample of 25" from the floor to 25" below the floor. The ice thickness was 140 cm. The top of the ice to the floor of the sea was 184 cm. The ice free-board was 18 cm. It was 90 cm from the floor of the rig to the ice surface. It's 10' 1" from the table elevation to the sea floor. Winds are from the east and our plowed road is drifing in.

31 March

Up at 6:00 AM and to work at 6:30 AM. It took until 11:00 AM to prepare the equipment for setting the first string of casing. The equipment was cold and no electrical power was available. Later in the day we did borrow some power from a cooperating project. We set casing to 13' below the table and cleaned out the casing to 13'. The jet auger was working poorly and as a result we pushed the casing ahead approximately 9". We decided then to try a drive sample from 14' 9" - 16' 10". It took 70 blows with the 140 lb. hammer to go 25" with the Washington sampler. We continued cleaning out the casing with a small roller rock bit. We set the casing to 17' after using the 140 lb. hammer; with slow penetration rates we put on the 300 lb. hammer. We drove the Washington sampler from 17' - 19' 1" below the table. It took 35 blows with the 140 lb. hammer, half of what it took on the previous drive. We added casing, cleaned out to 25' depth with the roller rock bit and drove the Washington sampler from 25' - 27' 1". This sample drive took only 30 blows with the 140 lb. hammer. We drained the pump and lines and started in for the VE Surfcote camp at about 7:30. Arrived at the VE camp at 8:30 PM.

Today the wind was from the west and was blowing in our trail quite badly. Our trail, from the Gull Island Road to the drill camp site, is in deep drifted snow due to some old seismic trails passing through the area. Away from this area the snow averages no more than about 30-40 cm deep but upon plowing, it provides plenty of opportunity for the snow to drift into the road. Yesterday I noticed the temperature at one time was -13°F with the winds and today it was approximately 0°F with the winds blowing out of the west. We had some trouble keeping the mud lines thawed-out.

1 April

Up at 6:00 AM and to work at 6:30 AM. Reached the drill site by 7:15 AM. Heating up equipment until 9:00 AM. Water lines were frozen and pit frozen. We need more heat and have no electrical power at this time. Pulled off a 5' piece of casing, added 10' and drove the shoe to 30' below the table. By 10:00 AM we had the 30' of casing set. At 11:00 AM we were working on the pump system and trying to thaw out the lines. The temperatures were -28°C at 11:00 AM. After driving the shoe to 30' the hole taped 25' from table to the sediments. A shell layer was hit at 29' while cleaning out the casing. The Washington sampler was run from 30' - 32' 1". Using 140 lb. hammer, it took 29 blows for a 25" drive. We have been recovering only about 18" or 19" out of 25" drives due to the compaction in the bit nose. After the material compacts in the nose the sampler merely pushes the bit through the sediments without taking in any more core. Three foot piece of casing added and drove the shoe to 33'. Cleaned out to 33' and hit a piece of gravel at that depth. Lynac sampler now being used. The sampled interval for the Lynac was 33' - 34' 8". The 20" drive took 62 blows. The Lynac sampler recovered about 17" or 18" out of the 20" drive. Added 2' more of casing and drove the shoe to 35'. The hole taped 30' after driving. Still using the 140 lb. hammer, it took 69 blows to drive the Lynac from 34' 9" - 36' 5". The Lynac being used is a 2" sampler. Water lines were drained and fuel tanks topped off. We quit at 6:30 PM and drove to VE, reaching VE approximately 7:15 PM.

2 April

At 8:00 AM the wind is out of the east and the temperature is -32°C A 2' piece of casing was added, putting the shoe at 37'. The casing was very difficult to drive. Still having trouble keeping lines thawed-out and we were not able to fill

the 500 gallon water tank until approximately 10:20 AM. Drilled out ice in casing and the hole taped 32½' from the table to the sediment. We need to clean out the casing to 37'. It is believed that the roller rock bit was washing ahead into the material. The procedure was to drill to the shoe and then sample ahead of the shoe. No doubt, the roller rock bit in some cases does disturb the sediments ahead of the shoe. It took 58 blows to drive the Lynac 18". The drive was from 37' 4" - 39'. Casing driven to 39'. Cleaned out casing and taped hole. It was 38' 10" from the table to the sediments in the hole. Used the Lynac again; 175 blows to go from 38' 10" - 40' 6". We are using a four finger basket and a latex sleeve in all of the Lynac sample runs. Added 2' of casing and drove the shoe to 41'. Hole taped 39½' after the drive. After cleaning out the casing the hole measured 40' 10". It took 141 blows with the 140 lb. hammer to drive the Lynac sampler from 40' 10" - 42' 6". The hole taped 41' 7" after the Lynac drive. Decided to stop drilling on this hole and install the PVC casing for thermal measurements. Approximately 40' of the PVC was installed. We had a visit from the Department of Environmental Conservation this afternoon. We pulled the casing and were back to the VE camp by 8:45 PM.

3 April

Up at 6:00 AM and to work by 6:30 AM. Broke up the drilling camp and left PB-5 drill site at 10:00 AM. Moved across Prudhoe Bay to the vicinity of the west dock.

Bore Hole PB-6

It was 5' 10" from the ice surface to the floor of the bay. There was 17" of freeboard on the ice. The snow cover is 3" - 4" thick. The ice thickness is 5' 8½". It is 3' 10" from the drill table down to the ice surface. Used a small stream sampler to take approximately 3 bottom cores. Next we made a 24" drive

with the Washington sampler. The interval sampled was from the bay floor to 24" below the floor. It took 38 blows with the 140 lb. hammer. Recovered about 23" out of the 24" drive. The material was fine sands. Used the D6 Cat as a taxi to move from the ice camp to the dock road. Used the pickup to reach VE by 7:30 PM.

4 April

Up at 5:45 AM and to work by 6:30 AM. After reaching the drill site we plowed a road from the dock to the drilling camp. Low on diesel fuel and our living quarters not delivered from CATCO. The camp finally arrived about 11:30 AM with electrical power. The air temperature was approximately -35°C at 7:30 AM and had warmed to only -33°C by noon. The hole through the ice sheet had to be re-augered prior to setting the first 10' of casing. The shoe was set to 13' below the table. The sediment level was at 11'; drilled out from 11' - 13' before sampling. The bore hole taped 13' after clean out. Drove the Lynac from 13' - 14' 8". It required 35 blows with the 140 lb. hammer. The recovery was about 12½" out of the 20" drive. Drove down 2' more of casing. The shoe is now at 15'. Cleaned out and used the Washington sampler to drive from 15' - 17' 1". The 25" Washington drive sample required 27 blows with the 140 lb. hammer. The recovery was approximately 22½" out of the 25" drive. Drove 2' more of casing to put the shoe at 17' below the table. Cleaned out and again put in the Washington sampler and drove from 17' - 19' 1". It required 40 blows for the 25" drive with the 140 lb. hammer. Drained the pump lines and drove to the VE camp. Arrived about 7:50 PM.

5 April

Moved out of the VE camp by 7:00 AM and into the ice quarters near the west dock by 7:45 AM. Drove casing shoe to 19' and cleaned out the bore hole. Drove the

Washington sampler from 19' to 21' 1". It required 35 blows for the 24" of the drive. The recovery was 10" out of the total 25". Put on 2' of casing and drove the shoe to 21'. Changed over to the Lynac sampler and drove 20" with the 140 lb. hammer after the clean out. The Lynac run was from 21' - 22' 8" and required 28 blows. The clean gravels, in the top of the sampler, indicated washing by the roller rock bit. Next added 5' piece of casing to put the shoe at 26'. Wash samples were caught from 22' 8" - 26'. Had been driving the casing with the 140 lb. hammer until this 5' piece was added. Switched over to the 300 lb. hammer which will permit faster setting of the casing. Wash samples were caught from 22' - 24' and 24' - 26'. After the cleanout it required 63 blows with the 140 lb. hammer for the Lynac to go 20". The Lynac sample was from 26' - 27' 8". Added three 1' pieces of casing and drove the shoe down to 29'. The hole taped 26' 5" after driving the casing. Used the Lynac sampler to sample from 29' 7" - 31' 3". The hole taped 29' 7" after the clean out prior to the sample run. The blow count was 22 blows with the 140 lb. hammer for 20". We are now in large gravels and sands. Recovered only about 6" out of the 20" drive. Decided to pull out the casing and take off all the short pieces, add 10' lengths, and go back down. Upon pulling the casing, we discovered that the casing shoe had spun off. We left the shoe in the hole and skidded the rig and the shop sleds back about 4'. This is the end of bore hole PB-6. After skidding 4' the hole is designated PB-6A. Quit work at 7:30 PM.

Bore Hole PB-6A

6 April

West winds, temperature -28°C at 7:30 AM. Went back to VE to pick up casing. Today the winds had picked up as of 4:00 AM and the blow was quite significant by noon. Fresh water and propane were picked up and hauled to the site. Arrived back at the ice camp by 11:00 AM. The air compressor was moved to the site and

the winds began to diminish by 3:00 PM. On bore hole PB-6A we used the heaviest casing we had which was a 4½" casing available from Diamond Drill Contractors. This was an attempt to test the heavier casing system with the pneumatic hammer and air compressor. The casing shoe had an outside taper and was bolted to the threads by a set screw technique. The wind was down and no blowing snow by 5:00 PM. Drove approximately 20' of the casing with the drop hammer and will now experiment with the casing hammer and guide system. The pneumatic hammer system is more efficient and has a higher frequency but does not have any more energy than the 300 lb. hammer that we normally use. We quit at 9:30 PM. Dinner was after 10:00 PM.

7 April

Up at 6:00 AM and to work by 7:00 AM. Last evening we drove approximately 3½', then added a 10' piece of casing. Using the air hammer, easily drove down the 10' to put the shoe at 30' below the drill table. Added another 10' of the heavy casing. Using the air hammer it took less than 10 minutes to drive 10' in the gravels. (Yesterday the first 20' was set with the small 140 lb. hammer.) At 12:30 PM we were ready to drill out the 40' of casing. Cleaned out to 40', used the Lynac sampler and 140 lb. hammer to drive 21" from 40' - 41' 9". This required 47 blows. In all cases of the drive sampling, the NW rod is being used to control the sampler. After the Lynac drive we drove another 10' of casing with the air hammer. At approximately half of the 2" air line open, the rate was 3 minutes per foot. It required about 1 3/4 minutes with the air line wide open to drive 1'. Fifty feet of casing is now set. Upon drilling out we encountered gravel at 44' and again at 46'. Gravels graded from coarse to fine before hitting coarse gravel again at 46'. All of PB-6A is being drilled out with the roller rock bit. After clean out the hole taped 50'. The Lynac sampler was used to sample the interval from 50' - 51' 9". It required 28 blows with the 140 lb.

hammer to go 21". Essentially, no recovery. The sampler contained approximately six pebbles and one large piece of rock which blocked the nose of the sampler. It was 7:30 PM. Added another 10' of casing and finished driving it by 9:20 PM. Quit at 10:00 PM.

8 April

Up at 6:30 AM and to work by 7:30 AM. Sixty feet of casing has been set and needs to be cleaned out. The air temperature has warmed up considerably and it is now -26°C at 8:00 AM. At 10:30 AM we were filling the water tanks. We still need to clean out 60' of casing and then sample. The sediments in the hole taped approximately 54' from the table. Wash samples were collected from the tee for the 54' - 57' interval and 57' - 60' interval. After clean out the Lynac was used to drive a sample from 60' - 61' 9". It required 54 blows to make the 21" drive with the 140 lb. hammer. Approximately the first 15-20 blows were very minor as the sampler broke out of the casing shoe. Recovered about 7" of the sample. Another 10' piece of casing added and air hammer used to drive the casing down to place the shoe at 70'. Rates for the pneumatic hammer were 197 blows per foot in 50 seconds, 266 blows per foot for 1 minute and 2 seconds, 252 blows per foot in 1 minute and 3 seconds. The sediments in the hole taped 64' 11" after the drive. Cleaned out to 70'. It takes approximately 1 hour to rig up, run the rod in the hole and drill out 6' of the sediments. The Lynac sampler required 82 blows with the 140 lb. hammer to go 21". Approximately for the first 14 blows, the sampler bit was still within the casing shoe and breaking out. Recovery was large rocks and represented about 7". The interval sampled was 70' - 71' 9" below the table. The air hammer was rigged up once again and the casing driven to 80'. The hammer was producing approximately 25 blows per inch. After driving the casing to 80' the sediments in the hole taped

about 74'. Cleaned out from 74' - 80'. We were cleaning out to 80' at 7:30 PM. Itwas very difficult drilling to 80' with large gravel being encountered. After clean out the Lynac was driven from 80' - 81' 9". No recovery from this sample run. It required 42 blows for the last 6" of the drive. Obviously the large rocks were compacted in the nose of the bit, preventing any material from entering. All day today we have had light winds from the east. Quit work at 9:30 PM.

9 April

Up at 6:30 AM, to work by 7:30 AM. Light winds from the east. At 9:00 AM we were rigging up to drive another 10' piece of casing to put the shoe at 90'. It took 14 minutes to drive the 10' piece of casing with the pneumatic hammer. The hammer being used is the McKiernan #5 pneumatic hammer. After driving the casing, the sediments taped 83' in the hole. Drilled out from 83' - 90', taking two wash samples, each representing a 3½' interval. Drilled out the casing to 90' by 11:00 AM. At 11:30 AM, the hole taped 90' from the table to the sediments. The Lynac sampler required 93 blows for a 21" drive with the 140 lb. hammer to sample the interval from 90' - 91' 9". We recovered approximately 1' of sample. We made the sample run and tripped out of the hole by 12:15 PM. At 1:00 PM drove casing to 100'. Actually it took from 1:04 PM to 1:29 PM to drive the 10' of casing. The hammer utilized 240 blows per minute at 100 psi. After driving the casing, the hole taped approximately 94½'. While cleaning out to 100', sands were hit at 98' 6" - 99' 1", approximately a 7" thick lens of sand. By 3:30 PM we were at 100', drilled out, cleaned out and tripped out to get the sampler. The hole taped 100' from the table after the clean out. The 300 lb. hammer was rigged up to drive the Lynac from 100' 2" - 101' 11". Approximately half of the 21" drive was with the 300 lb. hammer. Changed over to the 140 lb. hammer and it required 30 minutes to go about 6" with the 140 lb. hammer. It is

very difficult driving with 100' of rod and the springy effect as the hammer falls on these rocks. The drive actually consisted of only 17". Pulled the sampler out and recovered approximately 1'. Attempted to add a 5' piece of casing and drive it down in preparation to obtain another sample. We had to take off the 5' piece and put on a 3' piece of casing; unable to easily drive the 5' of casing down. The shoe finally ended up at 103' below the table. The circulating water temperature is approximately -2.5°C The casing drive, with the air valve approximately half open, took about 15 minutes to go the first 2'. It required 27 minutes to drive 3' of casing with the air hammer. After the drive, the time was 7:11 PM. Cleaned out to 103' by 8:30 PM. Used the Lynac sampler to sample from 103' - 103' 10". The 300 lb. hammer was used. By 9:30 PM the Lynac sampler was tripped out of the hole and the water lines drained. The sampler from the 103' - 103' 10" interval was stuffed with material. The sampler is merely bouncing on top of the sands and gravels, chewing it up and stuffing it inside. We need to apply pressure to the rods, hydraulically and drive at the same time. This will prevent stuffing the sampler full or sort of gathering it up all over the bottom of a 4" hole. We are only using a 2" sampler and it merely bounces around the bottom of the hole with this type of technique. We quit at 10:00 PM.

10 April

Up at 6:30 AM and off to VE at Prudhoe Bay at 8:00 AM. Back to the drill camp on the ice by 1:00 PM. Will pull 103' of large casing utilizing the DDC casing puller assembly. Using the casing pullers and the hammer, we moved the casing back 3', taped the hole and found that it was 100' deep. Put in the PVC for thermal measurements and quit work at 9:00 PM.

11 April

Up at 6:00 AM and to work by 7:00 AM. Continued to pull the large casing after installing the PVC. Ice in the annulous threatened to bind the PVC casing. A small spoon assembly had to be rigged up and utilized to dig the ice out between the casing being pulled and the PVC thermal tubing. Approximately five 20' pieces of PVC was installed. Quit work about 8:00 PM. This marks the end of bore hole PB-6A.

12 April

Up at 6:00 AM and to work at 7:00 AM. The generator has failed approximately three times in ten hours. We continue to be plagued by generator problems. We are ready to move drill camp this morning. The temperature was -17°F at 8:00 AM.

Bore Hole PB-7

We were finally in position for bore hole PB-7 approximately at 1:00 PM. At 1:00 PM the air temperature was up to -9°F We have approximately 6" of snow cover at this site. It is 3' 9" from the drill table down to the ice surface. The ice surface to the floor of Prudhoe Bay is 9' 4". The ice thickness is 5' 11". The ice freeboard, i.e., the distance between the ice surface and the actual water level, is 4 1/3". This means the drill table elevation down to the floor of Prudhoe Bay is 13' 1". Utilizing the Washington sampler and 15' of NW rod the sampler sank 2½" into the bottom sediments by weight alone. It required 13 blows with the 140 lb. hammer to go the remaining 23". The sample interval was from the bay floor to 25½" below the floor. The recovery was approximately 19". Before the Washington sampler was used to sample the bottom, the stream piston sampler was used to take 3 small bottom cores. By 7:00 PM 20' of NX casing was set in preparation for the second sample run with the Washington sampler. After driving to 20' it was 15' 7" from the table to the sediments in

the casing. While washing out, wash samples were caught from the 16' - 20' interval. We pumped directly from the sea and washed over the casing collar without utilizing circulation through the pit. The casing shoe after clean out was at 20' 1" below the table. The Washington sampler was used to sample from 19' 11" just inside the shoe to 22'. It required 20 blows with the 140 lb. hammer for a 25" sample run. We recovered 100% of the sample, i.e., 25" for a 25" drive. Added 5' of casing and cleaned out. The hole taped 20' 6" before the clean out began. Wash samples were caught from the 20' - 25' interval. Upon cleaning out, gravels were hit at 23' 7" in the casing. After clean out the hole taped 25'. Quit work at 9:30 PM. At these shallow depths it is necessary to use casing clamps and chains to hold the casing and prevent it from rotating as you drill out the inside. At 10:00 PM the air temperature was -19°F.

13 April

At 7:00 AM the air temperature was about -10°F The wind and blowing snow increased. We left the hole last night at 25' from the table down to the sediments, after the clean out. On the morning of the 13th in preparation to driving the Lynac, which we actually did, we then discovered that sands had run back into the hole up to 19' 6". We utilized 10 blows of the 140 lb. hammer to go 1' and then realized what had happened. Nevertheless, the sands did run in over night. We added a 1' piece of casing to put the shoe at 26' below the table. Drilled out the casing to 26'. After the clean out the hole taped 25' 2". The shoe is at 26'. It required 59 blows on the Lynac with the 140 lb. hammer for a 20" drive. The interval sampled was from 25' 2" - 26' 10". Recovered 100% of the drive. Added another 2' piece of NX casing, drove it down, placing the shoe at 28'. Cleaned out the casing, catching wash samples from the 25' 5" - 28' interval. Sands ran back in the hole from 28' up to the 25' 8" level. Took the check valve out of the Lynac sampler and washed it down. It required 20 blows with the 140 lb. hammer to go 21" after washing the

sampler back down to the 28' position. The actual interval sampled with the Lynac by washing it down was 27' 10" - 29' 7". A sample was recovered. Stopped for a break and lunch as usual about 2:00 PM in the afternoon. Added one 1' and two 2' pieces of casing to drive the shoe to 33' below the table. Up until now the 140 lb. hammer has been used, but will switch over to the 300 lb. hammer to drive the casing. The casing drove easily with the large hammer. After the drive, drilled out sediments inside the casing from 29' - 33'. The wind died down at noon. Wash samples were collected from 29' - 31' and from 31' - 33'. Then drove the Lynac 20", utilizing 66 blows with the 140 lb. hammer. Recovered approximately 6" of sample. Some sands were caught by the latex sleeve but most of the lower part of the sample washed out. Added two 2' pieces of casing and drove the shoe to 37'. Wash samples were caught while cleaning out the casing from 33' - 35' and from 35' - 37'. After the clean out the hole taped 37' 1". The Lynac was used to sample the interval of 37' 1" - 38' 9". The 20" drive with the Lynac and 40' of rod with the small hammer required 82 blows. The recovery was approximately 10". We pulled the NX casing and then quit at approximately 8:00 PM.

14 April

Up at 5:45 AM and to work at 6:45 AM. Set 40' of the heavy wall casing. Radiator on drill engine developed a bad leak and was down for repairs. Had to re-auger the hole through the ice sheet since it froze in during the night. We set the 4½" casing and again bolted the shoe to the casing. We set 40' of heavy casing, the first 30' with the 140 lb. hammer and the last 10' of the 40' string was set with the 300 lb. hammer. Cleaned out to 40'. After the clean out, the

hole taped 39' 8". The Lynac sample run was made from 39' 8" - 41' 4". It required 26 blows for a 20" drive with the 140 lb. hammer. Approximately 8" was recovered and the fine material on top of the core probably represents bit wash. Rocks plugged the Lynac bit and the sampler merely pushed ahead without taking in any sample. The air temperature is approximately -3°F at 6:15 PM. Added another 10' piece of casing and drove the shoe to 50'. It took 6 minutes to drive 10' with the pneumatic hammer. The hole taped 41' from the table down to the sediments in the bore after the 10' drive. In cleaning out from 41' - 50' wash samples were caught for the intervals 41' - 43' 43' - 45', 45' - 48', and 48' - 50'. Gravels were encountered inside the casing at approximately 43' 6". This gravel could represent a condition left by winnowing out the fine materials from utilizing the roller rock bit. After the clean out, the Lynac sampler was run in the interval 50' 2" - 51' 10". It required 154 blows for the 20" drive utilizing the 140 lb. hammer. We recovered a good sample and quit work at about 8:45 PM.

15 April

Up at 6:00 AM and to work by 7:00 AM. Added 10' of the heavy casing and drove the shoe to 60' below the table. It required 7½ minutes to drive the casing down 10' at 92 psi. The hole taped 53' from the table to the sediments after the drive. The hole was cleaned out from 53' - 60'. After clean out the hole taped 59' 7". The 140 lb. hammer and Lynac sampler, with 53 blows was used in the interval of 59' 7" - 61' 3". The first eight blows were very easy and fast. We recovered only about 8". At least 5" of the sample was debris left in the bottom of the hole. A large 2" rock plugged the sampler bit and prevented anything else from entering it. Drove 10' of heavy casing to put the shoe at 70' below the table. It required 10 minutes to drive the 10' of casing. After the drive the hole taped 63' 3". Cleaned out from 63' - 70' and caught wash samples. The

hole taped 70' 1" after the clean out and prior to running in the Lynac. One big rock could be felt on the bottom of the hole with the measuring tape. The time was 3:15 PM.Going in with the Lynac sampler to make a 20" drive. It required 104 blows utilizing the small hammer. About 9" recovered and looks like a good sample. The sampled interval represented 70' 1" - 71' 9". Added 10' piece of casing and used the air hammer to drive to 80'. It required 10½ minutes to make the drive. The hole taped 72' 10" after the drive. Sands were encountered in the casing from 74' 8" - 75'. Very difficult drilling in these gravels. Hole taped 80' 1" after the clean out run. The Lynac was tripped into the hole and driven 20" from 80' 1" - 81' 9". It required 161 blows with the 140 lb. hammer to go 20". The recovery was about 13". Another 10' piece of heavy casing was added and driven with the air hammer, putting the shoe at 90'. It required 13.3 minutes to make the 10' drive. Quit work at approximately 8:00 PM.

16 April

Up at 6:30 AM and to work by 7:00 AM. The sediments in the hole taped 81' 6". The shoe is at 90'. Wash samples were caught from 81' - 90'. Coarse sand with some gravel was encountered in the interval 84' - 86' 8". After clean out the hole taped 90' 2". The shoe was placed at 90' 3" below the table. The Lynac run began 1" inside of the shoe. Using a 140 lb. hammer, the Lynac was driven 20" from 90' 2" - 91' 10". It required 115 blows. Recovery was approximately 9" out of the 20" drive. Another 10' piece of casing was driven, putting the shoe at 100'. It required 13 minutes to drive with the air hammer. After the drive, from the table to the sediment in the hole, the distance was 93' 6". It was 1:00 PM. The casing was drilled out to 100'. Wash samples were caught from 93' - 100'. Essentially coarse sands, except heavy gravel encountered

at 97' 6". The hole taped 100' after clean out from the table down to the sediment level. In this type of material, a larger Lynac sampler, more suitable for the 4" I.D. of the casing would be desirable. The Lynac sampler was used to sample the interval 100' - 101' 8". Recovery was approximately 7" out of the 20" drive. It required 53 blows with the small hammer. The first 8 blows were very easy. Debris left in the hole made up essentially the top 4½" of the core and this was the reason for the first easy blows. Another 10' piece of casing was driven, placing the shoe at 110' below the table. It required 16¼ minutes to drive the 10' of casing with air. The hole taped 103' 6" after the drive. Wash samples were collected from 103' 6" - 110'. Organic material appeared in the cuttings. At 108' 3" large gravel was encountered again. Woody debris began appearing at about 107'. The hole taped 110' 1" after clean out. The Lynac was run in the hole again and used to sample the interval 110' - 111' 9". Approximately 9" of core was recovered out of the 20" drive. After sampling, another 10' piece of heavy casing was added and it required 13 minutes to drive. The shoe was at 120' below the table. Drained the pump and water lines; quit work at 9:00 PM.

17 April

Up at 6:30 AM and traveling in to VE camp. The hole taped 114' 2" from the table to the sediments in the hole. Upon drilling out the casing, a lot of organic material was flushed out. The hole taped 119' after the clean out run. This means that 1' of sand ran back into the hole. Just 5 minutes later the hole taped 117' 4" indicating additional sands ran into the hole. The shoe is at 120'. The hole held at 117' 4" after approximately 30 minutes of down time. Decided not to sample at 120'. Added 10' of casing and drove the shoe to 130'. In an attempt to control the sands, the casing was filled with water as the rods were extracted after the clean out run. It required 13 minutes to drive 10' of casing by 9:00 PM. We quit work at 10:00 PM.

18 April

Up at 7:00 AM, to work by 7:30 AM. Cleaned out casing from 122' 10½" - 130'. Sand and organic material until 126' and then encountered the first gravels. The hole taped 130' 2" after the clean out. The Lynac sampler with consistent penetration rates required 256 blows to go 20" with the 140 lb. hammer and 13 rods attached. The sampled interval was 130' 2" - 131' 10". The Lynac was stuck in the hole and had to be worked loose after the drive. Recovered about 11" out of the 20" drive. It appeared that part of the sample was bit wash. It takes approximately 1 hour to trip in, sample and trip out of the hole again at this 130' depth. Added another 10' piece of casing and drove the shoe to 140' below the table. It required 19 1/3 minutes to drive the 10' distance with the air hammer. The casing is stored outside of the protection of the drill house. Upon bringing the casing inside, it is extremely cold and when added to the string and driven down through the water column, ice forms on the inside of the casing. By 1:30 PM the casing was cleaned out to 140'. The hole taped 139' 6" after the clean out. It took 40 minutes to trip out of the hole. The time was 2:10 PM. The Lynac sampler required the 140 lb. hammer and 50 blows to sample the interval between 139' 6" - 141' 2". It was a 20" drive. Recovered about 8" of material. The shoe was at 140'. It took about 1 hour to make the sample trip in and out of the hole. It took 16 minutes to drive another 10' of casing with the air hammer. The casing shoe is now 150' below the table. The hole taped 143' 2" after driving the casing. Wash samples were caught while cleaning out the casing from 143' - 150'. Large gravel was encountered at 146'. After clean out the hole taped 150' ½". The Lynac sampler was utilized to sample the interval 150' - 151' 8". It required 102 blows with the 140 lb. hammer for the 20" drive with 15 pieces of rod. Recovery was about 13". We quit work at 8:30 PM.

19 April

Up at 5:45 AM, to work by 6:45 AM. Another 10' piece of casing was added, placing the shoe at 160'. It took 16½ minutes to drive 10' with the air hammer. After the drive the hole taped 154'. It took approximately 30 minutes to drill out the casing from 154' - 160'. After clean out the hole taped 159' 1½". Approximately 1' of sand ran back into the casing. Used the Longyear split-tube sampler which has a 7" trash tube for the next sample run. The Longyear sampler was driven 28". Recovery was approximately 12". There was 1" of fine sand on top of the recovered core and the remainder of the core looks like bit wash. An additional 10' piece of casing was added and the shoe driven to 170'. It required 19½ minutes to drive with the air hammer. After driving the casing, the hole taped 164' 3" from the table to the sediment level. Wash samples were caught. After clean out, the hole taped 169' 7". We drilled to 170'. Decided not to sample at 170'. Added another 10' piece of casing and drove the shoe down to 180'. With the air valve half open and 90 psi, it took 22¼ minutes to drive the 10' distance. After the drive with the air hammer, the top of the casing extended 4½" above the table. The time was 5:45 PM. After the drive, the hole taped 173' 9" from the table to the sediment level. Cleaned out to 180' by 7:00 PM. After the clean out run, the hole taped 178' 8½". Sands ran back into the hole. Decided not to sample. Added another 10' piece of casing and drove the shoe to 190'. It's obvious the hammer had a more difficult time to drive using the same techniques and running approximately 90-95 psi on the air pressure. It requires approximately 40 blows per inch; 270 blows per minute. It requires 25 seconds to go 2". The total drive of 10' with the air hammer required 22¼ minutes. Quit work at 9:30 PM.

20 April

Up at 6:00 AM and to work by 7:00 AM. It took approximately 30 minutes to trip 180' of rod into the hole with the bit. Cleaned out 184' - 190' inside the casing. Mostly sands with only a rare piece of gravel in the interval of 184' - 186'. The sands were evident as far up the hole as 180'. Gravel was encountered in the casing again at 187'. However, the gravel content was not very significant as compared to the sands being encountered. It required approximately 30 minutes to drill out the 6' plug of material inside the casing and another 30 minutes to trip the rod and bit out of the hole. The hole taped 189' 3" from the table to the sediment level after cleaning out to 190' with the roller rock bit. Therefore, there is approximately 1' of sand which ran back into the casing. Decided not to sample. Drove 10' of casing, placing the shoe at 200'. It required 29½ minutes for the air hammer to drive the casing from 190' - 200' level. With 5' of the drive remaining, the penetration rate was 30 seconds per 2". With 2' remaining to drive the air hammer was penetrating at 45 seconds per 2". Silts were encountered at this deeper level. The hole taped 191' 6" after driving the shoe to 200'. While cleaning out from 191' 6" to 200' heavy gravel was encountered at 195½'. At 197' pieces of wood appeared in the cuttings. Silts began showing up at 198'. This corresponds with the hard driving witnessed by the hammer on the previous casing drive. Circulating water temperatures are -2°C to -2.5°C The hole taped 200' from the table to the sediment level. Tripped out of the hole in about 25 minutes. It required 110 blows per 5". The total drive interval was over 15½" from 200' - 201' 3½". The recovery was about 1' out of the 15½" drive. The drive was limited to 15½" due to the springy rod conditions and extremely hard driving. The core was composed principally of a clayey silt and fine sand with some gravel. Added 5' piece of heavy casing. It required 21 3/4 minutes to drive the 5' piece. The casing shoe was at 205' below the table elevation. From the table to the sediments

in the hole it was 198' 7" after the drive. Wash samples were caught on cleaning out from 199' - 205'. After the clean out the hole taped only 202' 8" after drilling to 205'. Sands ran back into the casing. Quit work about 8:30 PM after draining the water lines, water tank and the pump.

21 April

Up at 7:00 AM and to work at 7:30 AM. The outside air temperature is about +18°F at 7:30 AM. Added another 5' piece of large casing and will try to drive to 210' with the shoe. It required 17½ minutes to drive the 5' with the air hammer. A few days ago the compressor operator misread the compressor output at 92 psi. This should be changed to 86 psi. After the drive the hole taped 205'. Drilled out from 205' - 210' and caught wash samples. The hole taped 210' 3" to the sediments below the table after the clean out run. The shoe is positioned at 210' 4" below the table elevation. A Lynac sample was taken next starting 1" inside of the shoe. The Lynac sample interval was from 210' 3" - 211' 11". It was a 20" drive with the 140 lb. hammer. Approximately 10" was recovered. It was necessary to use the 140 lb. hammer to jar the Lynac sampler loose after the sample run. Added another 10' piece of casing. The rate was 45 seconds per 2" with the air hammer. It took a total of 39 minutes to drive the 10' of casing. The shoe was positioned at 220' below the table. The hole taped 212' 9" after the drive. There was almost no gravel in the 215' - 219' interval. The discharge water became very dark at the 216' - 217' level. After the clean out run the hole taped 220' 1". This means there is 2" of sediments left inside the shoe. The Lynac sampler was used for a 20" drive. The Lynac interval was 220' 1" - 221' 9". A recovery of 13" was made in fine-grained soils. Approximately one half of the 20" drive was very easy which probably indicates that this was bit wash material. Added another 10' piece of casing but it was very difficult driving. It took 1 minute and 10 seconds per inch. Took off the 10' piece of casing and

added a 2' and a 3' piece. The shoe will be positioned at 225' after this drive. While driving the 5' section at one point it took 9 minutes and 35 seconds to go 17". Quit work at 9:00 PM.

22 April

Up at 6:30 AM and to work by 7:30 AM. From the table to the sediments in the hole it was 215'. Caught wash samples from 215' - 225'. However, all of this material is from the 220' - 225' interval only. The hole taped 225' after the clean out. No gravels were encountered in cleaning out. Since the soils are very cohesive at this depth it was decided to use a Washington sampler and the 140 lb. hammer to make a 20" drive from 225' - 226' 8". After making the sampler drive the CRREL personnel decided to jar the sampler back with the 140 lb. hammer. The driller advised against this especially while using a Washington sampler. The procedure should be to rotate the rod and jack the sampler back out gently since there is no core catcher or basket in this type of sampler. The CRREL personnel insisted on the hammer. The result was zero recovery. We were out of the hole with the sampler by noon. By 3:15 PM the PVC thermal casing was installed and we began to jack and jar back the large casing. By 9:30 PM the casing extraction was progressing very well. Decided to lower the water level in the annulous between the PVC and the steel casing and shut down for the night. We had pulled off 15' of the 225' casing string by quitting time. We attempted to pull down the water level in the annulous between the PVC and the steel casing with the mud pump. We were unable to do this which indicated that water was entering from somewhere approximately 200' below. When water was added to the annulous above the sea level, the level in the annulous slowly lowered to sea level. We quit work at 10:15 PM.

23 April

Up at 6:30 AM and jarring out the casing and using jacks by 7:45 AM. The higher velocities obtained with the 140 lb. hammer and the casing jacks gave the best results in extracting the casing. The casing jacks alone were able to move the casing when 160' of casing remained in the hole. One piece of this heavy duty casing broke in the female threads. A number of the joints of this 4½" casing were loose. All of the casing string had been extracted by 2:30 PM. This marks the end of bore hole PB-7. We quit work approximately at 8:30 PM.

24 April

Clocks were set 1 hour ahead. Went in to the VE camp. Returned to the site of bore hole 7, hooked the Caterpillar onto the drill and shop sleds and moved to Reindeer Island by detouring a pressure ridge. The trip from PB-7 to the PB-8 site took about 3 hours. We left the drill and shop sled at Reindeer Island and returned with the Bombardier and Cat to the sleeper at bore hole 7. We arrived at PB-7 about 10:00 PM.

25 April

The camping unit with the kitchen and sleeper, generator and fuel and air compressor will be moved today to the site of bore hole 8. The driller went to VE camp to make phone calls. The driller and one USGS man drove the pickup over an ice road back to Reindeer Island between 7:00 and 7:30 PM.

Bore Hole PB-8

At bore hole PB-8 there was 22' 11" from the ice surface to the sea floor. From sea level up to the ice surface the freeboard was 7". The ice thickness was 6' 7". Three 10' pieces of NX casing were initially set. It is 3' 9" from the drill table to the ice surface. The Washington sampler was used to sample the interval 26' 8" - 28' 9" below the table. The 25" drive went in 9" by the weight of the drill rod

and sampler alone. The 140 lb. hammer was used to tap the rest of the way. The recovery was 100%. Quit work at approximately 8:00 PM.

26 April

Up at 6:30 AM and to work by 7:00 AM. The casing shoe is at 29' 6". After the clean out run the hole taped 29' 6" from the table down to the sediments. The Washington sampler was used to sample the interval from 29' 6" - 31' 7". The 25" drive required 37 blows with the 140 lb. hammer. The sampler recovered 18" of the 25" drive. Added 2' piece of NX casing and used the small hammer to drive the shoe down to 32' below the table. After clean out the hole taped 31' 7". Five inches of the material remained between the bottom of the hole inside the casing and the end of the casing shoe. The Washington sampler was used to sample the interval from 31' 7" - 33' 8". Recovered 19" of the 25" drive. The material was clayey sands, dark in color. Added another 2' piece of NX casing and drove the shoe to 34'. The air temperature is +10°F and very windy at 10:00 AM. The clean out run resulted in a depth of 33' 11". The Washington sampler was used to sample the interval from 33' 11" - 36'. It required 47 blows with the 140 lb. hammer for the 25" drive. Added another 2' piece of NX casing and placed the shoe at 36' below the table. In the last two core samples, ice-rafted stones appeared. The shoe is now at 36'. After the casing drive the hole taped 34' 6". After the clean out the hole taped 35' 10". The shoe is at 36'. The Washington sampler was used to sample the 25" interval from 35' 10" - 37' 11". The recovery was 100%. Another 2' piece of casing was added and the shoe driven to 38'. After driving the hole taped 35' deep. The hole taped 37' 10" after the clean out run. The Washington sampler was used again to sample from 37' 10" - 39' 11". It required 63 blows for the 25" drive using the 140 lb. hammer. A total of 19" of soil material was recovered out of the 25" drive. Broke a pull piece while using the big hammer to drive casing. A 2' piece of NX casing was

added and driven down with the large hammer, placing the shoe at 40' below the table. The hole taped 38' 2" after the easy drive. After the clean out, utilizing sea water and the small roller rock bit, the hole taped 39' 11". The Washington sampler required 47 blows with the 140 lb. hammer to go a total of 24". The sample drive was from 39' 11" - 41' 11". Added another 2' piece of NX casing and drove the shoe to 42'. The hole taped 40' 10½" after the drive. Cleaned out with the small roller rock bit and sea water to 42'. The hole taped 41' 9" after the clean out. The Washington sampler was used to sample the 25" interval from 41' 9" - 43' 10". It required 51 blows with the 140 lb. hammer. An excellent sample was obtained. Another 2' piece of casing was added and the shoe driven to 44'. The hole taped 42' after the drive. After the clean out run the hole taped 43' 11". Again, the Washington sampler and 140 lb. hammer were used to sample a 25" interval from 43' 11" - 46'. It required 28 blows. The recovery was 24½" out of the 25" sampled interval. Another 2' piece of casing was added and the shoe driven to 46'. After the drive from the table to the sediment level it was 43' 11". The hole was cleaned out to 46'. After the clean out run the hole taped 45' 11". The Washington sampler was used to sample the interval from 45' 11" - 48'. It required a mere 13 blows with the 140 lb. hammer. Initially the sampler sank about 2" with just the weight of the rod. Recovery was 100%. Quit work at 8:30 PM. The weather was still windy with blowing snow.

27 April

Up at 7:00 AM and to work by 8:00 AM. Blowing snow and about 0°F. air temperature. Drove 2' of NX casing, putting the shoe at 48' below the table. After the drive and clean out the hole taped 47' 10". The Washington sampler was used on the interval 47' 10" - 49' 11". The sampler sank approximately 10" with just the weight of 5 rods. Once the 140 lb. hammer was placed atop of the rod, the sampler continued for the rest of its interval, i.e., we did not have to drive at all.

Upon retrieval of the sampler we discovered that the sample coned on the end and we recovered 10" out of the 25" interval. Decided to remove 8' of casing from the string, put on a 10' piece of casing, go back and drive the shoe to 50'. After putting on the 10' piece and driving the shoe back to 50' the hole taped 46' 9". Cleaned out to 50' with sea water and a small tri-cone bit. The Washington sampler was used to sample the interval from 49' 11" - 52'. Actually there was a 5" overrun and the end of the sampler bit ended up at 52' 5". Upon tripping out with the sampler, we recovered a 26" sample. Added 3' of NX casing and drove the shoe down to 53'. The hole taped 50' after the drive. The hole taped 53' after the clean out. During the clean out the drill water being returned was light in color from 50' - 52½'. The water color changed to dark in the interval from 52½' - 53'. Used the Washington sampler again to sample from 53' - 55' 1". The weight of the drill string and sampler almost went down the total sample interval; the last 6" and the 140 lb. hammer was used. The recovery was 22" out of the 25" drive. Added 2' more of NX casing and drove the shoe down to 55'. The hole taped 52' 8" before the clean out. Cleaned out the interval from 52' 8" - 55'. The material being sampled with the Washington sampler has become more stiff. The Washington sampler was used on the interval from 55' - 57' 1". The recovery was 21" for a 24" drive. The sampler was merely tapped in with the small hammer. An additional 2' of casing was added and the shoe driven down to 57'. The hole taped 55' 6" after driving 2' of NX casing. The clays being encountered armor the drill rod and the inside of the casing. The shoe is at 57' and after the clean out the hole taped 57' 1". The Washington sampler was used to sample from 57' 1" - 59' 2". It required approximately 50 blows for the last foot of the drive. The recovery was 24" for the 25" drive. An additional 2' of NX casing was added and the shoe driven to 59'. The casing is beginning to drive hard at 58' while using a 300 lb. hammer. The hole taped 57' 8" after driving the 2' piece. Upon cleaning out to 59' the bit hit one piece of gravel

at about 58' 8". The hole taped 59' after the clean out. The Washington sampler was used to sample the interval from 59' - 61' 1". Approximately 10" of sample was recovered. About half of the 10" sample appeared to be cuttings left in the bottom of the hole. Later, and upon closer inspection, the geological technician on duty said that the upper 5" did not appear to represent cuttings on the bottom of the hole. The 25" interval drove rather easily at first and then the material stiffened; it required approximately 1 blow per ½" for the last foot. Drove the casing down 2' more to put the shoe at 61' depth. Quit work at 9:00 PM. The wind has diminished considerably this evening.

28 April

Up at 6:30 AM and to work by 7:30 AM. The hole taped 61' after the clean out. The Washington sampler required approximately 50-60 blows for the last foot of the 25" drive. The recovery was 16" for the drive. The interval sampled was 61' - 63' 1". The casing was driven down to 63'. After the 2' casing drive, the hole taped 61' 3½" from the table down to the sediment level. Some gravel was encountered at 62' 10" while cleaning out the casing. After the clean out run the hole taped 63' 1". The Washington sampler was used to sample the interval 63' 1" - 65' 2". The recovery was 15" for the 25" drive. Approximately 50 blows were utilized with the 140 lb. hammer for the last foot of the drive. At 12 noon drove an additional 2' of casing to put the shoe at 65'. After the drive the hole taped 63' 2". Gravel was encountered at 63' 9" while cleaning out. The Washington sampler was used on the interval of 65' 2" - 67' 3". It required 30 blows with the 140 lb. hammer with just half of the drop distance for the first foot. The second foot required 53 blows of the full drop distance. The hammer drop distance is 30". The Washington sampler revealed a sample consisting of lenses of coarse sands and some gravel. Attempted to drive 2' more of casing to put the shoe at 67' but did not make the distance. After approximately 9"

pull piece for the large hammer broke again. Decided to pull all of the NX casing and go back to this depth to 70' with the heavy duty 4½" casing. At 6:00 PM it was very difficult to jack and jar back the NX casing. By 7:30 PM only about 5' of the NX casing had been extracted. The casing finally broke loose and by 9:00 PM we had the entire string of casing out of the hole. Quit working at 9:30 PM.

29 April

Up at 6:30 AM and to work by 7:00 AM. Set 35' of the 4½" heavy duty casing in the old hole left open by the NX casing. The casing easily slipped into the hole with its own weight. An additional 5' was easily accomplished with the 140 lb. hammer. The shoe was at 40'. Ten feet of casing was added and tapped down with the 140 lb. hammer. The casing broke loose and free-fell in the 50' - 55' interval. The driving became more difficult from 55' - 60'. Added another 10' piece of casing and using the air hammer easily drove the casing down to 70'. The air hammer in 20 blows over a 5 second interval moved 2". We are still in the old hole left by the NX casing and this is in the interval of 60' - 65'. Beyond the 65' depth the hammer required 10 seconds to penetrate 2" while the casing was driving in new hole. Later on in the new hole and before the 70' depth, the hammer required 17 seconds per 2". After driving the casing shoe down to the 70' depth the sediments in the hole taped 49' 6" below the table. Considerable gravel was encountered at the 67' depth while cleaning out. Pump pressure and volume had to be increased since the gravels encountered were not moving up the annulous very well due to armored clays on the rod and inside of the casing. After the clean out run from 50' - 70' the hole taped 70' and very clean. Utilized the Lynac sampler to sample the interval from 70' - 71' 9". The weight of the drill string and sampler enabled the unit to sink 5" of the 21" drive. One hundred blows of the 140 lb. hammer were required to move the sampler

the additional 13". The recovery was 17" for a total 21" drive. Added another 10' piece of the 4½" casing and drove the shoe down to 80'. It required 9 3/4 minutes to drive 10'. The last 5' of the drive in the 75' - 80' interval went very fast. Decided not to sample but added another 10' piece of casing and drove to 90'. While driving at the 87' depth the penetration rate was 33 seconds per 2". It required a total of 15½ minutes to drive from 80' - 90'. The hole taped 70' 4" from the table to the sediment level after the drive. Went in with the roller rock bit and cleaned out the interval 70' - 90'. The hole taped 90' after clean out. Went in with the Lynac sampler to sample the interval from 90' - 91' 9". It required 113 blows with the 140 lb. hammer. The rate or penetration was very even throughout the drive. Added 10' more of casing and using the air hammer it took 17 minutes to drive this down to 100'. Added another 10' piece at 9:00 PM and drove the shoe down to 110' depth. The air hammer required 18½ minutes to drive the casing through the 100' - 110' interval. Quit working at 9:45 PM.

30 April

Up at 6:30 AM and to work by 7:15 AM. A rather strong breeze out of the east this morning. The hole taped 99' 11" from the sediment level to the table. Cleaned out to 110'. After the clean out the hole taped 109'. One foot of sands ran into the hole. Decided not to run the Lynac sampler. PVC thermal casing was installed. Finished the hole about 2:00 PM. Rigged up the casing jacks and the 140 lb. hammer and started jarring back the casing string. The first 1" on the casing moved easily. The bail on top of the 140 lb. hammer broke, requiring us to go to the 300 lb. hammer. The 300 lb. hammer cannot attain the velocity of the 140 lb. hammer and probably results in less energy. By 10:30 PM we had 110' of the 4½" casing pulled. It was a very tough job until we got past the clay zone in the lower part of the hole.

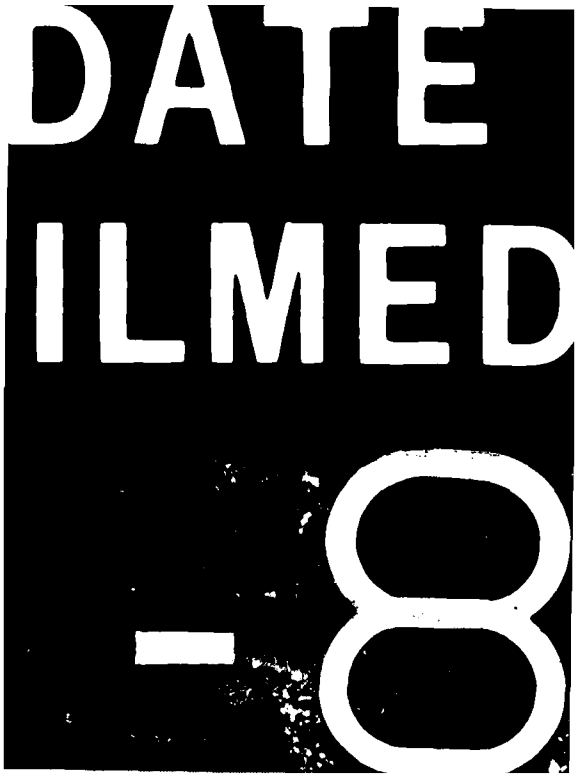
1 May

Up at 6:15 AM and to work by 7:00 AM. The wind has subsided. The PVC was cut off in order to clear the drill sled frame. It was 31¼" from the top of the PVC up to the drill table level. By 6:00 PM the two drill sleds were moved back to VE Surfcote camp. We checked into the NORCON camp at 7:15 PM. Finally quit work about 11:00 PM.

2 May

Up at 6:30 AM and to work by 7:00 AM. Cleaned up the drilling equipment and sleds.

Clean up of equipment and storage for the winter continued over 3 and 4 May. Finished up last details and left Prudhoe Bay the morning of 5 May.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