

ICE DRILLING DESIGN AND OPERATIONS - TECHNICAL ADVISORY BOARD

Tuesday, September 13, 2016

Union South - Agriculture Room, 3rd Floor

University of Wisconsin – Madison

Madison, WI 53706

Attendees:

Mary ALBERT – Dartmouth College	Terry BENSON – UW Physical Sciences Lab
Fred BEST – UW SSEC	Steffen BO HANSEN – University of Copenhagen
Grant BOECKMANN – UW IDDO	Jeff CHERWINKA – UW Physical Sciences Lab
George COOPER – Univ. of CA – Berkley, ret.	Josh GOETZ – UW IDDO
Chris GIBSON – UW IDDO	Mike JACKSON – NSF
Michael JAYRED – UW IDDO	Jay JOHNSON – UW IDDO
Jim KOEHLER – UW IDDO	Tanner KUHL – UW IDDO
Don LEBAR – UW IDDO, ret.	Keith MAKINSON – British Antarctic Survey
Jill MIKUCKI – Univ. of Tennessee	Hideaki MOTOYAMA – Nat. Institute of Polar Research Japan
Mark MULLIGAN – UW IDDO	Chris NIENDORF – UW IDDO
Dennis NIELSEN – DOSECC Exploration	Marshall PARDEY – QD Tech, Inc.
Dale POMRANING – Univ. of AK – Anchorage	Alex PYNE – Victoria University of Wellington
Alex SHTURMAKOV – UW IDDO	Kristina SLAWNY – UW IDDO
Pavel TALALAY – Polar Research Center, Jilin Univ.	Mark TWICKLER – Univ. of New Hampshire
Tony WENDRICKS – UW IDDO	Frank WILHELMS – Alfred Wegener Institute
Kris ZACNY – Honeybee Robotics Spacecraft Mechanisms	

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|----------------|---|------------------|
| 8:30 AM | Welcome and Introductions | Mulligan |
| 8:35 AM | Meeting Logistics | Wendricks |
| 8:40 AM | Chairman Opening Comments | Wilhelms |
| 8:45 AM | Update on the IDPO Science Advisory Board | Albert |
| | <ul style="list-style-type: none">• Zacny: Are all US drilling developments done at UW?<ul style="list-style-type: none">• Albert: WISSARD was done at UNL.• Cooper: What about RAID?<ul style="list-style-type: none">• Albert: The system is at DOSECC. Described the history of it.• Jackson: Currently managed by DOSECC, but long term it may come under IDDO. He has encouraged IDDO to become familiar with the system and hopes that an IDDO staff member can participate in the activities this season.• Wilhelms: Is there a reason for the lack of research in East Antarctica?<ul style="list-style-type: none">• Albert: IDDO's activities are set by science priorities. Gaining a better understanding of what is going on at WAIS, since it may have an impact on the US, drives the priorities.• Talalay: Does funding support drill operations and development?<ul style="list-style-type: none">• Albert: Yes. | |
| 9:08 AM | SAB / SAWG Update | Mikucki |
| | <ul style="list-style-type: none">• Talalay: Inquires about the design of the WISSARD System.<ul style="list-style-type: none">• Mikucki: UNL adopted a keep it simple philosophy to control costs. Need for continuity of drillers/engineers with large systems (i.e. WISSARD). | |
| 9:23 AM | Update on the Long Range Drilling Technology Plan | Slawny |
| | <ul style="list-style-type: none">• Cooper: What is the concept for the winch simulator? Will it be software?<ul style="list-style-type: none">• Slawny: The goal is to have a small simulator that can be shipped to the PI to test their tool at their location rather than them travel to Madison. They may still need to come to Madison if they need to conduct a pressure test of their tool.• Zacny: How does IDDO handle requests for using the same system at the same time? | |

- Slawny: We acknowledge in the letter of support that there is another request for the system at that time and we make sure the NSF is aware of it as well. Which project to fund is the decision of the NSF. This has been an issue for the BID. We are working to make a second system.
- Albert: We may try to manage things if it's an agile system that can be used twice within one season.
- Talalay: Does IDDO drill in ice-free areas?
 - Slawny: We have the ASIG and Winkie systems, which will drill through ice and then rock, but we have not had requests for drilling directly into rock.

9:35 AM 2015-16 Field Season & Upcoming 2016-17 Field Season Slawny

- Nielsen: What fluid on ASIG?
 - Slawny: Isopar-K

10:00 AM Rapid Air Movement (RAM) Drill Johnson

- Nielsen: Design on hammer?
 - Jay: We are planning to go rotary, so no hammer. Described the current state of the design.
- Cooper: Have you considered using the existing system as a loss circulation system? Perhaps using something like bentonite to fill the firm as you go down?
 - Jay: Tried using a parachute to line the hole, but locks up the system at 25-m. We also considered a side spraying hot water nozzle to freeze and close the walls, but it takes a day to freeze and resulted in potentially dangerous shards of ice being blown out of the hole..
- Talalay: An air drier may help. Johnson agrees.
- Marshall: Suggests a different motor for a recirc system. Johnson agrees.
- Cooper: The down hole air is wet?
 - Johnson: Yes, which is why Talalay suggested the drier.
 - Cooper: A powder material, like bentonite, would cake up if injected prior to drying. Johnson agrees.
- Pomraning: Anyway to pack it as you go down?
 - Johnson: We have considered a hammer.
- Cherwinka: Do you need to stop airflow to connect the pipe?
 - Johnson: Yes, we could not keep going with the forward circulation. With the chips in the center, wait until chips clear to stop and connect.
 - Cooper: There is a risk for some chips going into the annulus. Johnson agrees.
- Talalay: Wasn't there a graduate student firm study?
 - Albert: Yes, a student did research the firm. The solutions being discussed may address the issues in her student's research.
- Cooper: What about weight on the system?
 - Johnson: For a 100 m deep hole, the mast will need to hold up 2,000-3,000 pounds. The 10-m tubes should easily be able to handle it.
- Pardey: We have used 10-m carbon fiber tubes with titanium ends
 - Pyne: CSIRO used diamond-coring rods with carbon-fiber tubes. They worked well in tension, but the rods were susceptible to failure in torsion. Wouldn't rotation be an advantage if the drill were stuck?
 - Johnson: We could back cut without rotating the rod.
 - Cooper: Are their issues with galling with titanium on titanium? Pardey: No.

10:20 AM MORNING BREAK

10:35 AM DISC vs. IDD Deep Analysis Shturmakov

- Talalay: DISC was originally designed for 4-meter cores. It failed to meet this spec due to the pump. Will there be a redesign?
 - Shturmakov: Not a complete redesign but larger screens to handle the chips.
 - Talalay: You need to consider the pump as well. The redesign should be tested.
- Wilhelms: Are the science requirements finalized?

- Shturmakov: It's in process. There is a current push to reduce logistics needs on all drilling and a hold on deep drilling. This created the need to look hard at IDD-Deep. Site selection at Herc Dome was not funded this year.
- Wilhelms: Replicate coring allows for the borehole logging. That would be lost with IDD-Deep once a whipstock is in.
 - Shturmakov: At Herc Dome, replicates would be deep. We (Scientists/IDPO/IDDO) need to consider and trade off the science requirements.
- Cooper: Could we use a "drillable" whipstock? I.e. use a polymer that can be used to deviate and then put a different drill head on that allows you to drill through the whipstock. (Possibly a pilot hole and then full drill head?)
 - Shturmakov: Would need to remove the entire whipstock so that borehole tools could get passed.
 - Cooper: Possibly use a smaller drill for the replicate that allows for a smaller whipstock and removal.
 - Pyne: Perhaps under ream it? In the oil industry they under ream, drop in a whipstock, and eventually drill out the whipstock.
 - Pardey: The industry has used a removable whipstock that comes out as the drillhead is pulled out. The core is smaller.
- Pardey: Core length of IDD is 3-m? Very similar to Japan drill which goes 3.8-m.
 - Shturmakov: Could be longer but would require more modifications than assumed in this presentation.
 - Johnson: There is a scaling that goes with the drill system infrastructure. But, yes, even with a longer core, the logistics of IDD would still be less than DISC.
 - Bo Hansen: IDD is based on the Hans Tausen drill, as is a Japanese system, each of which get 4-m core. It can be done. Having a stock drill and deviating can be very important; however.

10:57 AM IDDO Hot Water Drills

Gibson / Goetz

- Cherwinka: Would the Modular 2500-m Clean Drill replace WISSARD?
 - Albert: We are working on the science requirements but fleshing it out depends a lot on BAS efforts with their 2300-m system (not on table in the slides). NSF may be reluctant to fund a US drill that is the same as the BAS system but encourage collaboration with BAS.
 - Mikucki: Getting the science requirements is important so the community is documenting their needs.
- Albert: There is a proposal submitted by Mikucki (PI) and Albert (Co-I) to the NSF to fund the SchWD system.
- Cooper: The weatherproof covers are fabric?
 - Goetz: Yes, cold-rated nylon. It saves volume and weight over a box.
- Pomraning: The crate is made out of what material?
 - Goetz: Wood. It's used to get to McMurdo. It's then uncrated and shipped to the site.
- Goetz: The SmHWD only gets to 60-m. The SchWD is required to get to 1000-m.
- Talalay: The SchWD is not clean?
 - Gibson: It's designed to be clean, but the initial system will not have filtration.
 - Mikucki: Have you thought about how the system would clean?
 - Gibson: Feels the system design will be driven by the cleanliness requirements, but the current design will not do anything to prevent later implementing the cleanliness requirements.
- Makinson: What is the thermal power?
 - Benson: 60kW/heater, 120kW total. Same for 30 or 60 m, the difference is the hose.
- Makinson: Has the SmHWD been used and do you have performance vs. design data?
 - Benson & Gibson: We do not have good field performance data but scientists have been happy.
- Pyne: What is the time driver, melting ice for drilling or drilling itself?
 - Benson: Unsure how the scientists are operating the system.

- Pyne: What is the cycle time?
- Gibson & Benson: Cycle times assume you are melting while you drill. If you have water, a hole (15 min) will come faster, longer if you need to melt and then drill.

11:18 AM Intermediate Depth Drill (IDD)

Johnson / Boeckmann

- Wilhelms: 14-15 season was a 2-shift operation? Johnson: Yes.
- Talalay: What was temperature inside tent?
 - Johnson: -20°C. They did have to open the doors at times to keep it cool. The control room was at 15-20°C.
- Wilhelms: Would be interesting to compare the core breaks and the cutters. The physical data could be very enlightening. The ice characteristics change as you change depth and have an effect on the drill.
- Johnson reports a 10% chip loss rate, which Bo Hansen says is consistent with the Dane's experience.
- Pomraning: Is the Estisol from the same manufacturer?
 - Johnson: Yes, different batch. We did a better job keeping it out of the control room.
 - Gibson: Temperature is a key. Johnson agrees.
- Wilhelms: The final depth was limited by...?
 - Johnson: Time. 1900 m of cable on the winch and we collected 1751 m of core.
- Cherwinka: EHWD had issues with any aluminum connection that wintered over. They all had to be retightened at the start of the season.
- Pomraning: What brand of motor? Johnson: Parvalux
- Cooper: Were plugs press fit?
 - Johnson: Yes, he could put them in with 2 fingers. Mitigated with a breather workaround, since the vendor felt we did not need one.
- Kuhl: What was the source of the shorts?
 - Johnson: Flat spots that the vendor feels did not occur during manufacturing. They may have developed during spooling.
 - Makinson: What is the solution to prevent them?
 - Johnson/Cherwinka: Spool under tension.
 - Johnson: We would hear knocking noise due to differences in tension going down and up.
- Wilhelms: What insulation did they use on cable?
 - Johnson: It was a PTFE derivative.
 - Wilhelms: Had PTFE mixed with fibers?
- Talalay: How did you fix the cable fibers?
 - Johnson: Sandwich broken wires between shim stock secured with the good wires on either side of the broken ones.
- Motor Troubleshooting:
 - Motor Power Supply does not current limit properly.
 - Pomraning: Were brushes seizing prior to failure. Johnson: No.
 - Wilhelms: What voltage is the motor at?
 - Johnson: 210-volt, 600 W. It would be a custom-modified motor. Sticking with brushed motor to use it on Foro as well. TENC.
- Talalay: What is the diameter of the winch cable? Johnson: 7/32
- Talalay: Breaking strength? Johnson: 22.7 kN for the new cable, 24 kN for the old cable.
- Wilhelms: Voltage rating? Johnson: 600-volts.
- Talalay: What was Trevor's role?
 - Johnson: He was not there to support a shift, but he would periodically come over to observe/help.
- Pyne: Did not have as much chip loss while on Ross. Reasons?
 - Johnson: Slower speed for pulling out and 132 mm hole.
 - Wilhelms: Lower pitch?

- Bo Hansen: At Greenland, temps are warming, so the chips would sink. Would pick up the chips with the next core.
- Johnson: Did experience some floating / some sinking.
- Bo Hansen: Different speeds for different hole sizes?
 - Johnson: Yes, up to 1-m and limited to 0.7-m in smaller dia. Observed speed changes going up as well, sheave tension dropped off once they hit the larger diameter hole.

12:07 PM LUNCH (provided): Continue Discussions

1:15 PM Portable Firn Coring Drill Shturmakov

- Talalay: The drill is operational by one person?
 - Shturmakov: Yes, often used with more than one person, but only one person is required.
- Cooper: How long will battery pack run?
 - Shturmakov: 1 day, but planning for backup. Unsure how 1 day is defined, 12 hours? The solar panels can be deployed for power as well.
- Bo Hansen: Expressed concern about the lack of an outer jacket. He is leery of it working on all glacier conditions. Works in some places, not sure it will work everywhere.
- Talalay: Suggests trying to work chip transport with varying speeds.
- Pomraning: Recalls Bruce using a solar panel drill that would get too hot during the day and would need to stop.
 - Shturmakov: Would drill at night if too warm in the day.
- Zacny: How big is battery pack.
 - Shturmakov: Day operation.
- Cooper: Presumably the solar panel floats across the battery.

1:30 PM Foro Drill Johnson

- Wilhelms: Motor/gearbox: did observe grease leaking from the gearbox back towards the motor. Johnson: 8-pole, 3 phase motor.
- Wilhelms: What is the screen? Johnson: An LCI-90i display, rated to -40, splash proof, and viewable in bright light and off angle. Used on other systems.
- Cooper: Tower is fiberglass? Yes, custom ordered to meet thickness.
- Pomraning: Voltage on the cable? 200-volts.
- System is compatible with the 4-inch drill, but you need to run the 4-inch drill control box.
- Talalay: Dry? Yes, planning to run dry, but could do wet drilling like Hans Tausen. Simpler system for dry.
- Wilhelms: Inclinable tower? No.
- Wilhelms: Keep torque off drill?
 - Johnson: The drill is laid down and separated for core delivery. Some projects prefer the tall tower for deployment of other tools.

1:41 PM Winkie Drill Boeckmann

- Talalay: Not planning to collect ice core? Boeckmann: Not planning to collect it for this project but we could use an ice core bit. Tried it during testing but the cores were pucks.
- Pyne: Are you taking the water out of the air before it goes down the hole? Boeckmann: We do not have an air dryer. Hoping the air is dry enough. Pyne does use them even at high altitude at low RH. Perhaps bring a boiler with ethanol. Rods are aluminum.
- Talalay: Temp of air after compression? Boeckmann: Near ambient if not pressurized.
- Cooper: Can you pour water in the hole to freeze and seal cracks? Boeckmann: Possibly. Could consider it.
- Cherwinka: Depth? Boeckmann: 10-50 m depths.
- Kuhl: Could do fluid circulation in the ice? Boeckmann: Yes, if we had to.
- Pyne: Could use lay flat tubing on the surface to cool the air, need to shield it from the sun.
- Nielsen: Sounds like you are aware of the Winkie drill engine reliability.
- Talalay: Suggests familiarizing ourselves with the issues other users have had.
- Zacny: Does it do a standard core break?

- Shturmakov: Yes.
- Zacny: What is the force?
- Shturmakov: We are unsure, but could measure it in testing?

2:04 PM

Agile Sub-Ice Geological Drill

Gibson / Kuhl

- Pomraning: Suggests a change to make the fluid recovery system work more like a pumping system.
- Talalay: How fast can we clean? Same speed as the pump?
 - Kuhl: Need to clean faster than the filter clogs, but we can stop to catch up.
- Pyne: What percentage of cuttings goes into the filter socks?
 - Gibson: When we go to rock we will bypass. The filter socks are a backup.
- Pomraning: Regarding the anchor pull tests, how long were the flights?
 - Boeckmann: They were like threaded rods with plates on the end.
 - Gibson: We have made our own based on Boeckmann's tests.
 - Cherwinka: Inquires a bit about the design and how it works.
 - Gibson: There is an off center hole in plate, push it down and it bites in as you lift.
 - Pyne: How does fracture pressure compare to the theory?
 - Gibson: Have heard numbers as high as 300.
 - Johnson: We went by firm density, 0.87 as a guide.
 - Cherwinka: Where are you drilling?
 - Gibson: Pirrit Hills.
 - Cherwinka: Pullout is heavily dependent on temperature. South Pole should be worst case.
 - Twickler: Pirrit Hills densifies quickly.
- Pyne: The ice well, did it freeze from the bottom up or top down?
 - Gibson: Bottom up, mainly due to the small pours.
 - Pyne: Glycol loop did not force it to freeze from the bottom up?
 - Gibson: No, it's temperature was fairly isothermal.
- Talalay: Hole depth?
 - Gibson: 50 ft. (Cherwinka: 13 m)
- Talalay: Diameter?
 - Gibson: Not 50 ft. Ice was 10" and the hole was 2.5"
- Nielsen: Drill fluid?
 - Gibson: Isopar-K
- Cooper: What is the attraction of the site?
 - Albert: Doing cosmogenic dating to find out when is the last time it was not covered by ice.
- Nielsen: Plastic liners?
 - Kuhl: No?
 - Nielsen: Do not want the top rock core to see sunlight.
 - Kuhl: Stone has come up with a system for black bags.
- Pyne: Regarding fracture gradients, in the colder ice at the firm ice transition, will it be stronger?
 - Kuhl: Yes, according to Jeff Severinghaus paper.
 - Twickler: -20°C temperatures expected.
 - Pyne: You will be close (temperature-wise) to McMurdo.
 - Kuhl: Honestly not sure what temperature we will hydro fracture at. Higher with rock coring bit, but not 100 psi.
 - Pyne: His group has conducted some tests recently with air and the back pressure was in excess of 100 psi.
 - Cooper: Higher pressure will be ahead of the bit and drop off after that.
 - Kuhl/Gibson: Yes.
 - Wilhelms: Russian claims of hydrofracture?
 - Talalay: Unsure. A few bars?
- Cherwinka: Bottom line, if you can test the anchors in the field that is all that matters.

- Kuhl & Pardey: The anchors are really not needed due to the weight of the rig. Can't pull the packer out with the full weight of the drill.
- Wilhelms: His group has used a disc of aluminum with an anchor rod screwed into it, which will be removed when the anchor is no longer needed.

2:55 PM AFTERNOON BREAK

3:20 PM Open discussion of IDDO Drill Systems

- RAM Drill
 - Uses: ARA (5-inch hole) and Sridhar (2-inch hole); current hole is 4-inch
 - May need two systems.
- Estisol-140:
 - SPICE Core processing: could be smelled but no one complained. Are adding active filters to the system.
 - May have been effecting the O-17 analysis or sublimation was the cause.
 - Danes drilled dry in the EGRIP pilot hole. Planning to use Estisol-240 with Coasol. Contaminates the core if it has cracks. Seems to be better accepted by the drillers – less irritation. Seems to work well with warm ice, much better than 140. 240 seems to be “greasier”.
 - Have chemists tried to get rid of contaminates?
 - Pyne: Nancy's group is using a cutter that allows them to cut at angles through cracks. Lose ice but allows them to cut out the contaminated sections.
 - Talalay: Silicone will evaporate – eventually. No test of what it does to the CFA.
 - Zacny: Has a partial vacuum ever been tried? Does evaporate quite quickly. Kris does not think the ice will break because it's driven by temperature. Likely use a cold trap to grab the Estisol.
- WISSARD
 - Mikucki: What is the board opinion on how to move forward with the WISSARD?
 - Makinson: Has a significant logistics impact due to packaging, which is not considered the way forward. This could be addressed on some level.
 - Cherwinka: The sleds did not perform well during the traverse. Different groups designed containers and the sleds.
 - Makinson: BAS uses smaller pallets that go on to the sleds, which allow flexibility.
 - Mikucki: The containers were nice for the labs. Group agrees.
 - Kuhl: Air ride sleds could work well. Agreed.
 - Nielsen: RAID looked at this quite a bit. They have 50' containers using stronger steel. They are riveted together.
 - Cherwinka: If the goal is to drill 1000 m holes near the coast, it could be repackaged. Makinson agrees.
 - Makinson: Can there be savings by investing in miniaturizing the logging tools to reduce the hole size?
 - Pyne: Have Lake Ellsworth tools been used elsewhere?
 - Mikucki: No, can't state that they are properly tested. Max dia is 20 cm.
 - Wilhelms: Where next? What size?
 - Mikucki: The four white papers from the SAWG workshop summarize this. A 30-cm hole would accommodate almost everything. Most tools are 20 cm but you need a buffer zone due to length of deployment.
 - Cherwinka: Could ream the hole to enlarge it.
 - Prepping in McMurdo this season and next year going out to Lake Mercer. Believe it's the whole system going out.
 - Pomraning: There were issues with AMANDA being outside. Cold air feeding the boilers. Shoveling out the system.
 - Slawny: This year's plan is to gain a better understanding of the system, what would it take for IDDO to assume ownership. (Perhaps evaluate scope of repackaging it?)

- Albert: NSF has encouraged IDDO to adopt the drill but there will not be additional funding.
- Jackson: Concurr, but really wants to see how things play out. Other facilities have maintained drills under the science project budgets; may move to that model.
- Cherwinka: Concerned about continuity with care of the system. HWDs are big and dangerous. Need to allocate funds to maintain the equipment and the personnel base. Can't just turn these drills on and off.

4:10 PM

"Deep" Planetary Drill

Zacny

- Wilhelms: How was soil unstuck from scoop?
 - Zacny: Cross contamination was not a concern.
- Cherwinka: How does the 16 kW probe make it to Europa without melting?
 - Zacny: 3.8 m tube with fins.
- Shturmakov: Asks about electronics selection based on the temperatures he is stating.
 - Zacny: Use Mil-Spec parts, usually rated to 80 C, dump the heat into the metal.

ICE DRILLING DESIGN AND OPERATIONS - TECHNICAL ADVISORY BOARD

Wednesday, September 14, 2016

Union South - Agriculture Room, 3rd Floor

University of Wisconsin – Madison

Madison, WI 53706

Attendees:

Mary ALBERT – Dartmouth College	Terry BENSON – UW Physical Sciences Lab
Steffen BO HANSEN – University of Copenhagen	Grant BOECKMANN – UW IDDO
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Hideaki MOTOYAMA – Nat. Inst. of Polar Research	Mark MULLIGAN – UW IDDO
Dennis NIELSEN – DOSECC Exploration	Marshall PARDEY – QD Tech, Inc.
Dale POMRANING – Univ. of AK – Anchorage	Alex PYNE – Victoria University of Wellington
Alex SHTURMAKOV – UW IDDO	Kristina SLAWNY – UW IDDO
Pavel TALALAY – Polar Research Center, Jilin Univ.	Mark TWICKLER – Univ. of New Hampshire
Tony WENDRICKS – UW IDDO	Frank WILHELMS – Alfred Wegener Institute
Kris ZACNY – Honeybee Robotics Spacecraft Mechanisms	

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| 8:35 AM | Travel Expense Reimbursement Information | Wendricks |
| 8:40 AM | Next TAB Meeting <ul style="list-style-type: none">Frank would like to come up with a date within the next 2-3 weeks. | Slawny |
| 8:44 PM | Recent Japanese Ice Core Drilling and Borehole Logging <ul style="list-style-type: none">Pomraning: Core depth in Kamchatka?<ul style="list-style-type: none">Motoyama: ~100 mTalalay: What is the temperature at the bottom?<ul style="list-style-type: none">Motoyama: -2.2°CWilhelms: So that is pressure melting?<ul style="list-style-type: none">Motoyama: Yes.Wilhelms: The 10 bar is at bottom or top?<ul style="list-style-type: none">Motoyama: Top.Talalay: Drill in Antarctica as deep as possible. Why stop?<ul style="list-style-type: none">Motoyama: Ran out of time. | Motoyama |
| 9:20 AM | ARA Drilling Preparations for 2017-18 <ul style="list-style-type: none">Hose: 1-inch ID hose. Standard polyester/nylon wrap hose.Firn Drilling: Want to use electric heating with glycol loop for no loss firn drilling. Do it overnight while the team is sleeping. There will be one 5-6 person drill shift.ARA is already collecting data from the few holes already instrumented.Examining trade-offs with RAM vs. ARA Drill for future drilling. Karle is pushing on the collaboration to improve instrumentation so that it can fit into a RAM sized drill hole.ARA needs 4-6 holes per location at MANY locations; several hundreds of holes total | Benson |
| 9:45 AM | Summit Micro Turbine Update <ul style="list-style-type: none">Nano turbines: 25% efficient, but unsure how that is effected by temperature.A diesel is probably 35% efficient; however, heat recovery on turbine is straightforward (hot air) vs. diesel.Run-time: Jeff thinks you can run continuously at 8 kW. | Cherwinka |

- Pyne: How long between major maintenance – how many running hours?
- RIPEnergy
- The cost is ~\$30-35k from RIP Energy. A comparably sized Honda or Onan generator is ~\$5k. Honda vs. Onan figures were not at altitude but neither is the 8 kW for Nano turbine.
- Pyne: Regarding the unit at Summit, is the majority of its weight and size driven to make it work at altitude?
 - Cherwinka: Did not feel they were driving to make it light. The C-65 is highly efficient with heat recovery.
 - Pyne: It seems they are taking a high density, portable unit and making it not portable when packaged for altitude.
 - Cherwinka: Could be broken down to 400 lbs. pieces to be put in helicopter.
- Pomraning: Used in AK?
 - Cherwinka: Yes, somewhere on the North Slope.
- Pomraning: Market?
 - Cherwinka: Principally for power and heat use. Biomass use. Used with methane burns. Commercial laundry and pools.

10:05 AM Current & Future British Antarctic Survey Drilling Activities Makinson

- Mikucki: Was freezing a problem with the grab and release?
 - Makinson: Had problems with levers to release weight. Have redesigned. Testing has shown it to work very well.
- Mikucki: Can they capture the “raining” basal material that the drill is trying to remove from his trigger mechanism?
 - Makinson: Could be done, but trying to avoid it. It’s the basal material that is trapped in the ice.
- BEAMiSH drill is independent of the Ellsworth drill
- Generators are configured in parallel so they need multiple pumps to pump water up the 200-250 m to the surface.
- Mikucki: A CAT pump driven by electricity?
 - Makinson: Yes. Works well. With motor drives.

10:30 AM MORNING BREAK

10:45 AM Summer Activities at East GRIP Hansen

- Kuhl: Large snow blower is Swedish? Yes.
- Roof snow density = to snow depth at 22m.
- Ambient Temp= -10°C
- Talalay: Any packing?
 - Bo Hansen: No.
 - Wilhelms: Have had it pack nearly overnight. Not sure it is temp dependent, but Pyne feels it does pack faster at colder temps.
- Pyne: What is the accumulation rate at EGRIP?
 - Bo Hansen: Unsure, close but slightly less than NEEM.
- Twickler: Netting for brittle ice?
 - Bo Hansen: Have it, but may or may not use it based on the quality of the core.
 - Twickler: It does provide thermal barrier from the trays.
 - Bo Hansen: Agreed, but the room is cooled.
- Cooper: Any light through snow roof?
 - Bo Hansen: No.
- Pyne: Will you cool the fluid after heating it for chips melting?
 - Bo Hansen: It will be routed to a holding tank to be cooled by ambient air.

11:19 AM HWD upgrades for drilling the Ross Sea near Jang Bogo South Korea Station Pomraning

- Pyne: Do they have a mast?

- Pomraning: No, the hose goes right over the reel. Lay the hose out in a figure 8 on the ground.
- Zacny: How do you go from a 6" to 12" hole?
 - Pomraning: Do two passes with a reamer.
- Mikucki: Do they back up their hose couplings?
 - Pomraning: Have not. Inspect couplings and replace if anything looks bad.
- Gibson: What is the hose length?
 - Pomraning: 100 m

11:29 AM RAID Development & Testing (Talk pre-lunch, follow up post lunch)

Nielsen

- Albert: What is being done to maintain holes?
 - Nielsen: Leaving them full of Estisol and moving on.
- Nielsen: Going to Minna Bluff to test this season, 200 km from McMurdo. 600 m depth.
- Pyne: Does the ice float?
 - Nielsen: Supposed to be a dry base.
 - Wilhelms: Not allowed to drill into a wet base. Confident it's dry?
 - Nielsen: The Pls say it is.
- Wilhelms: How long are the holes to be open?
 - Nielsen: 5-years. Packing and casing are being left in the hole.
 - Kuhl & Gibson: Tests holes as well?
 - Nielsen: Unsure, but thinks they are removing the packer and the Estisol.
- Kuhl: Continuous flight auger the pilot hole? What are you doing with the chips? Considered an air flush?
 - Nielsen: Have an air compressor. Deciding what to do is part of this test season.
- Gibson: Sediment coring bit?
 - Nielsen: Possibly a hybrid bit. Unsure what the transition is going to be like. Tried to simulate with concrete but concrete just fell apart due to temps.
- 6 Drillers for test season. During actual field operations, RAID will run (3) 8-hour shifts with 3 drillers per shift and 1-2 engineers.
- Cherwinka: Container weights?
 - Nielsen: Heaviest is rod container. All are street legal, which limits them to 48,000 lbs. ASC is towing. They provide all of that.
- Pomraning: Do they have a suspension and pivot point?
 - Nielsen: Yes.
 - Cherwinka: Does the cross beam pivot?
 - Nielsen: Yes.
 - Wilhelms: Pivot design comes from Canada. Thinks the design came to Germany via one of Charlie's PhD students. Not sure why US "lost the knowledge" with WISSARD.

12:00 PM LUNCH (provided) Continue Discussions

1:11 PM Recent progress on Chinese ice drilling projects in Antarctica

Talalay

- Wilhelms: How bad was the drill fluid, butyl acetate, smell at -40°C?
 - Talalay: Team used masks. Have improved ventilation. The altitude is over 4,000 m. At Dome Fuji, the temperature is -20°C and is at an altitude of 3,800 m. With the strong ventilation, no mask is required.
- Cherwinka: Why is season so short?
 - Talalay: Logistics – ship does not arrive until mid-Dec and then have to traverse. Entire season is 21 days.
- Wilhelms: What is the status of the Basler?
 - Talalay: Used only for radar.
 - Wilhelms: Can it land at Dome A?
 - Talalay: Circled but did not land. Operated by Canada.

- Ice Well: 5 cooling zones to allow them to freeze from the bottom up. Building over the hole can be cooled to -20°C.
- Pyne: What is the synchronized frequency?
 - Talalay: 100 kHz.
 - Zacny: How do you control it?
 - Talalay: Both are turned on at the same time.
- Cherwinka: What is the insulator on the cable (sonde cable)?
 - Talalay: Undecided. Might be Kevlar, as the drill may weigh 600-700 kg.
- Cherwinka: What temp should the surface of the sonde be to get the drill rate?
 - Talalay: 200°C. Insulation needs to be300°C?
- Cooper: If the device turns off...?
 - Talalay: It will freeze in and be lost.
- Cooper: The Badger Drill, from Norway, is used for gas research. It cuts up ice, passes it behind itself, and then compacts it, sort of burying itself in the ice as it descends.
- Pyne: What sediment were they drilling?
 - Talalay: Specially prepared mix based on what they expect to see in the ocean.

1:50 AM Coring in Lake Ohau, South Island NZ and other Antarctic Activities Pyne

- Lake Ohau: Want to get sediment samples from the base of the far end of the lake as it has a climate history since the last glacial period.
- Drilling in the Friis Hills in the Dry Valleys at the top of the “mountains”. There is frozen sediment in 12% ice.
- Lake sediments are fine/sandy silts but expecting bigger content with perhaps more ice. May have been the warm period just before Antarctica started cooling down. Slow RPM drilling. 10-meter/day in 10 hours would be good progress.
- Have a large compressor like one of the RAM drills, but in two parts due to flight constraints.

2:12 PM Drill component testing at Neumayer III Wilhelms

- Mast is proof of concept for a deep hole. They did a 100 m hole with it. Really proof of concept.
- Generator: the driver is a 4-cylinder diesel. Does not expect the price to come down. \$18kEuro.
- Weight is 140 kg.
- Mikucki: What are the vertical lines in the hole?
 - Wilhelm: Anti-torque blades.
- Pardey: Williamson in Seattle has a TENC Camera with 24 hours of HD rated to 0 C at 4000 m of depth.

2:35 PM Marshal Pardey Impromptu Talk on one their systems

- Circulating 1.5-2 gpm of sea water
- RPM was 400-600
- Core Break: Couldn't see it. Pyne Rig will pull back 10,000