

**WASHINGTON USGS THERMAL DRILLING PROJECT
ON THE SOUTH CASCADE GLACIER 1994
48°20'52"N, 121°03'01"W**

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PICO
OR-94-04

September 1994

*PICO is operated by the University of Alaska Fairbanks under contract to the National Science Foundation, Office of Polar Programs.

INDEX

INTRODUCTION	1
METHODS	2
DRILLING NOTES	4
ENGINEERING NOTES	7
RECOMMENDATIONS	9

INTRODUCTION:

The Polar Ice Coring Office (PICO) was tasked by the National Science Foundation, Office of Polar Programs to support ice coring activities in the Cascade Mountains, Washington State for the Branch of Sedimentary Processes, United States Geological Survey (USGS). The purpose of the ice coring project was to recover an ice core from the P-5 accumulation area of the South Cascade Glacier in order to determine the viability of paleoclimate reconstruction from a temperate ice core with high dust loading and well documented mass balance data.

The USGS project was carried out under the direction of Dr. Joan Fitzpatrick, Branch of Sedimentary Processes, United States Geological Survey, Denver, Colorado, with assistant Keith Woodburne.

METHODS:

PICO supplied a 9 cm thermal drill and two drillers for the project: David Giles and Jay Kyne. The drill consisted of a standard 200 meter winch and tower, and both a two meter and a one meter thermal core barrel. The one meter core barrel was a spare and was not used. The power control is the same as that used for the PICO four inch electromechanical drill. Power was supplied by a Honda EG-5000X generator with a maximum output of 5 Kw.

Although the drilling site is in a wilderness restricted area, the approximately thirty year research history of the USGS Water Resources division in this area allowed us to use helicopter transport on weekdays and a generator to power the drill. No helicopter flights were allowed on Saturday or Sunday. One item that affected the drilling was that 100,000 acres of Washington State was burning and the helicopters that we were to use to take out the core at the end of each day were also fighting forest fires. We would not know until late in the afternoon whether we would get a flight to take the day's core to a freezer van in Darrington, WA, which is 42 km WSW of the drill site.

Transport to the drill site from Darrington began at 7:00 am on Monday 1 Aug 94 and was completed by 3:00 pm that day. The camp and drill site were set up Monday and Tuesday and drilling began on Wednesday morning 3 Aug 94. During drill set-up it was necessary to re-wire the rental generator because the only 220V 1Ø receptacle on the genset was a NEMA L14-30 and we required an L6-30.

A spot was leveled uphill from the hole location and the drill sled was set up on a wooden pallet to prevent the drill sled from melting the snow due to solar gain heating the sled.

DRILLING NOTES:

Wednesday 8/3/94. Drilled 20.63 meters. We had problems with penetration after 19 meters. Penetration was slow and the core was only 5 cm diameter. Air temperatures were 60° to 70°F and it was smoky from the forest fires. Four boxes of core ready to go but there were no flights due to low ceiling.

Thursday 8/4/94. Penetration is still very slow. We moved the drill ten feet and restarted. Drilled 27.84 meters. Air temperatures were 60° to 70°F and it was still smoky. Eight boxes of core were on hand. Four core boxes were retrograded on one helicopter flight. Four boxes of core remain in camp.

Friday 8/5/94. No drilling. Joan Fitzpatrick had great concern about having too much core in camp and risking that it would melt over the weekend because we could not get a flight. Air temperatures were 60° to 70°F and it was still smoky. There was one flight of four core boxes. No core remaining in camp. We could have had two retrograde flights, but we did not know that until 6:00 pm, and by then it was too late to drill any core.

Saturday 8/6/94. No drilling. We hiked down to the USGS Water Resources cabin Saturday morning and hiked back to camp Sunday morning.

Sunday 8/7/94. Drilled 15.82 meters. The bottom of the hole at the end of the day was 43.66 meters. Rain started at 3:45 pm. We started drilling at 12:15 pm and ran into a void that kicked the drill off line and caused it to bind in the hole. We then spent a couple of hours trying to get the hole straight.

Monday 8/8/94. Drilled 75.04 meters. The bottom of the hole at the end of the day was 43.66 meters. Rain and low ceiling continued all day. The weather cleared for a couple hours at 4:00 pm and four boxes of core were flown out.

Tuesday 8/9/94. Drilled 32.50 meters. The bottom of the hole at the end of the day was 107.54 meters. The weather was clear, calm, and 38°F. When making a core break, the core dogs would normally slide up the core a short distance and then break the core, leaving a 10 to 20 cm piece of core outside the barrel. That piece of core would also break off and float up to the water surface at 14 meters. At 1:30 pm, just before lunch, the drill got stuck at about 40 meters on the way down. Two 10 cm to 15 cm pieces of core from previous runs got above the drill and were wedged below the thimble and above the barrel. They were apparently lodged in a small cavern/ crevasse at 26 meters depth. During future runs we will attempt to go back to the bottom after each core break to pick up short pieces of core.

We hit a 30 cm cavern at 102 meters. After drilling through it, the drill got stuck coming out of hole apparently because the square top on the core barrel supports caught on the top of the cavern. We were able to free the drill with some difficulty. Four boxes of core were flown out at 7:15 am, and five boxes were flown out at 5:15 pm.

Wednesday 8/10/94. Drilled 27.34 meters. The bottom of the hole at the end of the day was 134.88 meters. The weather was clear, calm, and 40°F. Some hole closure was noted this morning. We had to drill through two places on the first trip down. Core breaks below 104 meters have been very hard. Five boxes of core were flown out at 5:25 pm.

Thursday 8/11/94. Drilled 23.56 meters. The bottom of the hole at the end of the day was 158.44 meters. One heater ring element burned out at 1:00 pm and 152.02 meters depth. We finished drilling today and started to take down the camp. The remaining core and snow samples were flown to Darrington

.After pulling up the piece of core from 158.44, penetration slowed to almost nothing and in fact drilled only 6 to 10 cm in an hour of drilling over a three hour period. Due to the probably reduced diameter of the core, we could not grab on to it with the core dogs even after repeated attempts. Since radar indicated that the bottom was at 150 ± 10 meters, we declared this to be bottom.

Friday 8/12/94. Camp pullout was completed by 4:00 pm. The weather was clear and warm, with clouds moving in at 3:00 pm.

ENGINEERING NOTES:

During the first two runs (4 meters) the variac for the heating element was set at 80% (1200 watts). The setting was raised slowly so that after the fifth run (10 meters) the setting was 100% (1800 Watts). Normal penetration was 10 minutes per meter.

Genset versus solar panels: Based upon the past experience of PICO personnel with solar panels, the heavy smoke from the forest fires of 8/2 thru 8/5 and the cloud cover of 8/7 & 8/8 would have delayed the start of drilling until Tuesday 8/9/94. The Wind River project, which relied exclusively on solar panels, recovered the same amount of core as this project and took three weeks to complete. Even moderate cloud cover on the Wind River project reduced the solar panel output to the point where drilling had to be curtailed. The Cascades project took twelve days and would have been one day less if reliable helicopter support had been available. Clearly the use of a genset, where possible, saves substantial field time.

During the twelve days on-site, all fuel burning equipment (genset, chainsaw, and Coleman stoves & lanterns) used unleaded gasoline. One barrel (200 liters) of unleaded gasoline was used for the project. The second barrel was unopened. The fuel barrel was placed close enough to the genset that the genset could be fueled directly with the hand pump from the fuel barrel.

The core dogs flop all the way down instead of stopping when pointing towards the center of the core barrel. This causes a number of problems.

- Sometimes the core dogs catch on the top of the core and prevent it from going into the barrel until it is melted smaller than the core dogs. This also makes it hard to retrieve the core.
- Sometimes, when breaking the core, the core dogs flop down. This makes it very difficult to extract the core from the barrel.
- In most cases the core dogs don't break the core. The break is a tensile break that pulls the bottom out of the hole.

Installing the core barrel and changing the heater ring would be made much easier if an 8 pin Bendix plug with waterproof solder joints was placed on each heater ring. A waterproof grease could be placed at the plug/receptacle connection to keep out water.

RECOMMENDATIONS:

The following items should be included in the supplies for the next temperate glacier project

- 100 meter fabric tape
- Waterproof boots, i.e. Bunny Boots
- raingear
- ¼" x 1¼" x 3' or 4' wood lath for stakes. The solar heat and the fast snow melt causes other types of stakes to pull out very rapidly.
- Snow shovels, grain scoop type.
- ¾" plywood base for the winch sled with a one foot hole for the drill.
- Core dog springs.
- 3/16" braided line, 100' to 200'