WINTER 2024/25

ICE BITS

Newsletter of the U.S National Science Foundation Ice Drilling Program (IDP)

Blue Ice Core Quality Feasibility Study

Drilling in ice without the use of a borehole fluid can be achieved to depths of 300-350 meters before risking borehole closure. However, the ice cores extracted from depths exceeding 150-180 meters often exhibit very poor core quality. IDP has largely found this to be true, except when drilling at the Allan Hills in Antarctica, a Blue Ice Area (BIA), where core quality deteriorates at depths as shallow as 50 meters. The exact reasons for this deterioration in core quality at shallower depths in BIAs compared to non-BIAs are not fully understood.

(Left) An ice core with good core quality -- drilled with the Blue Ice Drill (BID) -- drilled during the 2022/23 field season at an Allan Hills, Antarctica, Blue Ice Area. The core is from 128 meters depth. Credit: Elizabeth Morton. (Right) An ice core with poor core quality -- drilled with the BID -- drilled during the 2022/23 field season at the same BIA at Allan Hills, Antarctica. The core is from 55 meters depth. Credit: Elizabeth Morton. The BID is an agile drill capable of retrieving cores of approximately 241 mm (9-1/2 inches) in diameter. The BID system was originally designed with a depth capability of 30 meters but was subsequently modified to allow for attempts at deeper coring to 200 meters depth at the request of the science community.

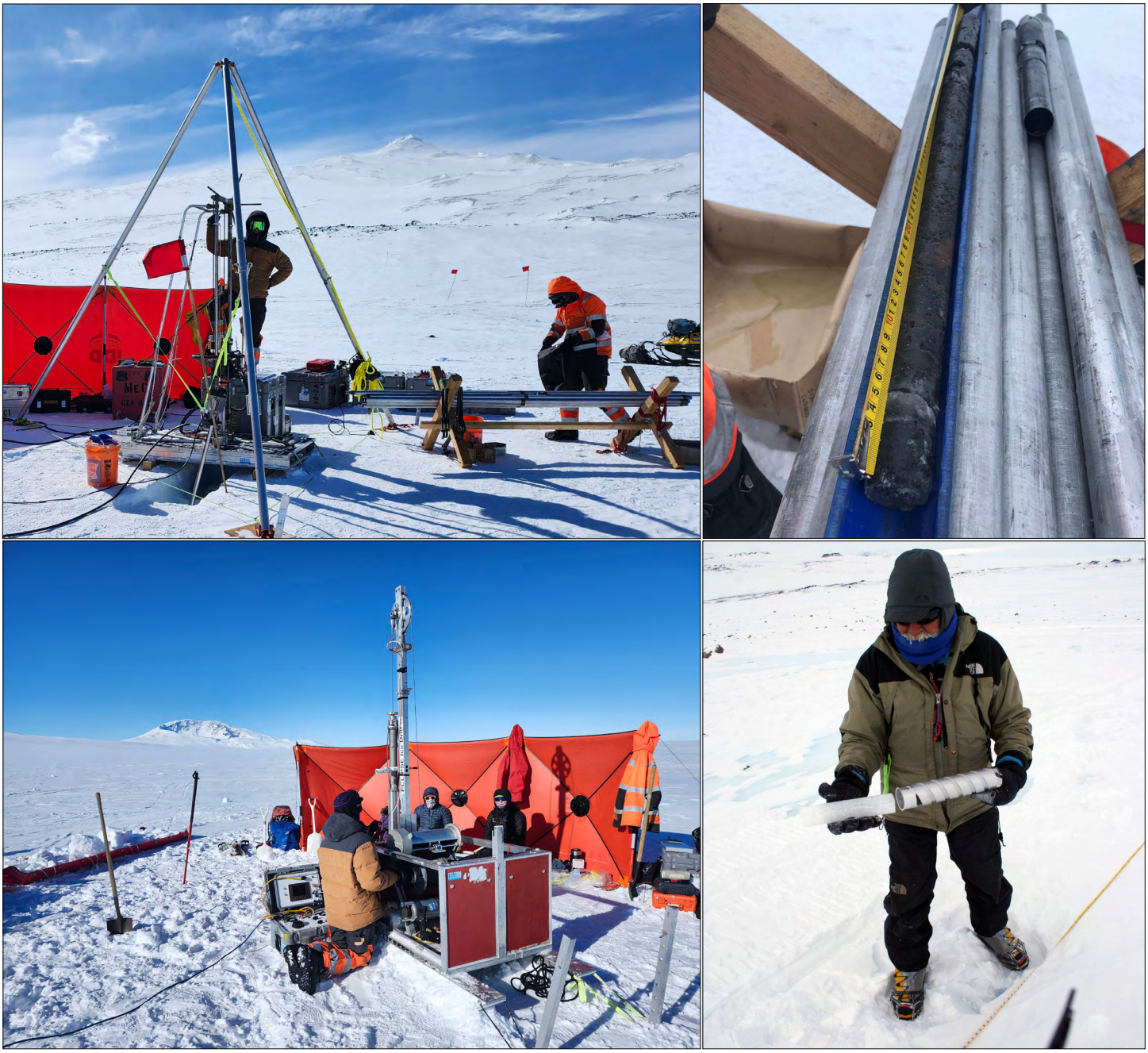
In IDP's 2024 Long Range Science Plan, IDP was tasked with conducting an engineering feasibility study to evaluate and recommend long-term drilling approaches for retrieving high-quality ice cores down to a depth of 400 meters in BIAs. In a new report, IDP outlines several solutions proposed to improve core quality in BIAs, along with the advantages and disadvantages of each. The report also discusses how core quality is defined, the past performance of IDP's shallow drills, and lessons learned from drilling in non-BIAs. For more information, read the Blue Ice Core Quality Feasibility Study.

IDP Completes Support of 2024-2025 Antarctic Field Season

At Dome C in East Antarctica, IDP engineer/driller Jay Johnson used the 4-Inch Drill to support the I-159-E project (PI Vas Petrenko). The drilling goal was to complete one 300-meter-deep core near Concordia Station. Drilling began on November 19, 2024, and finished on January 5, 2025. Over the seven weeks, two cores were drilled with the 4-Inch Drill, one to 302.5 meters and a second to 195 meters, surpassing the drilling goal for the season. The drilling was conducted in temperatures that averaged -25°C to - 30°C with -30°C to -40°C wind chills. The project is a collaboration between the US National Science Foundation and the French Polar Institute, who also collected two ice cores using their own drill. The researchers are measuring in situ cosmogenic carbon-14 of carbon monoxide (14CO) and carbon-14 of methane (14CH4).

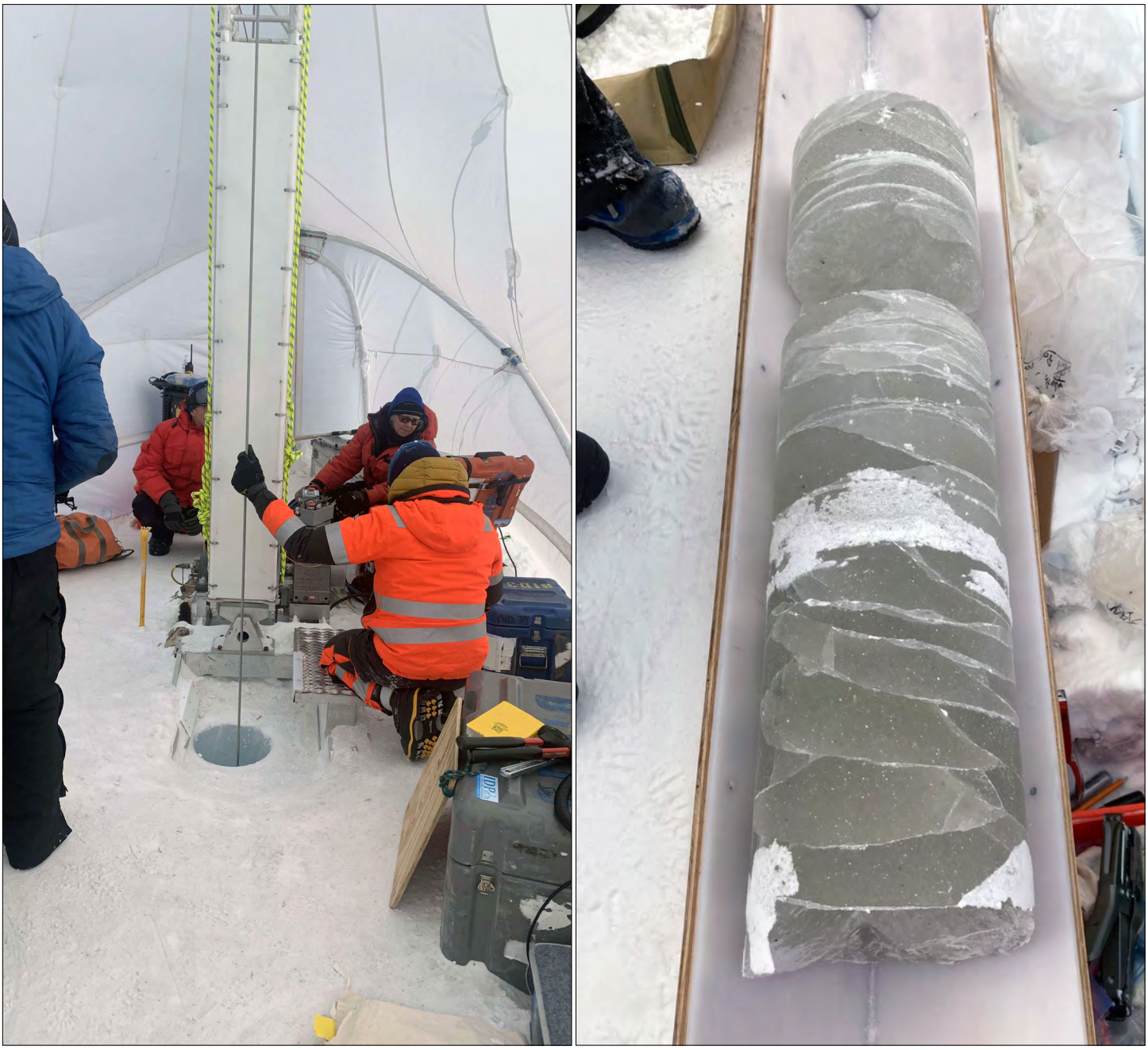
(Top, Left) Jay Johnson operates the 4-Inch Drill at Dome C, Antarctica. Credit: Alexander Ihle. (Top, Right) Jay Johnson holds the last core segment from the second borehole drilled with the 4-Inch Drill. Credit: Alexander Ihle. (Bottom, Left) Vas Petrenko loads the onsite melter to extract the air from the ice cores for analyses of carbon monoxide and methane isotopes. Credit. Jay Johnson. (Bottom, Right) Vas Petrenko fills a sample canister with the extracted air. Credit: Jay Johnson.

At Mount Waesche in West Antarctica, IDP engineer/driller Elliot Moravec and driller Forest Harmon used the Eclipse Drill and Winkie Drill to support the G-065-M project (PIs Matthew Zimmerer, Nelia Dunbar, Bill Mcintosh, and Seth Campbell). Using the Winkie Drill, the team successfully recovered three subglacial porous lava bedrock cores from holes between 50-85 meters deep, the first core being 92 cm long, the second 78 cm long, and the third 57 cm long. The project team will use cosmogenic nuclide inventories and 40Ar/39Ar dating of the subglacial cores to constrain West Antarctic Ice Sheet (WAIS) elevation during the last interglacial. Using the Eclipse Drill, the team drilled two ice cores, one to 40 meters and one to 30 meters. The researchers will use the cores to help constrain the age – using isotopic measurements of the overlying and underlying ice – of sub-glacial unconformities in the WAIS adjacent to Mt Waesche that record the downdraw of the ice sheet surface. Lastly, the science team used the Chipmunk Drill to collect over 400 samples of short, vertically oriented ice cores along a 4 km transect across a vertically oriented ash-bearing blue ice sequence.

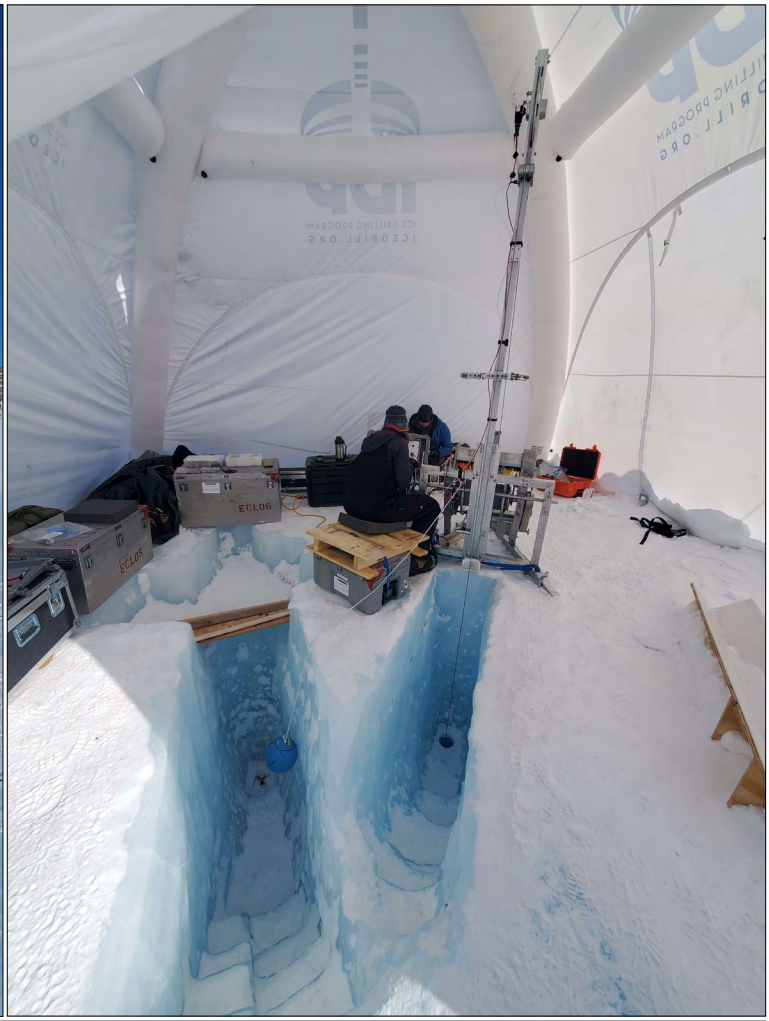


(Top, Left) Drilling with the Winkie Drill at Mount Waesche, West Antarctica. Credit: Nels Iverson. (Top, Right) A subglacial porous lava bedrock core recovered with the Winkie Drill. Credit: Elliot Moravec. (Bottom, Left) Drilling with the Eclipse Drill at Mount Waesche, West Antarctica. Credit. Nels Iverson. (Bottom, Right) Bill Mcintosh holds a short core drilled with the Chipmunk Drill. Credit: Nelia Dunbar.

At Allan Hills in East Antarctica, IDP engineer/driller Andrew Haala and driller Elizabeth Morton used the Blue Ice Drill (BID) and Eclipse Drill to support the I-187-M NSF COLDEX (Center for Oldest Ice Exploration) project (PI Ed Brook). The notoriously strong winds at Allan Hills delayed the setup of the drill tents and drills. Once set up, the science team used the BID to re-enter a borehole started during the 2023/24 field season. After drilling through several rocks, the hole was finished at 192 meters depth. Using the Eclipse Drill, the science team re-entered an Eclipse borehole started during the 2023/24 season. After two days of trying to drill past a rock that halted progress in 2023/24, the borehole was abandoned, and a new hole started. Drilling in the new hole reached 89 meters, and then a "rock" was encountered. This is the same depth that a "rock" was encountered in a nearby borehole last season, so it is possible the drilling may have reached bedrock. The science team also used a hand auger and the new Sidewinder to drill several cores at the cul-de-sac site to help establish drilling goals for the 2025/26 field season.



(Left) Elizabeth Morton (red jacket and sunglasses) and Andrew Haala (orange jacket) operate the Blue Ice Drill (BID) at Allan Hills, Antarctica. The BID cuts the largest diameter cores (241 mm; 9.5 inches) of all the drills in the NSF Ice Drilling Program drill inventory. Credit: Jenna Epifanio/NSF COLDEX. (Right) A greenish colored BID core recovered from the bottom of the 192 meter deep borehole. Credit: Elizabeth Morton.



(Top, Left) View of the drill tent that housed the Eclipse Drill at Allan Hills, Antarctica. Credit: Andrew Haala. (Top, Right) Drilling with the Eclipse Drill at Allan Hills, Antarctica. The borehole on the left was started during the 2023/24 field season. The borehole on the right, where the Eclipse Drill is positioned in the photo, is the new borehole from the 2024/25 field season. Credit: Andrew Haala. (Bottom) Group photo from the 2024/25 NSF COLDEX field season at Allan Hills, Antarctica. Credit: Jenna Epifanio/ NSF COLDEX.

On the Ross Ice Shelf, the D-550-M science team (PI Pedro Elosegui) used a Kovacs Mark II hand auger to take 3-meter-depth density measurements of the Ross Ice Shelf firn. The density measurements were necessary for the team's Seismogeodetic Ice Penetrator project, in which two ice penetrators outfitted with seismic and GNSS instrumentation were airdropped 5000 feet via helicopter. The impact force on sensitive payloads and overall impact depth strongly depends on the density of the firn that the penetrator hits. The science team completed two density samples before the airdrops to verify the suitability of the firn per their impact dynamics models and then collected another density sample after each airdrop for model verification.

(Top) Julie Webber (McMurdo Station Crary Lab, left), Parker Steen (Massachusetts Institute of Technology, middle) and Stine Ornes (USAP Field Safety, right) use a Kovacs Mark II hand auger on the Ross Ice Shelf, Antarctica, to measure the density of the Ross Ice Shelf firn. Credit: Bryan Minnear, Lead Pilot, Pathfinder Systems. (Bottom) Julie Webber (McMurdo Station Crary Lab) tests the Kovacs Mark II hand auger on the McMurdo Ice Shelf. Credit: Parker Steen (Massachusetts Institute of Technology).

The T-940-M (McMurdo Shear Zone) and T-941-M (Leverett Glacier) technical projects (PI Renee Melendy; Field Lead Zoe Courville) used a hand auger to drill short cores (1-4 meters depth) to determine snow density along the South Pole Traverse route, for examining snow bridge properties over crevasses along the Leverett Glacier to update crevasse crossing criteria in the region, to retrieve cores to shallow blue ice layers to validate the depths of ground penetrating radar profiles, to compare snow properties along the South Pole Traverse route, both on and off the route, and to determine the impact of snow compaction from tractor travel over the route.

(Left) Derek Pickell (Dartmouth College) uses the IDP hand auger to examine crevasse bridge properties at the base of the Leverett Glacier, Antarctica. The pink flag denotes the center of the crevasse bridge as identified by ground penetrating radar. Credit: Zoe Courville. (Right) One of the shallow cores collected from a crevasse bridge at the base of the Leverett Glacier. The team drilled several cores on and off the crevasse bridges they found and used the cores to study stratigraphy, grain sizes, and density. Credit: Zoe Courville.

Ice Drilling Support for NSF Polar Proposals

If you are preparing a National Science Foundation (NSF) proposal that includes any kind of support from IDP, you must include a Letter of Support from IDP in the proposal. Researchers are asked to provide IDP with a detailed support request six weeks prior to the date the Letter of Support is required. **Early submissions are strongly encouraged.**

Scientists who seek to include IDP education and outreach activities associated with U.S. ice coring or drilling science projects should contact Louise Huffman at Louise.T.Huffman@Dartmouth.edu during their proposal preparation stage.

For additional information on requesting IDP support, visit our website at https://icedrill.org/requesting-field-support or contact us at IceDrill@Dartmouth.edu.

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