SAWG Community Updates

SAB Meeting 4 March 2022

COLDEX
Center for Oldest Ice Exploration

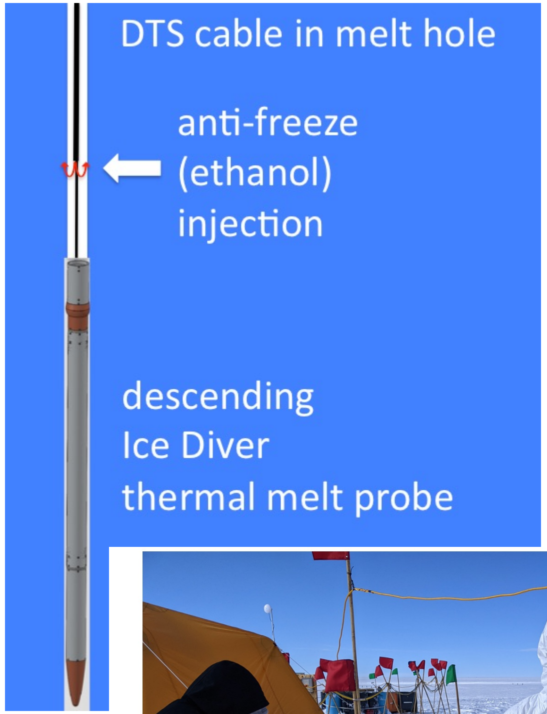
Optical Age-Depth Profiling for Fine-Scale Site Reconnaissance

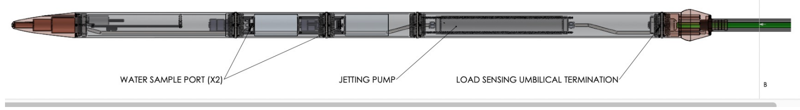
D.P. Winebrenner, University of Washington; R. Bay, University of California - Berkeley

Critical Challenge: Regional and Local Bed Variability

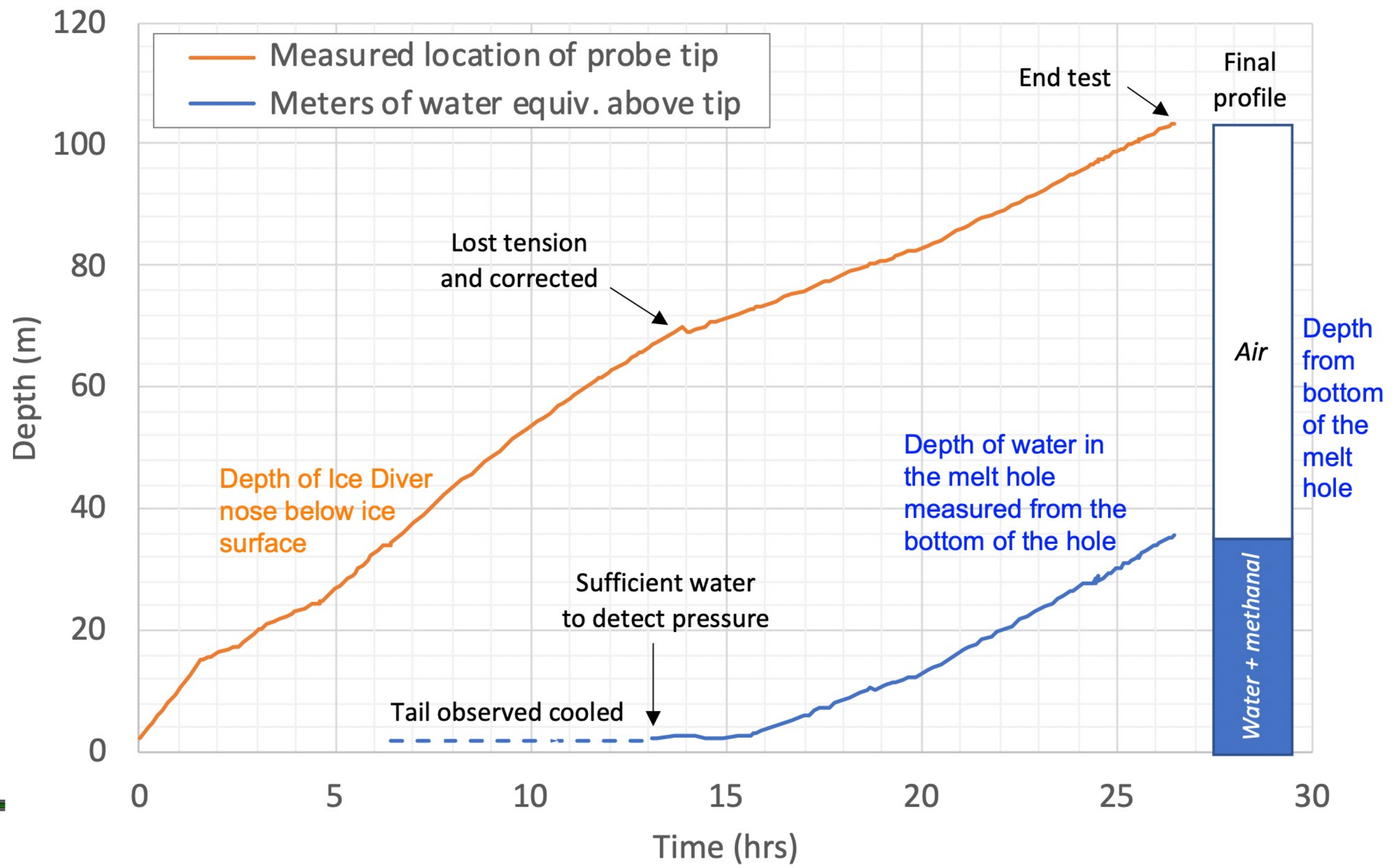
- Preservation of oldest ice hinges on local bed topography and geothermal flux – COLDEX could miss oldest ice even if it is just a few kilometers away
- Logistics costs preclude conventional ice coring for exploratory drilling
- Meet this challenge by building a next-generation ice melt probe that uses optical dust-logging to profile age vs. depth quickly in several locations
- Probe will also provide thermal state of the ice sheet bed, critical for understanding preservation of old ice
- Many applications for other problems in glaciology

University of Washington Ice Diver Melt Probe 2021 Greenland Summit Field Test of Anti-Freeze Method and Clean Sampling

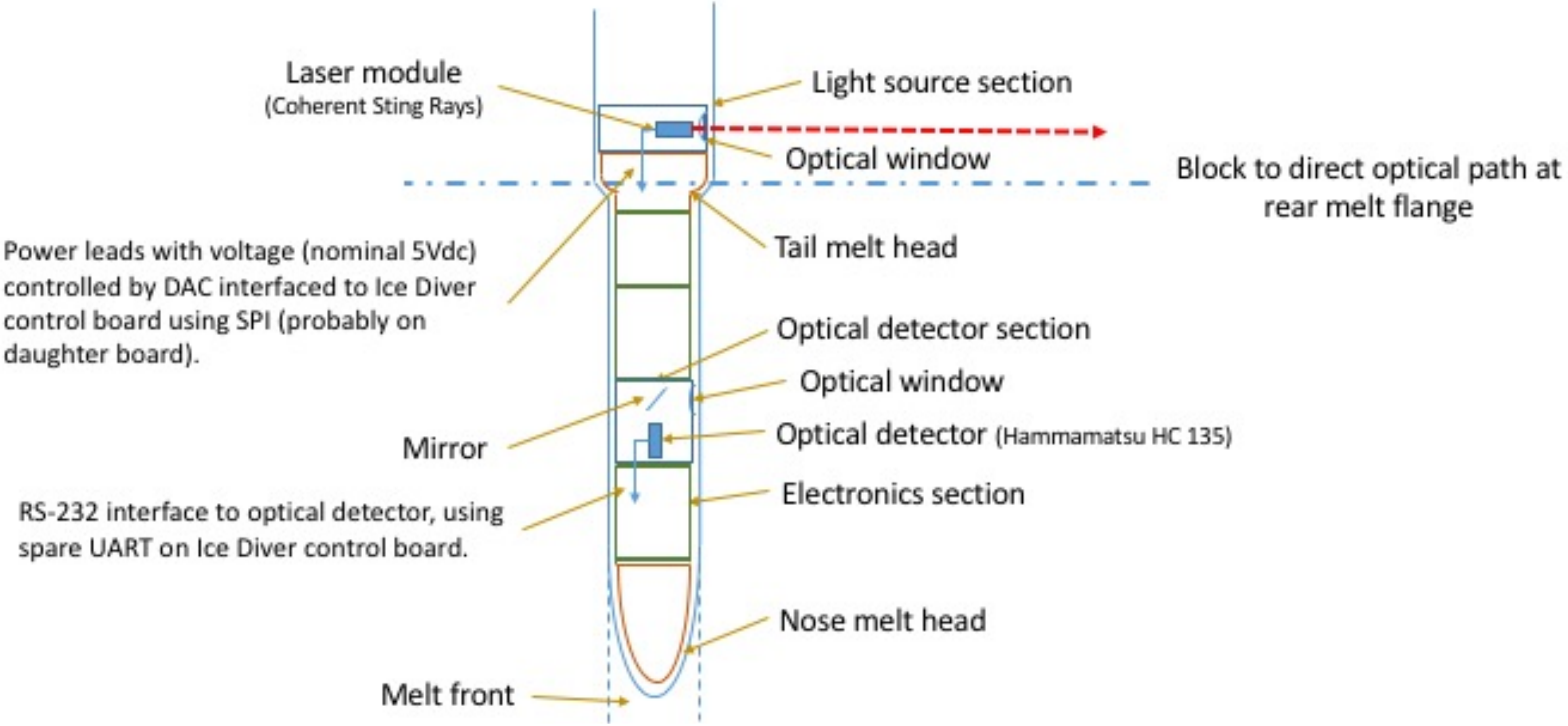




Progression to 103 m Depth, Sample Acquisition, and Probe Recovery



Integration of Dust-Logging and the 'Classical' Ice Diver



- Pendulum-steering flange blocks direct light path
- Challenges: 2.5 km depth (longer spool), East Antarctic temperatures (additional heaters)

COLDEX
Center for Oldest Ice Exploration

Subglacial Bedrock Activities

Not much activity due to COVID limitations

Completed projects

Ohio Range, Pirrit Hills

In progress

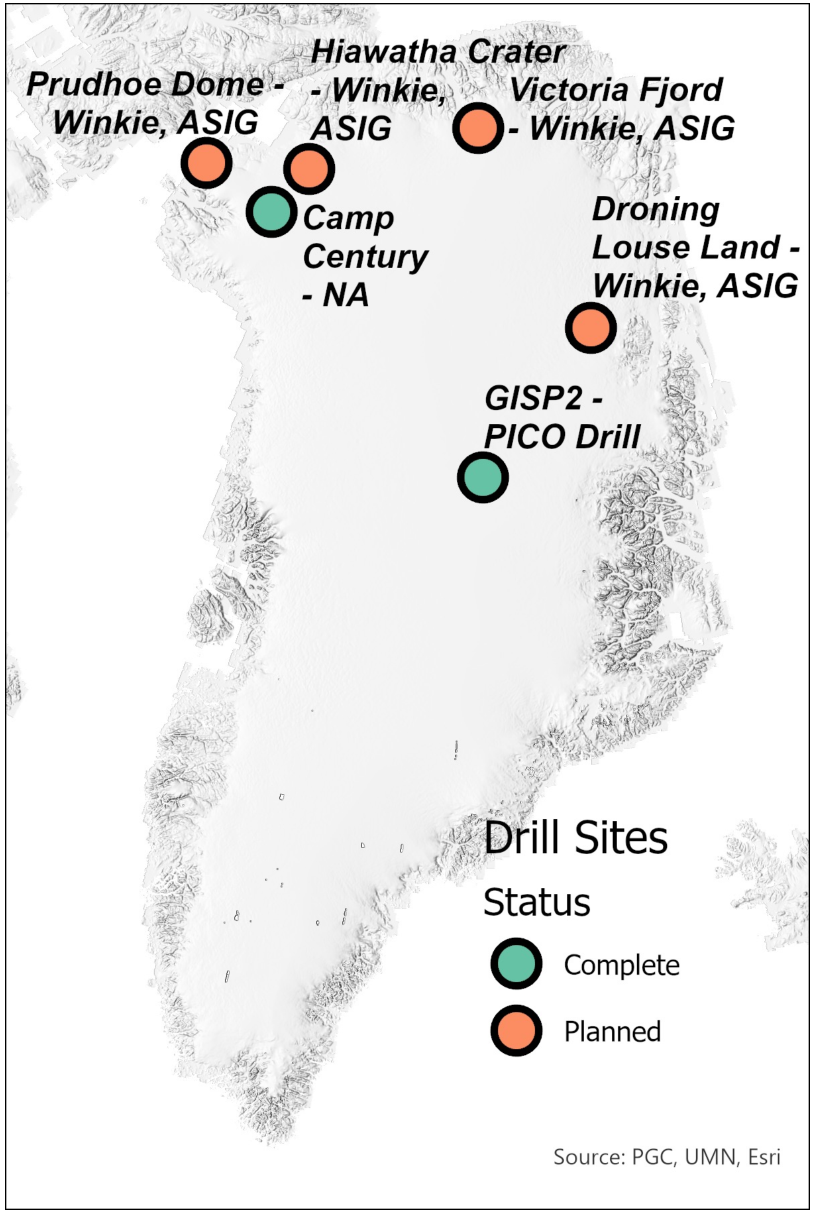
Thwaites Glacier - results from Mt Muphy, Hudson Mtn season delayed

Greendrill – delayed until at least summer 2022

Lots of future projects in planning stages

Subglacial Bedrock Activities

Subglacial Bedrock Activities



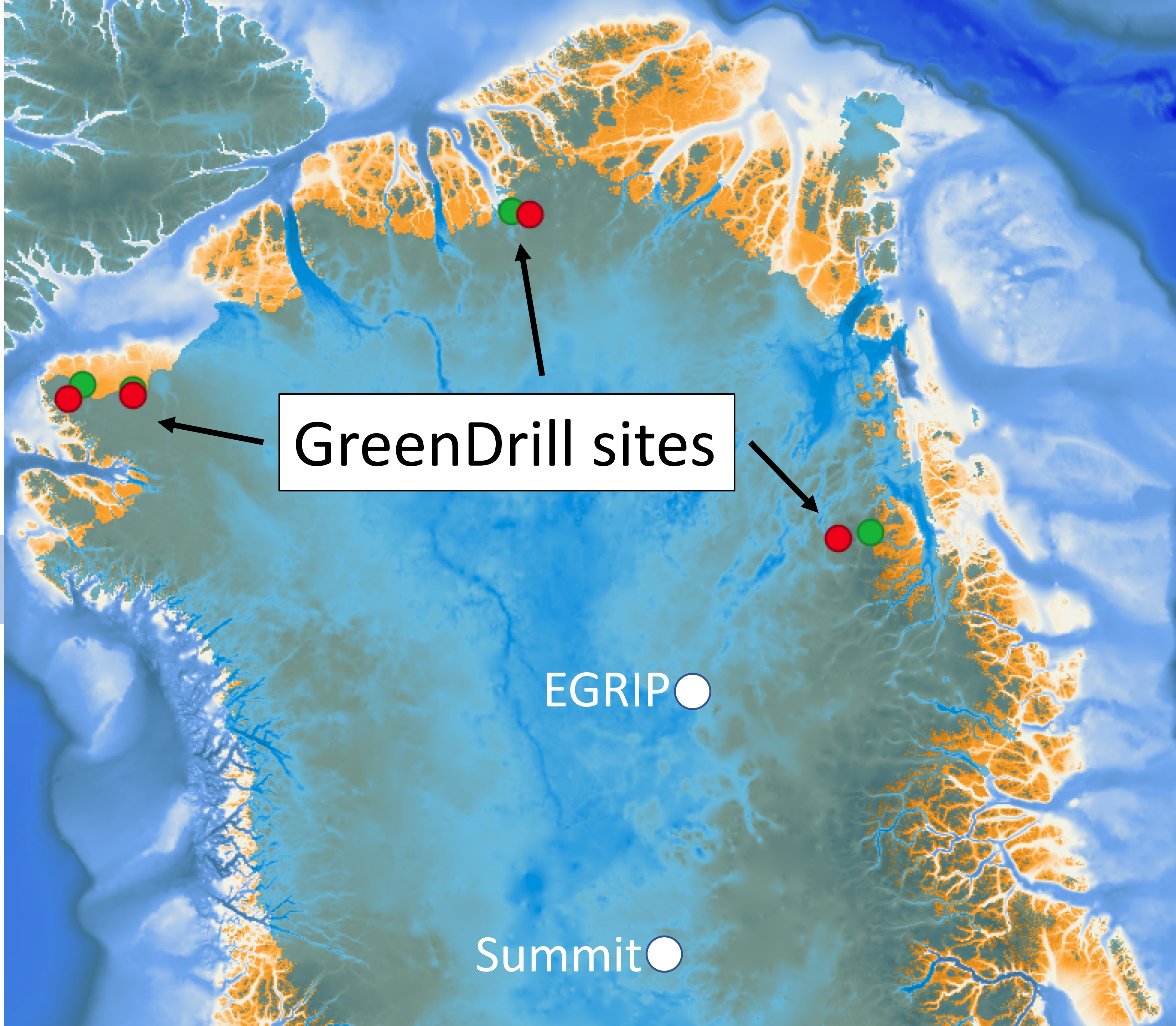
Sampling the bed to reconstruct Greenland Ice Sheet history

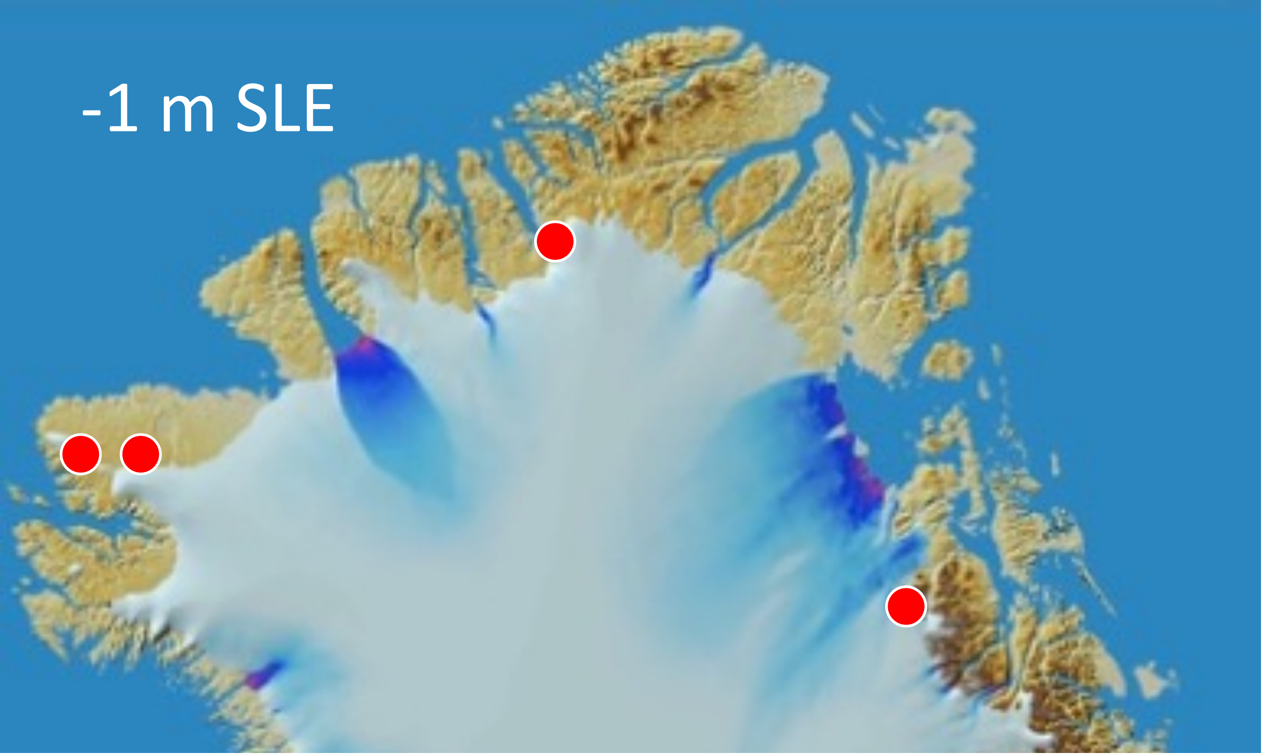
PIs: Schaefer & Briner
Young, Anandakrishnan, DeConto, Winckler

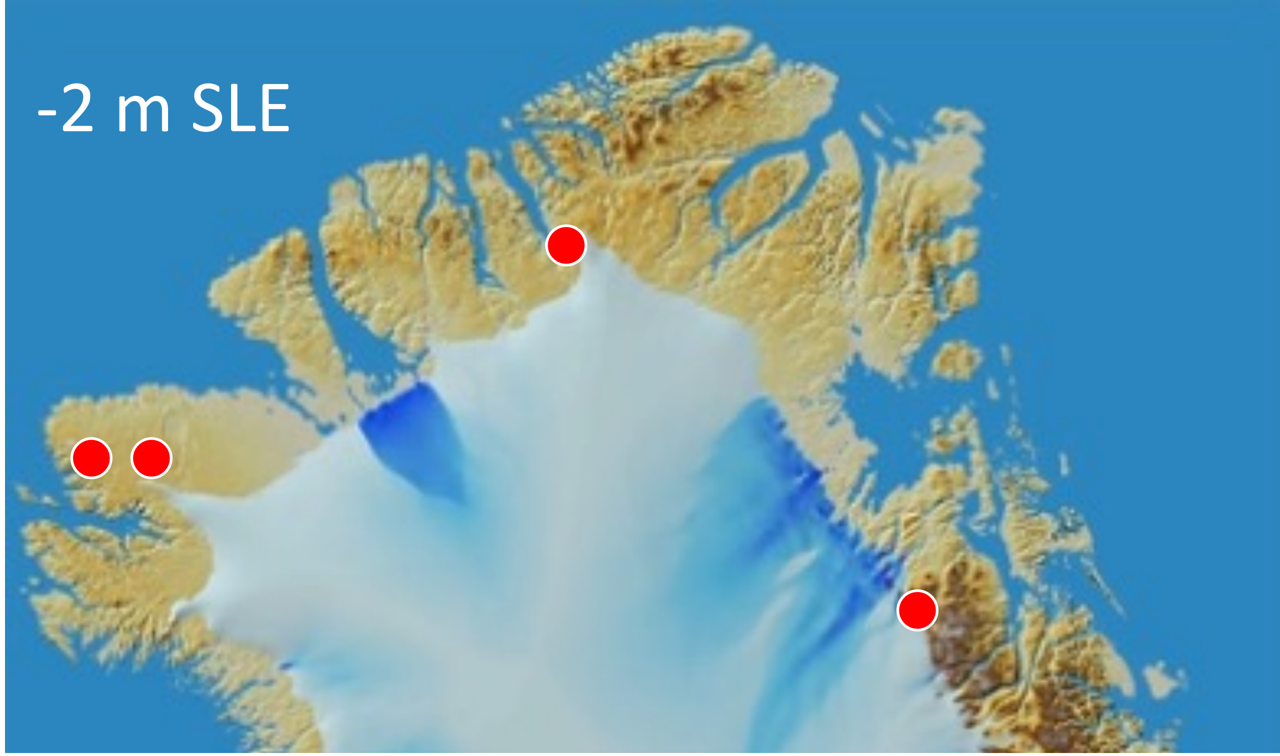
-> Uses existing drills on the ready from the US Ice Drilling Program.

-> Can drill through 700 m ice thickness to obtain 4-m-long bedrock cores.

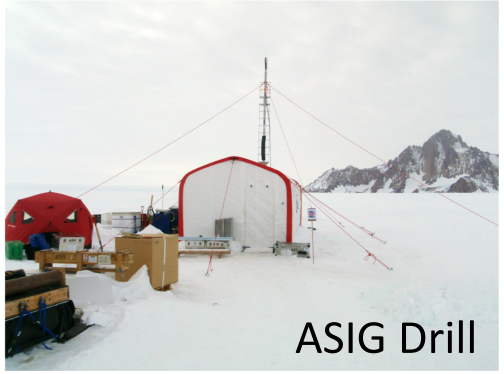
-> Drill sites selection criteria: frozen bed, Safety/crevasse considerations, bedrock lithology, science questions (eg, NEGIS).







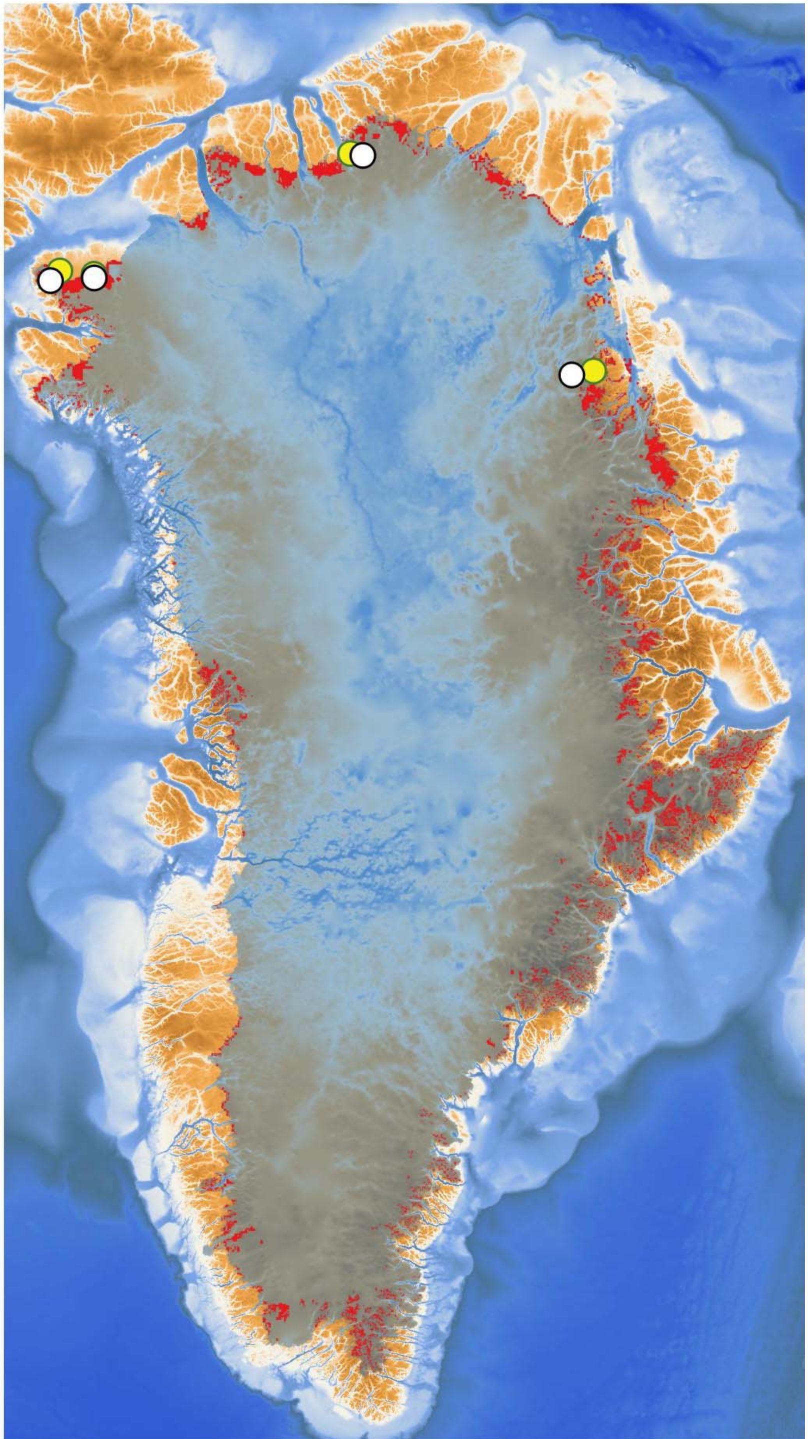
Simulations of Greenland ice: Drilling sites sensitive monitors of ice sheet response to past interglaciations



-> Locations chosen to represent a range of sites to constrain ice sheet contributions to sea level during past interglacials.

-> At each of four target regions, ASIG and Winkie drills will be used to acquire bedrock cores from a transect of sites.

Where in Greenland are we able to drill using IDP's current bed-access drills?



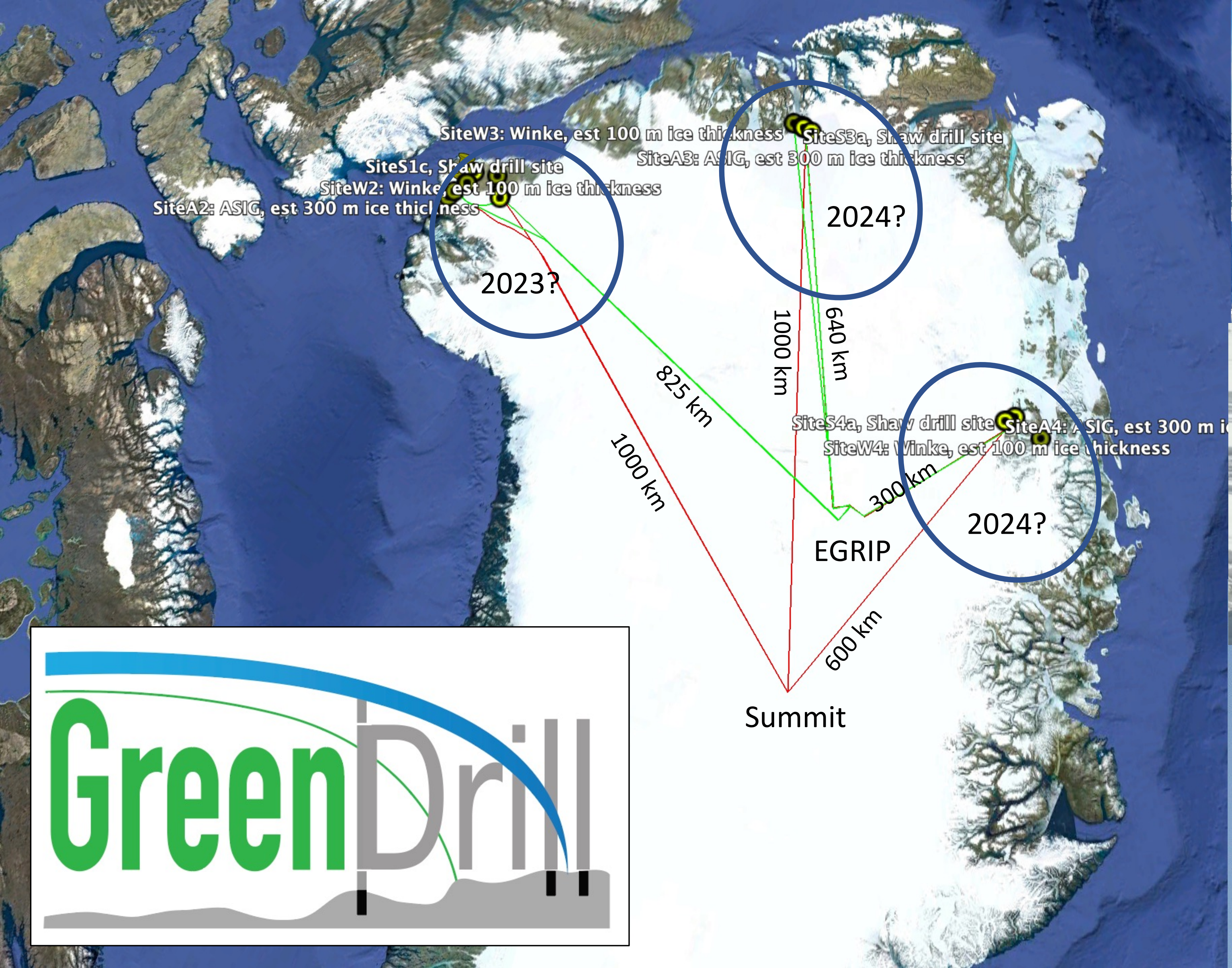
-> Need frozen basal thermal state
30.2% of GrIS (using MacGregor BTS v2)

-> Need ice thickness <700 m
15.4% of GrIS

-> Both frozen and <700 m
4.8% of GrIS meets both criteria

-> Is it safe to work? Crevasses >0.005/yr strain rate
3.3% of GrIS (Poinar and Andrews, 2021)

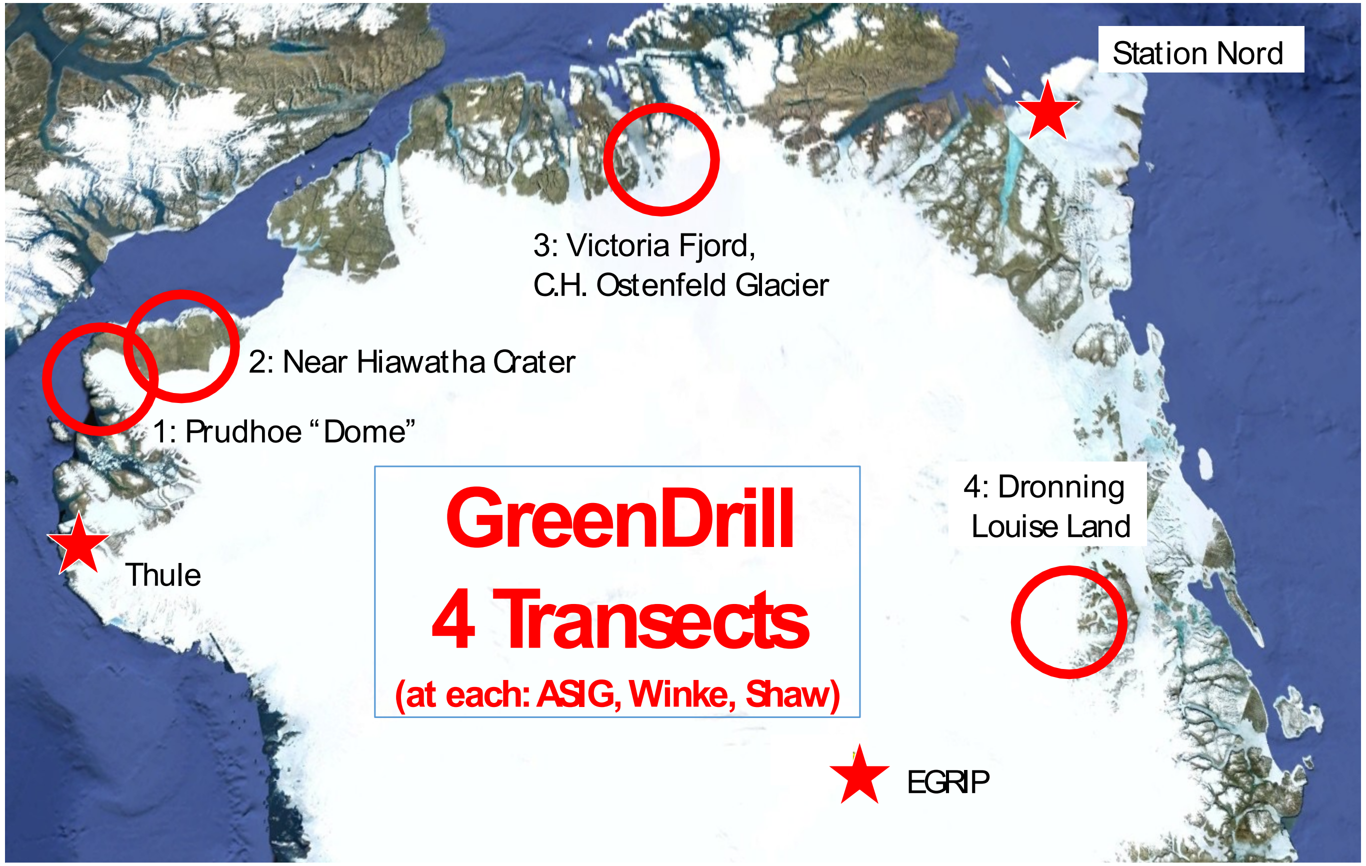
-> Science and bedrock lithology considerations?
<<3.3% of GrIS


SiteW3: Winke, est 100 m ice thickness
SiteS3a, Shaw drill site
SiteA3: ASIG, est 300 m ice thickness
SiteS1c, Shaw drill site
SiteW2: Winke, est 100 m ice thickness
SiteA2: ASIG, est 300 m ice thickness
2024?
2023?
1000 km
640 km
825 km
1000 km
SiteS4a, Shaw drill site
SiteA4: ASIG, est 300 m i
SiteW4: Winke, est 100 m ice thickness
300 km
2024?
EGRIP
600 km
Summit

GreenDrill


?


?



@ transect locations:

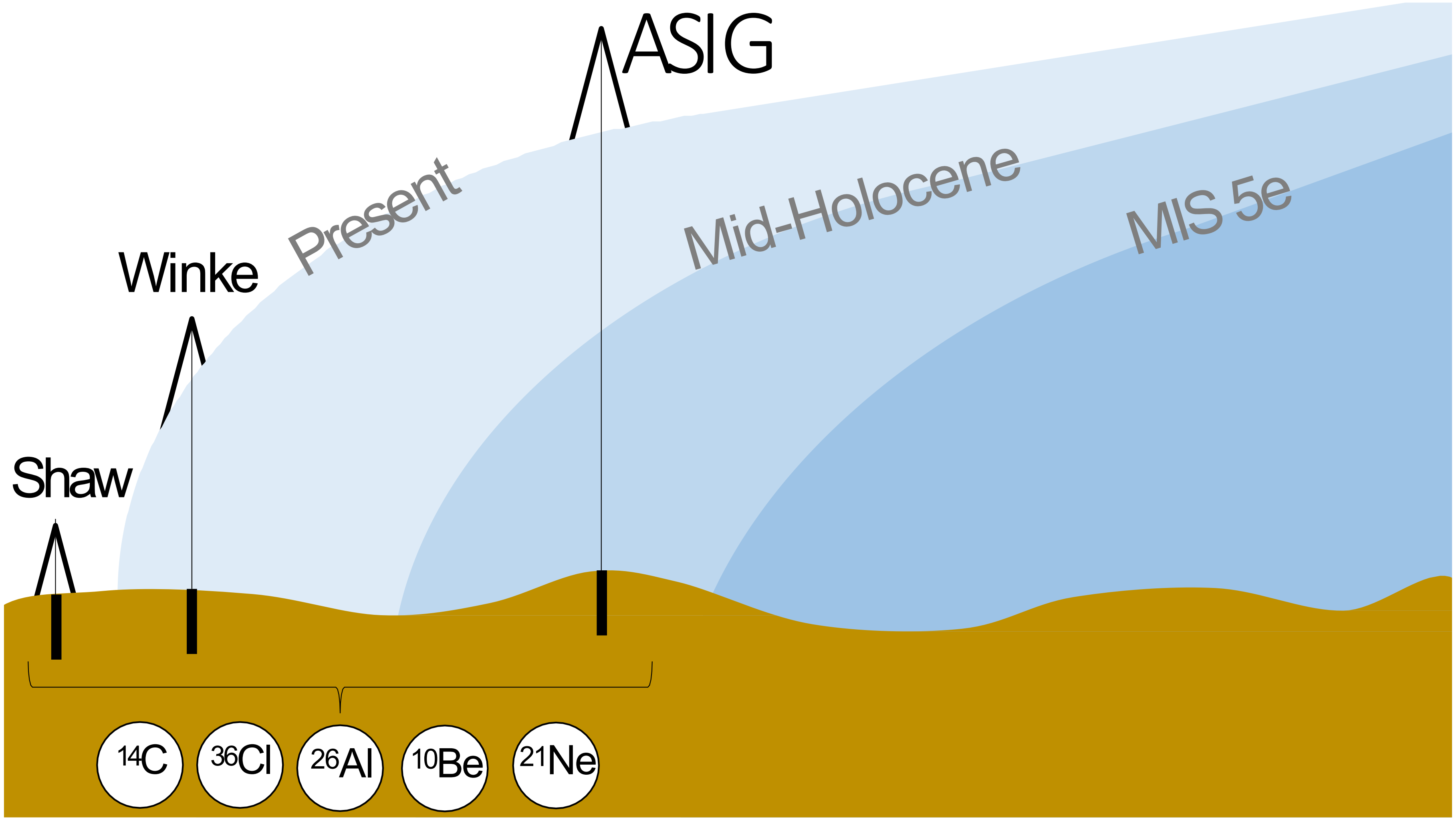
AISG Drill site: 500-300 m ice thickness.

Winke Drill site: 100 m ice thickness

Shaw Drill sites: pro-glacial landscape

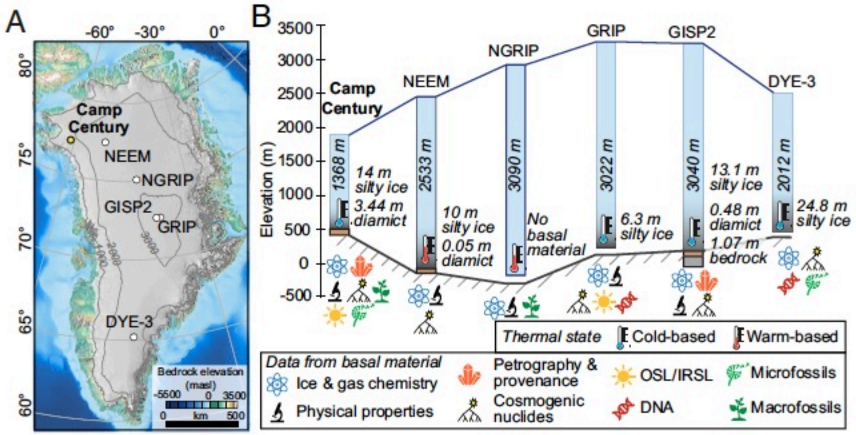
We will target 4+ m-long rock cores

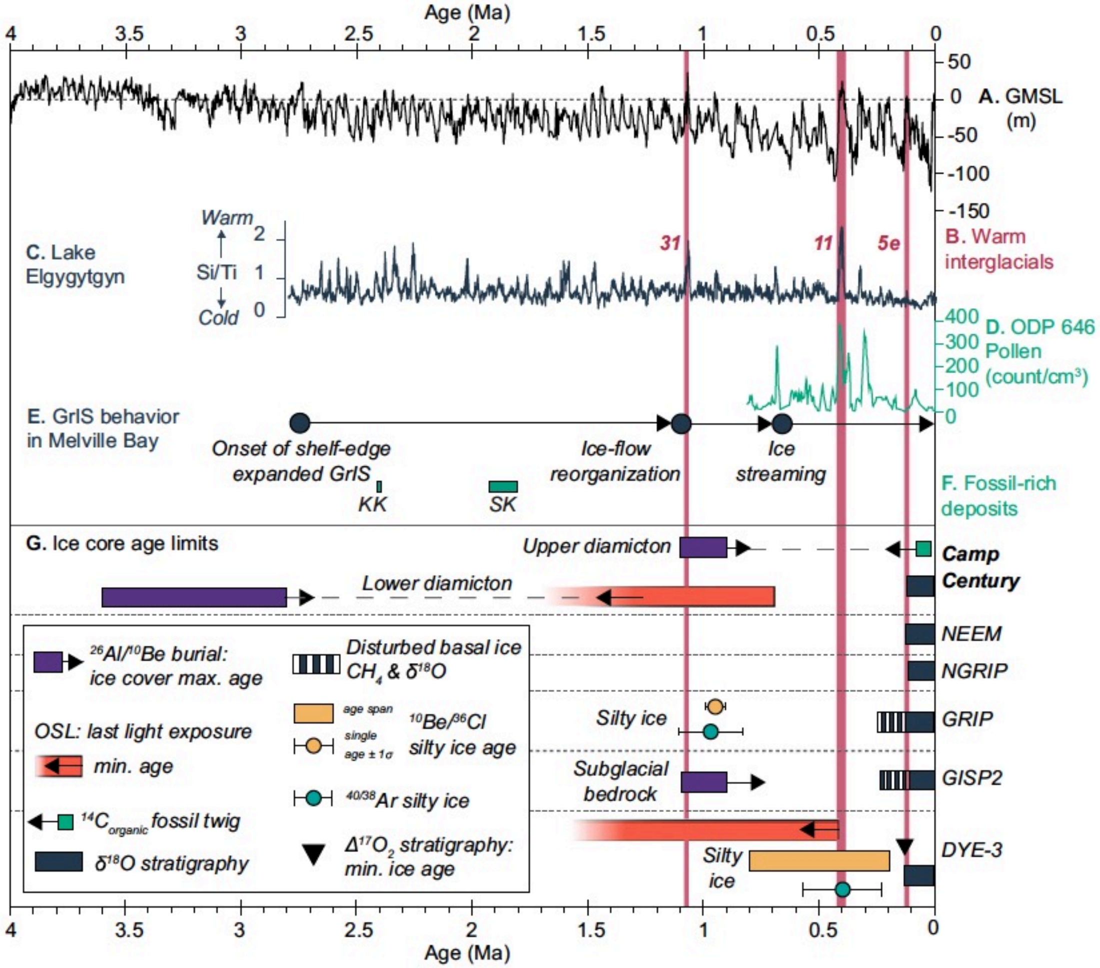
The selected sites check out for bedrock lithology; frozen bed;
ASIG >ELA = DC3 landing; ice thickness; Stars = landing strips/stations. We're exploring traverse.


ASIG
Present
Mid-Holocene
MIS 5e
Winke
Shaw
14C
36Cl
26Al
10Be
21Ne

A multimillion-year-old record of Greenland vegetation and glacial history preserved in sediment beneath 1.4 km of ice at Camp Century

Andrew J. Christ[a,b,1], Paul R. Bierman[a,b,c], Joerg M. Schaefer[d], Dorthe Dahl-Jensen[e,f], Jørgen P. Steffensen[e], Lee B. Corbett[a], Dorothy M. Peteet[d,g], Elizabeth K. Thomas[h], Eric J. Steig[i], Tammy M. Rittenour[j], Jean-Louis Tison[k], Pierre-Henri Blard[k,l], Nicolas Perdrial[a], David P. Dethier[m], Andrea Lini[a], Alan J. Hidy[n], Marc W. Caffee[o,p], and John Southon[q]

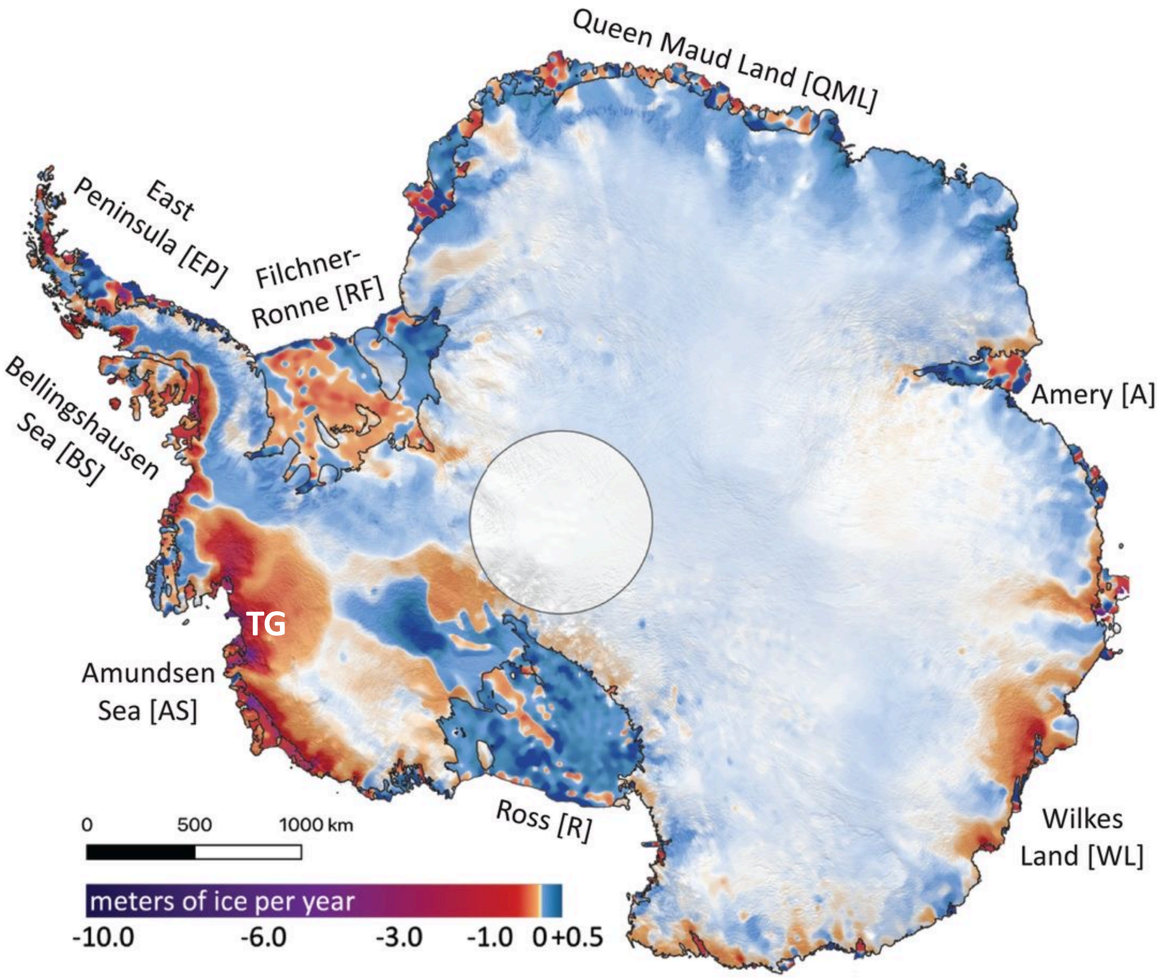




Christ et al., 2021 – conclude that the GrIS persisted through much of the Pleistocene but melted and reformed at least once since 1.1 Ma

Lots of continuing work

Regional context



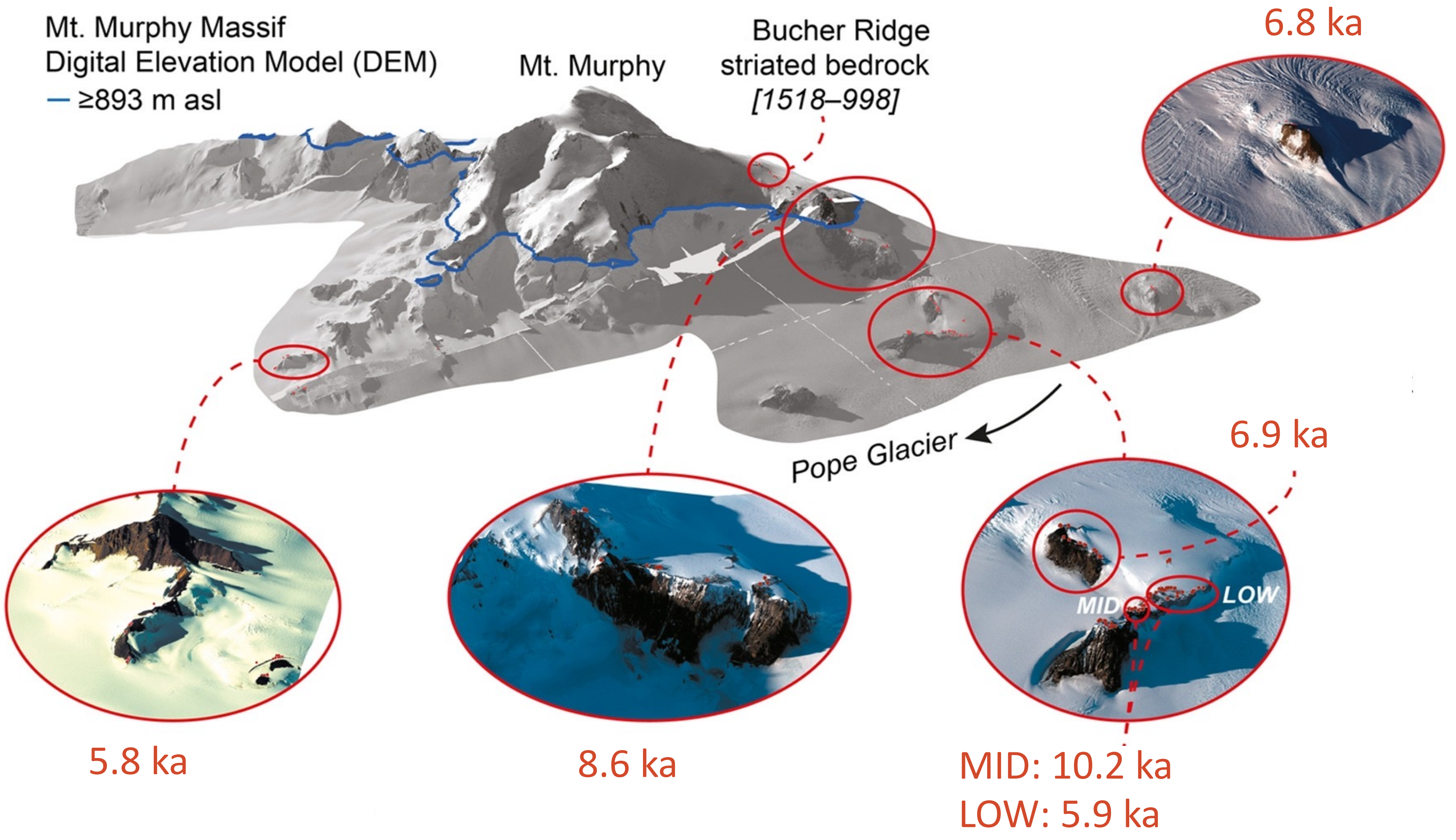
Smith et al., 2020

Modern observations show unequivocally that the Amundsen Sea Embayment is undergoing the largest changes of any ice-ocean system in Antarctica.

The question: Is this geologically unprecedented?

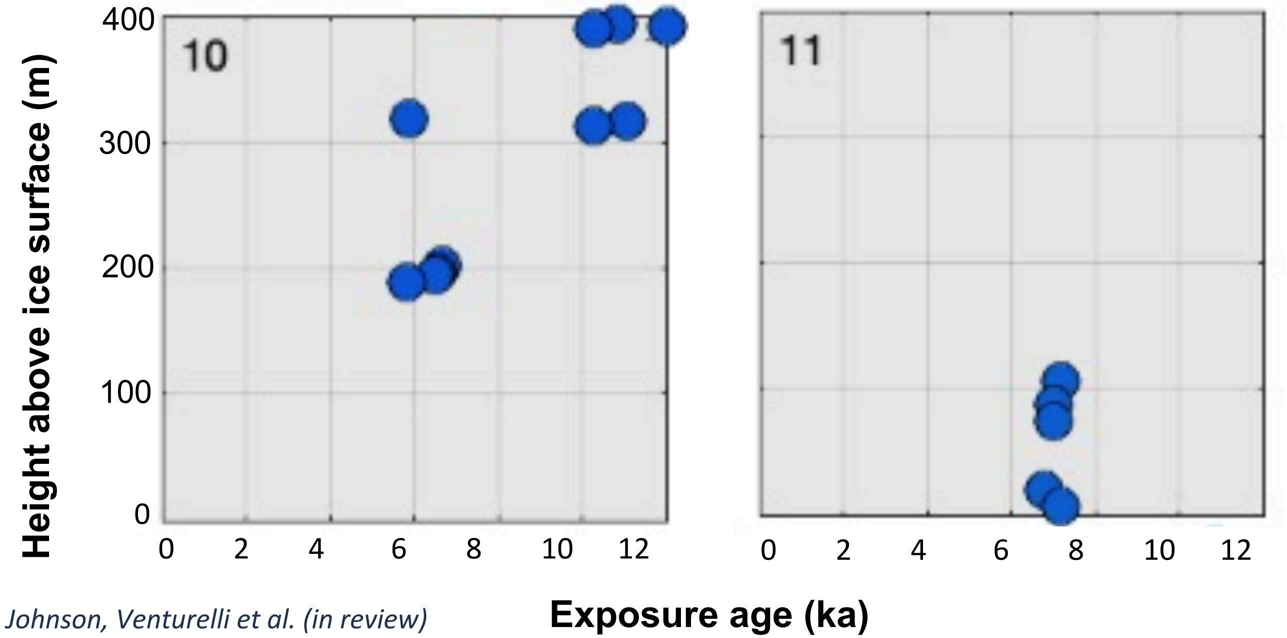
What we do know: Glacial history of Mount Murphy Massif

Exposed at:

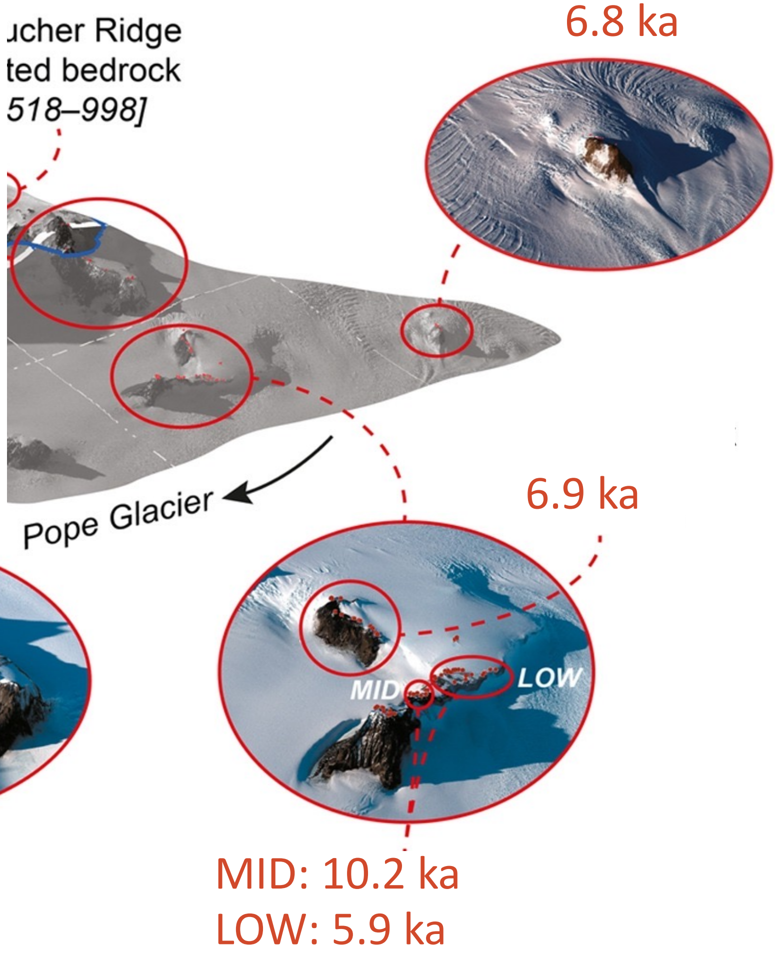


Johnson et al., 2020

Time gap:



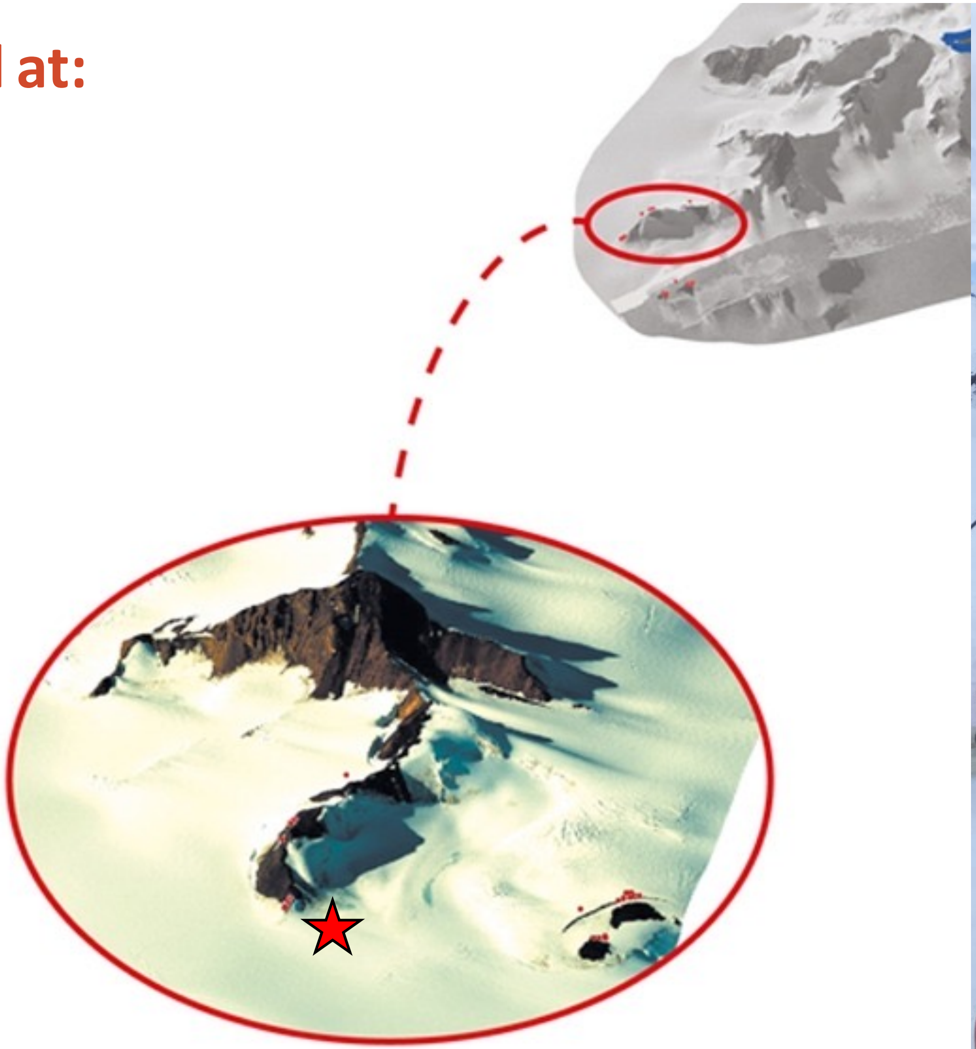
Johnson, Venturelli et al. (in review)



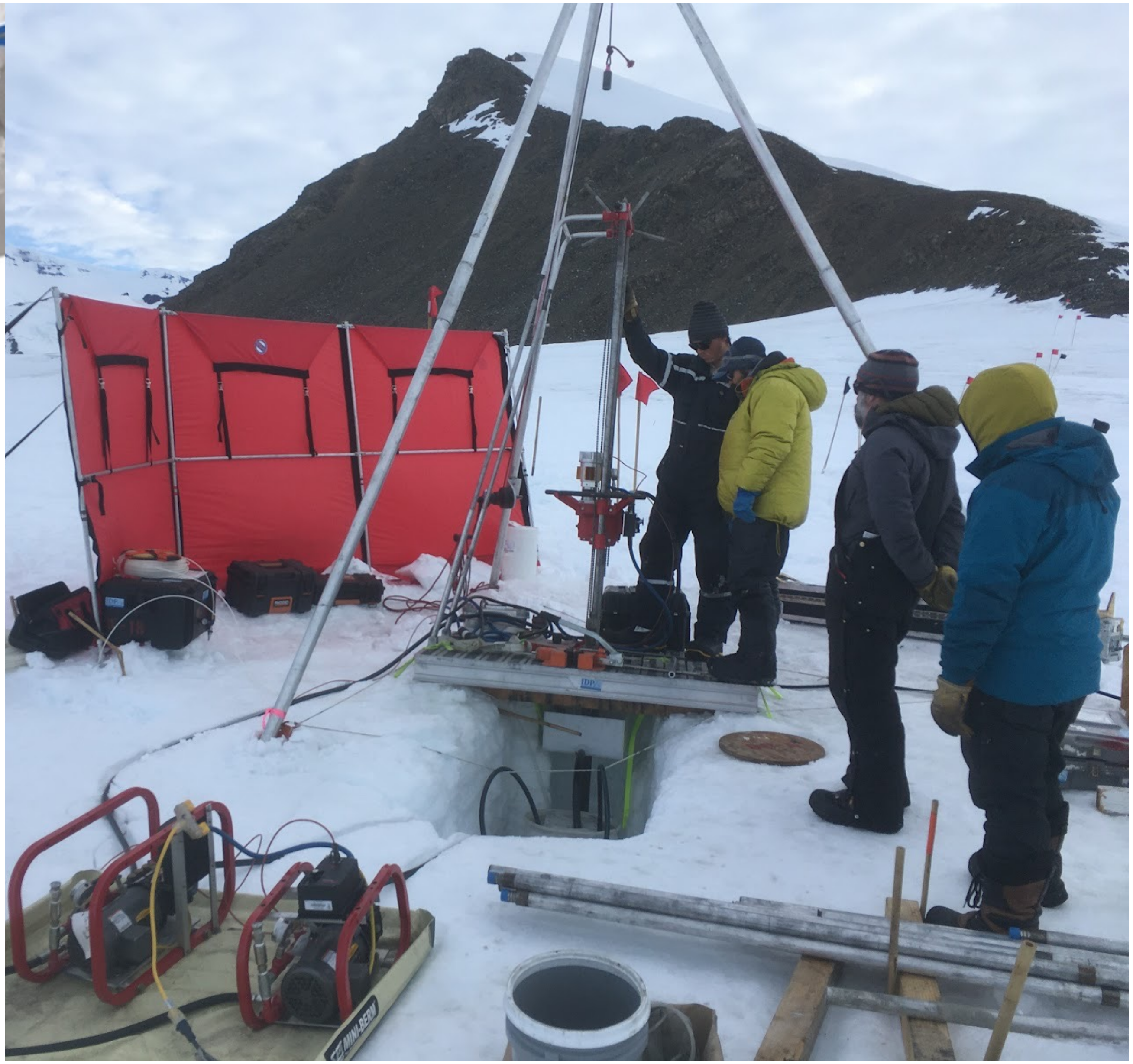
Johnson et al., 2020

Evidence lies below ice cover

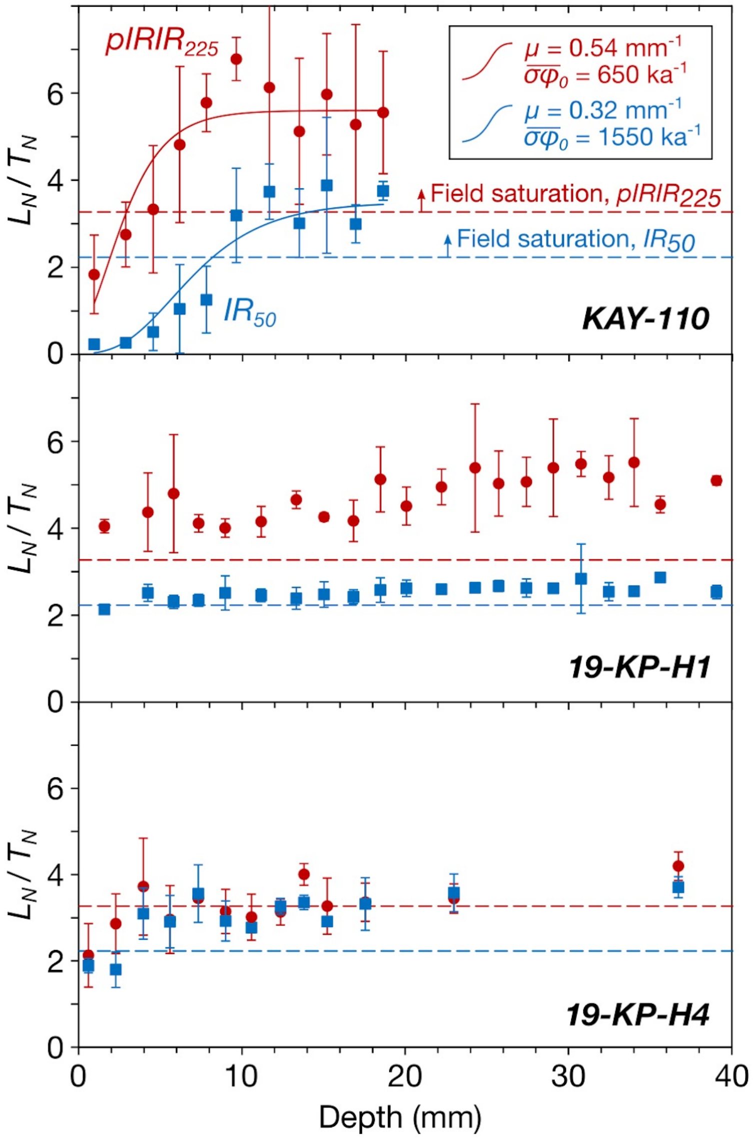
Exposed at:



5.8 ka



What are we finding?

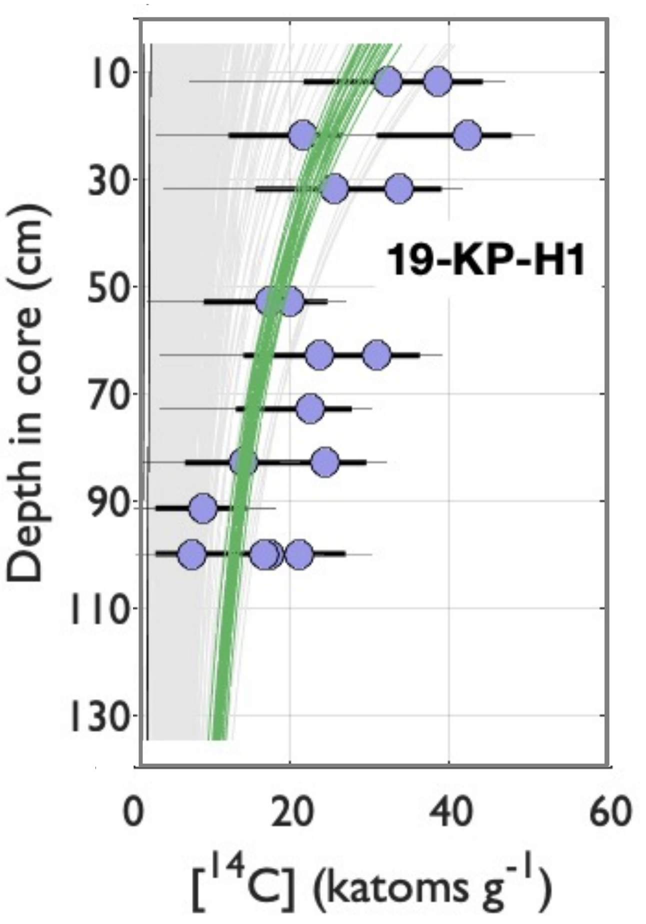


Depth profile from bedrock cores are luminescence saturated.

Suggests no ice-free conditions in past 200-400 kyr
Still allows for ice thinning with residual snow, ice, sediment.

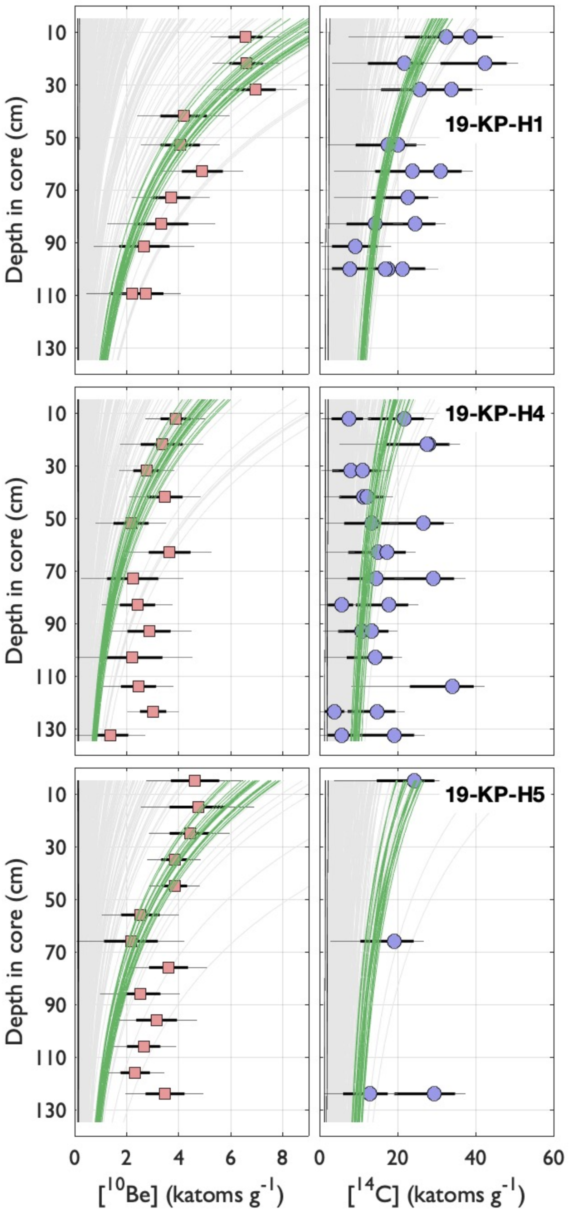
UNIVERSITY OF TEXAS ARLINGTON

What are we finding?

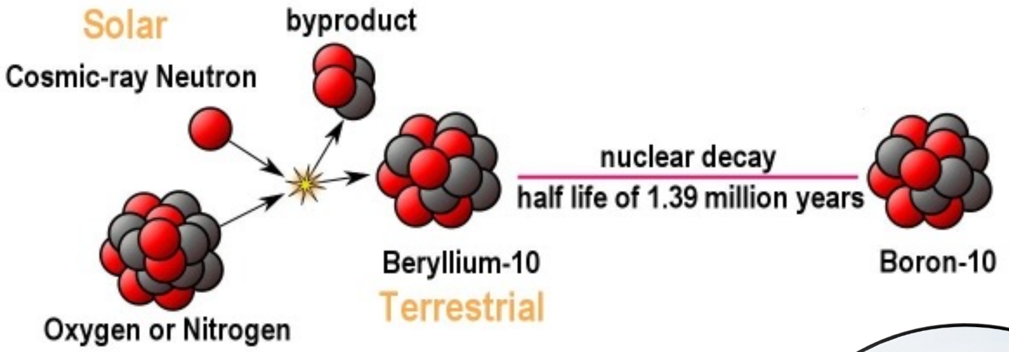


Measurable in situ ^{14}C at concentrations unequivocally above background

In situ ^{14}C concentrations as high as 42,000 atoms g^{-1} in core tops, and as low as 5,800 atoms g^{-1} at depth.

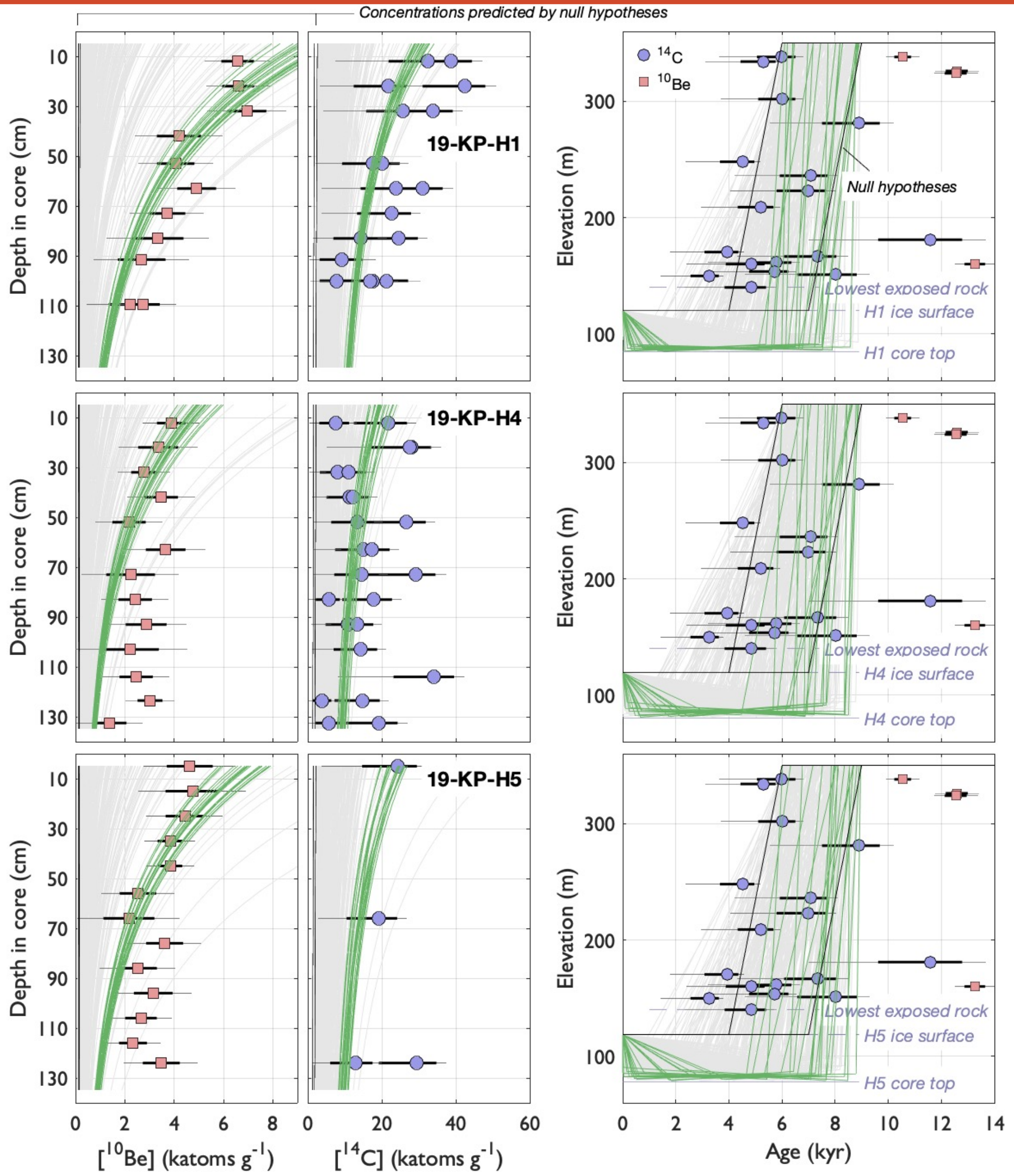


Measurements of ^{10}Be from the same samples illustrate a story consistent with in situ ^{14}C data.



Imperial College London

What does it all mean?



Consistent with output from simulations that model 10s of meters of thinning over a period of a few thousand years, followed by rethickening in the recent past.

Imperial College London

BGC Berkeley Geochronology Center

SALSA: Subglacial Antarctic Lakes Scientific Access

- SALSA is in wrap-up phases with some aspects of the project already closed out, some finishing out their extensions
- Three papers recently out for review, others soon to be
- Broader Impacts:
  - Kathy Kasic (Cal State Sacramento) and team produced film “Lake at the Bottom of the World”. Screenings at multiple film festivals and conferences, including recently at AAAS meeting
  - Other distribution options in the works

RAID update from John Goodge

- RAID platform completed successful tests and field trials during the (pre-COVID) 2019-20 season and is considered by the project to be field ready.
- During the current deployment restrictions, RAID is undergoing further improvements and modifications with design and fabrication work in the US.
- A recent paper in *Annals of Glaciology* reports on recent field trials.

Annals of Glaciology

IGS

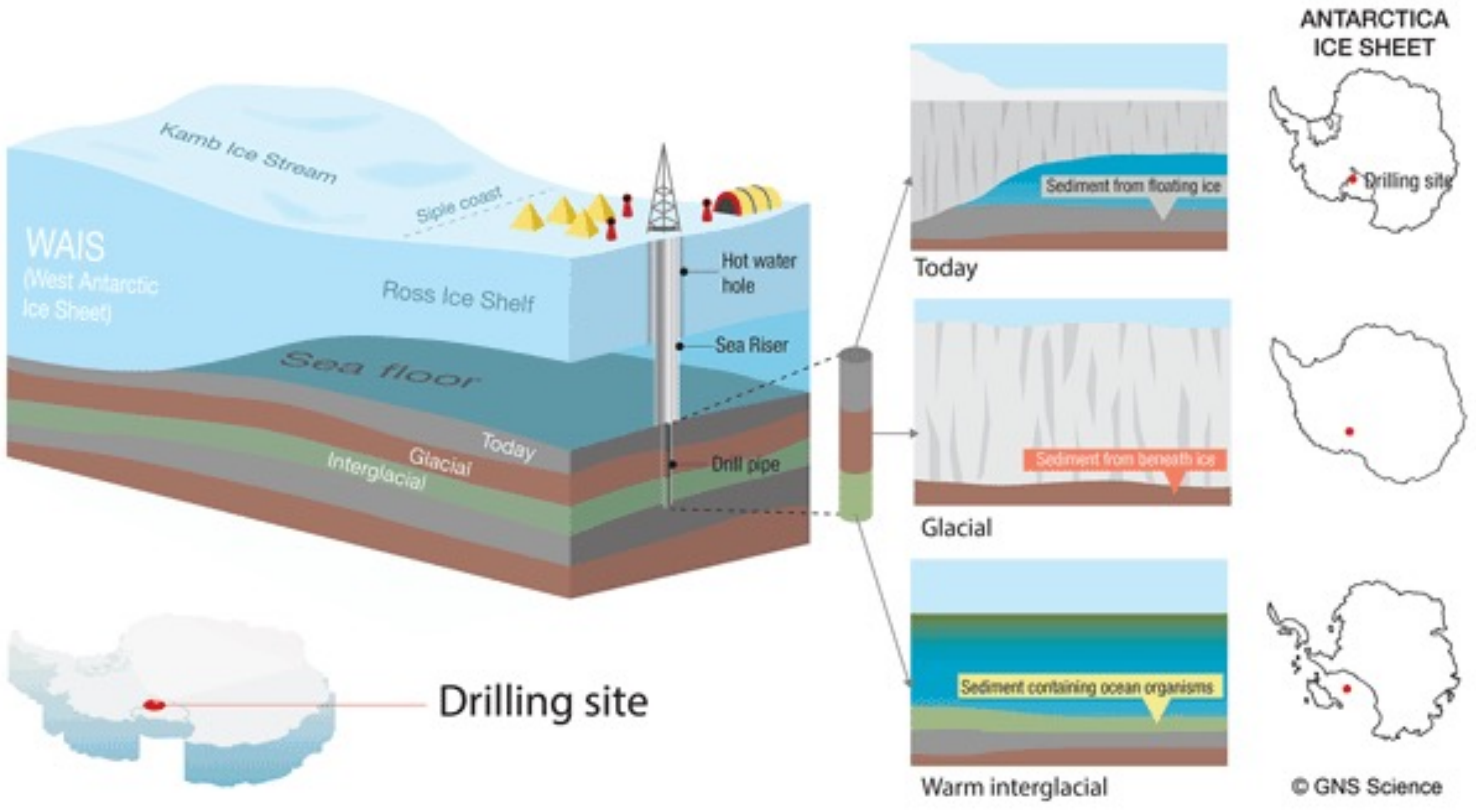
Article

Deep ice drilling, bedrock coring and dust logging with the Rapid Access Ice Drill (RAID) at Minna Bluff, Antarctica

John W. Goodge[1], Jeffrey P. Severinghaus[2], Jay Johnson[3], Delia Tosi[4] and Ryan Bay[5]

SWAIS 2C (Sensitivity of the West Antarctic Ice Sheet to 2℃)

- Drilling is led by NZ; US component of the project led by Molly Patterson (SUNY Binghamton)



The project will collect and study geological (rocks), glaciological (ice), and geophysical (Earth physical properties) data and provide new information to guide the development of climate and ice sheet numerical models to better understand and predict how the ice sheet on West Antarctica will contribute to future sea level rise.