

Optimizing rapid access englacial sampling location to date deep radiostratigraphy for old ice

Shivangini Singh¹, Duncan A Young¹, Shuai Yan¹, Gregory Ng¹, Dillon Buhl¹, Alejandra Vega² Gonzalez, Megan Kerr¹, Jamin Greenbaum³, Scott Kempf¹, Donald Blankenship¹

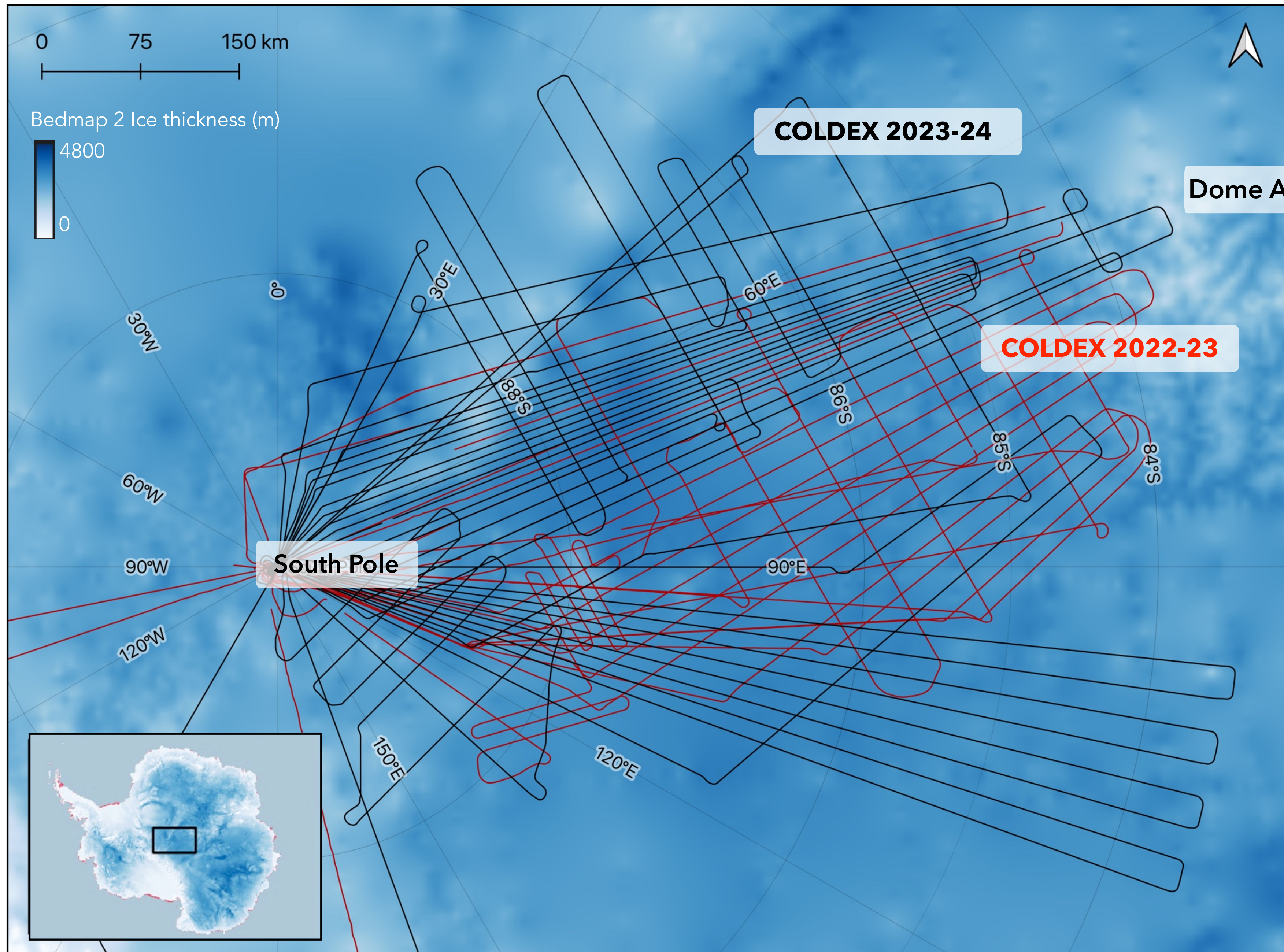
¹ University of Texas Institute for Geophysics, Austin, Texas, USA

² University of Puerto Rico Mayaguez, USA

³ Scripps Institution of Oceanography, La Jolla, CA, USA

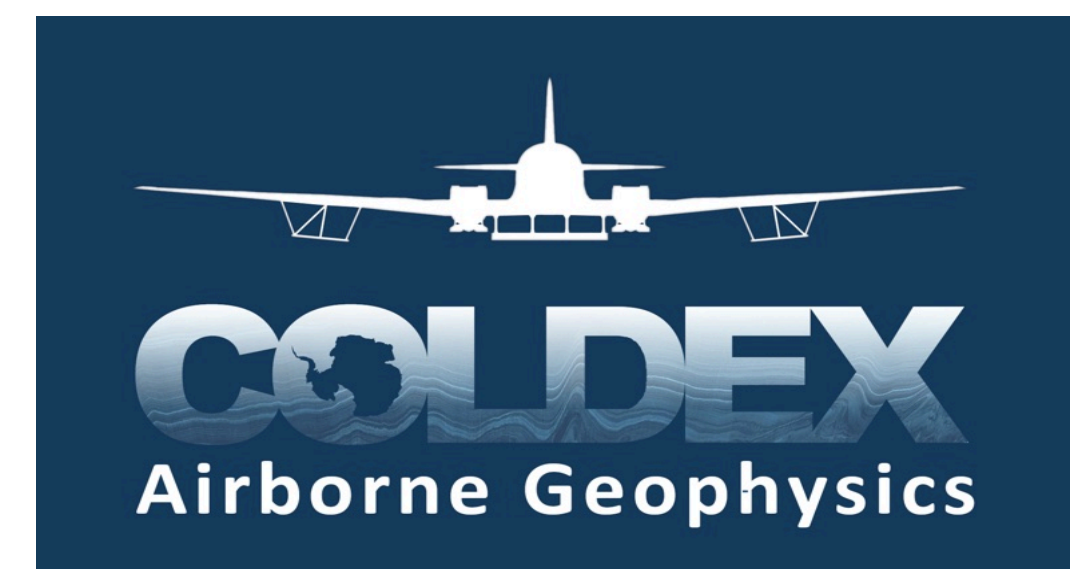


INSTITUTE FOR GEOPHYSICS
JACKSON SCHOOL OF GEOSCIENCES



Setup

- Extension of chronostratigraphic link between the southern flank of Dome A, SPICECore and dust profiles from boreholes
- ~40,000 km line of ice-penetrating radar data oriented along **flow lines**



Twofold Objective

Optimize for locations with high scientific leverage

1

Maximize age-depth scale extraction by dating the **deepest isochrones**

Provide constraints on **deep shear**

2

Strategically sample pervasive **basal layer** in the survey region

Understand the role of basal layer in preserving old ice

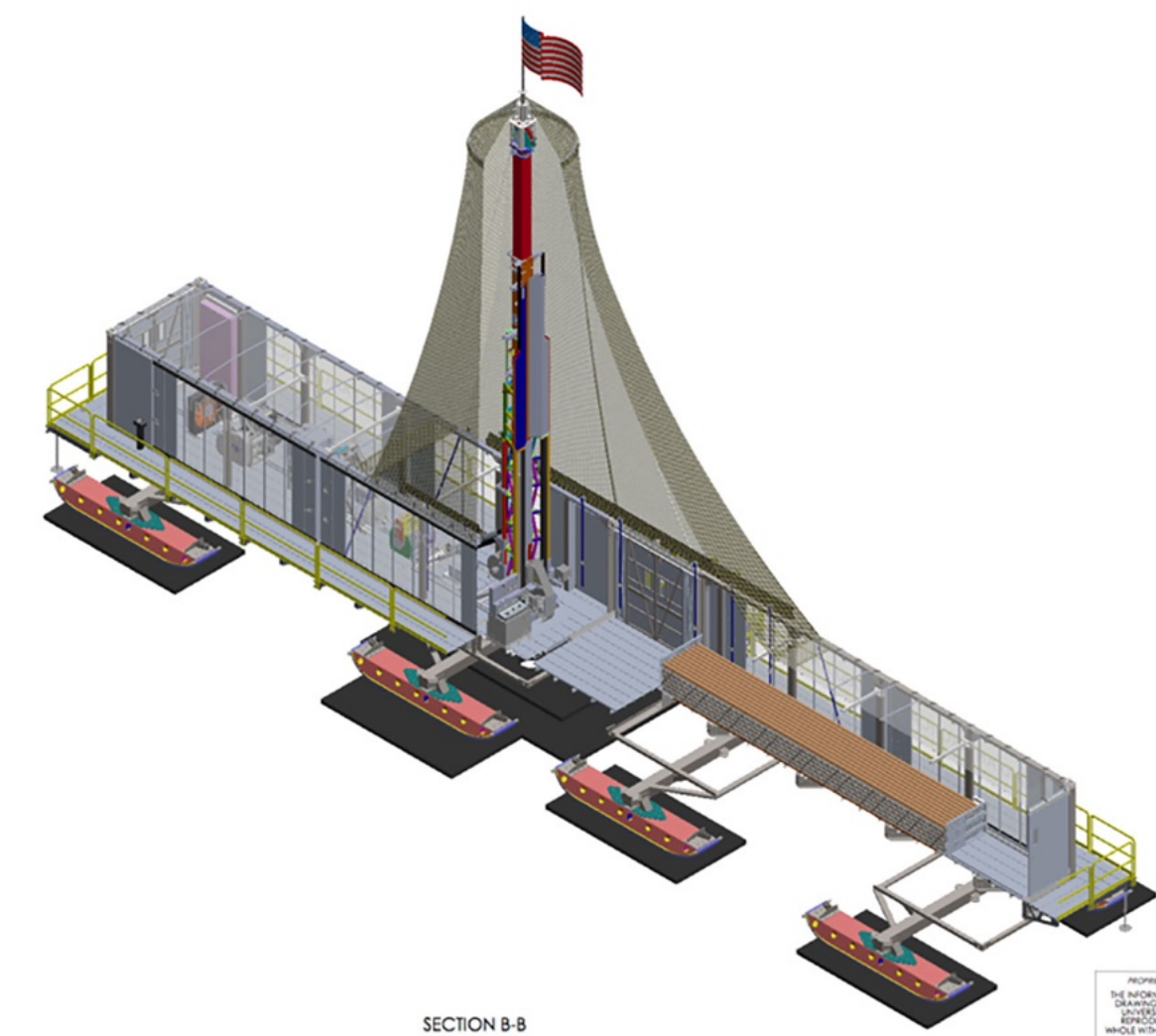
Tools to optimize for

IceDiver

- Melt probe housing an optical dust logger capable of **counting ice age dust cycles**
- **2000 m, 10 m per hour**
- Scheduled for field test in Greenland for Summer'24

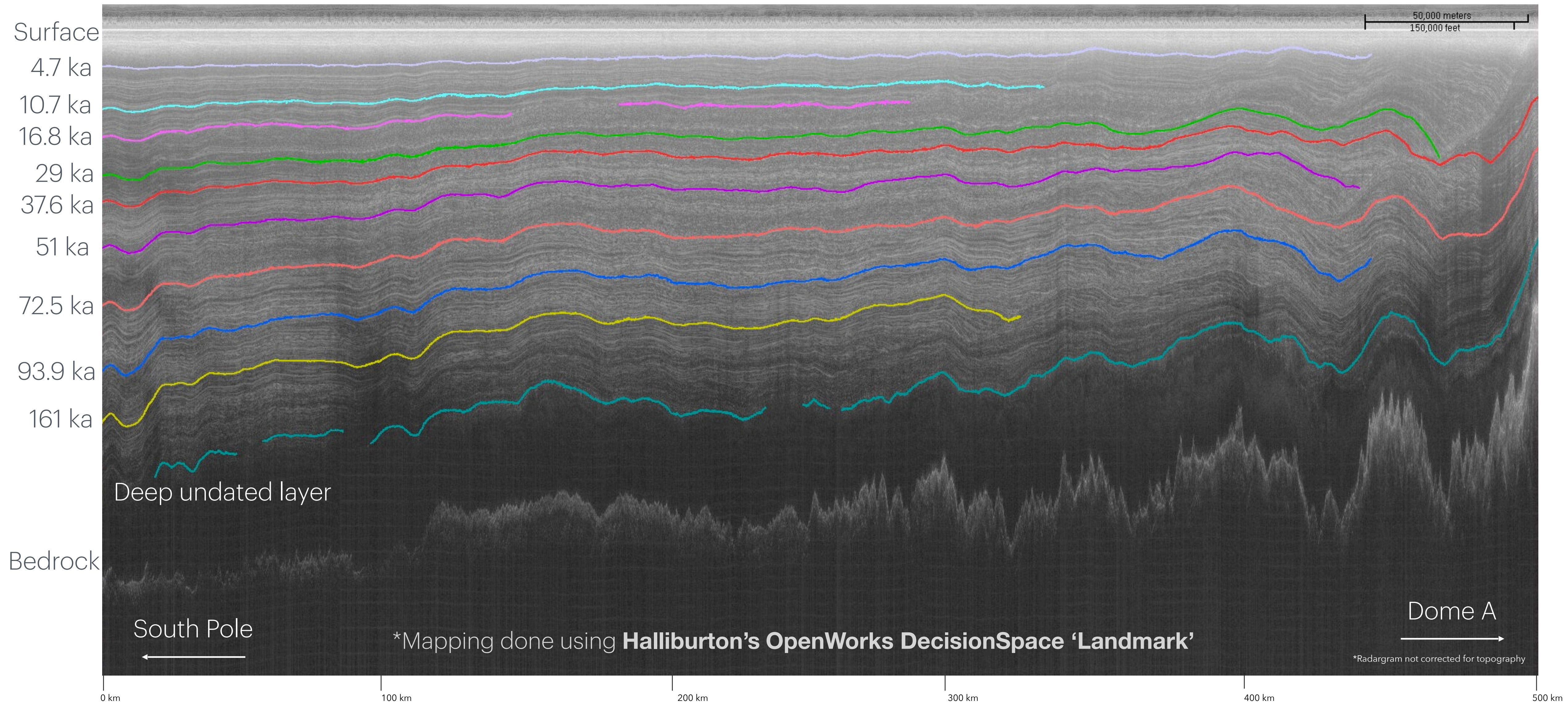
RAID (Rapid Access Ice Drill)

- Capable of quickly accessing glacial bed and retrieve short deep **ice cores** and **bedrock samples**
- Sled mounted mobile drilling system capable of making multiple narrow (8.9 cm diameter) boreholes
- **3000 m in 48 hours**



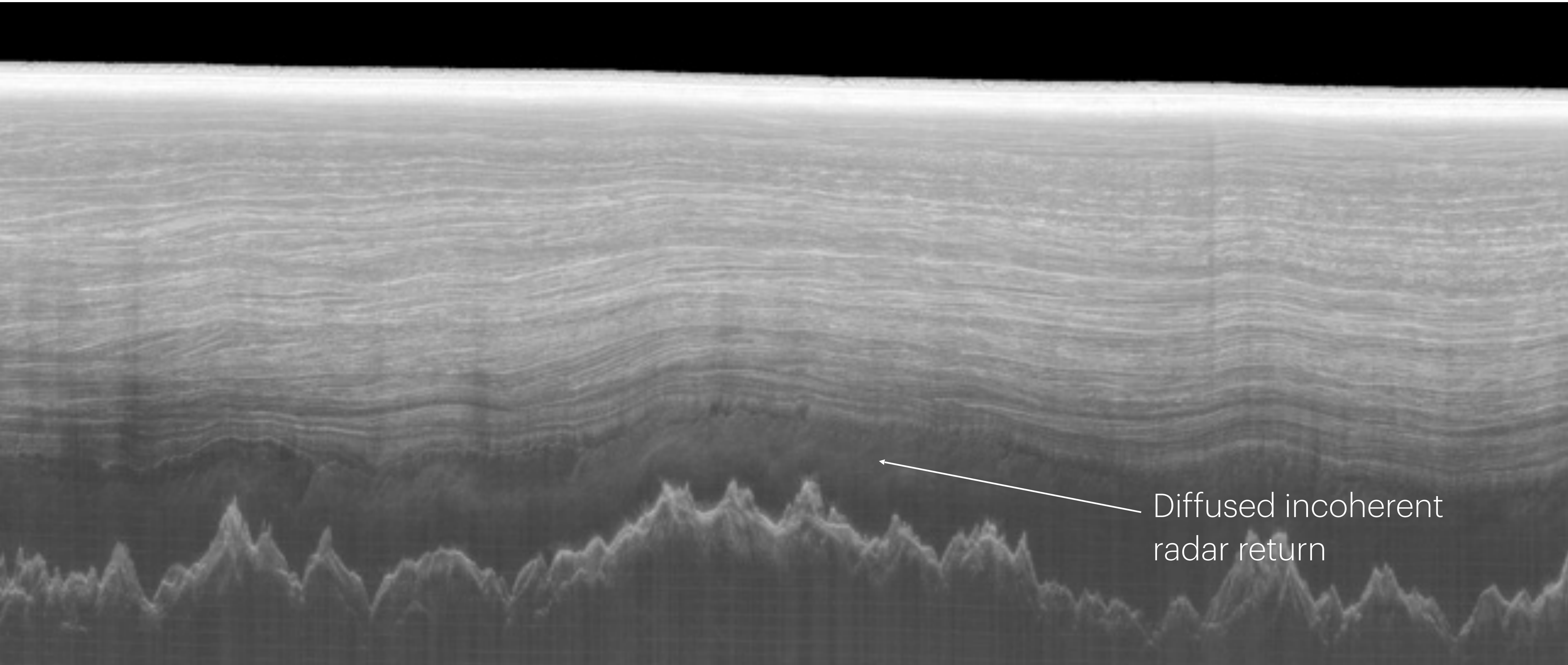
What do we have so far?

10 dated isochrones spanning the entire survey, ranging from 4.7 ka to 161 ka*

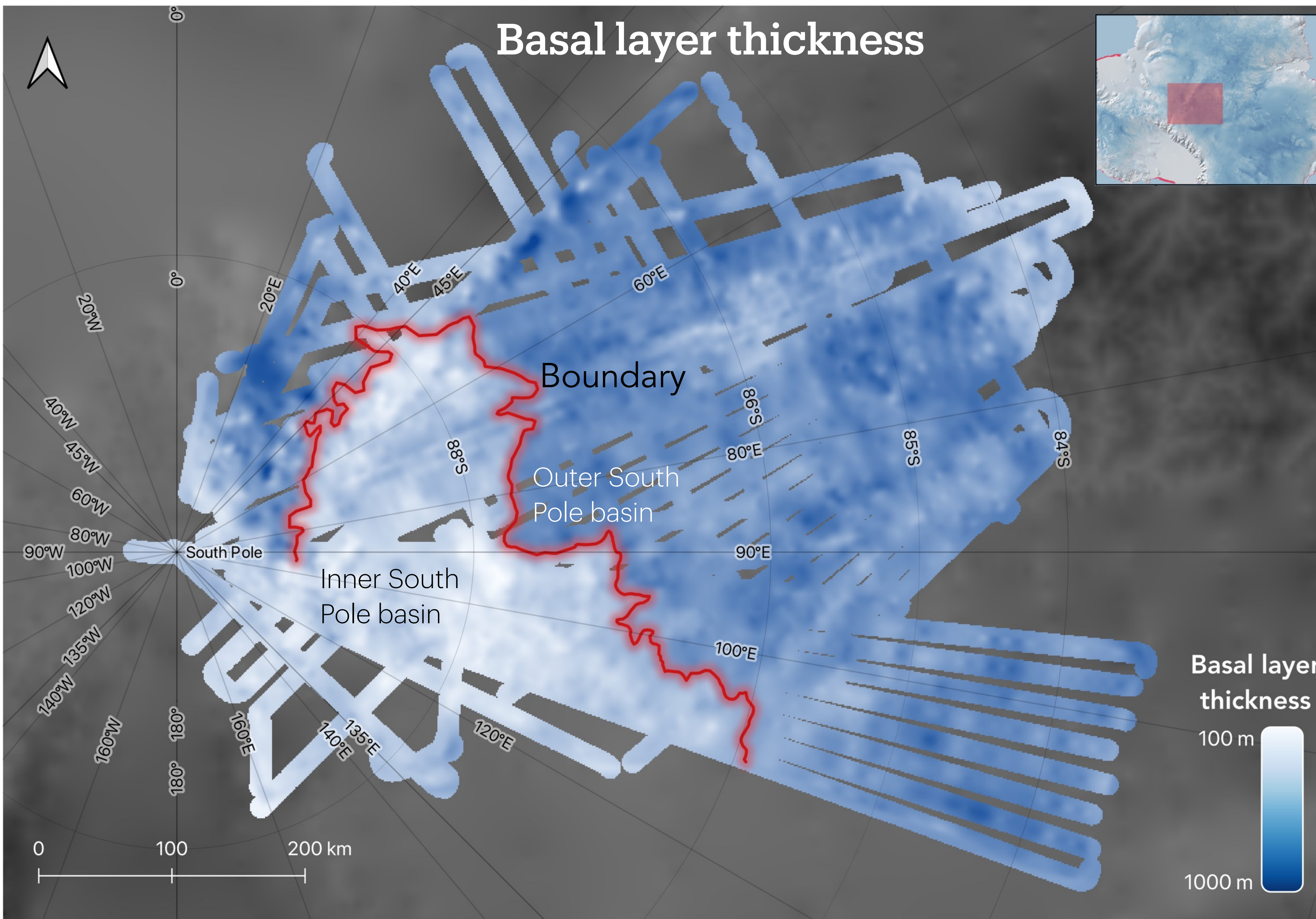


What do we have so far?

Mapping of the **deeper undated stratigraphy** and **basal layer**

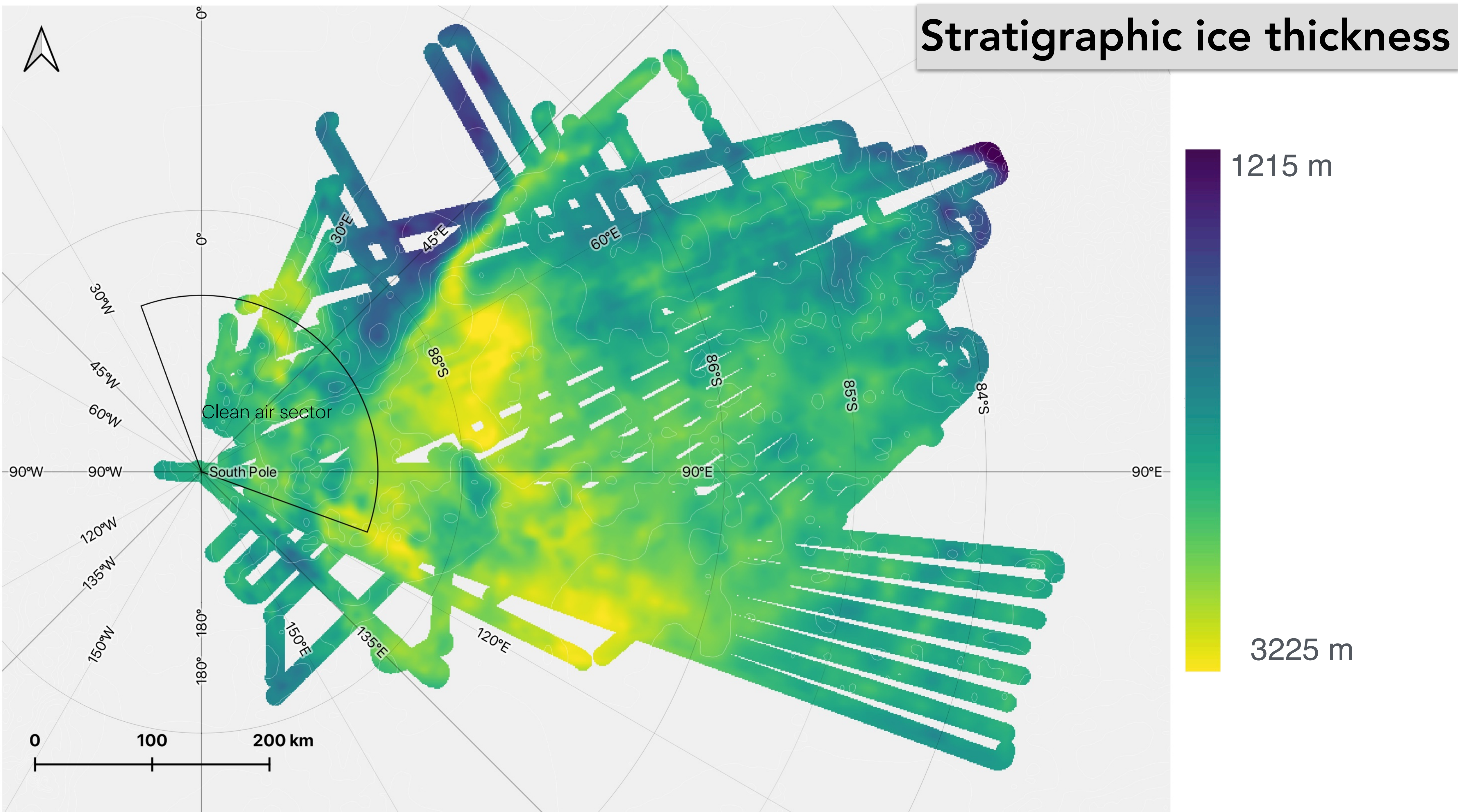


Basal layer thickness



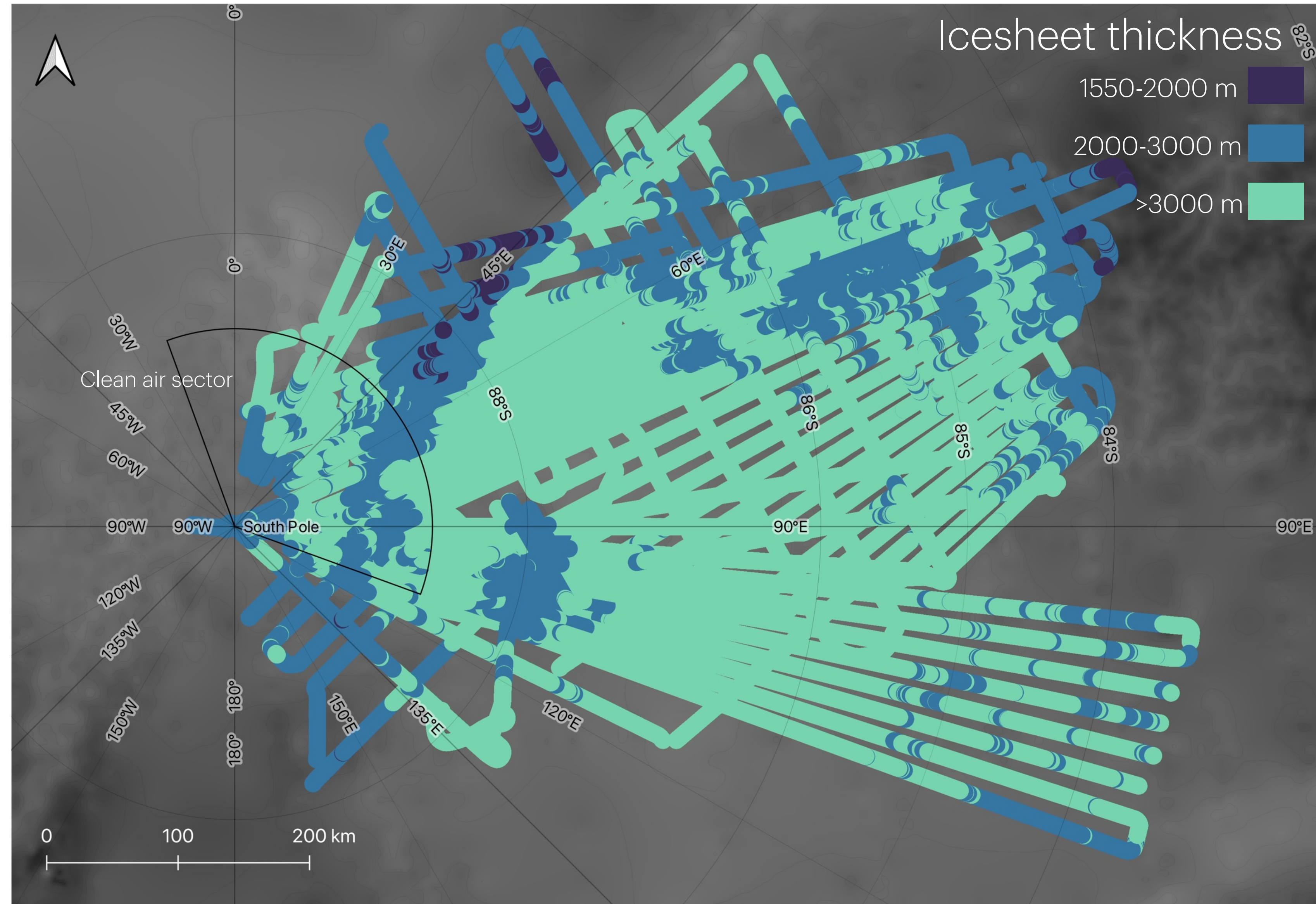
- Sharp decrease in basal ice layer thickness at the 'Boundary'
- The Boundary is likely due to a transition in **subglacial geology** from the outer to the inner South Pole basin

Stratigraphic ice thickness



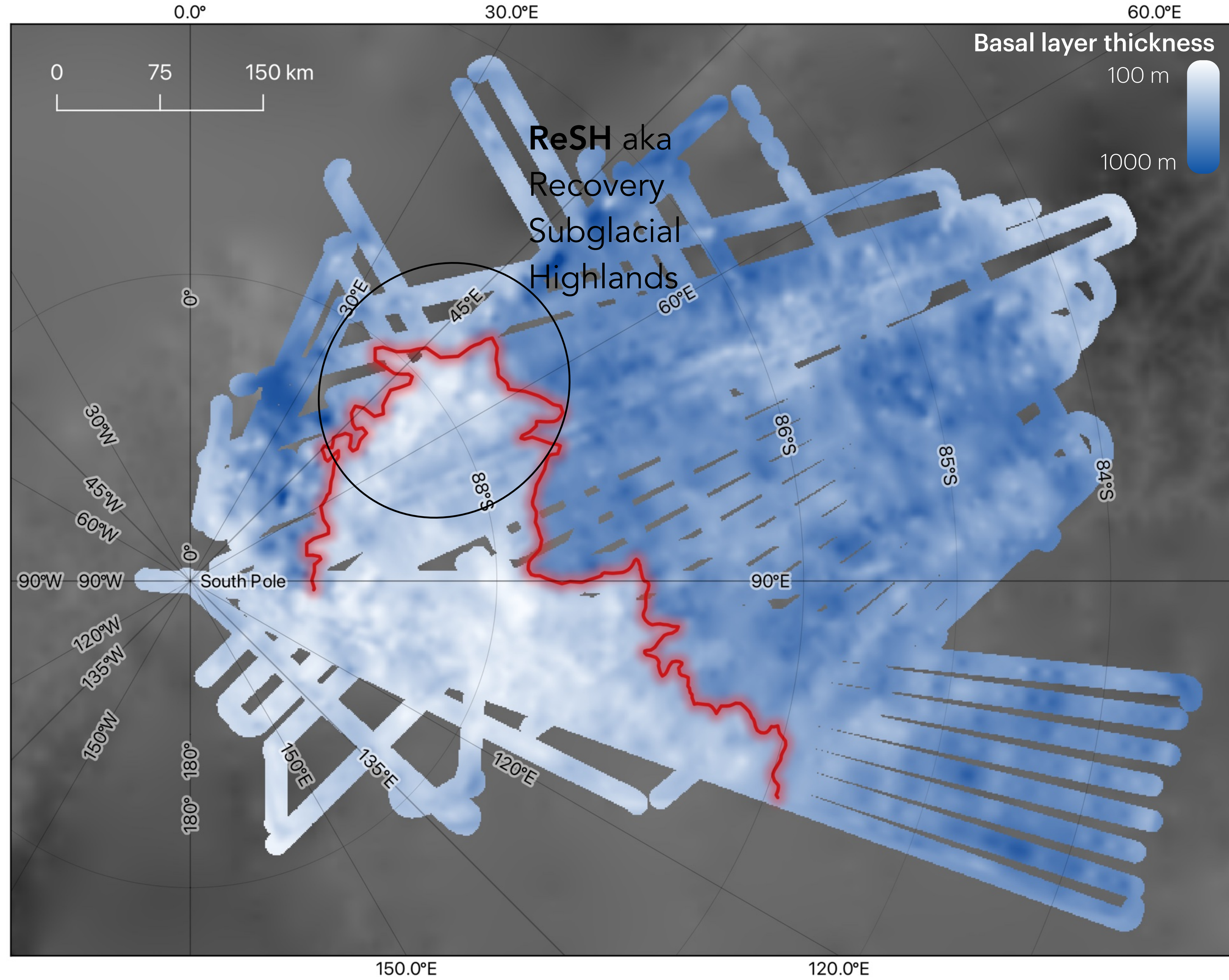
Criteria used for site selection

- Maximize chronology for deep undated stratigraphy (constraint on deep shear)
- Sample basal layer (Is there dateable stratigraphy in the basal layer?)
- Ice sheet thickness (Basal temperature)
- Understand the diffused (fuzzy) echoes within the basal layer



Candidate sites

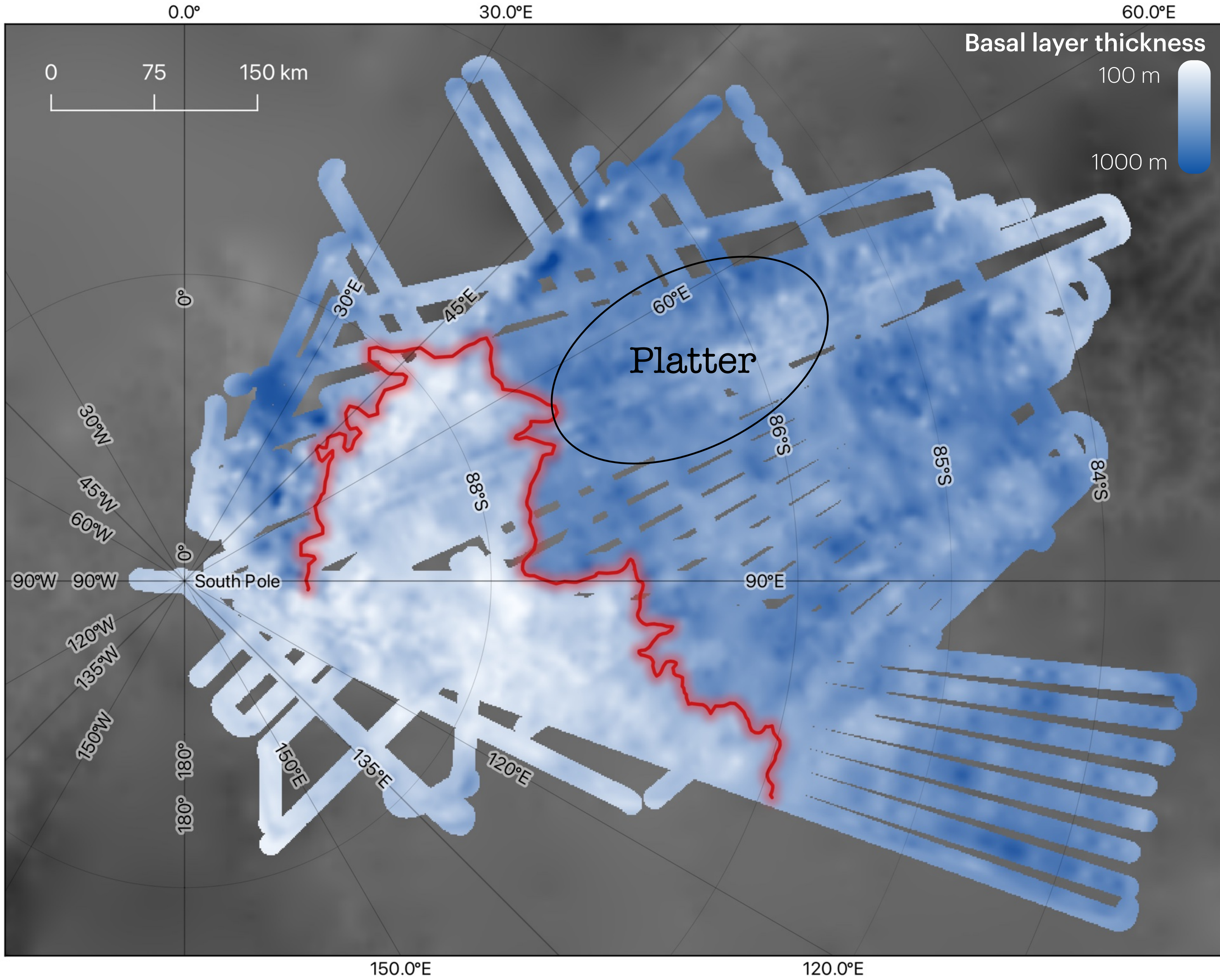
1. ReSH



Candidate sites

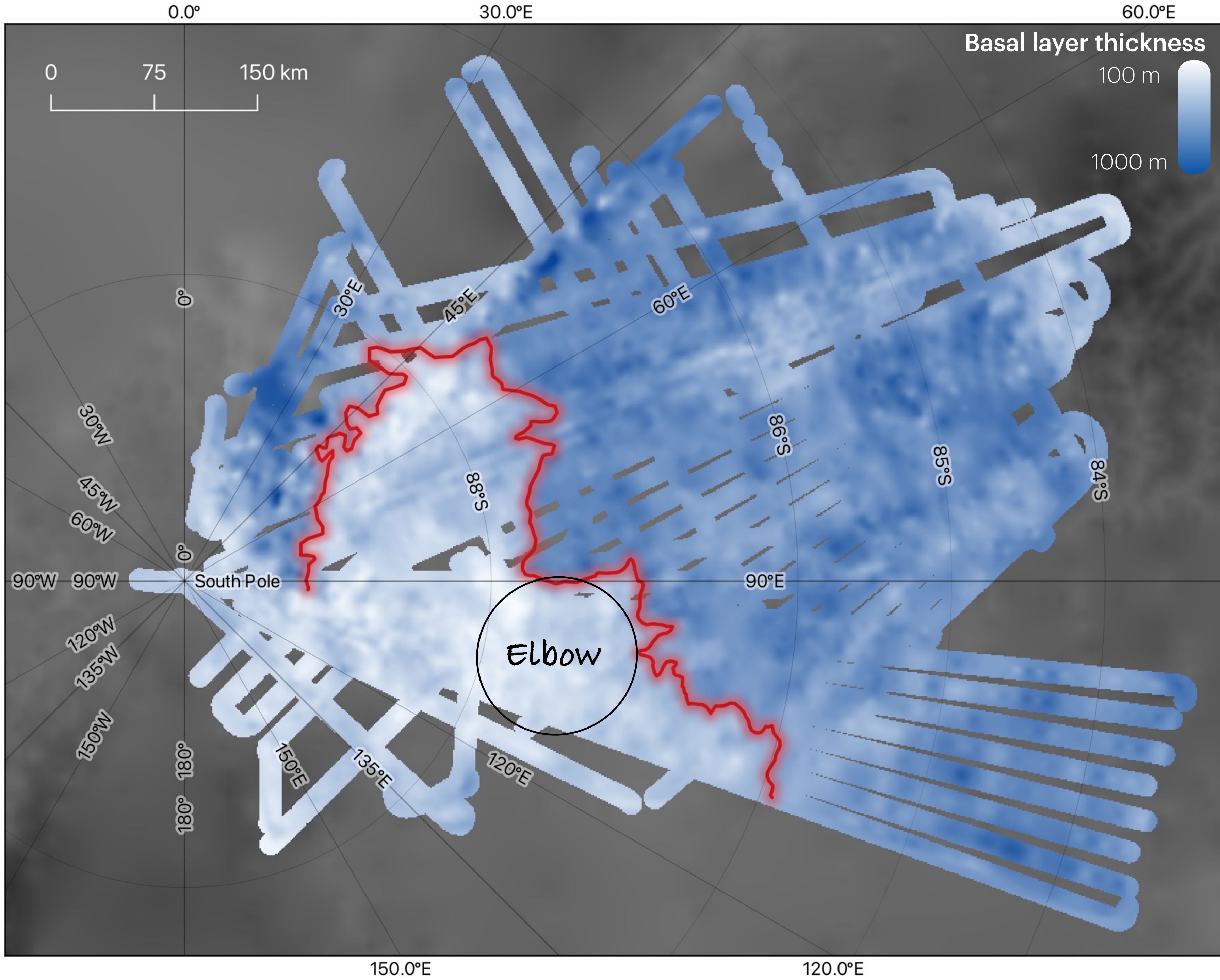
1. ReSH

2. Platter



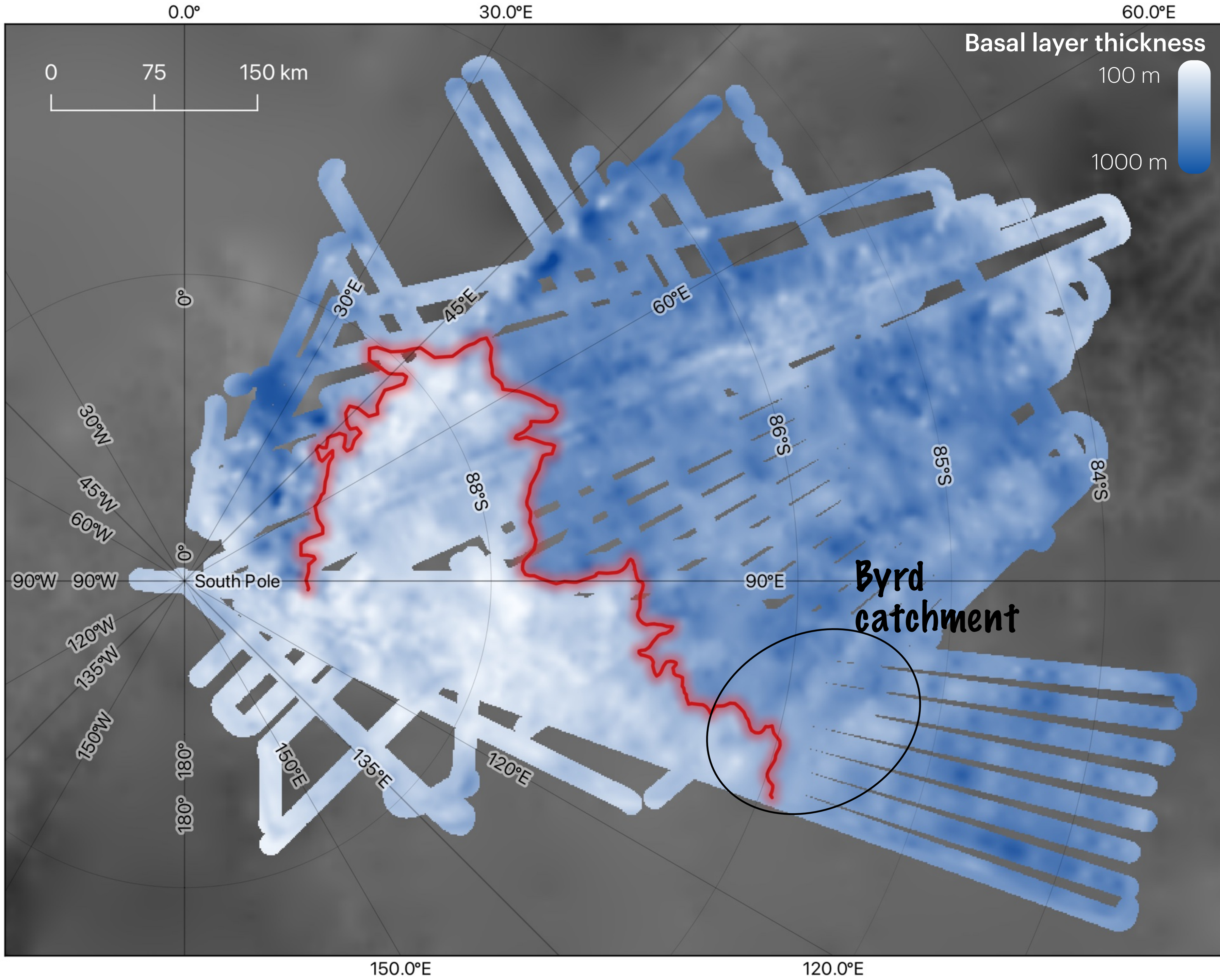
Candidate sites

- 1. ReSH
- 2. Platter
- 3. Elbow



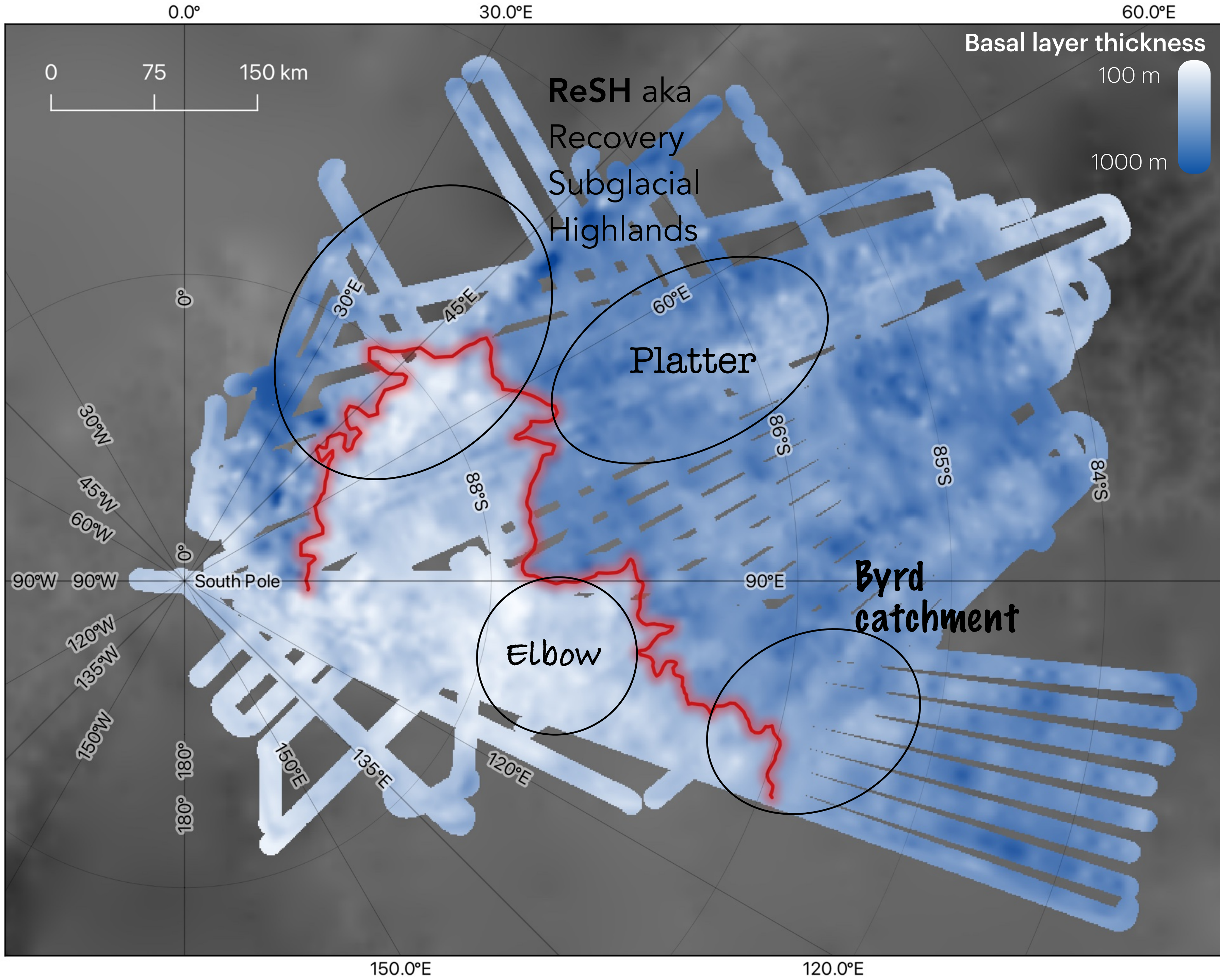
Candidate sites

- 1. ReSH
- 2. Platter
- 3. Elbow
- 4. Byrd**



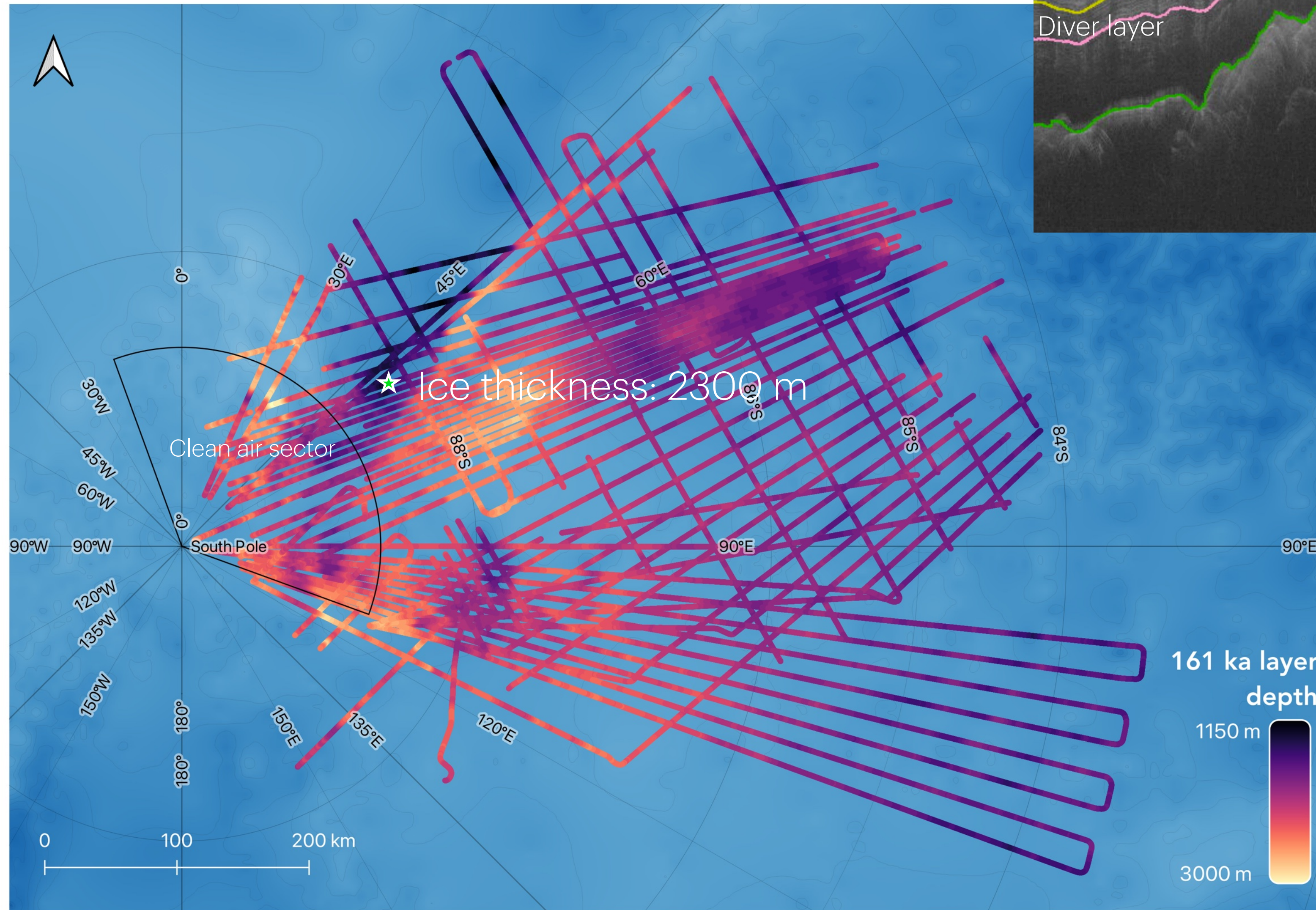
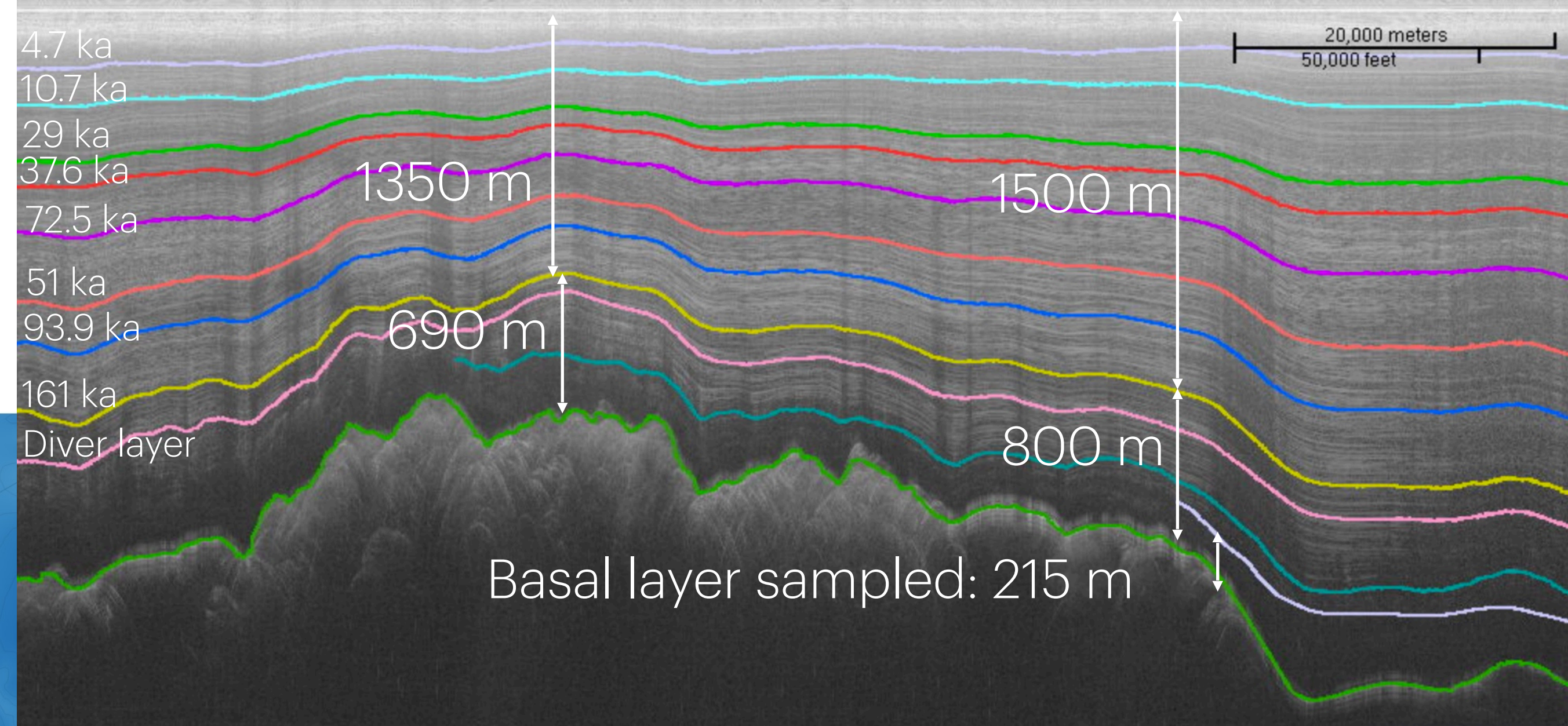
Candidate sites

- 1. ReSH
- 2. Platter
- 3. Elbow
- 4. Byrd

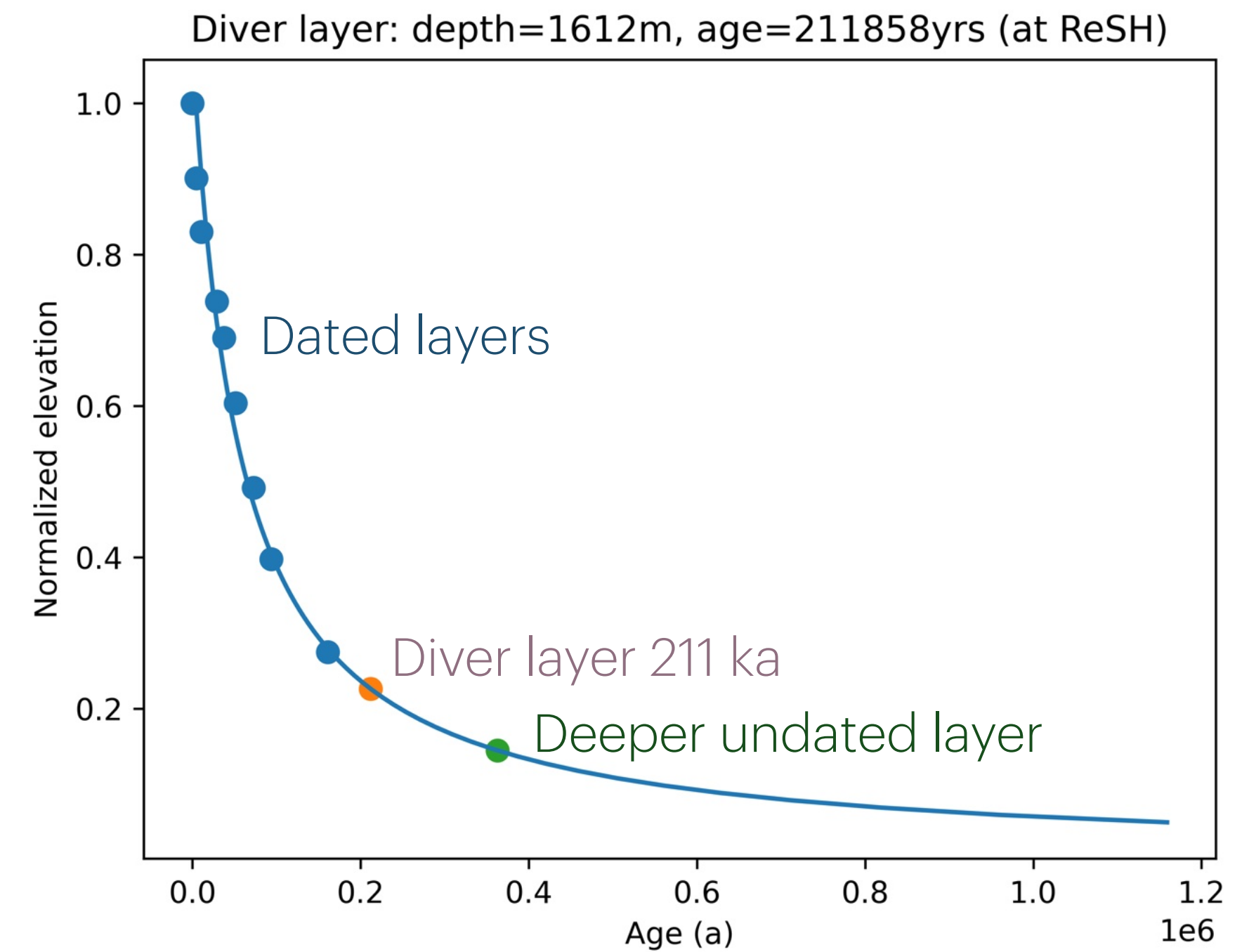


ReSH

- 161 ka depth: 1500(+/-20) m
- Diver layer depth: 1612 m

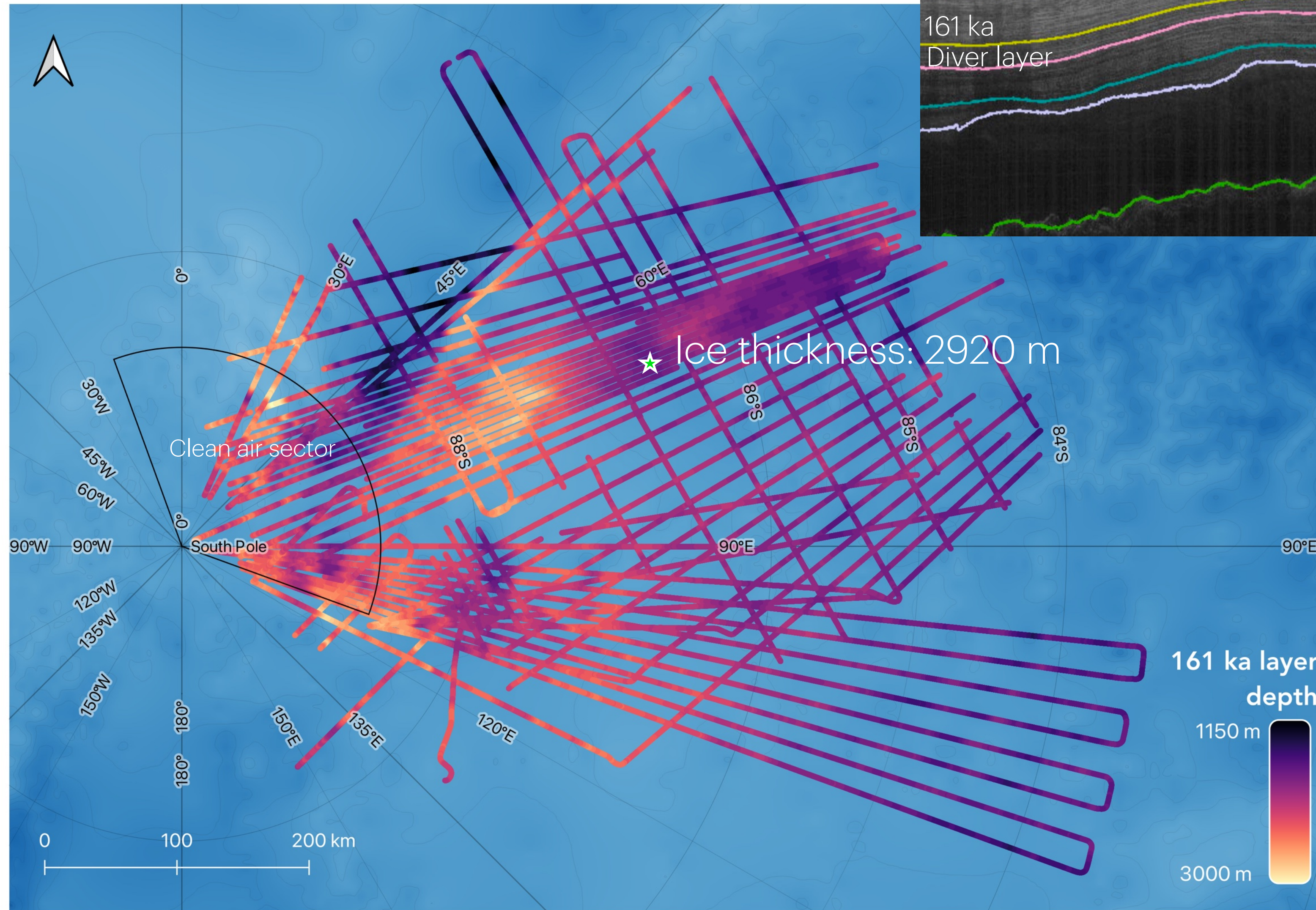
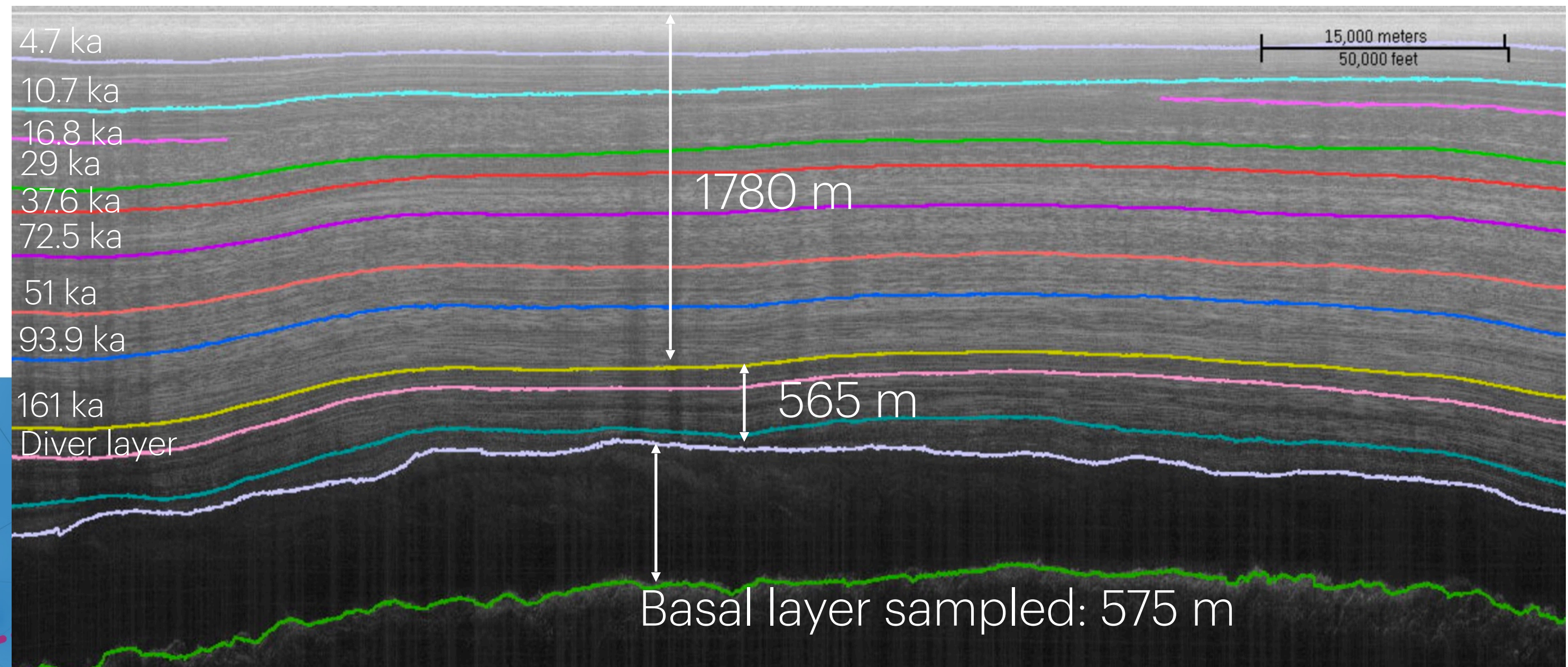


Age-depth estimation using Dansgaard-Johnsen model

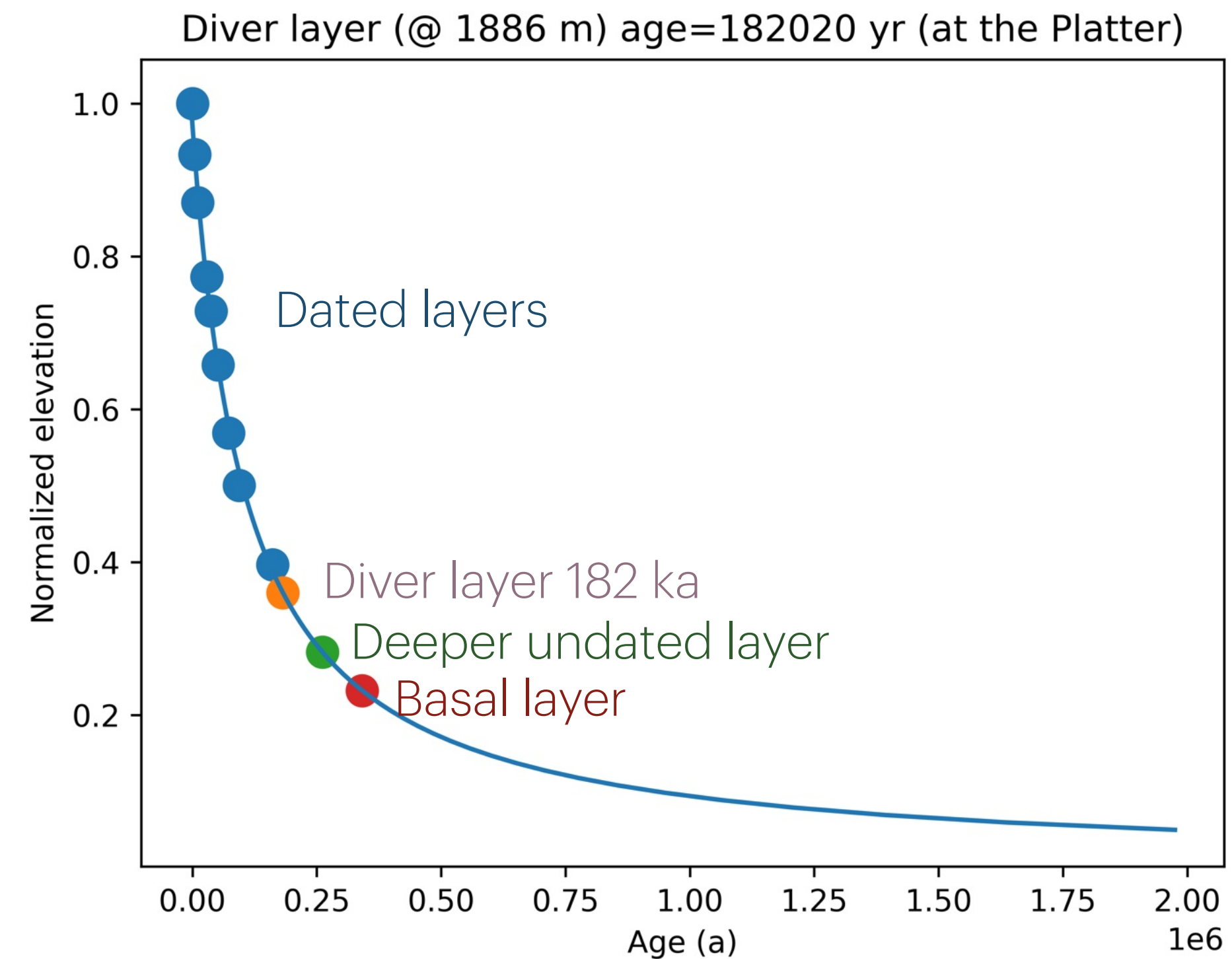


Platter

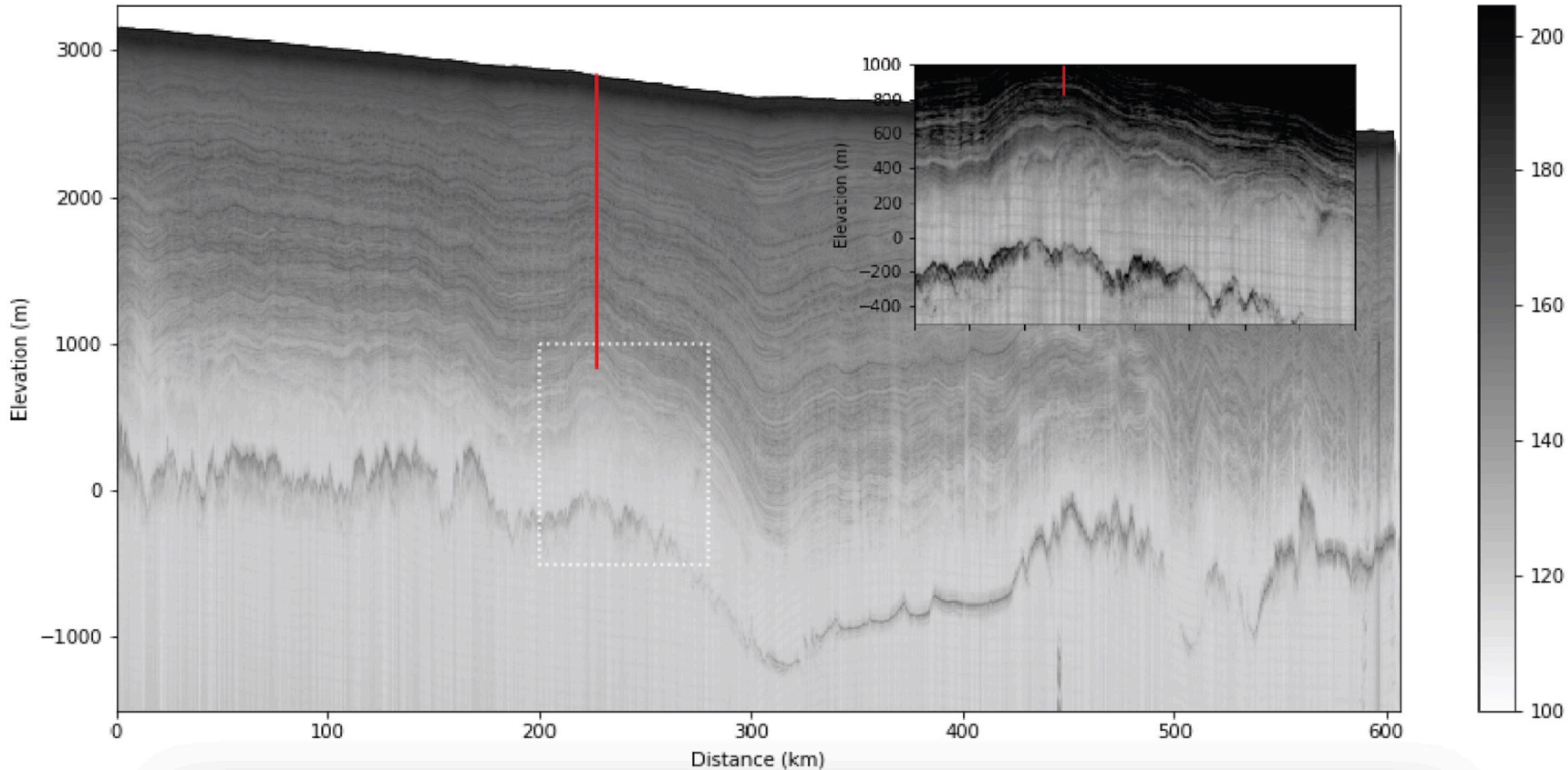
- 161 ka depth: 1780(+/-20) m
- Diver layer depth: 1886 m



Age-depth estimation using Dansgaard-Johnsen model

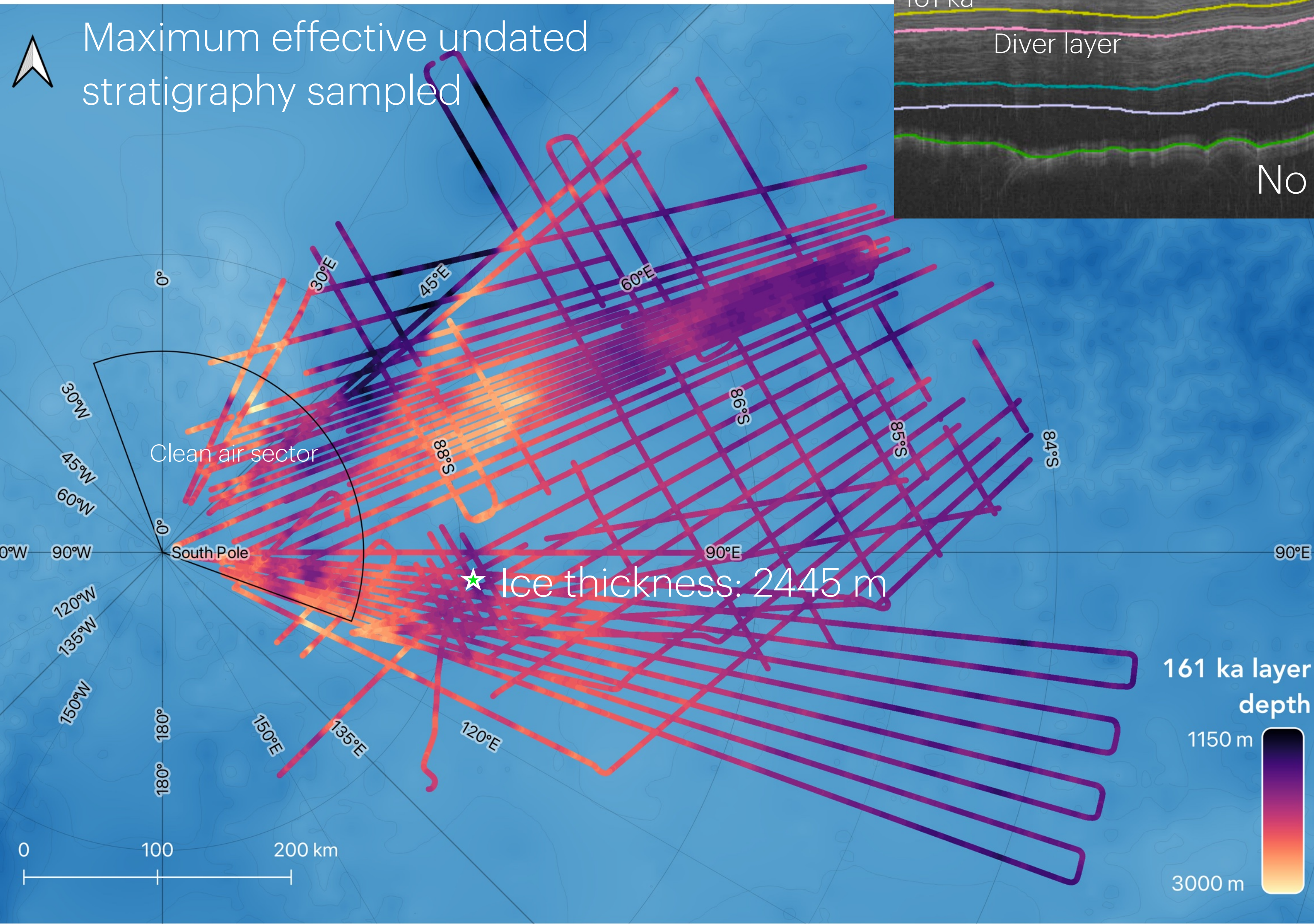
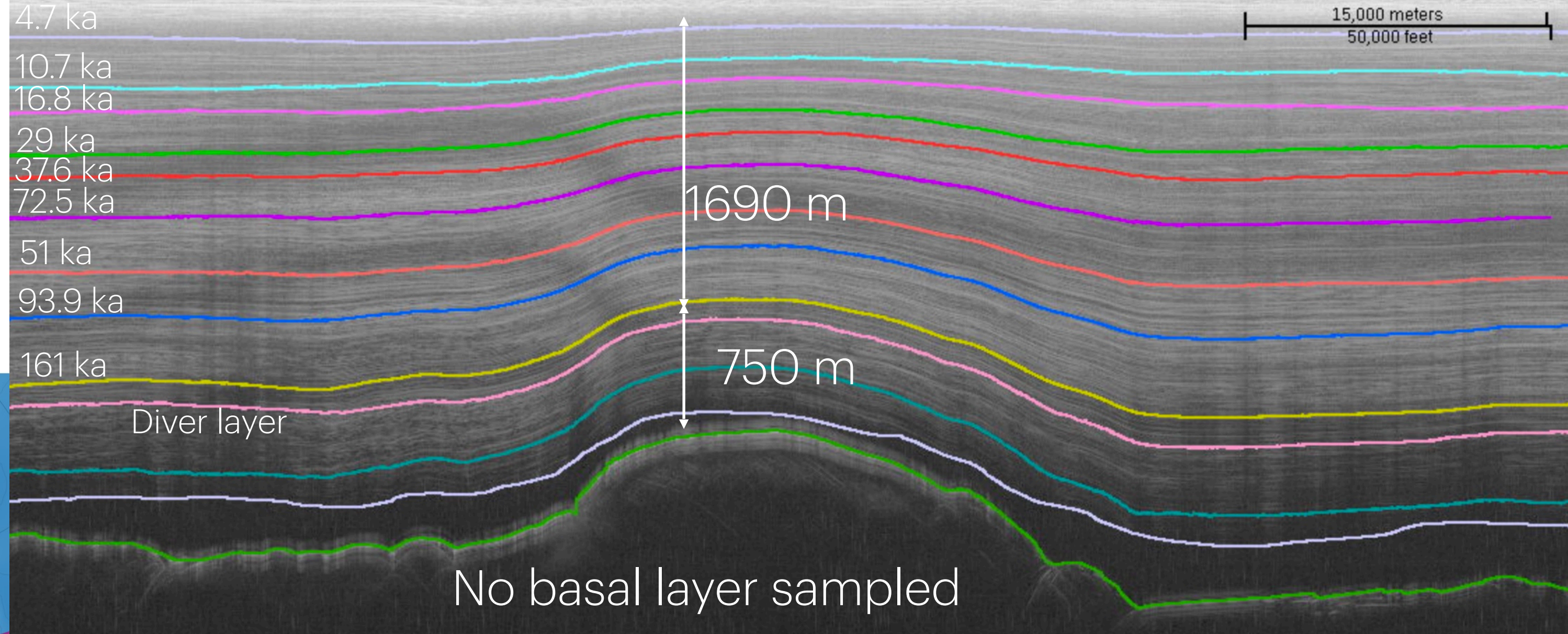


Platter

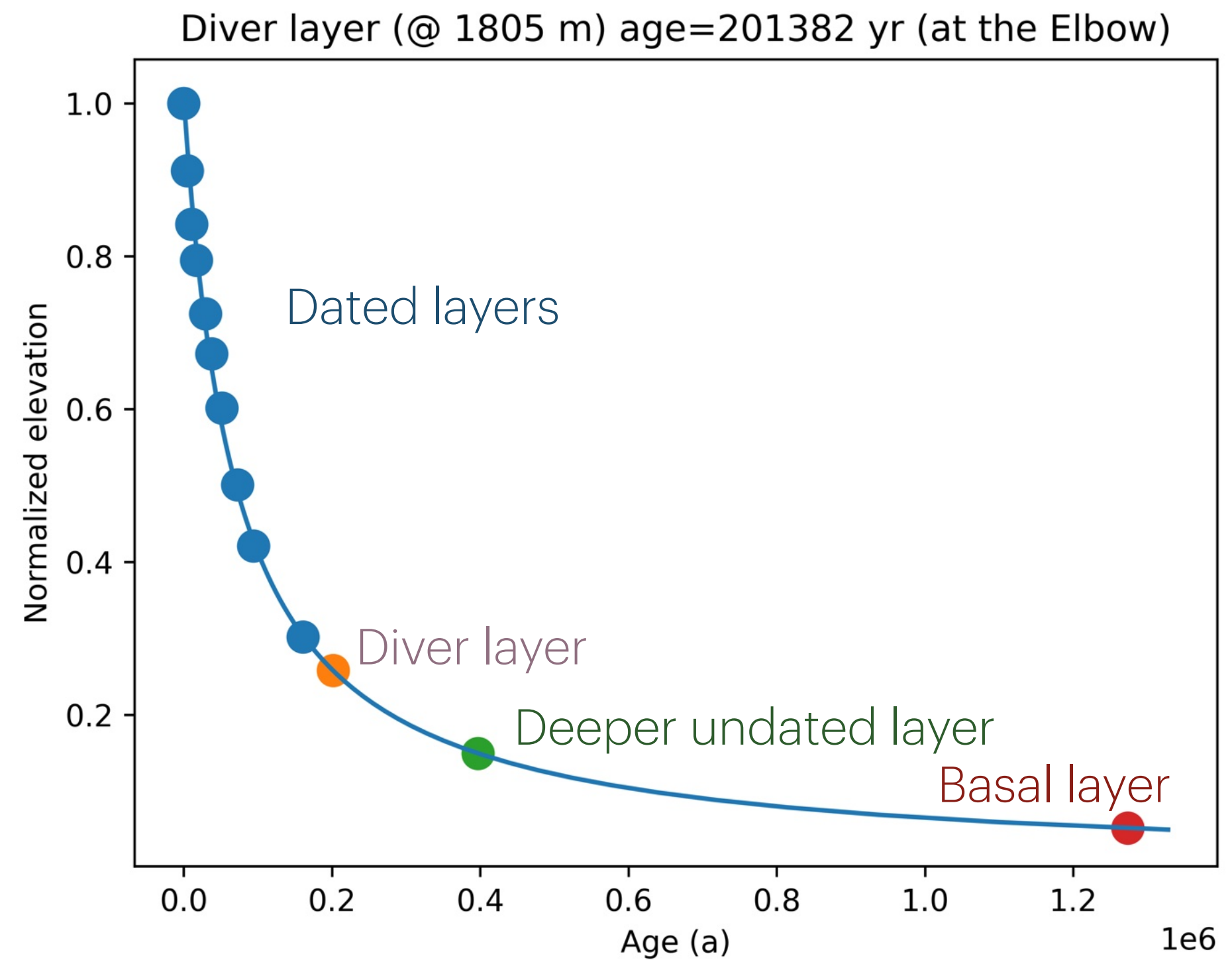


ELBOW

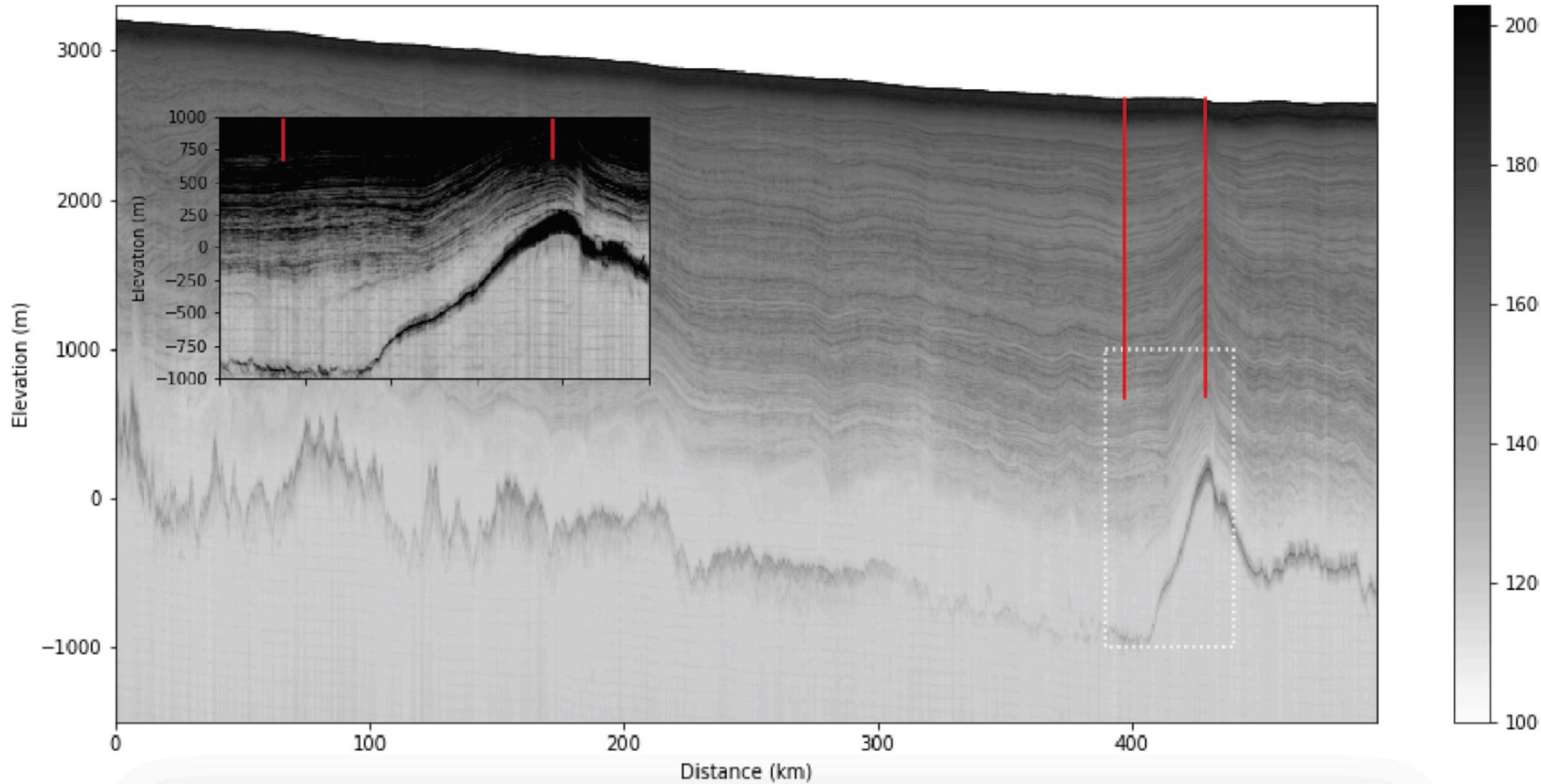
- 161 ka depth: 1690(+/-20) m
- Diver layer depth: 1810 m



Age-depth estimation using Dansgaard-Johnsen model

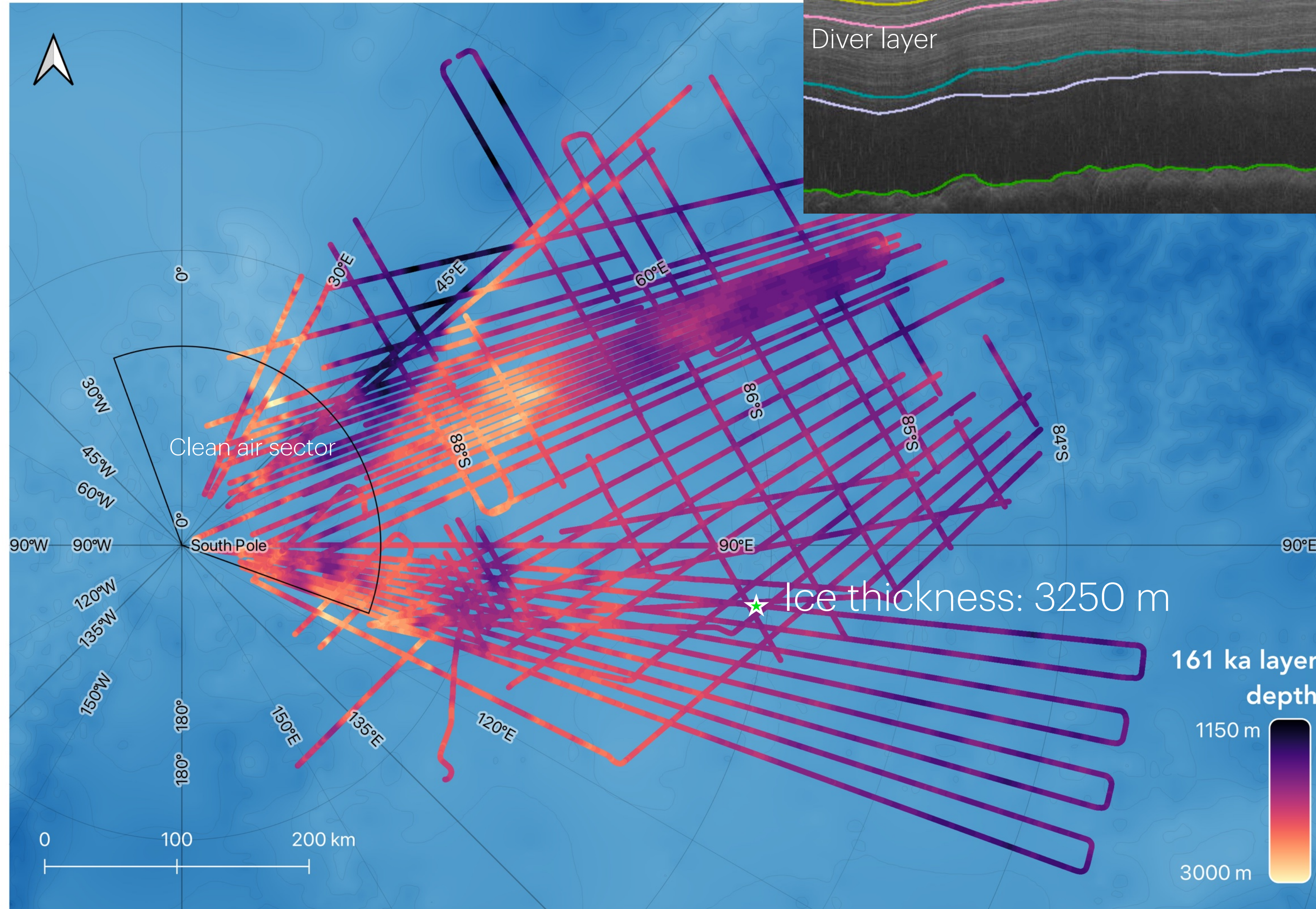
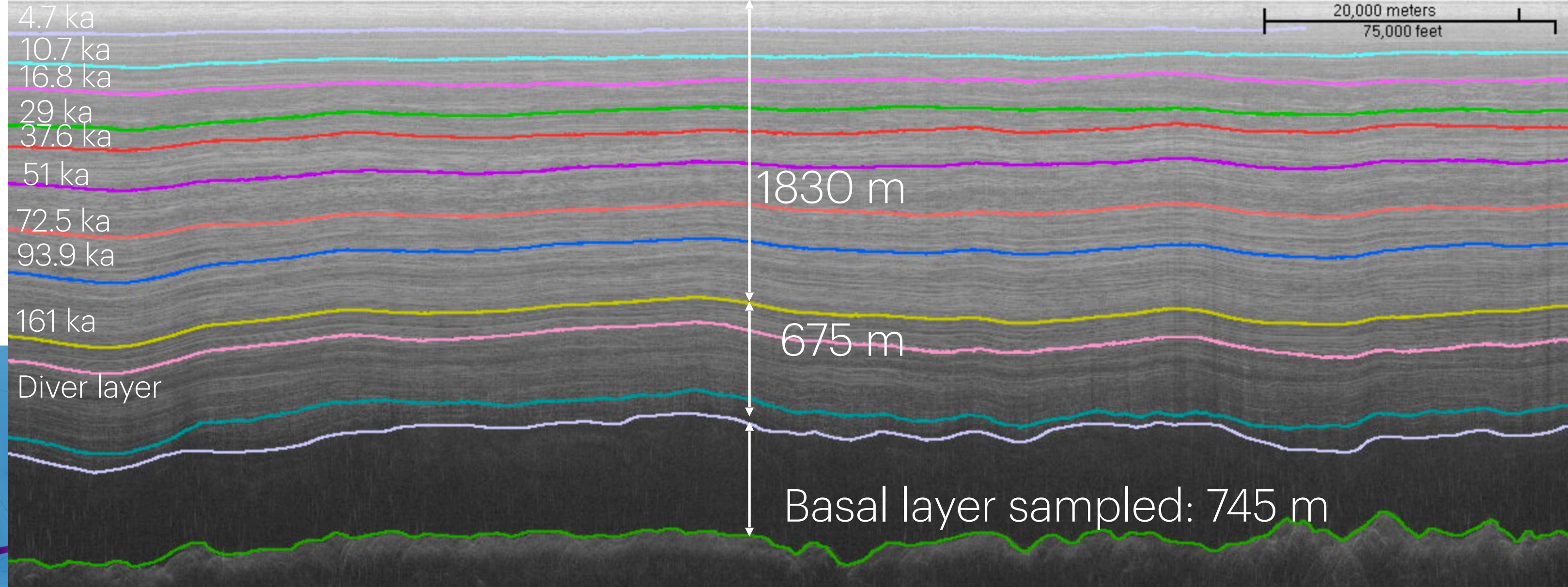


ELBOW

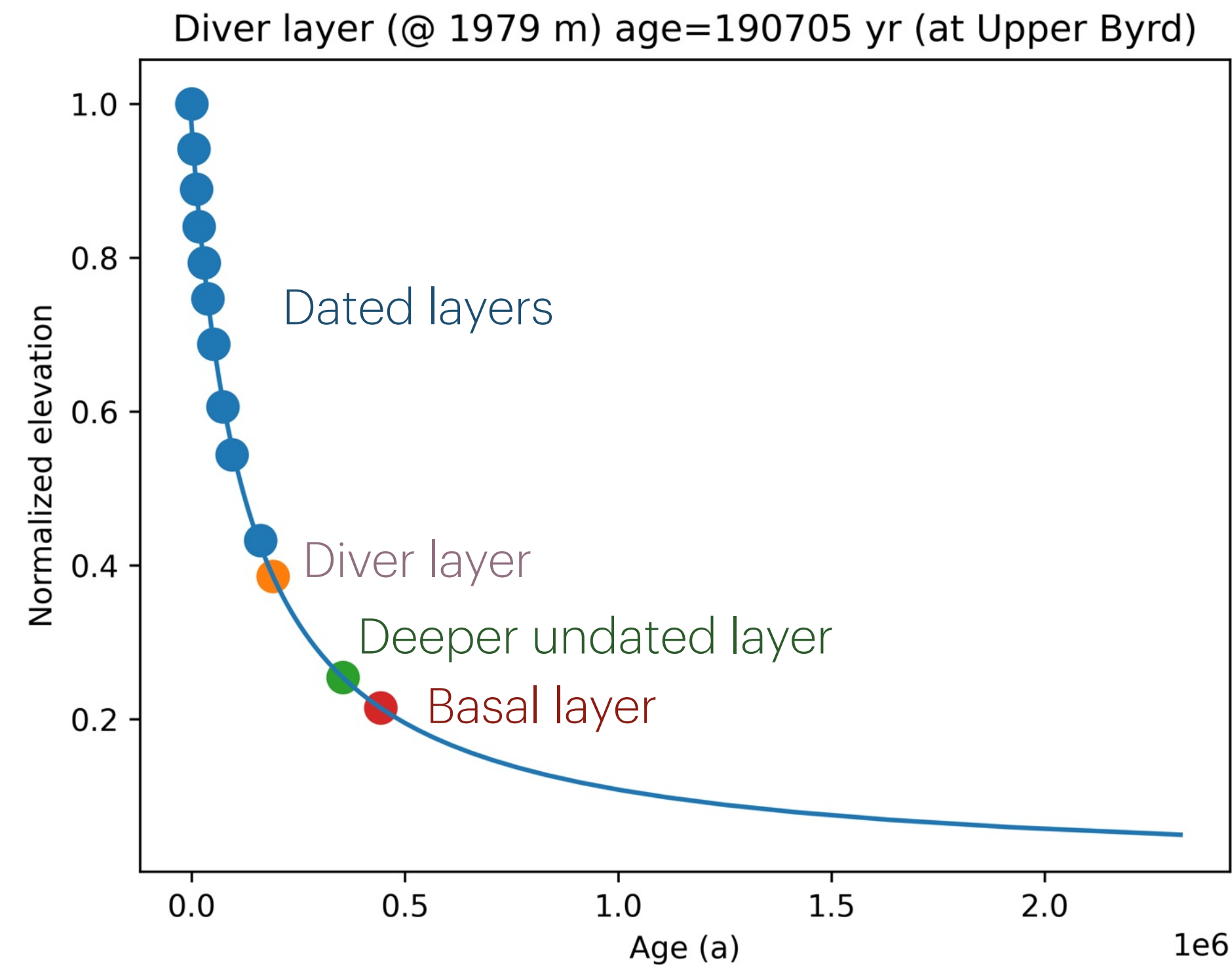


Byrd catchment

- 161 ka depth: 1830 m
- Diver layer depth: 1980 m



Age-depth estimation using Dansgaard-Johnsen model



Decision matrix

The diagram shows two drill types at the top: **IceDiver** (green box) and **RAID (Rapid Access Ice Drill)** (purple box). Arrows point from these boxes to the corresponding columns in the decision matrix below.

Criteria \ Sites	Deep(est) continuous layers	Icesheet thickness	Fuzzy basal stuff	Basal layer
ReSH	★	★		★
Platter	★	★	★	★
Elbow	★	★		
Byrd catchment	★		★	★

The decision matrix is a 5x5 grid. The first row is the header for 'Criteria' and 'Sites'. The first column is the header for 'Sites'. The cells contain performance ratings represented by stars. IceDiver (green stars) is rated 5 stars for 'Deep(est) continuous layers' and 4 stars for 'Icesheet thickness' at all sites. RAID (purple stars) is rated 5 stars for 'Basal layer' at all sites, 5 stars for 'Fuzzy basal stuff' at 'Platter' and 'Byrd catchment', and 4 stars for 'Icesheet thickness' at all sites. RAID is not rated for 'Deep(est) continuous layers'.

Takeaways



shivangini@utexas.edu

IceDiver

- Elbow and ReSH seem to be the highest leverage sites
- **Elbow** is logistically more easily accessible from South Pole and possibly the best choice to maximize dated stratigraphy extraction

<https://www.rapidaccessicedrill.org/>

2nd planning workshop:

September 25-27, 2024 (including 1/2-day session for Early Career Researchers!)

Venue: Washington Dulles Marriott Suites hotel, Herndon, VA

RAID (Rapid Access Ice Drill)

- **Platter** is the clear winner with optimum ice thickness, considerable basal layer with diffused reflections that can enhance our understanding of processes governing old ice preservation

