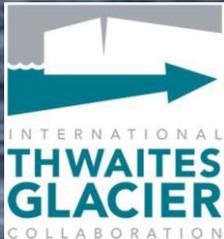


# Swirls and scoops: Ice base melt revealed by multibeam imagery of an Antarctic ice shelf



Presenter: **Stina Wahlgren**

Anna Wåhlin, Karen E. Alley, Carolyn Begeman, Øyvind Hegrenæs, Xiaohan Yuan, Alastair G. C. Graham, Kelly Hogan, Peter E. D. Davis, Tiago S. Dotto, Clare Eayrs, Robert A. Hall, David M. Holland, Tae Wan Kim, Robert D. Larter, Li Ling, Atsuhiko Muto, Erin C. Pettit, Britney E. Schmidt, Tasha Snow, Filip Stedt, Peter M. Washam, Stina Wahlgren, Christian Wild, Julia Wellner, Yixi Zheng, Karen J. Heywood



- **How does an ice shelf look from below?**
- **What does that tell us about melt processes?**



# AUV 'Ran'

- A Kongsberg Hugin 3000 m Autonomous Underwater Vehicle

3000 m depth rating

Battery for missions up to 300 km

2-6 knot speed

Very good navigation

38 sensors – velocity (500 kHz ADCP)

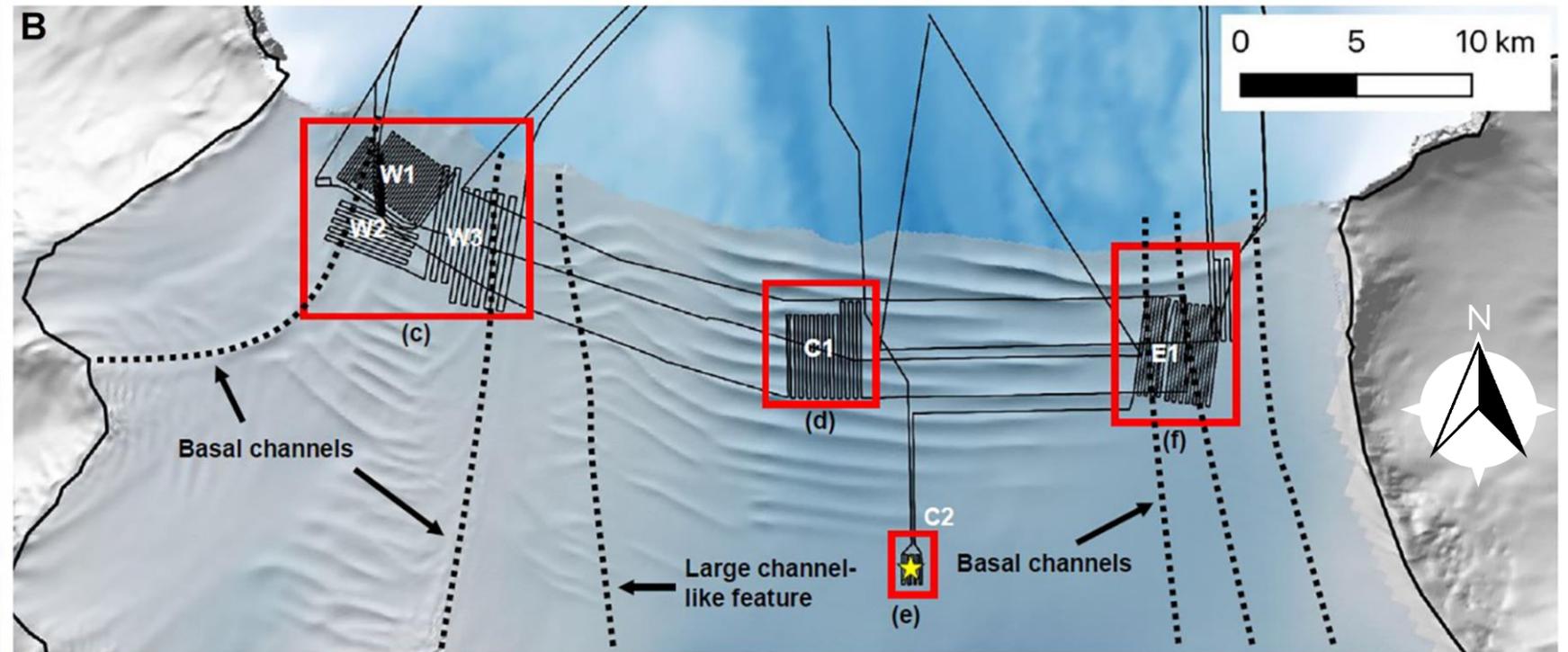
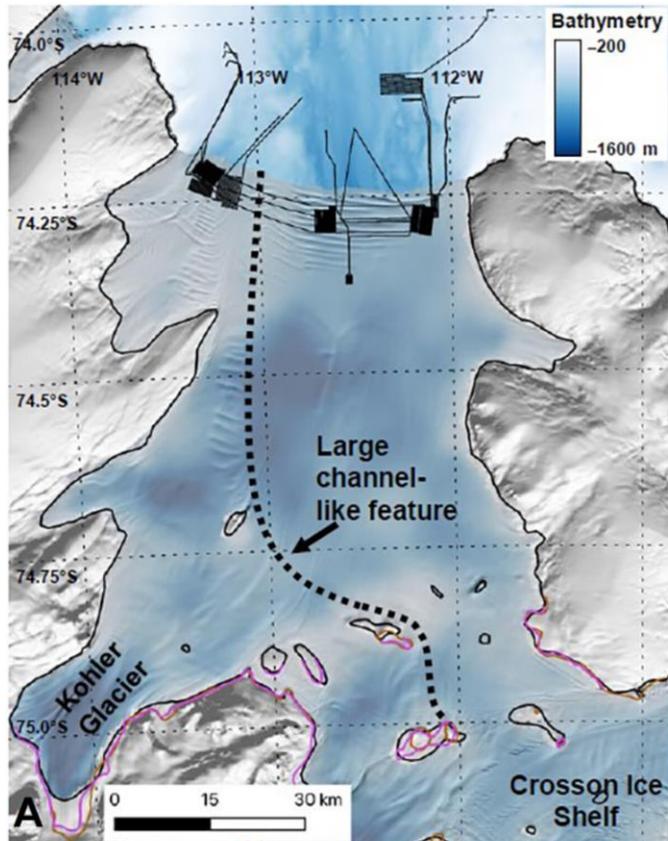
and CO2, water sampling **multibeam**



# Dotson 2022:

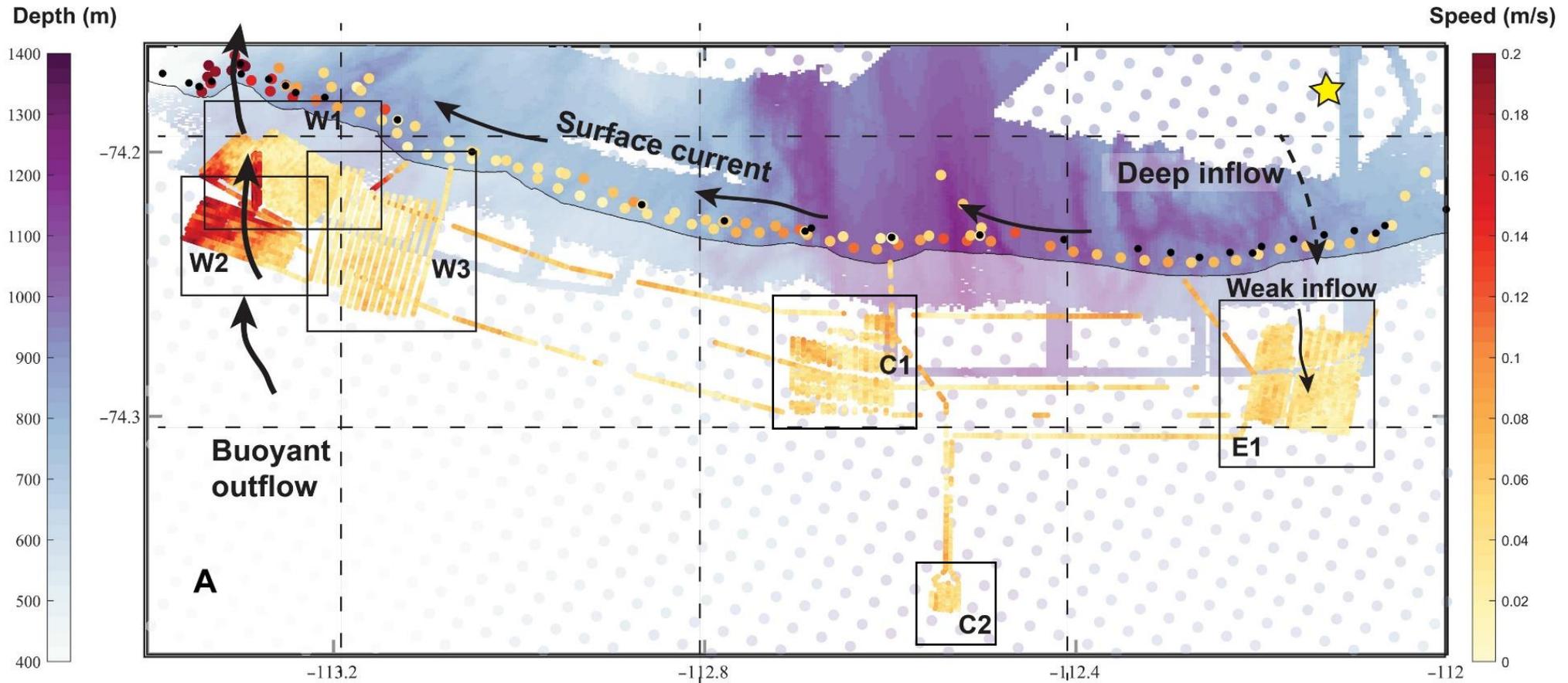
24 days of diving

1075 km under ice shelf (half of which were successful)

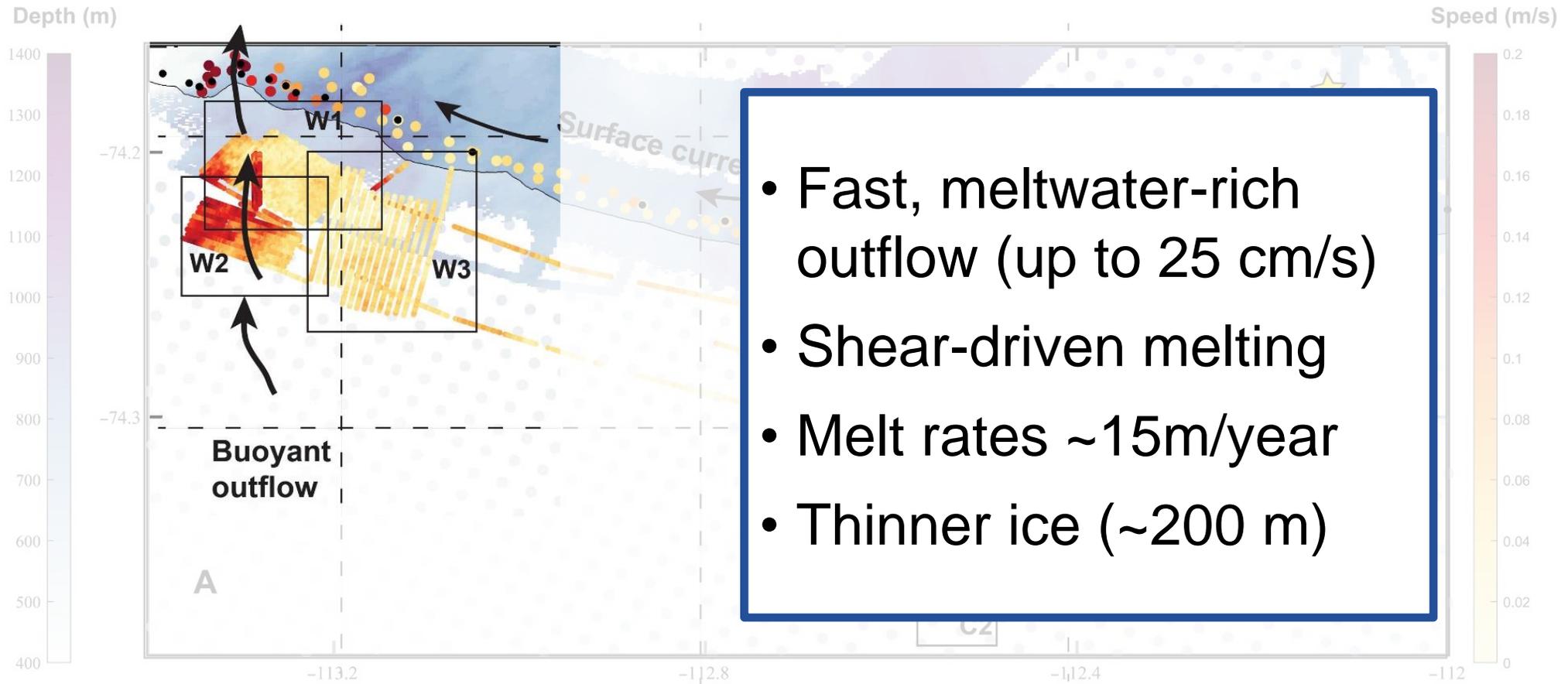


# Currents close to the ice base

## AUV + Ship ADCP



# Western region

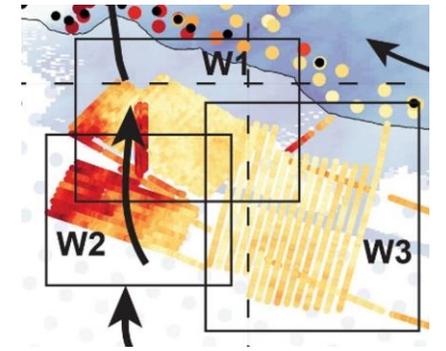
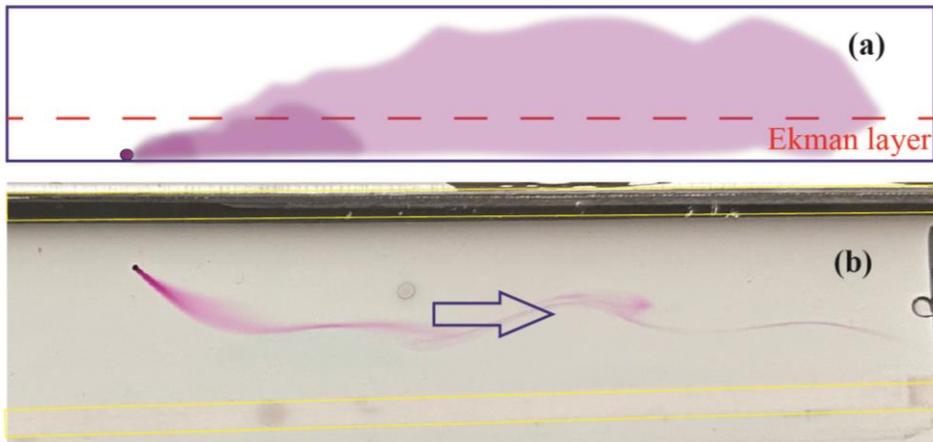
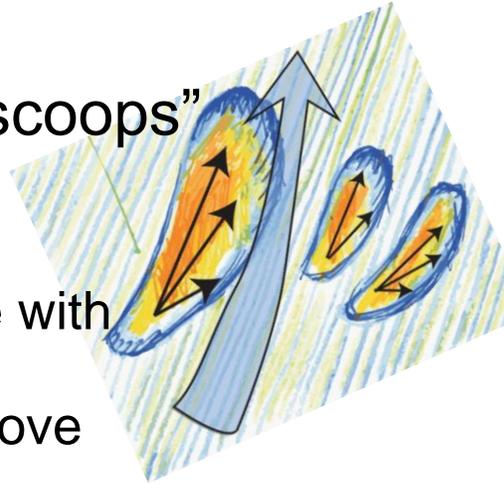


# Western region – multibeam imagery

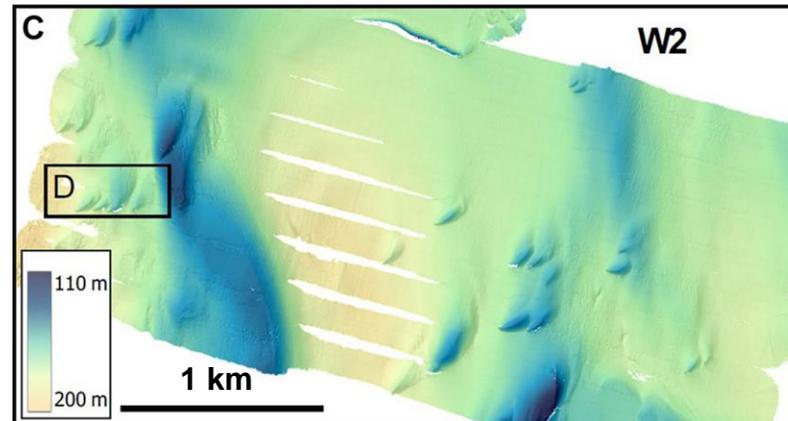
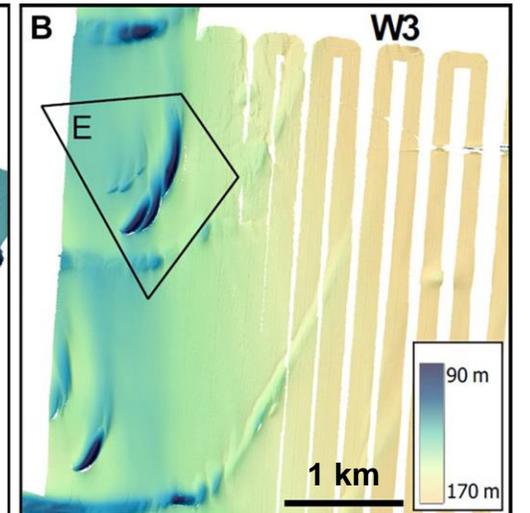
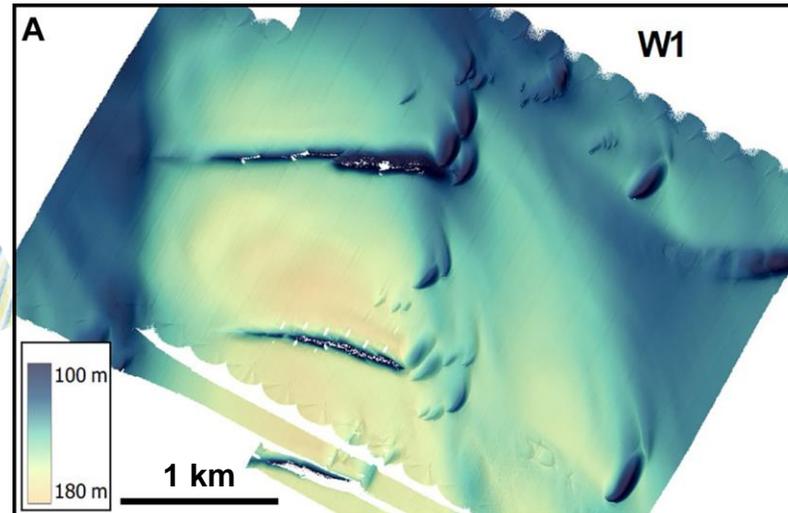
- Smooth base -> distributed melt

- Teardrop shaped “scoops”

- 20-170 m wide
- 2-50 m high
- Sharp end in angle with the main flow
- Not visible from above

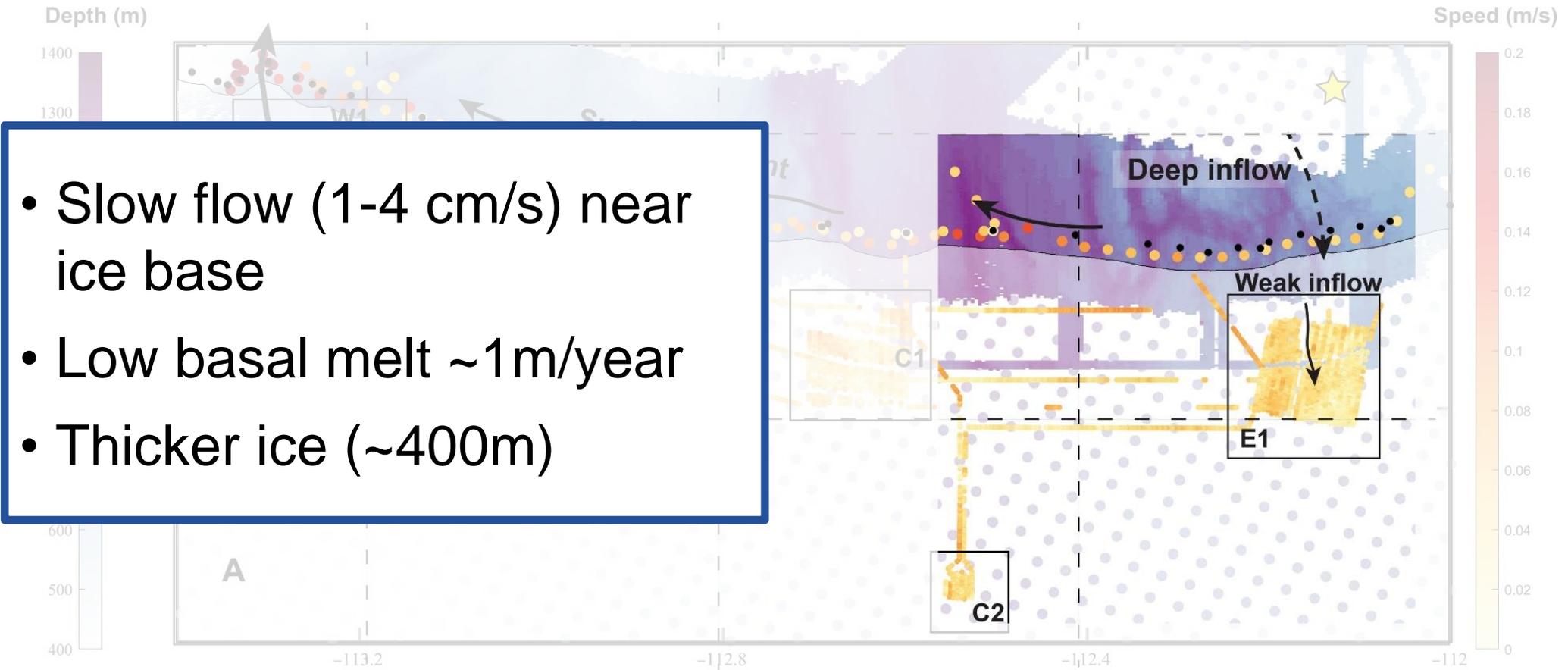


Thinner ice → Thicker ice



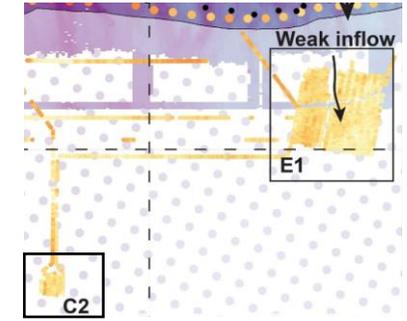
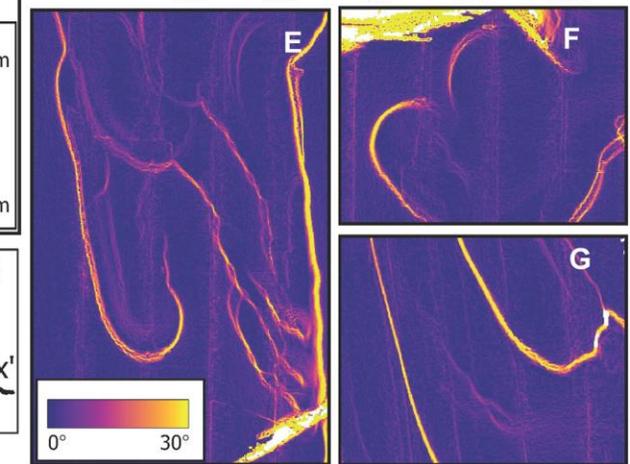
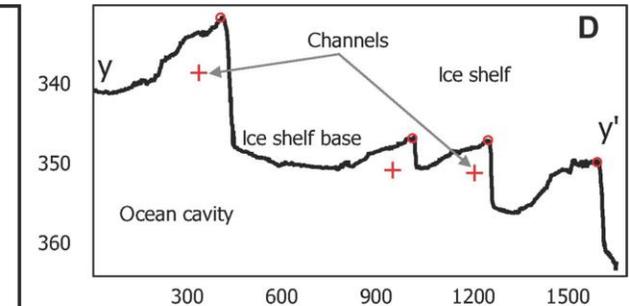
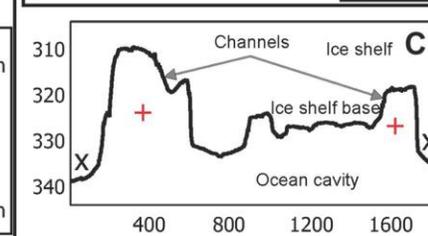
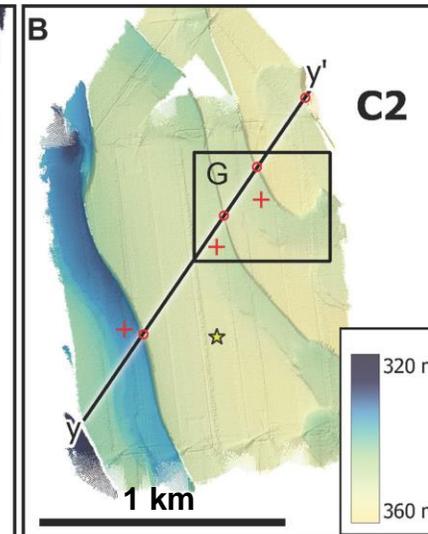
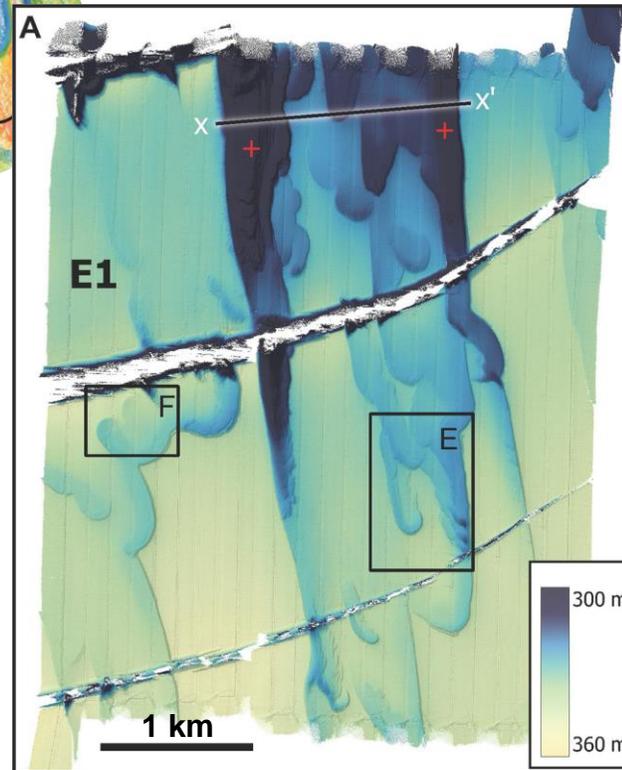
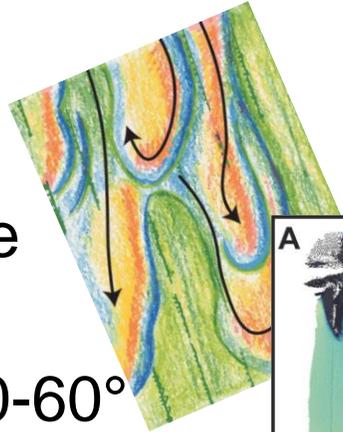
Flat → → Steep

# Eastern and central regions



# Eastern and central regions

- Flat terraces
  - 0.2-2 km wide
  - 0.5-5 m high
  - wall slope: 10-60°
  - not visible from above
- Sharp boundaries  
-> local melt
- Neighbouring walls similar  
-> spatially coherent formation process



Thicker ice

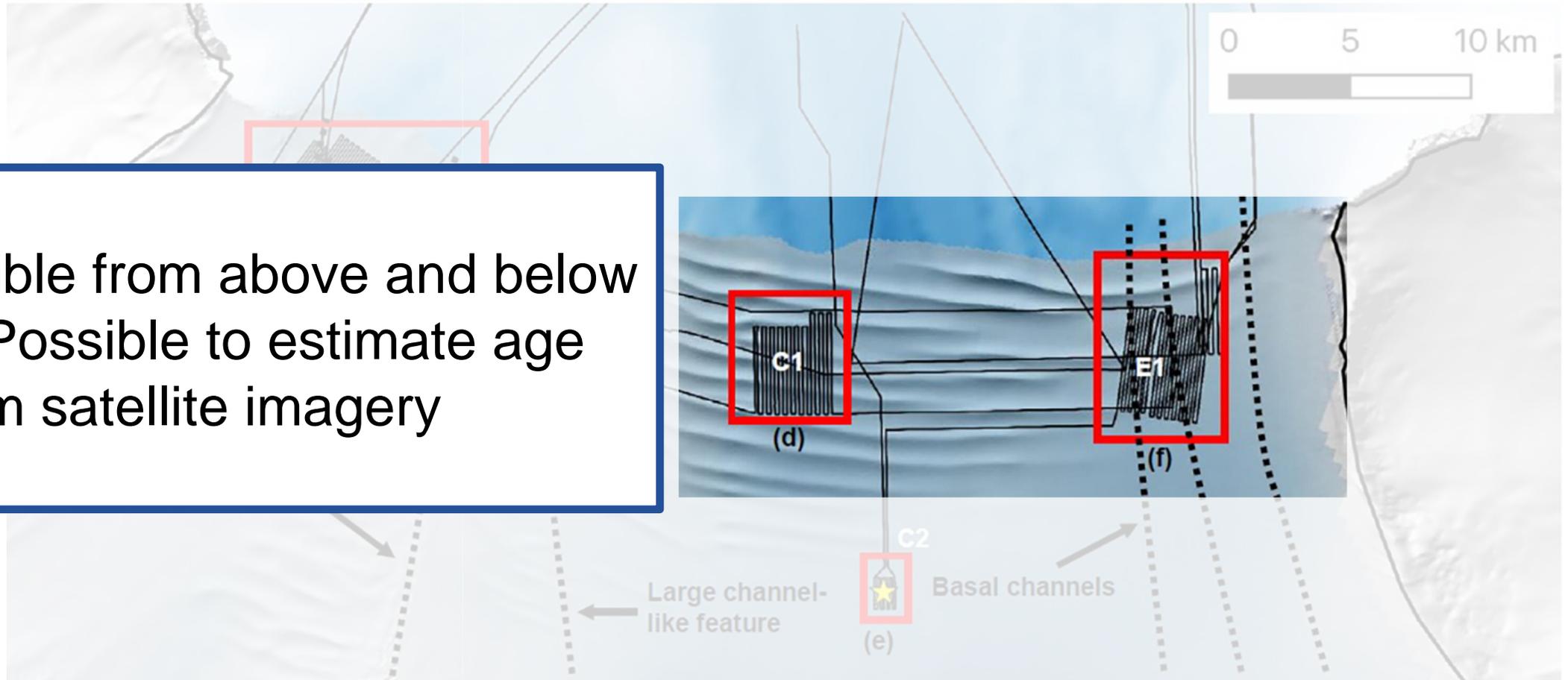
Thinner ice

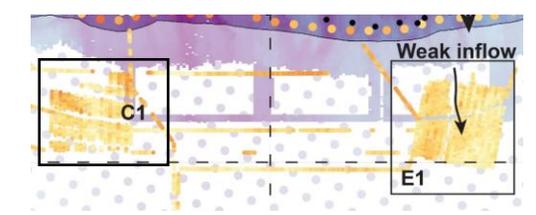
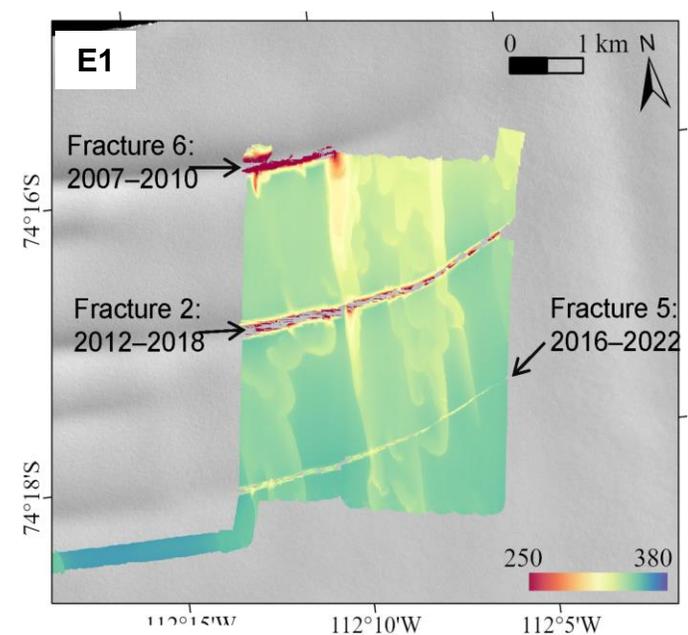
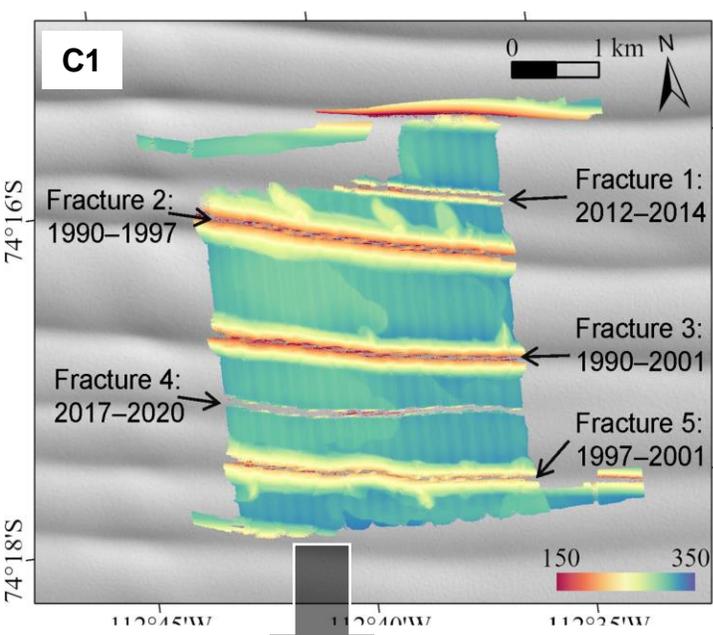
Flat

Steep

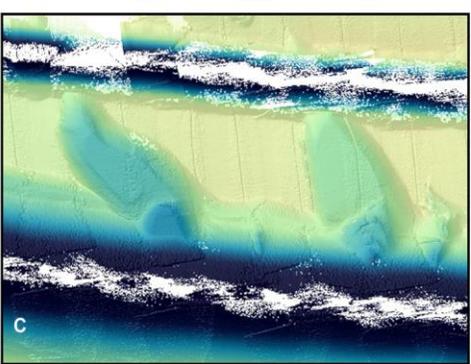
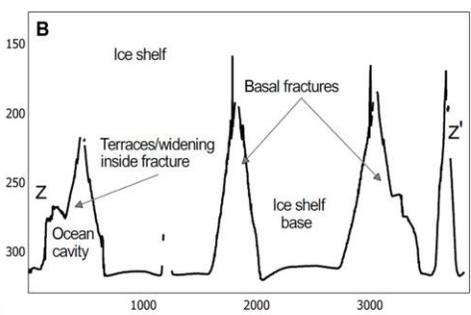
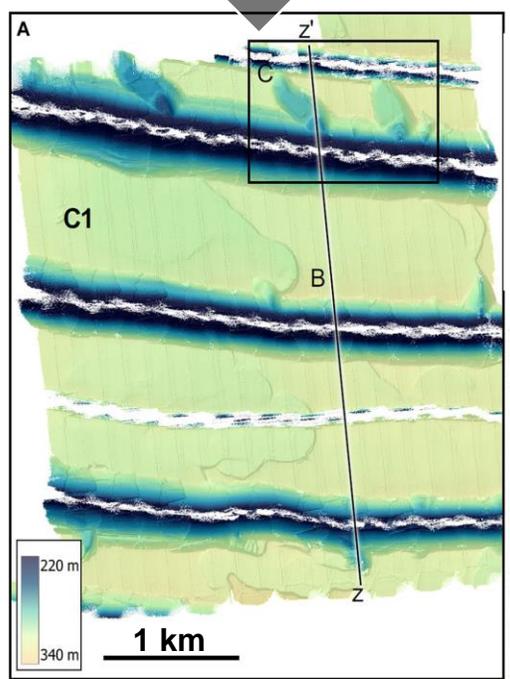
# Fractures

- Visible from above and below  
-> Possible to estimate age  
from satellite imagery





Fracture age based on appearance in Landsat imagery

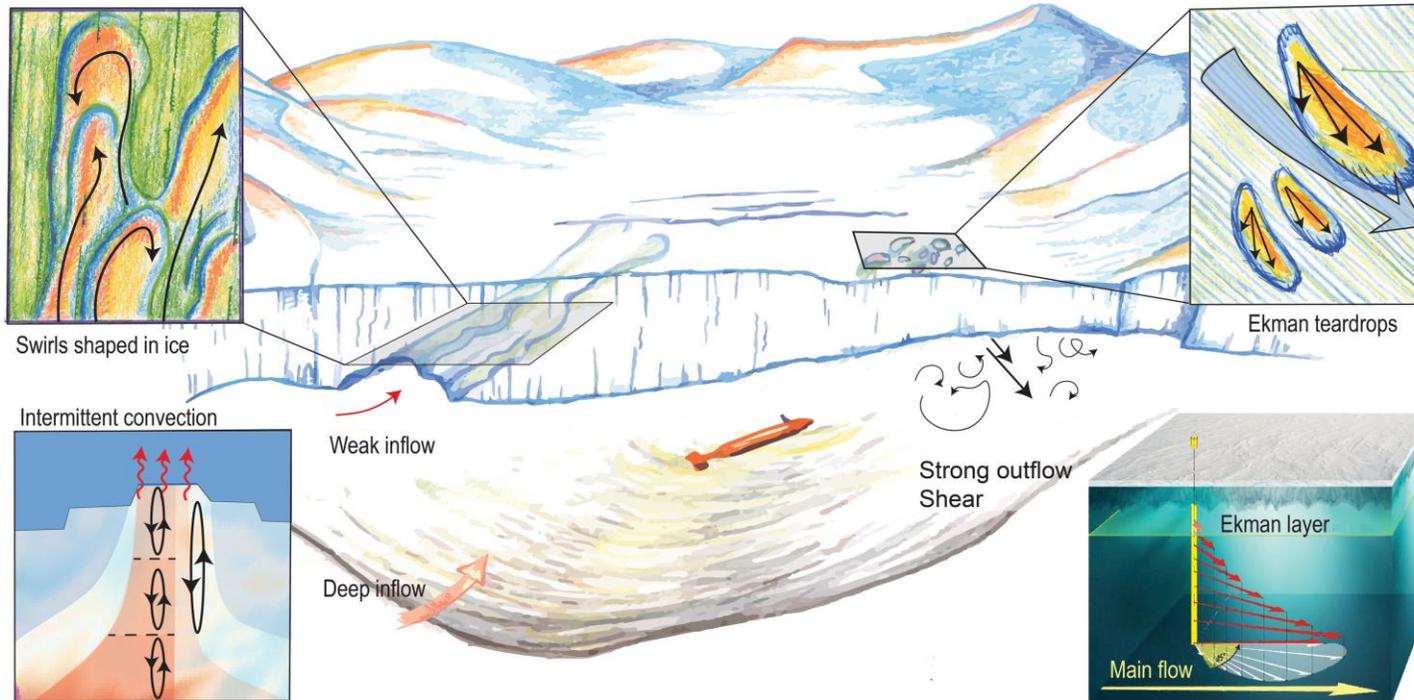


- Enhanced melting around fractures
- Oblique melt features at some of the fractures
- Age constraints on the terraces

Thinner ice      Thicker ice

## Western region (low melt rate)

- Flat terraces
- Local melt
- Spatially coherent formation process



## Eastern region (high melt rate)

- Shear driven melt
- Strong erosion
- Teardrop features

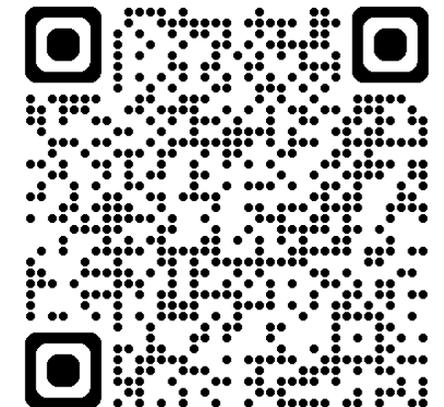
**Neither terraces nor teardrops are visible from the surface**

≡ **Science**Advances

**Swirls and scoops: Ice base melt revealed by multi-beam imagery of an Antarctic ice shelf**

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**Principle for an ice shelf cavity mission: Stay near seabed or near ice as much as possible (for good navigation)**

