# ANTARCTIC SUBGLACIAL LAKES: A CASE STUDY IN TACKLING INTERDISCIPLINARY PROBLEMS OF INTERNATIONAL INTEREST

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2009-2016

2016-2020

- Ice covers ~98% of the Antarctic continent
- Antarctic ice sheets contain ~60% o Earth’s freshwater and the equivalent of 58 m of sea-level rise

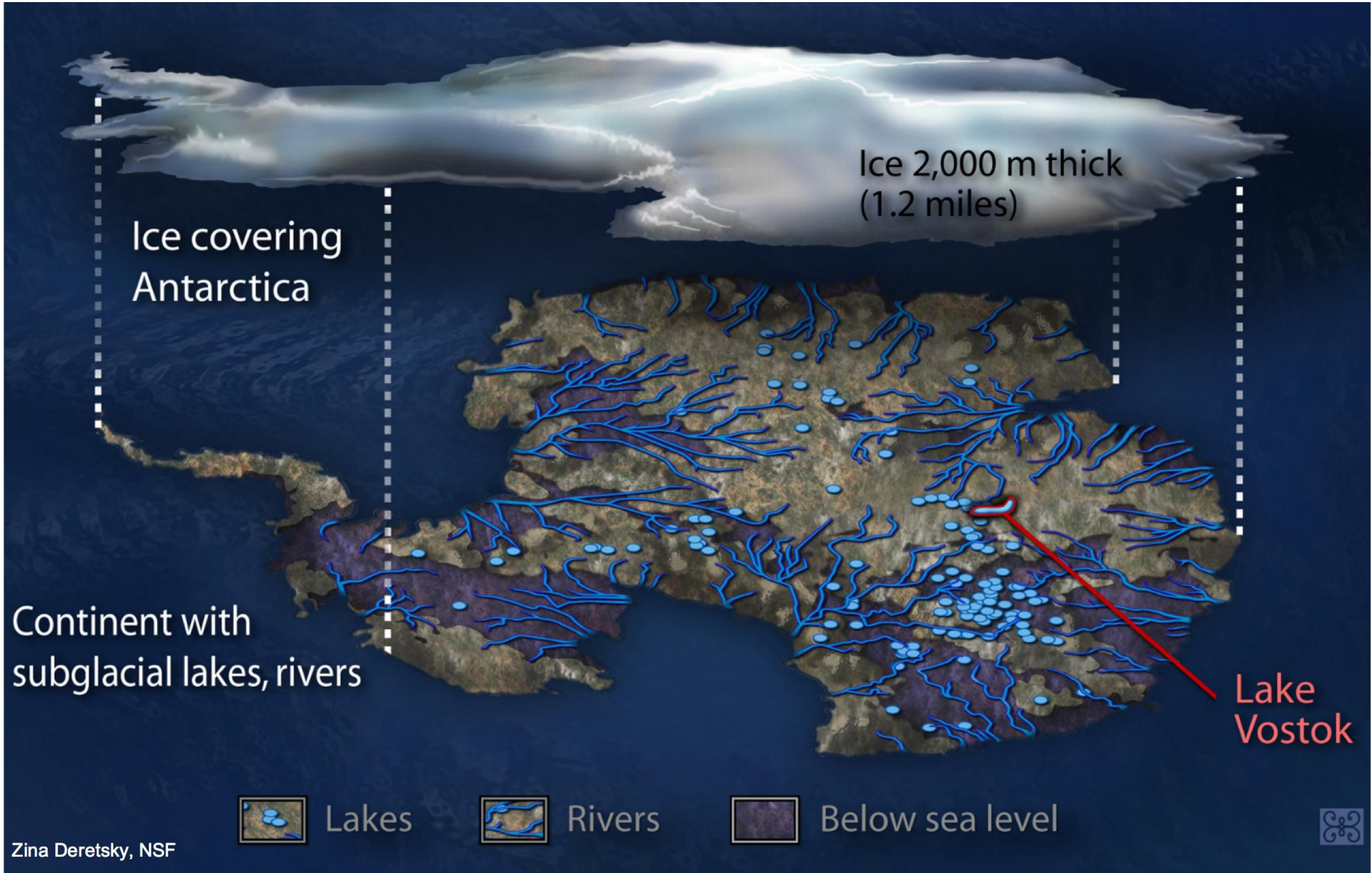
# Liquid water is widespread under Antarctic ice

**Known since the mid 1990s (delineation of Lake Vostok), hypothesized 1960s and 1970s**

**Current inventory of subglacial lakes: ~400**

**Scientific interests in:**

- **microbial life**
- **subglacial geology/sedimentology**
- **hydrology**



# A (partial) history of international subglacial lake exploration


1998: Completion of Vostok ice core (3623 m) - climate records and lake accretion ice.

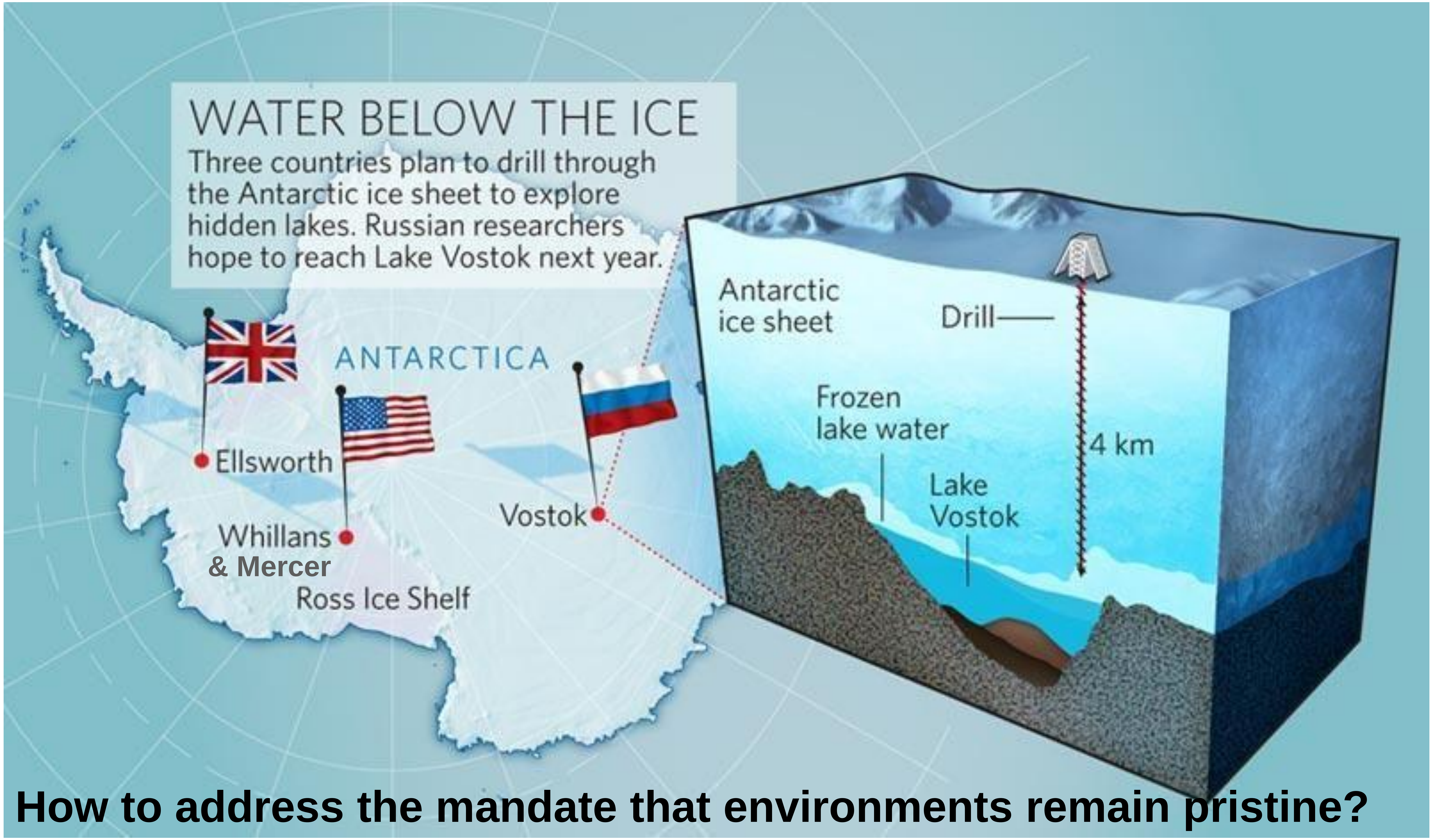
1999: Vostok accretion ice studies (Jouzel, et al., Karl et al., Petit et al., Priscu et al.).

2000-2009: Multinational committee work to determine importance of subglacial work and ensure that the environments remain pristine after work commences (Scientific Committee on Antarctic Research, National Academies/NRC, Antarctic Treaty).

2011: SCAR Code of Conduct for subglacial drilling presented at Antarctic Treaty Consultative Meeting.

2012-pres: National programs pursue subglacial lake access (Vostok (Russia), Ellsworth (UK), Whillans & Mercer (US).

# 2012 - present: national programs pursue subglacial lake exploration




**How to address the mandate that environments remain pristine?**

**Schiermeier, *Nature*, 2010**

# Clean Access to Subglacial Aquatic Environments

Control potential for contamination by:

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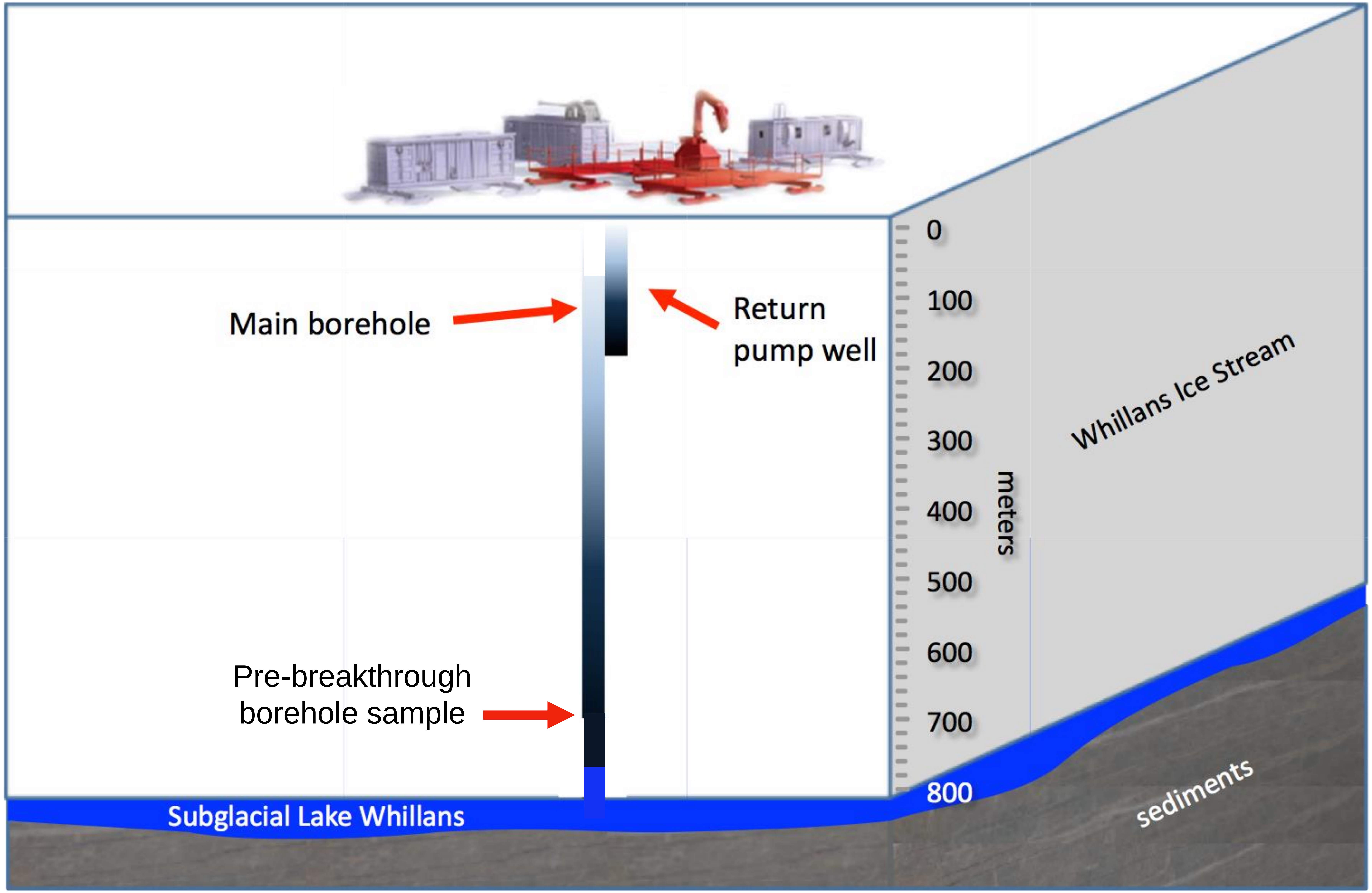
2. Pre-cleaning ($H_2O_2$) and bagging borehole instruments
3. Drilling with hot water

# Drilling into a subglacial lake: keeping it clean

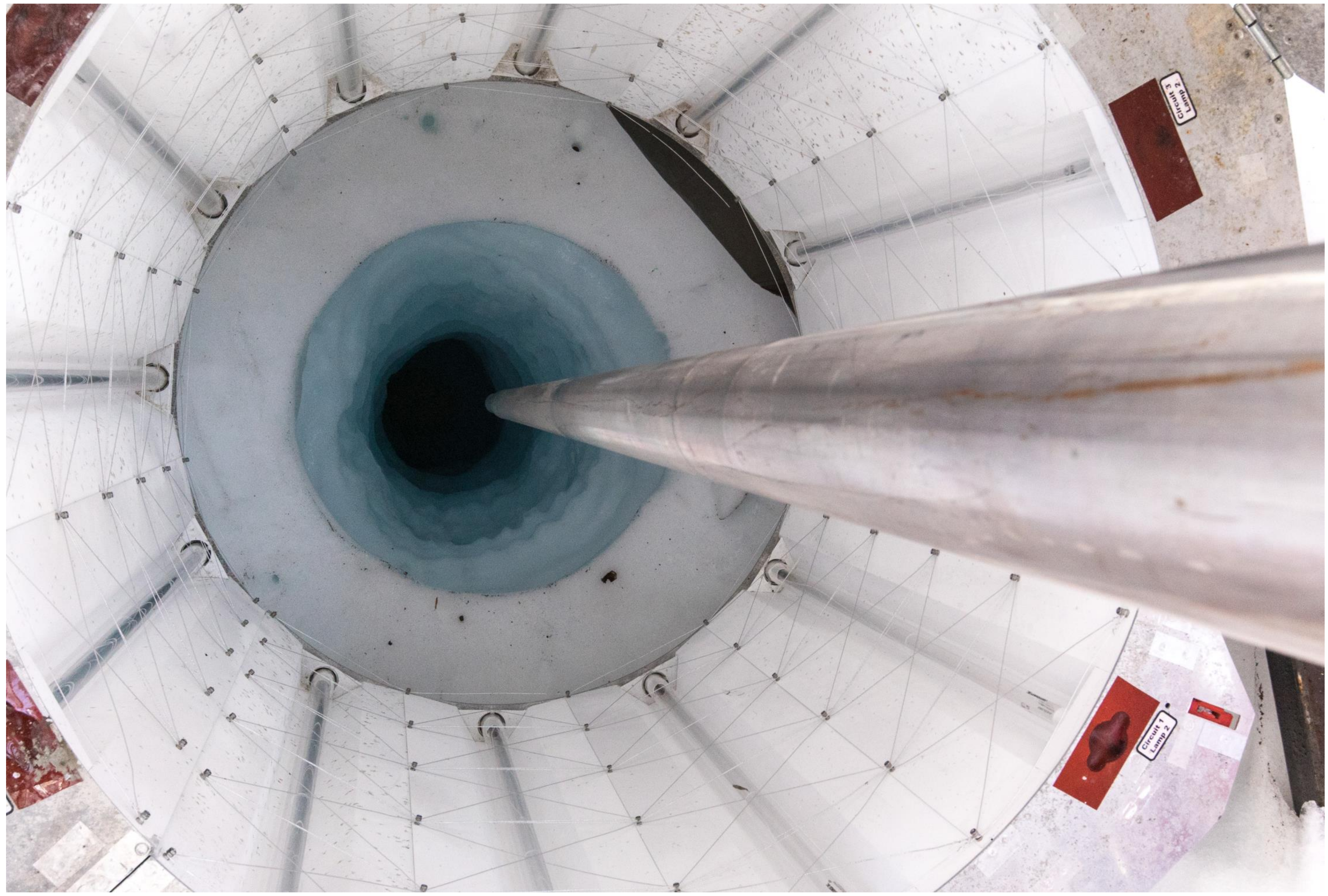
1. Melt snow from surrounding area
2. Pump high pressure hot water to melt a hole (90ºC)
3. Continually recirculate water through filters and UV light banks
4. Remove drill at 700 m to sample borehole water
5. Reduce borehole water level by 30 m before breakthrough
6. At 801 m, drill load cell unloaded and borehole water level increased by 30 m, indicating lake water movement into the borehole



# Clean Access: a 7-log cumulative reduction in microbial cell numbers in drilling water and on surfaces using a combination of: filtration, UV radiation, pastuerization, and surface disinfection with $H_2O_2$


Instruments in bags after cleaning with $H_2O_2$

Submicron filter units

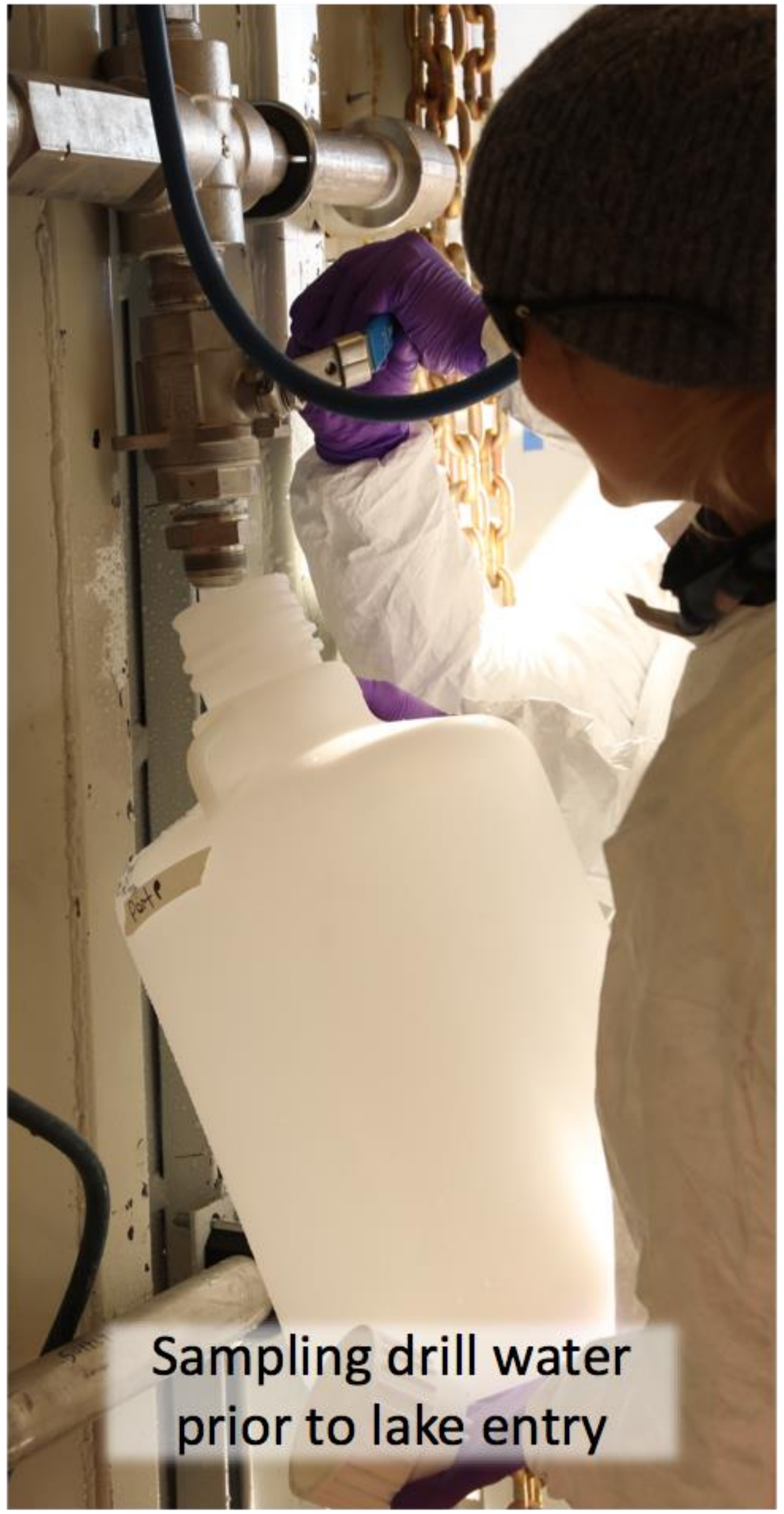


Borehole UV collar with drill hose

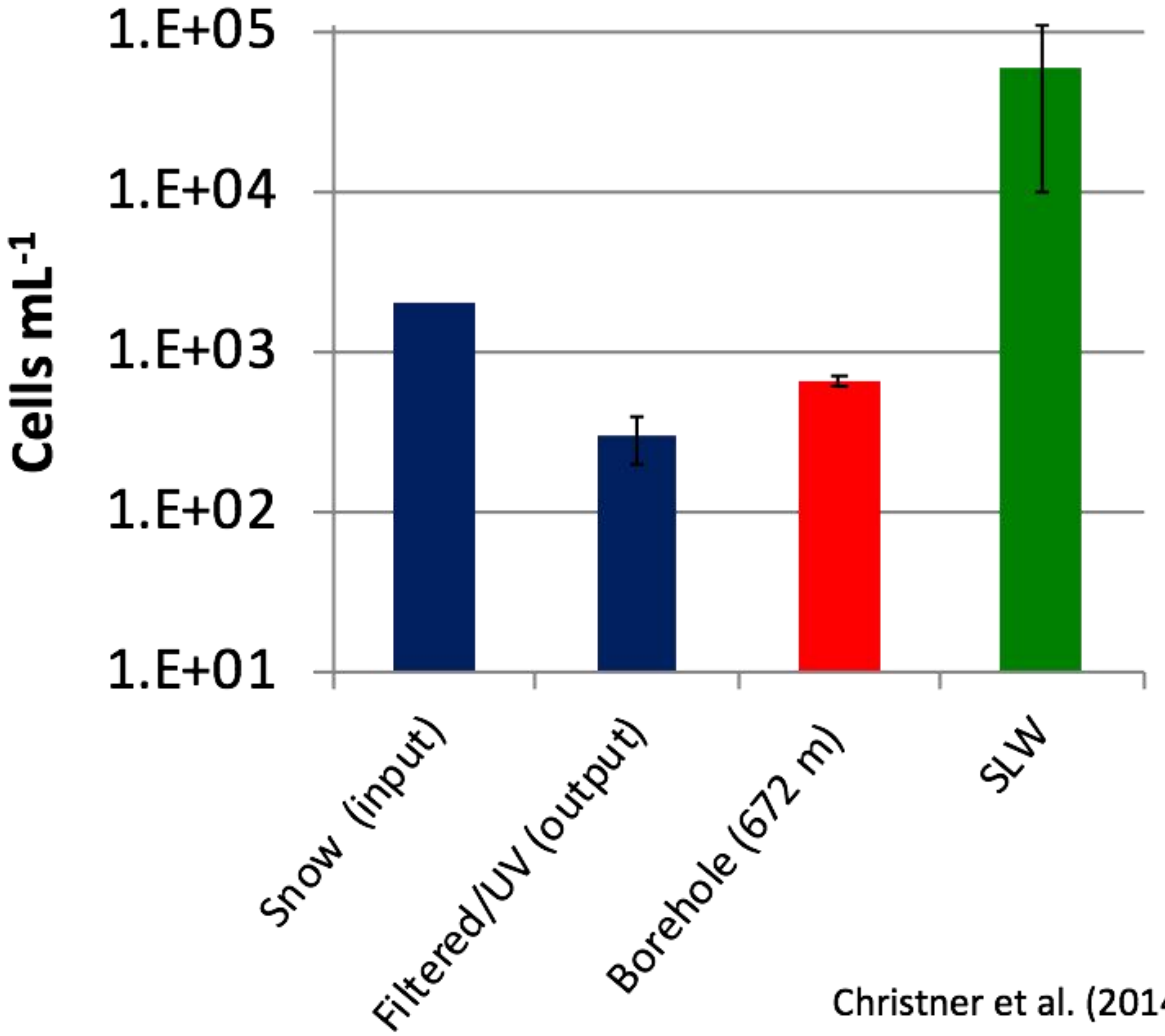
More on clean access:

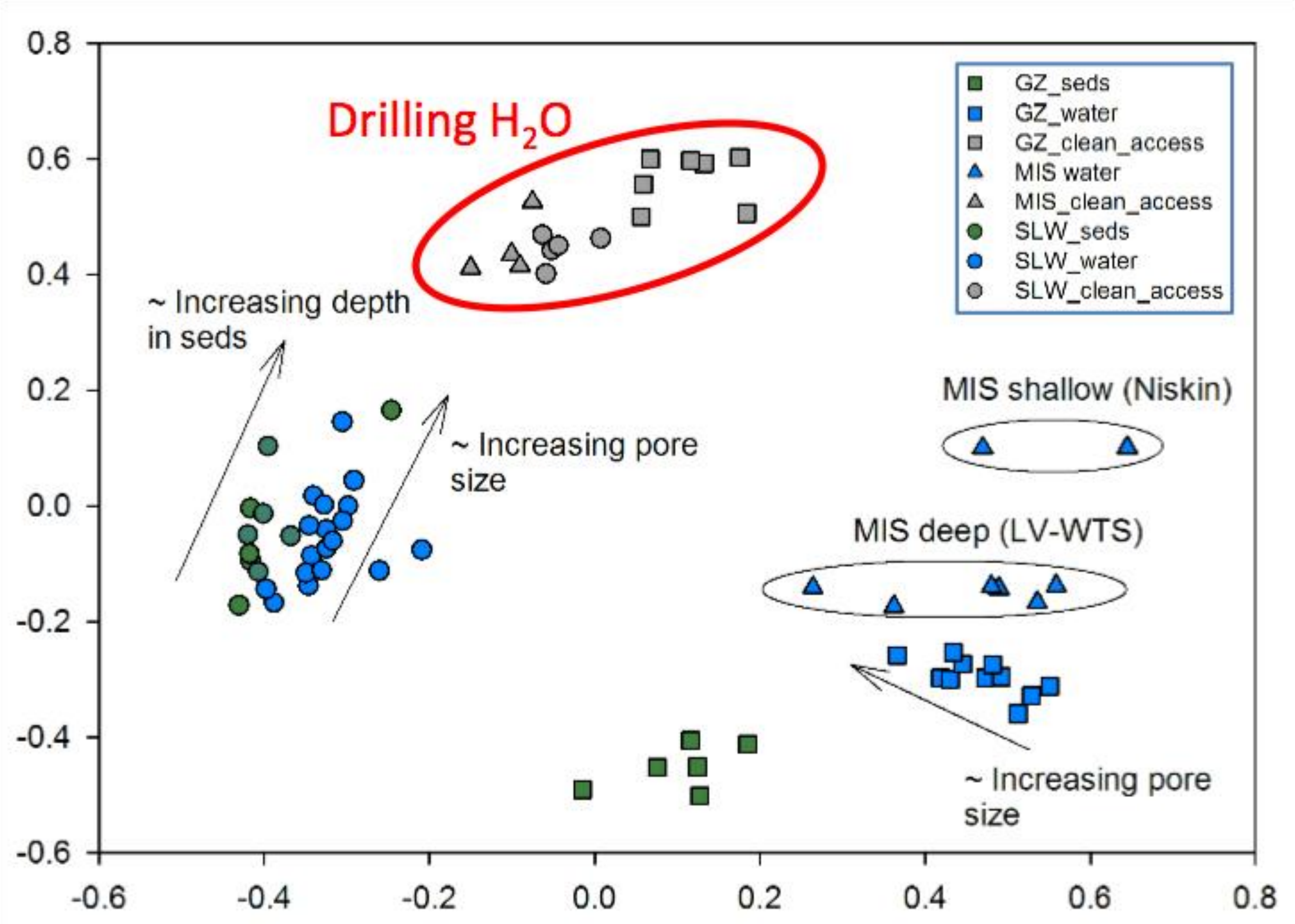
Priscu, et al., 2012, *Antarctic Sci.*; Christner et al., 2012, *Nature*; Achberger et al., 2016, *Front. Microbio.*; Michaud et al, *submitted*.

# Tracking contamination associated with the drill water




| Parameter | SLW Water | SLW Borehole |
|---|---|---|
| Conductivity (µS cm$^{-1}$) | 720 | 5.3 |
| pH | 8.1 | 5.4 |
| Cell density (cell mL$^{-1}$) | 1.3 x $10^5$ | 6.9 x $10^2$ |
| Cellular ATP (pmol L$^{-1}$) | 3.7 | 0.04 |




- NMDS plot based on 16S rRNA gene (rDNA) and rRNA sequencing data.
- Microbes in the WISSARD drill water statistically different from those observed in the lake, sub-ice shelf, and sediment communities (AMOVA, $p < 0.008$).
- Conclusion: there was very little exchange between the borehole and subglacial water.

Christner et al. (2014), *Nature*, 512:310-313; Achberger et al. (2016), *Front Microbiol*, 7:1457


Sediment lab
Launch and Recovery System (LARS)
Tent city
Generators (two – 225 kW)
Main hose reel container
Chemistry lab
Mess tent
Medical tent
Outhouses
Snow melter
Clean access module
Hot water heaters
Freezer
Mechanical tent
Traverse equipment
Prevailing wind direction
SALSA camp and drill site
84° 38.687' S, 149° 44.485' E
Mercer Ice Stream
December 2018—January 2019
Image: Billy Collins