Antarctic Subglacial Lakes:
What if we could look beneath the Antarctic ice sheet?

Priscu et al. 2009
Figure 2: Airborne ice-penetrating radar data through the Vostok core site transverse to the ice flow. The internal layers are the rugged, roughly horizontal features in the upper half of the image. The lake is the strong flat reflector between 50 and 51 s two-way travel time (3,745 m below the ice surface at the Vostok core site). The ice sheet sags as it enters the lake on the western grounding line, and compresses as it flows out to the east. The bounding topography is the rough feature on the western and eastern side of the image. The accreted ice layer is noted at 49 s—3,570 m below the surface. The accreted ice layer is observed to the east of the lake between the base of the internal reflectors and the subglacial topography. Three of the features in the internal layers traced to generate the flowlines are indicated with arrows. Vostok station appears as a major surface diffractor, roughly centered over the core site.

From R. Bell
Bacterial Counts in the Vostok ice core

Christner et al. 2006
Priscu et al. 2008

Lake water ~10^5 cell ml^-1

Obtained using segregation coefficients from a permanently ice-covered lake in the McMurdo Dry Valleys
IS THERE METABOLISM IN SOLID ICE?

The boundaries between crystal grains in deep ice may provide a viable liquid habitat for microbes. “A” polarized light image; “B” microscopic image.

Vostok accretion ice from 3590 m
1 micron fluorescent beads in an ice vein
We estimate that the vein volume provides 16.7 km$^3$ and 576 km$^3$ of habitable space within the Greenland and Antarctic ice sheets, respectively, which could support the metabolism of organisms that are capable of growing in cold, high ionic strength (mM-M) solutions with pH $\sim$3. 

Vein pH $\sim$3 coupled with high ionic strength = hard place for cell growth!! Cells will eventually run out of free energy to metabolize!

GISP 2 core at a depth of 146.39 to 146.46 m
Vostok Station
Cored 3769 m
Accretion ice
~240 m thick
Type 1
Type 2
Lake sediments 300-400m thick

Ice flow
Water, microbes, inorganic particles, gases, ions
Methane hydrates?
Geothermal?
melt water
refreeze circulation

LAKE VOSTOK
Liquid water depth
~800 m
•420,000 year climate record
•65 tons of kerosene!
Loss of accreted ice and associated matter
Accretion ice
~240 m thick
Type 1
Type 2
Lake sediments
300-400m thick
Clathrates?

Effective segregation coefficients ($k_{eff}$) from a mesocosm experiment on Sukok Lake water (Northern Alaska).

**Freeze-Down Experiment: Phase 1**

- ~8cm of insulation around the tub
- Ambient temperature was -10°C with cold ceiling at -50°C
- Conductivity increased from 67.9 μS/cm at 1% of water frozen to 646 μS/cm at 98% of water frozen
- Sedimentation of organic matter as a result of freezing
Problems with biosignatures in accretion ice:

- Segregation upon freezing will produce biological signatures near limits of detection
- Differential segregation of various constituents will lead to ambiguous results
- We have played the “biosignature game” for decades on Mars—and we still know little about life on Mars!

* Liquid water lenses cannot support extant life without energy disequilibrium (ie, constant REDOX gradient)