

A photograph of a snowy mountain landscape. In the foreground, there is a rocky outcrop covered in snow. The background shows a vast, snow-covered mountain slope under a clear sky. The text is overlaid on the top half of the image.

Validation of Mt. Waddington Ice Core Paleoclimate Record

Stable Isotope and Melt Stratigraphy Correlation

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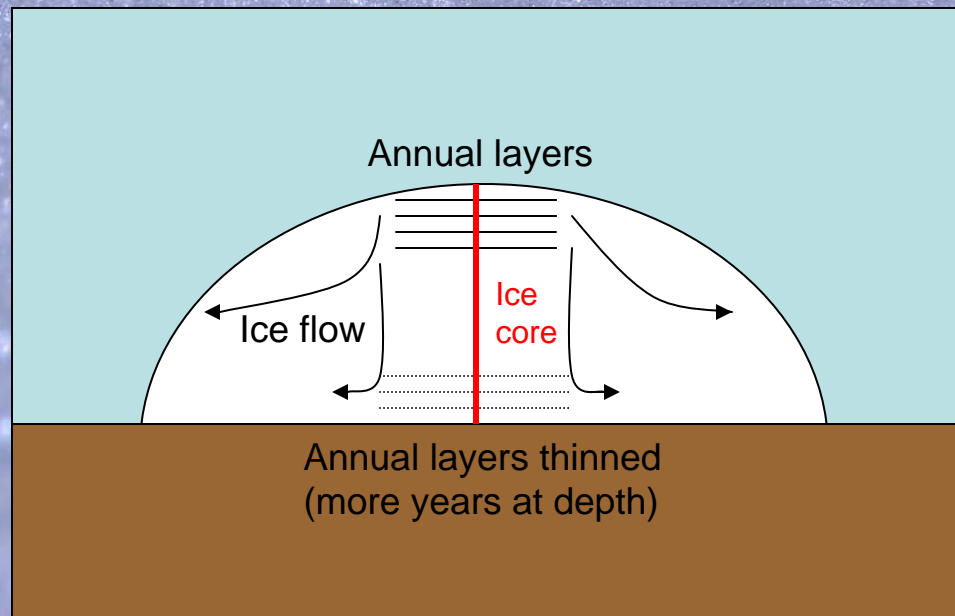
University of Washington

Eric Steig and **Ed Waddington**, faculty advisers

- Ice coring and paleo-temperature
- Project overview
- Sampling methods
- Core isotope and melt data
- Project summary/status

Ice coring and paleo-temperature

- **Question:** What information is stored in annually accumulated layers of snow and ice?
- **Answer:** A lot of things.
 - Carbon dioxide, methane, dust, volcanic horizons....
And STABLE ISOTOPES
- Isotopic composition of water in snow and ice.
 - This factor depends roughly on air temperature and so can illustrate short-term seasonal variations and long-term average temperature



Ice coring and paleo-temperature

Oxygen has three stable isotopes:

^{16}O , ^{17}O , and ^{18}O

Combinations important for paleo-temperature:

H_2^{16}O and H_2^{18}O

Lighter oxygen isotope gives H_2^{16}O higher vapor pressure than H_2^{18}O

Evaporation results in vapor with less ^{18}O than the original water source
-Vapor is depleted, or isotopically light

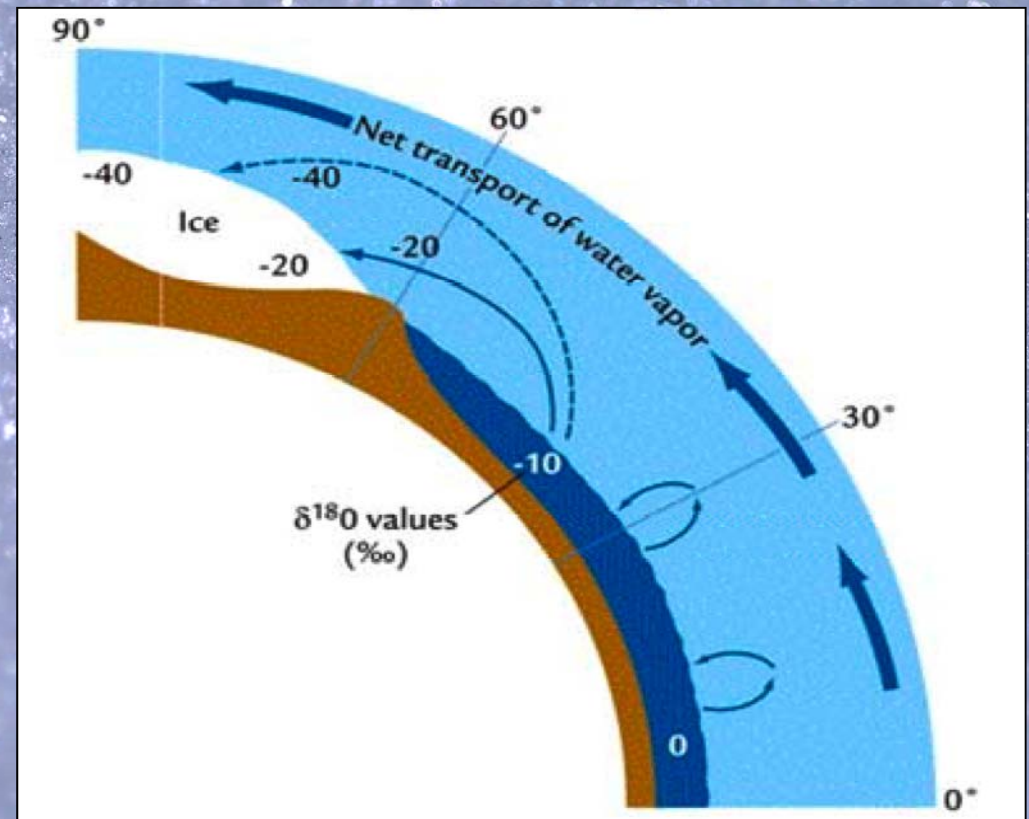
And

Condensation from vapor contains more ^{18}O than the vapor remaining
-Condensate is enriched, or isotopically heavy

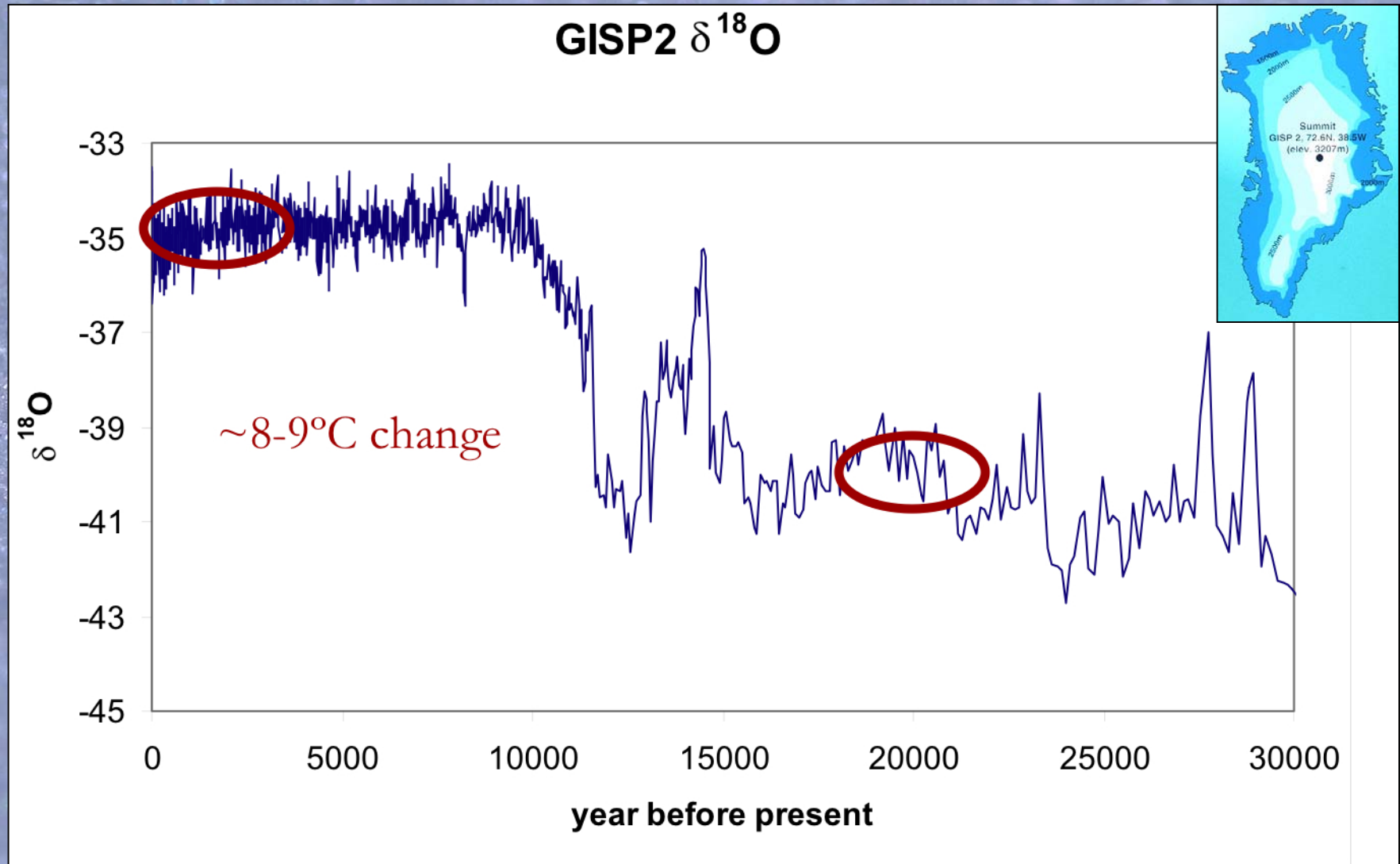
Ice coring and paleo-temperature

- As vapor is transported poleward, cooler temperatures result in continued condensation, therefore enriching condensate and depleting vapor
- If the average temperature at evaporation source and ice coring site changes, $\delta^{18}\text{O}$ in core shifts accordingly

$$\delta^{18}\text{O}_{ice} = \frac{\left(\frac{H_2^{18}\text{O}}{H_2^{16}\text{O}}\right)_{ice} - \left(\frac{H_2^{18}\text{O}}{H_2^{16}\text{O}}\right)_{\text{Standard}}}{\left(\frac{H_2^{18}\text{O}}{H_2^{16}\text{O}}\right)_{\text{Standard}}} * 1000\text{‰}$$



Ice coring and paleo-temperature

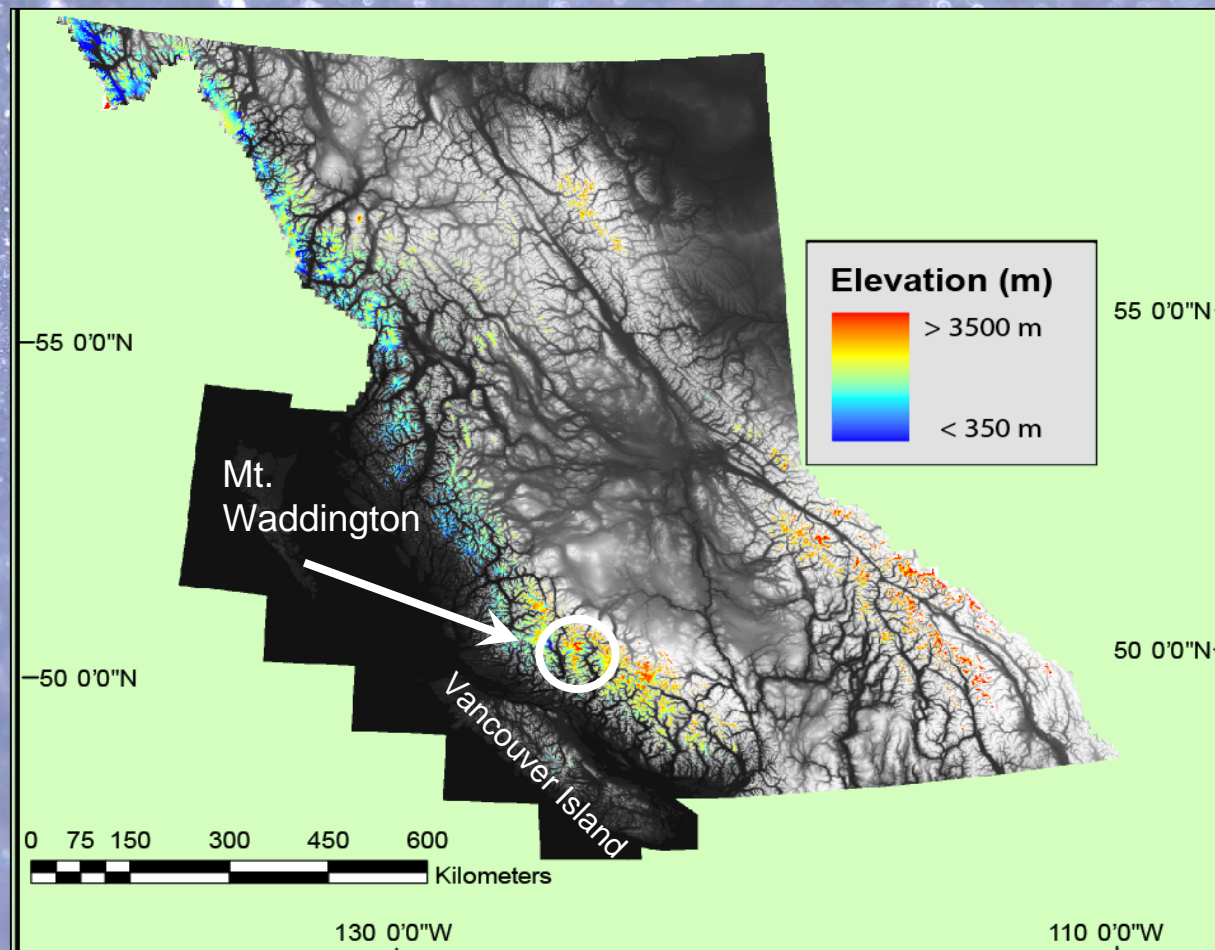


Present day $\delta^{18}\text{O} \approx 0.67\text{‰ per } ^\circ\text{C}$



Project overview

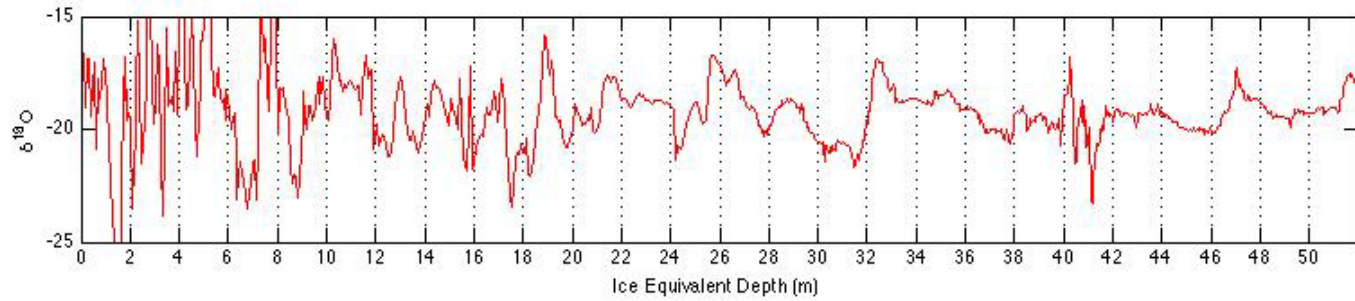
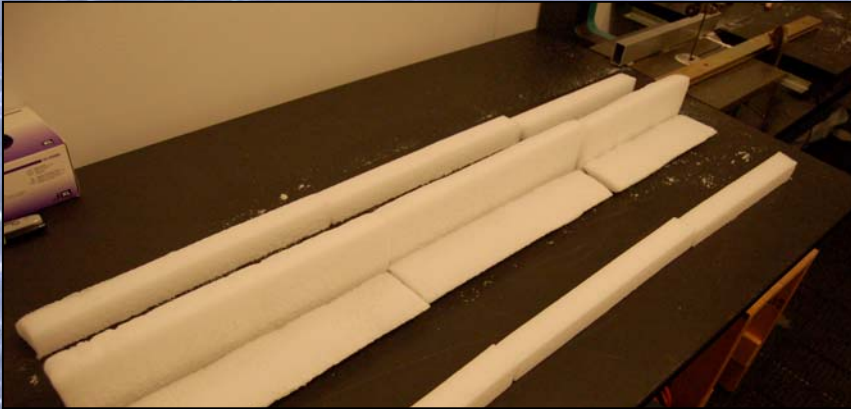
- 65 meter pilot ice core retrieved
Summer 2006
- Combatant Col, British Columbia, Canada



Project goals

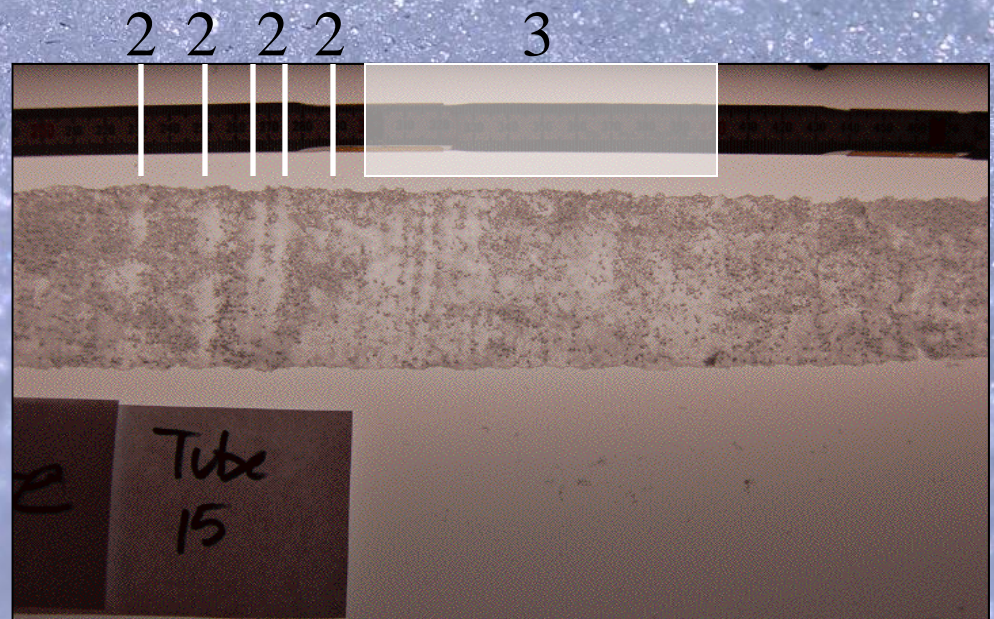
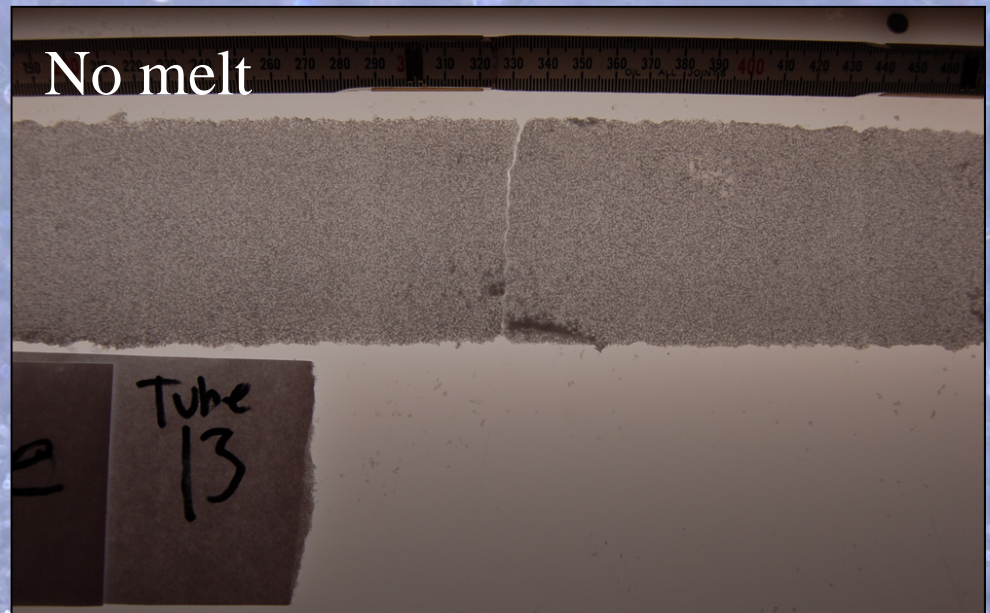
- Investigating site potential for providing high-resolution climate data for Pacific region
 - Snow accumulation data to compare with other ice cores
 - Decadal-scale climate variations
(Pacific Decadal Oscillation, El Niño-Southern Oscillation)
 - Precipitation variability relation to large-scale atmospheric circulation
- Isotope and melt stratigraphy correlation would indicate annual layer preservation
 - High $\delta^{18}\text{O}$ (~high temps) with high melt layer concentration and low $\delta^{18}\text{O}$ (~low temps) with low melt layer concentration

Sampling process

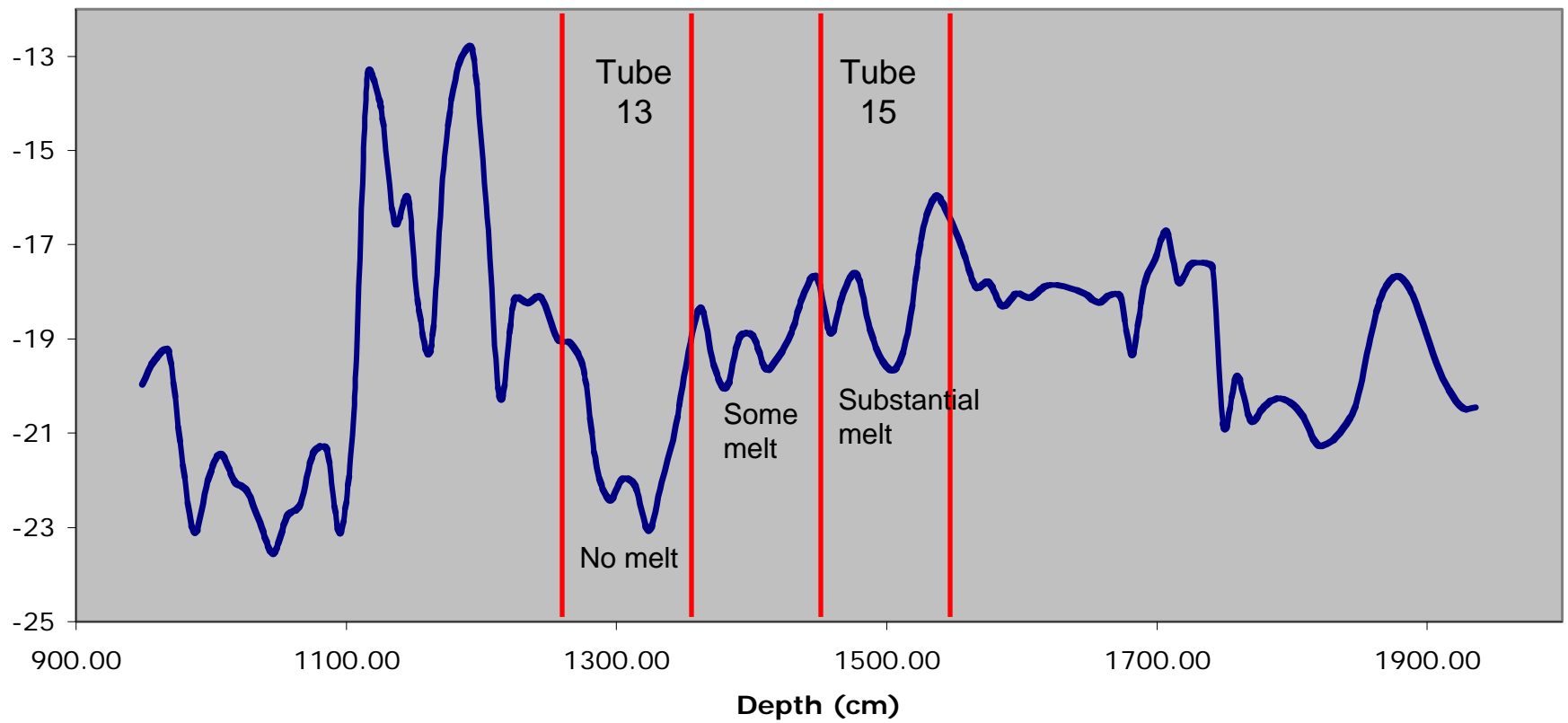
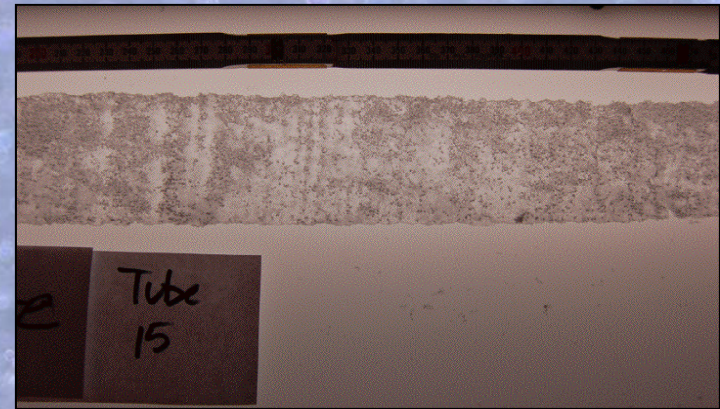
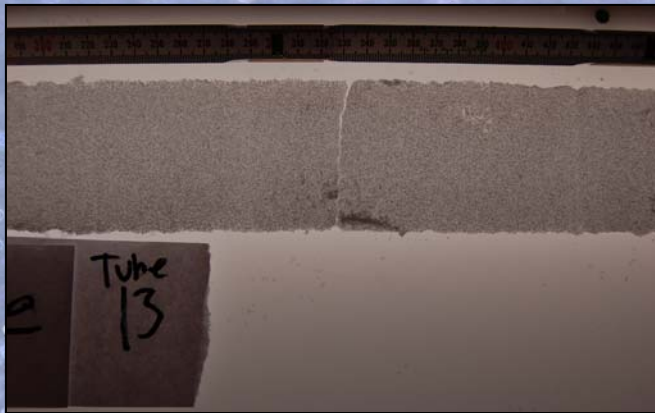


Logging melt stratigraphy

- Seasonal surface melt preserved
- Qualitative melt index
 - Melt magnitude
 - 0 1 2 3 4 5
- Regular shifts between high and low melt concentration
 - Summer and Winter
- No evidence that melting influences inter-annual stratigraphy

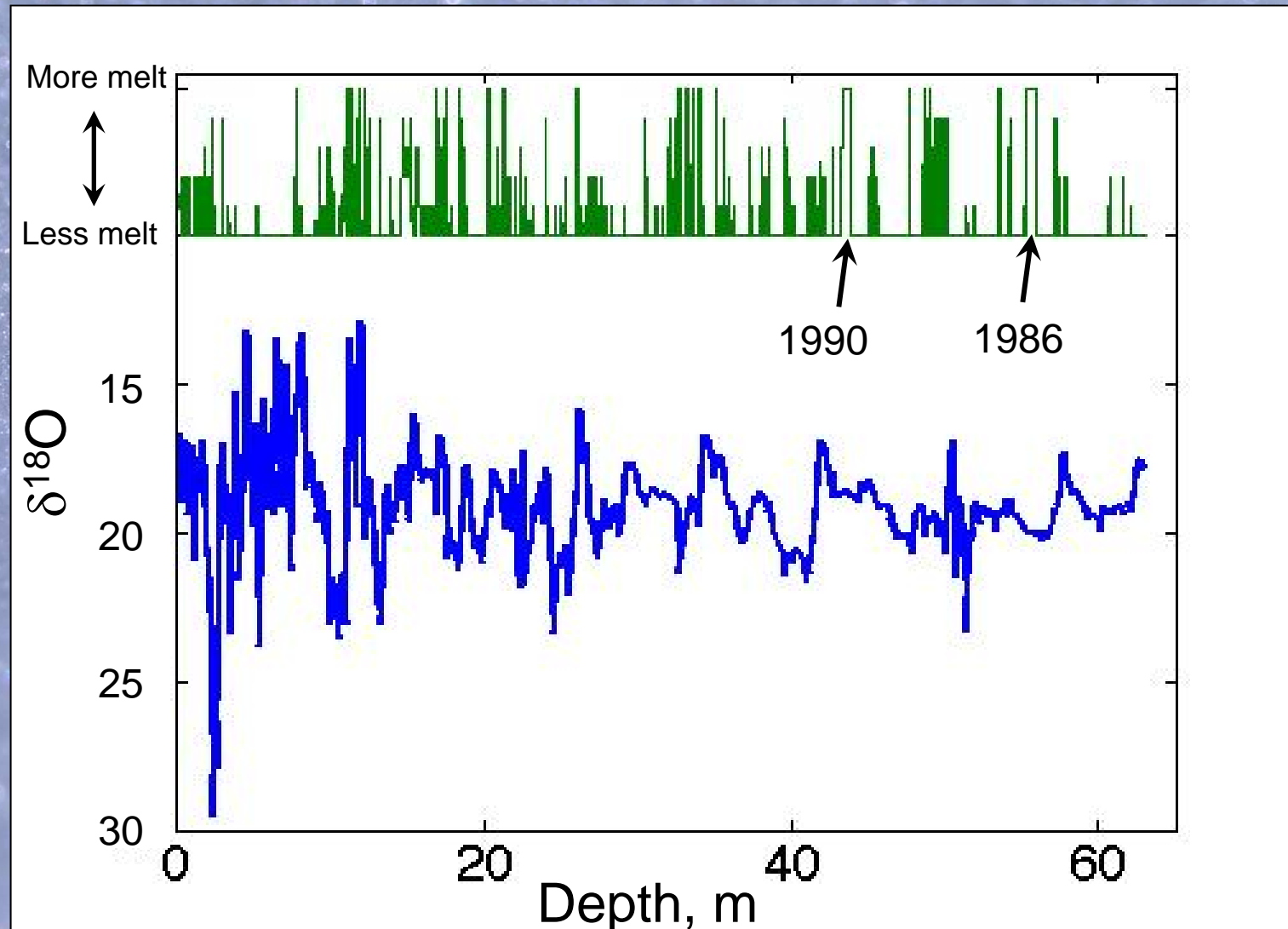


Combining stable isotopes and melt stratigraphy



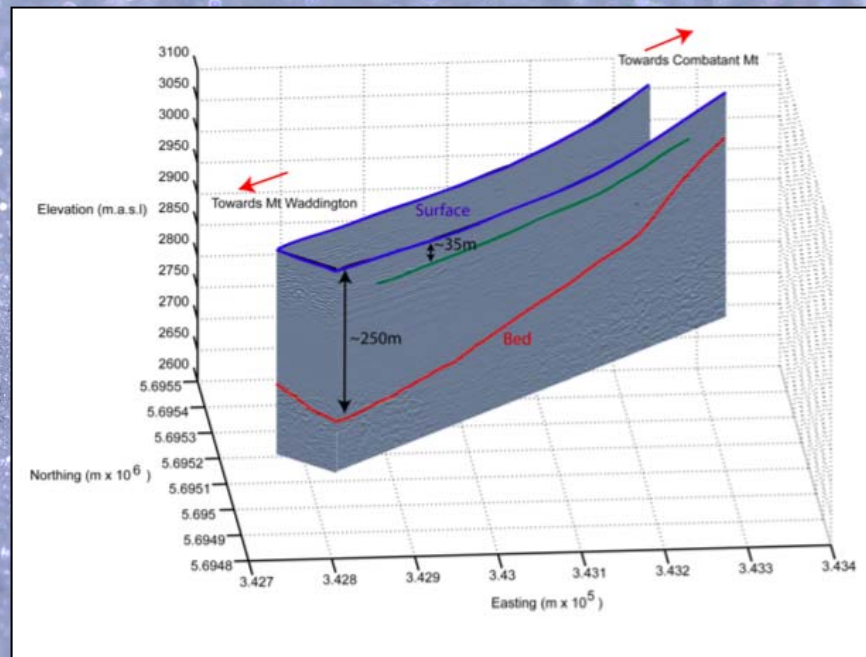
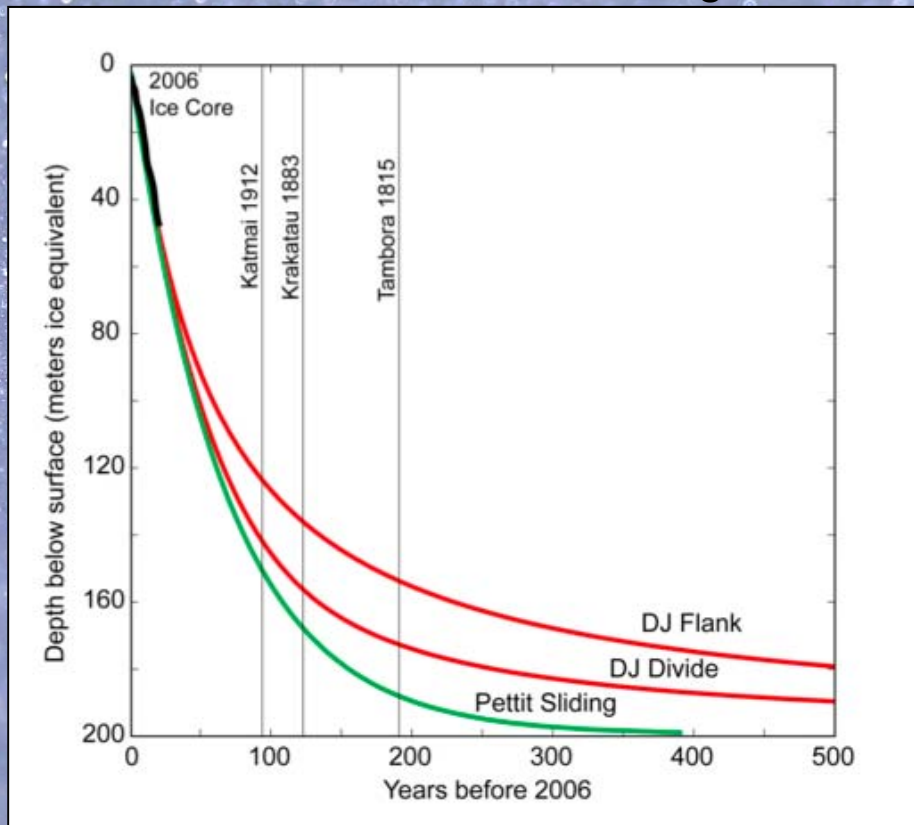
Combining stable isotopes and melt stratigraphy

- Preliminary age scale dates core base to 1983



Project summary / status

- Ice core analysis demonstrates inter-annual stratigraphy preservation, despite surface melting
- Independent confirmation from dust peaks at 1986 and 1993 in DRI data, as well as unambiguous annual peaks



- Site accumulation rate ~2m/year (ice equivalent), ice depth ~200m (confirmed by ice radar September 2007)
- Age of ice stratigraphy at depth likely 200 to 1000 years BP



- Proposal submitted to retrieve full core to bedrock
- Potential to gain robust datasets for interpretation of climate variation in the Pacific region

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