^{210}Pb study of fjord sedimentation rates in the South Shetland Islands and Antarctic Peninsula

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#1-INTRODUCTION and BACKGROUND:

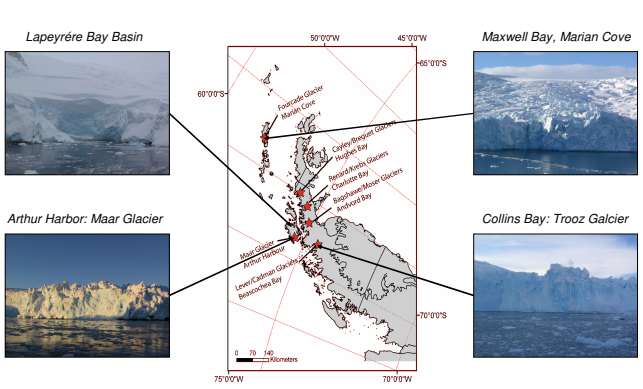
Photo taken by: Rodrigo Fernandez

As part of a study of factors controlling rates of glacial erosion and sedimentation across climatic regimes, 16 sediment cores were collected from 10 fjords in the South Shetland Islands and Antarctic Peninsula in April and May, 2007 from the *R/VIB Nathaniel B. Palmer*. These sediments were sampled for ^{210}Pb measurements of accumulation rates and associated sedimentological observations.

This project is a joint effort with John Anderson (P.I.) and co-workers (Rice University) to address the following questions:

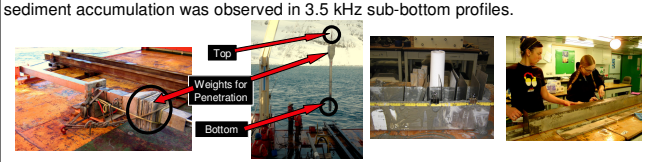
- What is the connection between the dynamic state of glaciers and the rate at which they erode?
- How does this connection change in the transition of warm- to cold-based glaciers?

The Antarctic Peninsula



#2-METHODS and ANALYSES:

A 3m-long kasten corer was used to collect sediment cores from fjord basins within a few kilometers of the calving front of major glaciers. Coring was focused where sediment accumulation was observed in 3.5 kHz sub-bottom profiles.



The cores were sampled every centimeter at the surface and then in progressively larger intervals to the bottom of the core. After the extensive task of sampling was completed, the samples were taken back to the University of Washington for ^{210}Pb analysis utilizing alpha decay.

#3a-RESULTS and CONCLUSIONS:

Core lengths ranged from 34 to 289 cm; in 7 of the 16 core locations, multiple deployments were required to retrieve even a short sediment core, due to the hardness of the bed. In order to calculate accumulation rates, the following equation was used.

Accumulation Rate Equation:

$$A = \frac{-\lambda z}{\ln \left(\frac{C_z}{C_o}\right)}$$

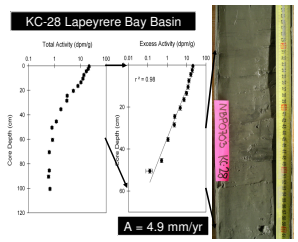
Where:

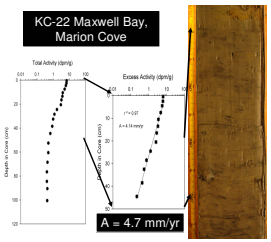
λ = decay constant (0.392/$t_{1/2}$)
z = thickness of the section
C_z = activity at depth
C_o = activity at surface

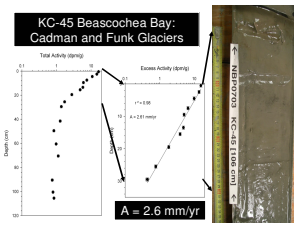
For most of the cores (10 of 16) sandy mud has accumulated steadily at rates ranging from 1 to 10 mm yr^{-1} over the past century, as tightly defined by clear linear trends of log ^{210}Pb values versus depth.

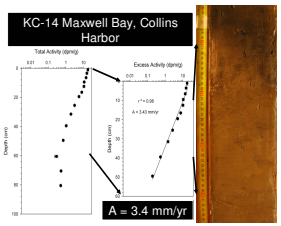
Core Type 1: Steady Accumulation –

These cores display a steady rate of accumulation as is evidenced by the down-core similarity in the photographs. The gray coloring of the sediment for KC-28 and 45 is typical of melt-water from the front of a calving glacier.









The rates of accumulation most likely reflect variability in glacial-marine characteristics of individual fjords, including: sediment delivery, basin morphology, and current direction and strength.

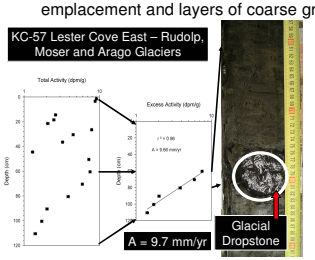
References:

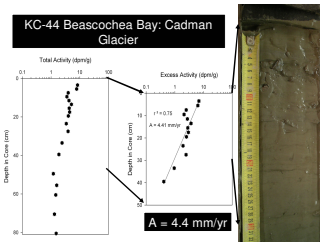
- **Domack,E.W.,and McClennen,C.E., 1996, Accumulation of glacial marine sediments in fjords of the Antarctic Peninsula and their use as late Holocene paleoenvironmental indicators, *in* Ross,R., et al., eds., Foundations for ecosystem research west of the Antarctic Peninsula: American Geophysical Union Antarctic Research Series,v.70, p.135–154.**
- **Harden S.L., DeMaster, D.J, Nttrouer C.A. Developing sediment geochronologies for high-latitude continental shelf deposits: a radiochemical approach. Marine Geology (1992) 103; 69-97.**
- **Harris, P.T., Domack, E., Manley, P.L., Gilbert, R., and Leventer, A. Andvord Drift; a new type of inner shelf, glacial marine deposystem from the Antarctic Peninsula. Geology (1999) 27: 683-686.**
- **Jaeger, John M. and Charles A. Nittrouer. Sediment deposition in an Alaskan Fjord: controls on the formation and preservation of sedimentary structures in Icy Bay. Journal of Sedimentary Research (1999) 65, No. 5; 1011-1026.**

#3b-RESULTS AND CONCLUSIONS:

Core Type 2: Coarse Layers -

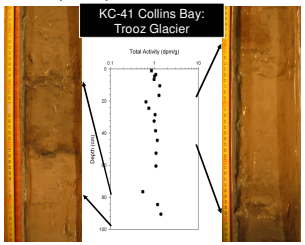
Several cores show evidence of variable sedimentation with pulses of sand emplacement and layers of coarse grains that affected the ^{210}Pb values.

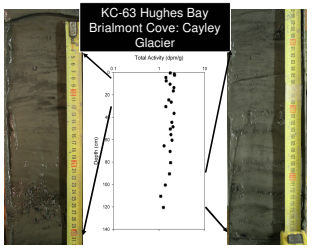




Core Type 3: Uniform Excess Activity -

Three cores contained a surficial layer >50 cm thick of uniform ^{210}Pb activity, indicating recent, rapid deposition of sediment.





The consistency of many of the ^{210}Pb profiles implies that:

- The glacial-marine processes that supplied, transported and deposited sediment in these sub-polar and polar fjords have not varied markedly.
- This contrasts with other glacial-marine systems in warmer regions such as SE Alaska, where sedimentation in the fjords from calving temperate glaciers tends to vary significantly, and where the accumulation tends to slow as the calving front recedes rapidly from the core location.

The rates of sedimentation reported here for the last 10-100 years in the fjords of the Antarctic Peninsula will be compared to those on a millennial time scale derived from ^{14}C data from the cores analyzed here, and will be interpreted in the context of corresponding bathymetric and glaciological data as they become available. Chronological data and corresponding seismic profiles for these cores, as well as similar published data from nearby areas (e.g. Harris et al. 1999; Domack and McClennen, 1996) will be used to determine volumes of sediment being deposited per unit time in these proglacial settings. This will enable us to infer erosion rates from the glaciers in the study area for a range of time scales, and to compare them to corresponding glaciological and climatological data.

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