From Teacher-At-Sea to Authentic Science in the Classroom

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Overview

- Teaching Science
- A Teacher Professional Development Experience
- Teaching Science After an Authentic Experience

Traditional Science Teaching

- Turn of the century courses and methods to prepare our students for the workforce
- Sputnik and the “new” curriculums
- Bottom line – teachers will teach
  - The way they were taught and/or
  - In a way they can cover all the content in a year

How can we change the way science is taught to reflect the nature of science?

Developing an Understanding of the Nature of Science

- What Science is & What Scientists do…
  - Science is a creative endeavor, and there exists many ways exist to do science.
  - Data doesn't speak, instead scientists have to develop an idea that makes sense of data
  - Knowledge in science can not be "proven" or "absolutely "true"
  - Not every activity in science is an "Experiment"
  - Not every activity in science starts with a hypothesis

Creating Authentic Classroom Science Experiences

- Require teachers to use specific methods without giving them any assistance OR
- Provide teachers the opportunity to participate in authentic science experiences such as
  - Field experiences
  - Lab experiences
  - Original research

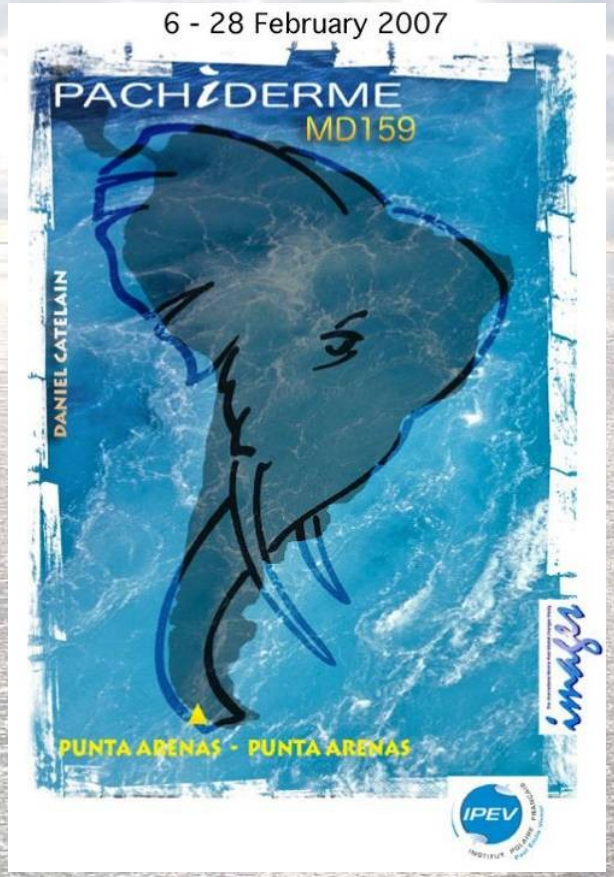
Authentic Science Experiences

- Work alongside scientists
- Assist scientists in the field research with the collection and analysis of data
- Pose a question, develop a hypothesis, and test the hypothesis
- Take science research experience back to the classroom and model the nature and methods of science for students

An Example of an Effective Teacher Professional Development Experience…

The PACHIDERME Cruise of the Research Vessel Marion Dufresne (PAcifique CHIli Dynamique des Eaux InteRMEdiaires)

MD 159 - IMAGES XV



Embarking on an Opportunity of a Lifetime!

- From being asked to join the research cruise
- To gaining release time from my school district
- To preparing myself
- To preparing my students

Preparing My Students

What science content?

- climate change
- ocean circulation
- atmospheric circulation
- proxy data records
- glacial geology
- the nature of science etc…

What lessons?

- The climate system
- Gathering and Understanding climate data
- Glaciology
- Using Science practices

Preparing My Students

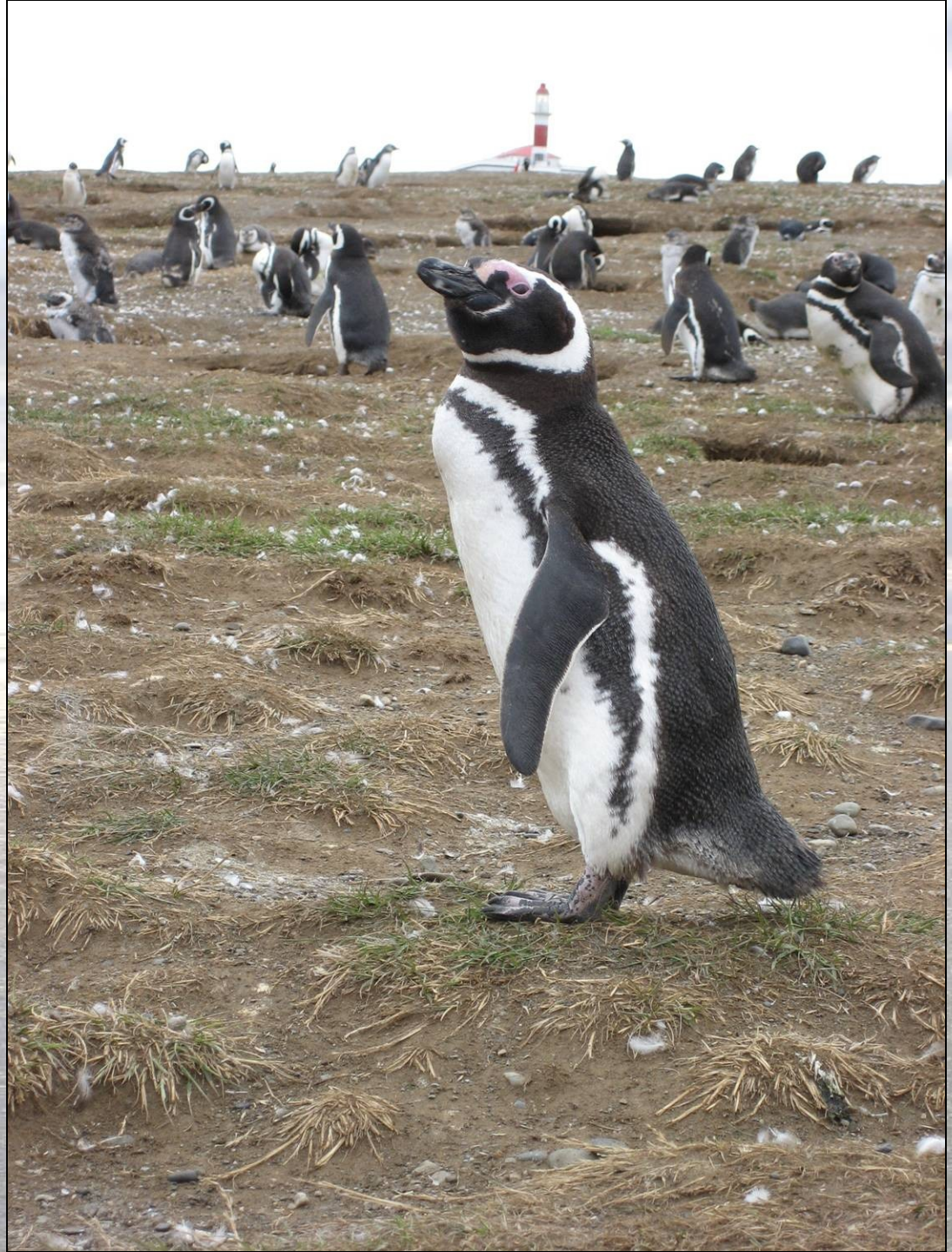
- Pre-trip powerpoint presentation
  - provided trip details – the logistics & the science
- Brief lesson on proxy data 
- The tasks of the students while I was away
  - Keep a journal, answer a question of the day, participate in a blog in any language
- Our own experiment… 

The Journey from Chatham, New Jersey to Punta Arenas, Chile…


CHINA
BEIJING
8961 KM.
1865
SCHOENSTATT
13607 KM.
12.241
La Koutoubia
BRNO 14.150 KM
HAKAN KUMUK
GÜRAL PORSELEN
BENGÜÇ ÖZERDEM
TURKEY
18.429 km.
İSTANBUL


HOSTAL


conaf Chile
MONUMENTOS NATURALES
BIENVENIDO
WELCOME TO
MONUMENTO NATURAL
LOS PINGÜINOS
GOBIERNO DE CHILE
CORPORACIÓN NACIONAL FORESTAL
XII REGIÓN DE MAGALLANES Y ANTARTICA CHILENA




INFORMACIÓN TURÍSTICA


TIERRA DEL
FUEGO

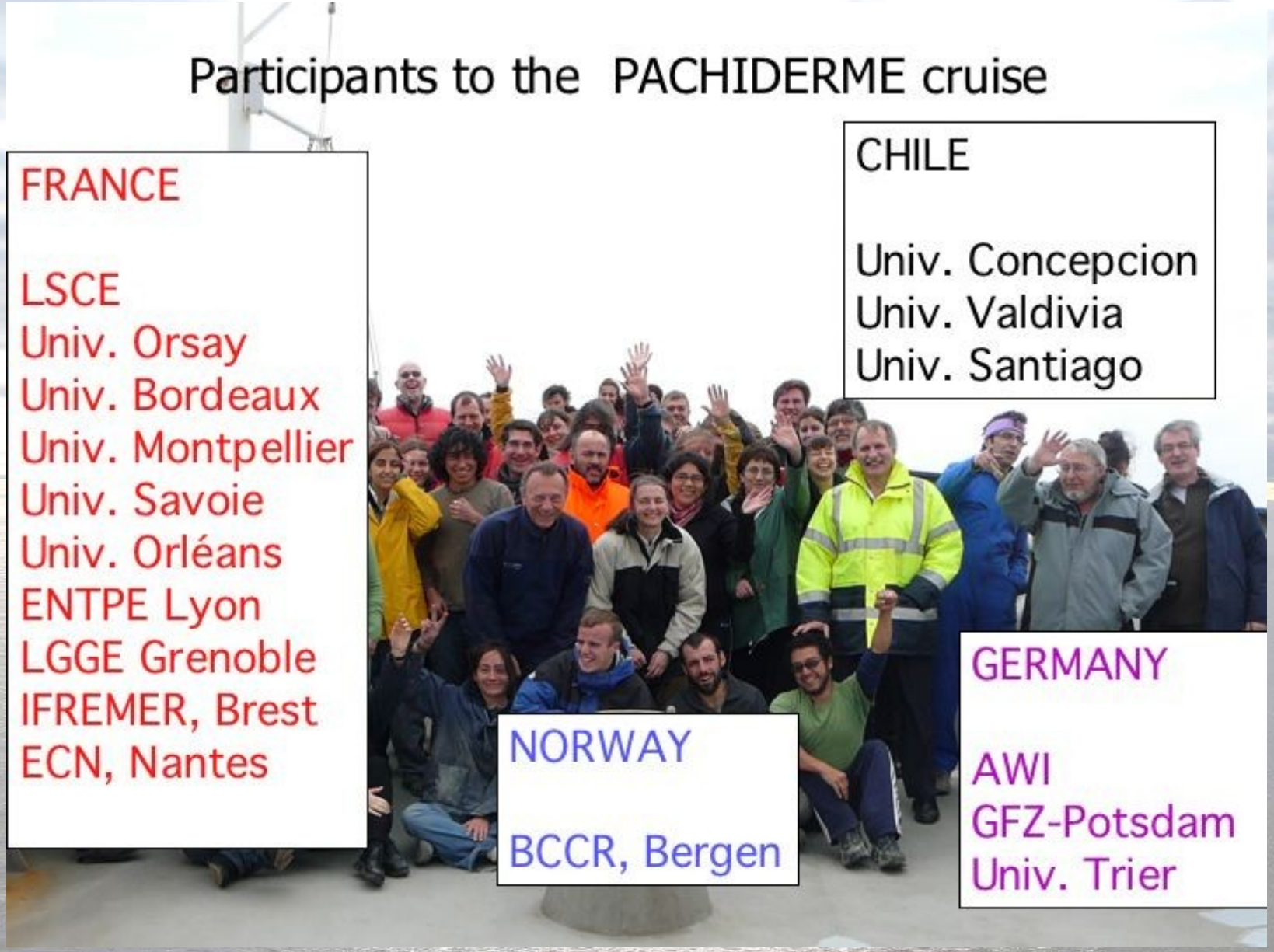
Good Luck from the Ono Toe!


IPEV
INSTITUT POLAIRE FRANÇAIS
Paul Emile Victor


MARION DU
TOYOTA

Participants to the PACHIDERME cruise

Participants to the PACHIDERME cruise



FRANCE

LSCE
Univ. Orsay
Univ. Bordeaux
Univ. Montpellier
Univ. Savoie
Univ. Orléans
ENTPE Lyon
LGGE Grenoble
IFREMER, Brest
ECN, Nantes

CHILE

Univ. Concepcion
Univ. Valdivia
Univ. Santiago

NORWAY

BCCR, Bergen

GERMANY

AWI
GFZ-Potsdam
Univ. Trier

Core Education
a teachers' program during Pachiderme

- 3 teachers from Chile and 1 from the USA under the guidance of Carlo Laj, LSCE, France:

- Participated in "watches"
- Took pictures, interviewed scientists
- Created daily logs
- Disseminated cruise information to teachers all over the world……

….so that the cruise has been followed by schools in :

Italy, Austria, Poland, Belgium, Czech Republic, Chili, USA, Bulgaria, Estonia, Germany, U.K., Holland, Hungary, Norway, Romania, Sweden, Canada, Portugal, Spain…

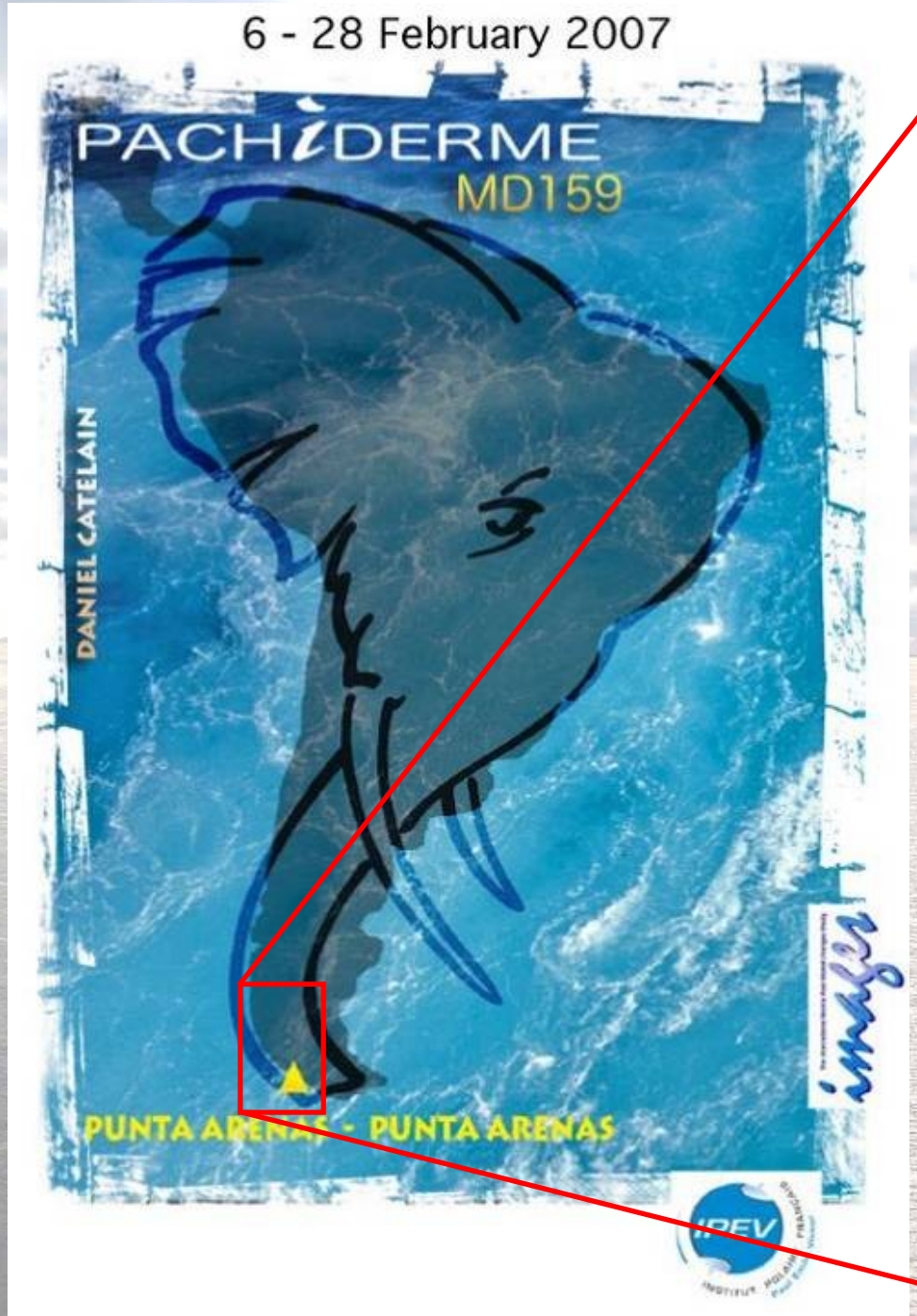
Slide courtesy of Lycée Roosevelt, Reims (France)

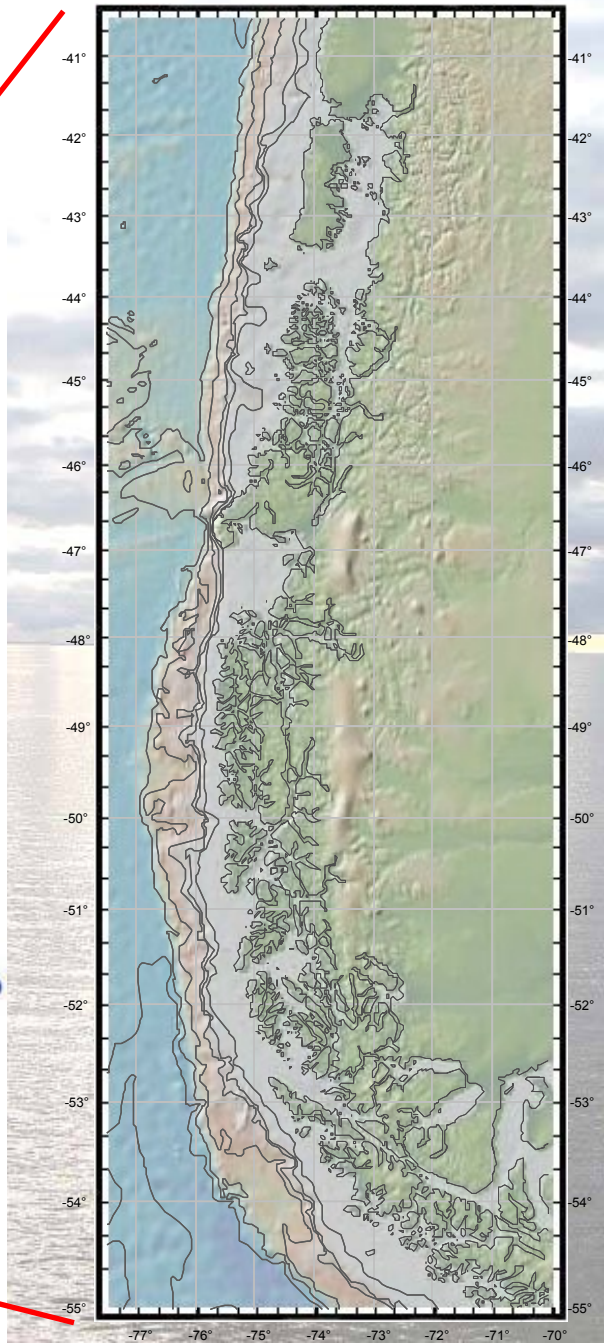
Why did all these scientists sail

together

on PACHIDERME?

MD159-PACHIDERME





Southern Chilean Margin

• The Southernmost 9° of fjord region = only continental mass intercepting the westerly winds within this latitude range:

==> critical topographic barrier on the oceanographic systems maintained by these winds.

•The southern Chilean continental margin = key area for:

- constraining ocean-atmospheric circulation systems of the mid to high southern latitudes
- document their roles in regional and global climate change.

Coring Objectives of the PACHIDERME Cruise

To recover marine sediment sequences which represent the archives for paleo-environmental, climatic, and oceanographic changes in the southeast Pacific along the Chilean margin in two different realms:

1) In the Open Ocean
2) In the Fjords Region

Open Ocean:
Divergence of the West Wind driven Current

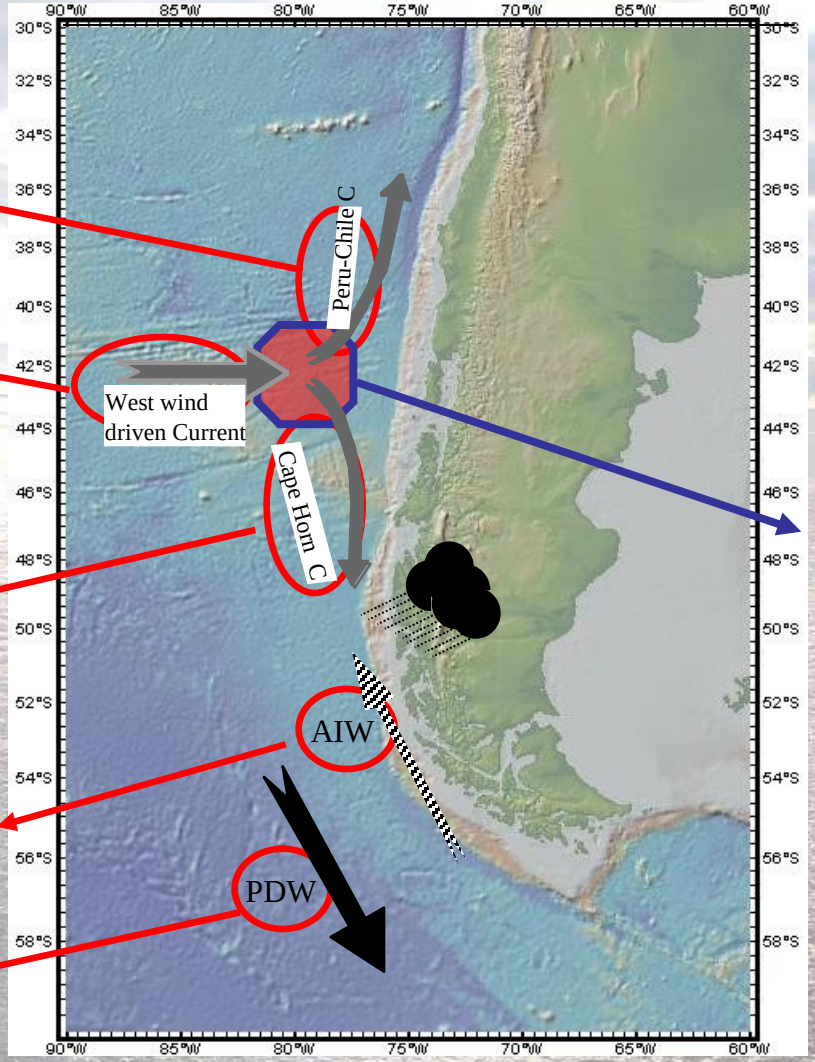
Peru-Chile Current

Antarctic circumpolar current

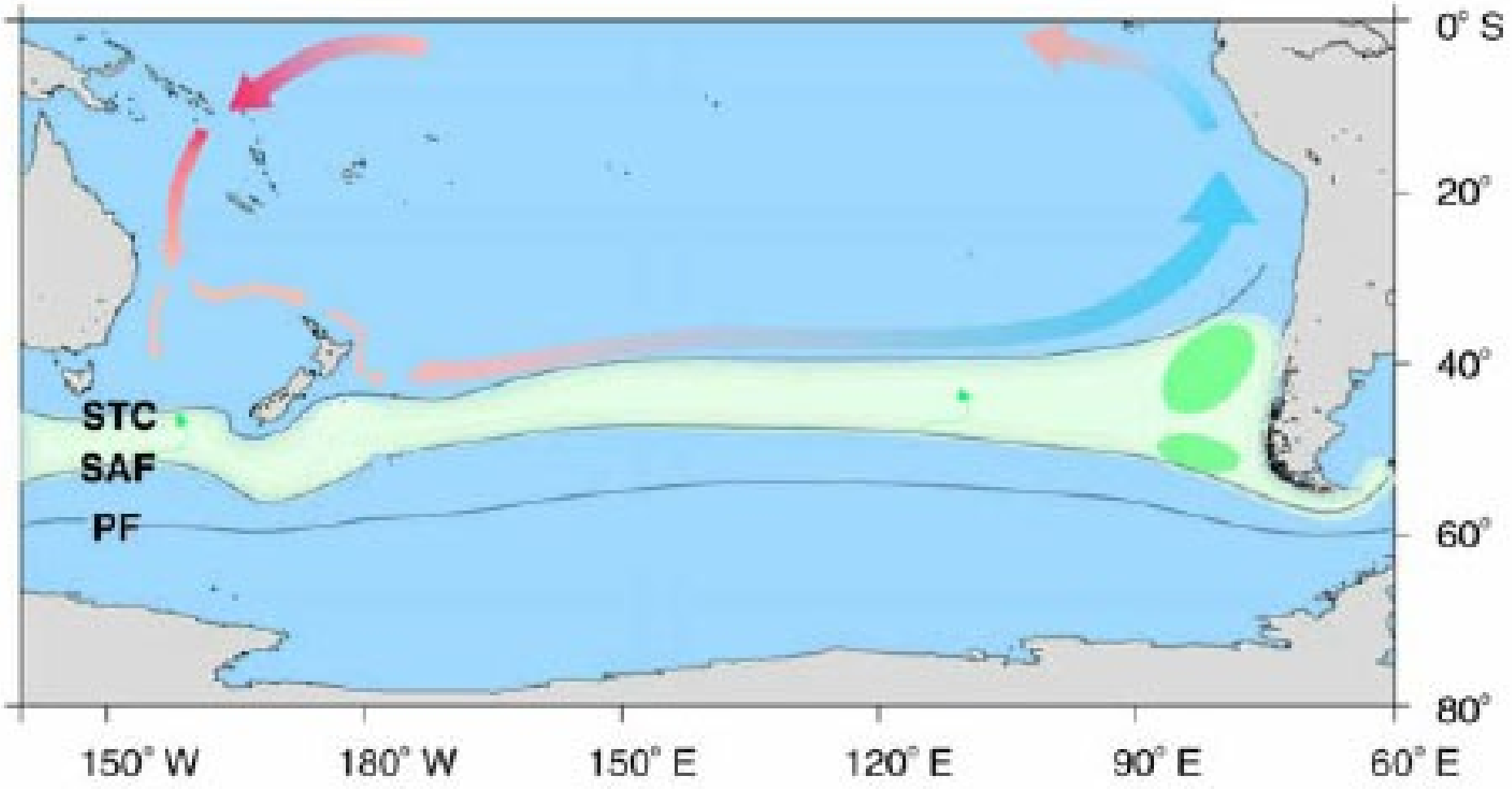
Cape Horn Current

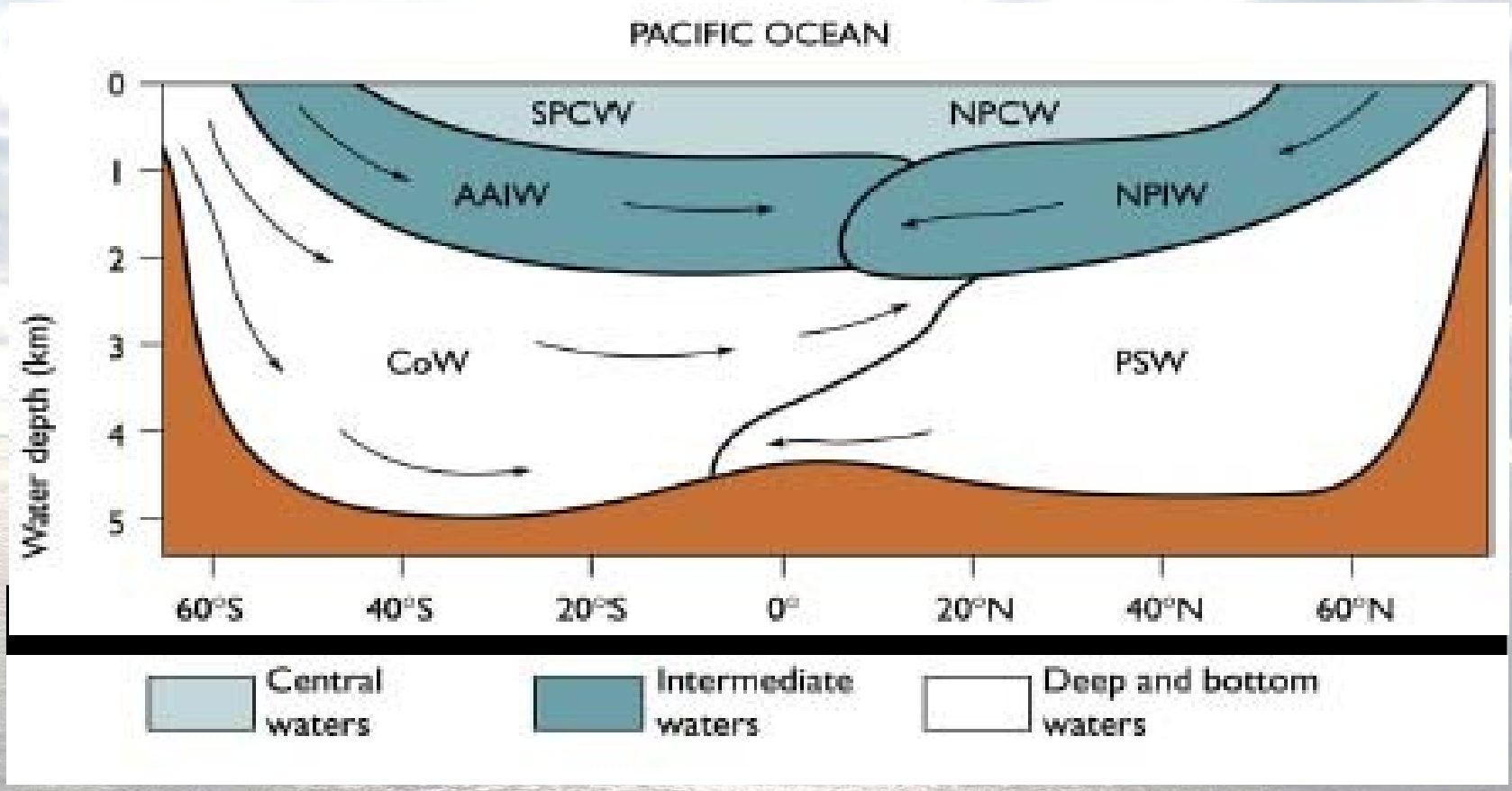
Antarctic Intermediate Water

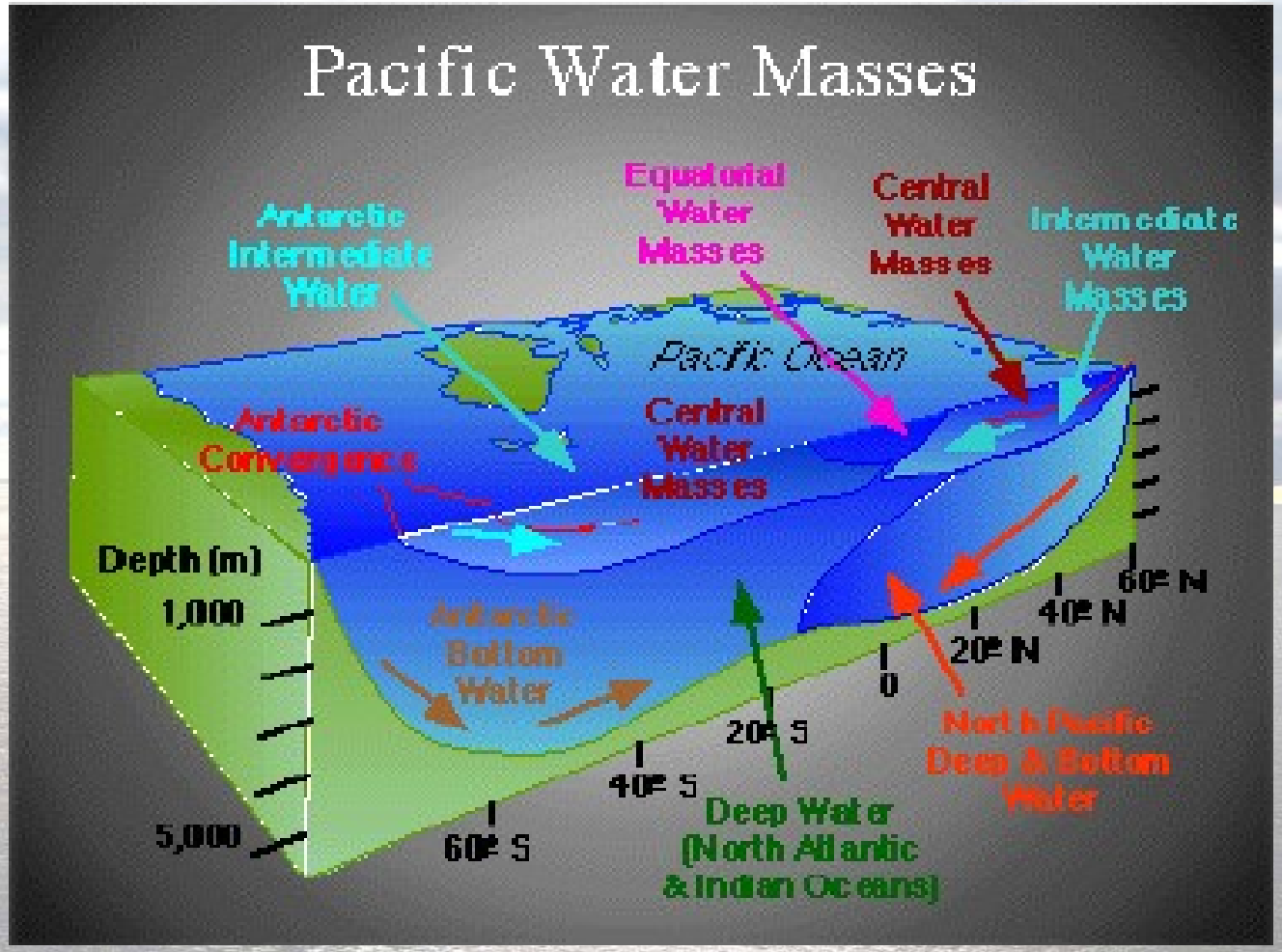
Pacific Deep Water



The cool surface waters of the ACC are driven eastward by the Southern Westerly Winds (SWW) and on southern Chile their flow is diverted meridionally
=> **transition zone** between the southward flowing Cape Horn Current and the northward flowing Peru-Chile Current.


0° S
20°
40°
60°
80°
STC
SAF
PF
150° W
180° W
150° E
120° E
90° E
60° E
AAIW formation
SAMW formation
Oceanic fronts
Subtropical gyre circulation

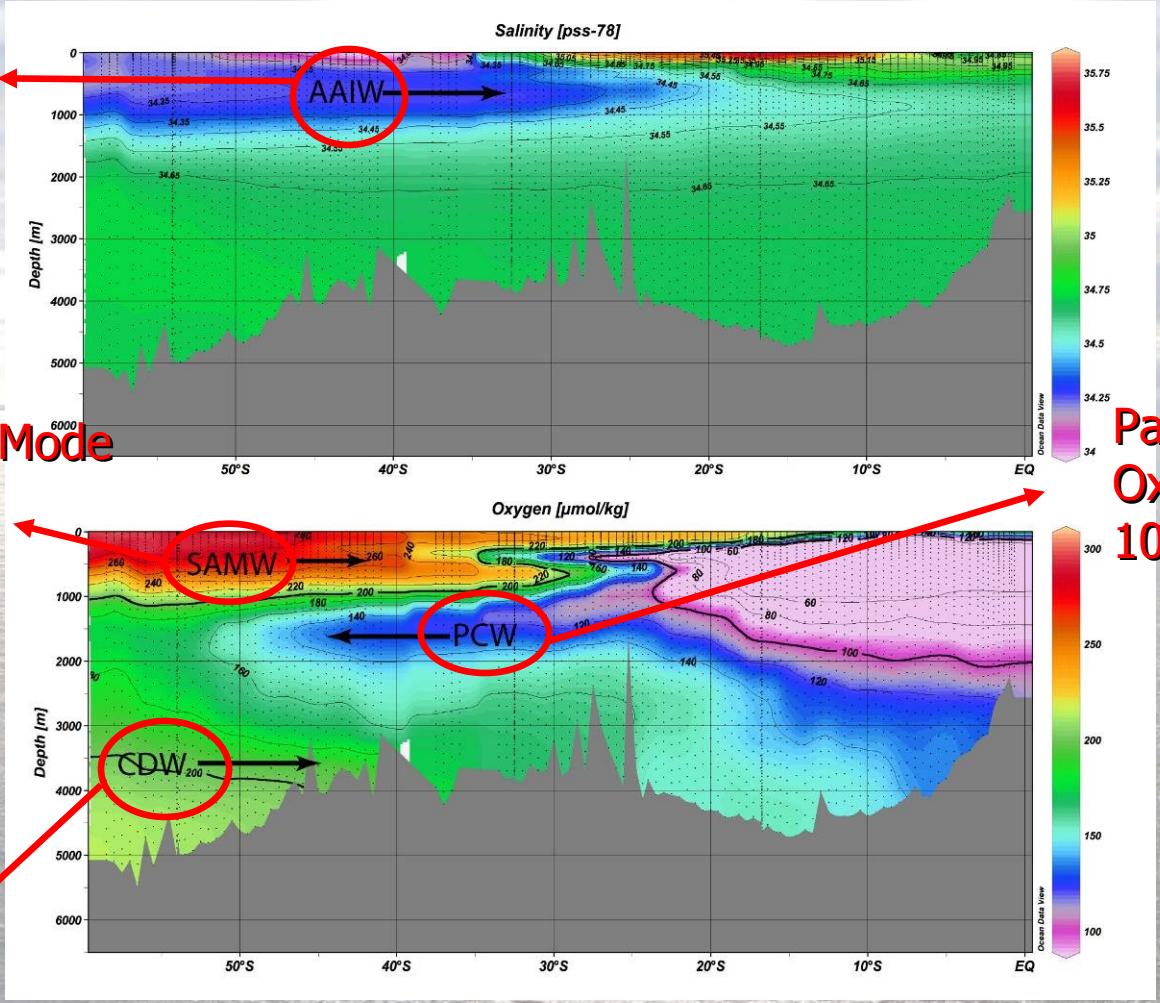

PACIFIC OCEAN
SPCW
NPCW
AAIW
NPIW
CoW
PSW
Water depth (km)
0
1
2
3
4
5
60°S
40°S
20°S
0°
20°N
40°N
60°N
Central waters
Intermediate waters
Deep and bottom waters


Pacific Water Masses
Antarctic Intermediate Water
Equatorial Water Masses
Central Water Masses
Intermediate Water Masses
Pacific Ocean
Antarctic Convergence
Central Water Masses
Depth (m)
1,000
5,000
Antarctic Bottom Water
60° S
40° S
20° S
0
20° N
40° N
60° N
North Pacific Deep & Bottom Water
Deep Water (North Atlantic & Indian Oceans)

Ocean Water Cross Section

(Note Changes in Salinity & Oxygen with Depth & Latitude)

Antarctic Intermediate Water
Low salinity
500-1000 m



Subantarctic Mode Water
Oxygen rich

Pacific Central Water
Oxygen poor
1000 - 3000 m

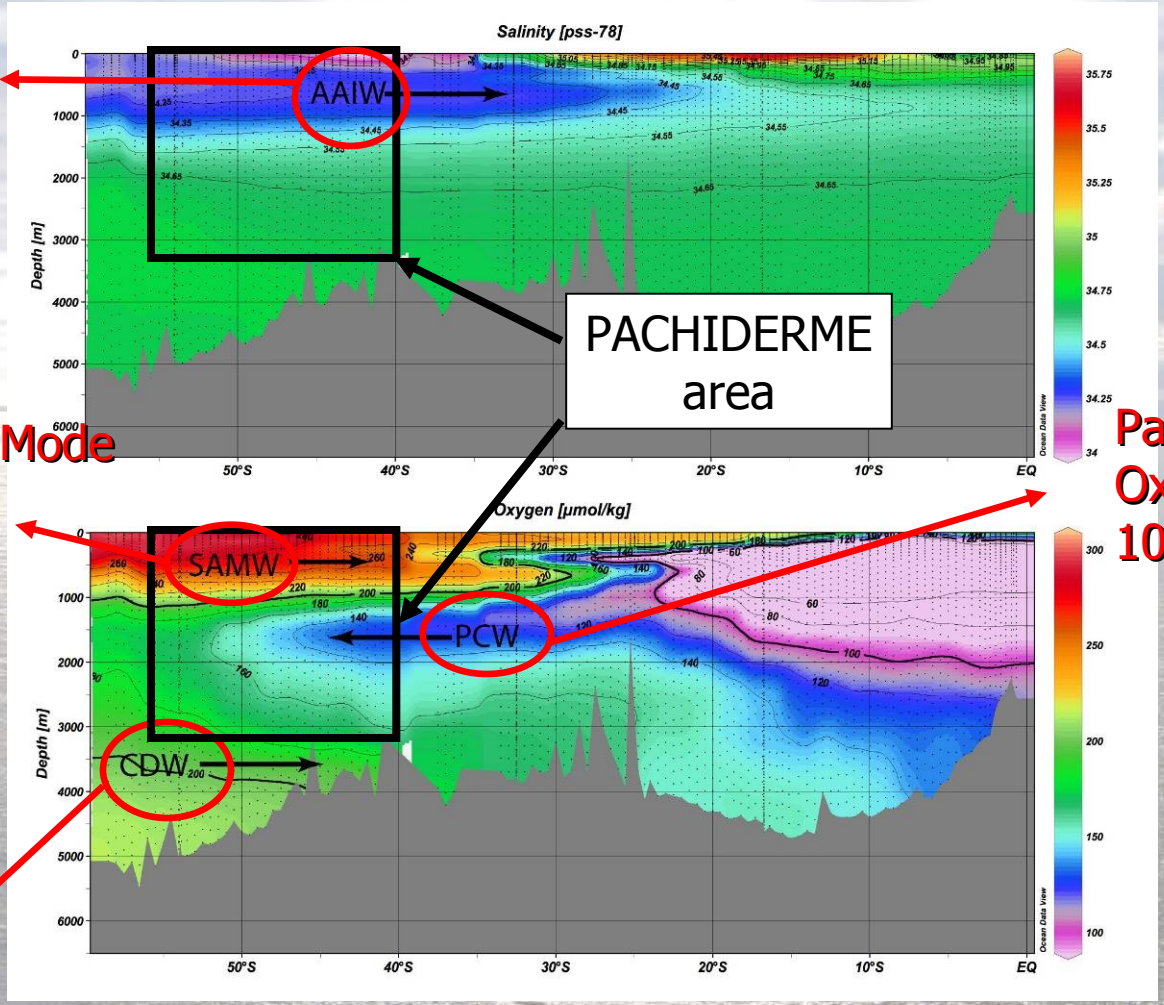
Circumpolar Deepwater
>3000 m

From World Ocean Circulation Experiment

Ocean Water Cross Section

(Note the Changes in Salinity & Oxygen with Depth & Latitude)

Antarctic Intermediate Water
Low salinity
500-1000 m



Subantarctic Mode
Water
Oxygen rich

Pacific Central Water
Oxygen poor
1000 - 3000 m

Circumpolar Deepwater
>3000 m

From World Ocean Circulation Experiment

Why is the study of these currents so important?

Intermediate depth waters feed or underlie the majority of the ocean's thermocline (boundary layer between the warmer well-mixed surface water and colder deep ocean water):

==> a conduit through which high latitude ocean anomalies are transmitted to lower latitudes?

A primary component of AAIW originates west of southern Chile **(PACHIDERME AREA!!)** and then spreads throughout the South Pacific as well as the Drake Passage where it is subsequently modified.

Computer Model results ==> changes in properties of intermediate depth waters feeding the equatorial thermocline can influence tropical sea surface temperatures on decadal to glacial-interglacial timescale and modulate frequency/intensity of El Nino.

In addition, changes in the nutrient chemistry of the intermediate water may influence **atmospheric CO_2 concentration** and global ocean productivity.

However, models remain largely **untested** because the properties of Southern Hemisphere intermediate water masses are poorly documented beyond the last few decades:

===> Need for data!

In The Fjord Region

TODAY:

- The coastal area south of 42° is characterized by fragmented topography resulting in a complex system of fjords and channels that are particularly vulnerable to climate changes.

- The westerly winds bring heavy rainfall to the coastal mountains and the Andes, resulting in high fluvial sediment fluxes to the ocean, *via* the fjords.

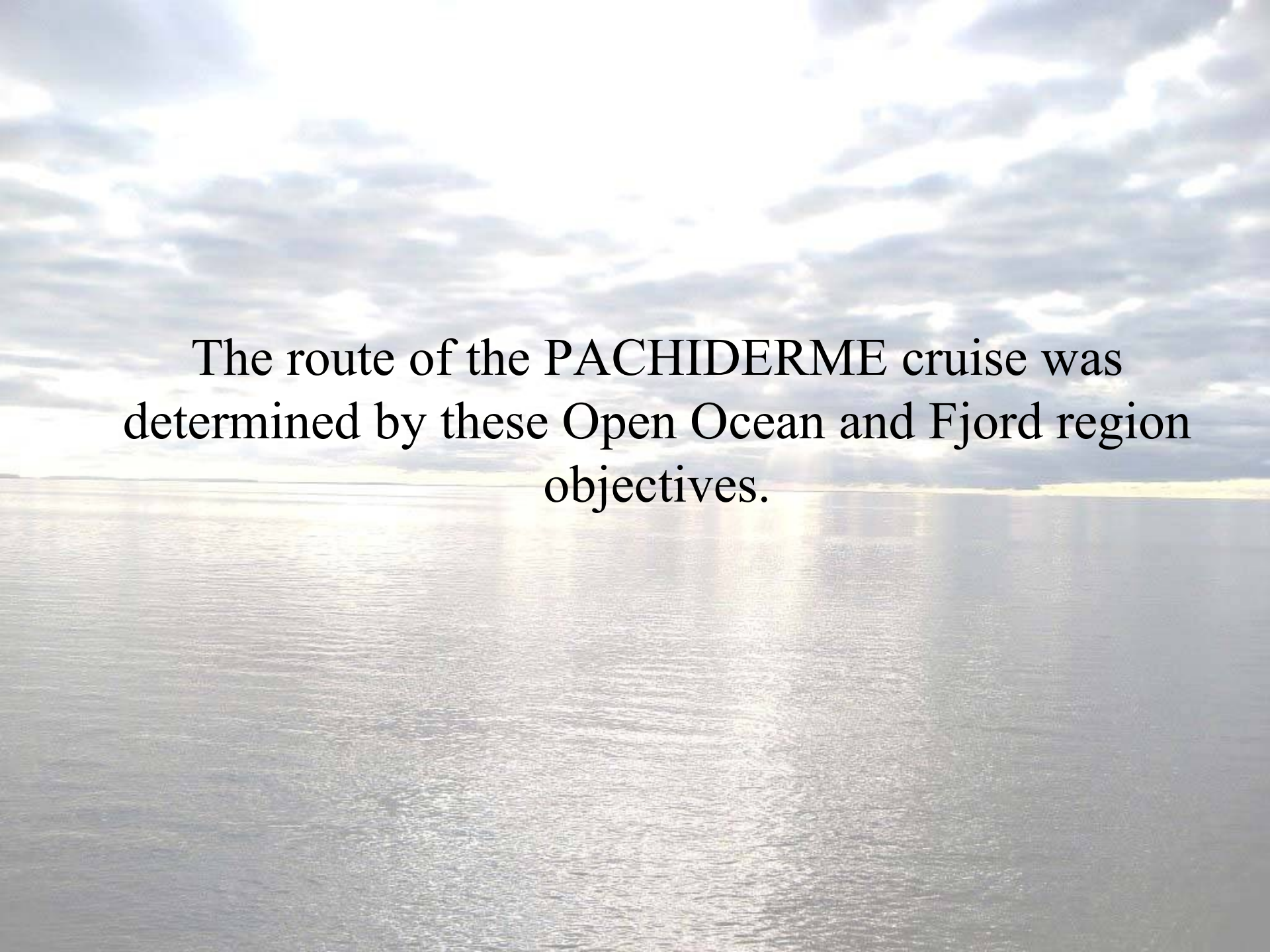
IN THE PAST:

Recovering the extremely high accumulation rates sedimentary sequences from the fjords, provide the rare opportunity to decipher paleoenvironmental histories with (sub) decadal resolution spanning the Holocene and last glacial cycle.

The fjord sediment sequences are therefore capable of portraying:

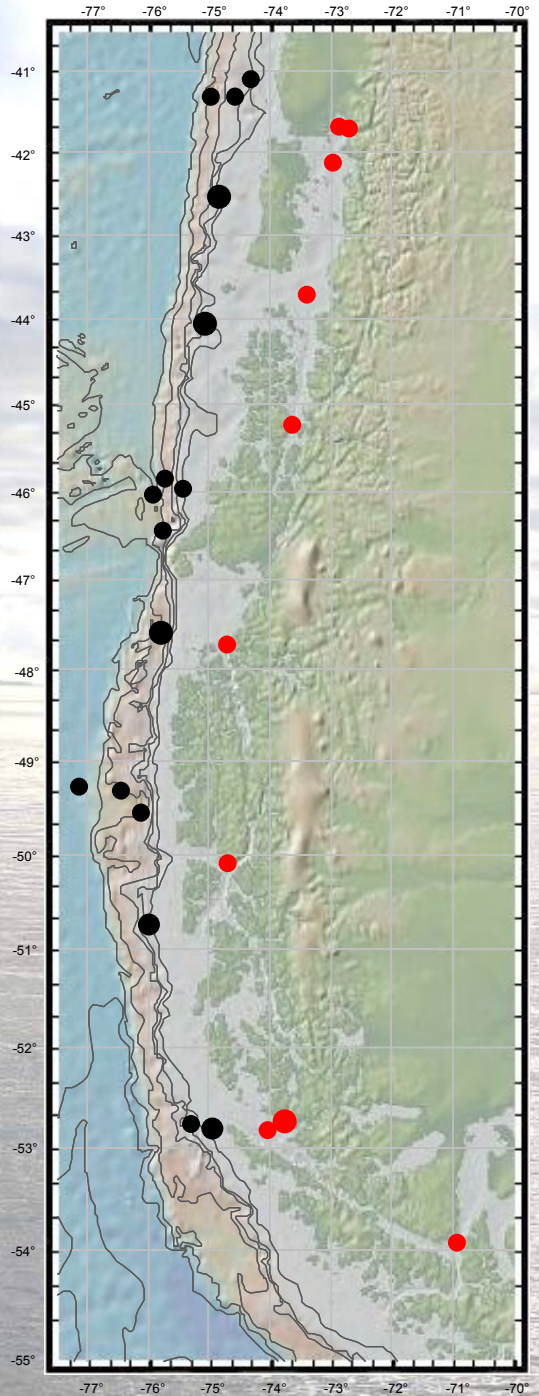
7)changes in continental climate (rainfall/glacial activity) and the latitudinal position of the westerly winds,

2) Southern Hemisphere natural climate variability on decadal to millennial timescales through the Holocene and last glacial cycle.

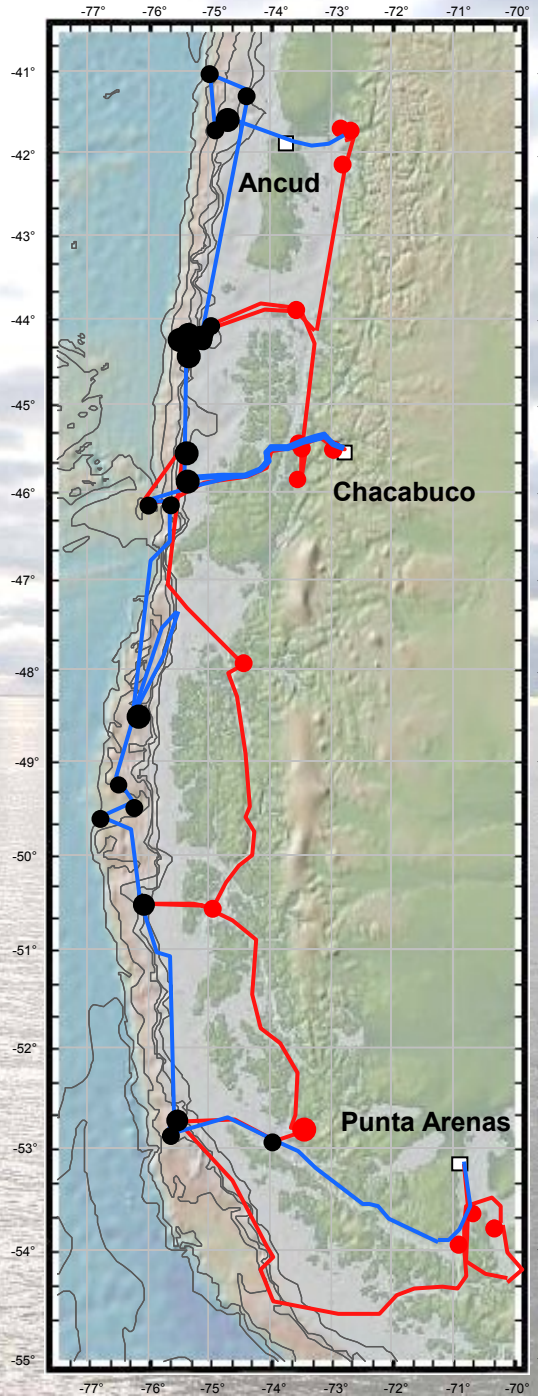


The route of the PACHIDERME cruise was determined by these Open Ocean and Fjord region objectives.

Scheduled
25 stations

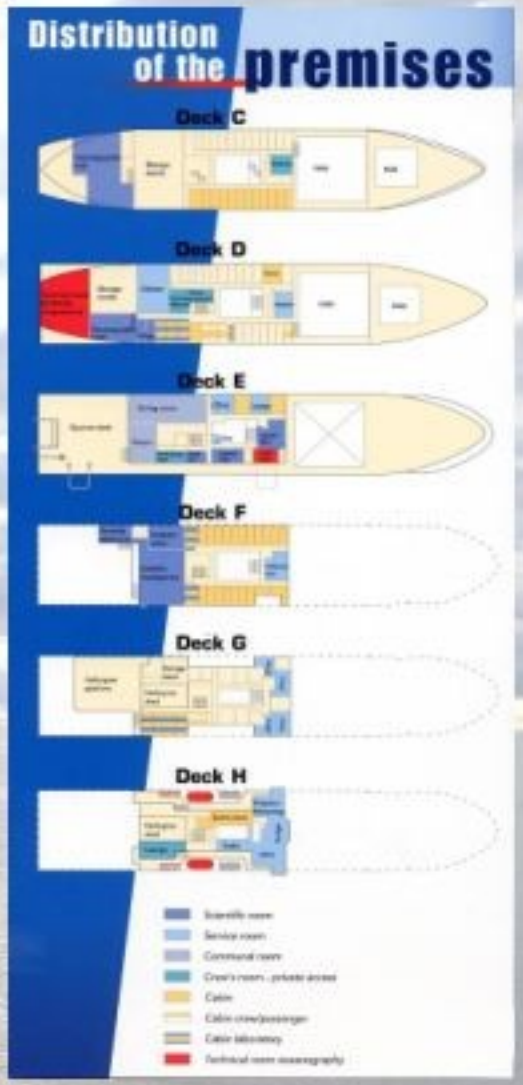


Done
38 stations



The Marion Dufresne at Punta Arenas…..
…departure tomorrow (February 6, 2007)!

The Marion Dufresne



Dimensions: length 120.50 m, breadth 20.60 m
Passenger accommodation: 110 passengers capacity, 59 cabins, 2 dining rooms, meeting room, lounges, conference/video room, and gym room.

Navigation: Staying on Course and Staying in Position

- 2 synchronous electric motors used for propulsion
- 3 diesel generators creating 8250 kWatts of electrical production capability from the diesel fuel.
- The use of electric motors is necessary to create a “quiet” cruising environment for the echo sounder to work effectively
- The vessel has the capabilities of moving at a maximum of 17 knots
- 3 GPS satellite positioning systems
- Ultra short baseline underwater objects positioning system
- Dynamic vessel positioning system.


Catherine Kissel
Chief Scientist

Scientific work on board:

1) Choosing a coring site

2) Coring operations

3) Core Handling

4) First shipboard measurements/observations

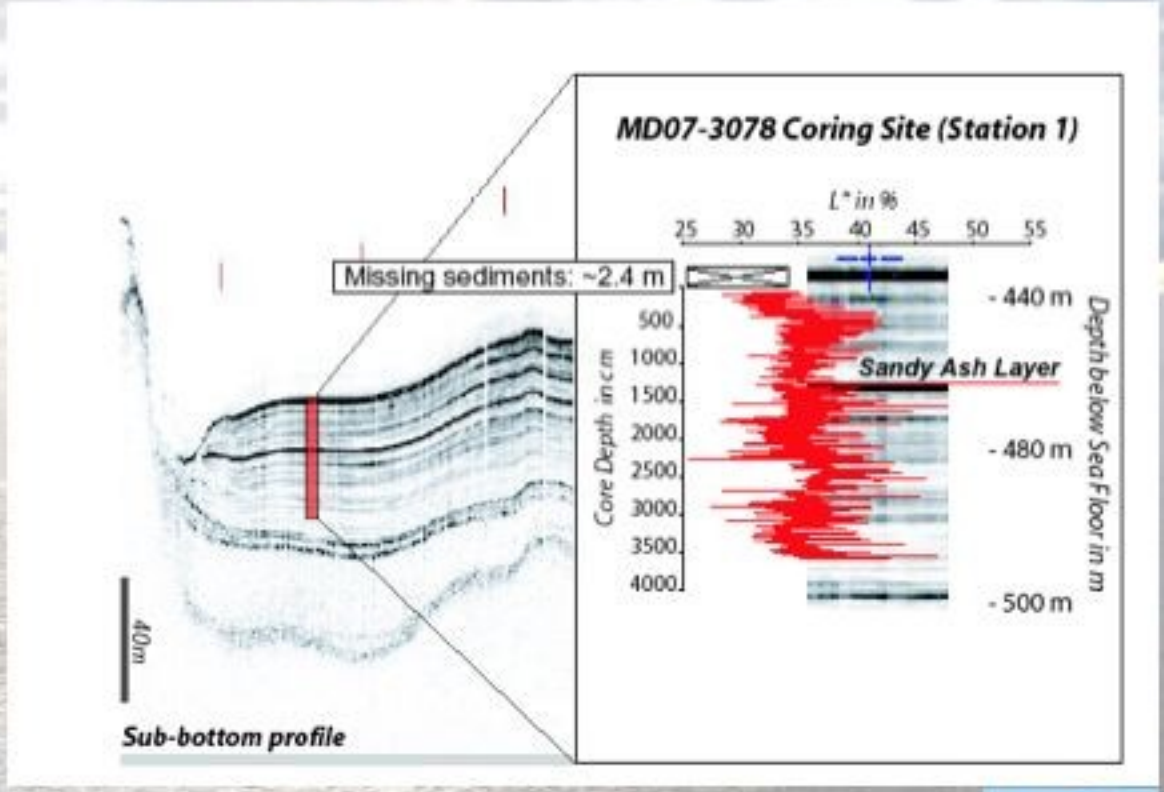
5) Final numbers

6) Celebration!

Scientific work on board:

1) How to choose a site

Echo Sounding Results

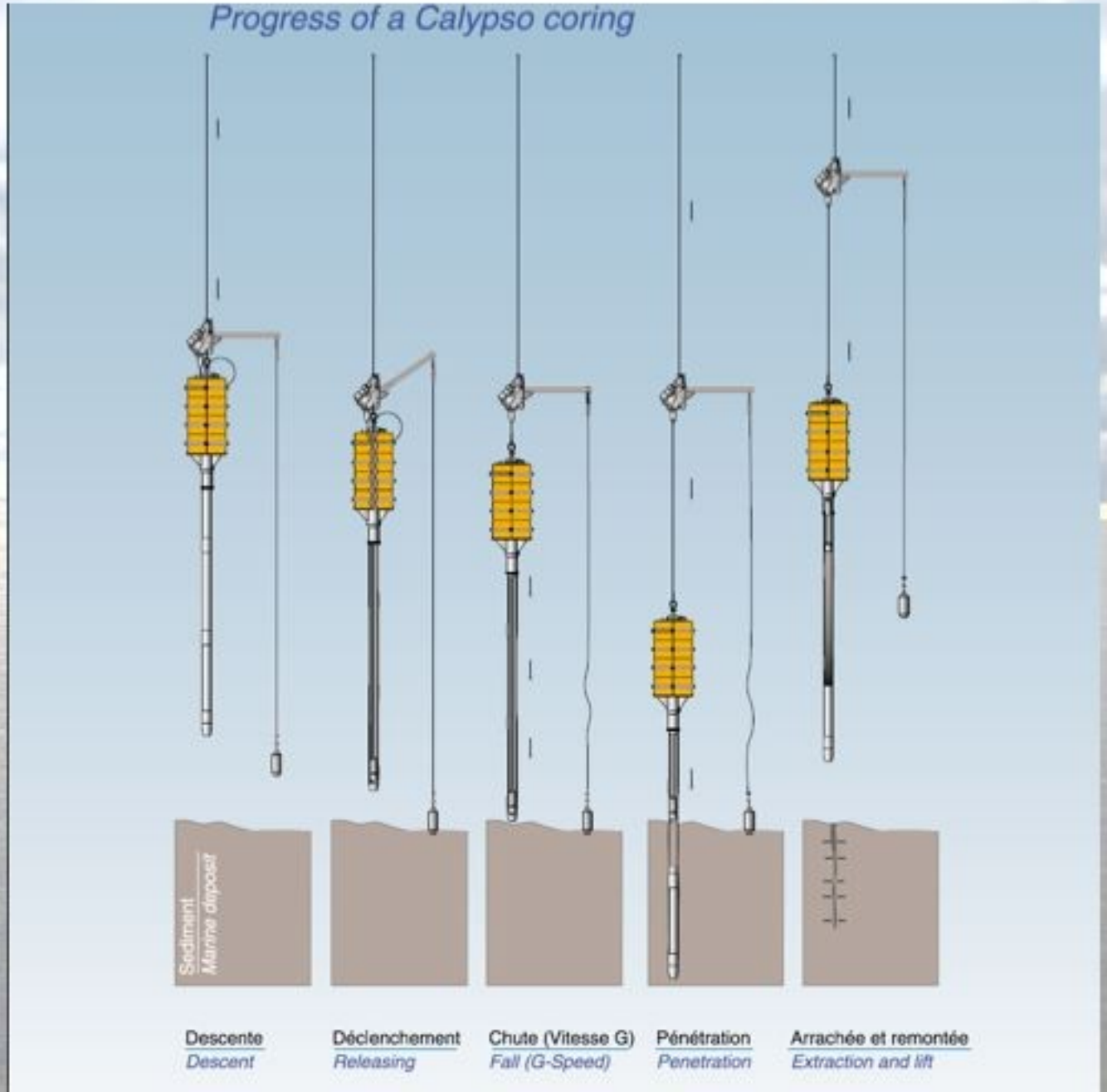


Scientific work on board:

2) Coring operations

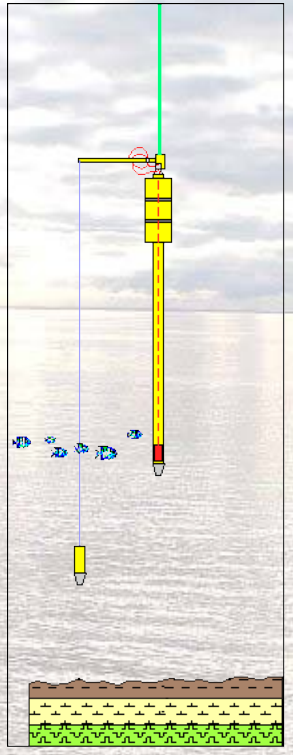
Calypso
Sediment Corer

Scientific work on board:



Scientific work on board:

Calypso Coring



Coming up!

Core Almost on Deck

Core on Deck!

Scientific work on board:

2) Coring operations

The Core Catcher
(Designed to prevent the sediments from coming out of the corer)

CoreHandling: Cutting the Core into 1.5 m Segments

Core Handling: **splitting Core Segments into a Working Half and an Archive Half**

Core Handling:

splitting Core Segments into a Working Half and an Archive Half

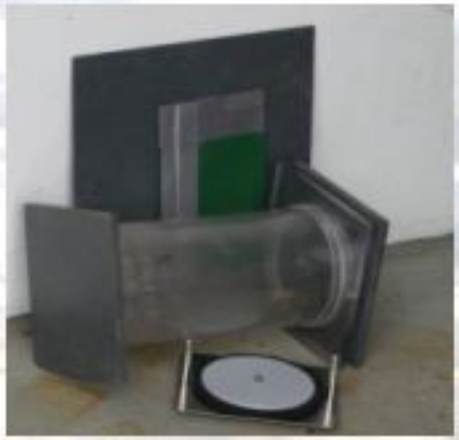
Core Handling: labeling the different segments

Coring with a Casq
(Calypso Square)

Processing a Casq Core

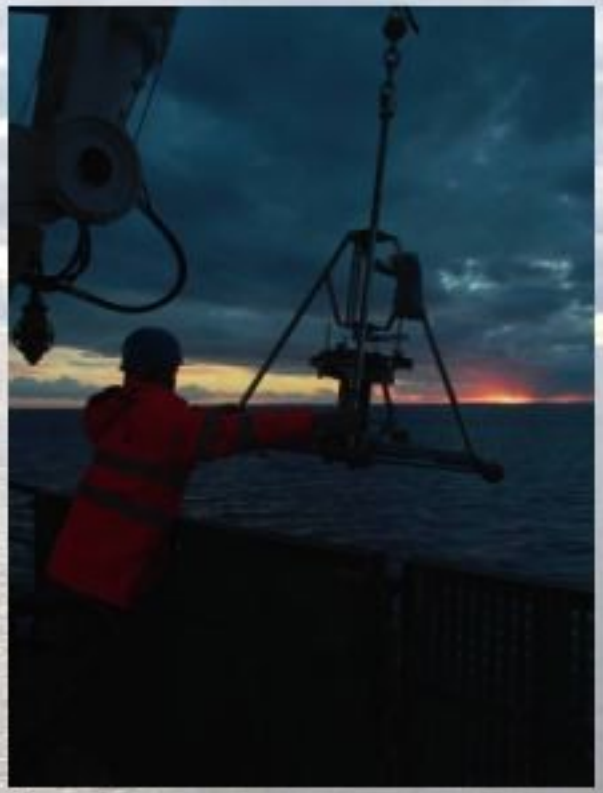
Using fishing line to cut through the sediments

HAPS Corer

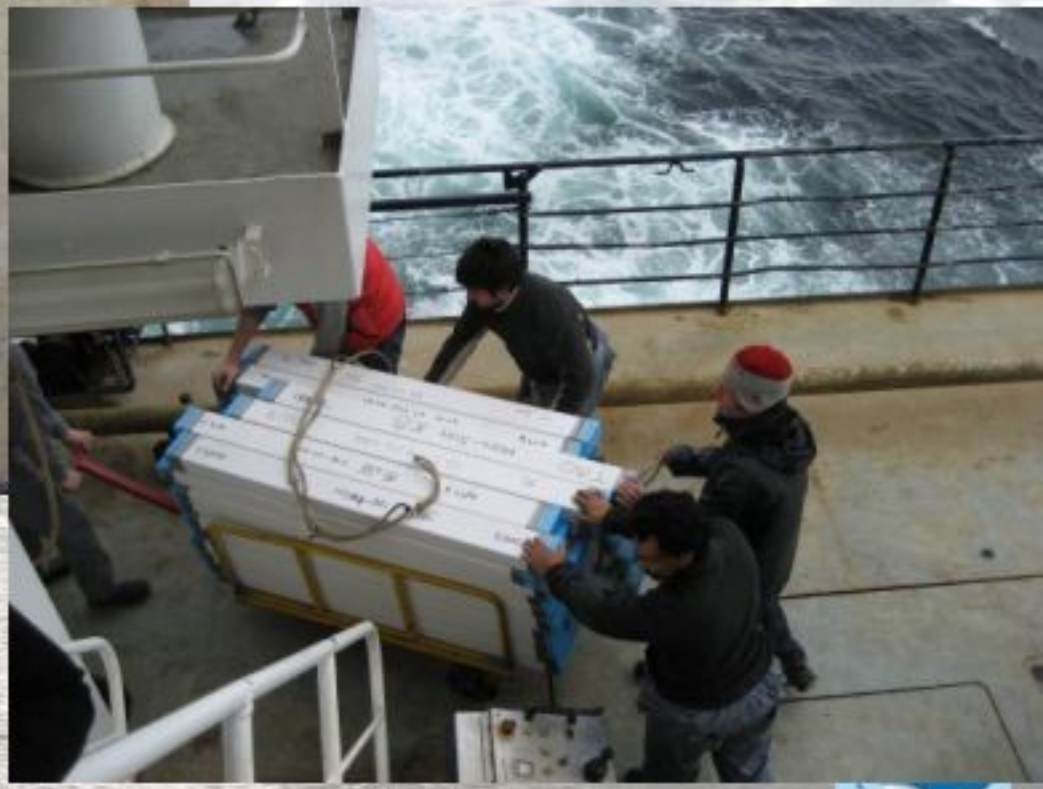


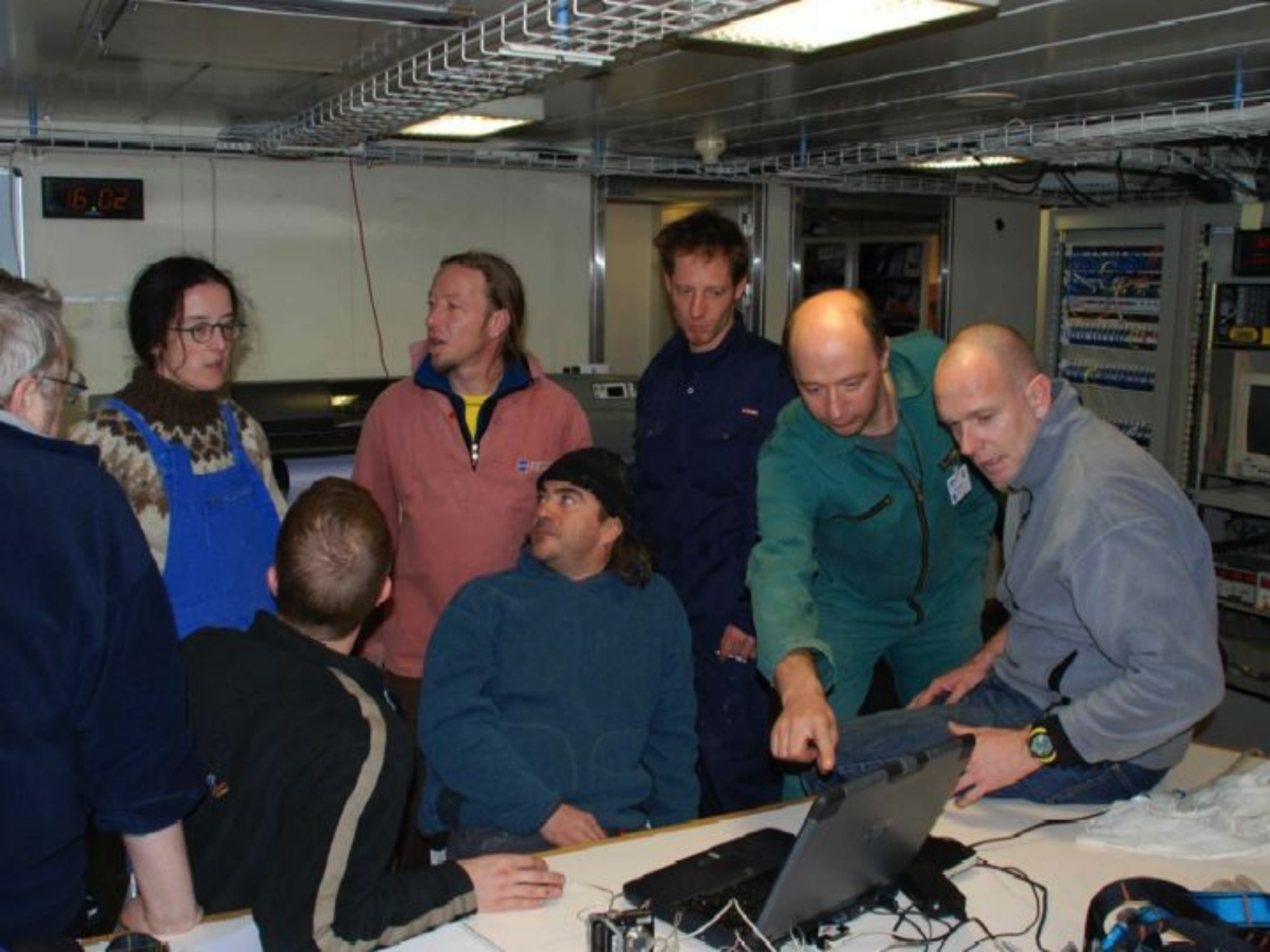
30 cm core catcher

Deploying HAPS



Cores are Ready to go to the Lab





Preliminary observations/measurements on board:

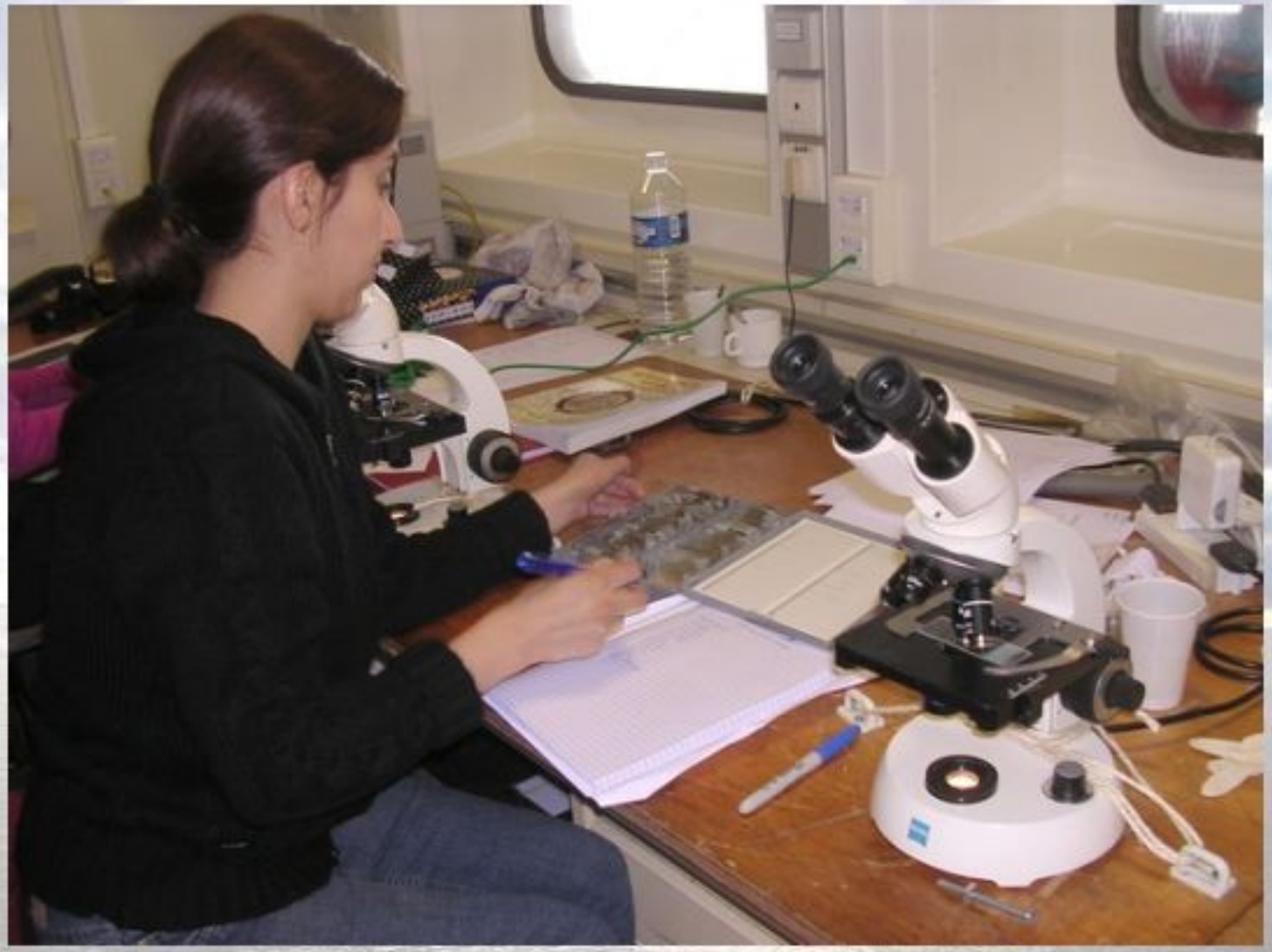
- **Core Description**
- MST
- Spectrophotometer

The sediment core descriptions summarize data obtained during shipboard visual inspection of each core segment.

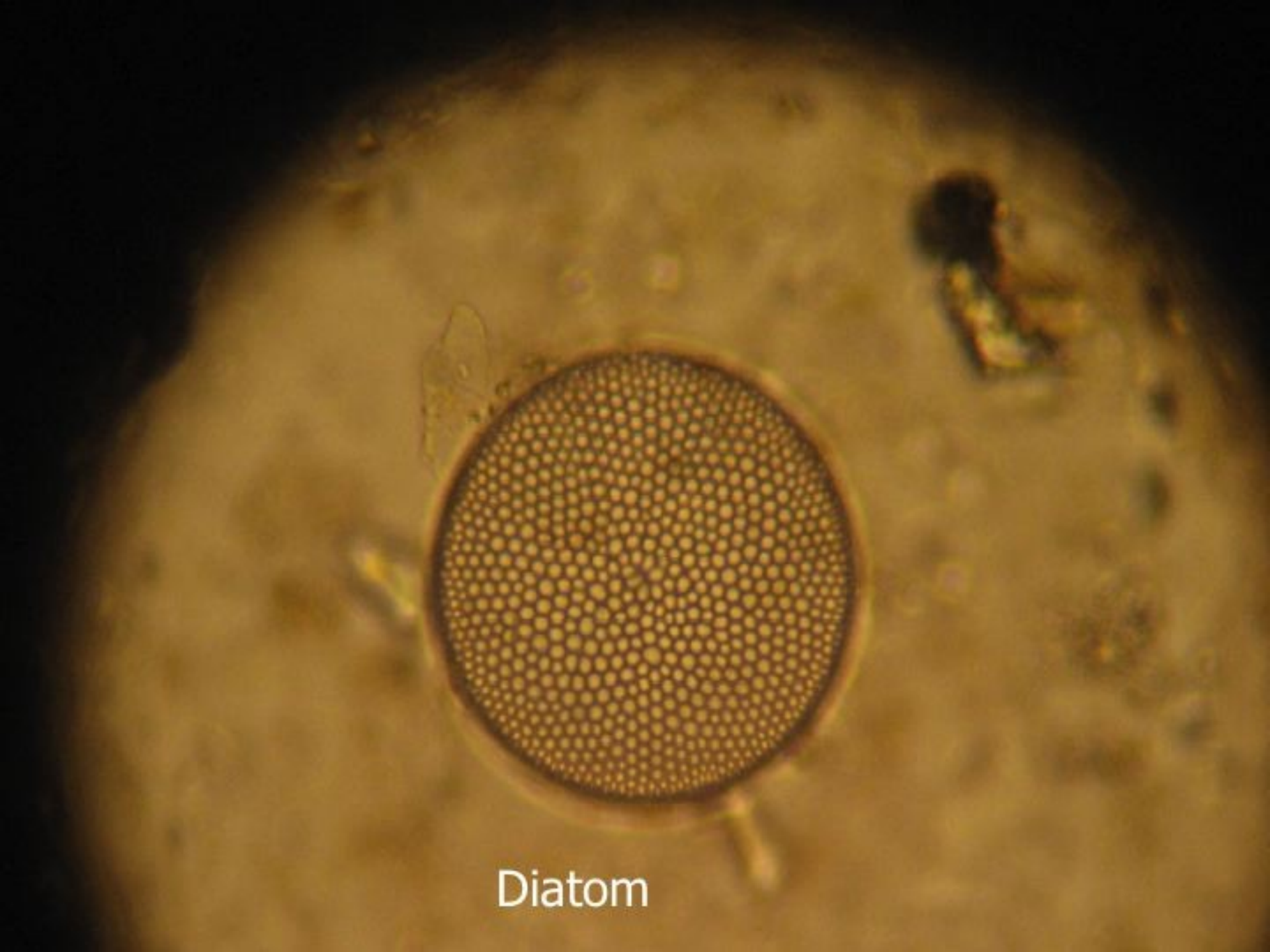
Sedimentology

Lithology, sedimentary structures, texture, fossil content and coring disturbances were described for each core section.

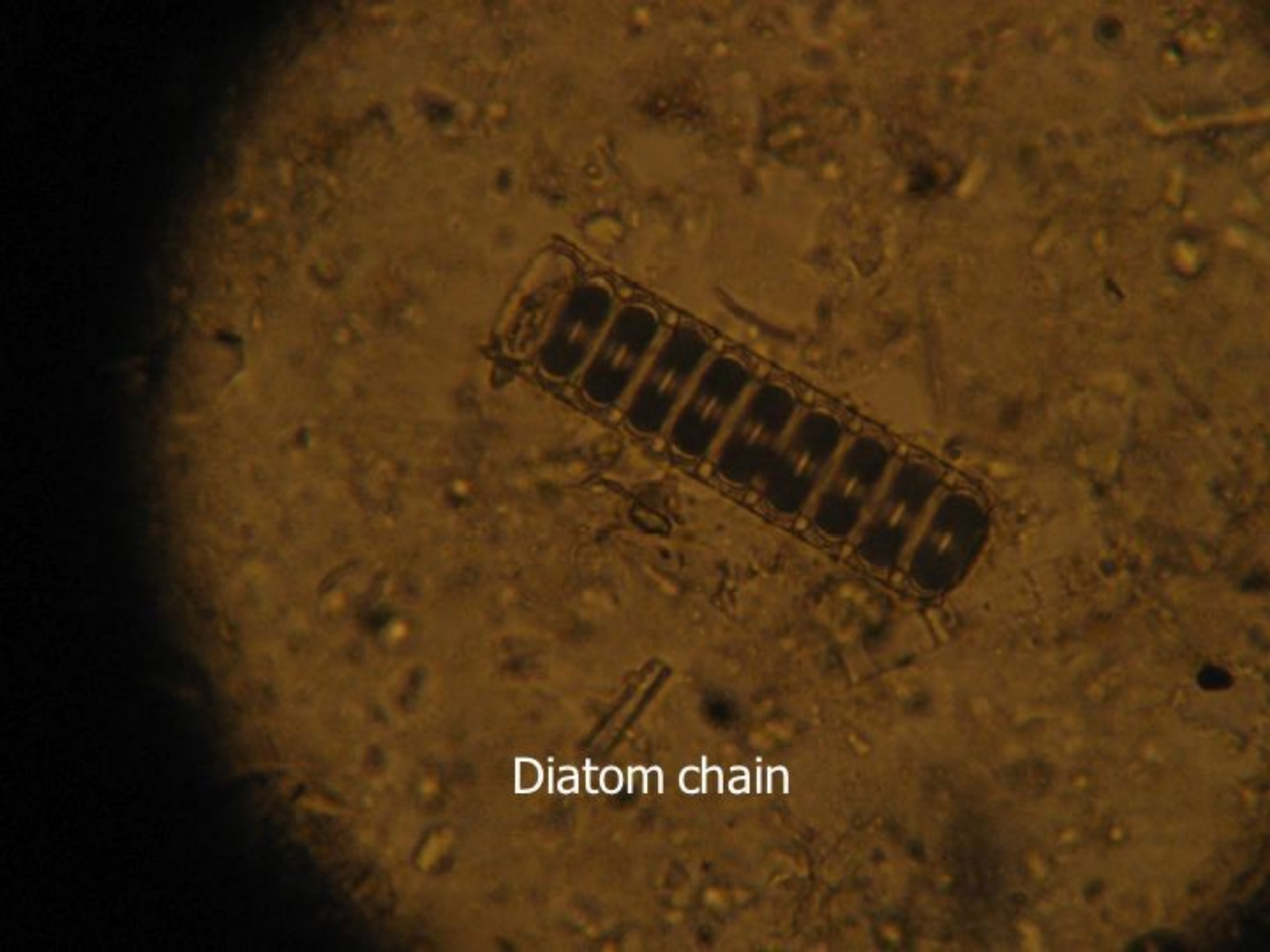
Some structures observed on the sediments were wood fragments, shell debris, volcanic ash grains, volcanic glass, microfossils.



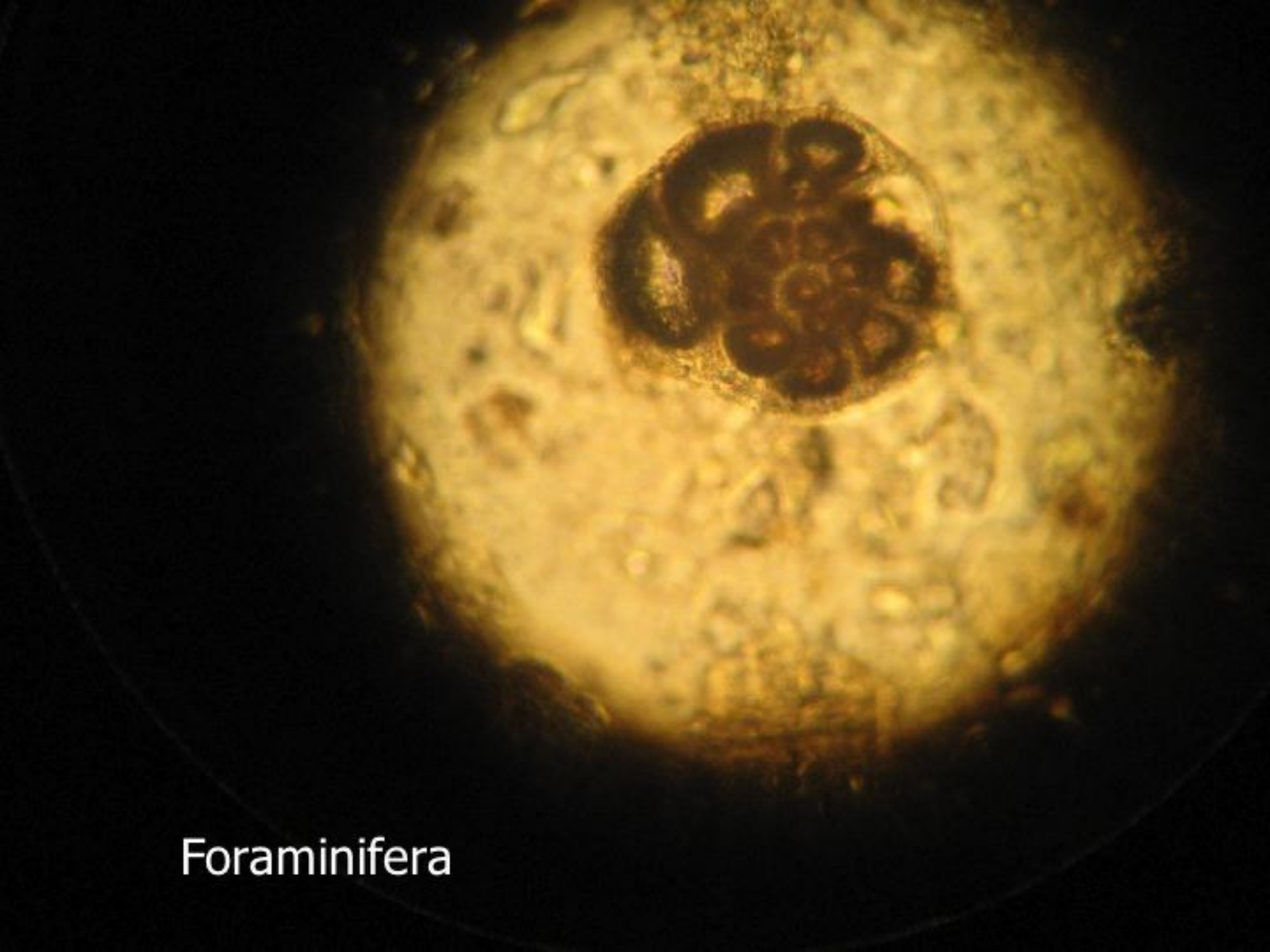
When possible, the visual inspection was supplemented by microscope examination of smear slides with shipboard microscopes, because the presence and relative abundances of different micro-organisms is an indicator of the climatic/environmental conditions at the site.



Diatom



Diatom chain



Foraminifera


Radiolaria


Silicoflagellate

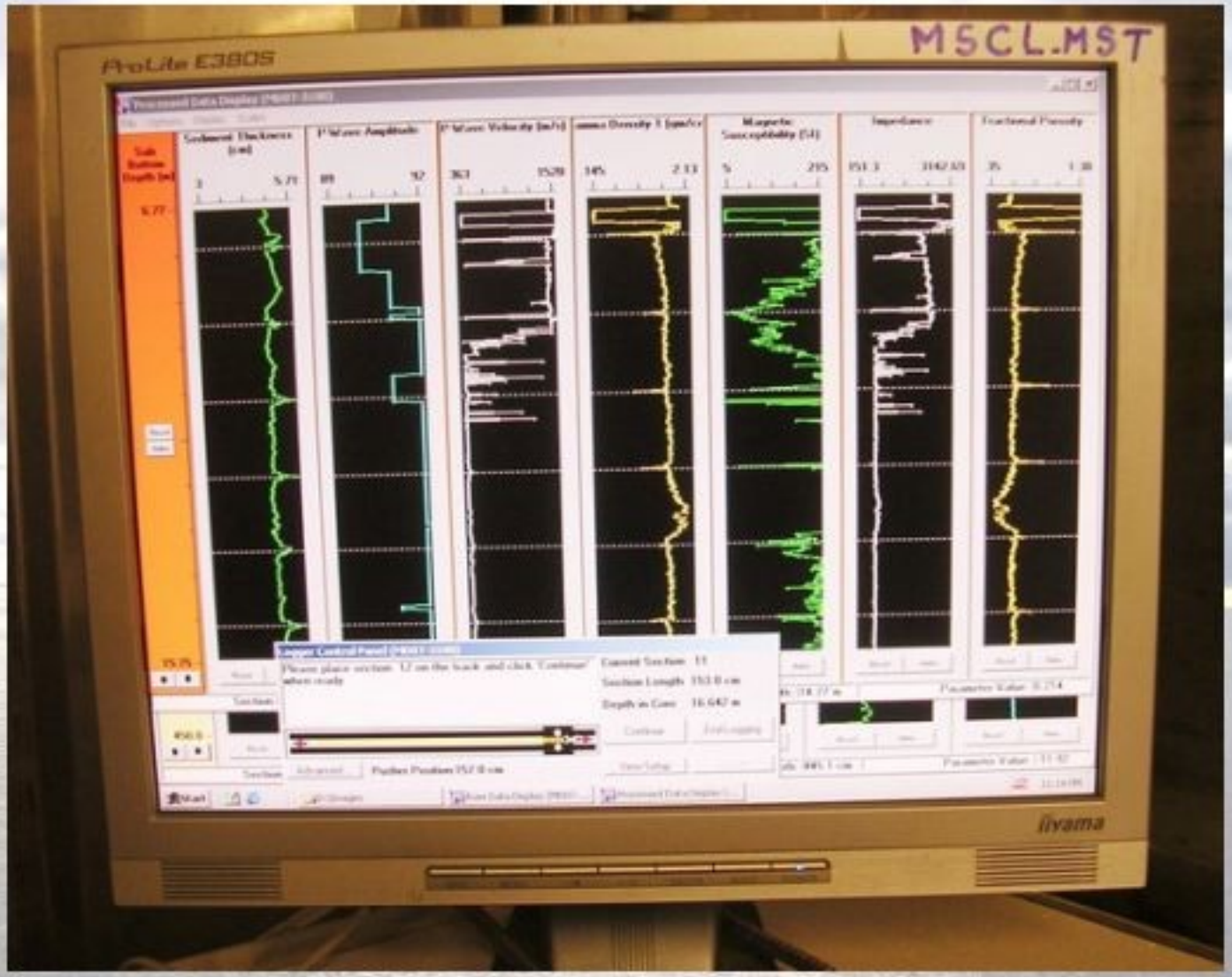
Preliminary observations/measurements on board:

- Core Description
- **Multi Sensor Track**
- Spectrophotometer

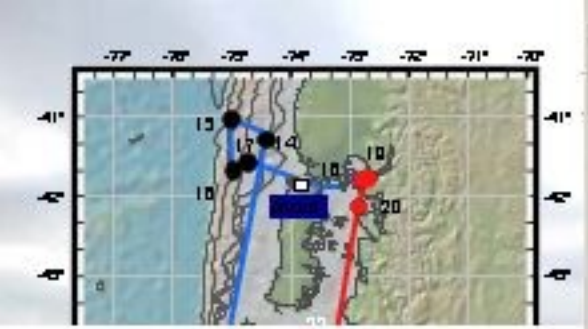
Multi-Sensor Track

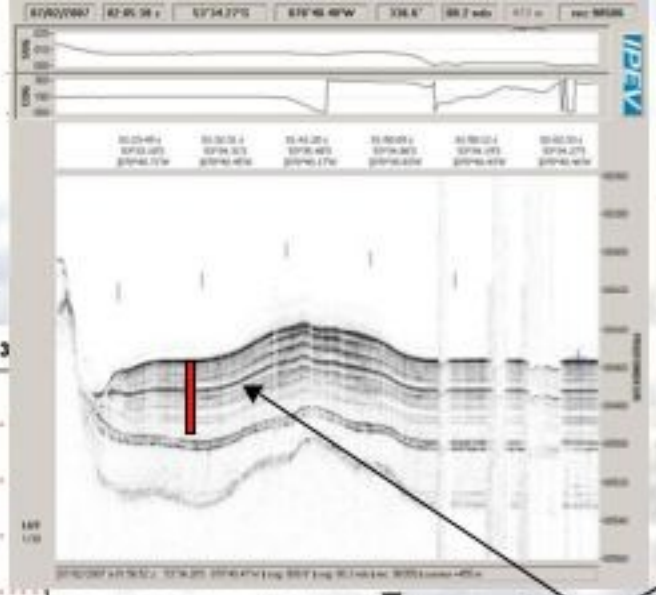
- Core diameter
- Temperature
- P-wave travel time (density)
- Gamma ray attenuation (porosity)
- Magnetic susceptibility

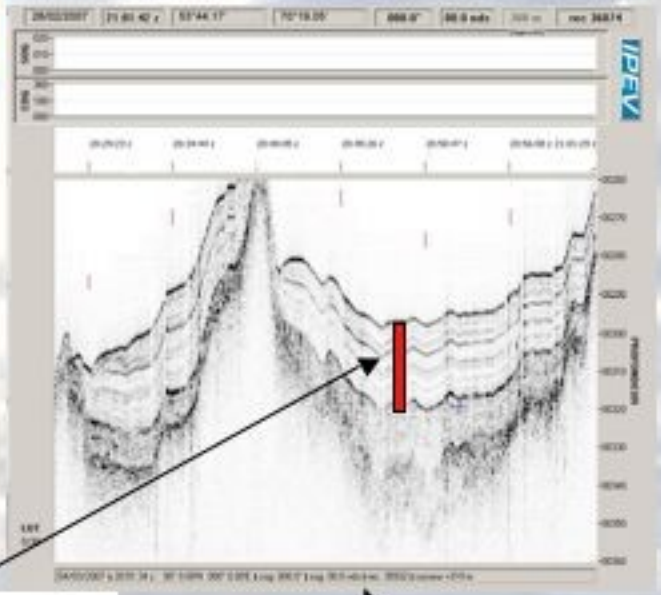

Multi sensor track

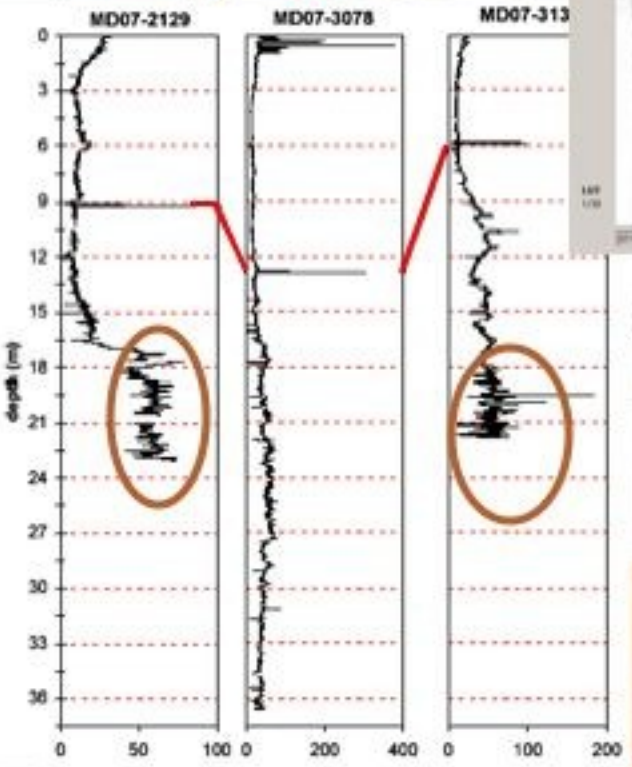


All these instruments have their associated software that records the data for future data analysis.

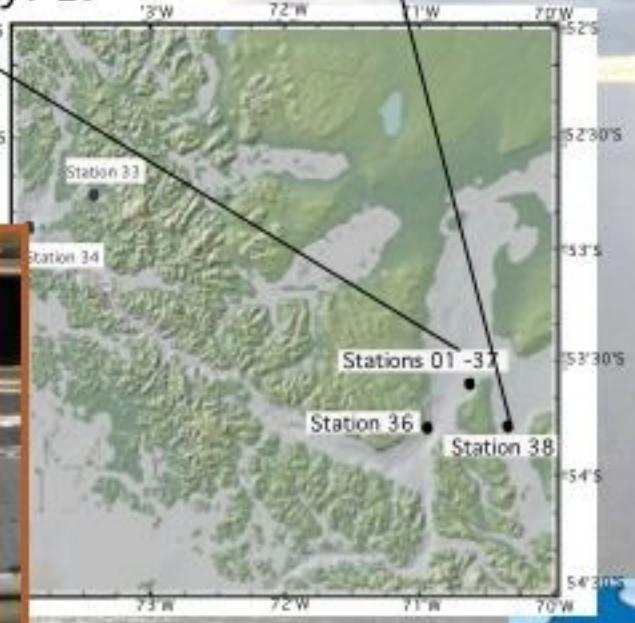








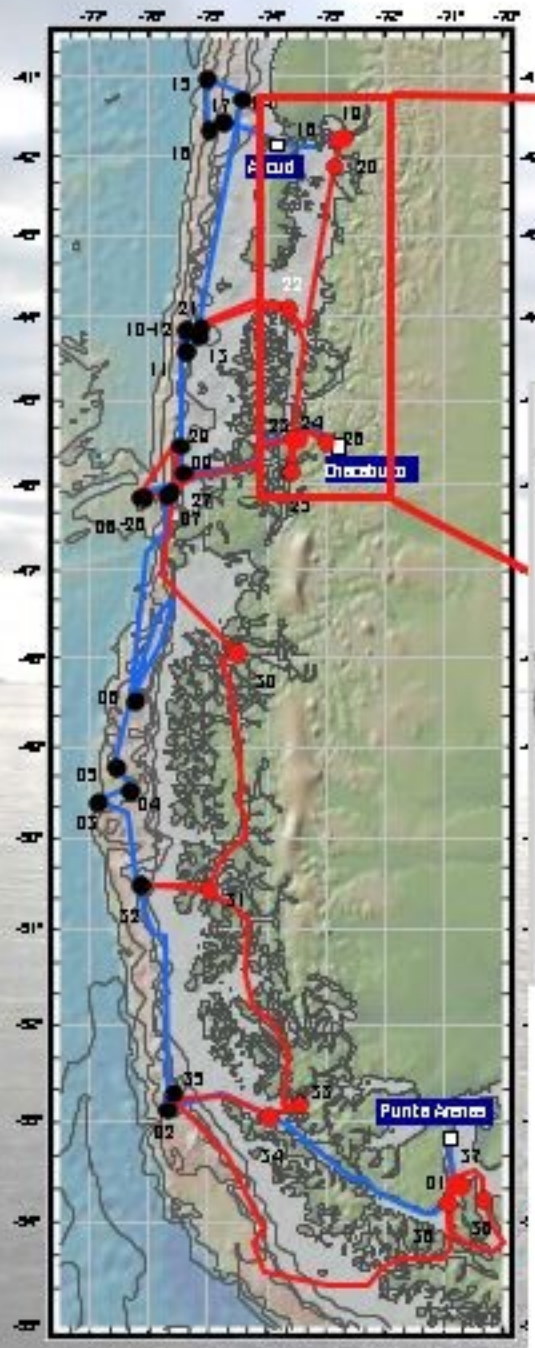
Mt. Burney eruption ~4.2 kyr BP

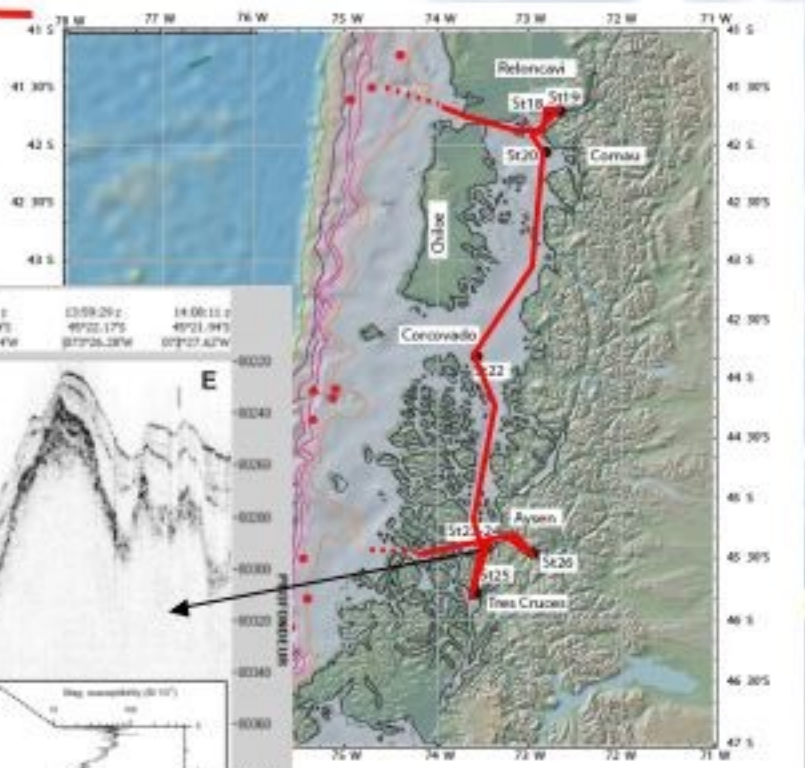


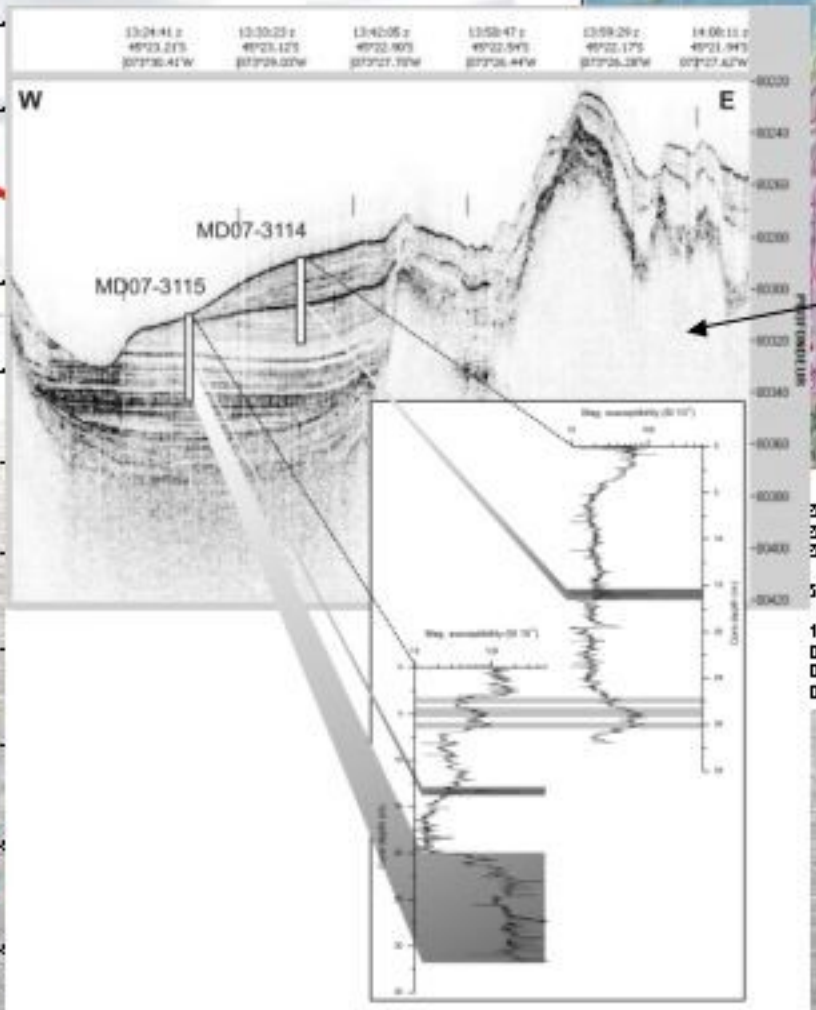
Magnetic susceptibility

Stations 01 and 37 (cores MD07-3078, MD07-3130G, MD07-3131G)
Station 36 (core MD07-3129)
Station 38 (core MD07-3132)

Northern Fjord Station







3102Cq; MD07-3103H; MD07-3104 3105Cq]
3106H; MD07-3107; MD07-3108Cq]
3109H; MD07-3110]

3112]

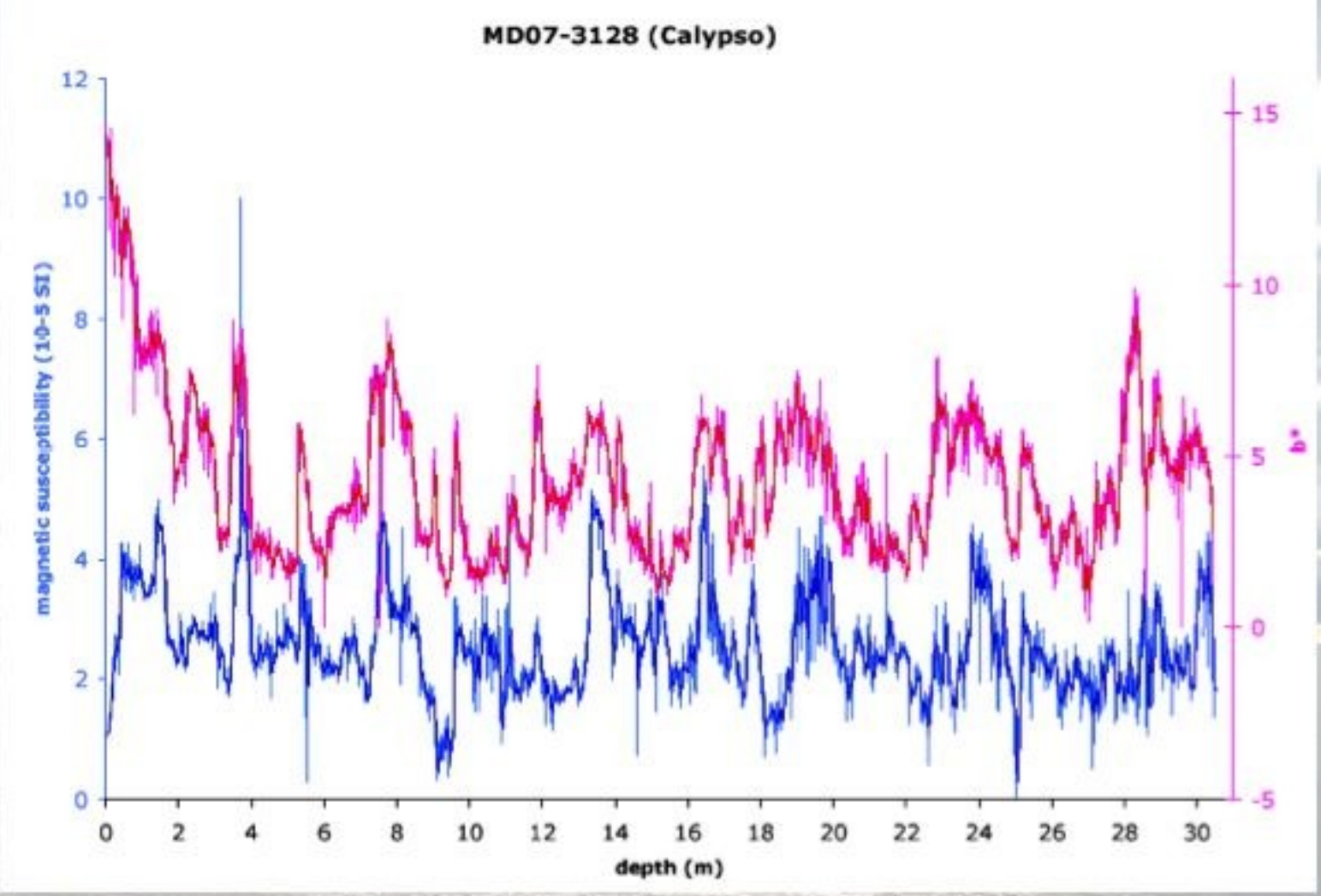
1007-3113H and MD07-3114]
007-3115]
007-3116H]
007-3117]

Preliminary observations/measurements on board:

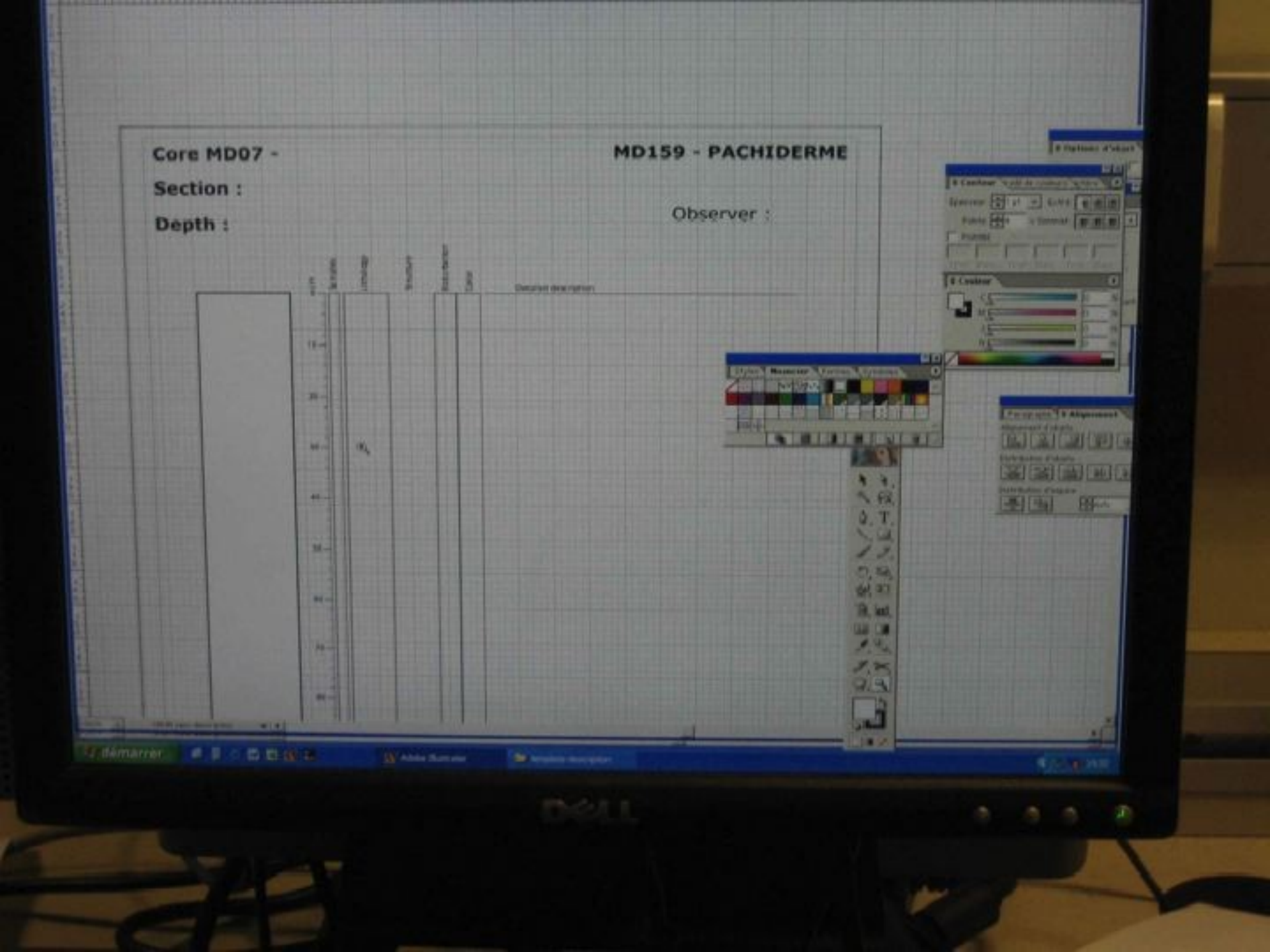
- Core Description
- MST
- **Spectrophotometer**

Color Reflectance Using a Spectrometer

Diffuse spectral reflectance on sediment surfaces provide a rapid, high resolution and non-invasive tool for estimating sediment compositions such as calcium carbonate, organic carbon, and opal concentrations, which are essential information for high resolution paleoceanographic research.



Comparison between the b parameter measured with the spectro-photometer and the magnetic susceptibility. It clearly appears that the two proxies have recorded the same fluctuations, linked to changes in the climatic/environmental conditions at this site (open ocean, our southernmost site)*


Core MD07 -
MD159 - PACHIDERME
Section :
Observer :
Depth :
démarrer

The Final Numbers

- **7695** = total number of kilometers traveled
- **34** = total number of Calypso cores
- **13** = total number of Casq cores
- **5** = total number of HAPS cores
- **848 m** = total number of meters of cores
- **46.3 m** = longest core
- **3266 m** = the deepest water for coring

Work is finished!

Everyone can go back to his favorite occupation…..

.....siesta-ing....

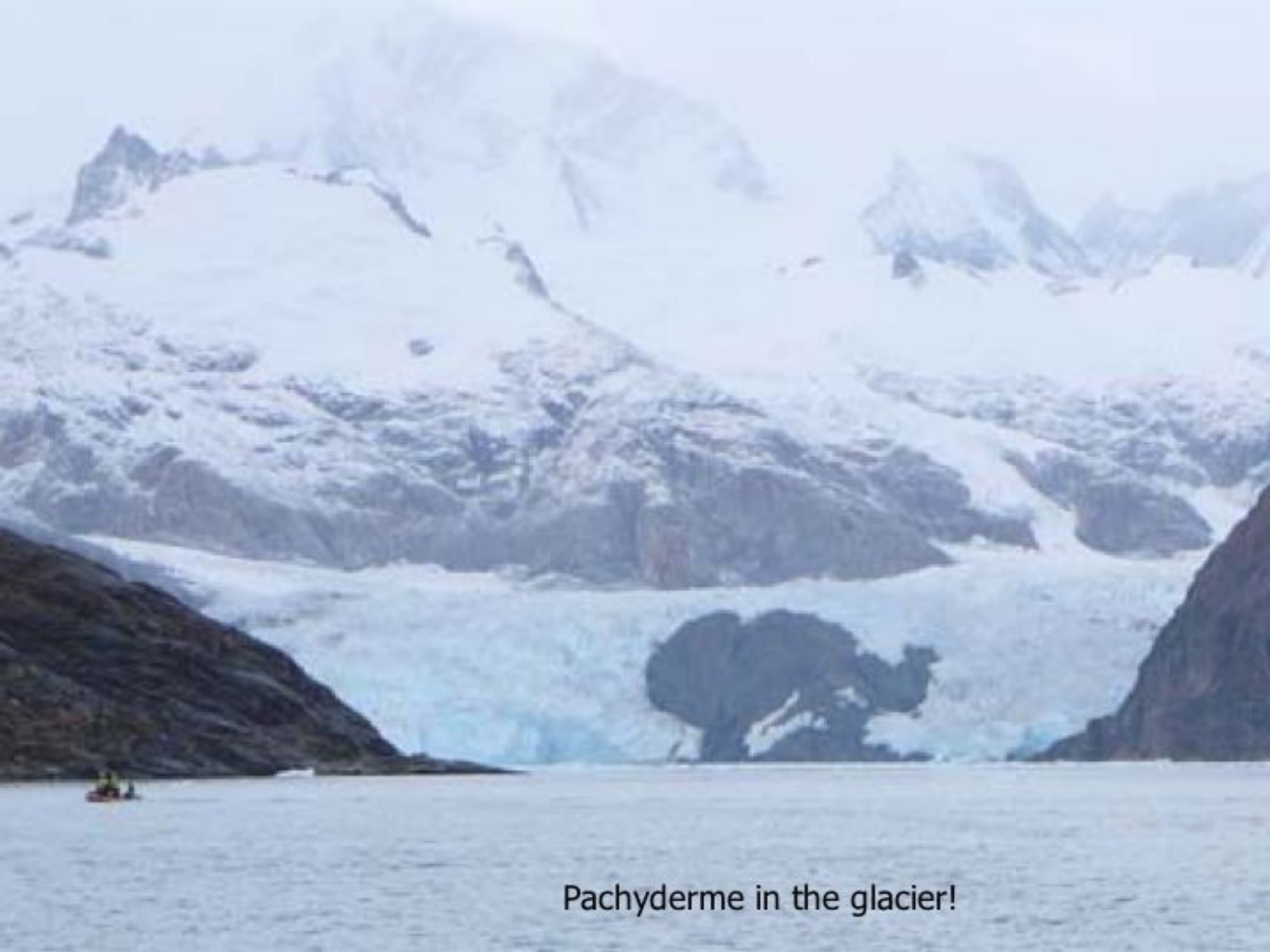
.....playing saxophone....

....bob sleighing...

....smiling.....

…sleeping
…at last!


Pelikans



Pachyderme in the glacier!


Celebration!


Punta Arenas
February 28, 2007

Back at Chatham HS

- Pre-trip activities related to climate change
- Website housed daily logs & pictures
- Students maintained journals including answers to “Questions of the Day”
- Each student sent a question to me and it was posted on a blog
- Post-trip presentation & activities related to using the data acquired while out at sea
- Visit & school presentation from Dr. Laj

The Cup Experiment

The Cup Experiment

Effective Teacher Professional Development

- Authentic (the teacher will know how to take it back to the classroom)
- Inquiry-based reflecting the nature of science for a particular discipline in science
- Reflective and sustained

Acknowledgements

We wish to express our deepest thanks to the French Polar Institute (Institut Paul-Emile Victor) for funding the teachers' program during PACHIDERME and supporting the 4 teachers on board the *Marion Dufresne*..

Photos by:

Aurélie Van Toer, Rolf Kilian, Marie-Hélène Castera, Patrice Bretel, Pierre Sangiardi, Pierre Gourdon, Vincent Jean-Baptiste, Catherine Kissel, Camille Wandres, Erika Gutierrez, Luis Pinto, Missy Holzer, Carlo Laj….

…all our apologies if we forgot someone!

This power-point presentation has been prepared by:

Margaret Ann (Missy) Holzer
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and

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CEA-CNRS-UVSQ
Gif-sur-Yvette, France


Thank you!

What we can learn from Oxygen Isotopes

- Joint Oceanographic Institute (JOI) Learning website
  - http://www.joiscience.org/learning

JOI Learning
Joint Oceanographic Institutions

Teaching for *Science* ◦ Learning for *Life*™ | www.joilearning.org

Secrets of the Sediments - Student Page

Using Marine Sediments to Study Global Climate Change

Before You Begin

1. Think about these questions and record your answers on your own paper or on the back of this page.

a. What is climate?

b. How would you describe the climate in your city, town or village?

c. Does climate have any direct effects on your life? Does climate change? Talk to your parents and grandparents about climate changes that they can recall.

2. Brainstorm and record some ideas for this essential question:

a. How can we study global climate changes?

Materials

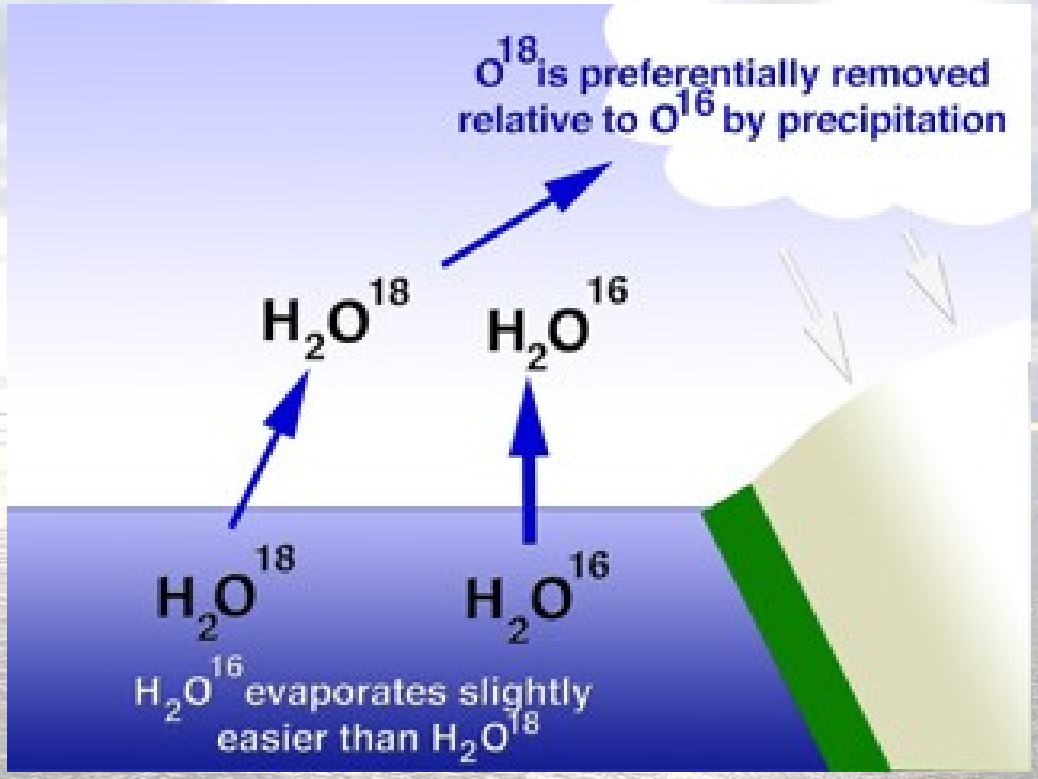
1. Graph paper
2. Rulers

Activities

1. Isotopes are atoms with the same number of protons, but different numbers of neutrons; the more neutrons, the heavier the isotope. Unstable isotopes, like uranium, decay over time and geologists can use them for age determination and dating. Stable isotopes do not decay and can therefore provide indirect records or proxies of past climate change. Oxygen occurs in three stable isotopes: oxygen-16 (^{16}O), oxygen-17 (^{17}O), and oxygen-18 (^{18}O). *Which isotope is heavier?*

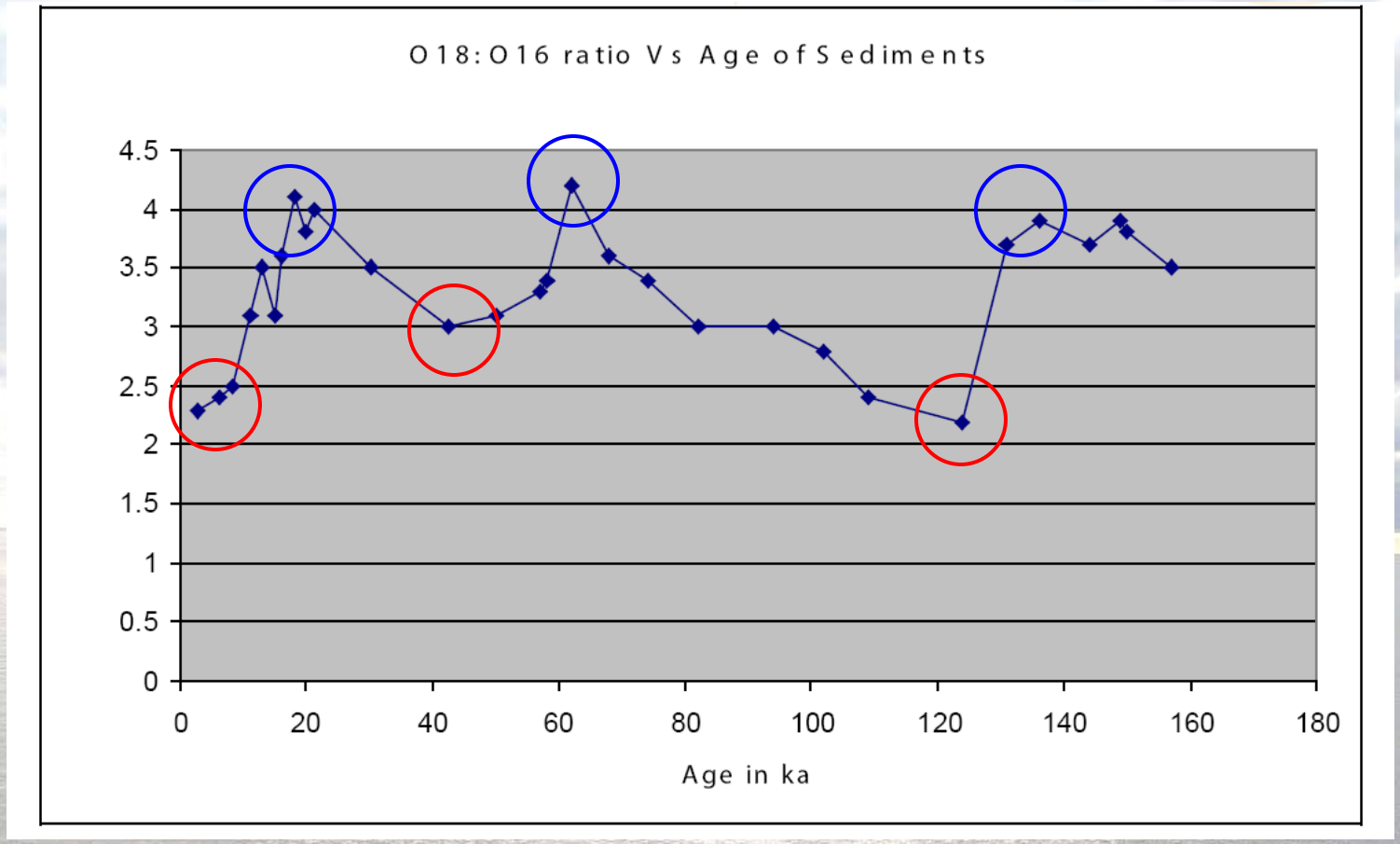
2. Water's chemical composition is H_2O. The oxygen in water is usually ^{16}O but sometimes ^{18}O, ^{17}O is very rare

Climate Temperature from Oxygen Isotopes



http://www.globalchange.umich.edu/globalchange1/current/lectures/kling/paleoclimate/index.html

Light oxygen in water (H2O16) evaporates more readily that water with heavy oxygen (H2O18). Hence oceans will be relatively rich in O-18 when glaciers grow and hold the precipitated O-16



High O-18:O-16 ratio = Glacial period with larger amounts of ice on land (O-16 is locked up in the ice)

The Cup Experiment…