U.S. Science Support Program – International Ocean Discovery Program Workshop
"Antarctica's Cenozoic Ice and Climate History:
New Science and New Challenges of Drilling in Antarctic Waters"

# A Short History of Past Antarctic Scientific Drilling


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ANDRILL SCIENCE MANAGEMENT OFFICE

Hot Water Drill Systems
Operations & Support:
Engineering Enabling
Science & Discovery

UNIVERSITY OF Nebraska Lincoln

# Scientific Drilling Programs

Scientists have been using drilling technology to investigate Earth history for over 50 years. In the oceans there have been four successive scientific drilling programs:

- Project Mohole (1958-1963)
- Deep Sea Drilling Project (1968-1983)
- Ocean Drilling Program (1985-2003)
- Integrated Ocean Drilling Program (2003-Present)

In Antarctica, there have also been multiple programs:

- Dry Valley Drilling Program (DVDP)
- McMurdo Sound Sediment and Tectonics Studies (MSSTS)
- Cenozoic Investigations in the western Ross Sea (CIROS)
- Cape Roberts Project (1997-1999)
- ANDRILL Program (2006-Present)

# Antarctic Shelf Scientific Drilling, Site Surveys and Modeling (1970-1990)

- **Geological sampling**
  - Drilling in Ross Sea - DSDP Leg 28
  - Drilling in the McMurdo Sound region
  - Sampling outcrops in the Transantarctic Mts and Prydz Bay
  - Drilling in Prydz Bay – ODP Leg 119
- **Seismic surveys**
  - Single channel seismic (SCS) surveys
  - Multi-channel seismic (MCS) surveys
- **Antarctic ice sheet models**

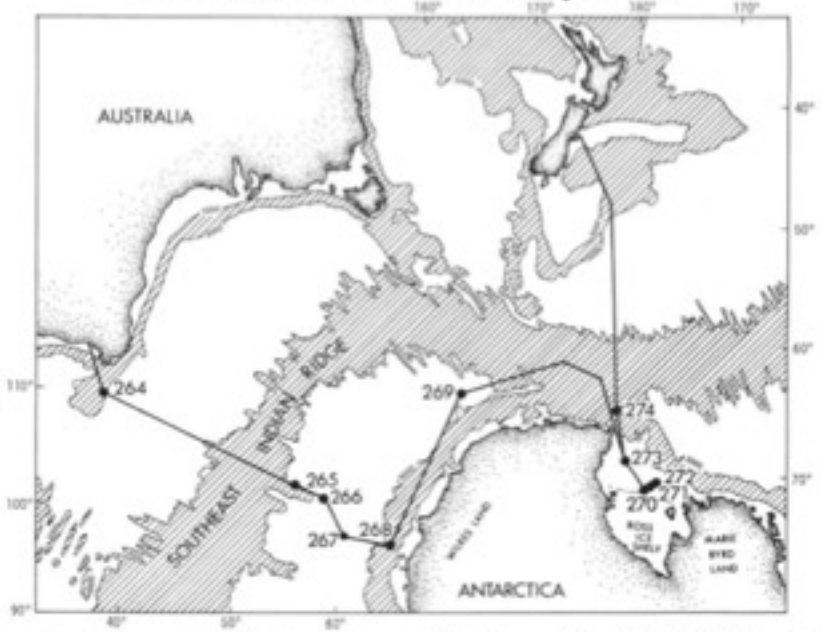
Modified slide from Peter Barrett, VUW

# DSDP Drilling Around Antarctica

**DSDP Leg 28** - **Ross Sea** — **Dec. 1972-Feb. 1973**

**DSDP Leg 35** - **Bellingshausen Basin** — **February-March 1974**

**DSDP Leg 28**
**December 1972 to February 1973**




**Dennis Hayes and Lawrence Frakes (Co-Chief Scientists)**
**Peter Barrett, Peter Webb**

http://www.deepseadrilling.org/28/volume/dsdp28_01.pdf
Total of 1404 m recovered from 16 holes at 11 site.

**DSDP Leg 35**
**February-March, 1974**

**Charles Hollister and Campbell Craddock (Co-Chiefs)**

http://www.deepseadrilling.org/35/volume/dsdp35_01.pdf
Total of 193 m recovered (37% of drilled sequence)

## Antarctic Legs (1972-1974)

# DSDP Drilling Around Antarctica

**DSDP Leg 29** - South Tasman Rise — February-March 1973

**DSDP Leg 36** - Falkland Plateau — March-April 1974

Peter Barker
Ian Dalziel
(Co-Chiefs)

David Elliot
Woody Wise

**DSDP Leg 36**
**April-May, 1974**

*Figure 1. Bathymetry of the southwestern Atlantic Ocean basin and location of Leg 36 sites.*

**DSDP Leg 29**
**March-April, 1973**

James Kennett and Robert Houtz (Co-Chief Scientists)

**Subantarctic Legs (1973-1974)**

# DSDP Leg 28 Coring Summary

TABLE 1
Leg 28 Coring Summary

| Hole | Dates (1972-1973) | Latitude | Longitude | Water Depth (m) | Penetration | No. of Cores | Cored (m) | Recovered (m) | Recovery (%) |
|---|---|---|---|---|---|---|---|---|---|
| 264 | 22-23 Dec. | 34°58.13'S | 112°02.68'E | 2873 | 215.5 | 15 | 142.5 | 65.2 | 46 |
| 264A | 23 Dec | 34°58.13'S | 112°02.68'E | 2873 | 158.5 | 4 | 38.0 | 33.2 | 87 |
| 265 | 30-31 Dec | 53°32.45'S | 109°56.74'E | 3582 | 462.0 | 18 | 169.0 | 108.0 | 64 |
| 266 | 2-4 Jan | 56°24.13'S | 110°06.70'E | 4173 | 384.0 | 24 | 219.5 | 145.2 | 66 |
| 267 | 6 Jan | 59°15.74'S | 104°29.30'E | 4564 | 219.5 | 7 | 58.0 | 25.9 | 45 |
| 267A | 7 Jan | 59°15.74'S | 104°29.30'E | 4564 | 70.5 | 3 | 28.5 | 11.6 | 41 |
| 267B | 7-8 Jan | 59°14.55'S | 104°29.94'E | 4539 | 323.0 | 10 | 95.0 | 53.5 | 56 |
| 268 | 10-12 Jan | 63°56.99'S | 105°09.34'E | 3544 | 474.5 | 20 | 189.5 | 65.6 | 35 |
| 269 | 18 Jan | 61°40.57'S | 140°04.21'E | 4285 | 397.5 | 11 | 103.0 | 38.8 | 38 |
| 269A | 19-21 Jan | 61°40.57'S | 140°04.21'E | 4285 | 958.0 | 13 | 123.5 | 55.4 | 45 |
| 270 | 30 Jan–2 Feb | 77°26.48'S | 178°30.19'W | 634 | 422.5 | 49 | 422.5 | 263.7 | 62 |
| 271 | 3-5 Feb | 76°43.27'S | 175°02.86'W | 554 | 265.0 | 24 | 233.0 | 15.3 | 7 |
| 272 | 6-8 Feb | 77°07.62'S | 176°45.61'W | 629 | 443.0 | 48 | 439.0 | 162.0 | 37 |
| 273 | 10 Feb | 74°32.29'S | 174°37.57'E | 495 | 76.0 | 9 | 76.0 | 27.9 | 37 |
| 273A | 11-13 Feb | 74°32.29'S | 174°37.57'E | 495 | 346.5 | 29 | 256.5 | 55.5 | 22 |
| 274 | 16-19 Feb | 68°59.81'S | 173°25.64'E | 3326 | 421.0 | 45 | 421.0 | 279.1 | 66 |
| Total | | | | | | 321 | 3013.5 | 1404.9 | 47 |

Extensive glaciation began on the Antarctic continent at least by the early Miocene (20-25 m.y. ago), much earlier than previously assumed.

# Antarctic Stratigraphic Drilling (1970-2000)

**DRY VALLEYS DRILLING PROJECT**, 1970'S (DVDP – 15 HOLES)
FIRST OFFSHORE HOLE – DVDP-15, 52% CORE RECOVERY TO 65 mbsf

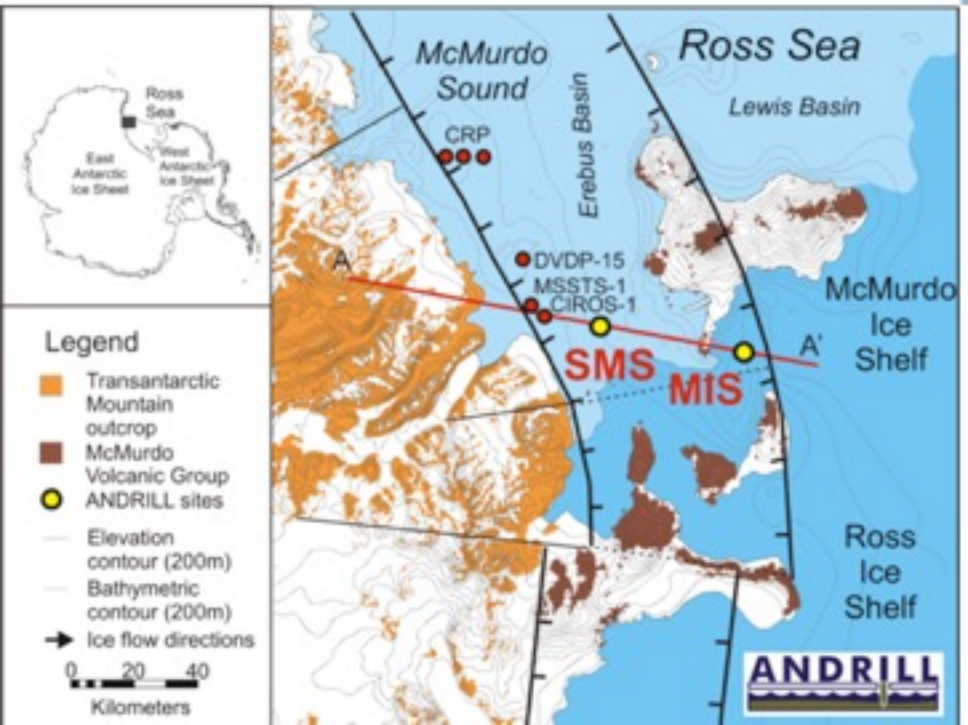
**MSSTS-1** (NEW HARBOR), 1979, 56% CORE RECOVERY TO 227 mbsf

**EASTERN TAYLOR VALLEY PROJECT**, 1980'S (ETV – 13 HOLES)

**CIROS-2** (NEW HARBOR), 1984 – 67% CORE RECOVERY TO 168 mbsf
**CIROS-1** (NEW HARBOR), 1986 – 98% CORE RECOVERY TO 702 mbsf

**CAPE ROBERTS PROJECT**, 1997-1999 – CONTINUOUS STRATIGRAPHIC TRANSECT TO BASEMENT, AGGREGATE 1500 m SECTION, >95% RECOVERY

- CRP-1
- CRP-2/2A
- CRP-3



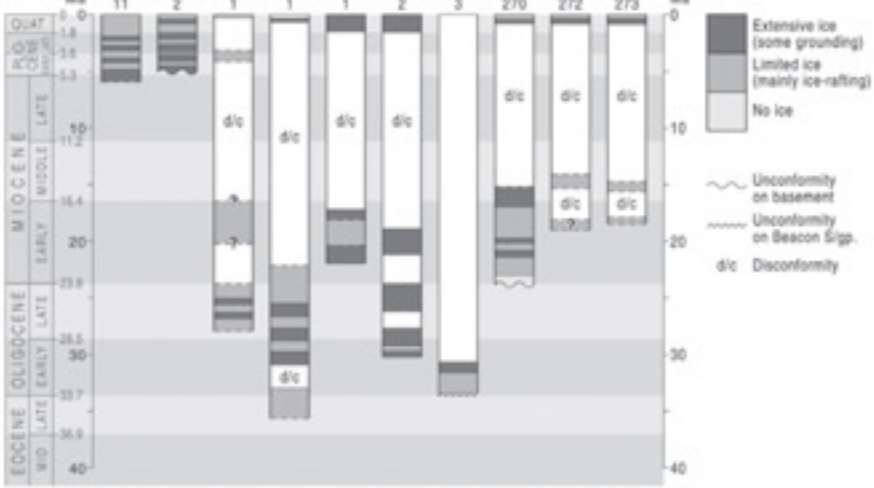




*Fig. 4.6-3: Summary of core-data, plotted against time, for drillsites in the western Ross Sea, illustrating relative extent of ice and disconformities.*

Image courtesy of Alex Pyne, ANDRILL Oxford Workshop

# ODP/IODP Drilling Around Antarctica

**ODP Leg 113** - Weddell Sea and E. Antarctic Peninsula
(12/25/86 – 3/11/87): Valparaiso, Chile to East Cove, Falkland Islands
Jim Kennett, Peter Barker / Suzanne O'Connell, Xenia Golovchenko

**ODP Leg 119** - Prydz Bay I and Kerguelen Plateau
(12/14/87 – 2/21/88): Port Louis, Mauritius to Freemantle, Australia
Roland Schlich, Sherwood Wise / Amanda Palmer, Beth Pratson

10 Years

**ODP Leg 178** - Western Antarctic Peninsula
(2/5/98 – 4/9/98): Punta Arenas, Chile to Cape Town, South Africa
Peter Barker, Angelo Camerlenghi / Gary Acton, Trevor Williams

**ODP Leg 188** - Prydz Bay II
(1/10/00 – 3/11/00): Freemantle, Aust. to Hobart, Tasmania, Australia
Alan Cooper, Phil O'Brien / Carl Richter, Trevor Williams

10 Years

**IODP Exp. 318** - Wilkes Land
(1/3/10 – 3/8/10): Wellington, NZ to Hobart, Tasmania, Australia
Carlota Escutia Dotti, Henk Brinkhuis / Adam Klaus, Trevor Williams

# JOIDES Science Advisory System
# 1984-1997

**Thematic and Regional Panels and committees that existed during the ODP early years**:

ODP Council (ODPC): 1983-2003
**Executive Committee (EXCOM)**: 1983-2003 [DSDP: 1972-1983]
**Planning Committee (PCOM)**: 1984-1997 [DSDP: 1979-1983]

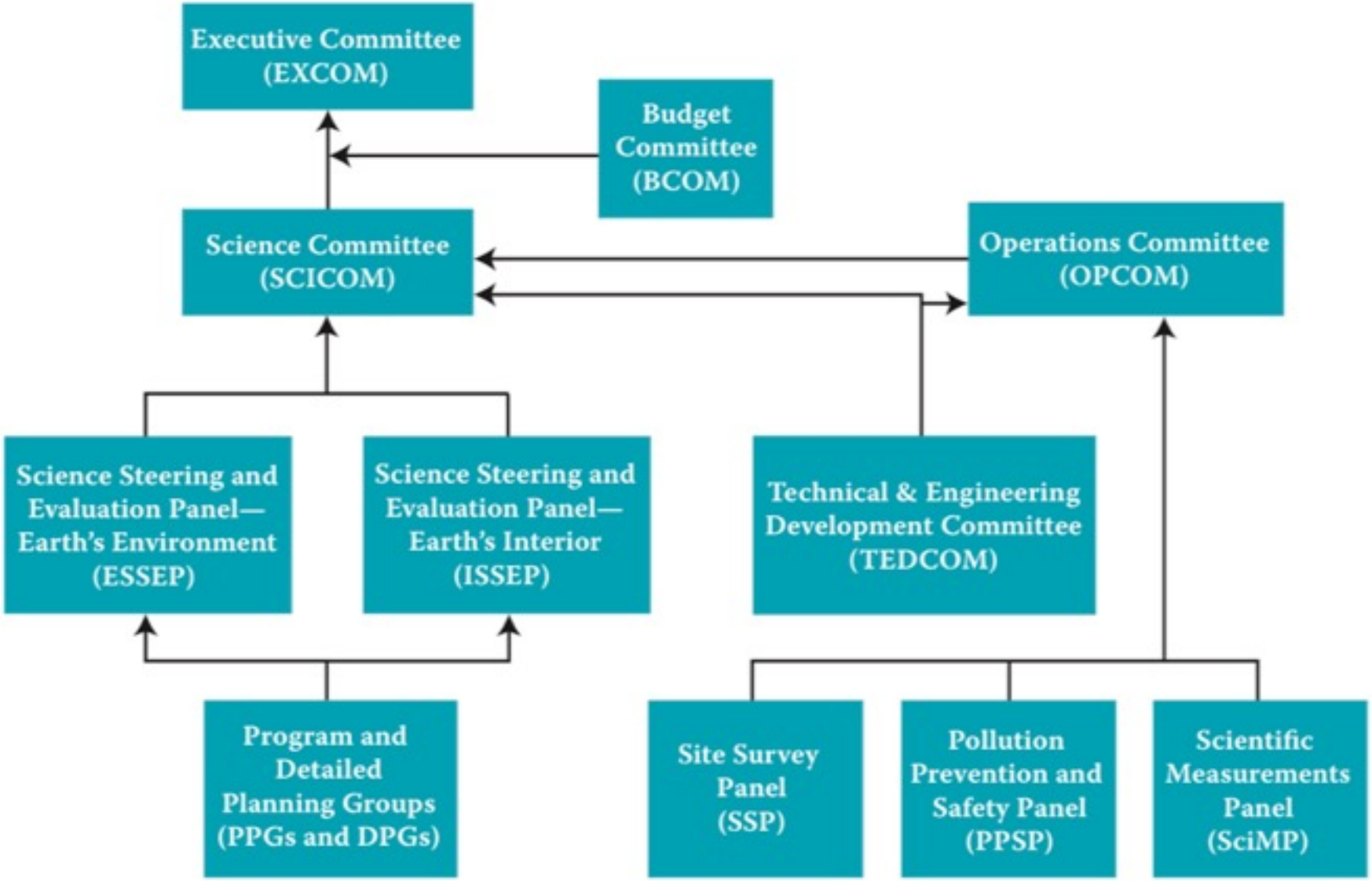
**Lithospheric Panel (LITHP)**: 1984-1996
**Ocean History Panel (OHP)**: 1984-1996
**Sedimentary and Geochemical Processes Panel (SGPP)**: 1980-1995
**Tectonics Panel (TECP)**: 1984-1996

Atlantic Regional Panel (ARP): 1984-1987
Central and Eastern Pacific Panel (CEPAC):
Indian Ocean Panel (IOP): 1984-1987
Sediments and Ocean History Panel (SOHP): 1984-1988
**Southern Ocean Panel (SOP)**: 1984-1988
Western Pacific Panel (WPAC): 1984-1988

Downhole Measurements Panel (DMP): 1984-1996
Information Handling Panel (IHP): 1985-1996
Technical and Engineering Development Panel (TEDCOM): 1985-2002
Shipboard Measurements Panel (SMP): 1989-1996

http://www.odplegacy.org/program_admin/sas.html

## JOIDES Science Advisory Structure
(as of 2003)




ODP Final Technical Report, 2007

# SCAR – Antarctic Offshore Stratigraphy (ANTOSTRAT)

In 1986, the science community established the **Scientific Committee on Antarctic Research (SCAR) Group of Specialists on Cenozoic Paleoenvironments in Southern High Latitudes** to study and assess geologic sample and core data as well as geophysical remote sensing data to better comprehend Antarctica's geologic history and its impact on global sea level and climate change.

Recognizing that Antarctica is 98% ice covered, the **Antarctic Offshore Stratigraphy project (ANTOSTRAT)** was established in 1989 under the aegis of the Group of Specialists to focus geoscience investigations on Antarctica's offshore regions.

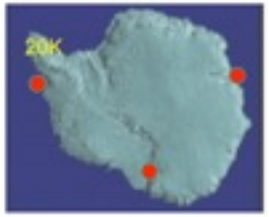
The stated objective of **ANTOSTRAT** was to bring together all research groups responsible for collecting offshore geological and geophysical data, to collaborate in field and laboratory studies directed toward understanding Cenozoic paleoenvironments, to plan future offshore geologic studies, and to promote scientific deep drilling.

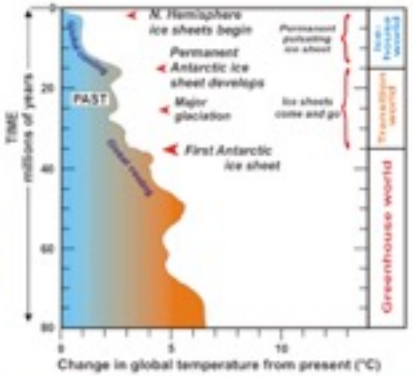
In April 1991, ANTOSTRAT convened a special workshop in Oslo, Norway, to develop and agree to a system by which the highly valued multi-channel seismic (MCS) data would be made openly accessible. In October 1991, the **SCAR Antarctic Seismic Data Library System for Cooperative Research (SDLS)** was adopted as part of the Antarctic Treaty System.

The ANTOSTRAT program officially came to an end in July 2002.

## Scientific Committee on Antarctic Research (SCAR)

## ANTOSTRAT (1990-2002) RESULTS




From Crowley & Kim, GRL,1995

Formed to take advantage of extensive seismic database (SCAR-SDSL) from the Antarctic shelf and slope regions.

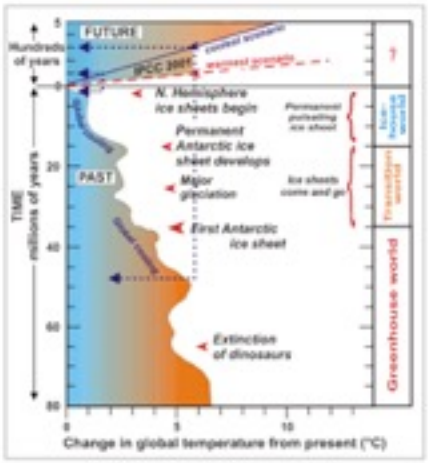
- Documented geometry of shelf basins, slope fans and rise drifts for drilling targets
- Cored Neogene record of WAIS from drifts on rise (Leg 178)
- Cored Quaternary fan and Neogene rise drift off Prydz Bay(Leg 188)
- Cored Oligocene-early Miocene shelf basin showing Milankovitch cyclicity and cooling climate (Cape Roberts Project)

**ANTOSTRAT also recognized the value of linking data and modeling**

Modified slide from Peter Barrett, VUW

## ACE (2002-2010)

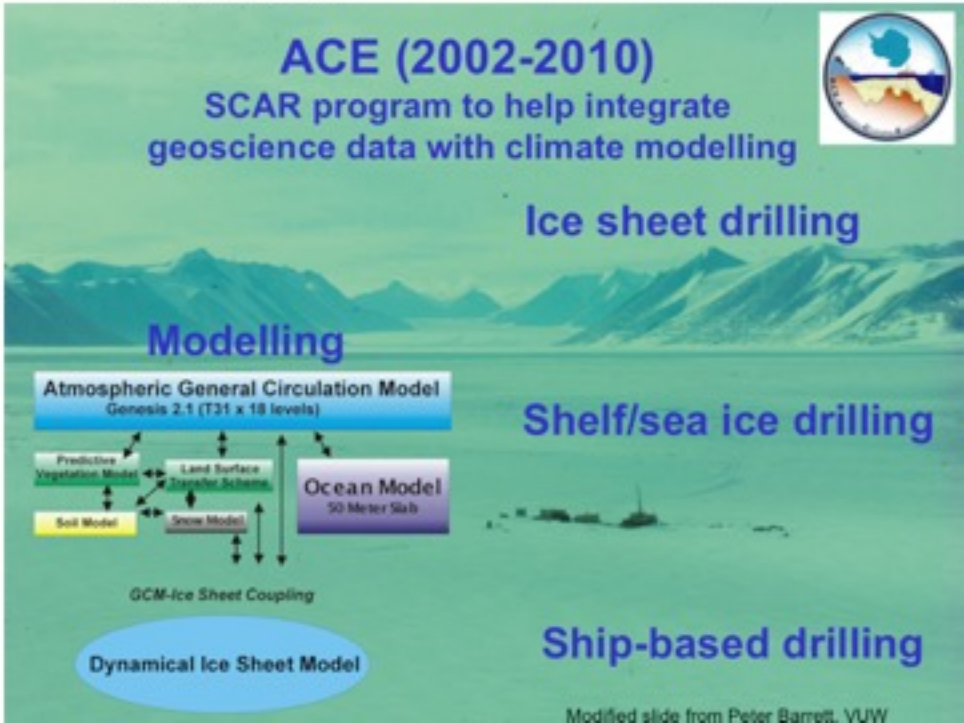
### SCAR program to help integrate geoscience data with climate modelling




From Crowley & Kim, GRL,1995

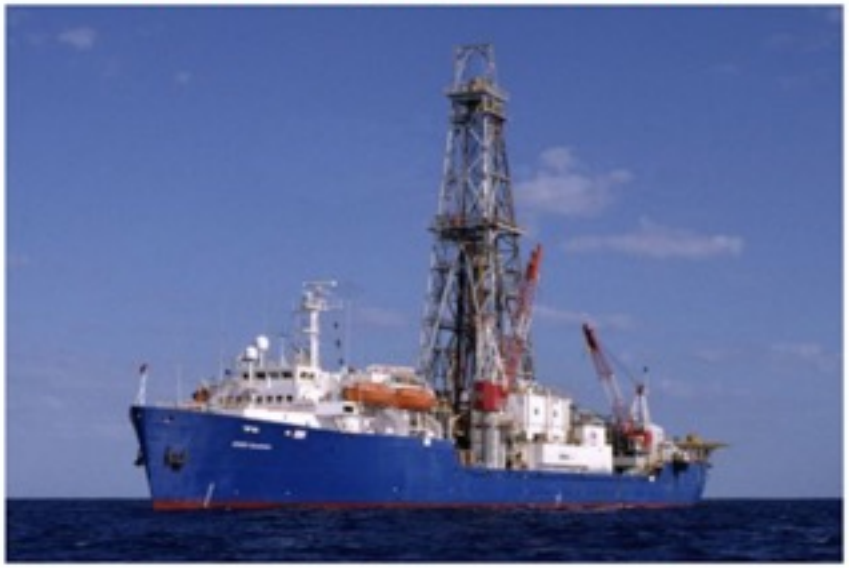
- More continuous records from key climate transitions and warm periods (to be extended by modeling)
- Higher resolution coupled climate-ice-ocean models for ice-sheet/ice shelf behavior on both continental and local scale (to be constrained by geoscience data)

Modified slide from Peter Barrett, VUW




Modified slide from Peter Barrett, VUW

## D/V JOIDES Resolution
## Ocean Drilling Program (1985-2003)



## ODP Drilling Around Antarctica

**ODP Leg 113** - Weddell Sea and eastern Antarctic Penninsula
**ODP Leg 114** - Subantarctic South Atlantic I

**ODP Leg 119** - Prydz Bay I and Kerguelen Plateau
**ODP Leg 120** - Central Kerguelen Plateau

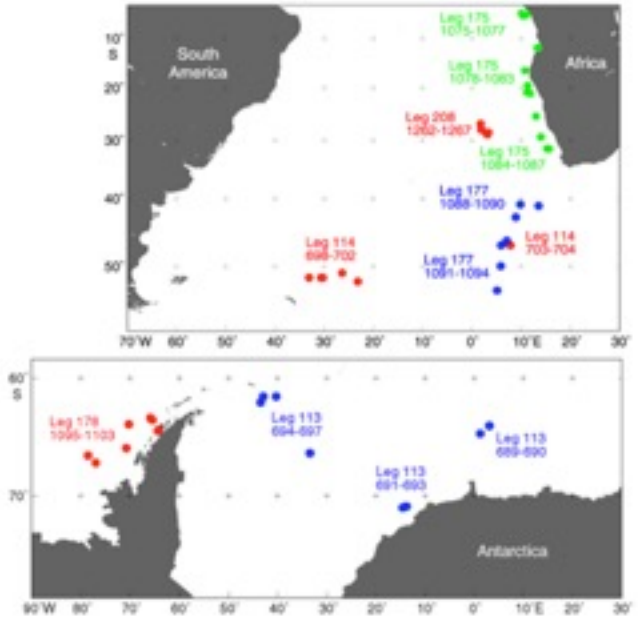
**ODP Leg 177** - Subantarctic South Atlantic II
**ODP Leg 178** - Western Antarctic Penninsula

**ODP Leg 181** - SW Pacific Gateway
**ODP Leg 183** - Kerguelen Plateau - LIP

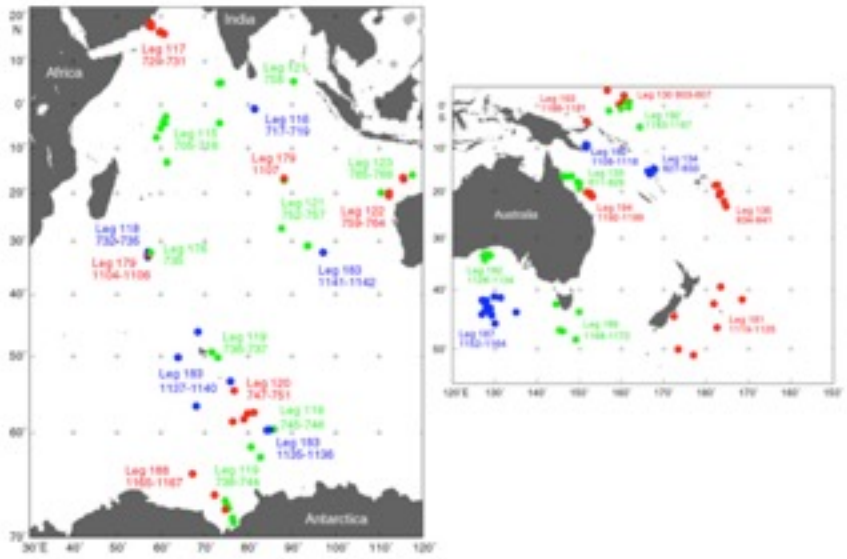
**ODP Leg 188** - Prydz Bay II
**ODP Leg 189** - Tasman Gateway

**Red = Subantarctic**
**Blue = Antarctic**

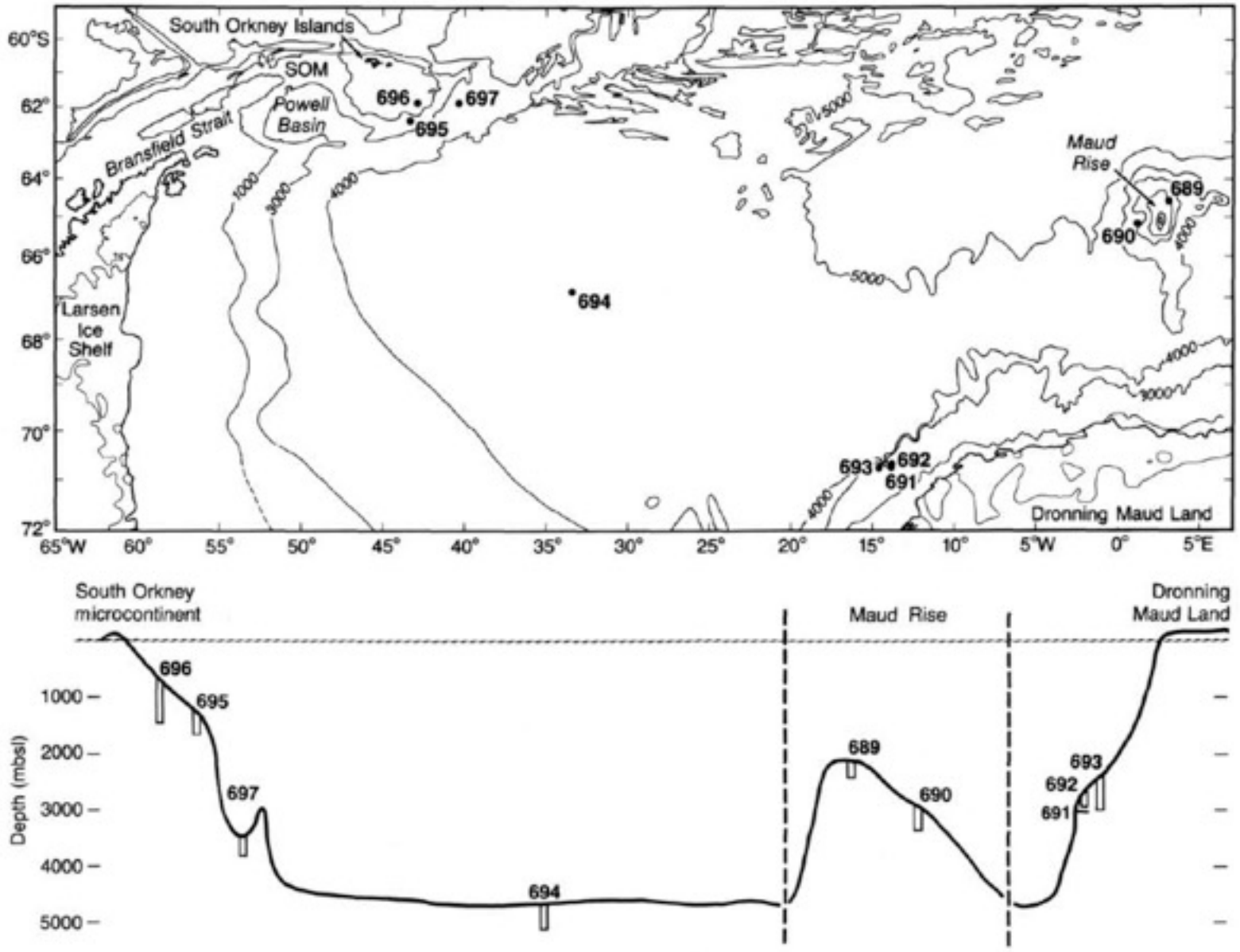
### Site Locations for ODP Legs 113-114 and Legs 177-178



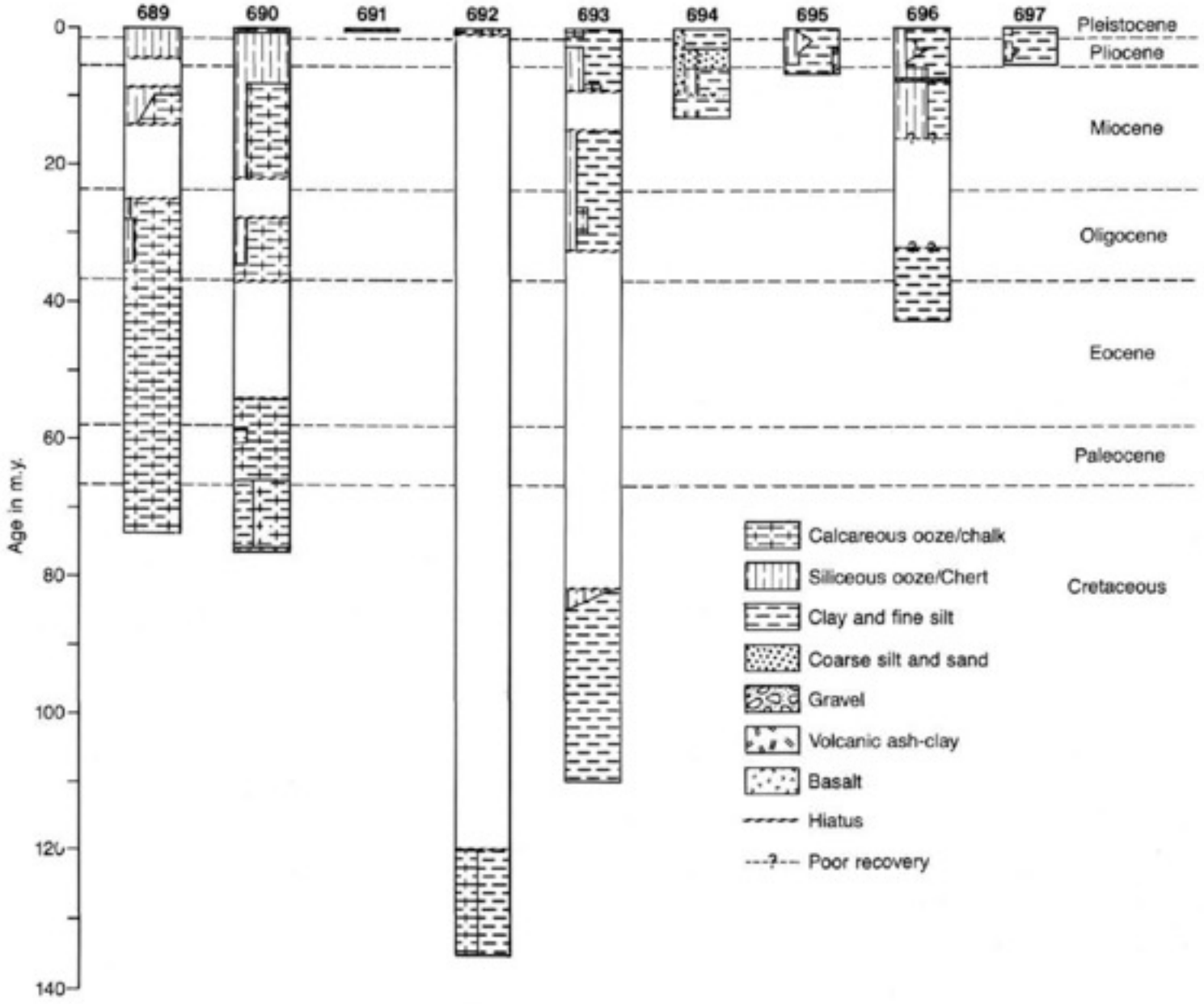

### Site Locations for ODP Legs 119-120, 183 and 187-188



# ODP Leg 113 – Weddell Sea Sites



# ODP Leg 113 – Weddell Sea Sites

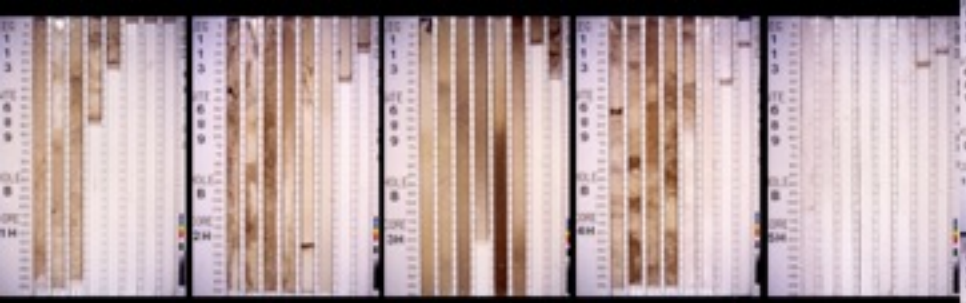


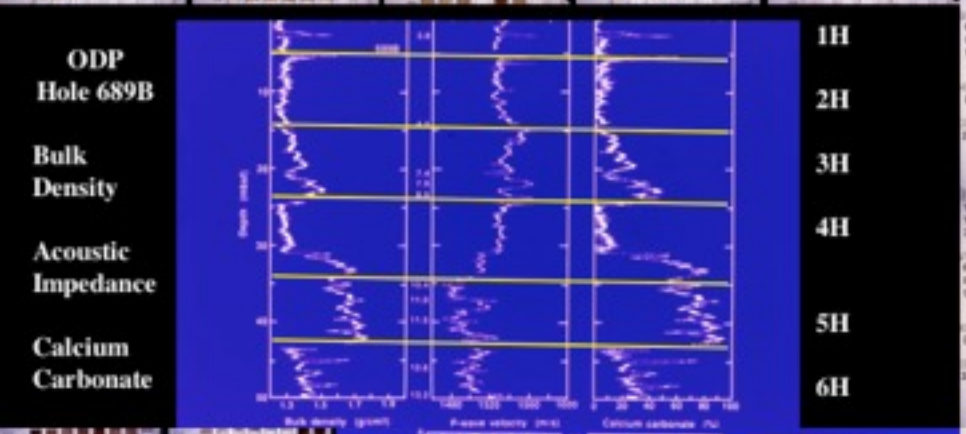
# ODP Leg 113 – Weddell Sea Sites

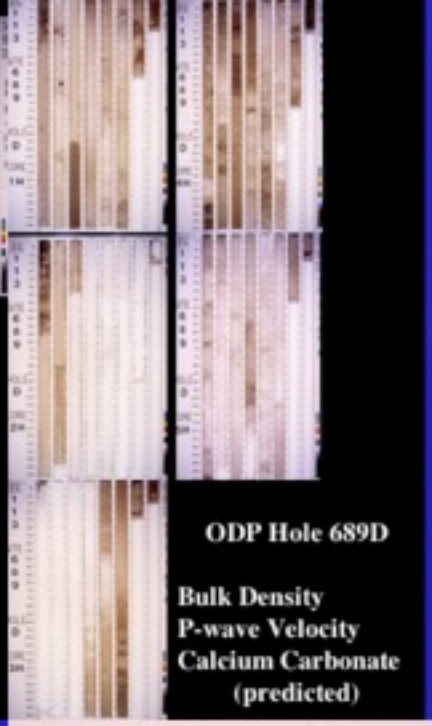
**Table 1. Leg 113 site location and coring summary.**

| Hole | Date (1987) | Latitude | Longitude | Water depth (m) | Penetration (m) | No. of cores | Cored (m) | Recovered (m) | Recovery (%) |
|---|---|---|---|---|---|---|---|---|---|
| 689A | Jan. 15–16 | 64°31.01′S | 3°06.00′E | 2080 | 11.8 | 1 | 9.5 | 9.4 | 98.4 |
| 689B | 16–18 | 64°31.01′S | 3°06.00′E | 2080 | 297.3 | 33 | 297.3 | 229.4 | 77.2 |
| 689C | 18 | 64°31.01′S | 3°06.03′E | 2080 | 27.6 | 3 | 27.6 | 20.5 | 74.4 |
| 689D | 18–19 | 64°31.01′S | 3°06.03′E | 2080 | 133.8 | 12 | 115.7 | 116.0 | 100.0 |
| 690A | 19–20 | 65°09.63′S | 1°12.30′E | 2914 | 9.9 | 1 | 7.7 | 9.9 | 128.0 |
| 690B | 20–21 | 65°09.63′S | 1°12.30′E | 2914 | 213.4 | 25 | 213.4 | 214.6 | 100.5 |
| 690C | 21–23 | 65°09.62′S | 1°12.29′E | 2914 | 321.2 | 24 | 200.6 | 185.6 | 88.3 |
| 691A | 25–26 | 70°44.54′S | 13°48.66′W | 3035 | 0.1 | 1 | 0.1 | 0.1 | 100.0 |
| 691B | 26 | 70°44.64′S | 13°48.56′W | 3038 | 1.7 | 1 | 0 | 0 | 0 |
| 691C | 26 | 70°44.58′S | 13°48.68′W | 3025 | 12.7 | 1 | 0 | 0 | 0 |
| 692A | 26 | 70°43.45′S | 13°49.21′W | 2880 | 6.7 | 1 | 6.7 | 0.7 | 10.0 |
| 692B | 26–30 | 70°43.43′S | 13°49.20′W | 2875 | 97.9 | 13 | 97.9 | 29.3 | 30.0 |
| 693A | Jan. 30–Feb. 5 | 70°49.89′S | 14°34.41′W | 2359 | 483.9 | 51 | 483.9 | 213.5 | 44.1 |
| 693B | Feb. 5–6 | 70°49.89′S | 14°34.46′W | 2359 | 403.1 | 19 | 167.4 | 92.2 | 55.1 |
| 694A | 9–10 | 66°50.83′S | 33°26.79′W | 4653 | 9.8 | 1 | 9.8 | 9.8 | 100.0 |
| 694B | 10–14 | 66°50.84′S | 33°26.83′W | 4653 | 179.2 | 24 | 179.2 | 67.1 | 37.4 |
| 694C | 14–18 | 66°50.82′S | 33°26.76′W | 4653 | 391.3 | 23 | 212.1 | 71.7 | 33.8 |
| 695A | 20–23 | 62°23.48′S | 43°27.10′W | 1305 | 345.1 | 42 | 341.1 | 254.4 | 73.7 |
| 696A | 23–24 | 61°50.95′S | 42°55.98′W | 650 | 103.0 | 12 | 106.0 | 58.3 | 55.0 |
| 696B | Feb. 24–Mar. 2 | 61°50.96′S | 42°56.00′W | 650 | 645.6 | 62 | 569.0 | 156.7 | 27.5 |
| 697A | Mar. 3–4 | 61°48.63′S | 40°17.27′W | 3481 | 20.9 | 3 | 28.1 | 26.6 | 94.7 |
| 697B | 4–7 | 61°48.63′S | 40°17.75′W | 3483 | 322.9 | 32 | 304.9 | 188.3 | 61.7 |

[a] Depth = bottom felt (m, drill pipe from the dual elevator stool)—11.1 m.

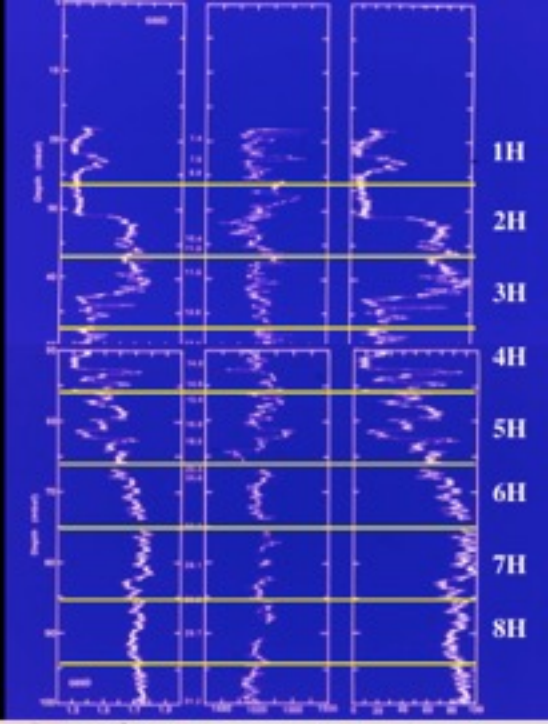


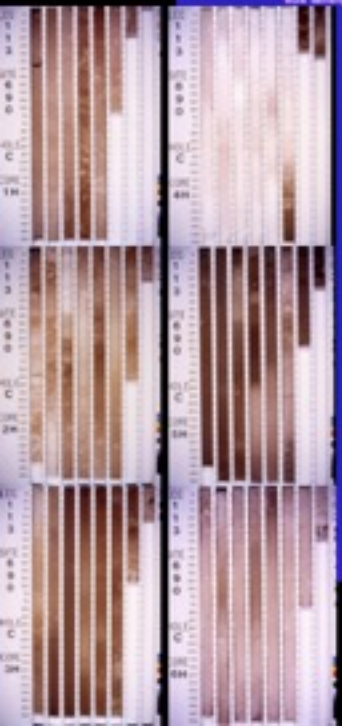


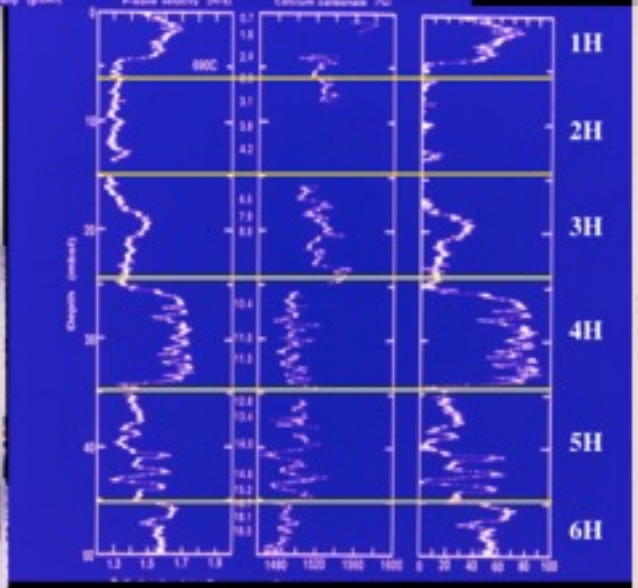



ODP Hole 689D

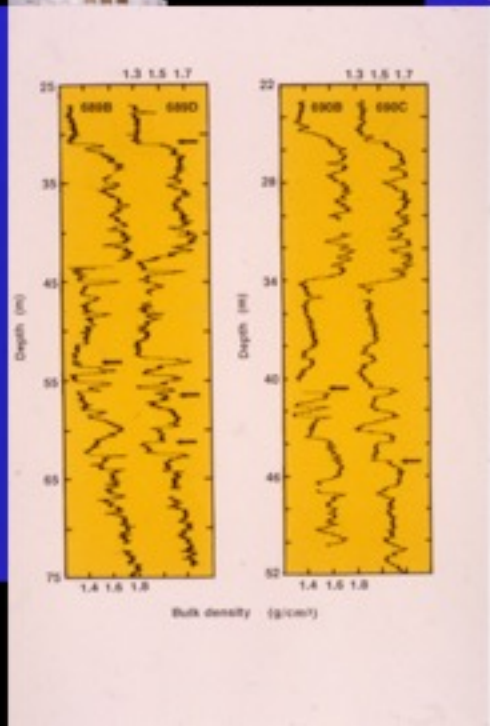
Bulk Density
P-wave Velocity
Calcium Carbonate
(predicted)

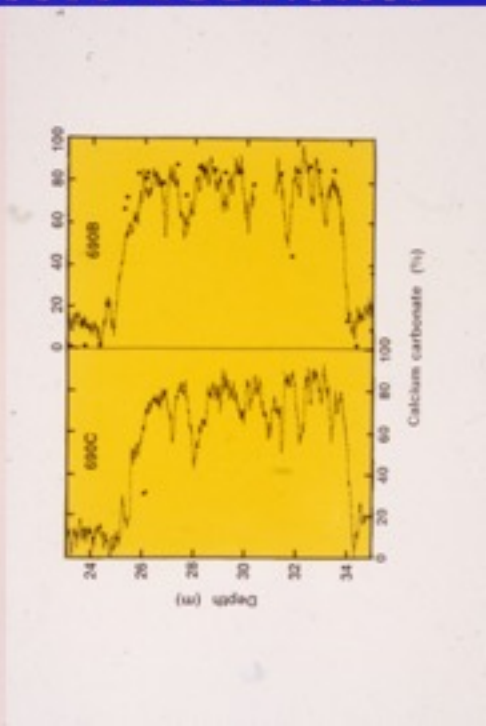


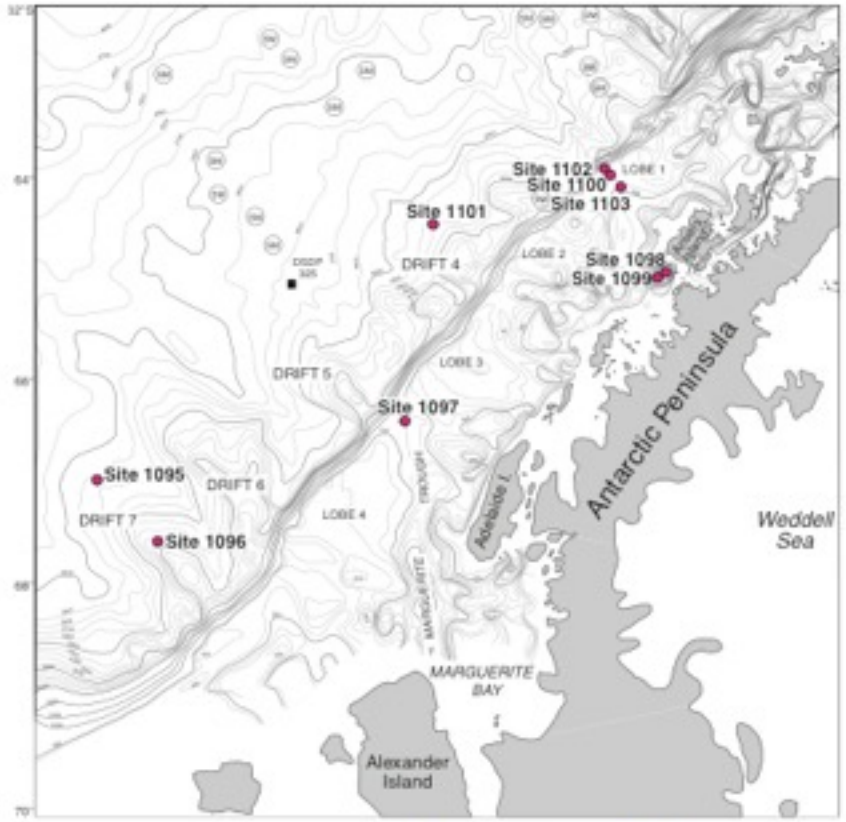


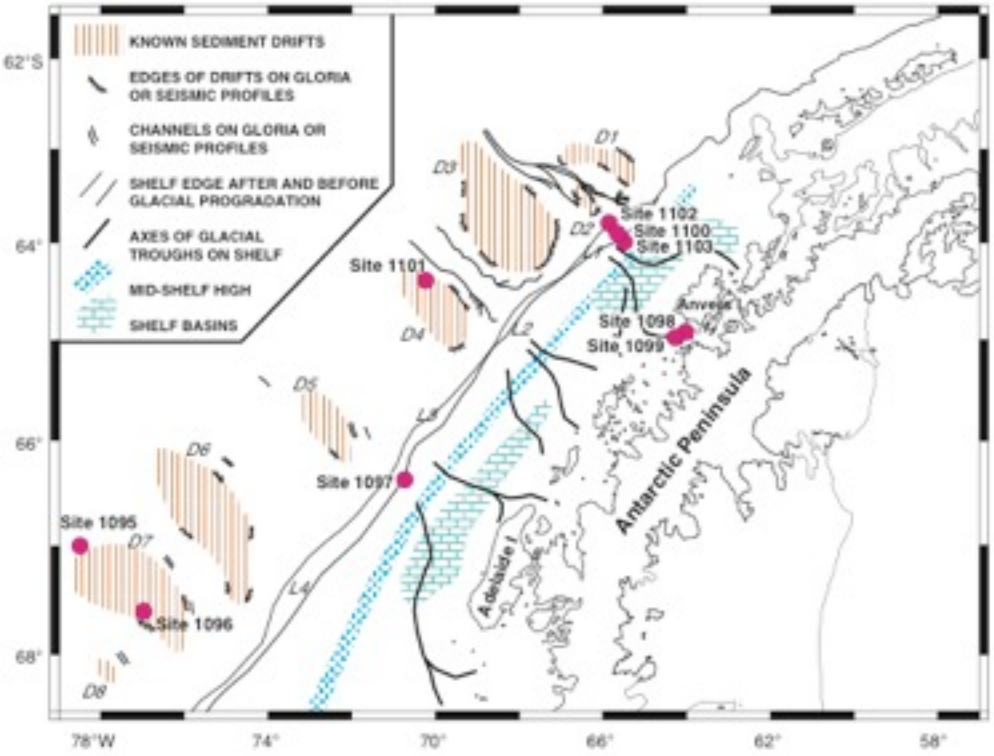

ODP Hole 690C
Bulk Density; P-wave Velocity
Calcium Carbonate (predicted)

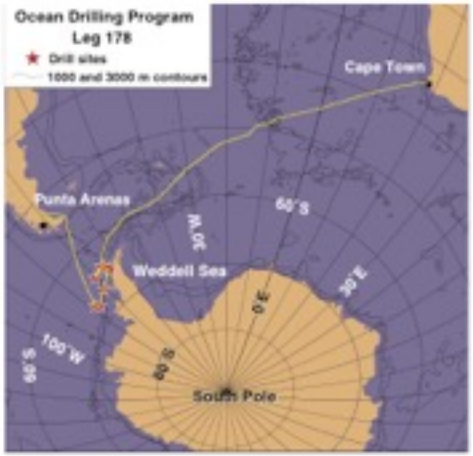


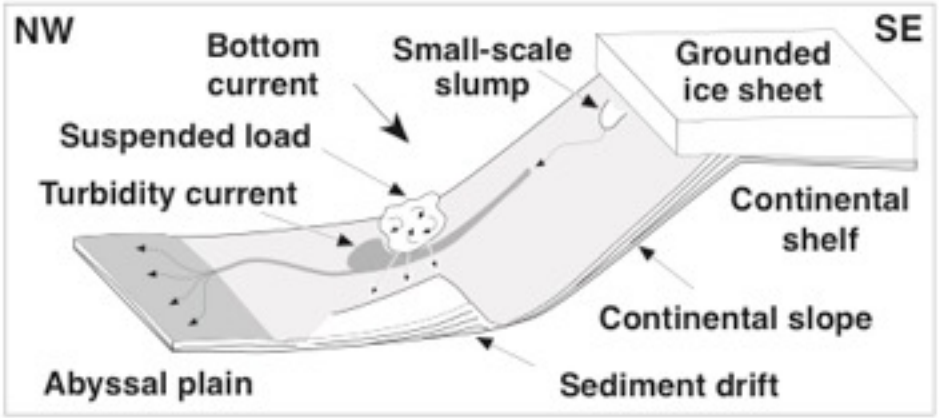



# ODP Leg 178 Sites



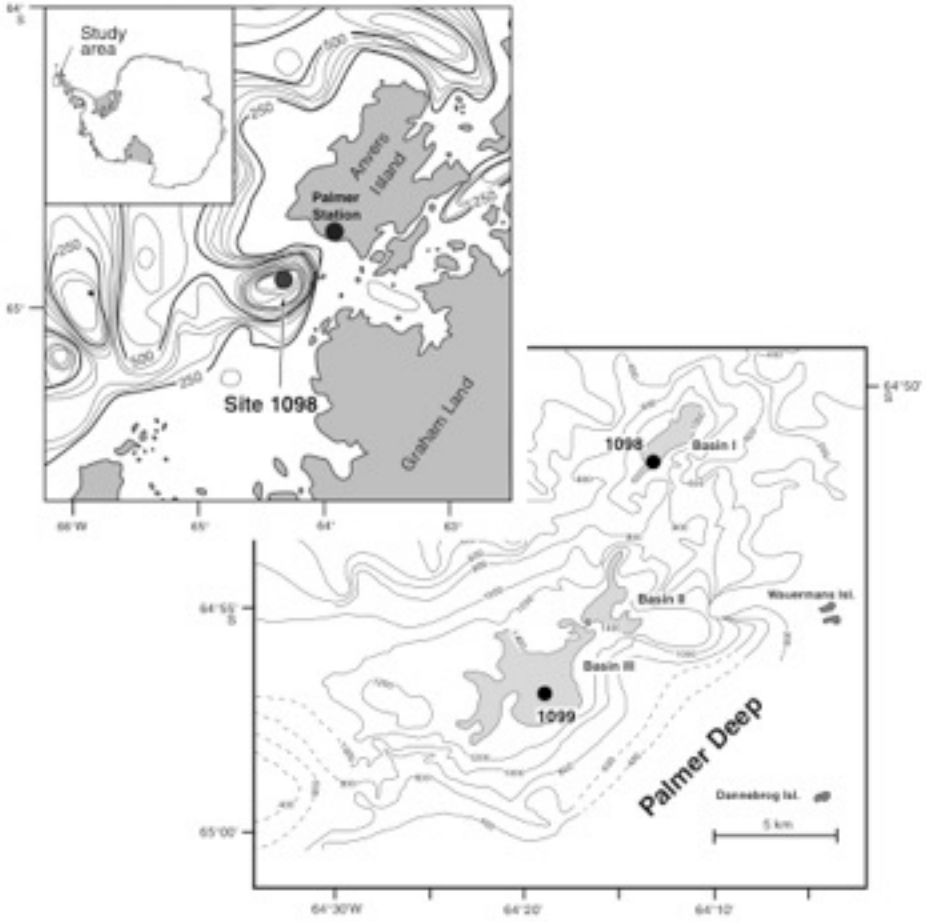



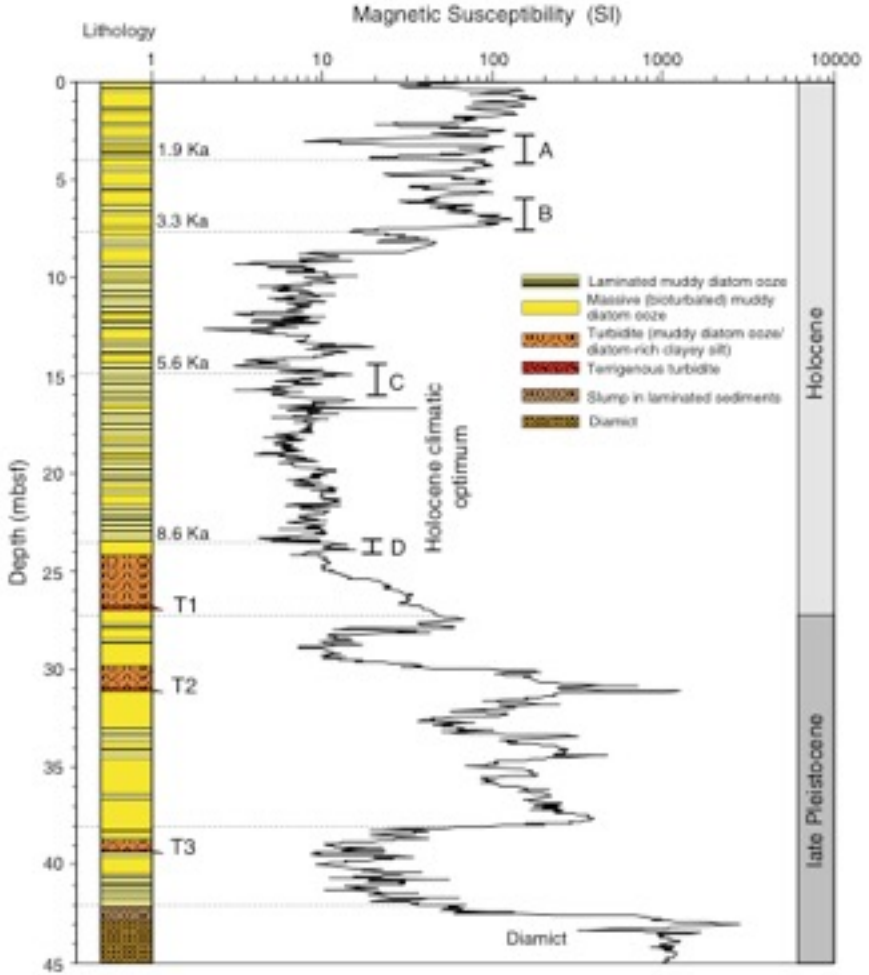



# ODP Leg 178 Sites

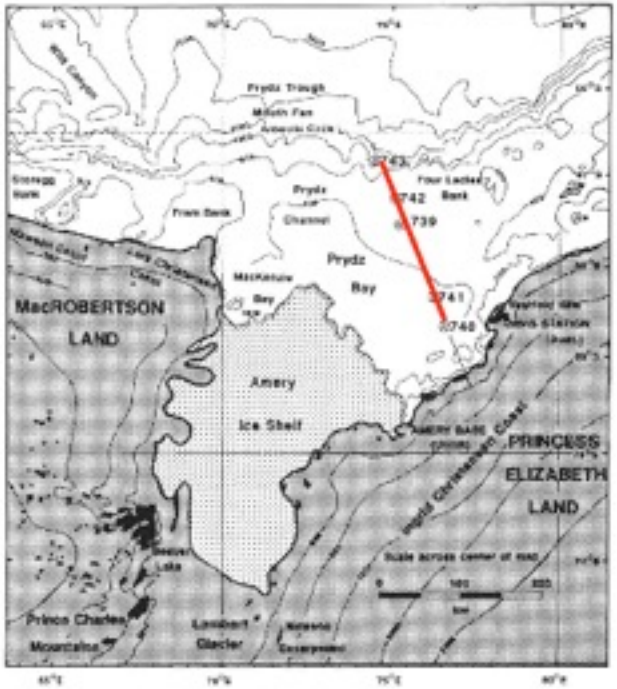
| Hole | Latitude | Longitude | Water depth (mbrf) | Number of cores | Interval cored (m) | Core recovered (m) | Recovery (%) | Drilled (m) | Total penetration (m) | Time on hole (hr) | Time on site (days) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1095A | 66° 59.1262' S | 78° 29.2384' W | 3852.6 | 10 | 87.30 | 86.48 | 99.1% | 0.0 | 87.30 | 27.25 | 1.1 |
| 1095B | 66° 59.1261' S | 78° 29.2696' W | 3852.6 | 52 | 487.20 | 385.75 | 79.2% | 83.0 | 570.20 | 125.25 | 5.2 |
| 1095C | 66° 59.1218' S | 78° 29.2949' W | 3852.6 | 1 | 2.90 | 2.87 | 99.0% | 0.0 | 2.90 | 1.50 | 0.1 |
| 1095D | 66° 59.1212' S | 78° 29.2854' W | 3851.9 | 9 | 84.60 | 78.96 | 93.3% | 0.0 | 84.60 | 0.00 | 0.0 |
| | | | **1095 site totals:** | **72** | **662.00** | **554.06** | **83.7%** | **83.0** | **745.00** | **154.00** | **6.4** |
| 1096A | 67° 34.0084' S | 76° 57.7935' W | 3163.2 | 15 | 140.70 | 118.52 | 84.2% | 0.0 | 140.70 | 22.75 | 0.9 |
| 1096B | 67° 34.0093' S | 76° 57.8118' W | 3163.7 | 32 | 260.60 | 209.77 | 80.5% | 0.0 | 260.60 | 56.75 | 2.4 |
| 1096C | 67° 34.0094' S | 76° 57.8263' W | 3163.7 | 43 | 409.90 | 344.98 | 84.2% | 197.8 | 607.70 | 125.00 | 5.2 |
| | | | **1096 site totals:** | **90** | **811.20** | **673.27** | **83.0%** | **197.8** | **1009.00** | **204.50** | **8.5** |
| 1097A | 66° 23.5678' S | 70° 45.3840' W | 563.0 | 51 | 436.60 | 59.30 | 13.6% | 0.0 | 436.60 | 134.50 | 5.6 |
| | | | **1097 site totals:** | **51** | **436.60** | **59.30** | **13.6%** | **0.0** | **436.60** | **134.50** | **5.6** |
| 1098A | 64° 51.7235' S | 64° 12.4712' W | 1022.6 | 7 | 45.90 | 45.78 | 99.7% | 0.0 | 45.90 | 17.00 | 0.7 |
| 1098B | 64° 51.7162' S | 64° 12.4795' W | 1022.0 | 5 | 43.00 | 44.66 | 103.9% | 0.0 | 43.00 | 4.67 | 0.2 |
| 1098C | 64° 51.7105' S | 64° 12.4690' W | 1021.8 | 5 | 46.70 | 46.30 | 99.1% | 0.0 | 46.70 | 5.58 | 0.2 |
| | | | **1098 site totals:** | **17** | **135.60** | **136.74** | **100.8%** | **0.0** | **135.60** | **27.25** | **1.1** |
| 1099A | 64° 56.7079' S | 64° 18.9171' W | 1411.2 | 7 | 62.30 | 63.74 | 102.3% | 0.0 | 62.30 | 8.50 | 0.4 |
| 1099B | 64° 56.7072' S | 64° 18.9155' W | 1411.2 | 5 | 47.50 | 48.34 | 101.8% | 60.0 | 107.50 | 9.75 | 0.4 |
| | | | **1099 site totals:** | **12** | **109.80** | **112.08** | **102.1%** | **60.0** | **169.80** | **18.25** | **0.8** |
| 1100A | 63° 53.0009' S | 65° 42.3388' W | 470.0 | 4 | 33.80 | 0.00 | 0.0% | 0.0 | 33.80 | 10.50 | 0.4 |
| 1100B | 63° 53.0098' S | 65° 42.3487' W | 470.0 | 1 | 2.00 | 0.15 | 7.5% | 33.9 | 35.90 | 12.00 | 0.5 |
| 1100C | 63° 52.9987' S | 65° 42.3635' W | 470.0 | 1 | 5.00 | 4.05 | 81.0% | 0.0 | 5.00 | 18.75 | 0.8 |
| 1100D | 63° 53.0053' S | 65° 42.3519' W | 470.0 | 12 | 110.50 | 5.28 | 4.8% | 0.0 | 110.50 | 52.50 | 2.2 |
| | | | **1100 site totals:** | **18** | **151.30** | **9.48** | **6.3%** | **33.9** | **185.20** | **93.75** | **3.9** |
| 1101A | 64° 22.3312' S | 70° 15.6708' W | 3291.2 | 24 | 217.70 | 215.75 | 99.1% | 0.0 | 217.70 | 39.25 | 1.6 |
| | | | **1101 site totals:** | **24** | **217.70** | **215.75** | **99.1%** | **0.0** | **217.70** | **39.25** | **1.6** |
| 1102A | 63° 48.1708' S | 65° 51.4934' W | 442.0 | 1 | 7.90 | 0.42 | 5.3% | 0.0 | 7.90 | 4.75 | 0.2 |
| 1102B | 63° 48.1675' S | 65° 51.4728' W | 442.0 | 1 | 7.50 | 0.39 | 5.2% | 0.0 | 7.50 | 4.50 | 0.2 |
| 1102C | 63° 48.1401' S | 65° 51.4920' W | 442.0 | 2 | 6.50 | 0.01 | 0.2% | 0.0 | 6.50 | 11.25 | 0.5 |
| 1102D | 63° 48.0713' S | 65° 51.3867' W | 442.0 | 1 | 14.90 | 0.85 | 5.7% | 0.0 | 14.90 | 14.25 | 0.6 |
| | | | **1102 site totals:** | **5** | **36.80** | **1.67** | **4.5%** | **0.0** | **36.80** | **34.75** | **1.4** |
| 1103A | 63° 59.9700' S | 65° 27.9190' W | 505.0 | 38 | 362.70 | 44.54 | 12.3% | 0.0 | 362.70 | 87.50 | 3.6 |
| | | | **1103 site totals:** | **38** | **362.70** | **44.54** | **12.3%** | **0.0** | **362.70** | **87.50** | **3.6** |
| | | | **Leg 178 totals:** | **327** | **2923.70** | **1806.89** | **61.8%** | **374.70** | **3298.40** | **793.75** | **33.1** |

# ODP Leg 178 – Site 1098: Palmer Deep



# ODP Leg 119 – Prydz Bay I



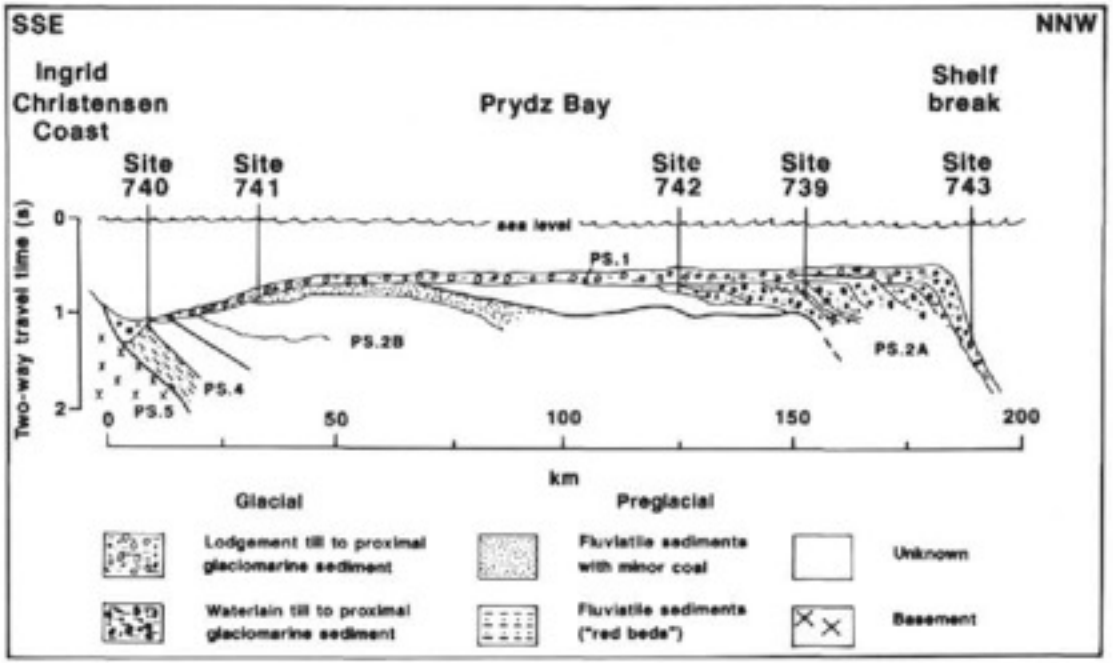
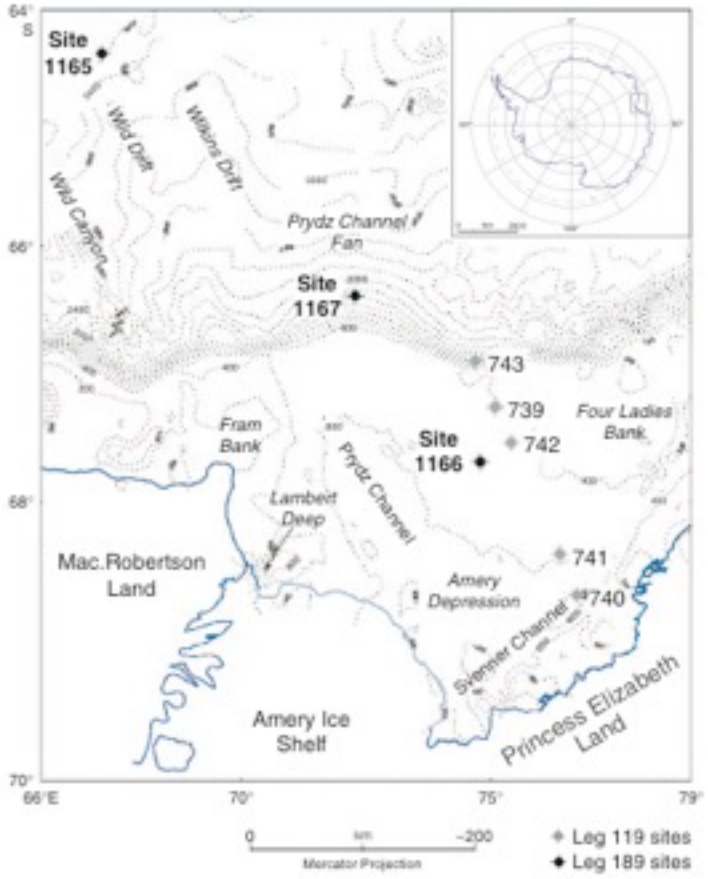
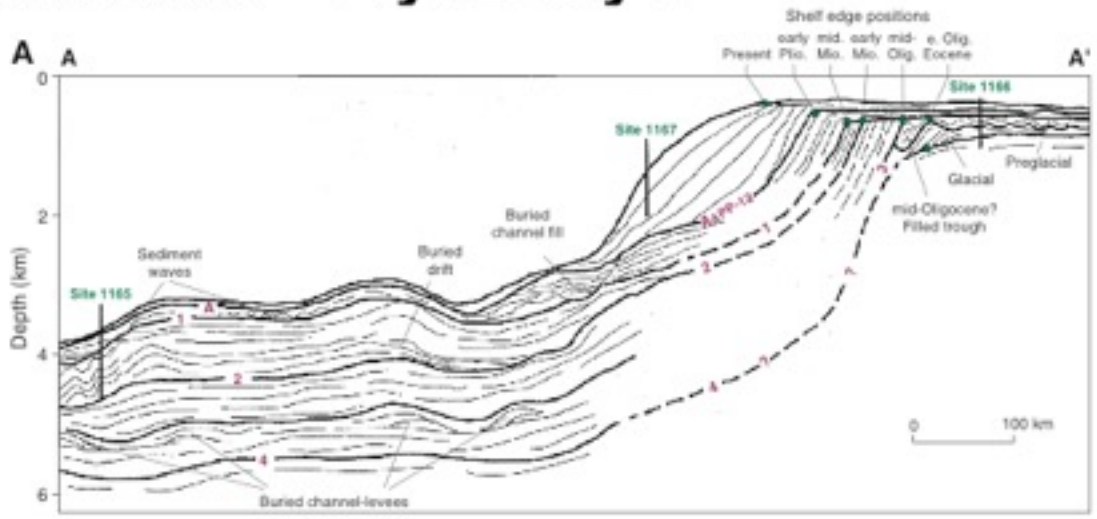



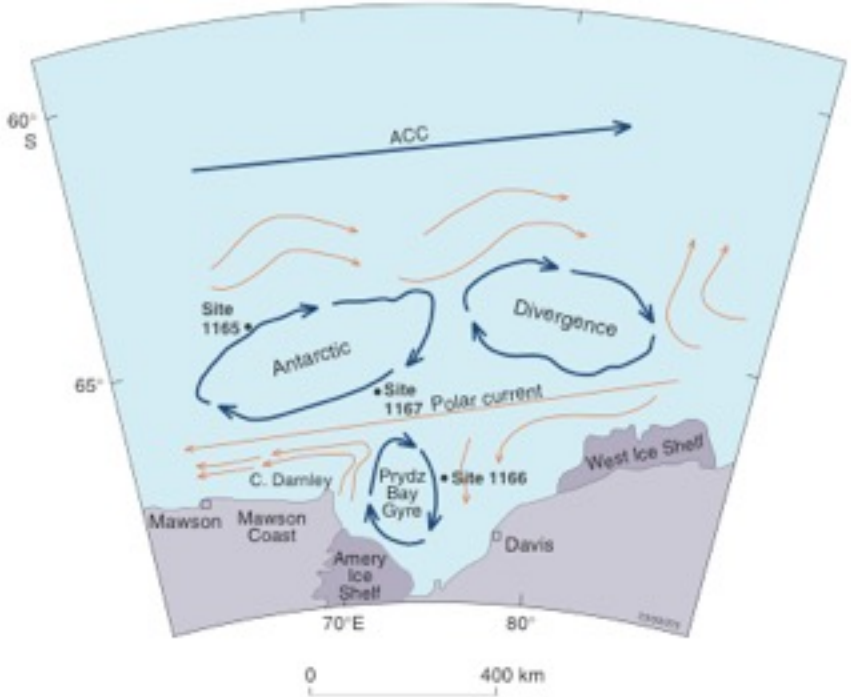

Table 1. Summary of drill site locations, Leg 119 (Prydz Bay).

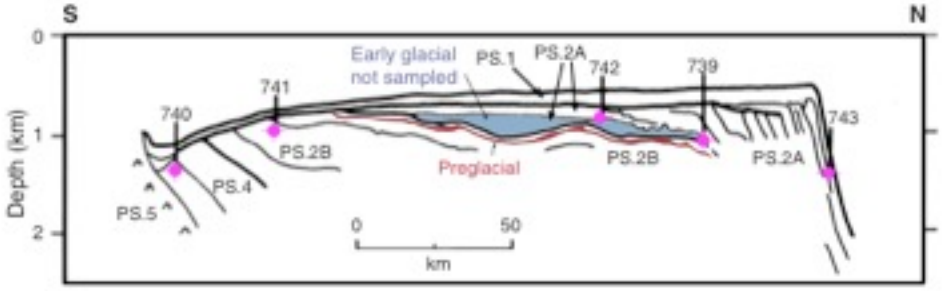
| Site (holes) | Latitude (S) | Longitude (E) | Location | Water depth (m) | Penetration (mbsf) | Percent recovery | Age of sediment | Principal lithologies |
|---|---|---|---|---|---|---|---|---|
| 739 (A-C) | 67°15.570′ | 75°04.914′ | Outer shelf | 412.3 | 487.0 | 35 | (?late Eocene)/Oligocene to Quaternary | Diamictite |
| 740 (A-B) | 68°41.220′ | 76°43.246′ | Inner shelf | 816.0 | 225.5 | 32 | ?Mesozoic to Quaternary | Diatom ooze, diamictite, sandstone and mudstone |
| 741 (A) | 68°23.160′ | 76°23.020′ | Inner shelf | 561.4 | 128.1 | 26 | Early Cretaceous to Quaternary | Diamicton, sandstone and siltstone with coal fragments |
| 742 (A) | 67°32.982′ | 75°24.270′ | Mid-shelf | 410.0 | 316.0 | 53 | (?late Eocene)/Oligocene to Quaternary | Diamictite |
| 743 (A) | 66°54.994′ | 74°41.423′ | Continental slope | 987.0 | 98.1 | 22 | Pliocene to Quaternary | Mud, diamicton |

# ODP Leg 188 Sites – Prydz Bay II



# ODP Leg 188 Sites – Prydz Bay II

| Hole | Latitude | Longitude | Water depth (m) | Number of cores | Interval cored (m) | Core recovered (m) | Recovered (%) | Drilled (m) | Maximum penetration (m) | Total drilled (m) | Time on hole (hr) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1165A | 64°22.8′S | 67°13.1′E | 3537.0 | 1 | 5.4 | 5.43 | 100.6 | 0 | 5.4 | 5.4 | 14.25 |
| 1165B | 64°22.8′S | 67°13.1′E | 3537.6 | 76 | 682.2 | 434.04 | 63.6 | 0 | 682.2 | 682.2 | 144.25 |
| 1165C | 64°22.8′S | 67°13.1′E | 3537.5 | 35 | 335.7 | 269.27 | 80.2 | 663.4 | 999.1 | 999.1 | 255.00 |
| Site 1165 summary | 64°22.8′S | 67°13.1′E | 3537.4 | 112 | 1023.3 | 708.74 | 69.3 | 663.4 | 999.1 | 1686.7 | 413.50 |
| 1166A | 67°41.8′S | 74°47.2′E | 475.4 | 40 | 381.3 | 71.25 | 18.7 | 0 | 381.3 | 381.3 | 134.50 |
| 1166B | 67°41.8′S | 74°47.3′E | 475.4 | 0 | 0 | 0 | 0 | 42.5 | 42.5 | 42.5 | 21.50 |
| Site 1166 summary | 67°41.8′S | 74°47.2′E | 475.4 | 40 | 381.3 | 71.25 | 18.7 | 42.5 | 381.3 | 423.8 | 156.00 |
| 1167A | 66°24.0′S | 72°17.1′E | 1639.9 | 49 | 447.5 | 191.33 | 42.8 | 0 | 447.5 | 447.5 | 130.42 |
| 1167B | 66°24.0′S | 72°17.0′E | 1639.9 | 0 | 0 | 0 | 0 | 261.8 | 261.8 | 261.8 | 33.08 |
| Site 1167 summary | 66°24.0′S | 72°17.0′E | 1639.9 | 49 | 447.5 | 191.33 | 42.8 | 261.8 | 447.5 | 709.3 | 163.50 |
| Totals: | 65°54.3′S | 70°49.7′E | 2120.4 | 201 | 1852.1 | 971.32 | 52.4 | 967.7 | 999.1 | 2819.8 | 733.00 |

# ODP/IODP Drilling Around Antarctica

ODP Leg 113 - Weddell Sea and E. Antarctic Peninsula
(12/25/86 – 3/11/87): Valparaiso, Chile to East Cove, Falkland Islands
Jim Kennett, Peter Barker / Suzanne O'Connell, Xenia Golovchenko

ODP Leg 119 - Prydz Bay I and Kerguelen Plateau
(12/14/87 – 2/21/88): Port Louis, Mauritius to Freemantle, Australia
Roland Schlich, Sherwood Wise / Amanda Palmer, Beth Pratson

10 Years

CRP – 1997-2000

ODP Leg 178 - Western Antarctic Peninsula
(2/5/98 – 4/9/98): Punta Arenas, Chile to Cape Town, South Africa
Peter Barker, Angelo Camerlenghi / Gary Acton, Trevor Williams

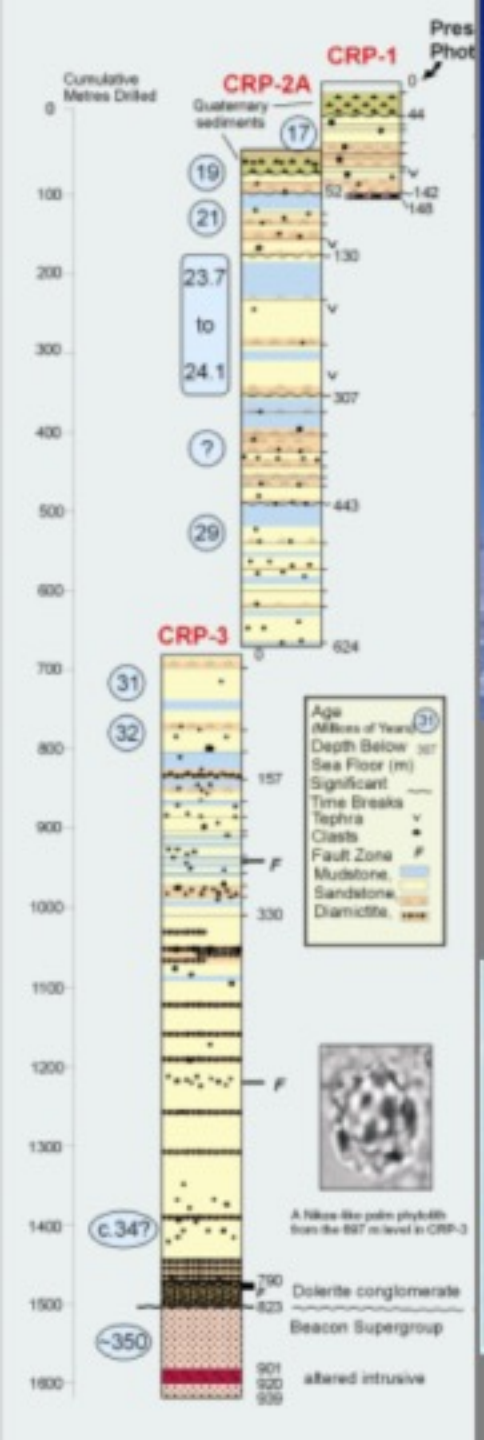
ODP Leg 188 - Prydz Bay II
(1/10/00 – 3/11/00): Freemantle, Aust. to Hobart, Tasmania, Australia
Alan Cooper, Phil O'Brien / Carl Richter, Trevor Williams

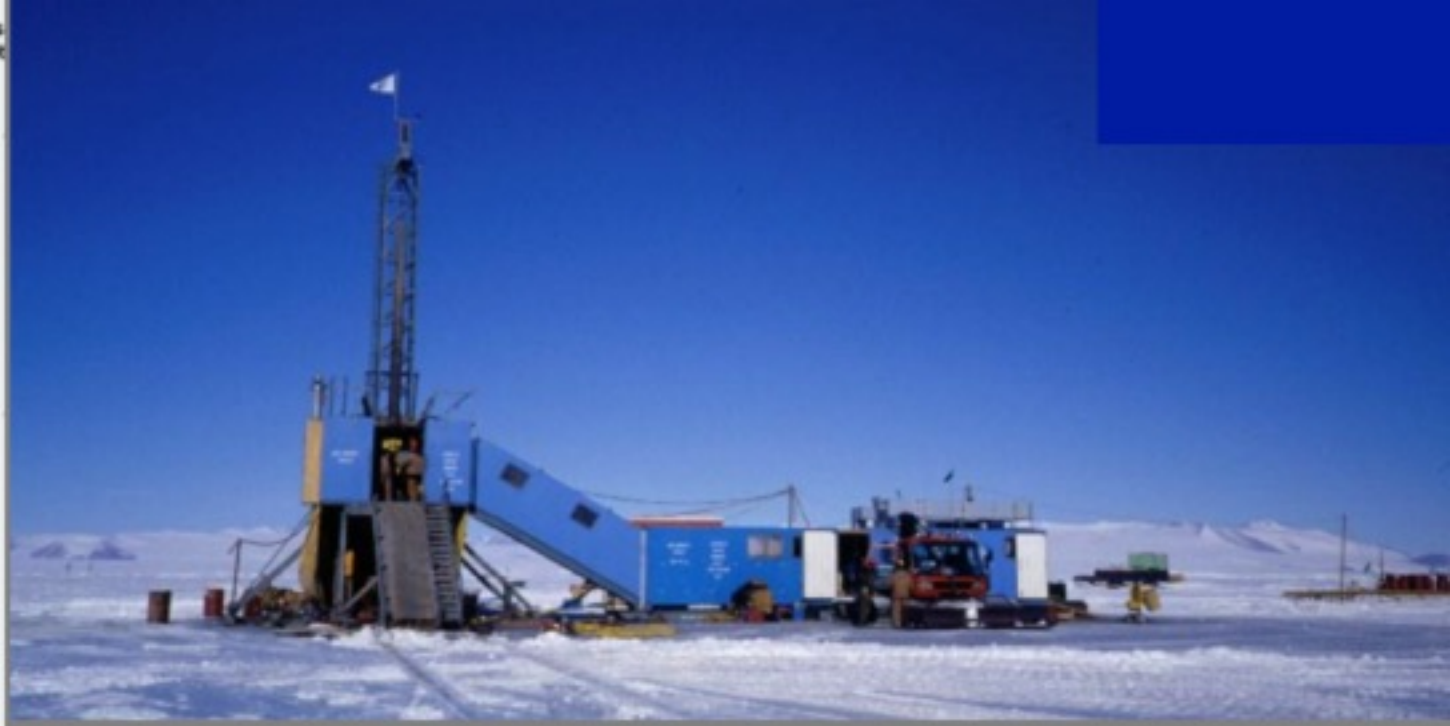
10 Years

SHALDRIL I & II – 2005-2006

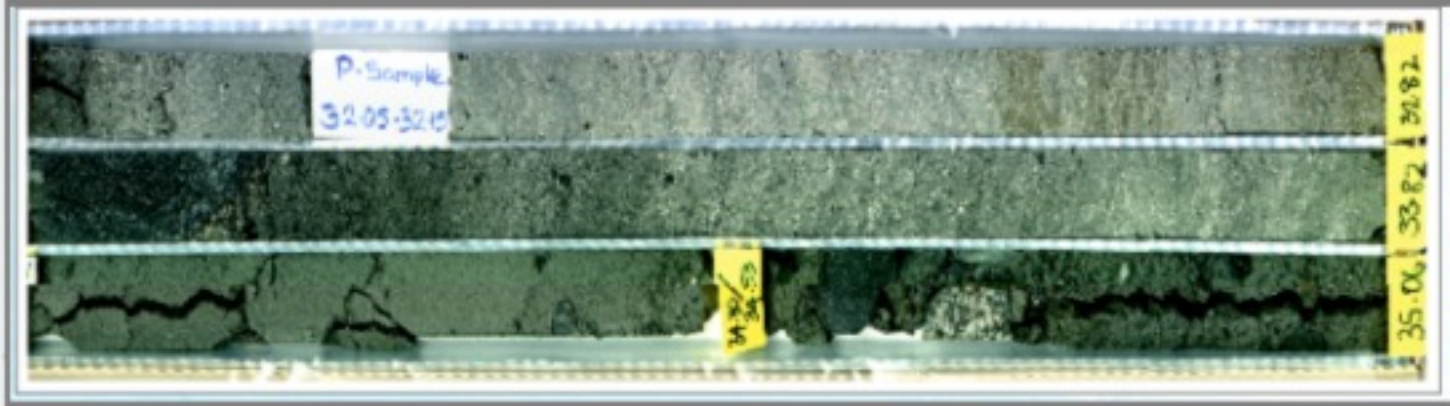
ANDRILL MSP – 2006-2007

IODP Exp. 318 - Wilkes Land
(1/3/10 – 3/8/10): Wellington, NZ to Hobart, Tasmania, Australia
Carlota Escutia Dotti, Henk Brinkhuis / Adam Klaus, Trevor Williams



# Cape Roberts Drilling Project (1997-2000)



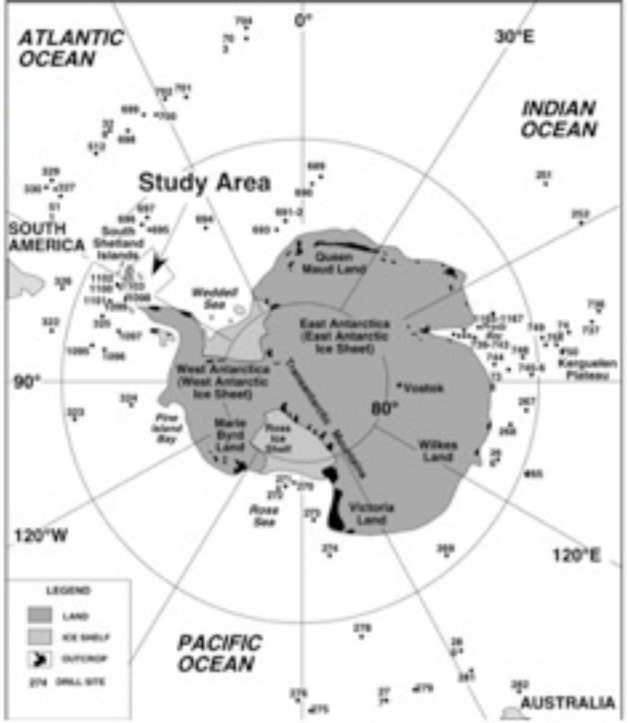

CRP-1 Cores (31.85-35.06 mbsf)

# Antarctic Scientific Drilling (1973-1999)

| Hole | Year | Latitude | Longitude | Elevation (m) | Penetration (m) | Percent Recovered | Oldest sediment |
|---|---|---|---|---|---|---|---|
| DSDP270 | 1973 | 77° 26.48'S | 178° 30.19'W | -634 | 422.5* | 62.4 | late Oligocene |
| DSDP271 | 1973 | 76° 43.27'S | 175° 02.86'W | -554 | 265.0 | 5.8 | Pliocene |
| DSDP272 | 1973 | 77° 07.62'S | 176° 45.61'W | -629 | 443.0 | 36.6 | early Miocene |
| DSDP273 & 273A | 1973 | 74° 32.29'S | 174° 37.57'E | -495 | 346.5 | 24.1 | early Miocene |
| DVDP 4/4A | 1973 | -77° .32'S | 161° 32'E | +83.6 | 4/17 | /95 | late Miocene |
| DVDP 8 | 1973 | 77° 34.43'S | 163° 31'E | +1.9 | 157.06 | 85 | middle Pliocene |
| DVDP 9 | 1973 | 77° 34.43'S | 163° 31'E | +1.9 | 38.34 | 96 | Pleistocene |
| DVDP10 | 1974 | 77° 34.72'S | 163° 30.70'E | +2.8 | 185.9 | 83.4 | early Pliocene |
| DVDP11 | 1974 | 77° 35.40'S | 163° 24.67'E | +80 | 328.0 | 94.1 | late Miocene |
| DVDP12 | 1974 | 77° 38.37'S | 162° 51.22'E | +75 | 166* | | ?Pliocene-Pleistocene |
| DVDP15 | 1975 | 77° 26.65'S | 164° 22.82'E | -122 | 65 | 52.0 | ?Pliocene-Pleistocene |
| MSSTS-1 | 1979 | 77° 33.43'S | 163° 23.21'E | -195 | 229.6 | 56.1 | late Oligocene |
| CIROS-2 | 1984 | 77° 41'S | 163° 32'E | -211 | 168.1 | 67.0 | early Pliocene |
| CIROS-1 | 1986 | 77° 04.91'S | 164° 29.93'E | -197 | 702.1 | 98.0 | late Eocene |
| CRP-1 | 1997 | 77.008° S | 163.755° E | -153.5 | 147.69 | 86 | early Miocene |
| CRP-2/2A | 1998 | 77.006° S | 163.719° E | -177.94 | 624.15 | 95 (below -45.97m) | early Oligocene |
| CRP-3 | 1999 | 77.011° S | 163.640° E | -295 | 939 | 97 | ?late Eocene |

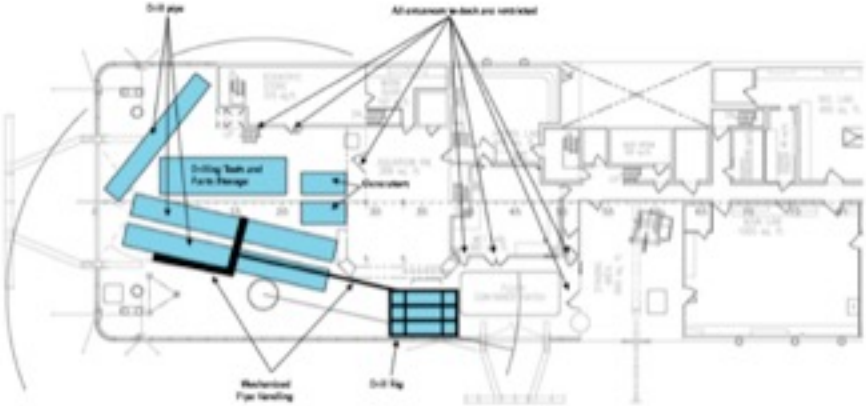
***Table 4.6-1:*** *Drillholes of the Ross continental shelf and coastal Victoria Land from which Cenozoic strata have been recovered.*

**Table courtesy of Alex Pyne, ANDRILL Oxford Workshop**




Slide courtesy of
Julia Wellner (U of Houston)

## SHALDRIL Drill Rig Layout Schematic



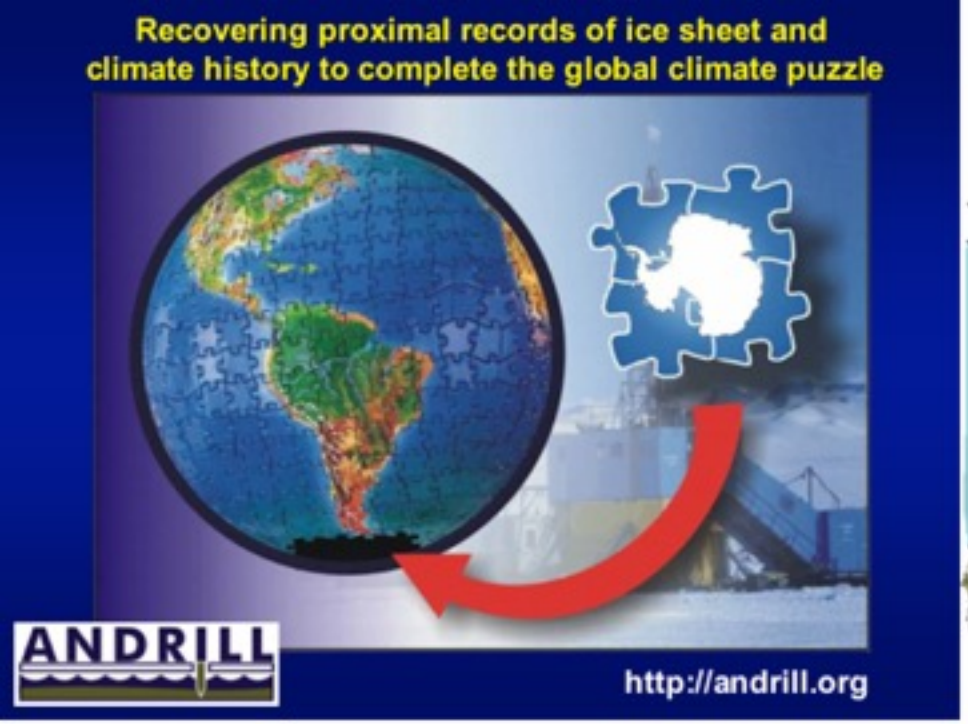
## SHALDRIL I & II Expeditions on the Nathaniel B. Palmer

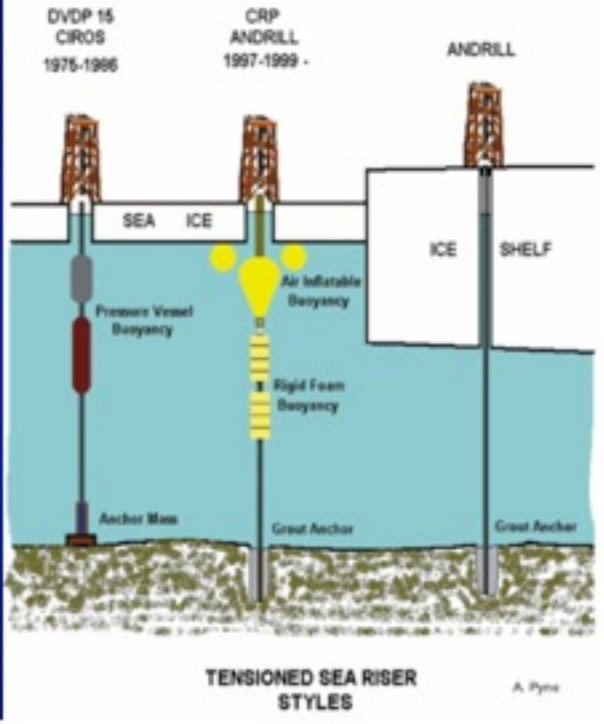
http://shaldril.rice.edu

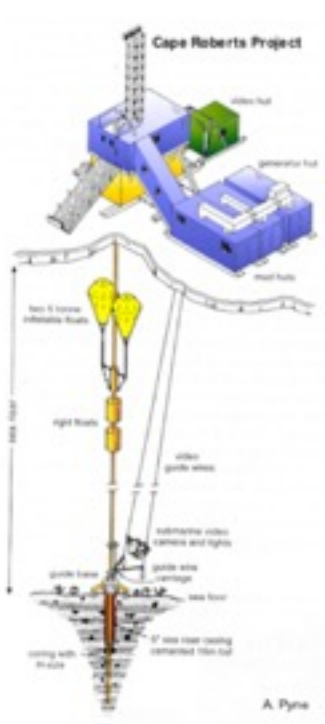
Slide courtesy of Julia Smith-Wellner

## SHALDRIL I & II – James Ross Basin

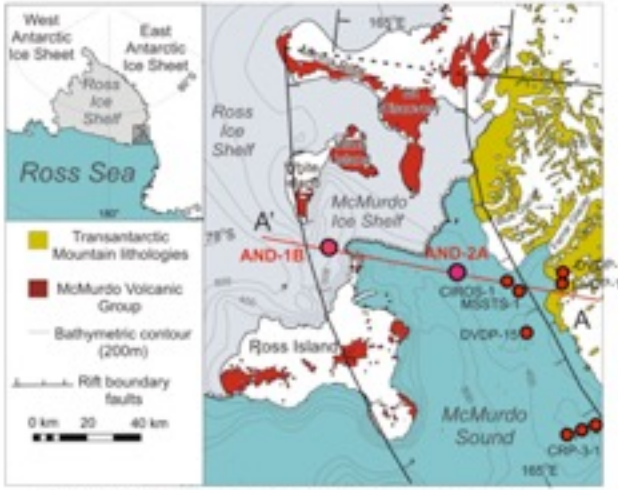
SHALDRIL slide courtesy of Julia Smith-Wellner
http://shaldril.rice.edu



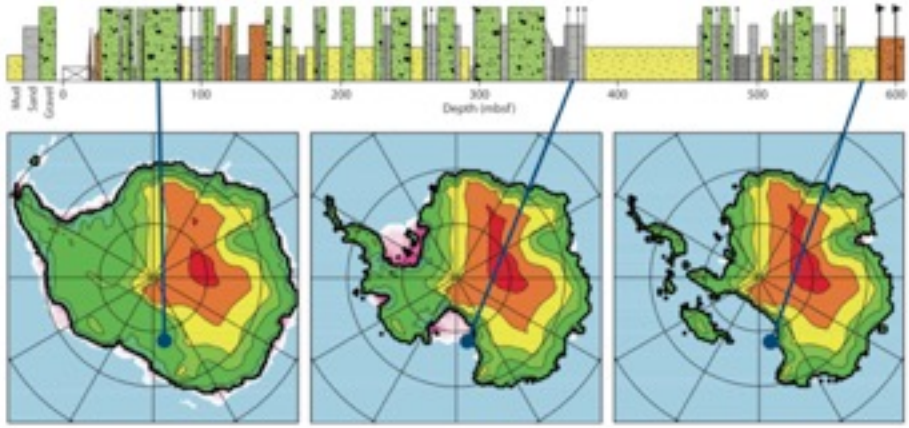




## ANDRILL McMurdo Sound Portfolio



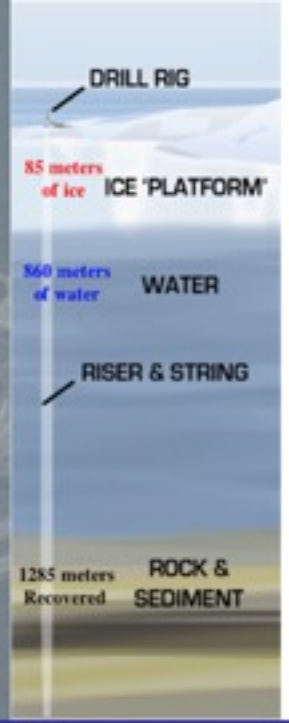

From Naish et al., 2009 (Nature, v. 458, online supplement).

## ANDRILL McMurdo Ice Shelf (MIS) Project




From "Illuminating Earth's Past, Present, and Future, IODP Science Plan for 2013-2023"

## MIS Project drillsite




- First geological drilling through an ice shelf.
- Recovered 1284.74 meters of sediment and rock core; 98% recovery.
- Age established as ~13 Million years old at base of hole.
- Observed ~60 glacial-interglacial cycles over last 6 Million years.
- Thick sequences of diatoms recovered indicating open water at site.
- Established chronology for seismic data in Victoria Land Basin.

ANDRILL

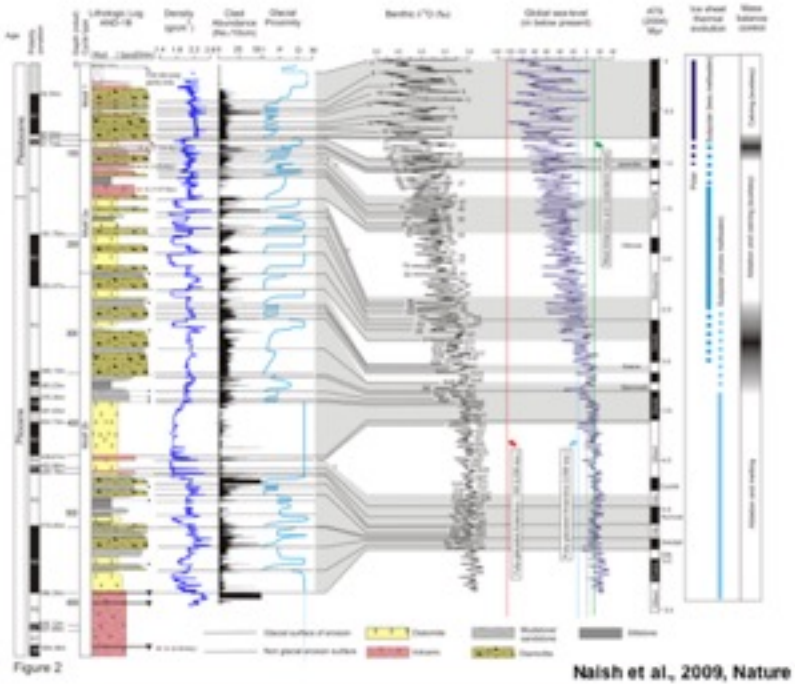


Figure 2

Naish et al., 2009, Nature 458

## Southern McMurdo Sound Project

8 m
ice thickness

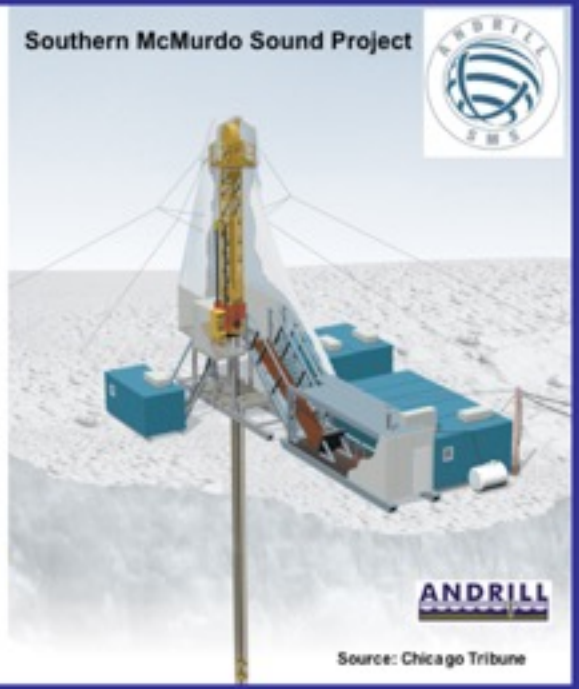
380 m
water depth

98%
core recovery

1138 m
sediment column

Early and Middle Miocene history

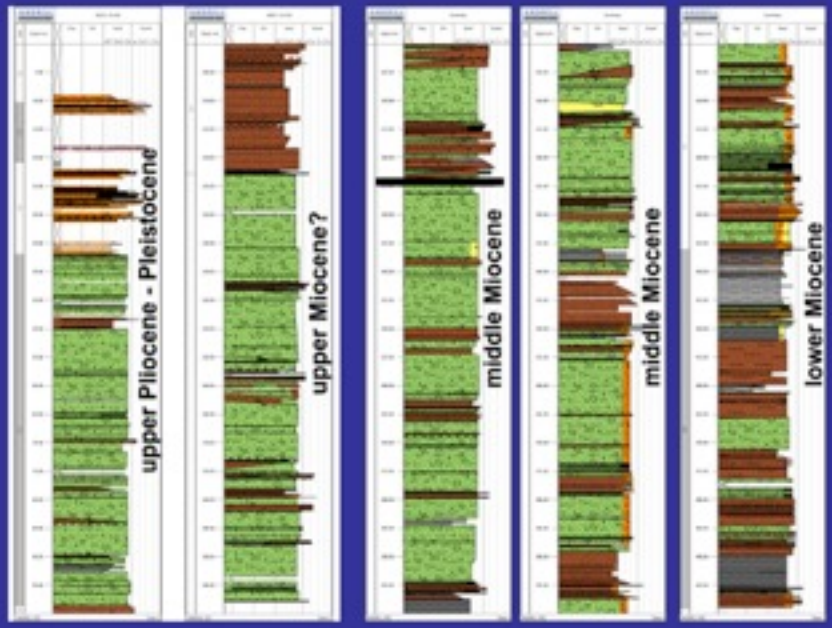
Recovered:
~14.3 to 20.2 Ma




Source: Chicago Tribune

## SMS Project AND-2A drillcore

SUMMARY LOG 0 – 498 mbsf



# IODP

Integrated Ocean Drilling Program

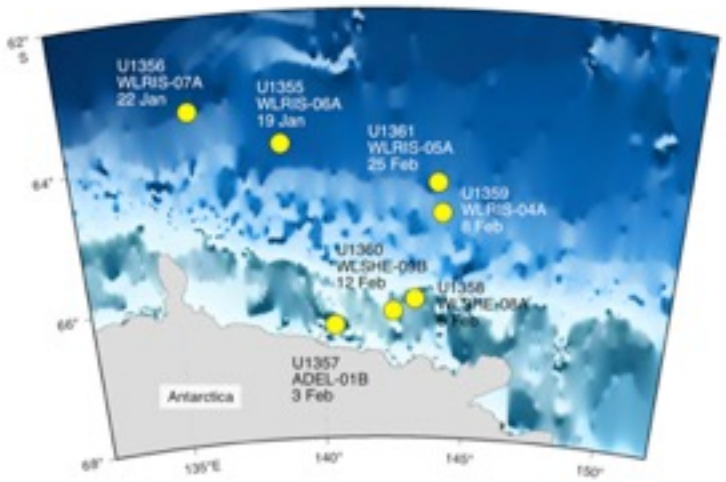
## Platform Operators for the IODP (CDEX, USIO, ESO)

**U.S.-NSF, Japan-MEXT, European-EMA/ECORD, and China-MOST (Science Funding)**
**IODP-MI (Science Operations Management)**

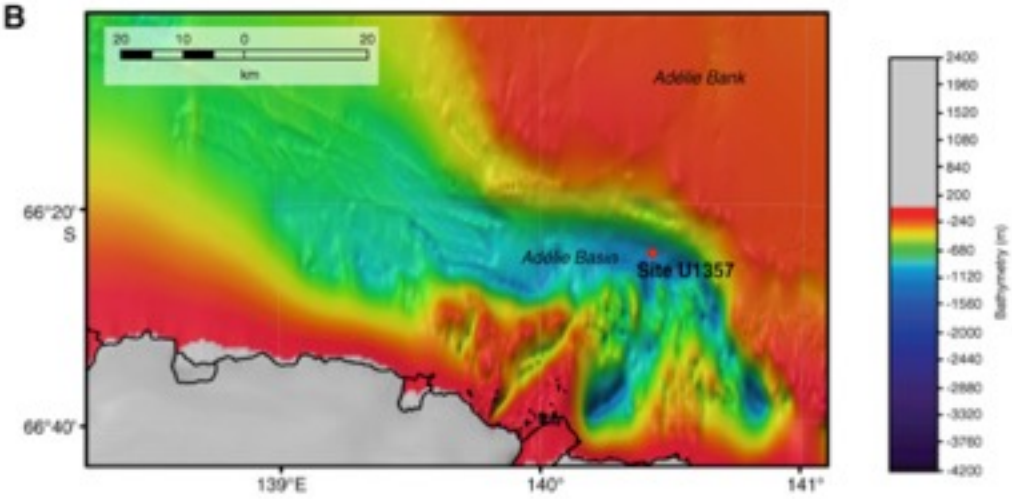
ADVANCING GLOBAL UNDERSTANDING OF THE EARTH

## IODP Expedition 318 – Wilkes Land & Adelie Drift

3 January – 8 March 2010



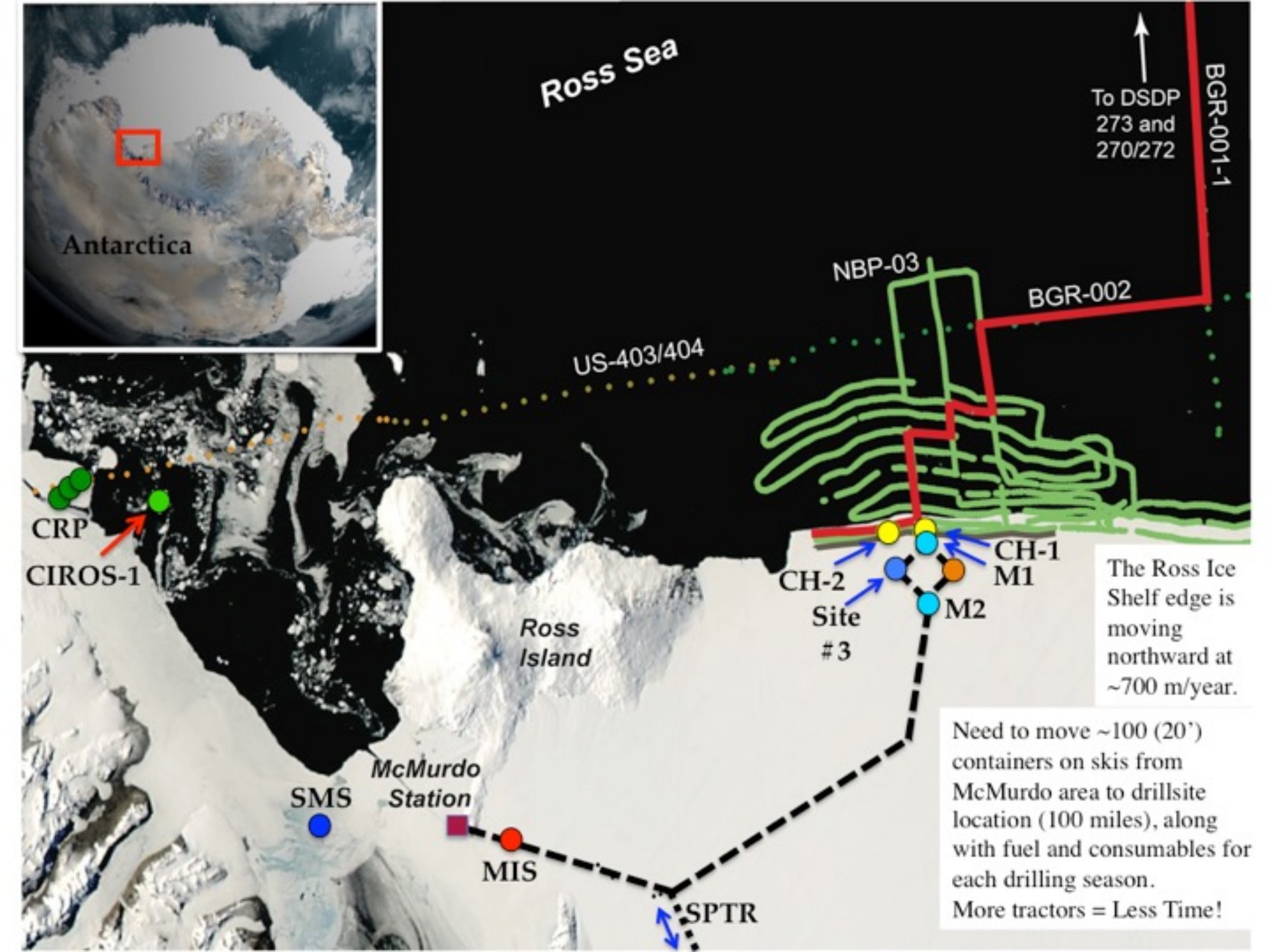

IODP Expedition 318 Site Map




## IODP Expedition 318 – Wilkes Land – Drilling/Coring Summary

**Adele Drift**

| Site | Hole | Latitude | Longitude | Seafloor depth (mbrf) | Cores (N) | Cored (m) | Recovered (m) | Recovery (%) | Drilled (m) | Total penetration (m) | Total depth (mbrf) | Time on hole (h) | Time on site (days) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| U1355 | A | 63°50.4704'S | 138°49.4270'E | 3734.0 | 4 | 31.7 | 14.95 | 47 | 0.0 | 31.7 | 3765.7 | 67.25 | |
| | | | Site U1355 totals: | | 4 | 31.7 | 14.95 | 47 | 0.0 | 31.7 | | | 2.8 |
| U1356 | A | 63°18.6138'S | 135°59.9376'E | 4003.0 | 106 | 1006.4 | 350.14 | 35 | 0.0 | 1006.4 | 5009.4 | 255.50 | |
| | | | Site U1356 totals: | | 106 | 1006.4 | 350.14 | 35 | 0.0 | 1006.4 | | | 10.6 |
| U1357 | A | 66°24.7991'S | 140°25.5008'E | 1025.9 | 21 | 186.6 | 183.87 | 99 | 0.0 | 186.6 | 1212.5 | 27.33 | |
| | B | 66°24.7990'S | 140°25.5705'E | 1028.0 | 19 | 170.7 | 172.44 | 101 | 0.0 | 170.7 | 1198.7 | 16.33 | |
| | C | 66°24.8013'S | 140°25.4651'E | 1027.7 | 11 | 103.8 | 110.71 | 107 | 0.0 | 103.8 | 1131.5 | 29.33 | |
| | | | Site U1357 totals: | | 51 | 461.1 | 467.02 | 101 | 0.0 | 461.1 | | | 3.0 |
| U1358 | A | 66°05.4247'S | 143°18.7674'E | 512.0 | 1 | 2.0 | 1.10 | 55 | 0.0 | 2.0 | 514.0 | 6.75 | |
| | B | 66°05.4244'S | 143°18.7666'E | 512.0 | 4 | 35.6 | 8.00 | 22 | 0.0 | 35.6 | 547.6 | 15.25 | |
| | | | Site U1358 totals: | | 5 | 37.6 | 9.10 | 24 | 0.0 | 37.6 | | | 0.9 |
| U1359 | A | 64°54.2377'S | 143°57.6825'E | 3020.9 | 22 | 193.5 | 154.08 | 80 | 0.0 | 193.5 | 3214.4 | 34.00 | |
| | B | 64°54.2431'S | 143°57.6553'E | 3018.8 | 28 | 252.0 | 198.92 | 79 | 0.0 | 252.0 | 3270.8 | 29.67 | |
| | C | 64°54.2477'S | 143°57.6248'E | 3022.3 | 18 | 168.7 | 150.73 | 89 | 0.0 | 168.7 | 3191.0 | 25.58 | |
| | D | 64°54.2596'S | 143°57.5624'E | 3023.0 | 47 | 450.0 | 269.72 | 60 | 152.2 | 602.2 | 3625.2 | 120.50 | |
| | | | Site U1359 totals: | | 115 | 1064.2 | 773.45 | 73 | 152.2 | 1216.4 | | | 8.7 |
| U1360 | A | 66°22.0395'S | 142°44.7050'E | 506.0 | 7 | 70.8 | 7.04 | 10 | 0.0 | 70.8 | 576.8 | 31.00 | |
| | | | Site U1360 totals: | | 7 | 70.8 | 7.04 | 10 | 0.0 | 70.8 | | | 1.3 |
| U1361 | A | 64°24.5728'S | 143°53.1992'E | 3465.5 | 41 | 388.0 | 338.86 | 87 | 0.0 | 388.0 | 3853.5 | 106.33 | |
| | B | 64°24.5454'S | 143°53.1966'E | 3466.9 | 2 | 12.1 | 12.04 | 100 | 0.0 | 12.1 | 3479.0 | 18.42 | |
| | | | Site U1361 totals: | | 43 | 400.1 | 350.90 | 88 | 0.0 | 400.1 | | | 5.2 |
| | | | Expedition 318 totals: | | 331 | 3071.9 | 1972.60 | 64 | 152.2 | 3224.1 | | 783.25 | 32.6 |


Antarctica
Ross Sea
To DSDP 273 and 270/272
BGR-001-1
NBP-03
BGR-002
US-403/404
CRP
CIROS-1
CH-1
M1
CH-2
Site #3
M2
Ross Island
McMurdo Station
SMS
MIS
SPTR
The Ross Ice Shelf edge is moving northward at ~700 m/year.
Need to move ~100 (20') containers on skis from McMurdo area to drillsite location (100 miles), along with fuel and consumables for each drilling season.
More tractors = Less Time!

# Workshop Report on "Developing an Integrated Strategy to Recover Paleoclimate Records from the Antarctic Margin and Southern Ocean", 12-13 September 2009 Granada, Spain

## A Proposal for a new SCAR/ACE Project Sub-Committee: PRAMSO (Paleoclimate Records from the Antarctic Margin and Southern Ocean)

Tim Naish, Laura De Santis, Richard Levy, Frank Rack

**Primary Workshop Objective:** To establish a framework for future Antarctic margin drilling of sedimentary records of paleoclimate - 2013-2023 (in line with the IODP INVEST process).

**Outcome:** White Paper submitted to IODP INVEST Workshop

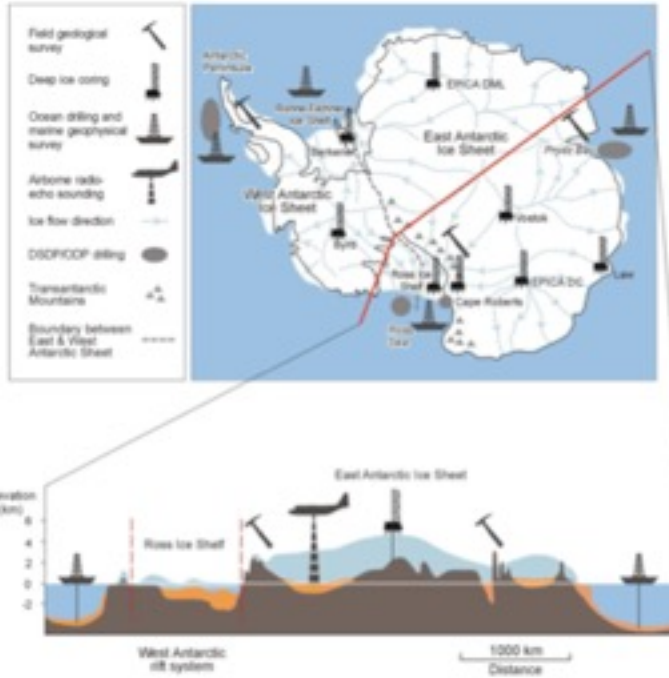
**Other Accomplishments:**

- Outlined strategy components – including science drivers and priorities, critical questions, available drilling programs and platforms, site survey requirements, scientific tools, and integration of drill core data with climate and ice sheet models.

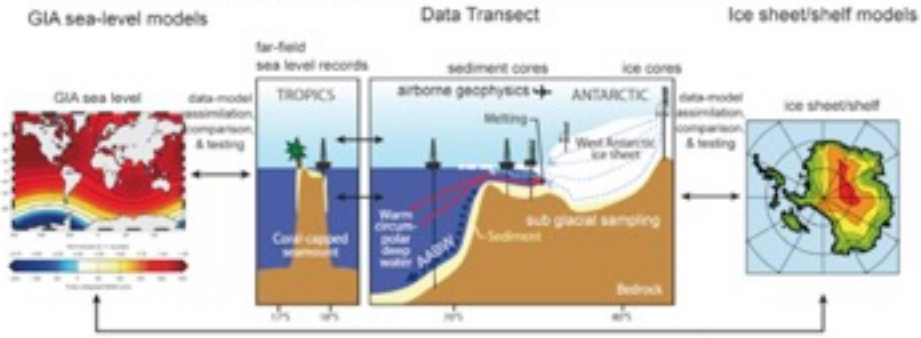
- Identified a list of future projects and proponents aligned with the agreed upon science priorities.

- Produced a summary of the communities' plan for future recovery of paleoclimate records from the Antarctic margin and Southern Ocean, as a White Paper submitted for the IODP INVEST meeting.

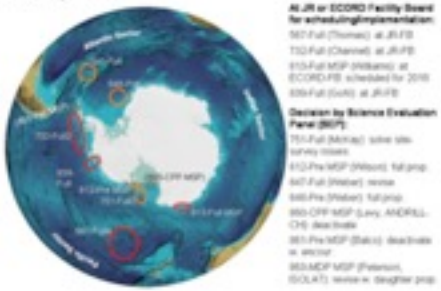
- Proposed convenors and committee members for PRAMSO, and the scope of future activities for approval by the SCAR/ACE Executive.

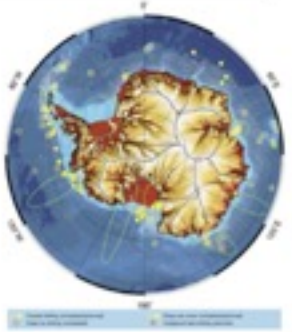



**PAIS ice-margin-offshore-far field transect concept and data-model comparison**




**Active IODP proposals for Southern Ocean around Antarctica**
status: August 2014





## Mission-Specific Platform (MSP) for Scientific Drilling

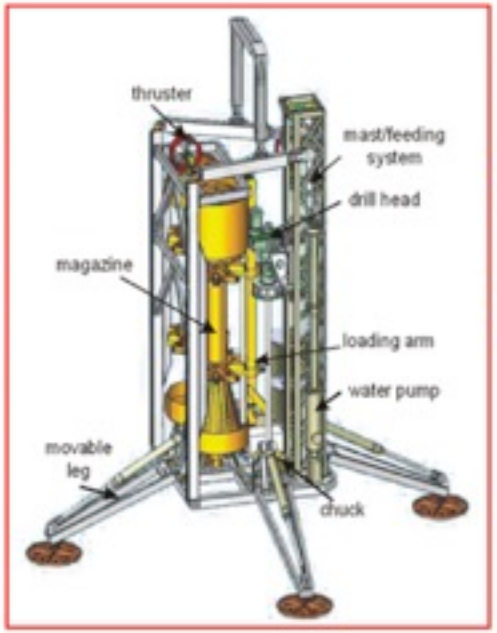
## BGS Seafloor Drill

Leon Holloway, March 2010

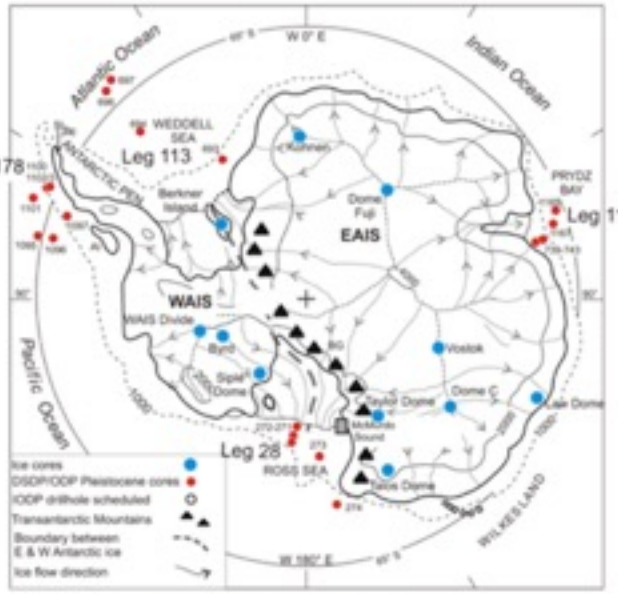
## MeBo Wireline Seafloor Drill

Foto: V. Diekamp

## MeBo Wireline Seafloor Drill



## Antarctic Margin Scientific Drilling and Core Recovery




**Core Recovery of Sandy Shelf Sediments:**

DSDP Leg 28 = <40%

ODP Leg 119 = <40%

ODP Leg 178 = <14%

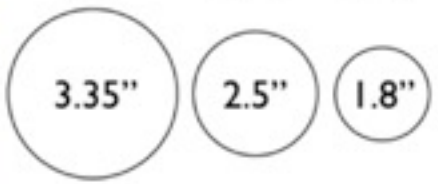
IODP Exp. 318 = <40%

ANDRILL = >98%

**APC Cutting Shoe**

**Rotary Coring Bit**

**Extended Core Barrel (XCB) Cutting Shoe**




## The Importance of a Small Kerf

(Kerf = width of material removed by a cutting process)

**IODP/ODP Coring Shoes and Bits**

ADCB = 101 mm
83 mm / 184 mm
20% of hole size remaining for core

XCB = 231
60 mm / 291 mm
8% of hole size remaining for core

**Mineral-type Drill Rods and Diamond Bits**

PQ3 = 40 mm
83 mm / 123 mm
46% of hole size remaining for core

HQ3 = 35 mm
61 mm / 96 mm
42% of hole size remaining for core

NQ3 = 31 mm
45 mm / 76 mm
35% of hole size remaining for core

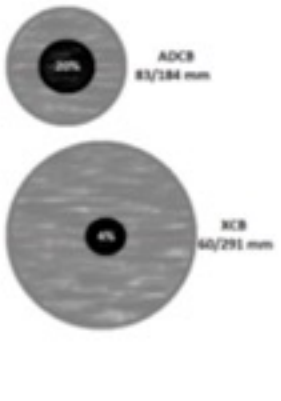
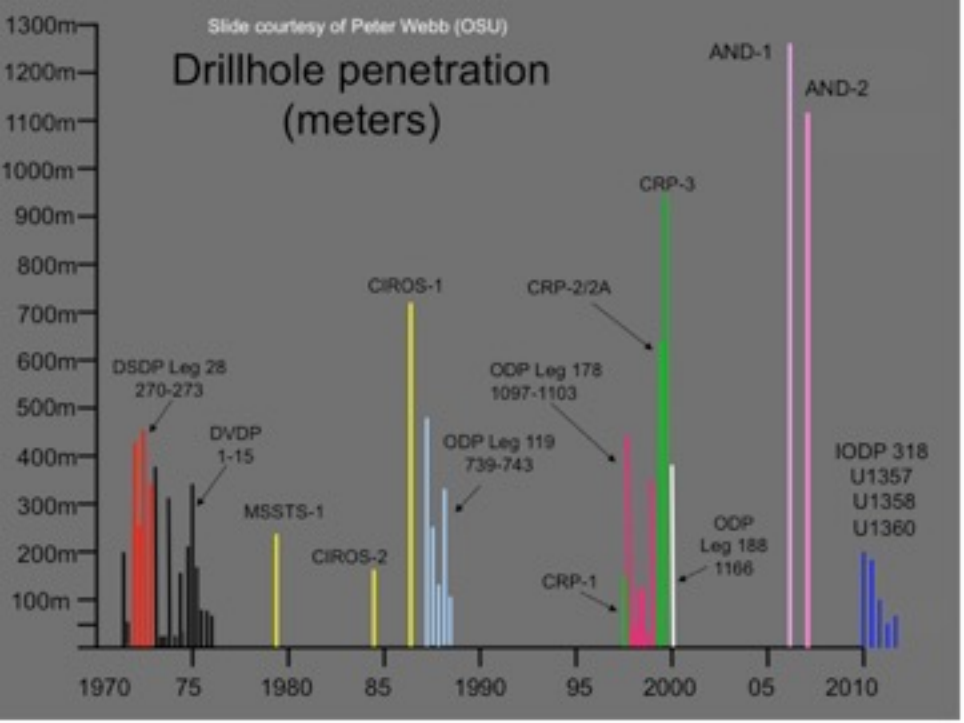
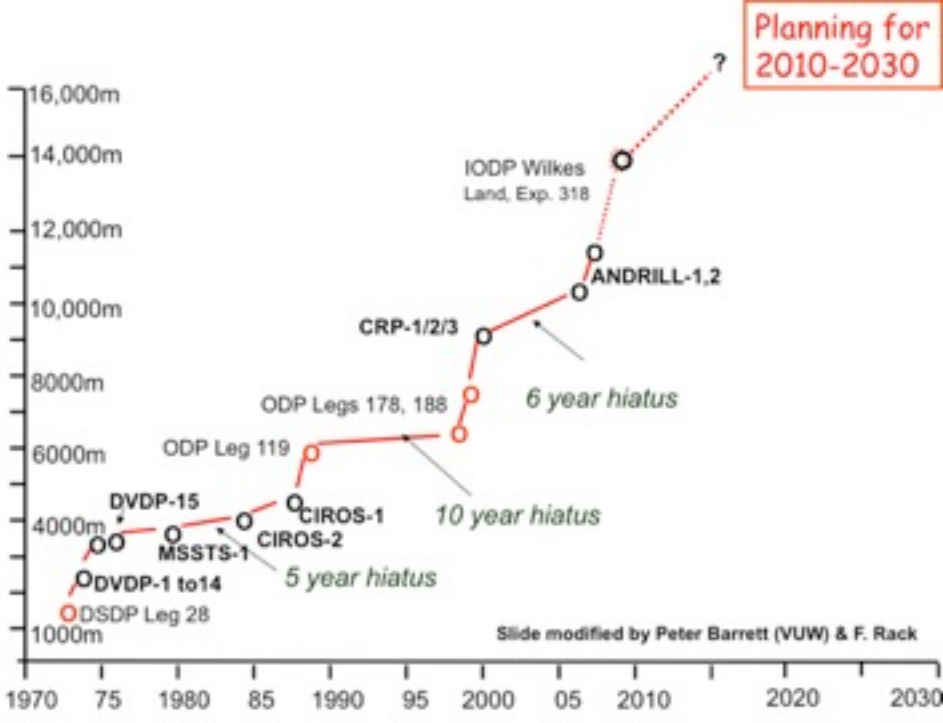



Figure modified after Alex Pyne, Victoria University of Wellington, ANDRILL Oxford Workshop (2001); In: Harwood, D.M., Lacy, L. and Levy, R.H. (eds.), 2002. Future Antarctic Margin Drilling: Developing a Science Plan for McMurdo Sound. ANDRILL Science Management Office (SMO) Contribution 1. University of Nebraska–Lincoln, Lincoln, NE. vi+301 pp.




## Southern Ocean ODP/IODP Estimated Costs per Core

| Leg | Days | Est. Cost/Day | Est. Cost/Leg | Core (m) | $/m of Core |
|---|---|---|---|---|---|
| 113 | 76 | $55,397 | $4,210,192 | 1944 | $ 2,166 |
| 114 | 63 | $55,397 | $3,490,027 | 2300 | $ 1,517 |
| 119 | 69 | $56,575 | $3,903,699 | 2102 | $ 1,857 |
| 120 | 68 | $56,575 | $3,847,123 | 1082 | $ 3,556 |
| 177 | 58 | $61,827 | $3,585,989 | 4046 | $ 886 |
| 178 | 63 | $61,827 | $3,895,126 | 1807 | $ 2,156 |
| 188 | 60 | $60,803 | $3,648,164 | 971 | $ 3,757 |
| 189 | 56 | $60,803 | $3,404,953 | 4538 | $ 750 |
| 318 | 64 | $121,600 | $7,782,368 | 1973 | $ 3,944 |
| Ave. | 64 | $65,645 | $4,196,405 | 2307 | $ 1,819 |
| Ant. | 66 | $71,240 | $4,687,910 | 1759 | $ 2,664 |
| Sub. | 61 | $58,651 | $3,582,023 | 2992 | $ 1,197 |
| ANDRILL | | | | | |
| MIS | 58 | $73,547 | $4,265,731 | 1259 | $ 3,387 |
| SMS | 55 | $77,559 | $4,265,731 | 1115 | $ 3,825 |

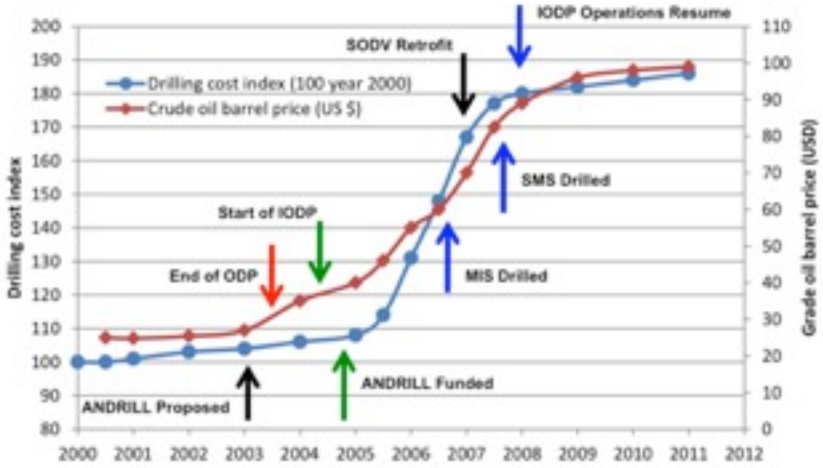



Figure 1 : Drilling cost vs. crude oil prices

# SCAR – Past Antarctic Ice Sheet dynamics (PAIS)

In 2014, the **SCAR-Past Antarctic Ice Sheet dynamics (PAIS)** program was created.

The SCAR Scientific Research Programme PAIS (Past Antarctic Ice Sheet dynamics) aims to improve understanding of the sensitivity of East, West, and Antarctic Peninsula Ice Sheets to a broad range of climatic and oceanic conditions.

PAIS builds on the success of SCAR-ACE (Antarctic Climate Evolution), but with a new focus on the ice sheet rather than palaeoclimate reconstructions. Study intervals span a range of timescales, including past "greenhouse" climates warmer than today, and times of more recent warming and ice sheet retreat during glacial terminations.

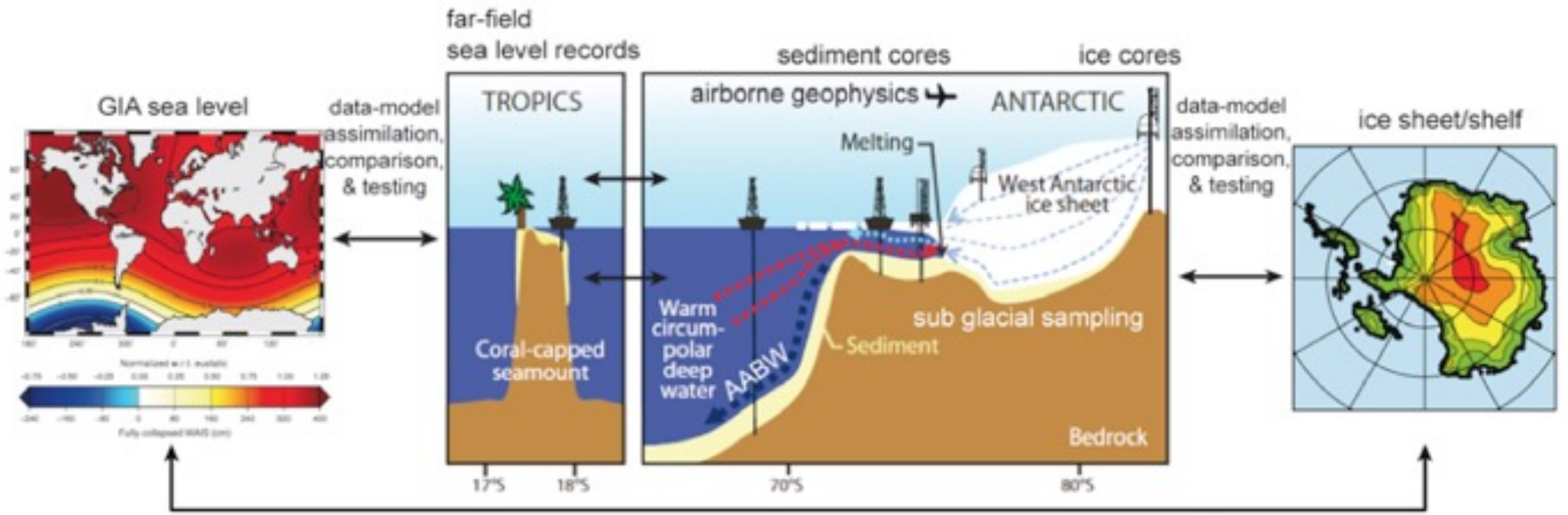
The PAIS research philosophy is based on data-data and data-model integration and intercomparison, and the development of "ice-to abyss" data transects, extending from the ice sheet interior to the deep sea.

The data transect concept will link ice core, ice sheet-proximal, offshore, and far-field records of past ice sheet behaviour and sea level, yielding an unprecedented view of past changes in ice sheet geometry, volume, and ice sheet-ocean interactions. These integrated data sets will enable robust testing of a new generation of coupled Glacial Isostatic Adjustment-Ice Sheet-Atmosphere-Ocean models that include new reconstructions of past and present ice bed topography and bathymetry.

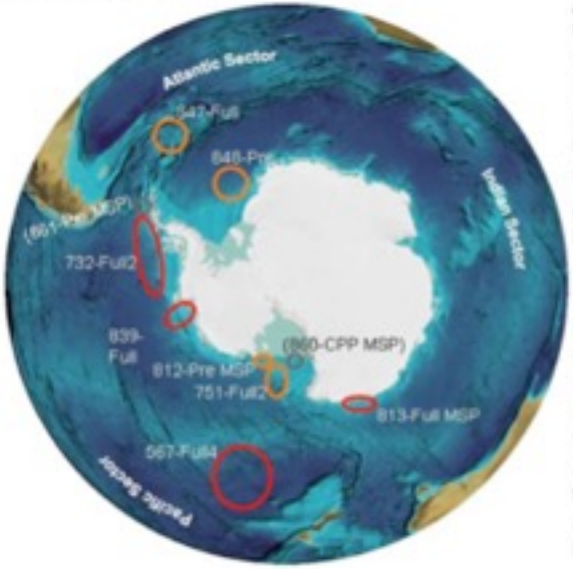
http://www.scar.org/srp/pais

# PAIS ice-margin-offshore-far field transect concept and data-model comparison

GIA sea-level models | Data Transect | Ice sheet/shelf models




**Active IODP proposals for Southern Ocean around Antarctica**
status: August 2014




**At JR or ECORD Facility Board for scheduling/implementation:**

567-Full (Thomas): at JR-FB

732-Full (Channel): at JR-FB

813-Full MSP (Williams): at ECORD-FB: scheduled for 2016

839-Full (GoM): at JR-FB

**Decision by Science Evaluation Panel (SEP):**

751-Full (McKay): solve site-survey issues

812-Pre MSP (Wilson): full prop.

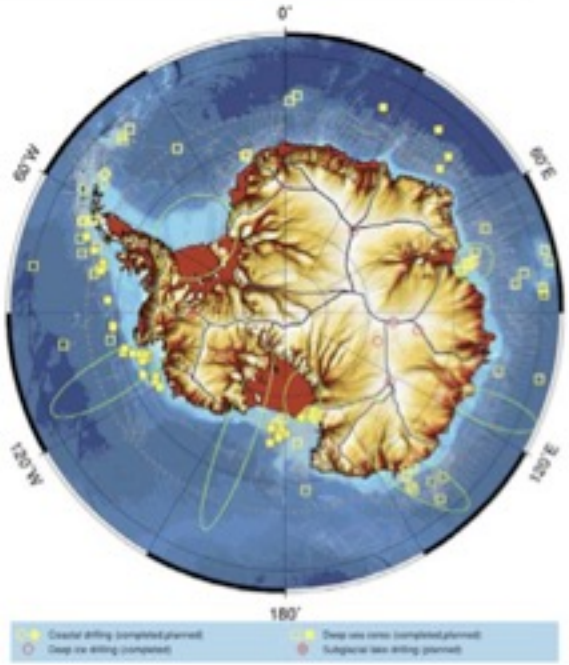
847-Full (Weber): revise

848-Pre (Weber): full prop.

860-CPP MSP (Levy, ANDRILL-CH): deactivate

861-Pre MSP (Balco): deactivate w. encour.

863-MDP MSP (Peterson, ISOLAT): revise w. daughter prop.



QUESTIONS?