Proposal 732-Full2:
Sediment drifts off the Antarctic Peninsula and West Antarctica

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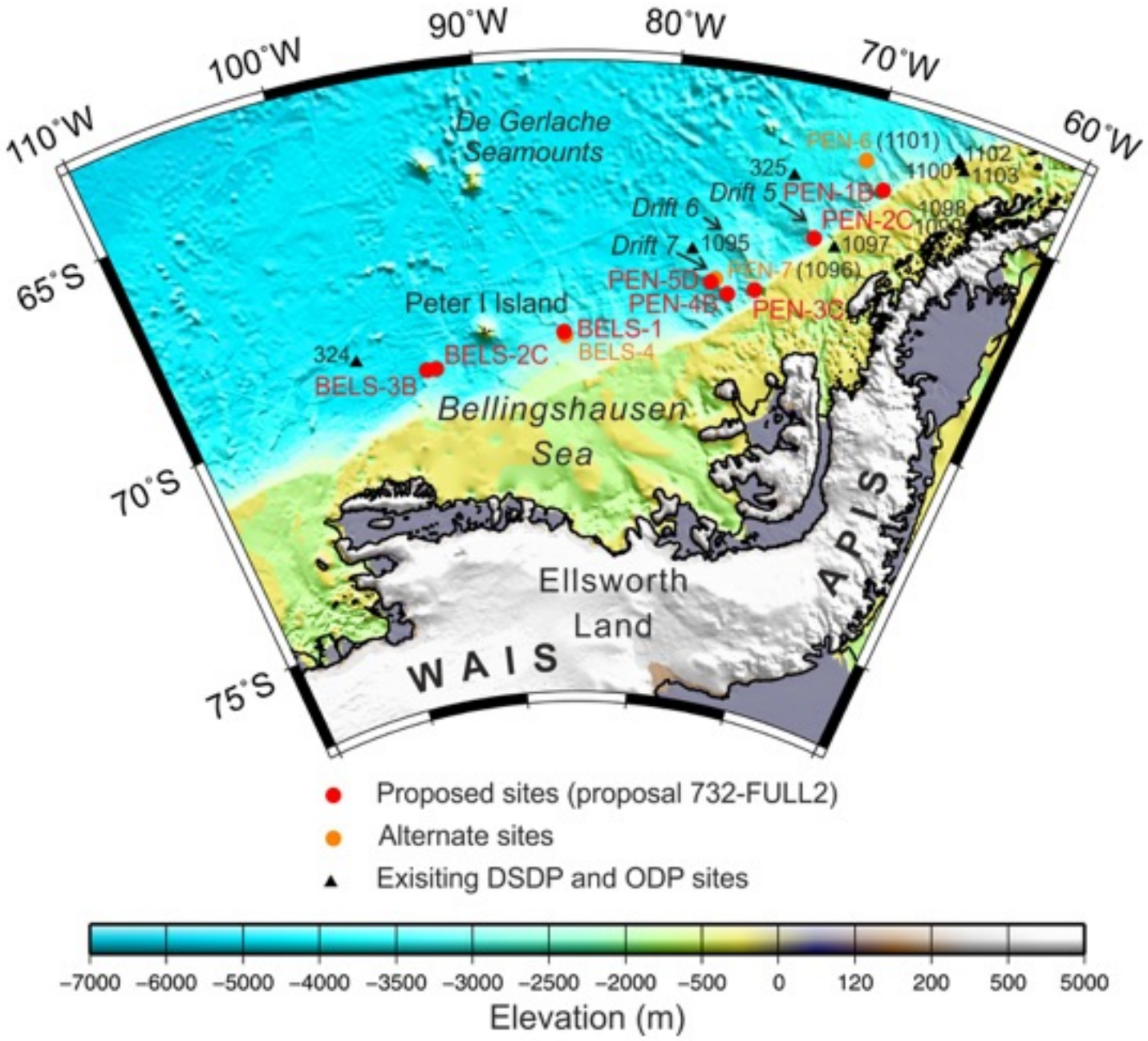
Antarctica's Cenozoic ice and climate history:
New science and new challenges of drilling in Antarctic waters
College Station, 9th May 2016

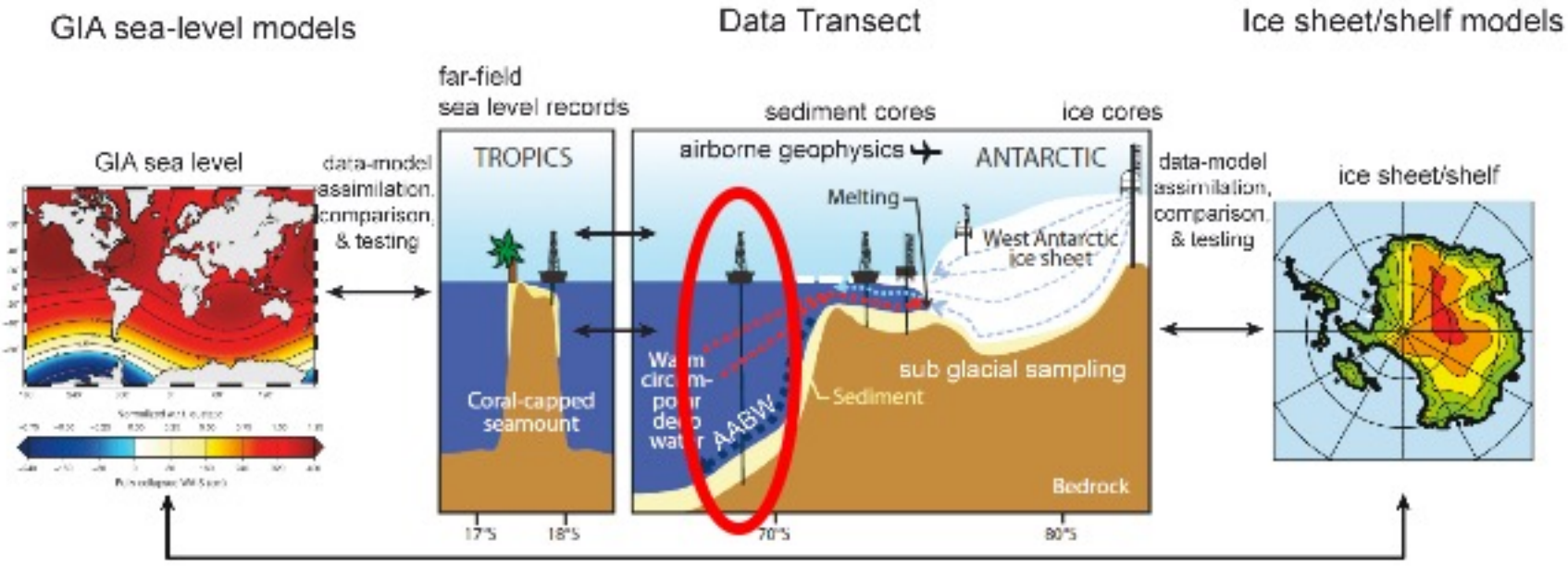

90°W
80°W
100°W
70°W
110°W
60°W
65°S
70°S
75°S
De Gerlache Seamounts
PEN-6 (1101)
325
1102
1100
1103
Drift 5
PEN-1B
Drift 6
PEN-2C
1098
Drift 7
1095
1097
PEN-5D
PEN-7 (1096)
PEN-4B
PEN-3C
Peter I Island
BELS-1
BELS-4
324
BELS-2C
BELS-3B
Bellingshausen Sea
Ellsworth Land
WAIS
APIS
Proposed sites (proposal 732-FULL2)
Alternate sites
Exisiting DSDP and ODP sites
−7000 −6000 −5000 −4000 −3500 −3000 −2500 −2000 −500 0 120 200 500 5000
Elevation (m)

Antarctic and Southern Ocean science questions

IODP Science Plan challenges:

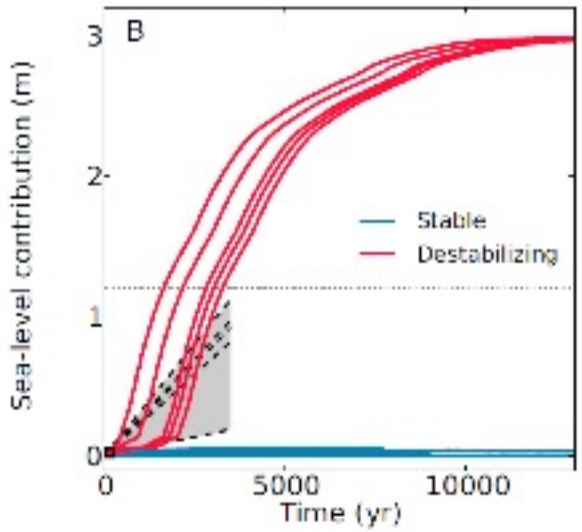
1. How does Earth's climate system respond to elevated levels of atmospheric CO_2?
2. How do ice sheets and sea level respond to a warming climate?

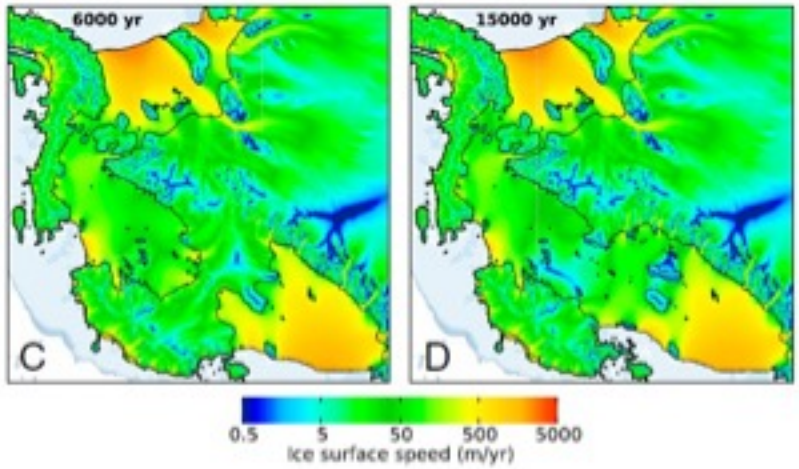
PAIS ice-margin-offshore-far field transect concept and data-model comparison



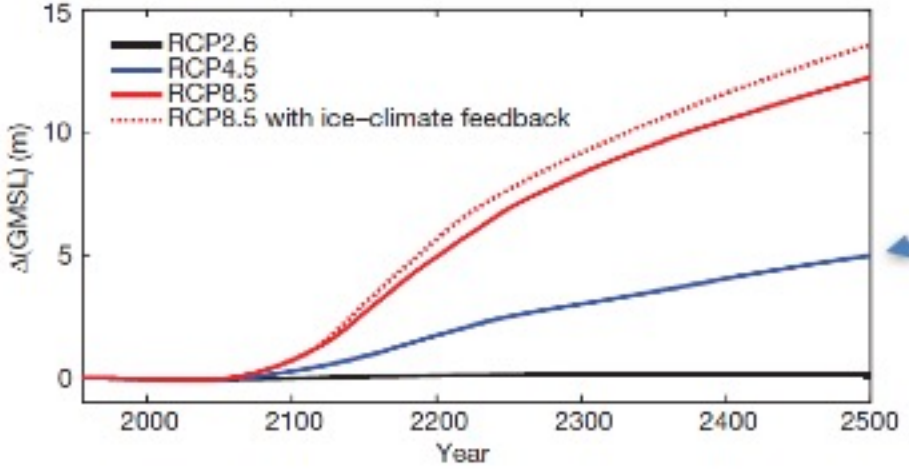
What time resolution do we need in order to capture ice dynamics?

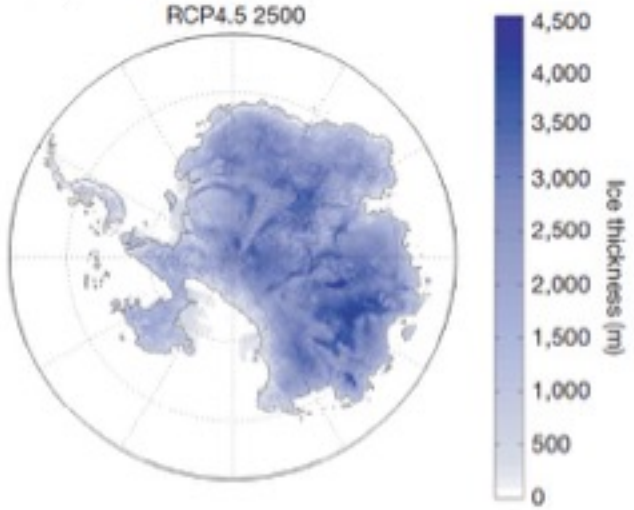
Feldmann & Levermann (2015) *PNAS* – unstable marine ice sheet retreat triggered by local, 60-yr perturbation in Amundsen Sea





DeConto & Pollard (2016) *Nature* – model incorporating marine ice cliff instability, and tuned with Pliocene and LIG sea level records





Challenges of drilling in the Southern Ocean

Main challenges encountered are:

1. On the Antarctic continental shelf

- Incomplete sequences
- Poor core recovery
- *JOIDES Resolution* not ice strengthened

2. Most areas

- Lack of foraminiferal carbonate
- Interpretation of ice dynamics from sedimentary record

Carbonate issue

Sites with carbonate do exist – need careful site selection

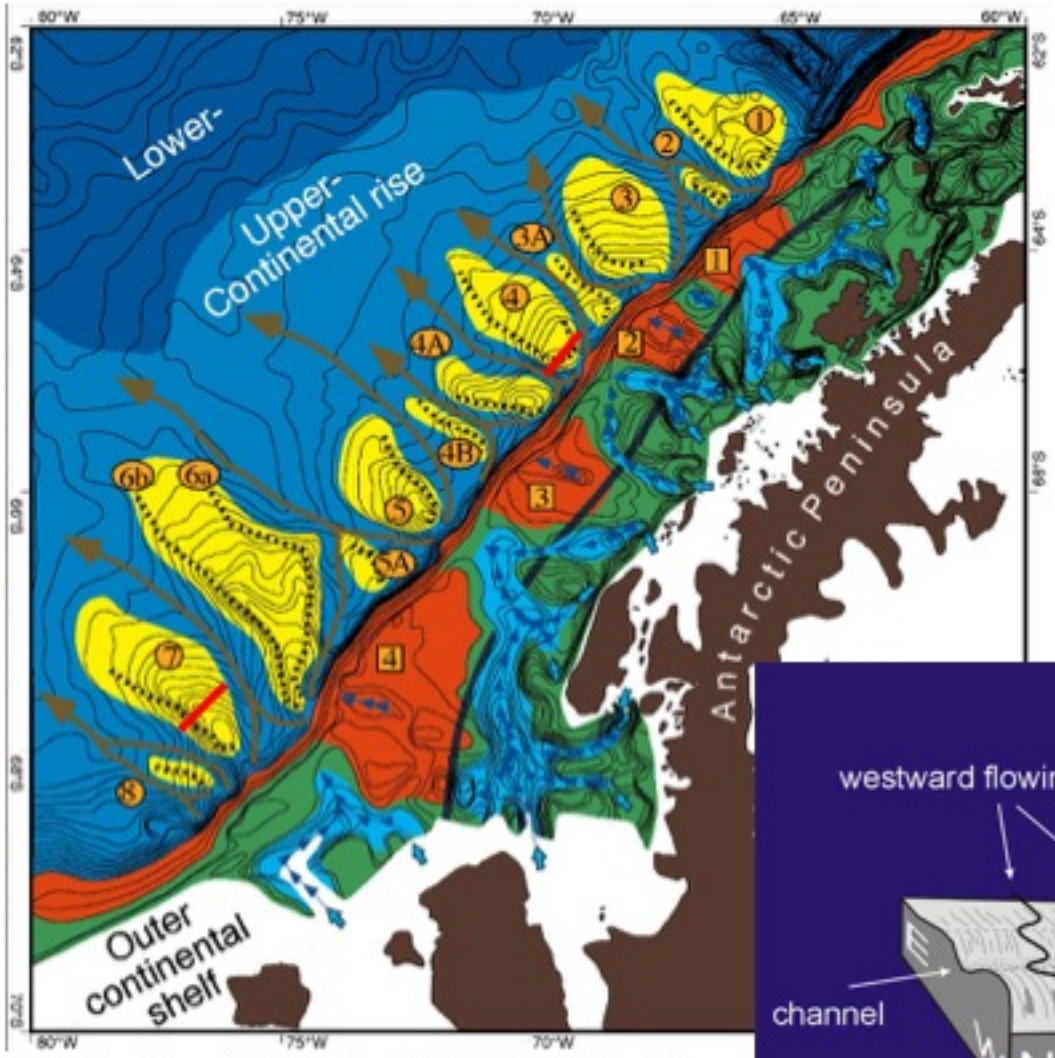
Can now complement with relative geomagnetic paleointensity (RPI) dating

Proposal 732 strategy to obtain detailed records

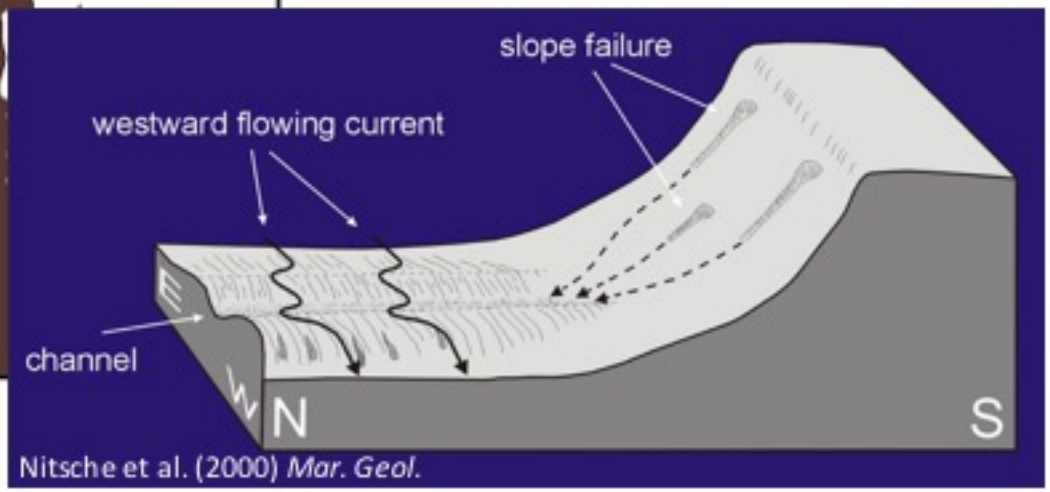
Target sites

1. where complete composite sections can be recovered
2. with continuous, high sed rates
3. as shallow as possible

Antarctic Peninsula continental rise drifts

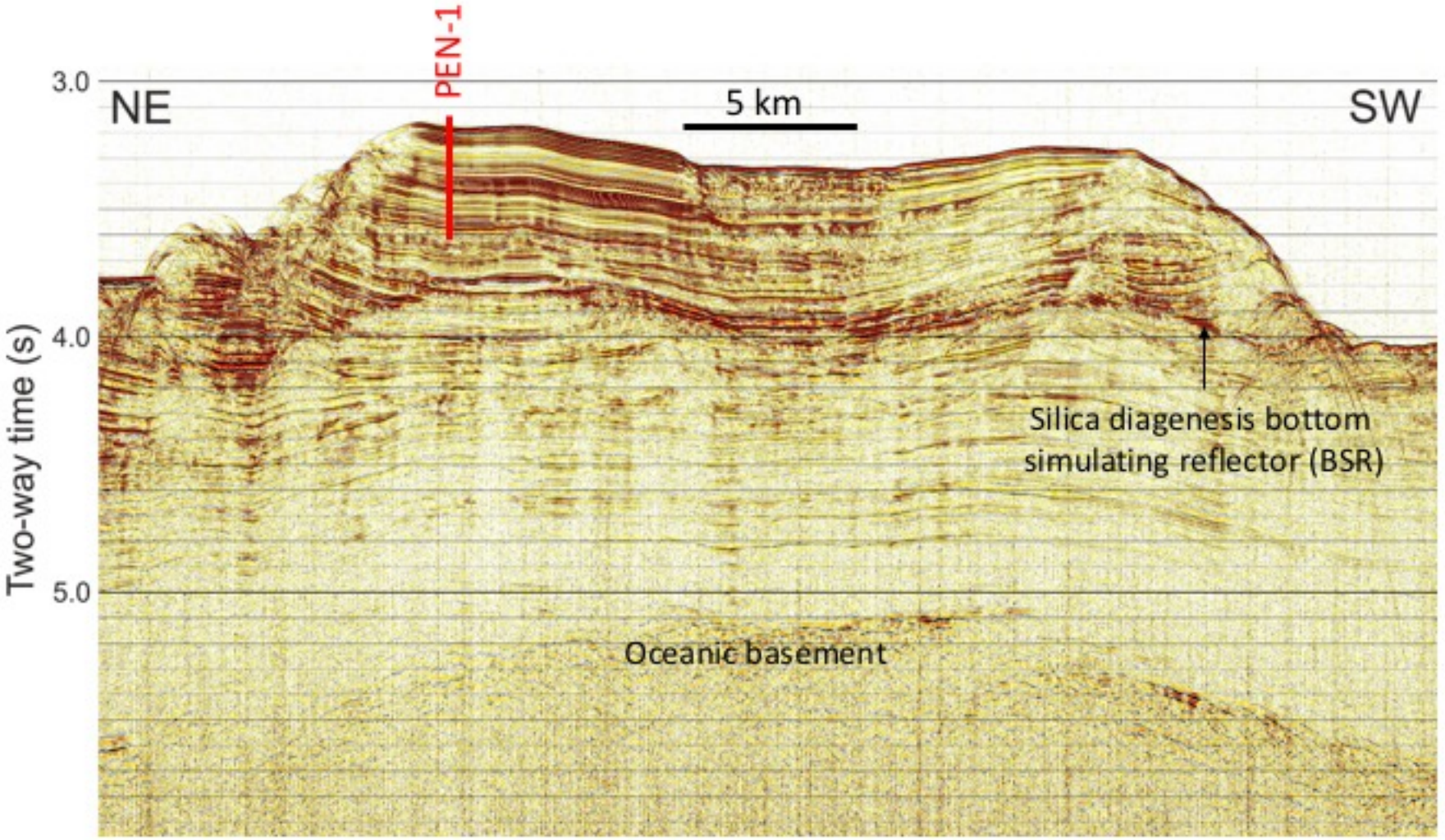


Modified from Rebesco et al. (1998) *Terra Antartica*
by F. J. Hernández-Molina

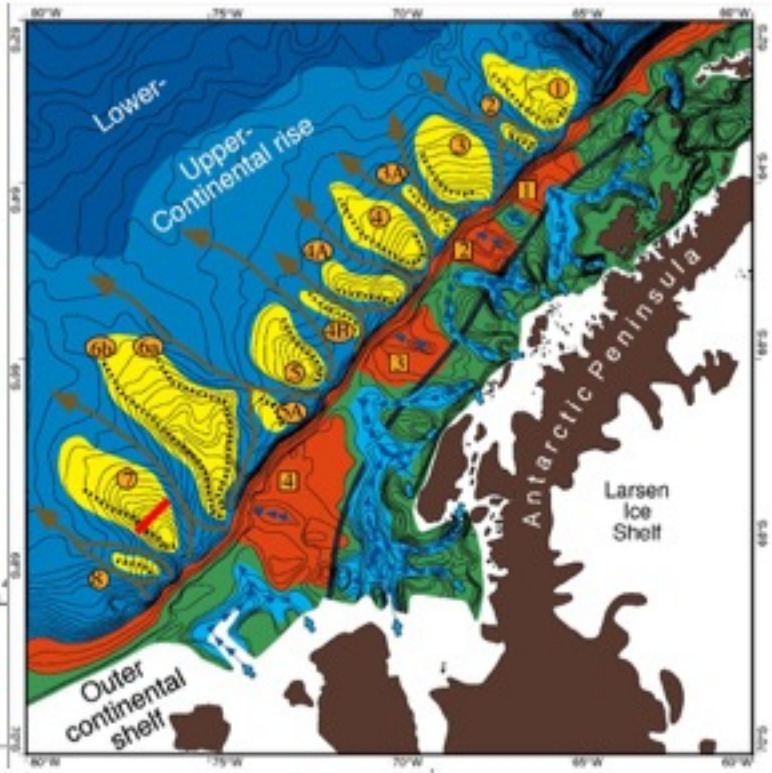


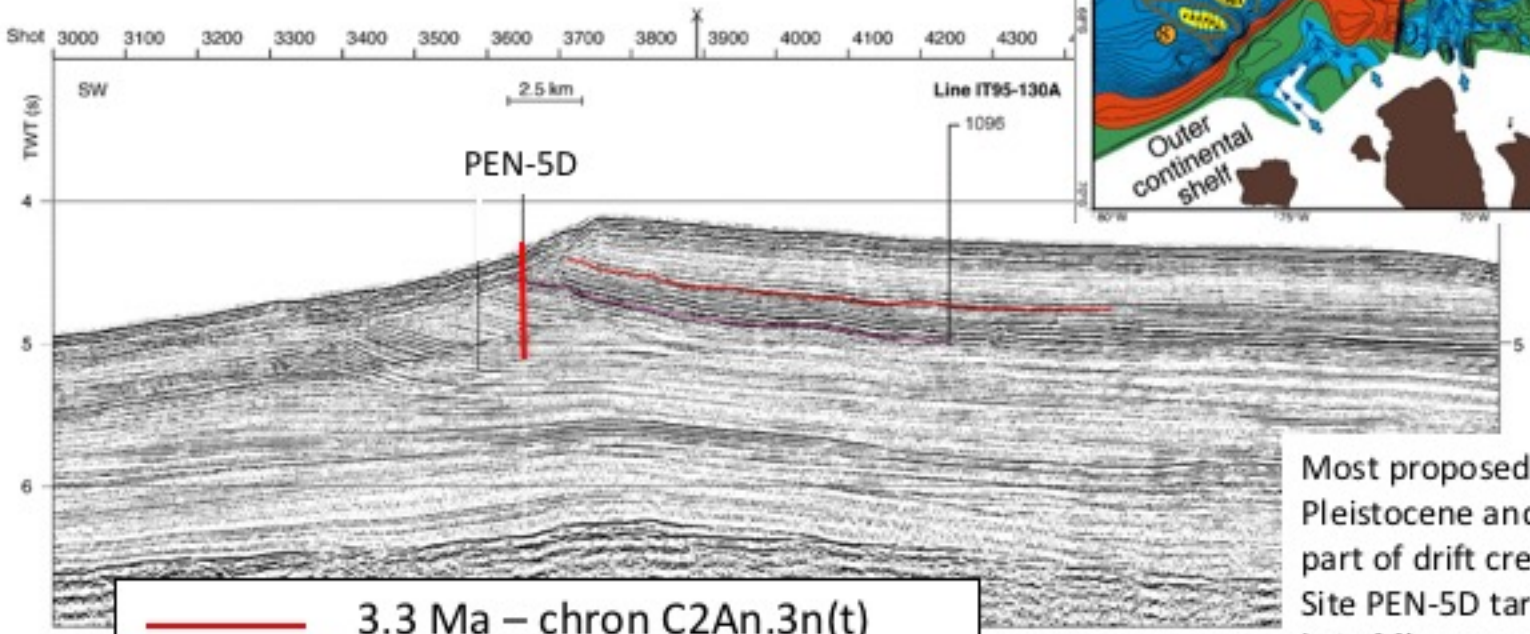
Nitsche et al. (2000) *Mar. Geol.*

MCS line BAS145-42 across Drift 4 (part of)



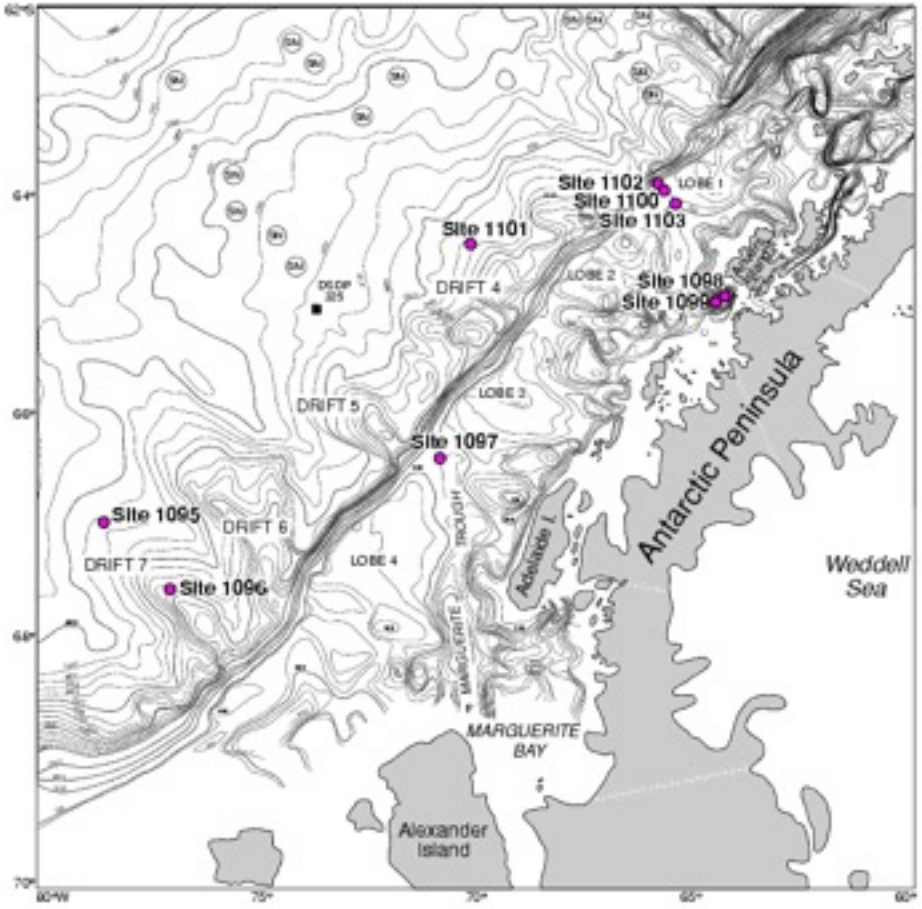
Two sites target pre-Pliocene succession





Most proposed sites target Plio-Pleistocene and are at shallowest part of drift crests (<2800 m), but Site PEN-5D targets Early Pliocene – Late Miocene section

Previous drilling in region – Leg 178 (1998)



Sites drilled on both shelf and rise

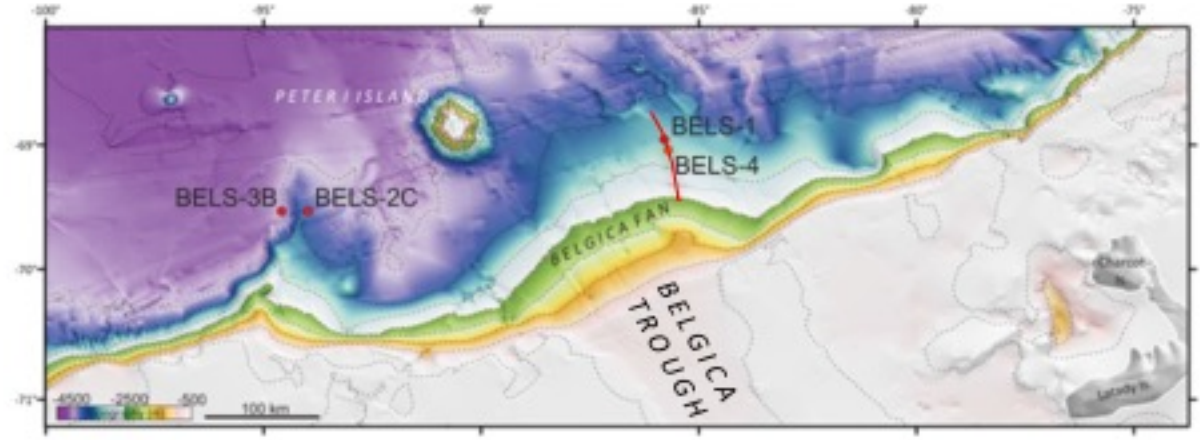
Sites 1098 & 1099 in Palmer Deep contained expanded post-glacial record

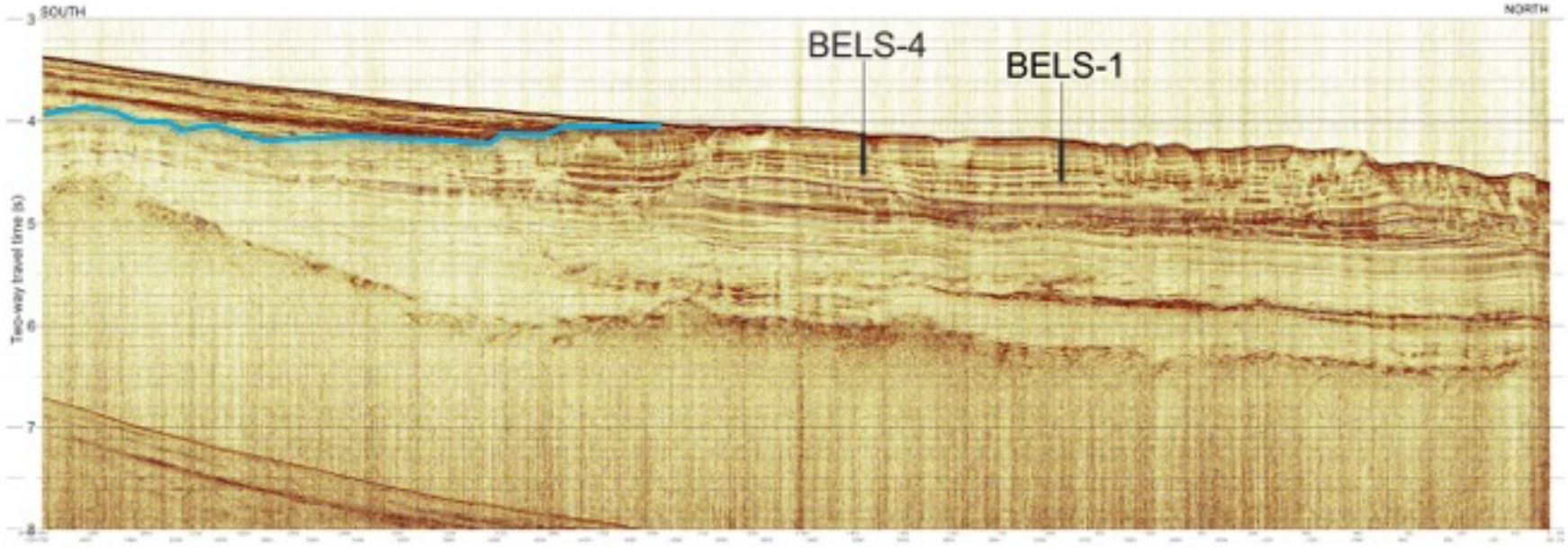
Other shelf sites had poor recovery

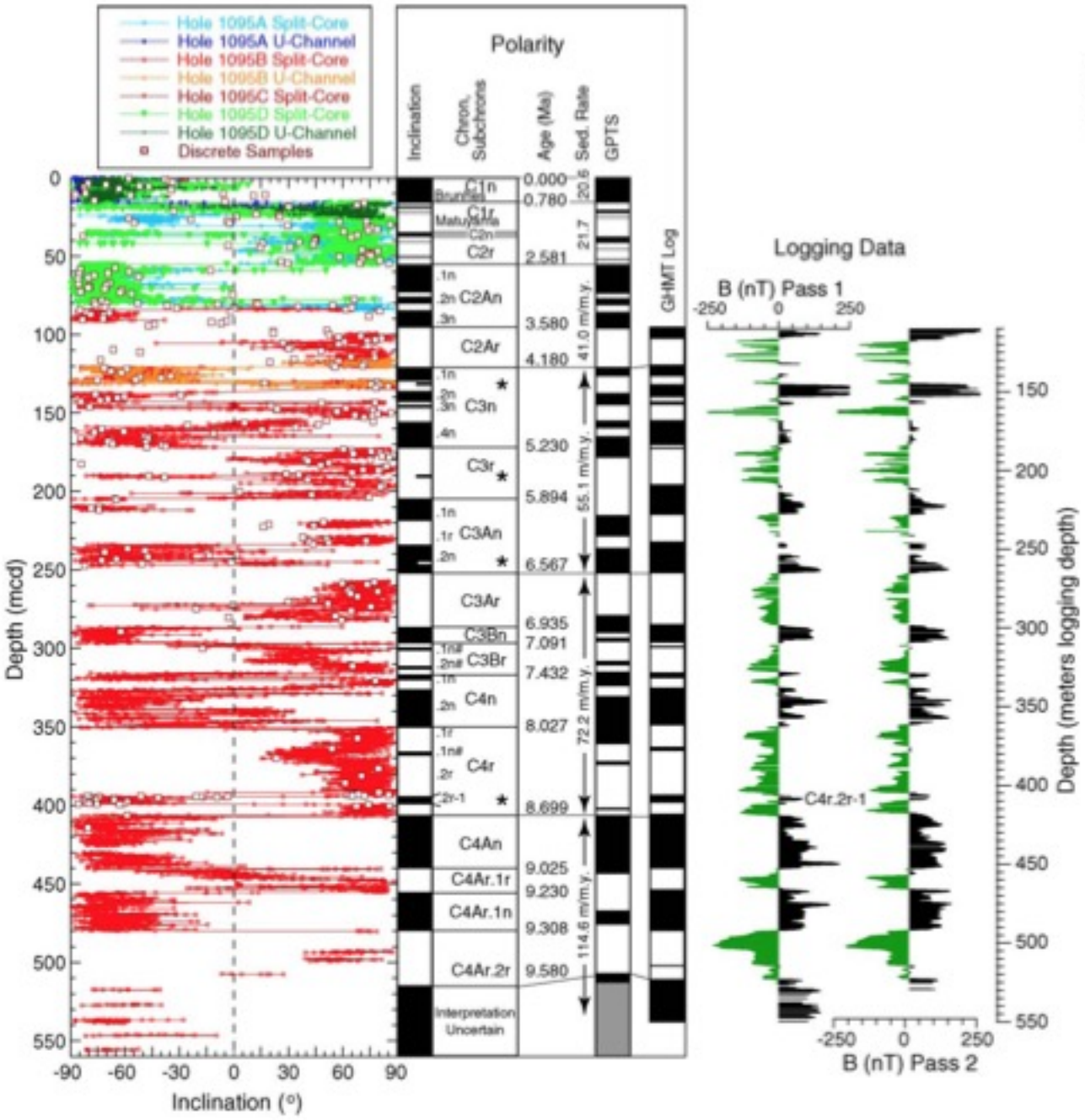
Three continental rise sed. drift sites:
1095 – double APC to only 84 mbsf
1096 – double APC to only 108 mbsf
1101 – only single APC/XCB hole
All three at >3100 m water depth

Previously, DSDP Site 325 was only spot cored, with 34.4 m recovered from 718 m drilled

Bellingshausen Sea sites – recording WAIS history

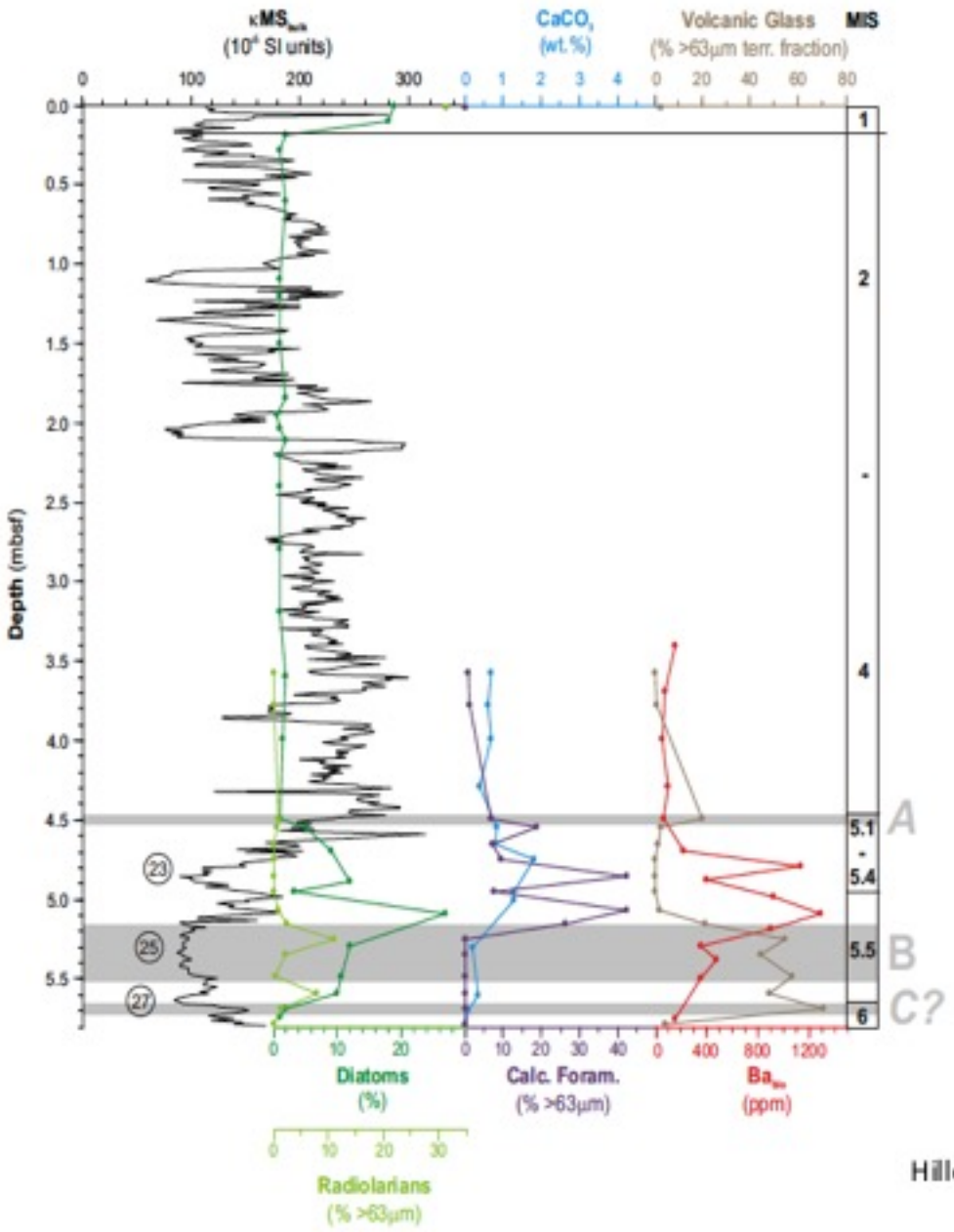






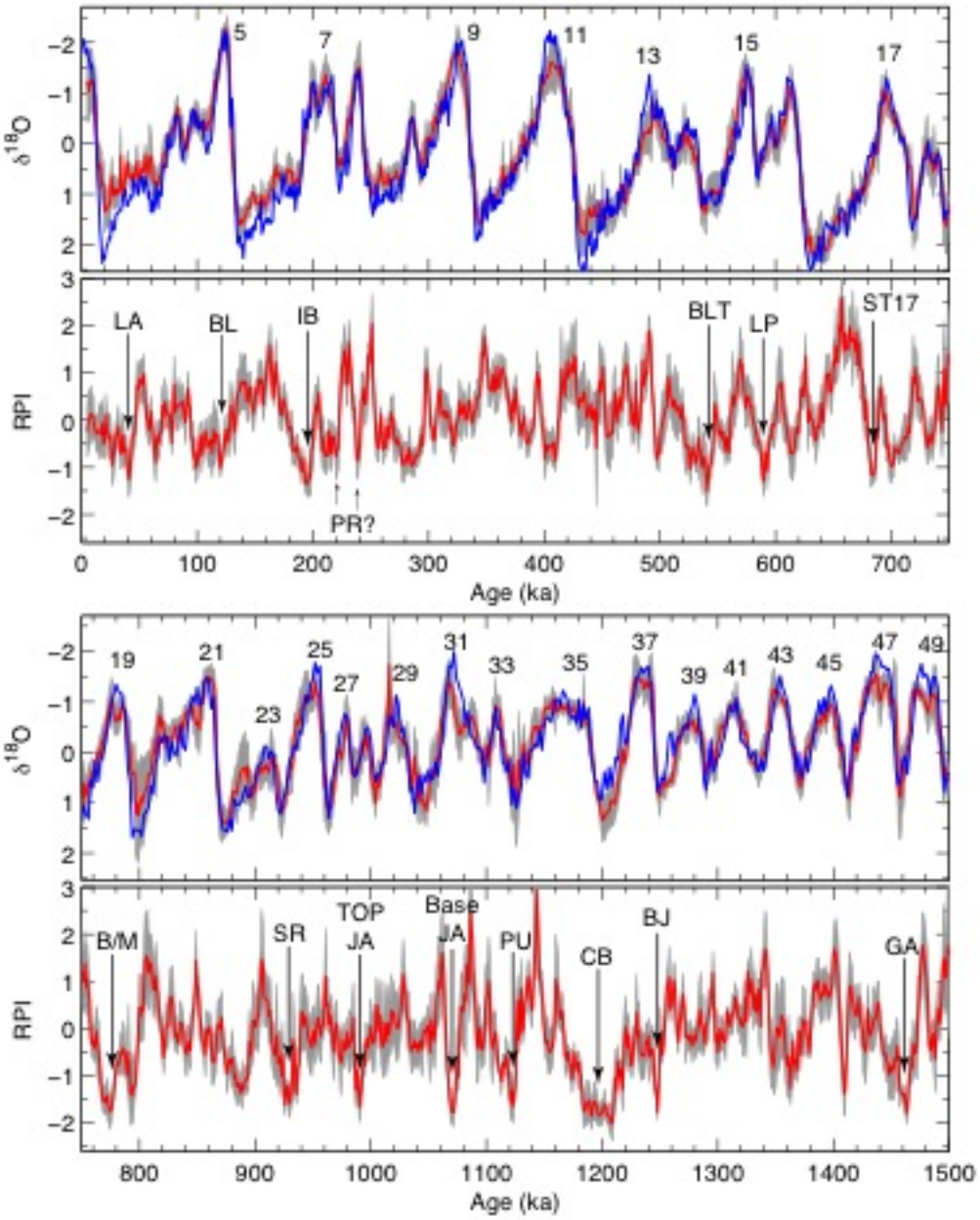
ODP Site 1095, Drift 7
(Acton et al., 2006)

SED07 (Drift 7)



Hillenbrand et al. (2008)

PISO-1500 RPI/$\delta^{18}O$ stack compared to LR04

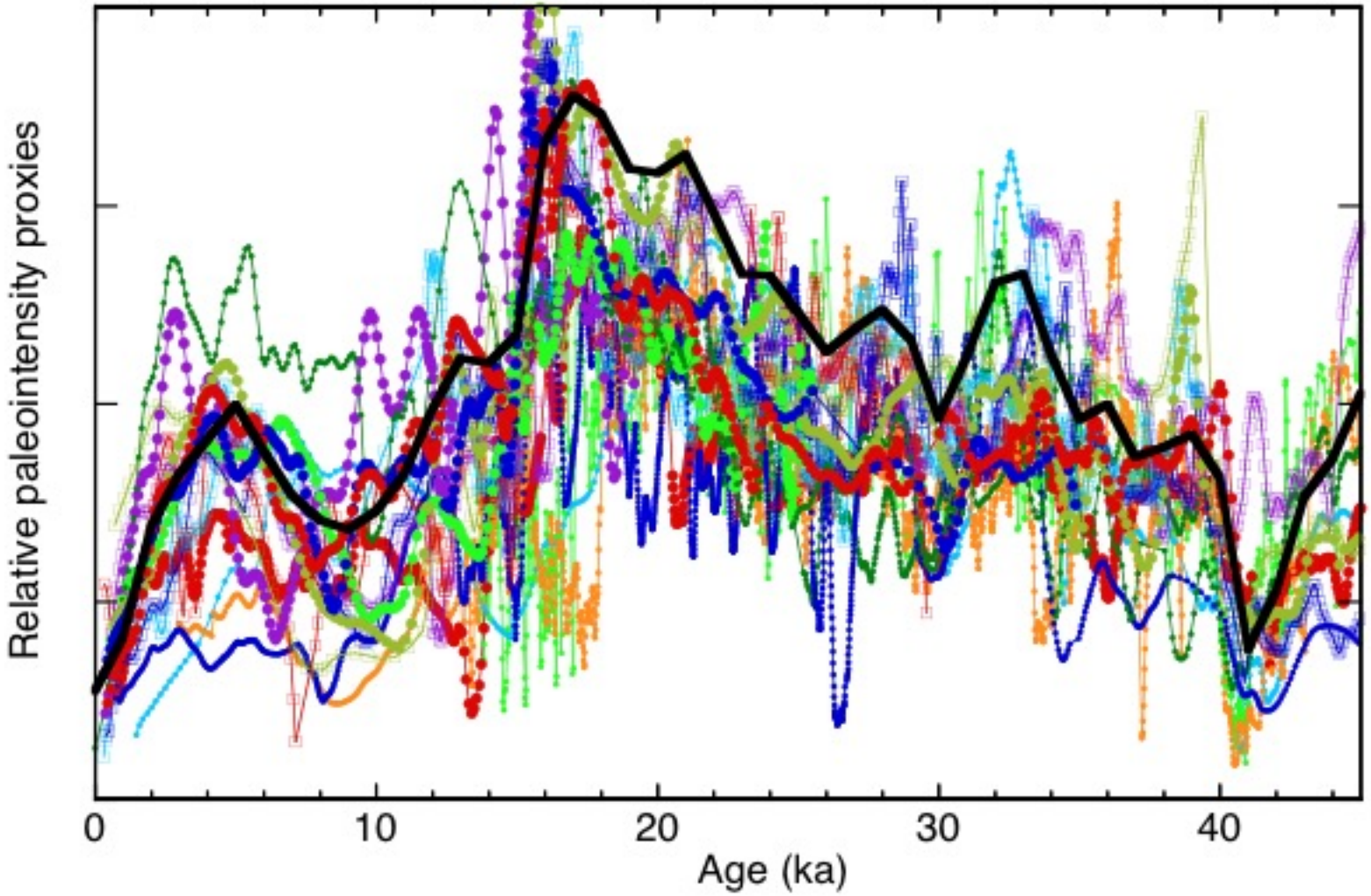


RPI (with $\delta^{18}O$) offers potential for near-millennial-scale chronology…also in Antarctic sediments that contain high-quality palaeomagnetic records.

Channell et al., 2009

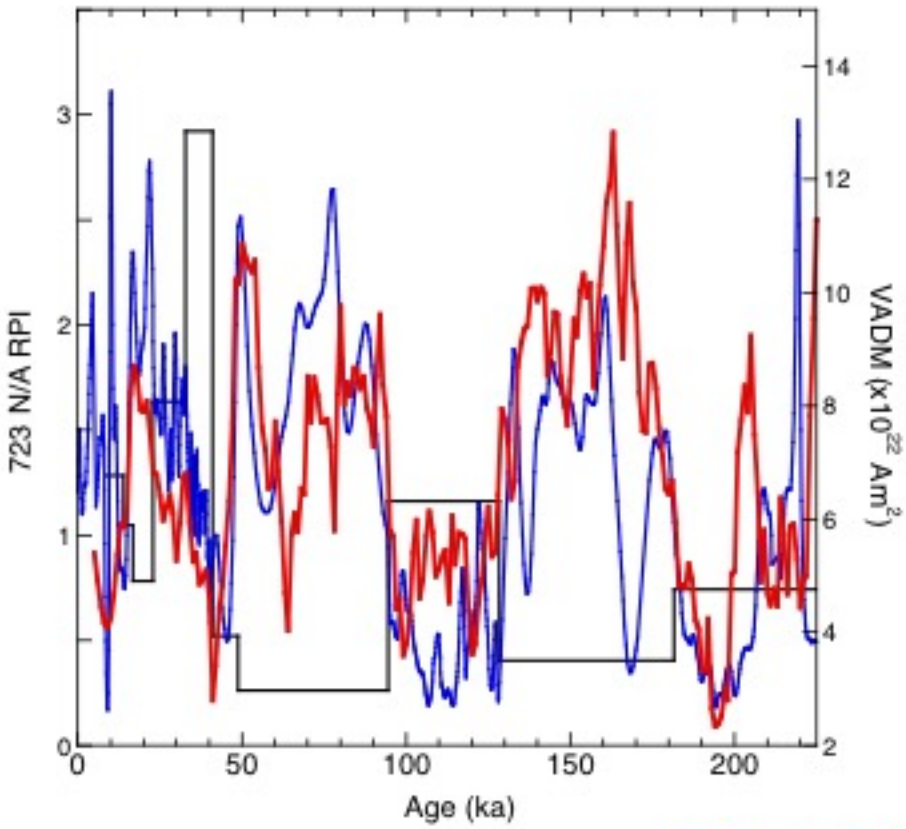
New RPI template for 0-45 ka

North Atlantic (plus two South Atlantic, one Pacific)
RPI records (19 in total) placed on their independent age models

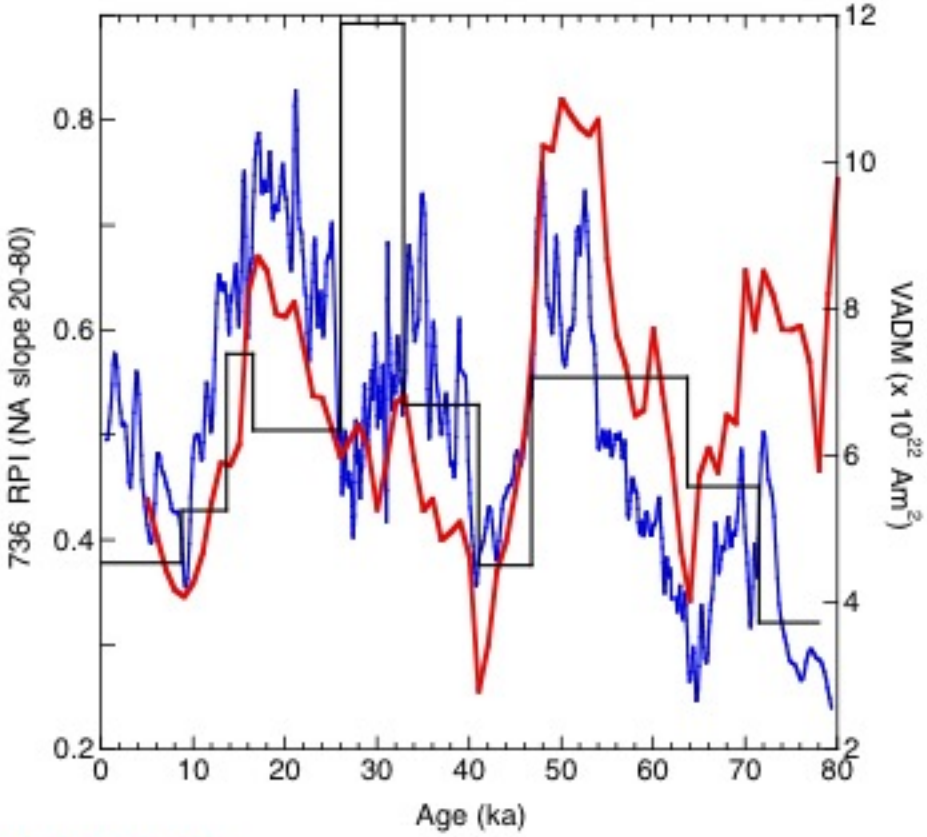


Cruise JR298 (Jan.-March 2015) – site survey for Prop. 732

723 (BELS-1)



736 (PEN-1, Drift 4)

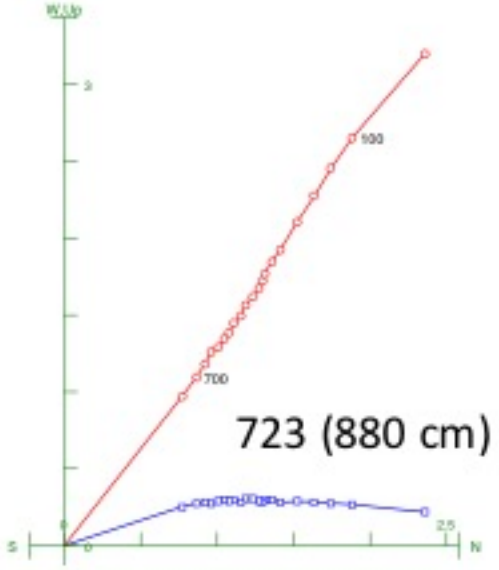


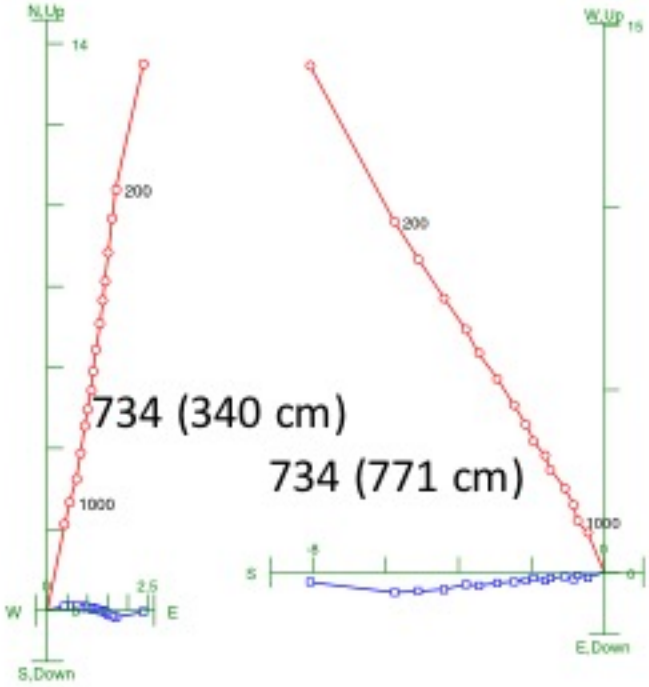
Reference RPI template in red

Mean sed. rate ~4.3 cm/kyr
Sed.rate range 2-17 cm/kyr

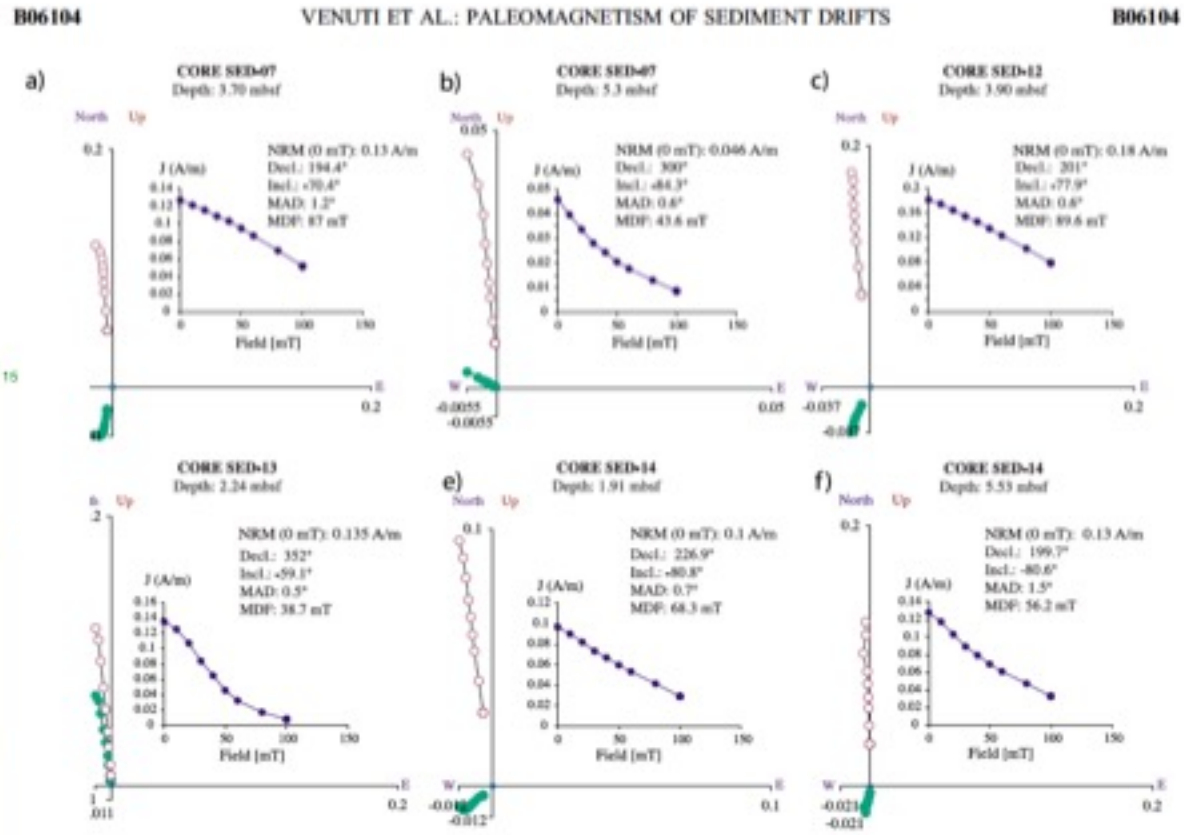
Mean sed. rate ~12 cm/kyr
Sed.rate range 5-30 cm/kyr

AF demagnetizaton of NRM

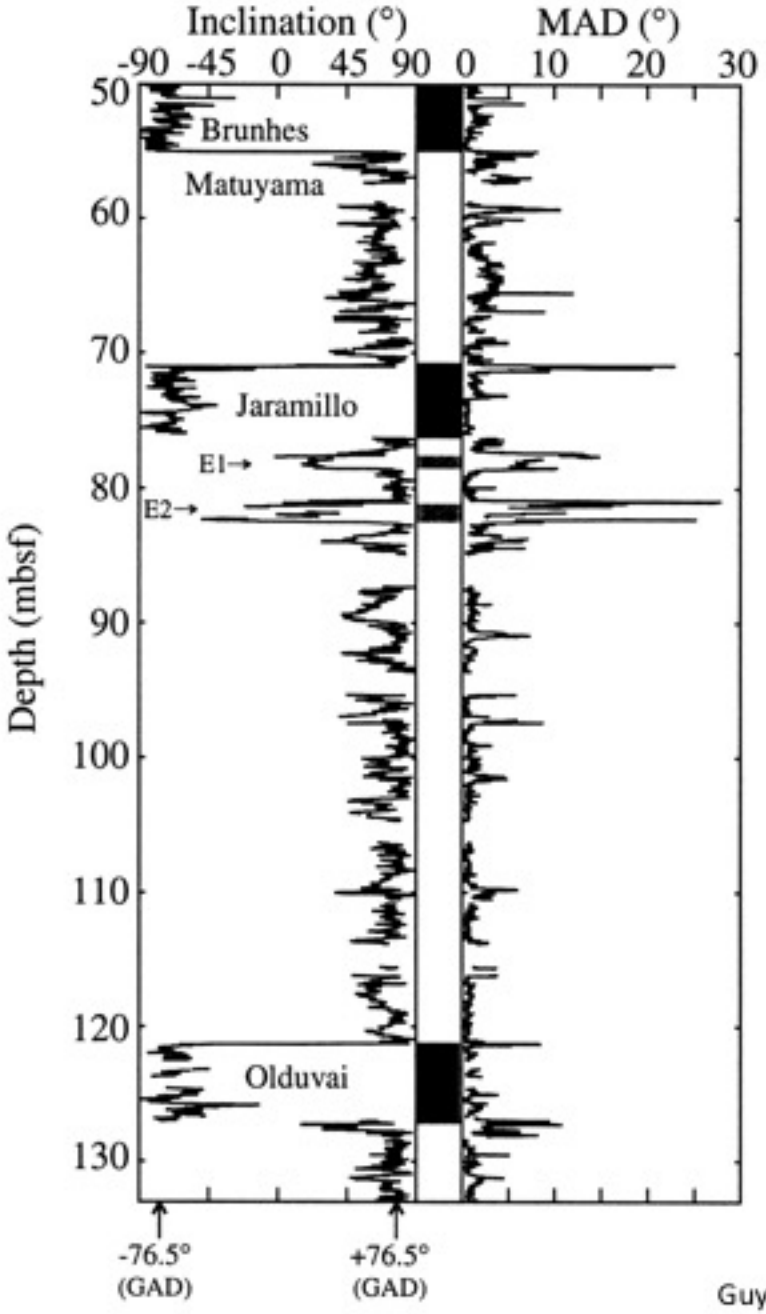


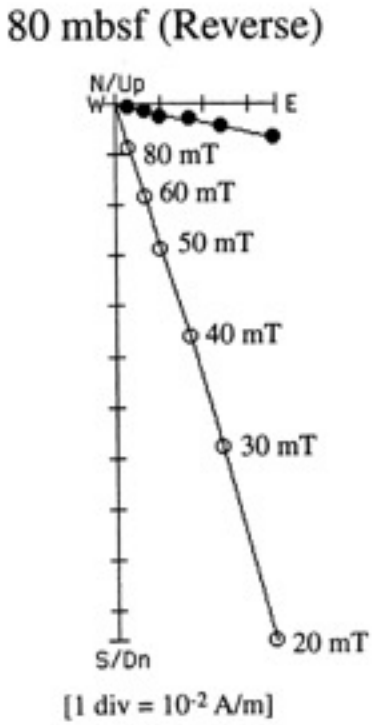


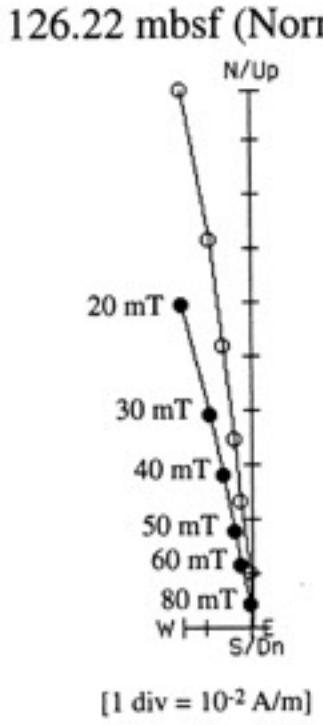
Venuti et al. (2011) Drift 7: "magnetically hard titanomagnetite"

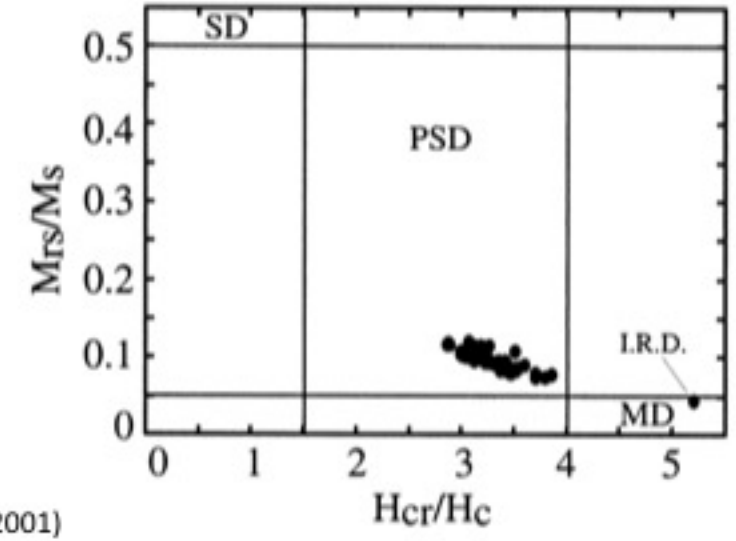


ODP Site 1101

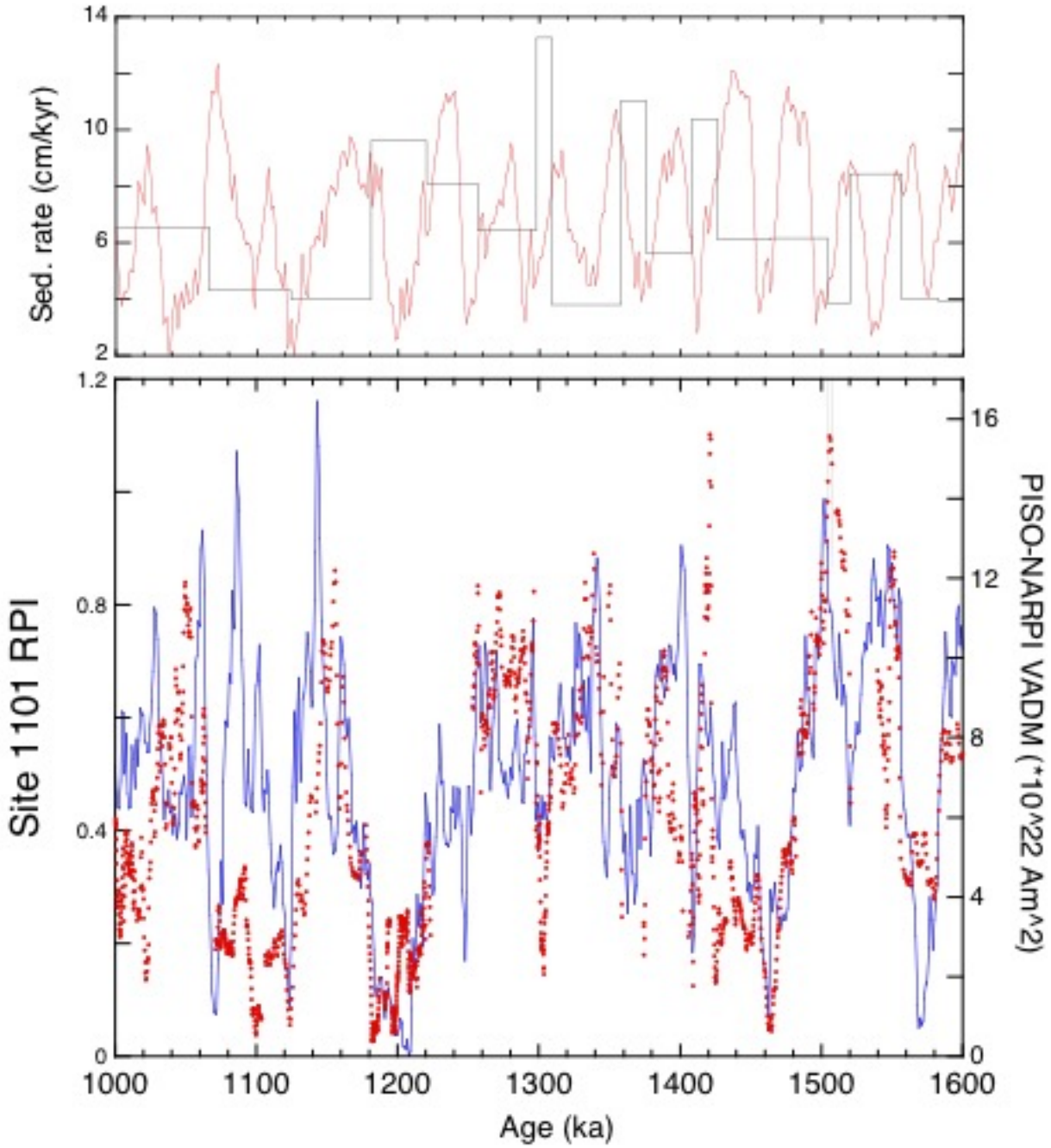








Guyodo et al. (2001)



ODP Site 1101

Site 1101 data from
Guyodo et al. (2001)
PISO-NARPI stack
(Channell et al., 2009, 2016)

Summary

- Drift sediments contain records of ice-sheet history and Southern Ocean paleoceanography, from multi-proxy methods
- Drifts are dominated by muddy sediments that have accumulated at relatively high sedimentation rates (often ~10 cm/kyr) and apparently without major hiatuses
- Chronostratigraphic problem due to general lack of foraminiferal carbonate prevents full exploitation of existing records
- Initial RPI results of existing cores (178-1101, SEDANO cores, PC466, JR298) suggest RPI can provide age control for off-shore drifts on orbital to millennial time scales, appropriate for reconstructing even short-term ice-sheet /climate changes