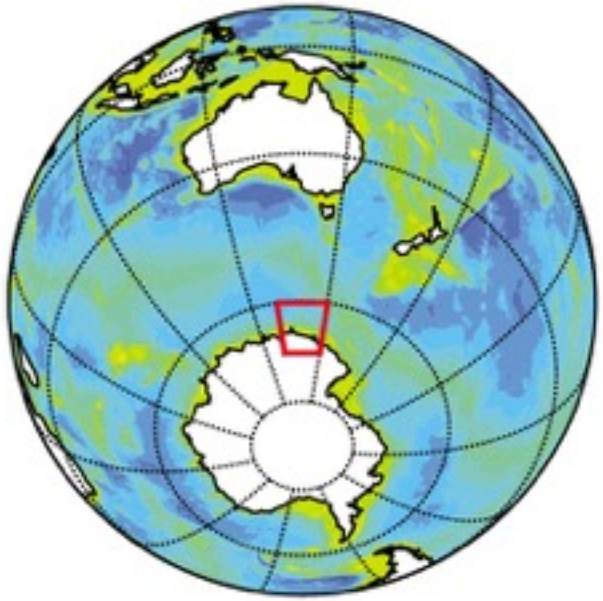
Scientific Background for IODP MSP proposal 813-Full
(early 2018)

Greenhouse to Icehouse
Antarctic paleoclimate and ice history
from George V Land and Adélie Land shelf sediments

("Antarctic Paleoclimate")



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Sean Gulick
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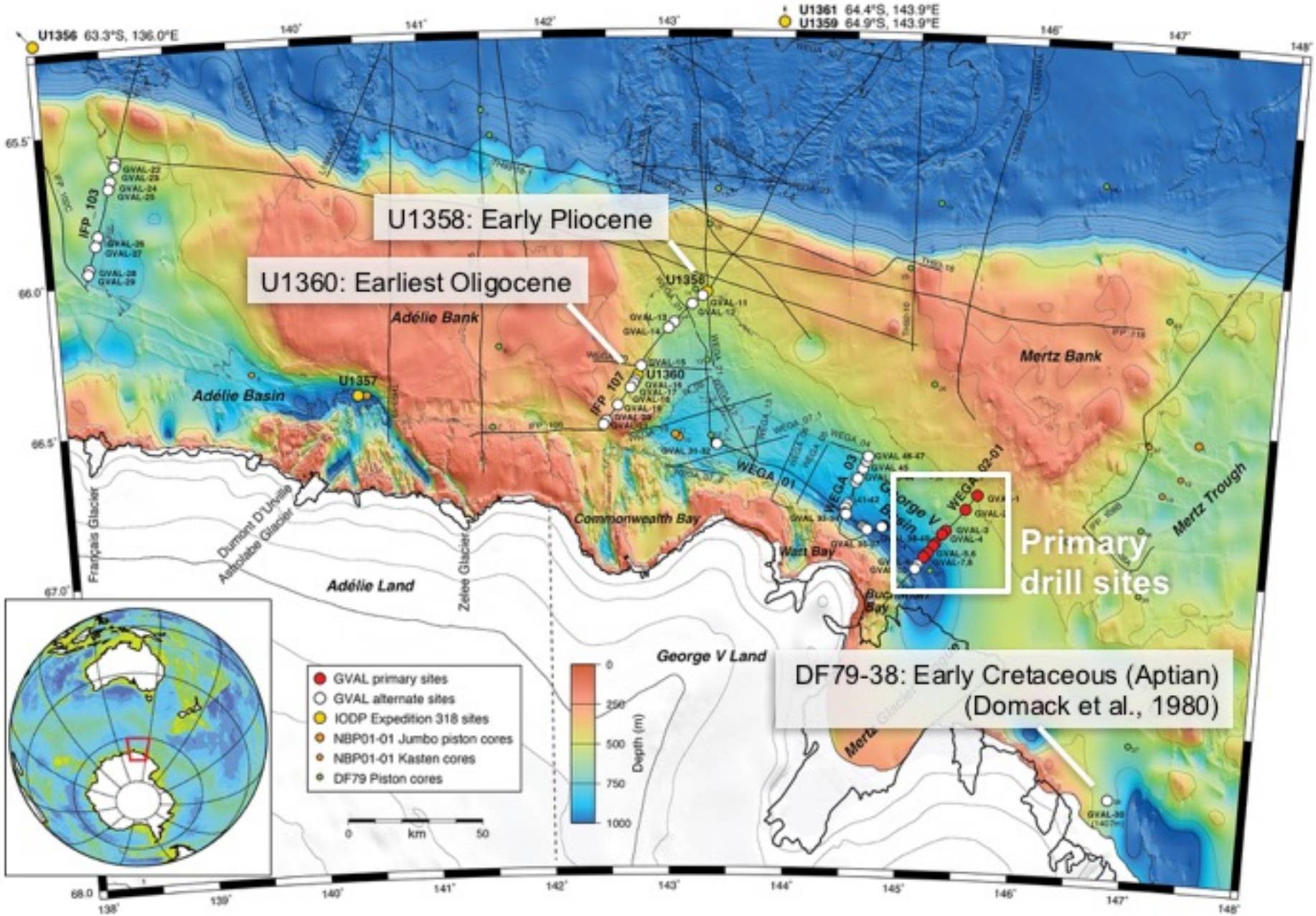
George V Land Antarctic Paleoclimate, IODP-813



IODP-813 Objectives

- Investigate Antarctica's climate during Early/Middle Eocene greenhouse warmth, including cyclicity, temperatures and vegetation. Pole-equator temperature gradient. Possible test of DeConto's permafrost hypothesis for hyperthermals.

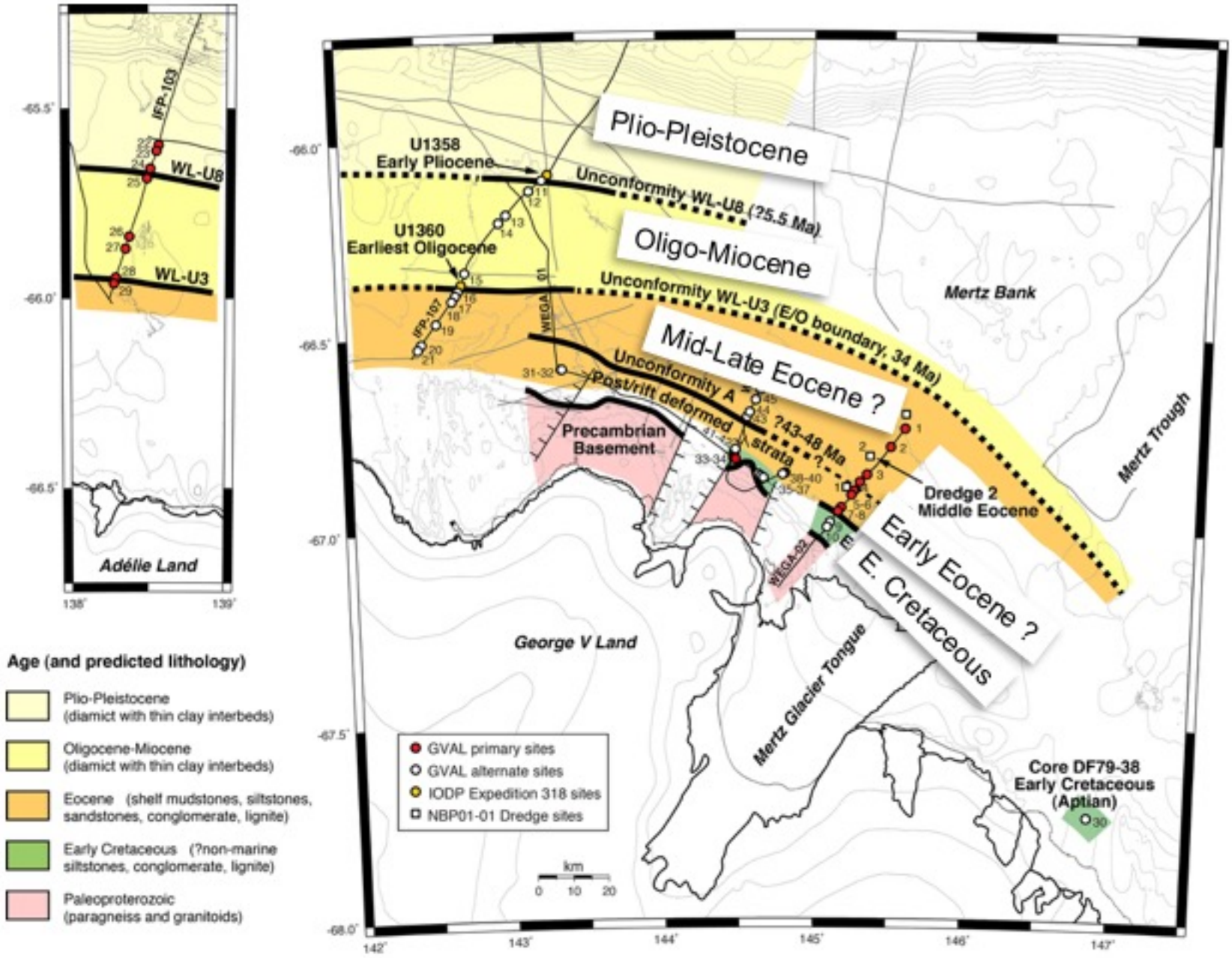
- Investigate climate cooling over the late Eocene in advance of main glacial inception. Were there precursor glaciations? How did Antarctica come to be the ice covered continent we see today?

- Investigate the timing and environmental conditions of major ice advances over the shelf. Eocene/Oligocene ice advance (~34 Ma) and Oligocene ice/climate conditions.

- Assess whether the predictions of glacial isostatic adjustment (GIA) models are recorded in the ice-proximal sediments (e.g., relative sea level rise adjacent to expanding ice sheets).

- **Alternate sites**: Cretaceous and Miocene-Pliocene strata available at shallow depths at alternate sites; Date the major unconformities (glacial advances, vertical crustal motion).

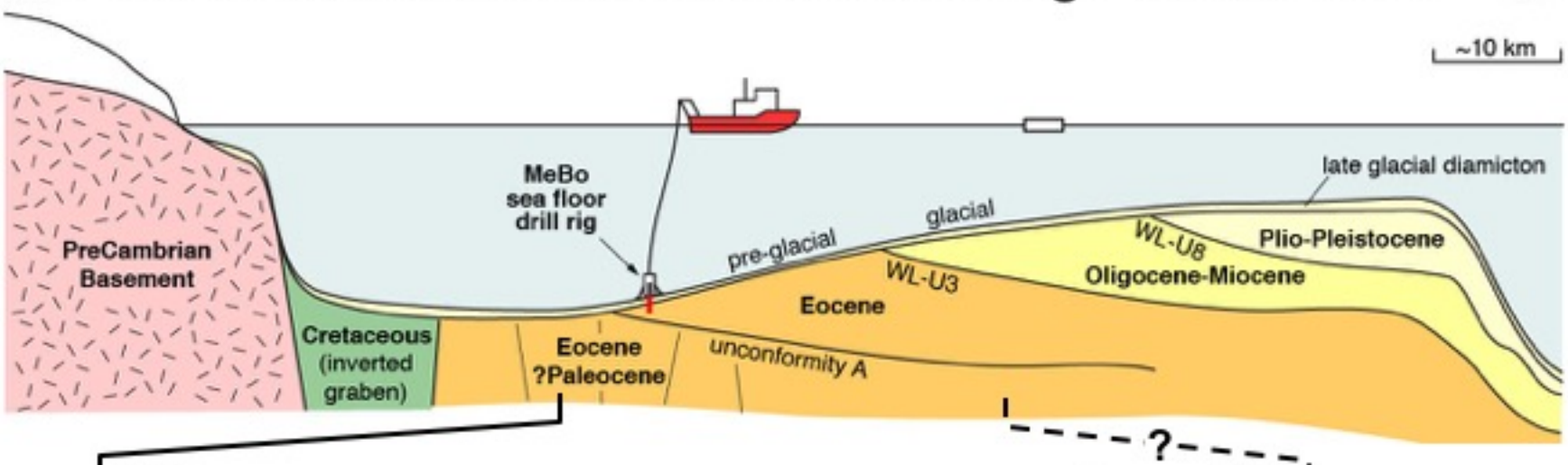
Early Cretaceous and Eocene to Pleistocene strata

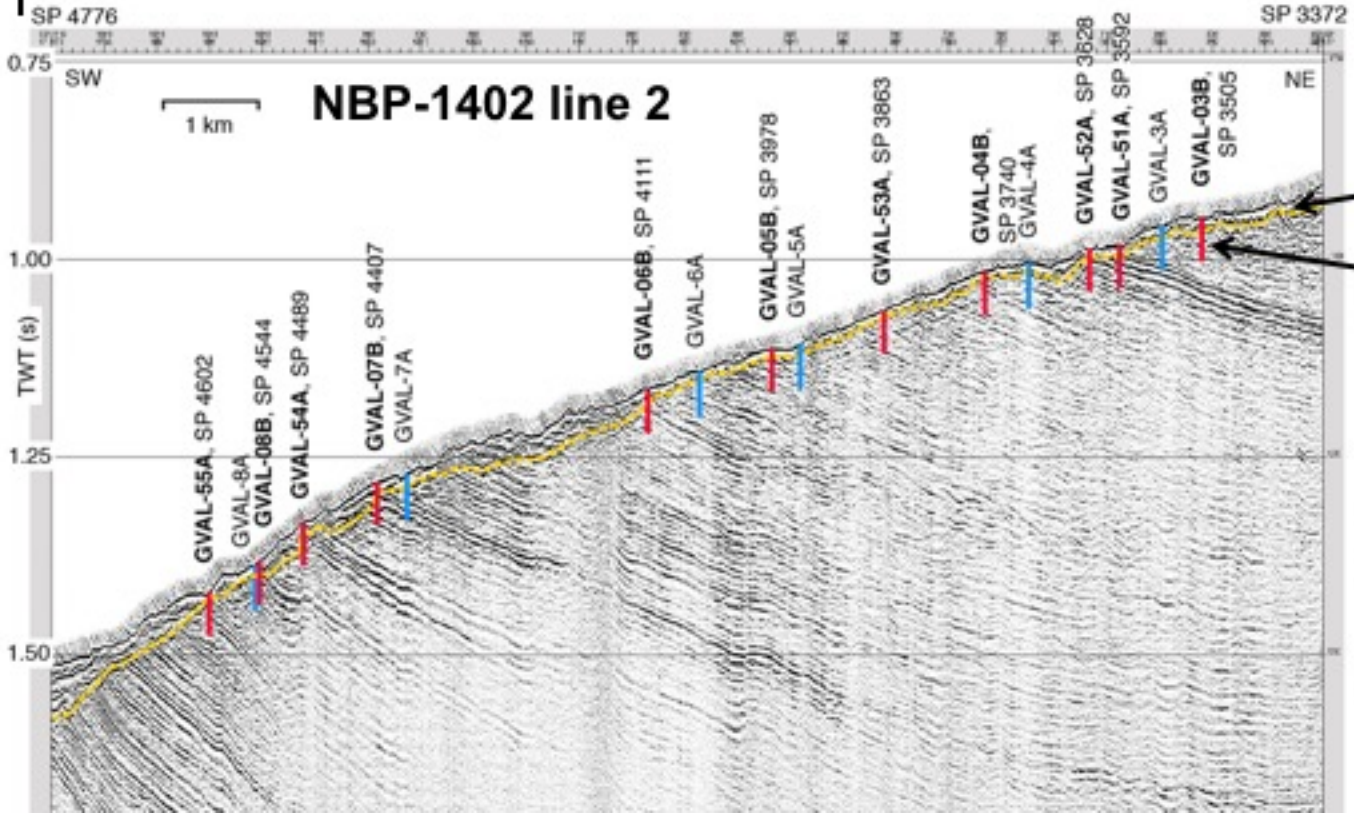


Age (and predicted lithology)

- Plio-Pleistocene (diamict with thin clay interbeds)
- Oligocene-Miocene (diamict with thin clay interbeds)
- Eocene (shelf mudstones, siltstones, sandstones, conglomerate, lignite)
- Early Cretaceous (?non-marine siltstones, conglomerate, lignite)
- Paleoproterozoic (paragneiss and granitoids)

Schematic cross-section of the George V Land shelf



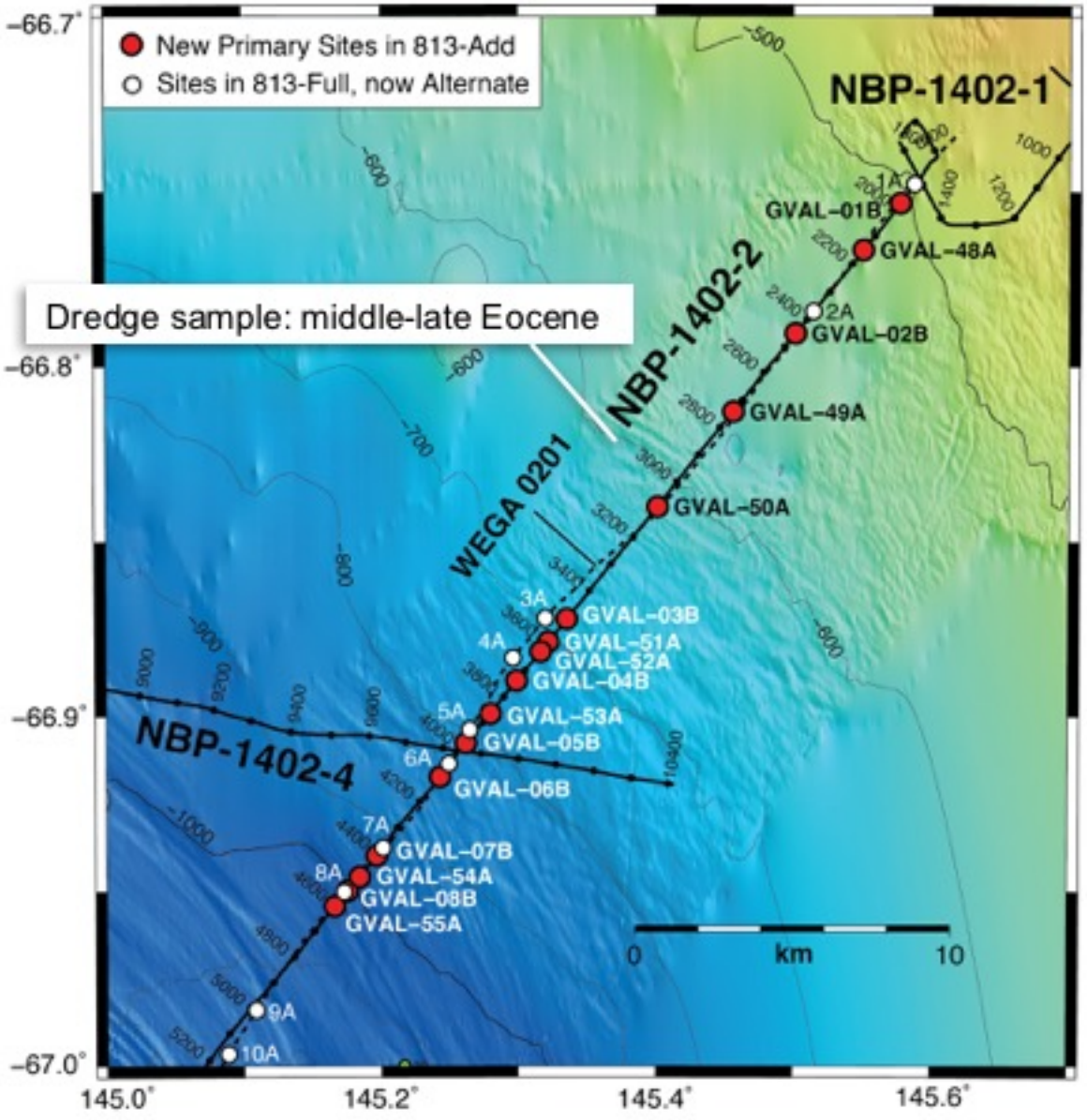


Late-glacial diamicton

Projected 50-m drill holes

New seismic profiles collected aboard N.B Palmer, February 2014. Pers. Comm Sean Gulick, UTIG.

Eocene strata at shallow burial depths



Vozzhennikova apertura
Francesca Sangiorgi

Dredge samples Leventer, Domack, et al., NBP01-01 2001.

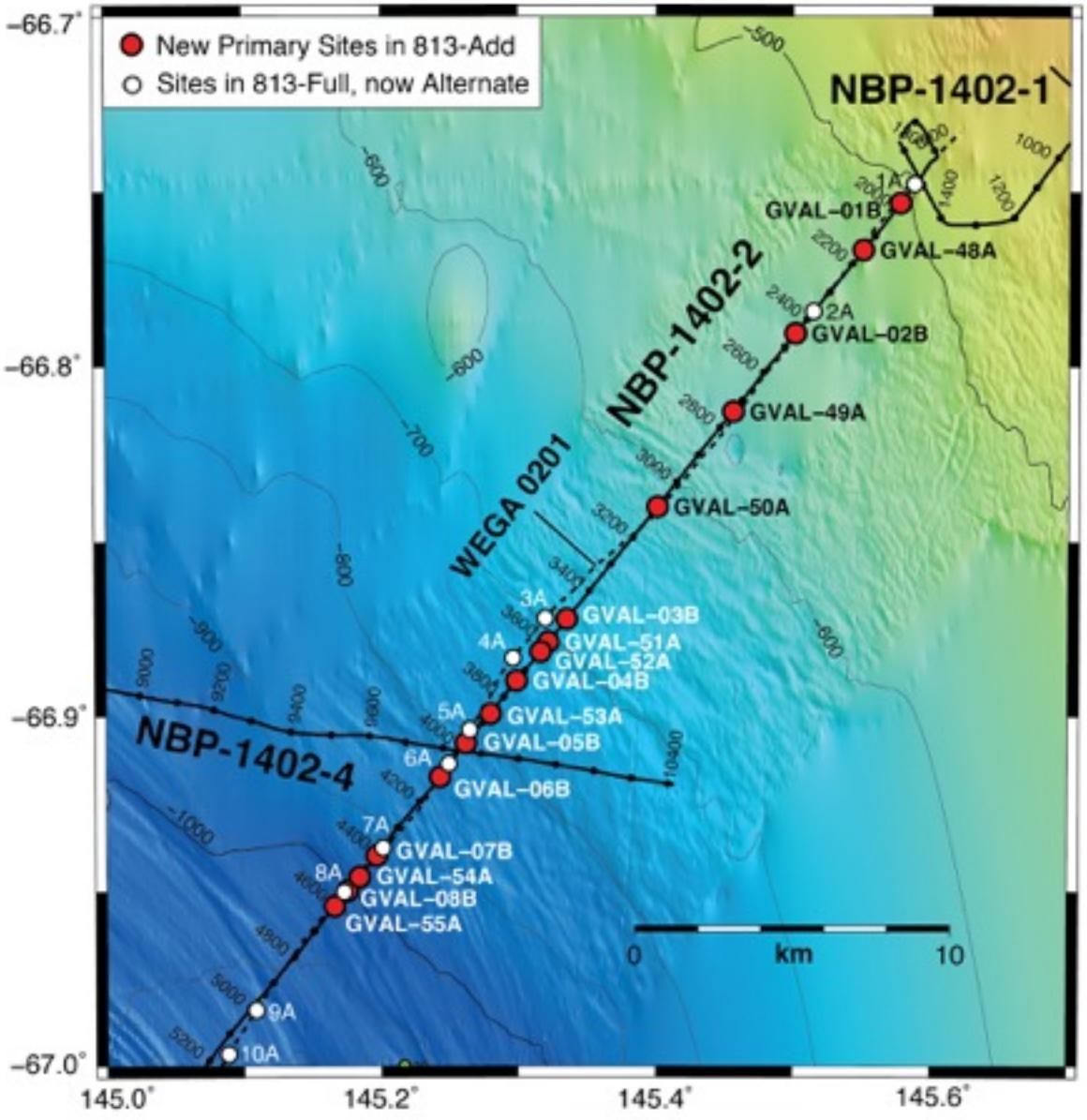
~1300 clasts

Sedimentary clasts 15-43% (per dredge)

Paleogene lignite present.

New Dredges from Leventer, Domack et al. NBP14-02
Campanian to L. Eocene

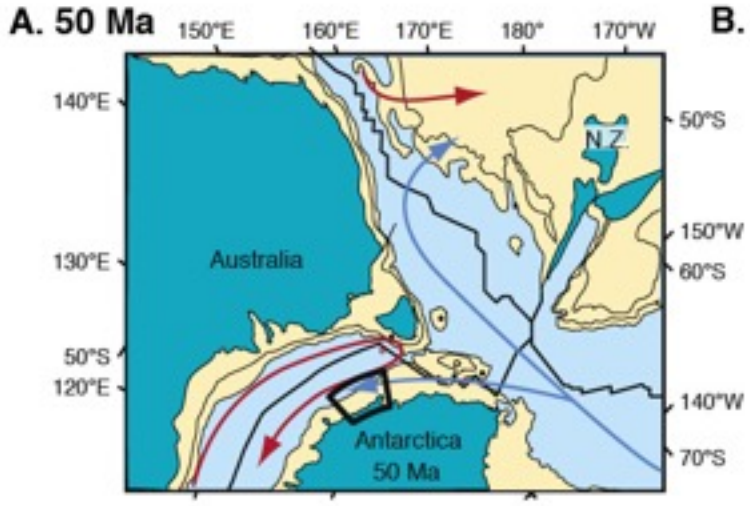
Eocene strata at shallow burial depths

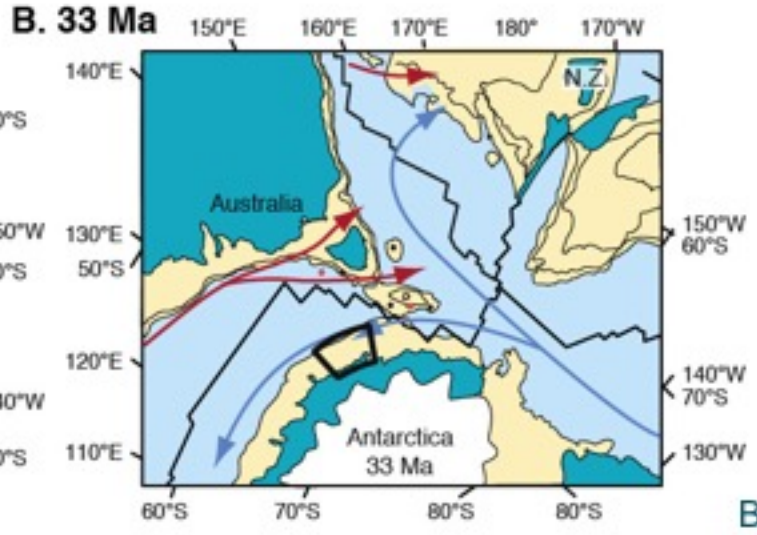


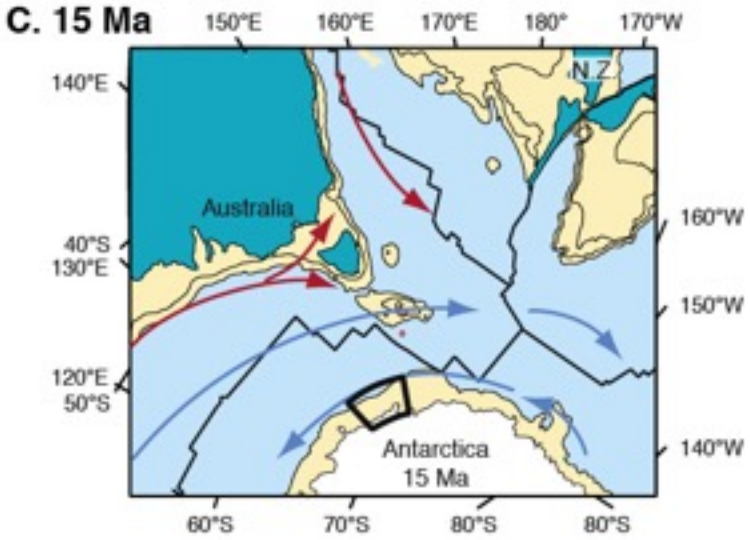
Seabed Rockdrill: BGSRD2

50m below sea bed

Max. 4000 m water-dpeth







Area of drilling in this proposal, and IODP 318 sites

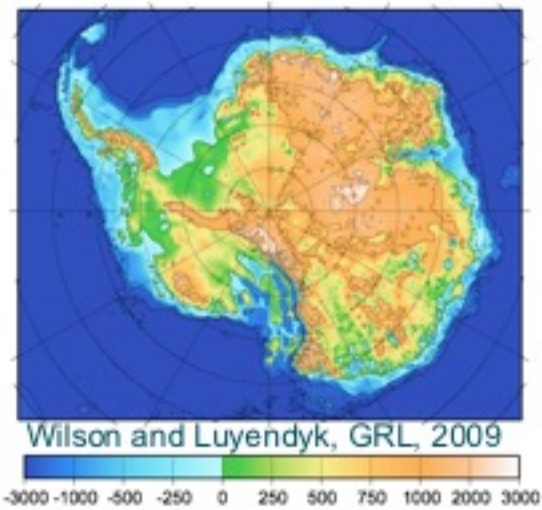
Warm currents

Cool currents

ODP Leg 189 sites

DSDP Leg 29 sites

Bed corrected for ice load, thermal contraction, sedimentation, erosion, and horizontal motion



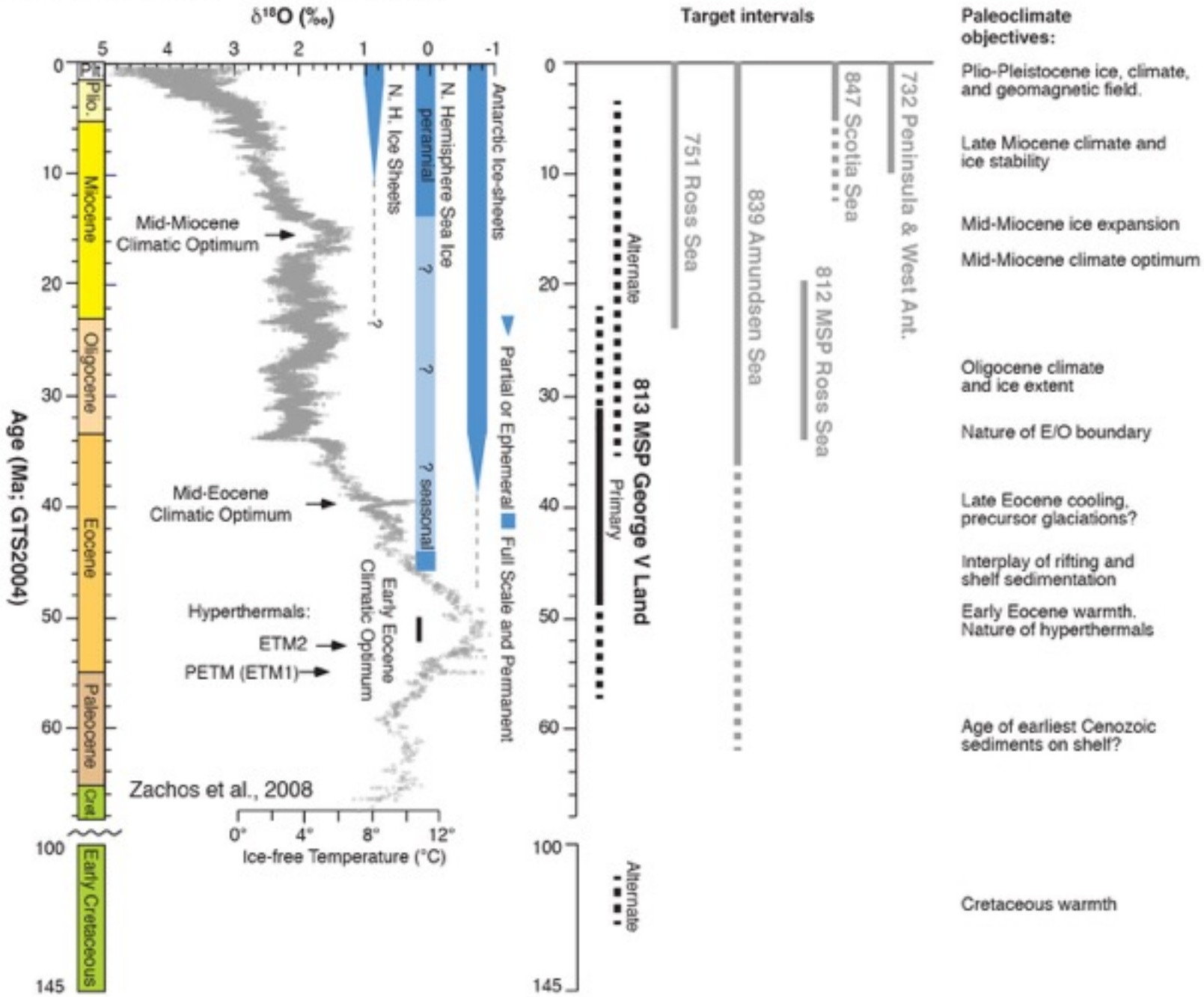
Wilson and Luyendyk, GRL, 2009

-3000 -1000 -500 -250 0 250 500 750 1000 2000 3000

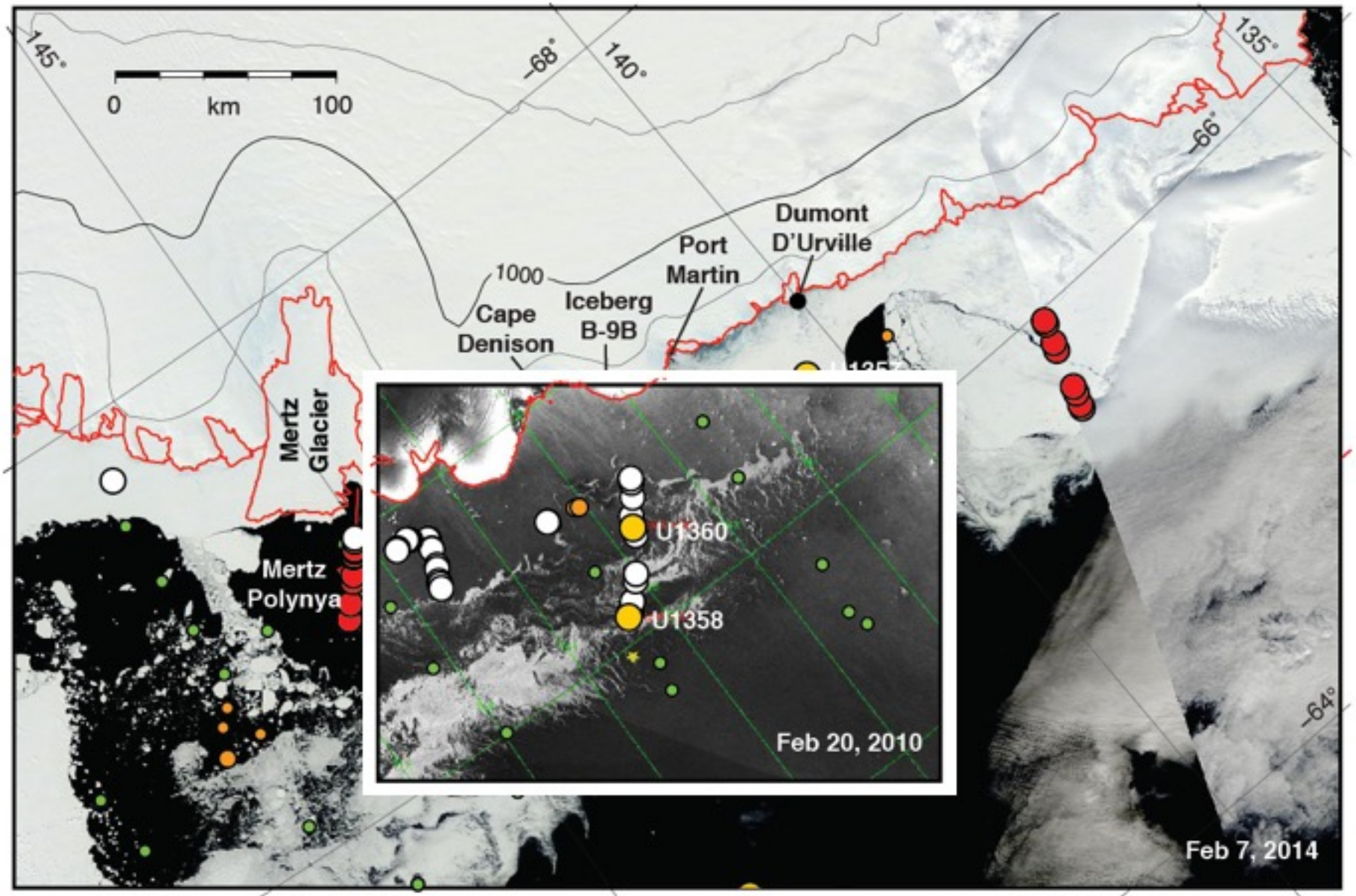
Paleogeography

Total Antarctic land area in latest Eocene was 10–20% greater than previously assumed.

Paleoclimate age objectives

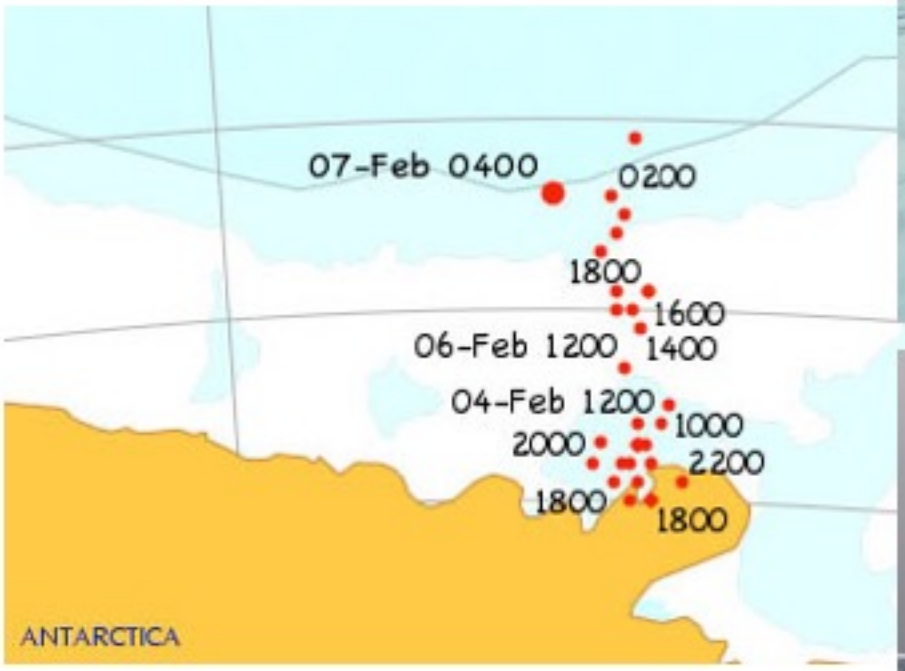


Sea ice conditions, 2014 / 2010 Modis images



http://lance-modis.eosdis.nasa.gov/imagery/subsets/?project=antarctica&subset=MertzGlacier

N.B. Palmer NBP14-02, 4-7 February 2014:



Temperature and wind conditions

Table 3. Monthly mean temperature, °C (Turner and Pendlebury, 2004)

	December	January	February	March
Dumont D'Urville	-1.7	-0.7	-4.1	-8.1
Port Martin	-2.0	-1.6	-5.7	-10.1
Cape Denison	-1.7	-1.6	-6.3	-11.7

Table 4. Monthly mean wind speed, knots, direction predominantly from SSE (Turner and Pendlebury, 2004). Note that wind speeds ease with distance away from the coast, where the katabatic winds are strongest, so that offshore wind speeds may be less than at these coastal weather stations.

	December	January	February	March
Dumont D'Urville	8.1	8.2	10.4	10.9
Port Martin	10.2	12.2	15.1	17.2
Cape Denison	12.0	14.2	18.0	22.8

February 4-6 2014, the *N.B. Palmer* experienced winds from 6 to 33 knots, and air temperatures from -5 to -12°C

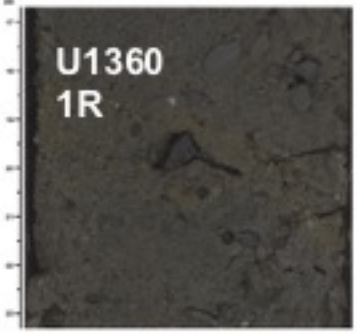
Planning for sea ice

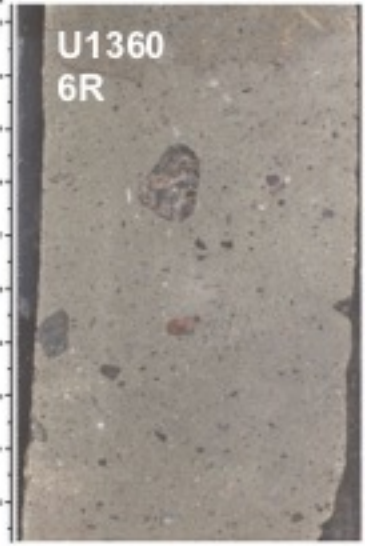
- Many primary and alternate sites – if some sites are covered, others can be accessed.
- Many sites located where there is a persistent polynya.
- EPSP has granted flexibility to drill along the main transect seismic lines within a 100-m-wide "ribbon".
- Sail an ice observer and a weather observer (as on Expedition 318).
- Rely on previous experience in the area (Palmer crew and others).
- Each hole can be drilled relatively quickly (<2 days).

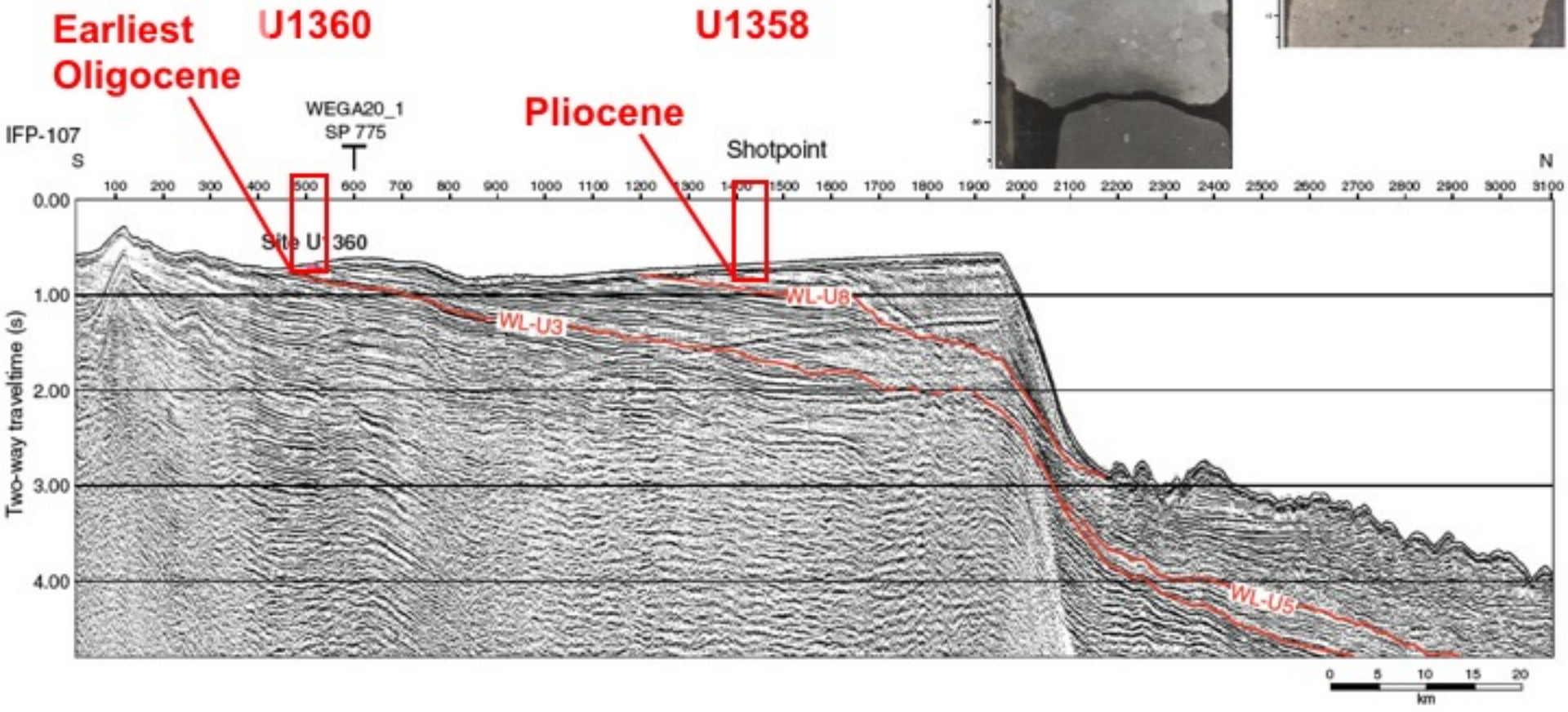

Thank you for your attention!

Expected Sediments

IODP Expedition 318

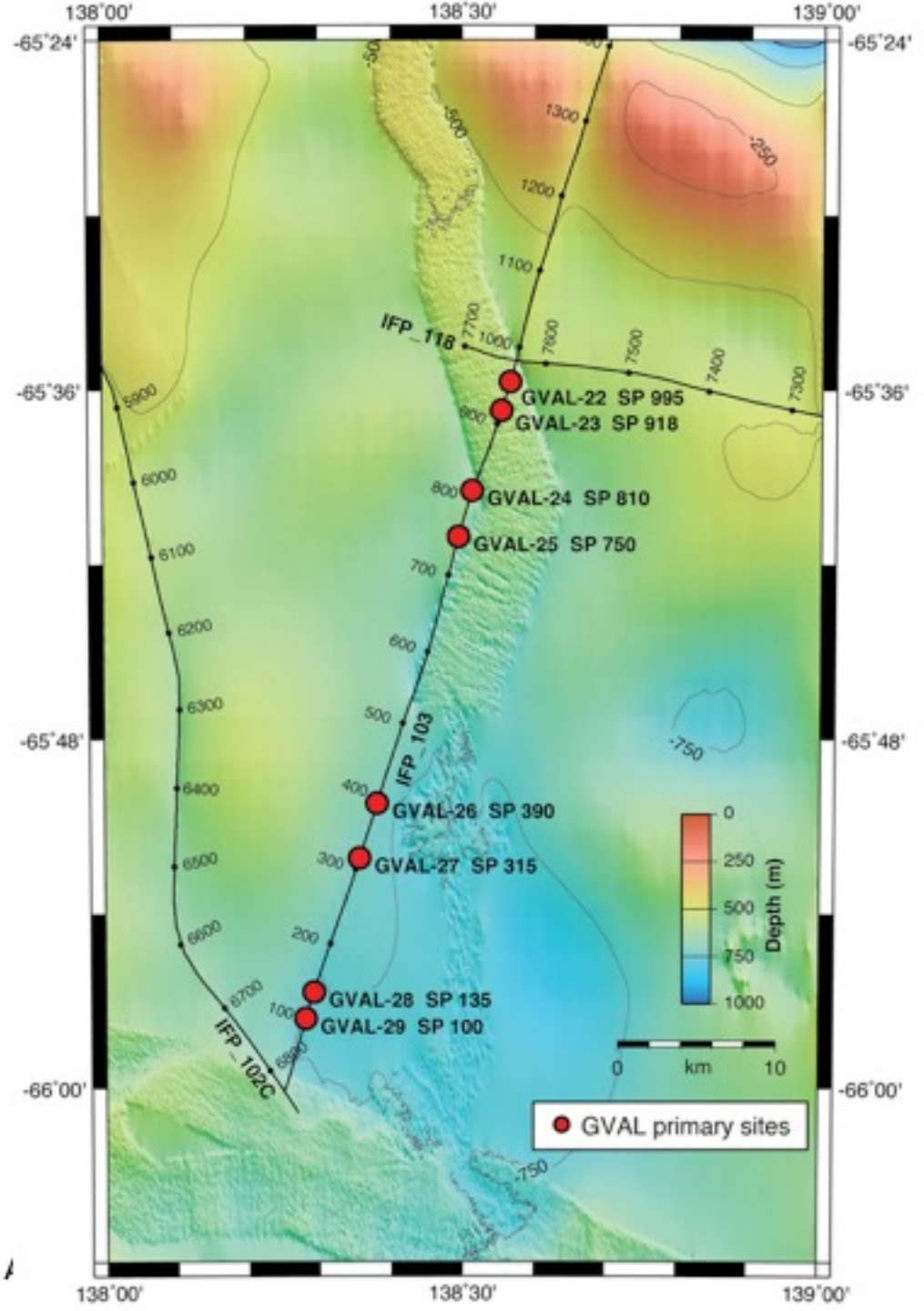






Alternate late Eocene to Pliocene (“icehouse”) Transect

Line IFP-103



Alternate late Eocene to Pliocene ("icehouse") Transect

Line IFP-107