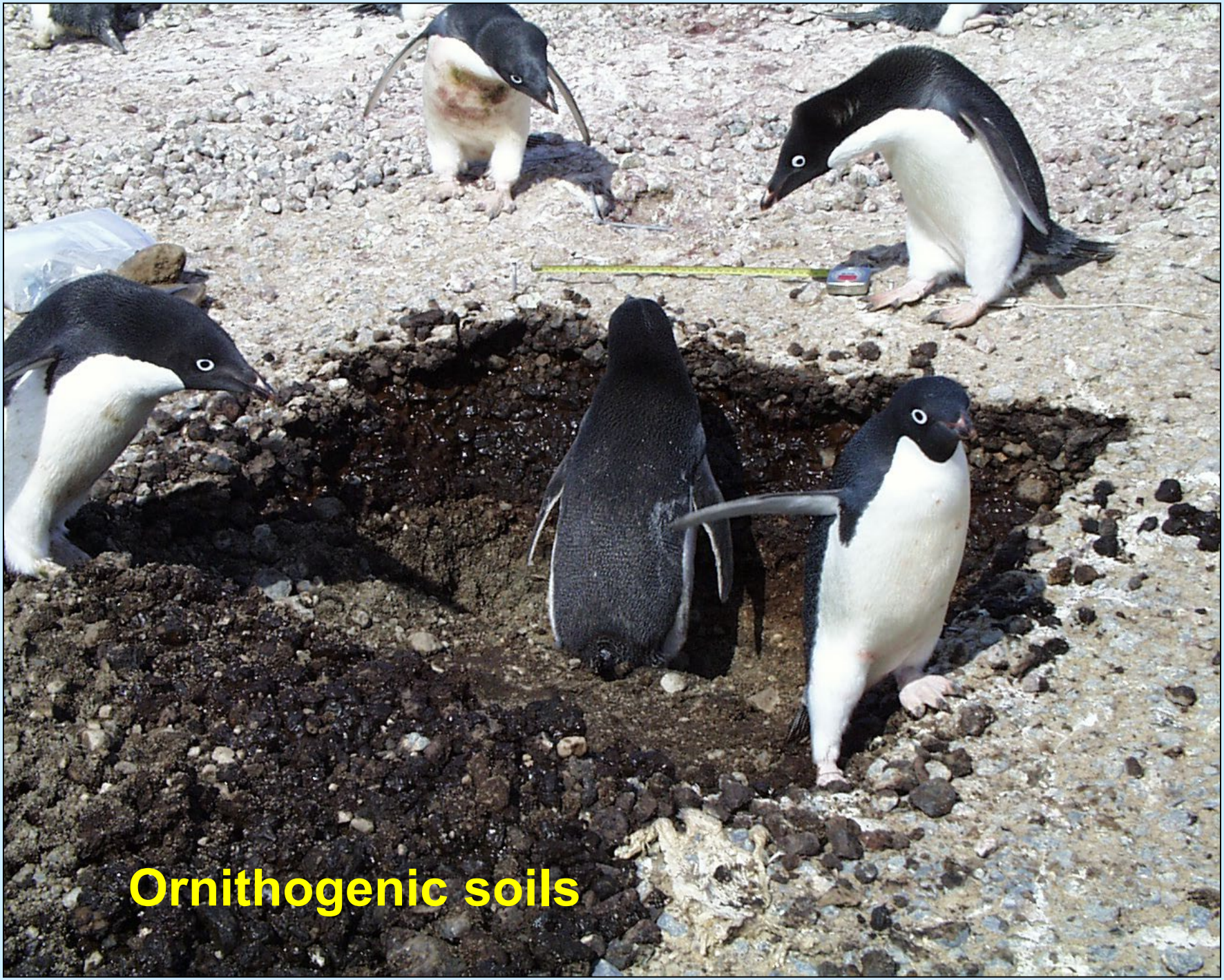
Adélie Penguin Paleohistory in Antarctica


Adélie Penguins need:
• Ice-free terrain
• Open-water access
• Nearby food sources
Cape Bird


…also pebbles

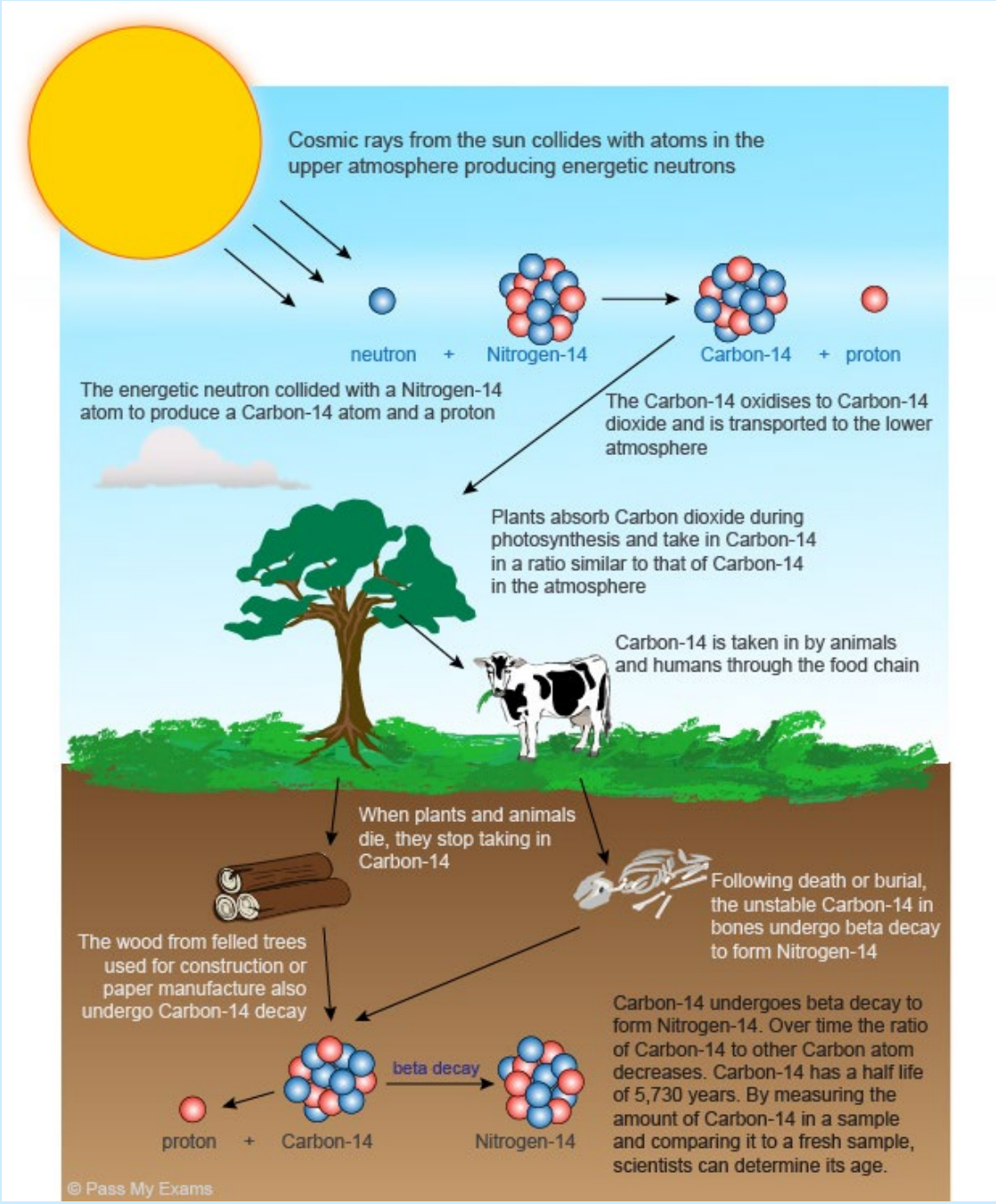

Ornithogenic soils

Radiocarbon Dating

Based on constant decay rate of the radioactive isotope of carbon, ^{14}C

When a plant or animal dies, it stops exchanging carbon with the environment and the amount stored within the tissue begins to decay

Half life of ^{14}C is 5730 years, so the decay can be measured in tissues up to 50,000 years old



http://www.passmyexams.co.uk/

Marine carbon reservoir effect

Exchange of radioactive carbon with the ocean as CO_2 is dissolved and decays

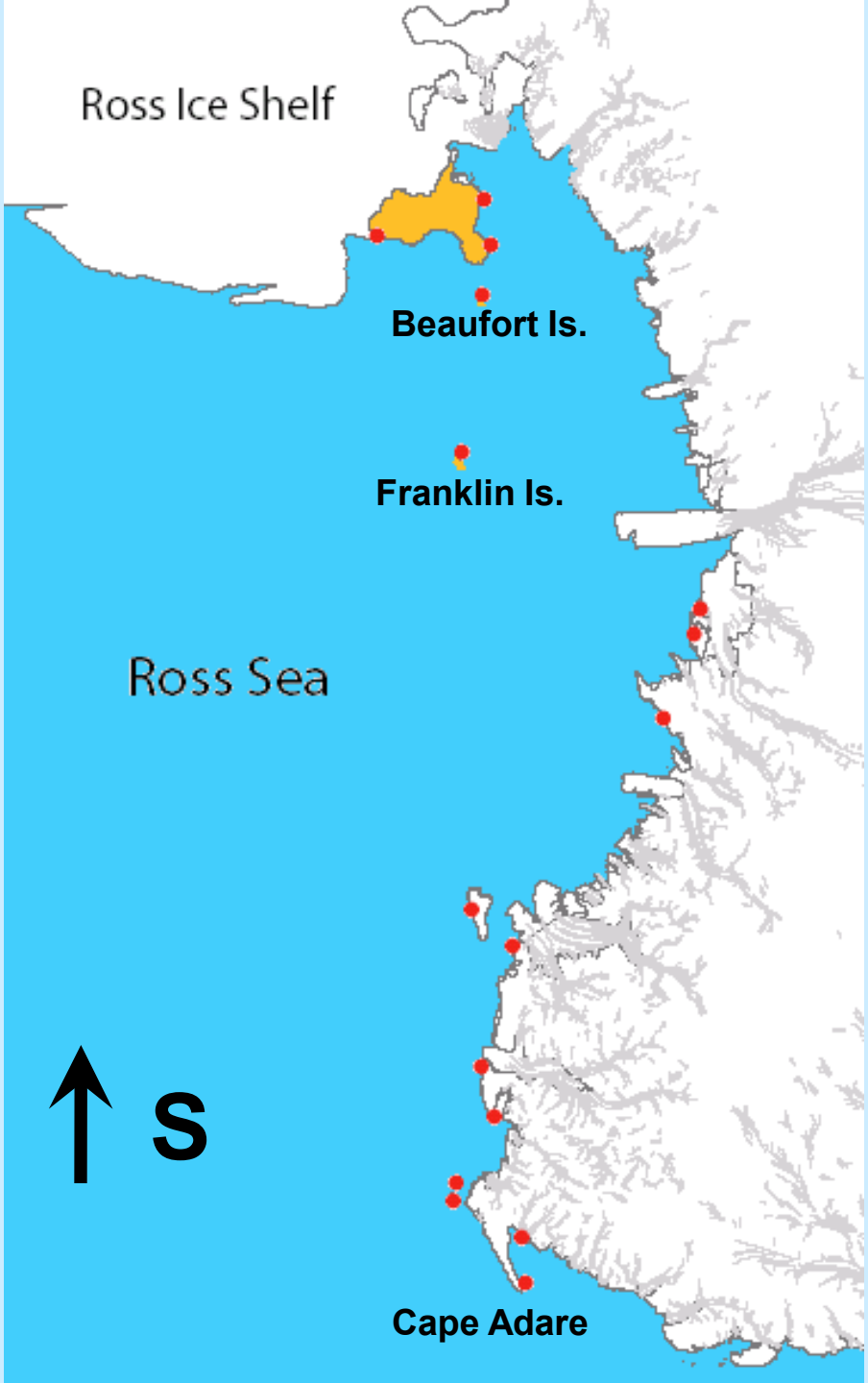
This 'old carbon' can be absorbed by living organisms and give them an apparent age that it much older than actual age

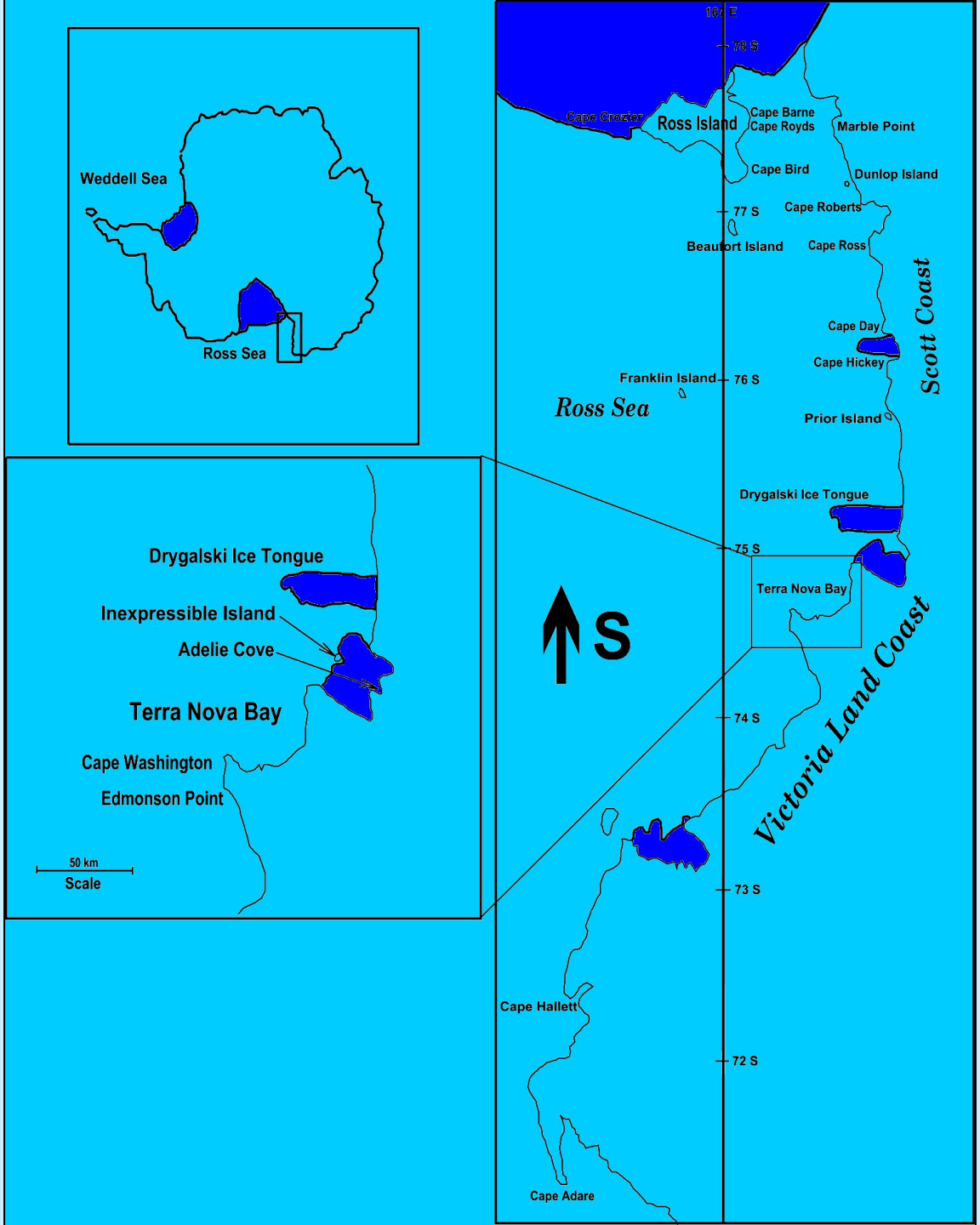
In Antarctica, upwelling of old carbon from deep ocean waters can cause living species to be dated at ~1200-1300 yrs old

Must correct for this when dating tissues preserved in sediments that are of marine origin

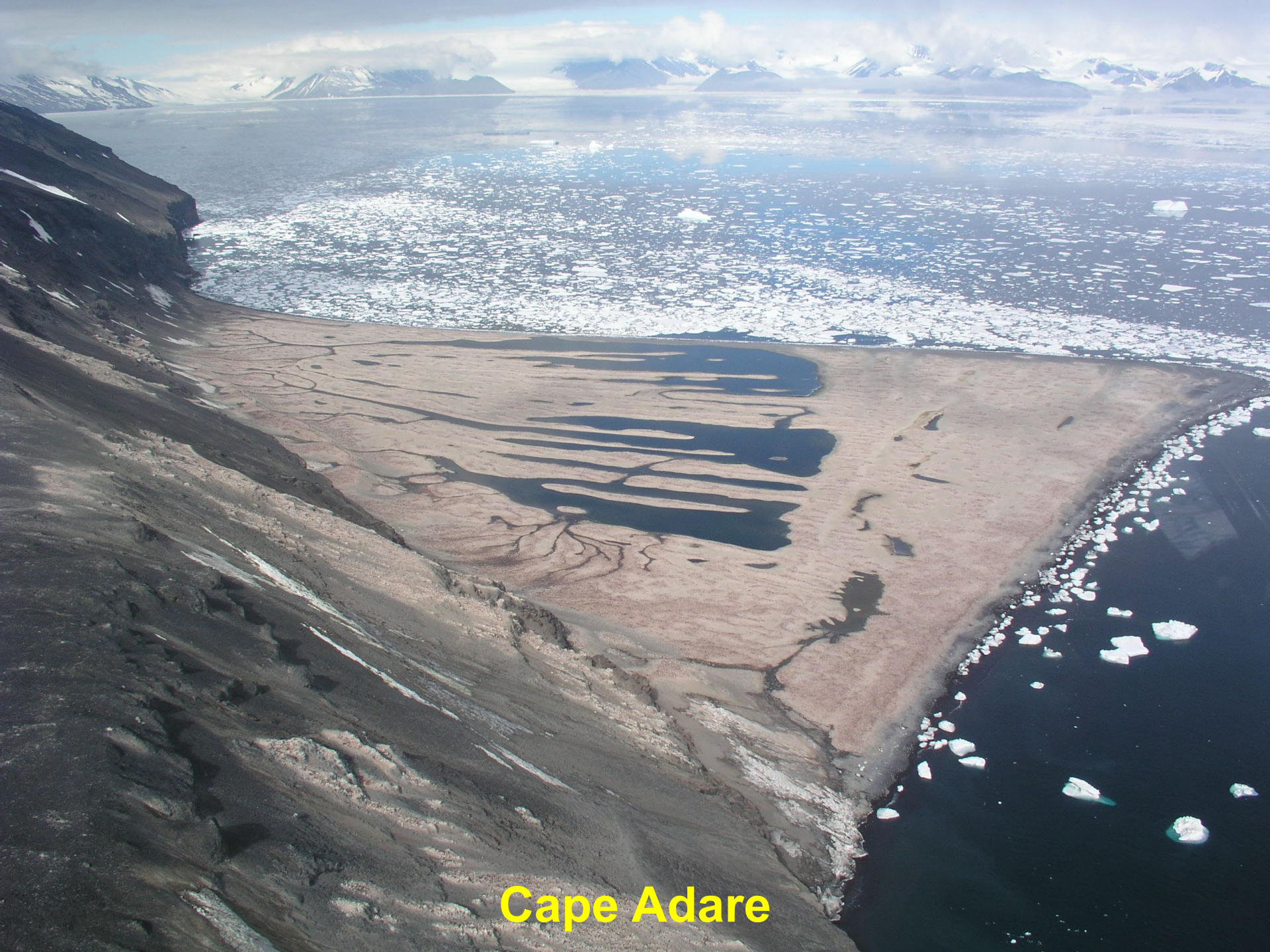
Adélie Penguin

Modern Occupations



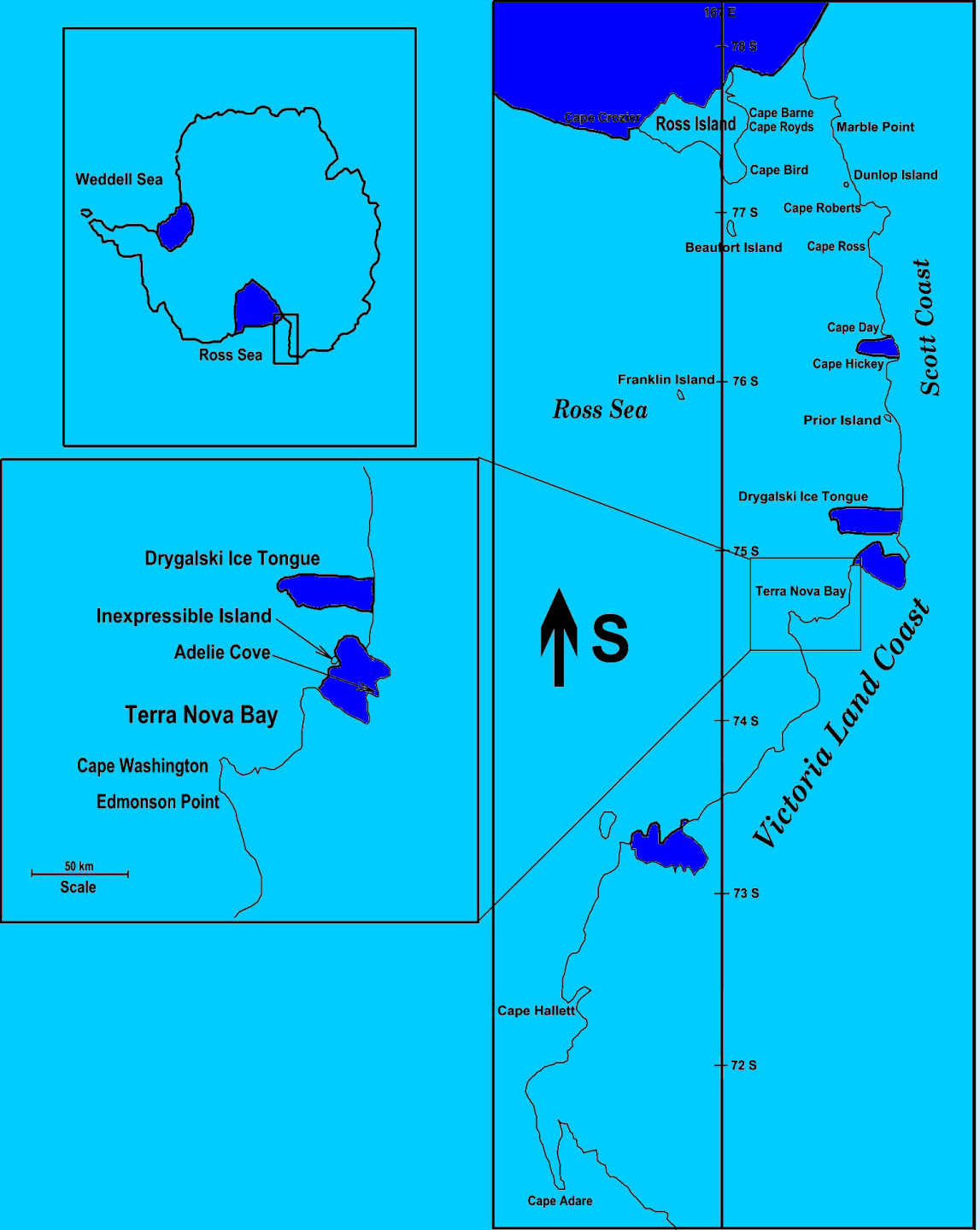

Weddell Sea
Ross Sea
Drygalski Ice Tongue
Inexpressible Island
Adelie Cove
Terra Nova Bay
Cape Washington
Edmonson Point
50 km
Scale
S
Cape Crozier
Ross Island
Cape Barne
Cape Royds
Marble Point
Cape Bird
Dunlop Island
Cape Roberts
Beaufort Island
Cape Ross
Cape Day
Cape Hickey
Franklin Island
Ross Sea
Prior Island
Scott Coast
Drygalski Ice Tongue
Terra Nova Bay
Victoria Land Coast
Cape Hallett
Cape Adare
76 S
77 S
75 S
74 S
73 S
72 S

Cape Barne (77° 35´ S, 166° 14´ E)


Cape Adare


Currently ~338,000 breeding pairs
Largest Adélie penguin colony in Antarctica

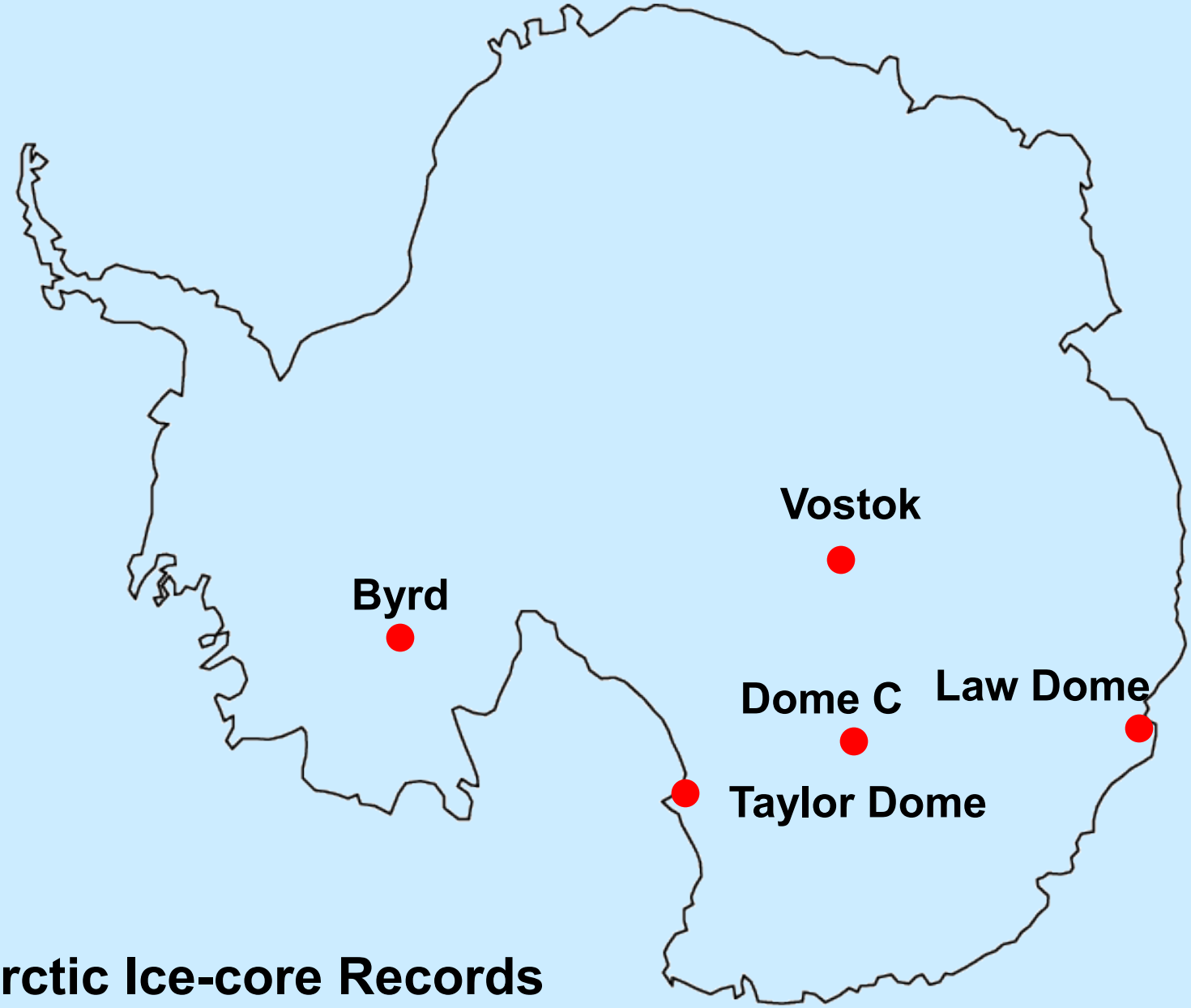

Sites date from 2110 B.P. to present



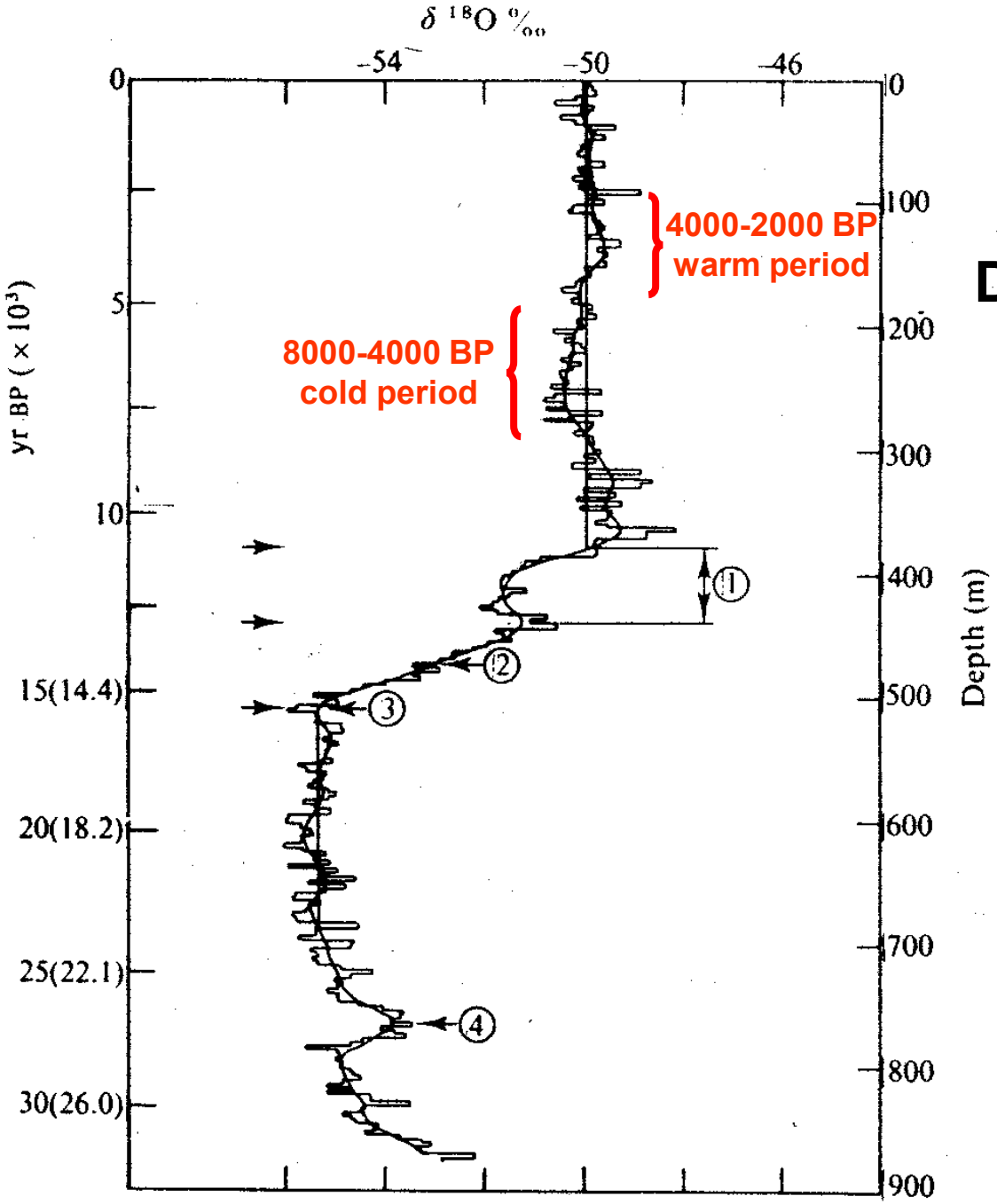
Occupation history of Adélie Penguins in the Ross Sea

Based on >150 ^{14}C dates from active and abandoned colonies only

All dates corrected and calibrated for marine carbon reservoir effect and reported in cal. Yr. B.P.



Antarctic Ice-core Records



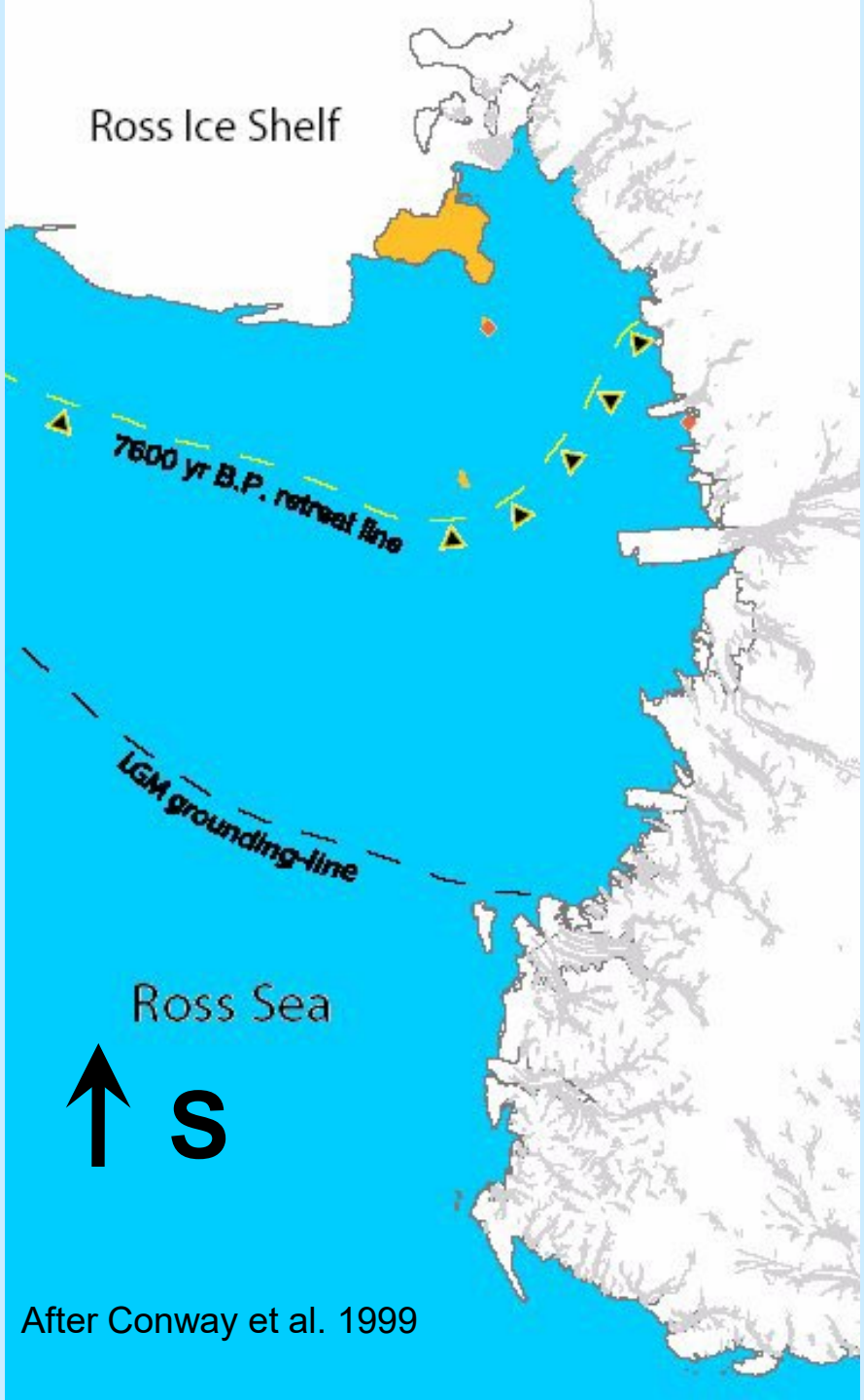
Dome C Ice-core Data

from Lorius et al. 1979

Ross Ice Sheet (RIS) advanced to LGM grounding line by 18,000 – 20,000 BP

Exactly when this advance began is unknown

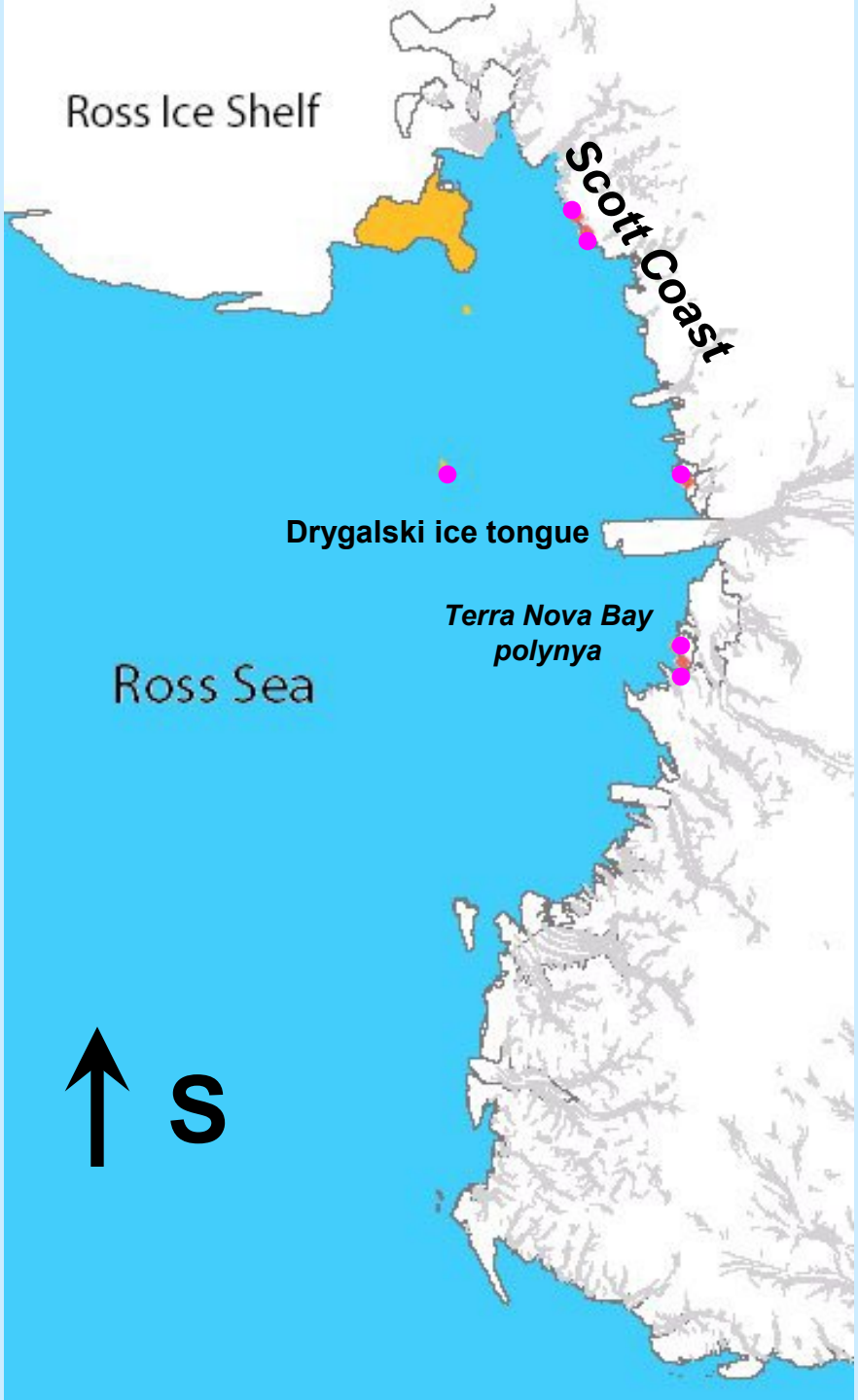
RIS retreat began ~13,000 BP



After Conway et al. 1999

First Holocene Occupations

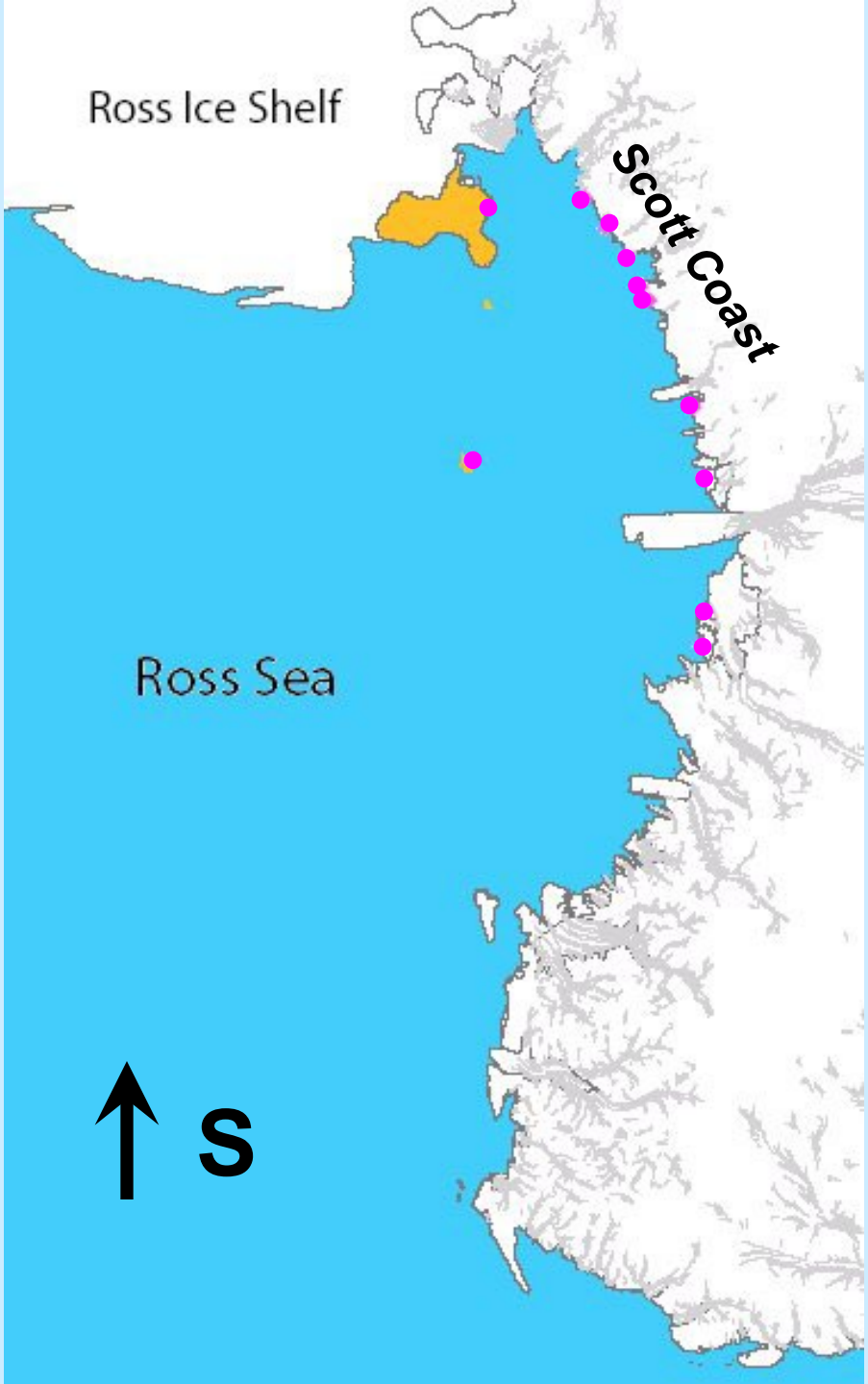
7000 – 4000 BP

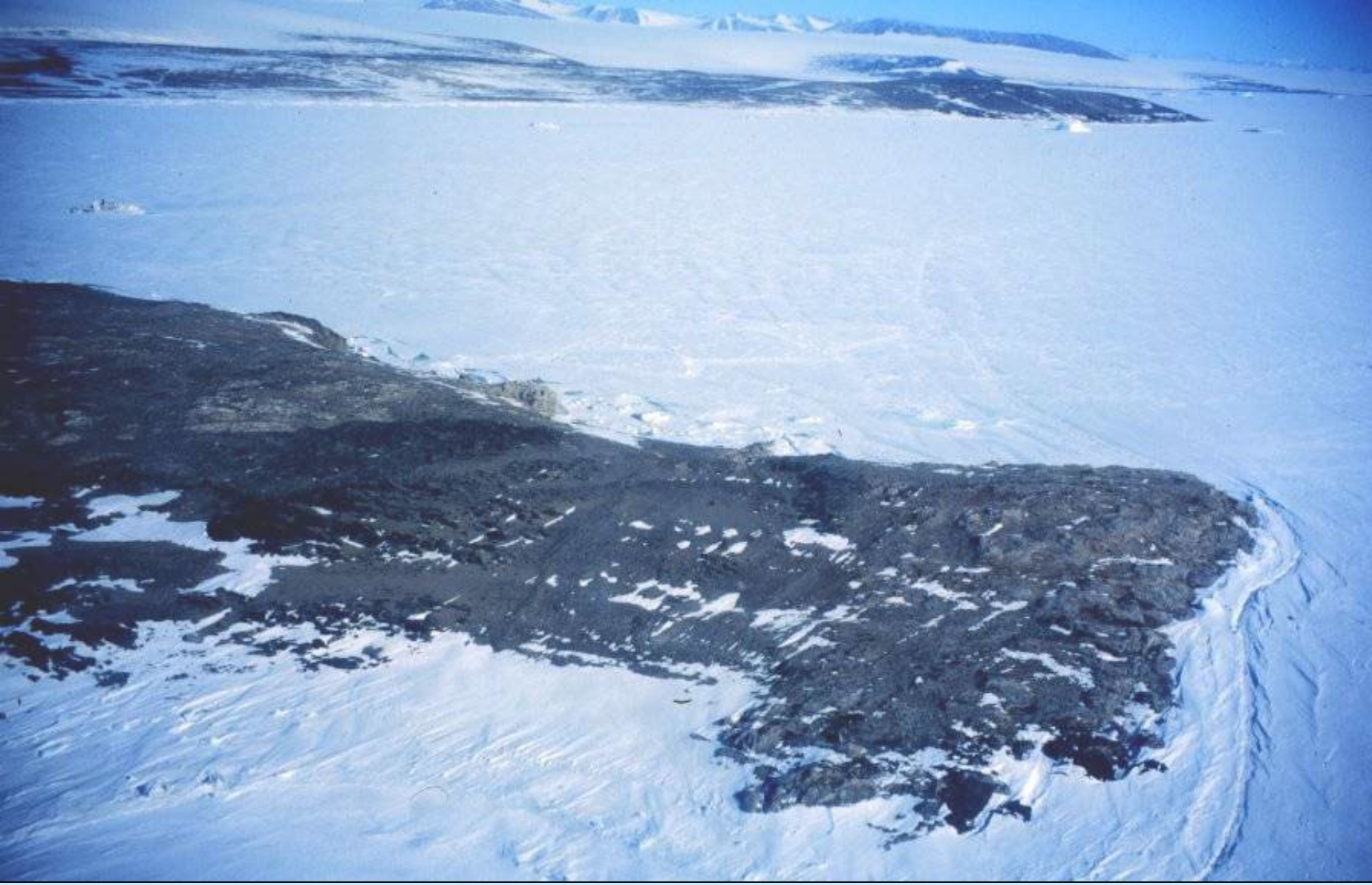


Cape Spike

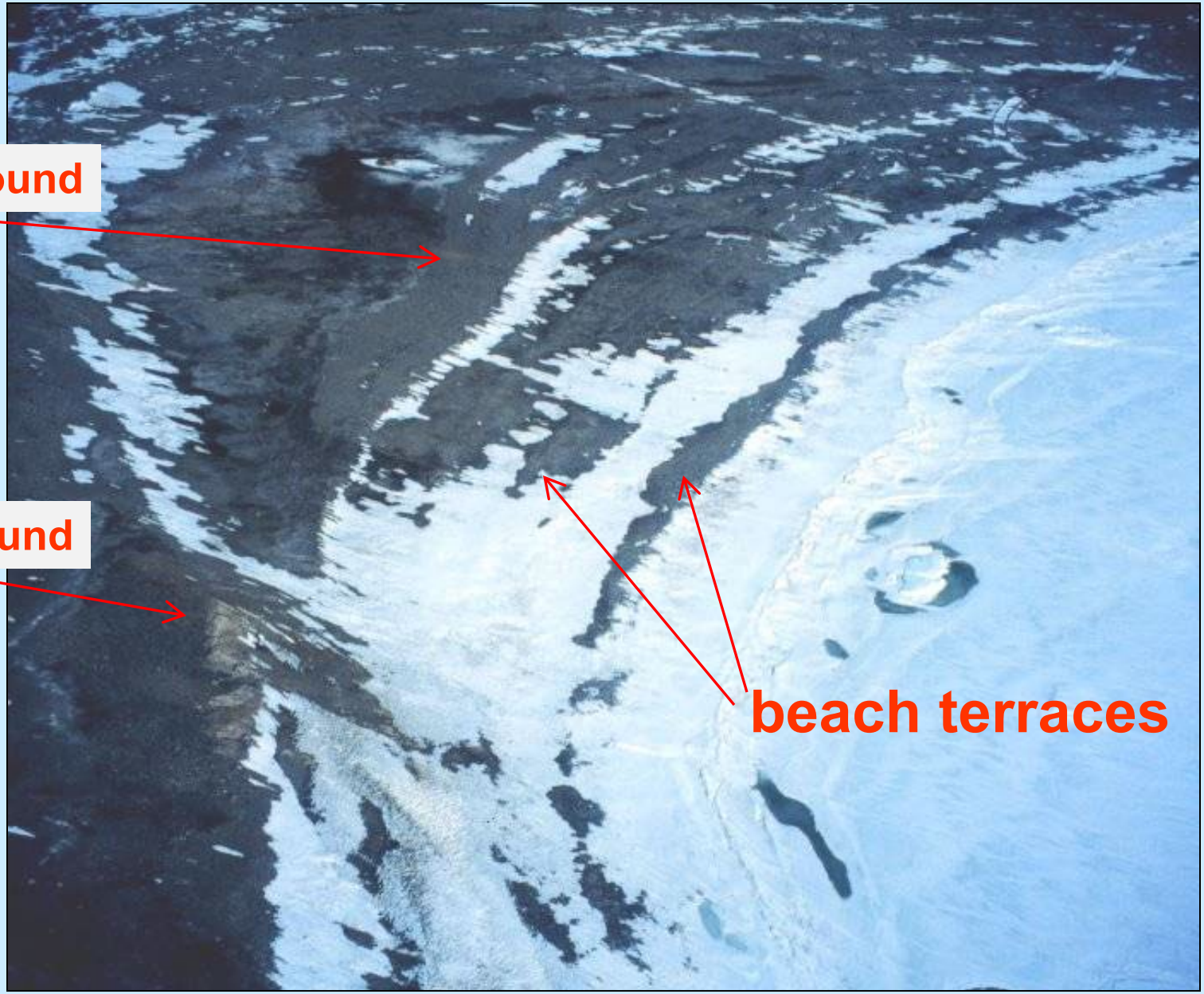
Penguin ‘Optimum’

4000 – 2000 BP





Marble Point

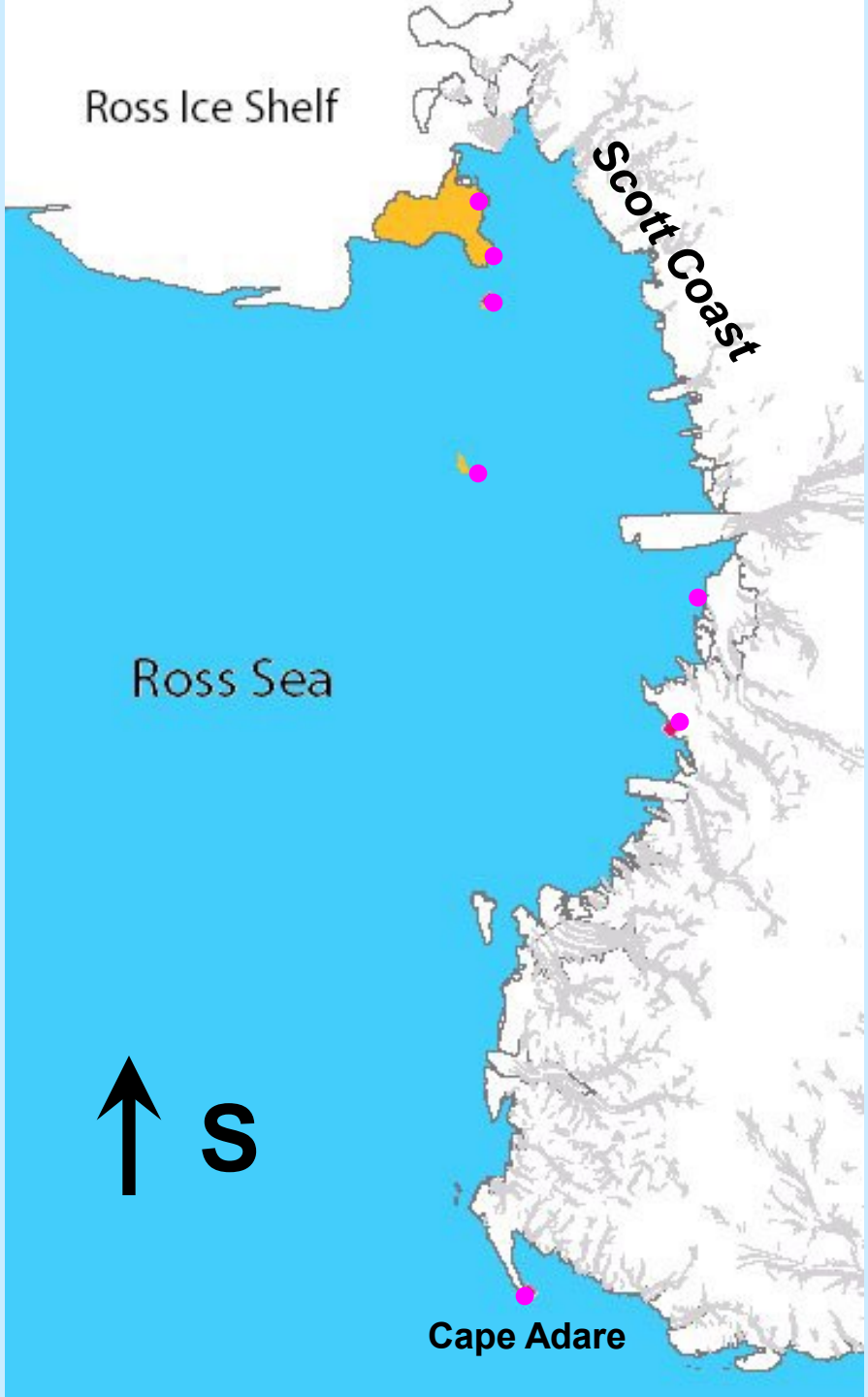


Marble Point


Pebble mounds
Inexpressible Island

Late Holocene

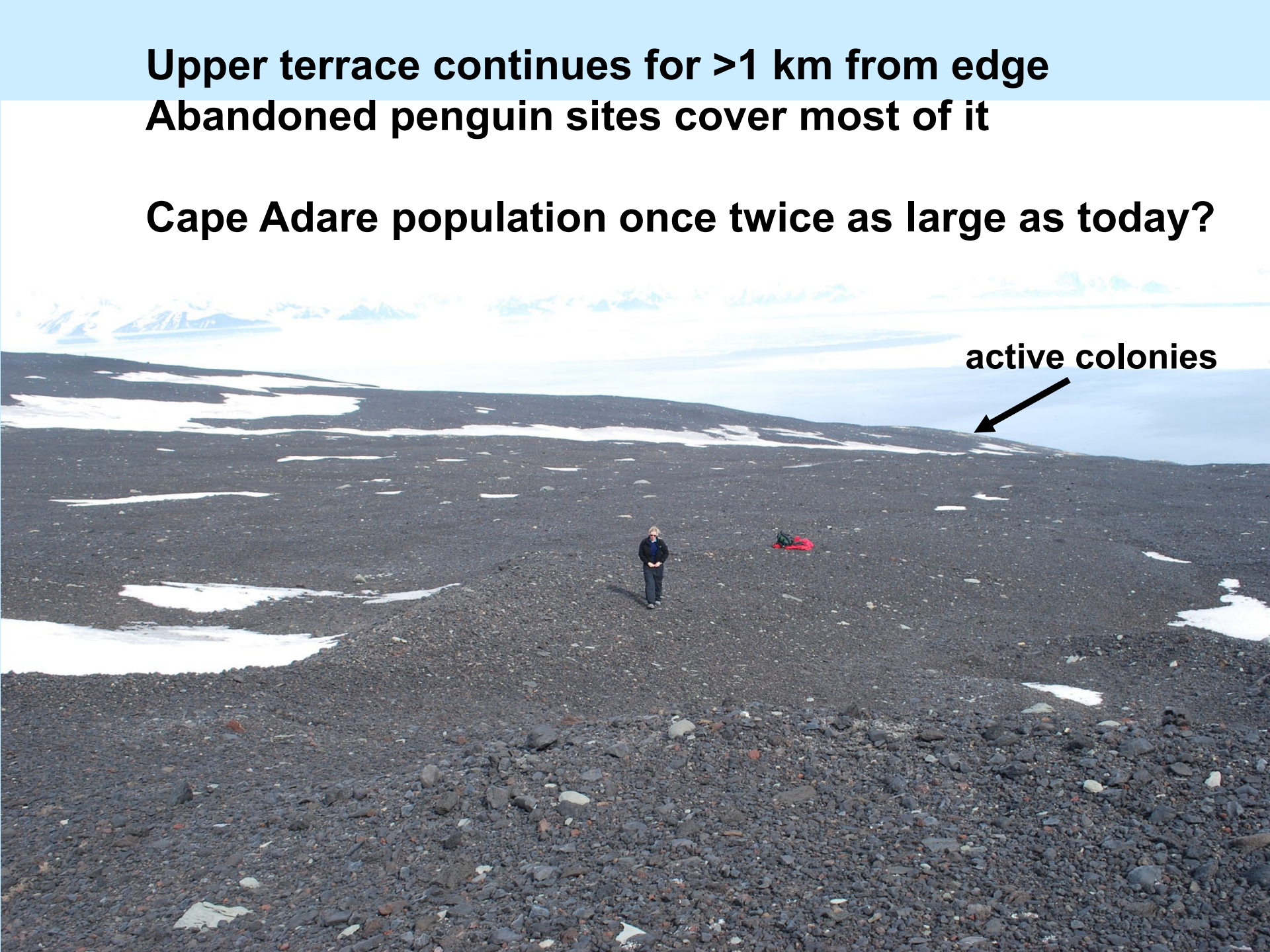
2000 – 1100 BP

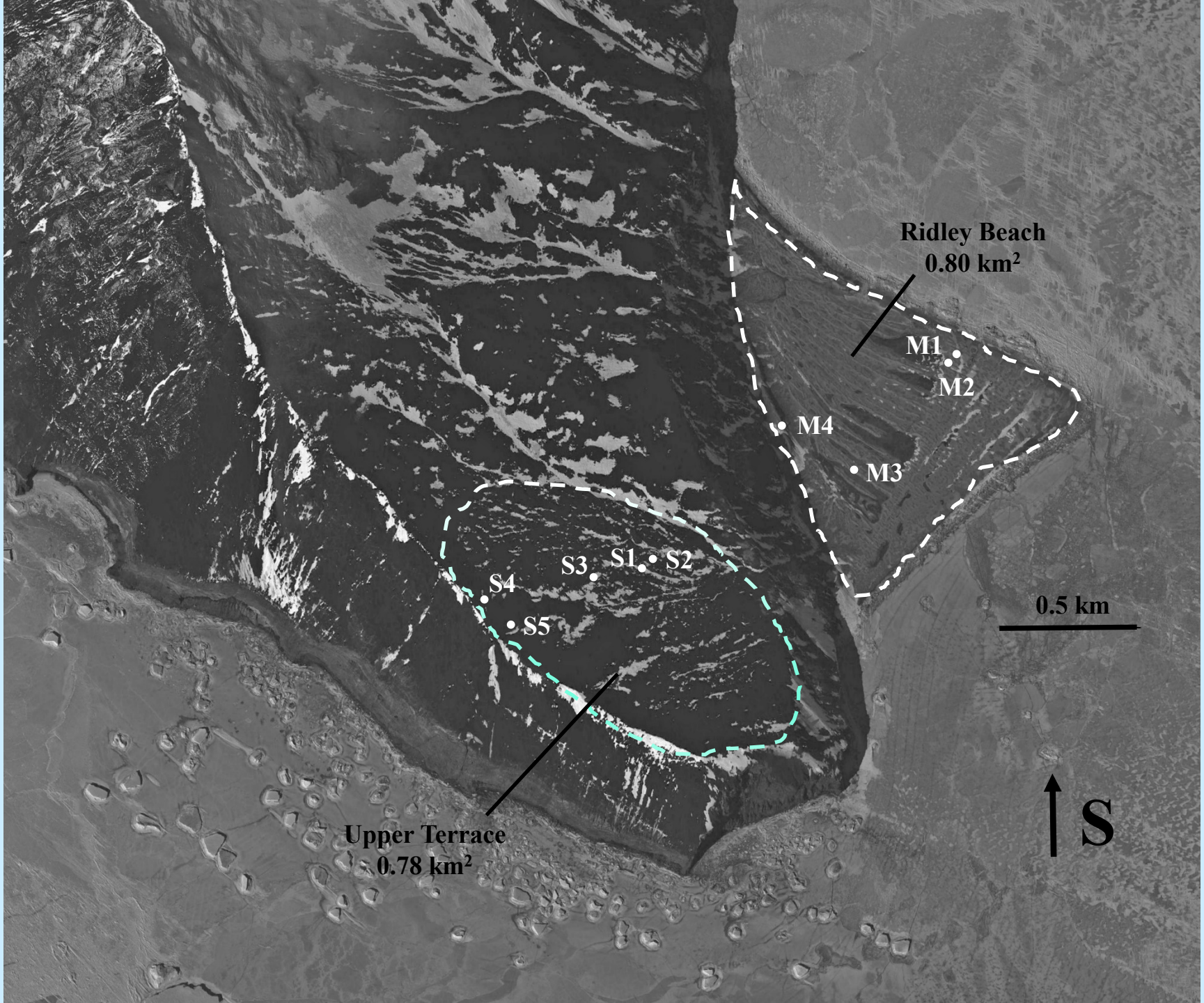



upper terrace
~300 masl

Upper terrace continues for >1 km from edge
Abandoned penguin sites cover most of it

Cape Adare population once twice as large as today?




Ridley Beach
0.80 km²
M1
M2
M4
M3
S3
S1
S2
S4
S5
0.5 km
Upper Terrace
0.78 km²
S

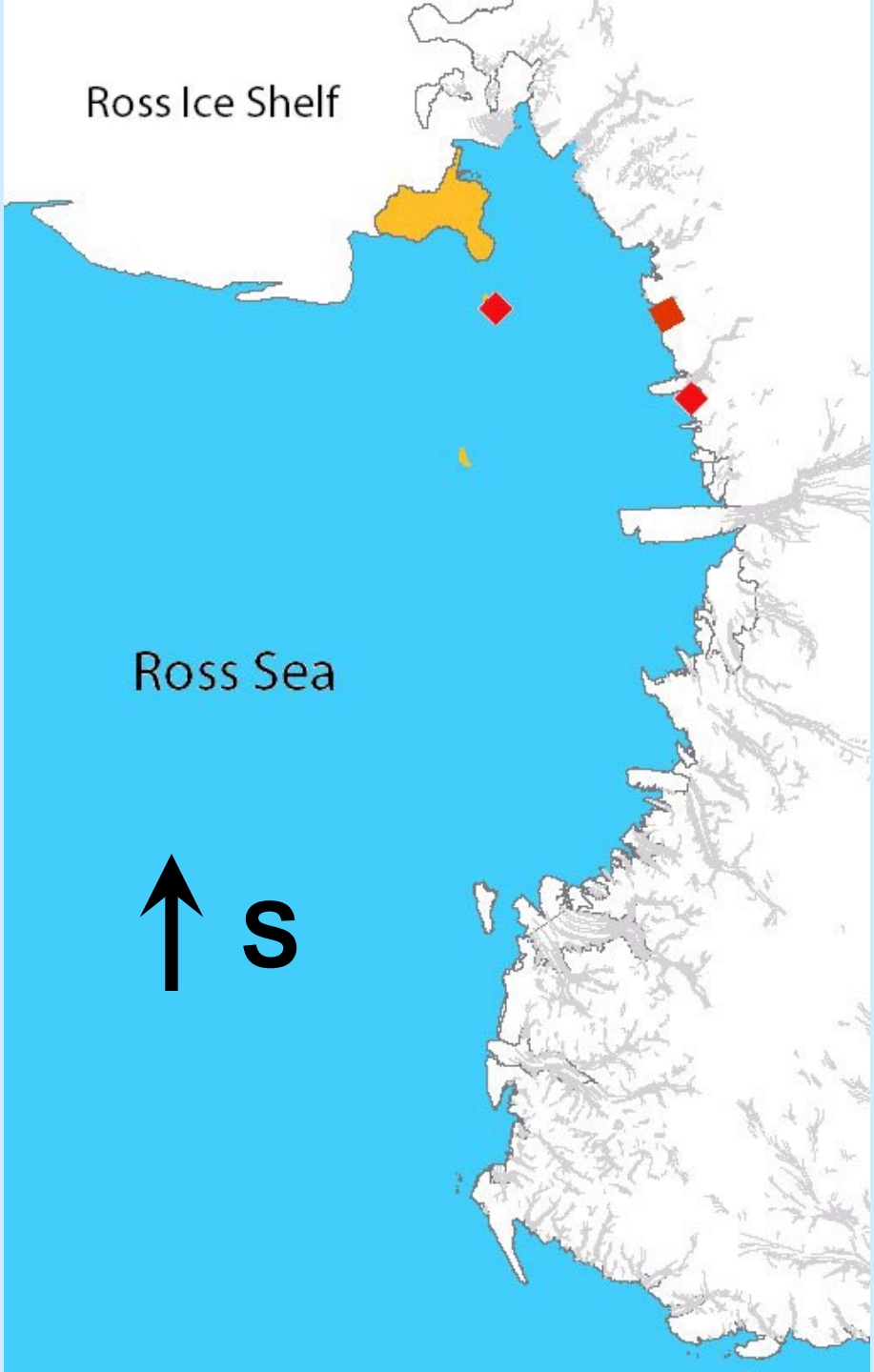

N
Google Earth
1 km
Cape Adare
edge of upper terrace
1250 - 995 BP
1880 - 1550 BP
1860 - 1490
2110 - 1820 BP
1990 - 1700
Colony continued growing from 2000 BP to ~1100 BP, reaching a size of over 500,000 breeding pair, a ‘supercolony’


Cape Adare:
Highly vulnerable to sea level rise.
Perhaps the most endangered penguin colony
in the world!


…but, where were Adélie Penguins during the Pleistocene?

Late Pleistocene Occupations

Beaufort Island
Cape Hickey
Tripp Island

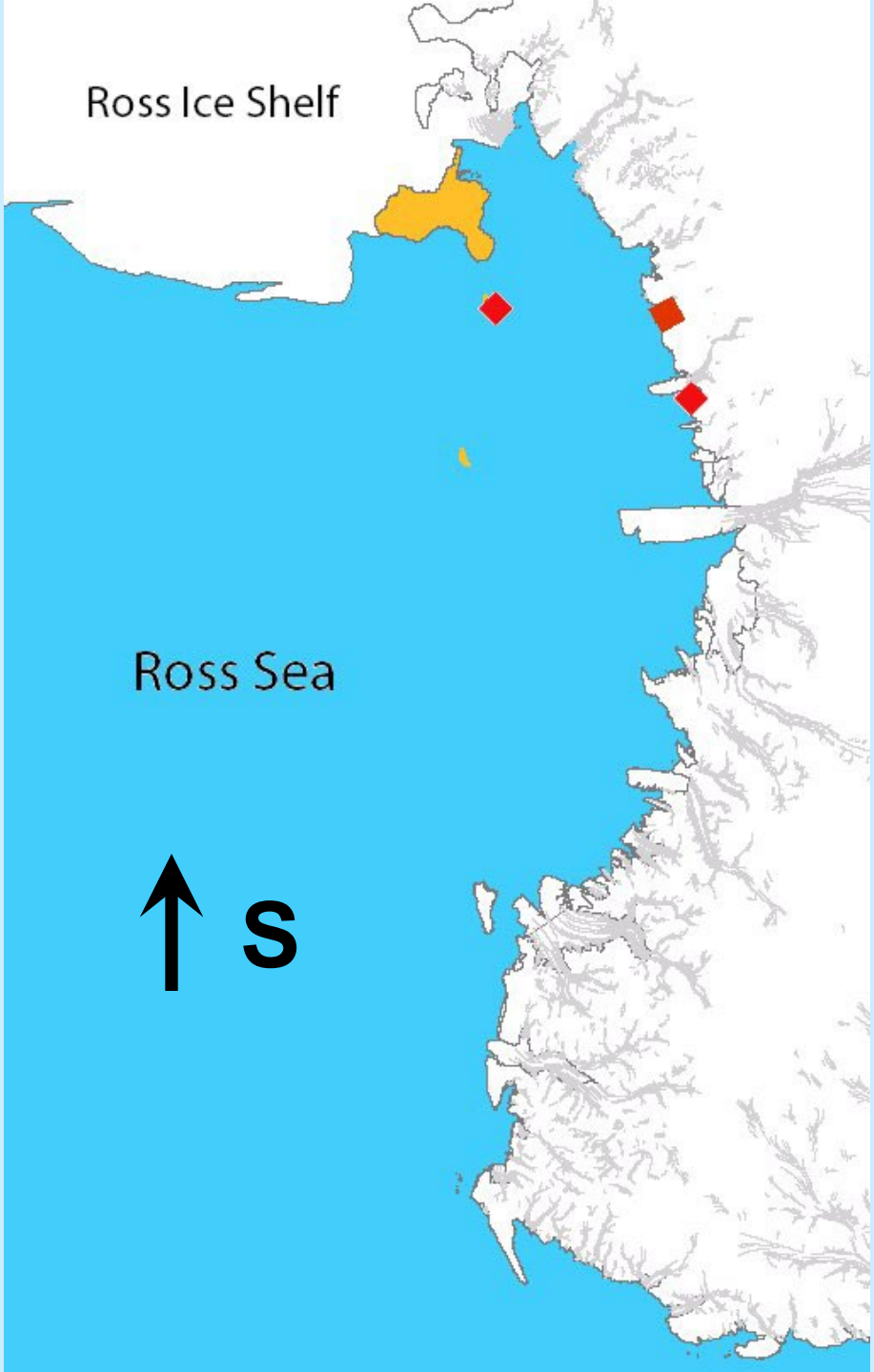



abandoned sites
Cape Hickey


Eggshell dates
27170 ± 250
34220 ± 500
35250 ± 620
38230 ± 810
41870 ± 1300
43010 ± 1400
Cape Hickey

Late Pleistocene Occupations

Beaufort Island
Cape Hickey
Tripp Island

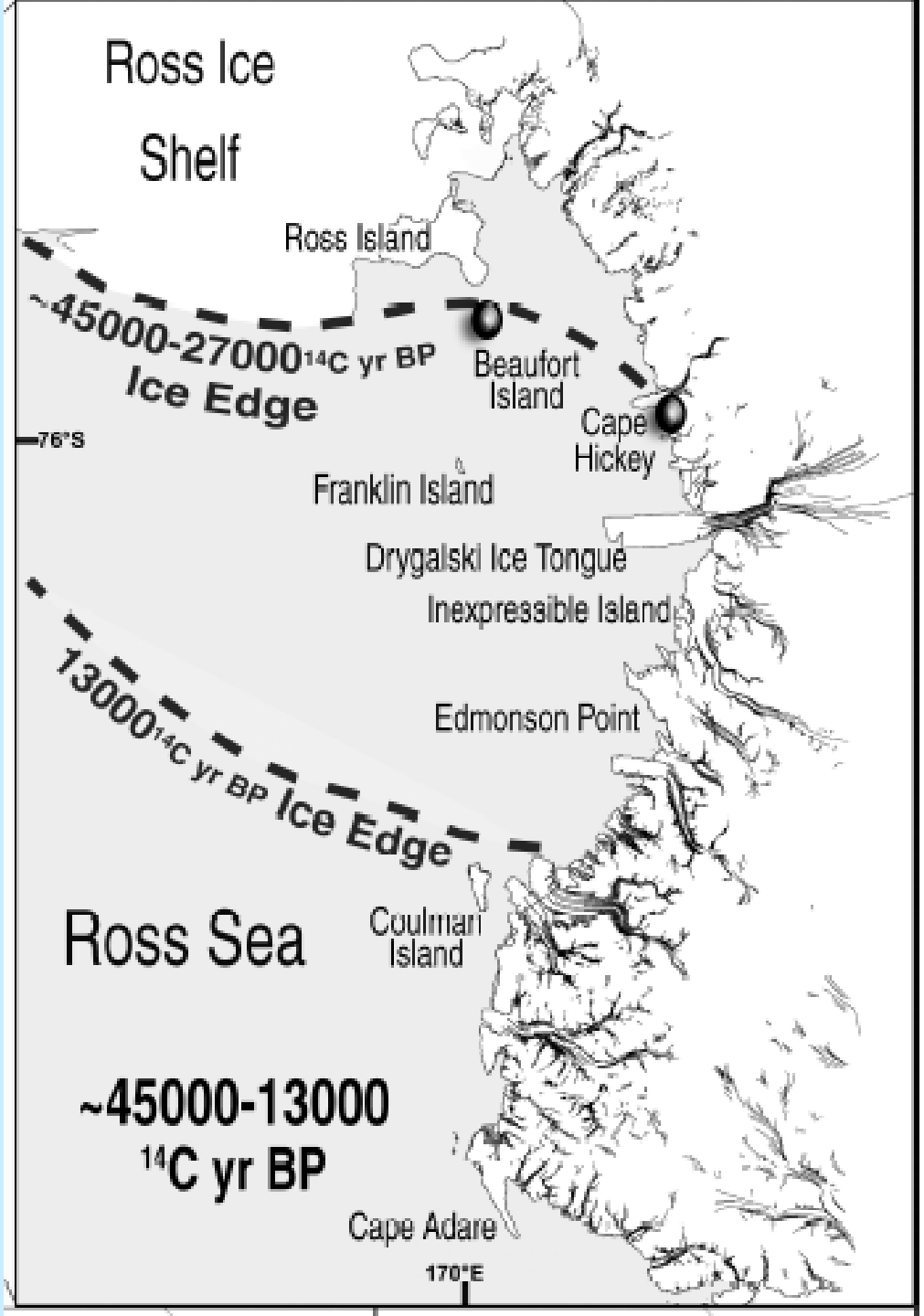



Beaufort Island molt layers


Two feathers and one bone dated at > 44,000 BP

Late Pleistocene RIS advances and retreats

Last advance began ~27,000 BP
LGM grounding at ~ 20,000 BP
Retreat began ~13,000 BP



Quiz

1. What makes the Adélie Penguin a good bio-indicator species?

2. How does radiocarbon dating work and why must you correct for a marine carbon reservoir effect?

3. When did the Ross Ice Shelf begin its last advance and subsequent retreat in the Ross Sea?

4. Where did Adélie Penguins have their longest continuous occupation in the Ross Sea and why?

5. Why is Cape Adare the ‘most endangered penguin colony in the world’?

Next lecture begins the history and policy section of this course

Be sure to read Ch. 1 in the text