Oxygen isotope dating the Australian regolith: A review and new applications

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Acknowledgments

Michael Bird
Julius Atlhopheng
Behrooz Karamiqucham
Sol Buckman
Brad Pillans
Florian Dux
David Wheeler

Tectonic position of Australia; its translation northwards

(What is deep or intense weathering?)

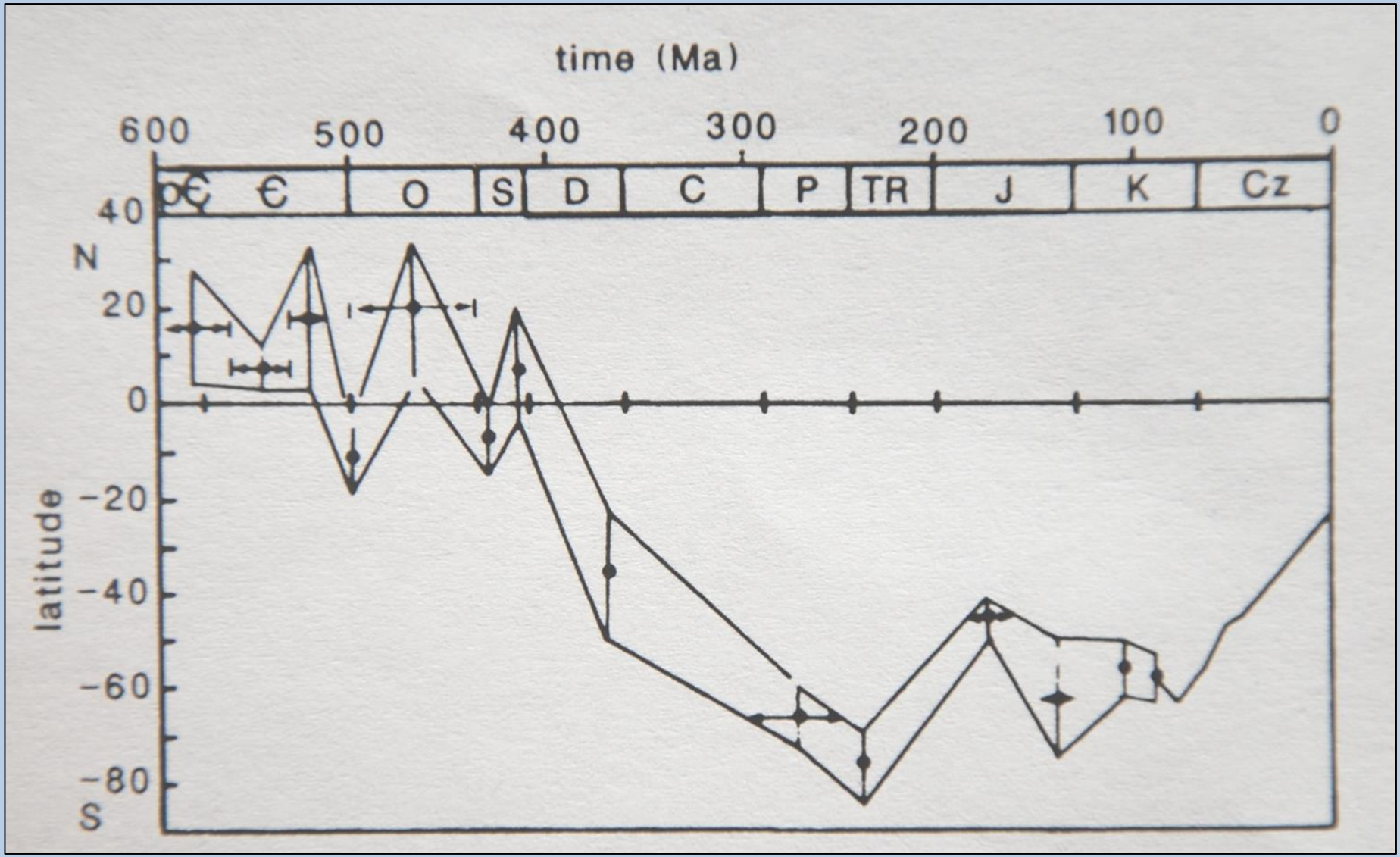
The global meteoric water line for oxygen isotopes in water

Oxygen isotopes in kaolinite of weathering origin

Ages of weathering in Australia

Examples: Yilgarn Craton and then inselbergs in the landscape

Iron oxides



(modified from Veevers, 1984)

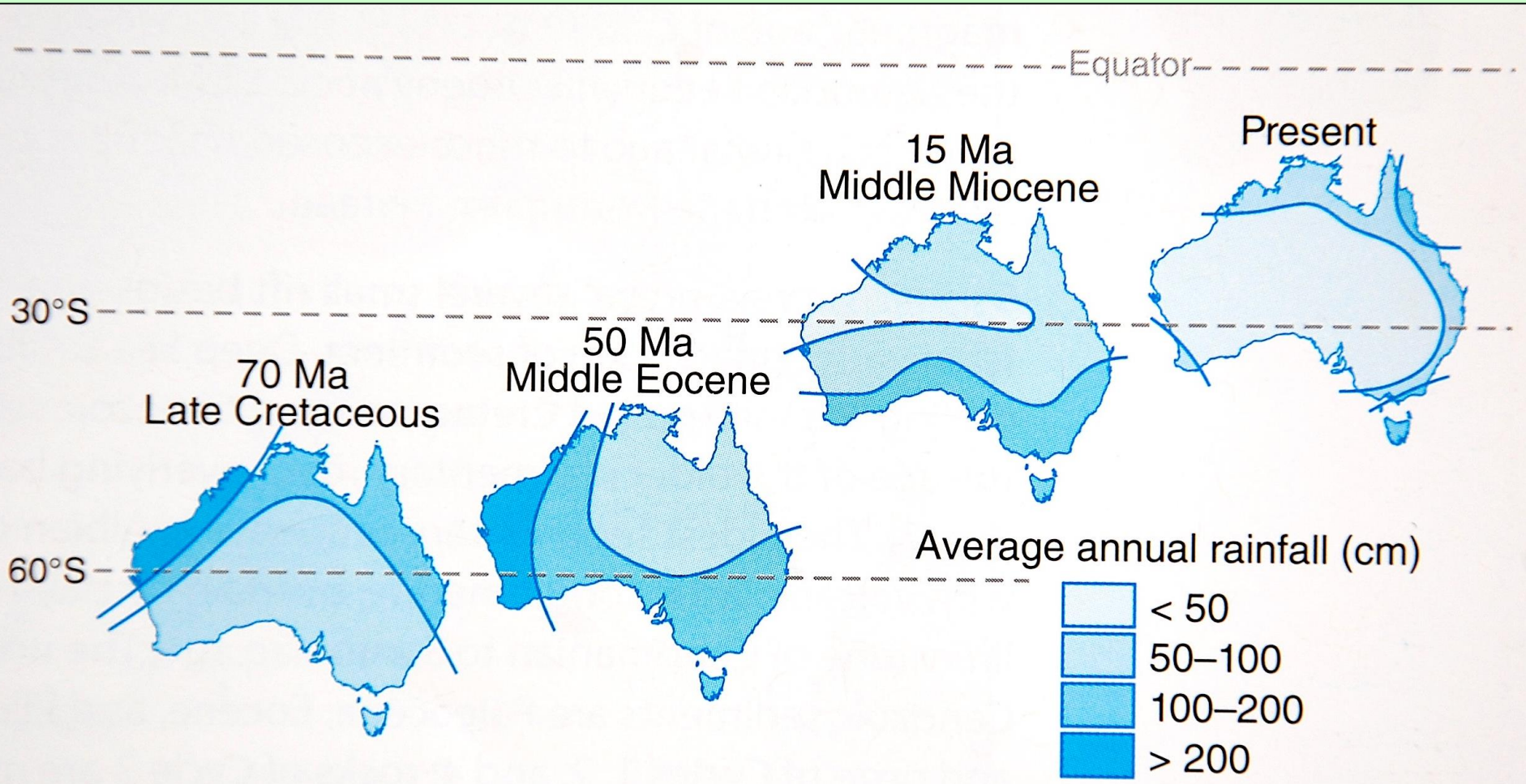
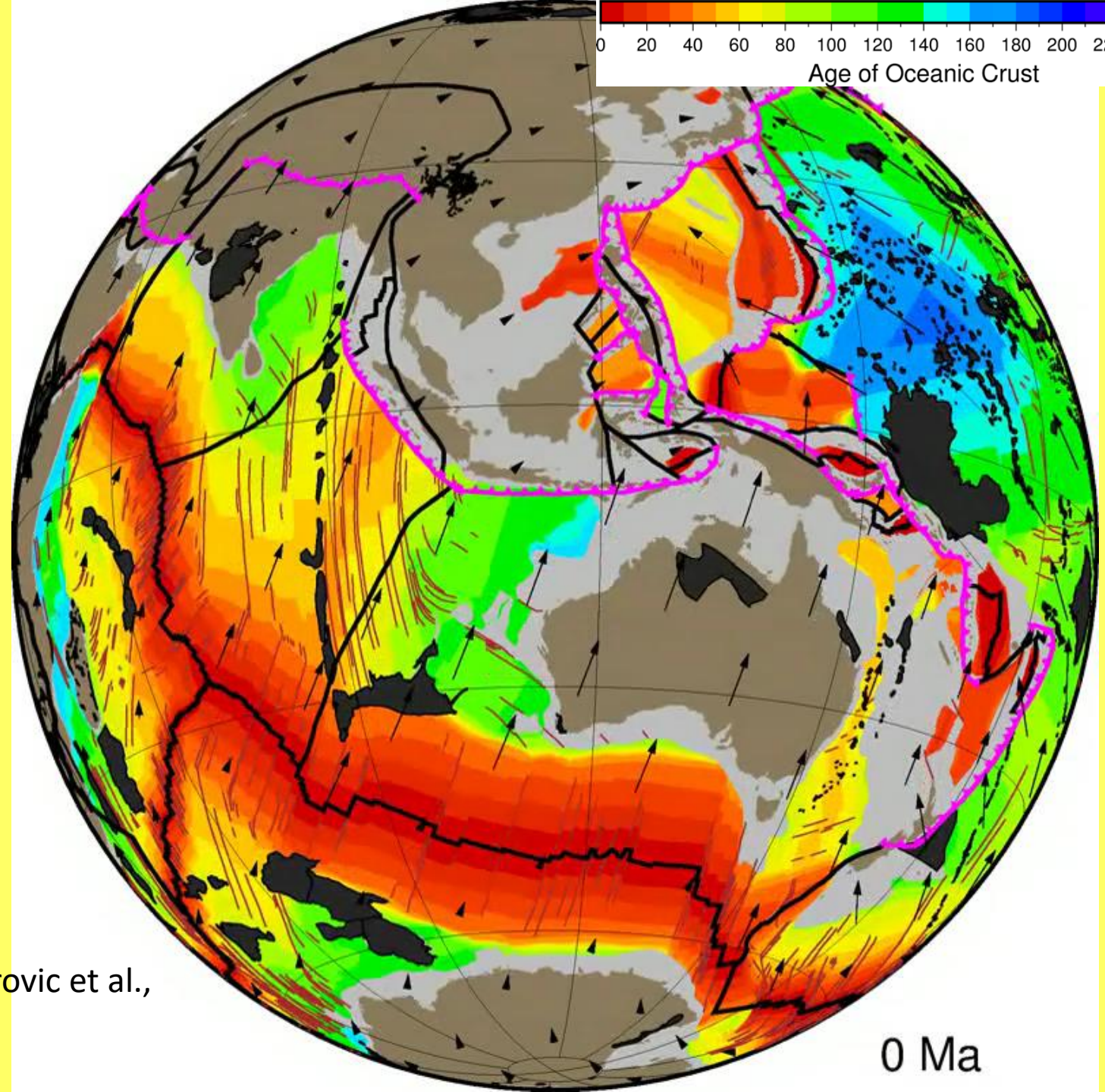
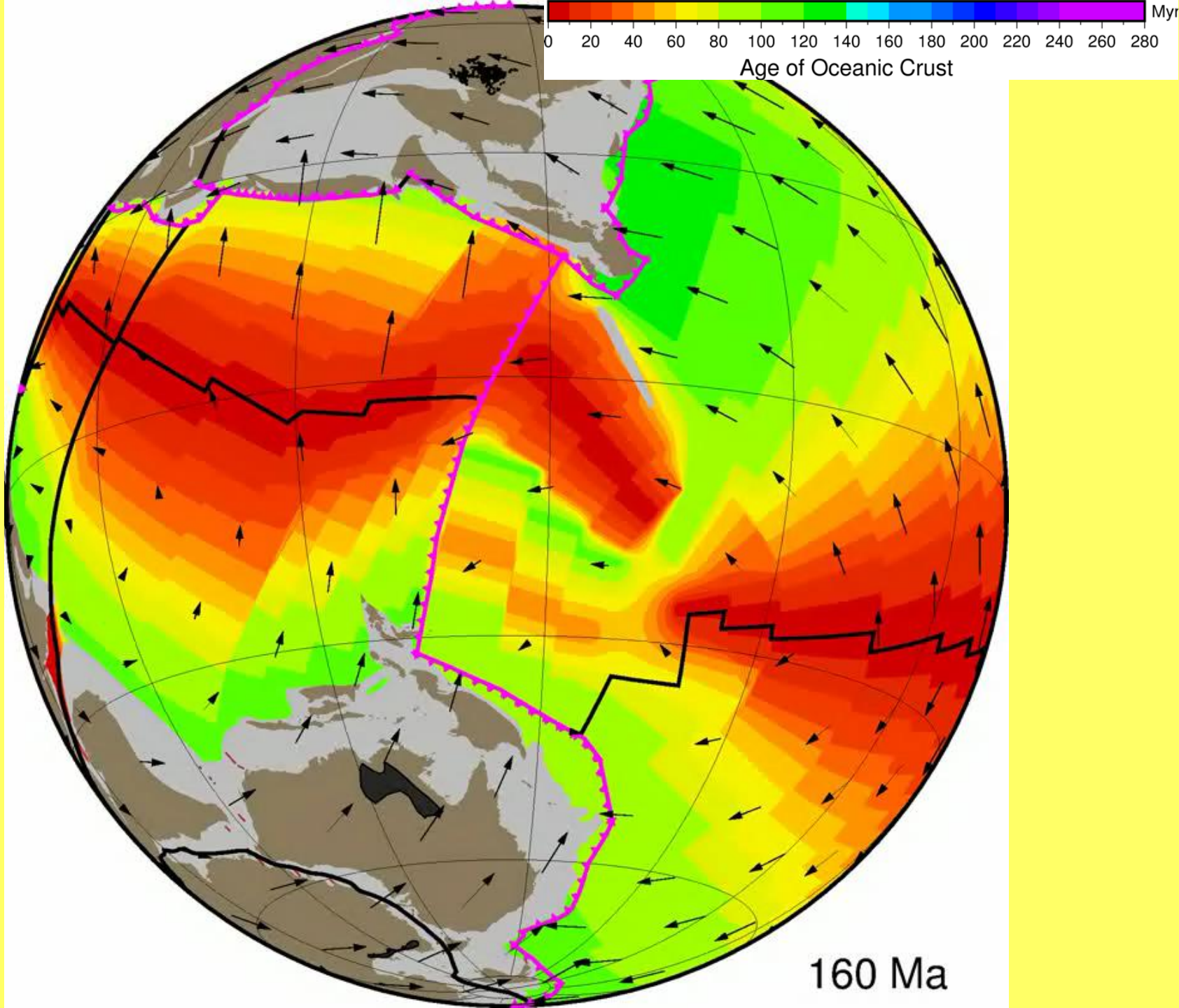
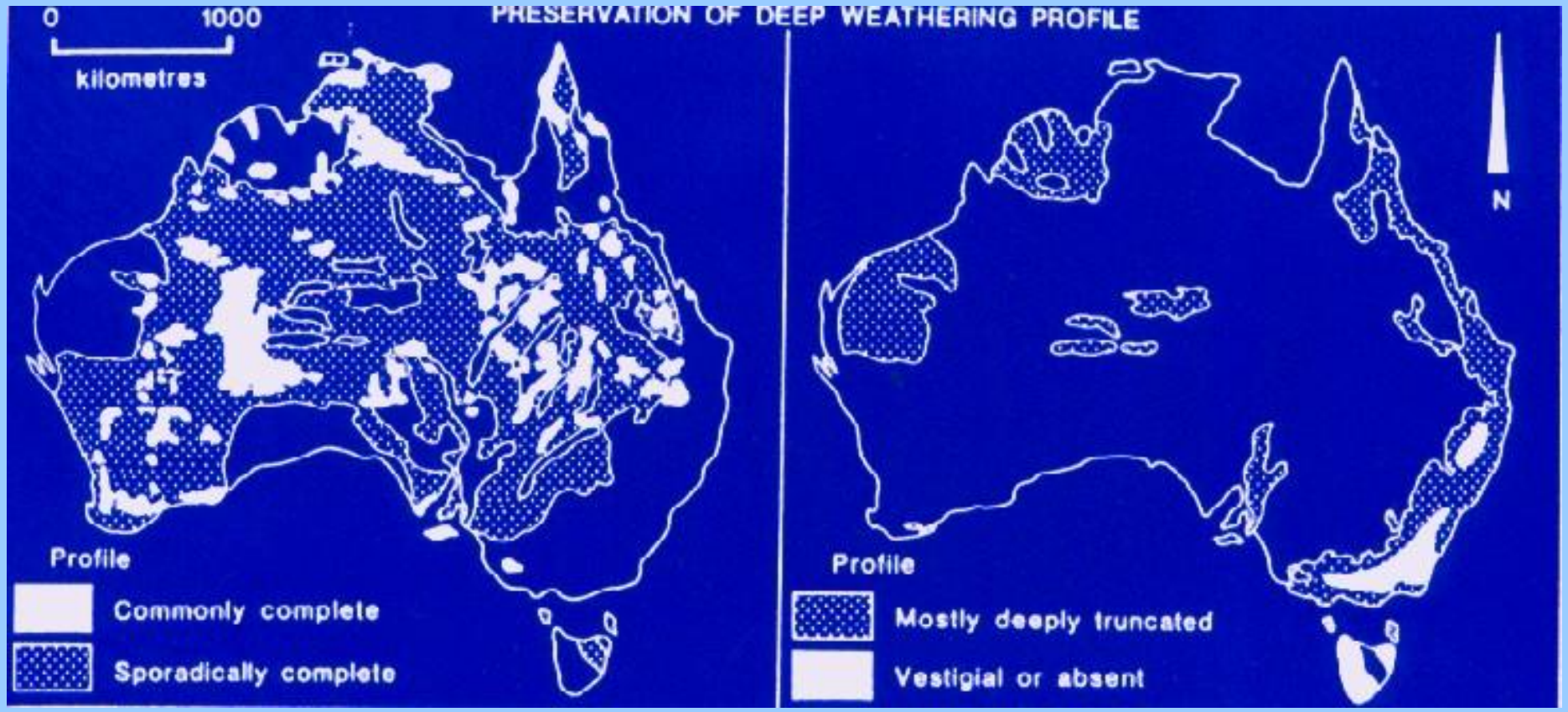


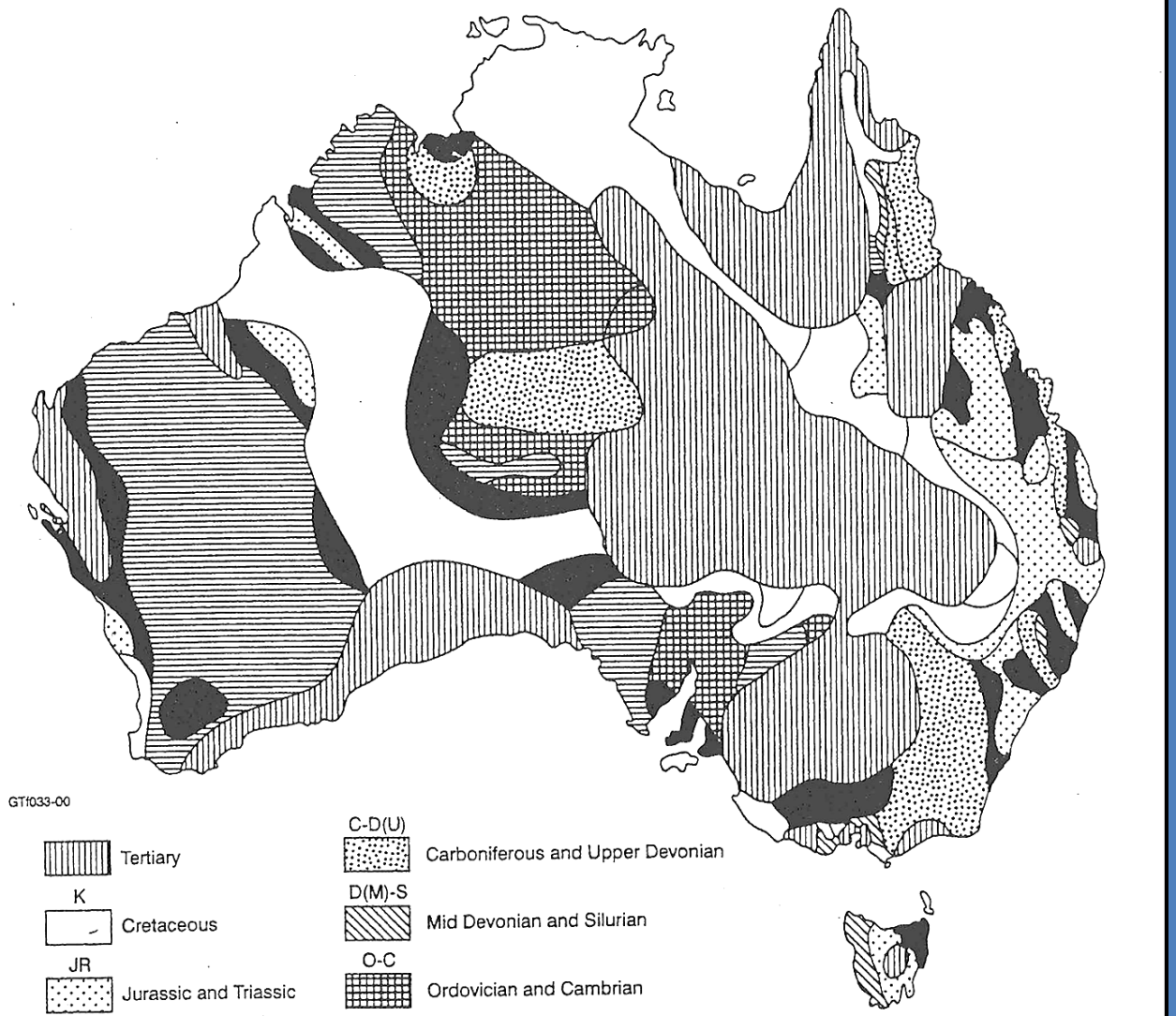
Figure 6. Australia's migration north since the Late Cretaceous (after Anand, 2005, fig. 5)

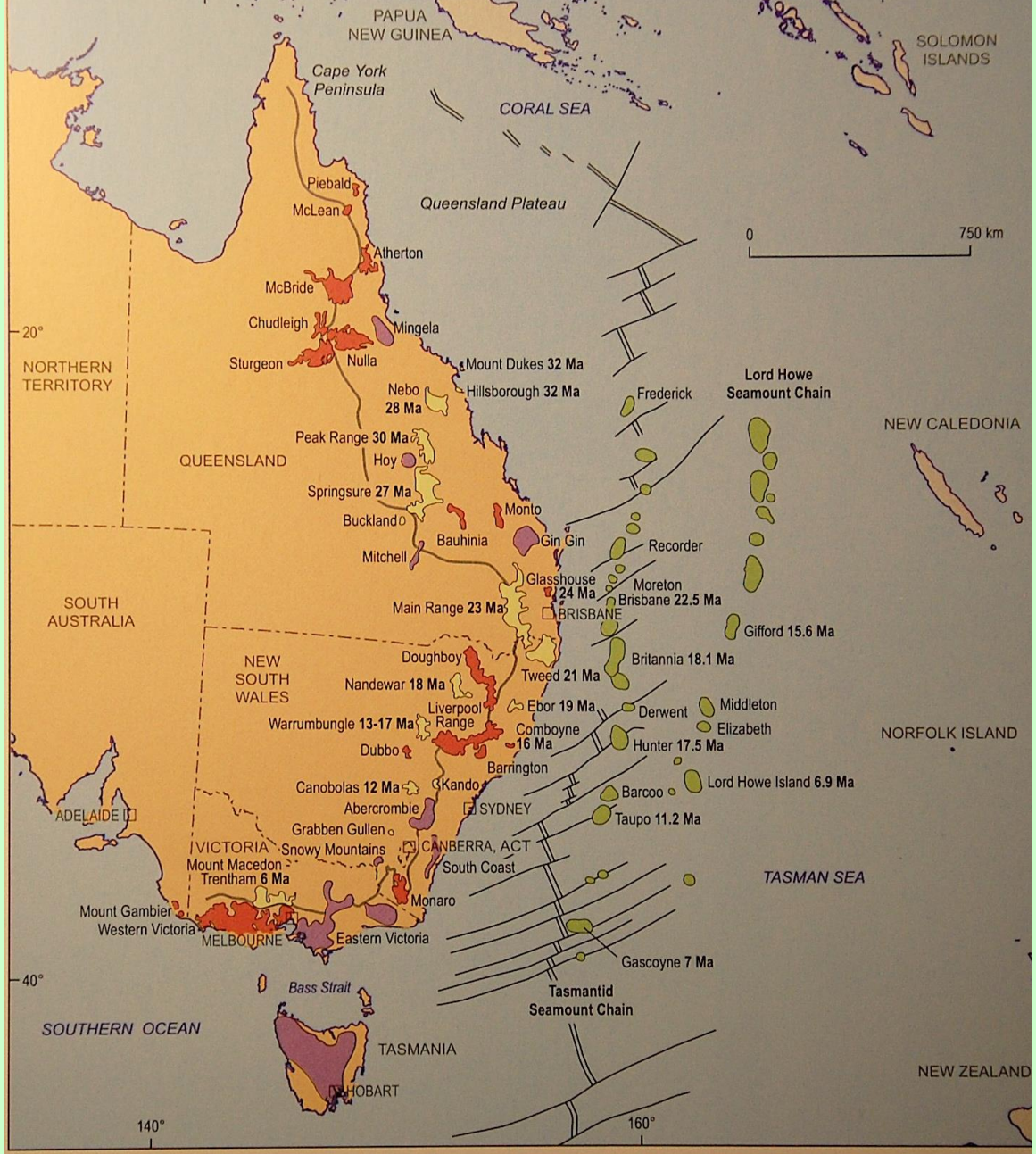


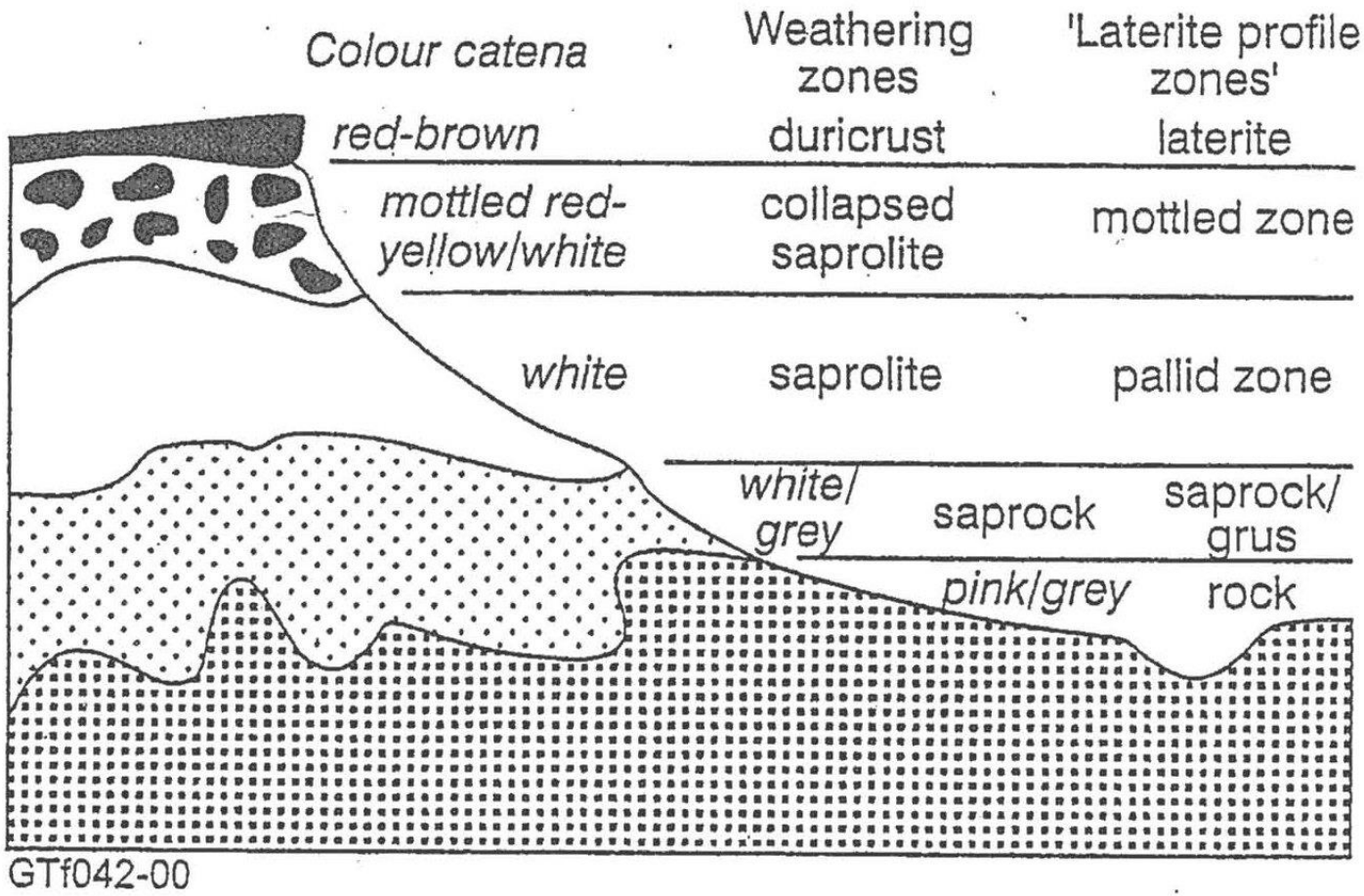
From Zahirovic et al., 2016

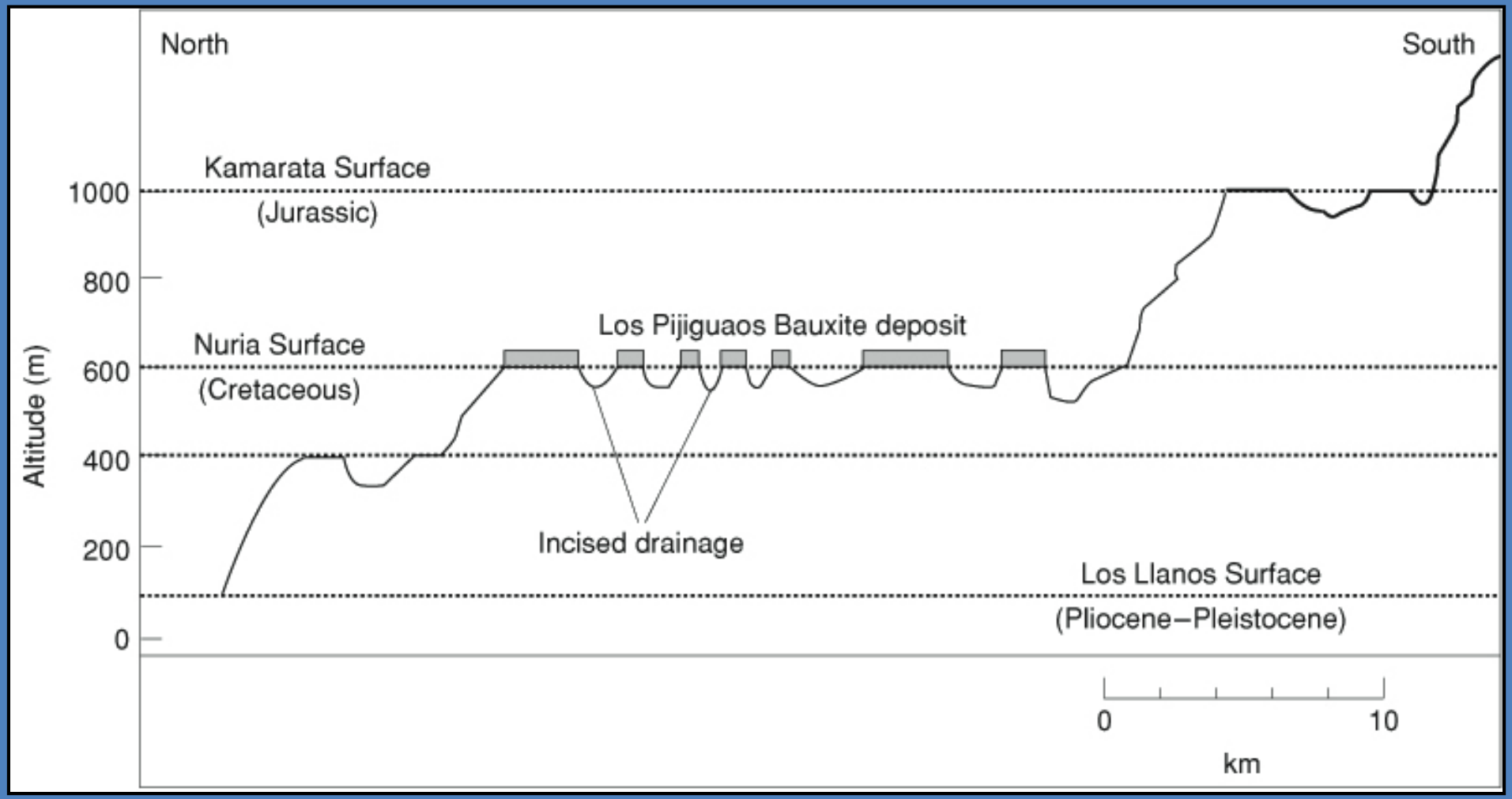

0 20 40 60 80 100 120 140 160 180 200 220 240 260 280
Myr
Age of Oceanic Crust
160 Ma


0
1000
kilometres
PRESERVATION OF DEEP WEATHERING PROFILE
N
Profile
Commonly complete
Sporadically complete
Profile
Mostly deeply truncated
Vestigial or absent


GTf033-00
Tertiary
K
Cretaceous
JR
Jurassic and Triassic
Permian
C-D(U)
Carboniferous and Upper Devonian
D(M)-S
Mid Devonian and Silurian
O-C
Ordovician and Cambrian
PC
Precambrian
e.g.
All of these areas have been continuously exposed to weathering and denudation since the Permian


PAPUA NEW GUINEA
SOLOMON ISLANDS
Cape York Peninsula
CORAL SEA
Piebald
McLean
Queensland Plateau
0
750 km
Atherton
McBride
Chudleigh
Mingela
20°
NORTHERN TERRITORY
Sturgeon
Nulla
Mount Dukes 32 Ma
Nebo 28 Ma
Hillsborough 32 Ma
Frederick
Lord Howe Seamount Chain
NEW CALEDONIA
Peak Range 30 Ma
QUEENSLAND
Hoy
Springsure 27 Ma
Monto
Buckland
Bauhinia
Gin Gin
Recorder
Mitchell
Glasshouse 24 Ma
Moreton
Brisbane 22.5 Ma
SOUTH AUSTRALIA
Main Range 23 Ma
BRISBANE
Gifford 15.6 Ma
Doughboy
Britannia 18.1 Ma
NEW SOUTH WALES
Nandewar 18 Ma
Tweed 21 Ma
Liverpool Range
Ebor 19 Ma
Derwent
Middleton
Warrumbungle 13-17 Ma
Comboyne 16 Ma
Elizabeth
NORFOLK ISLAND
Hunter 17.5 Ma
Dubbo
Barrington
Canobolas 12 Ma
Kando
Barcoo
Lord Howe Island 6.9 Ma
ADELAIDE
Abercrombie
SYDNEY
Taupo 11.2 Ma
Grabben Gullen
VICTORIA
Snowy Mountains
CANBERRA, ACT
Mount Macedon
South Coast
TASMAN SEA
Trentham 6 Ma
Monaro
Mount Gambier
Western Victoria
MELBOURNE
Eastern Victoria
Gascoyne 7 Ma
40°
Bass Strait
Tasmantid Seamount Chain
SOUTHERN OCEAN
TASMANIA
NEW ZEALAND
HOBART
140°
160°
Lava field
Scattered lava field remnants and other vents
Central shield volcano
Seamount (seabed volcano)
Extinct spreading ridge and transform faults
Great Divide


Colour catena
Weathering zones
'Laterite profile zones'
red-brown
duricrust
laterite
mottled red-yellow/white
collapsed saprolite
mottled zone
white
saprolite
pallid zone
white/grey
saprock
saprock/grus
pink/grey
rock
GTf042-00

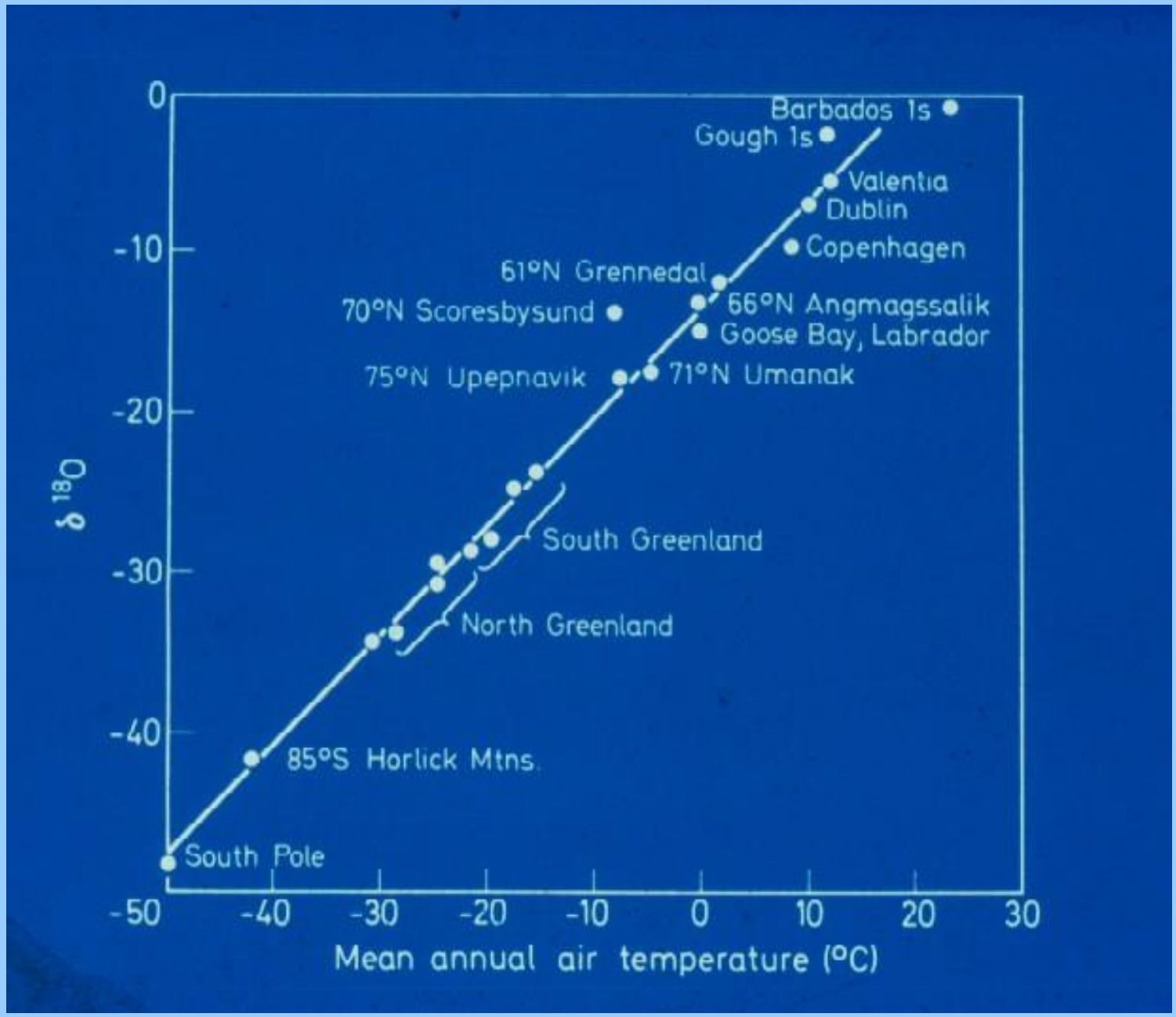

North
South
Kamarata Surface
(Jurassic)
1000
800
Nuria Surface
(Cretaceous)
Los Pijiguaos Bauxite deposit
600
400
200
0
Altitude (m)
Incised drainage
Los Llanos Surface
(Pliocene–Pleistocene)
0
10
km

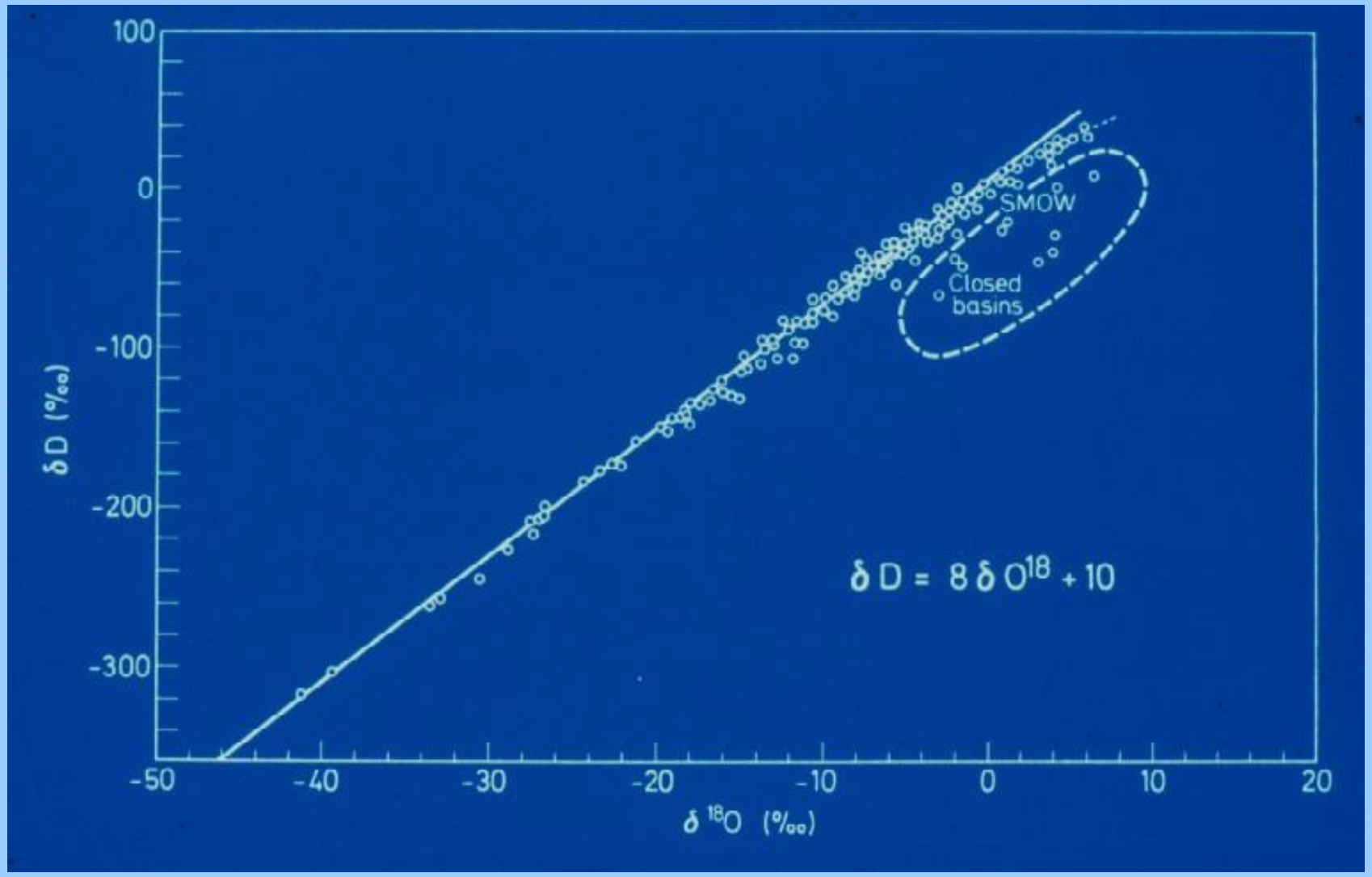

Pentland, Queensland


Weipa, Far North Queensland (bauxite)

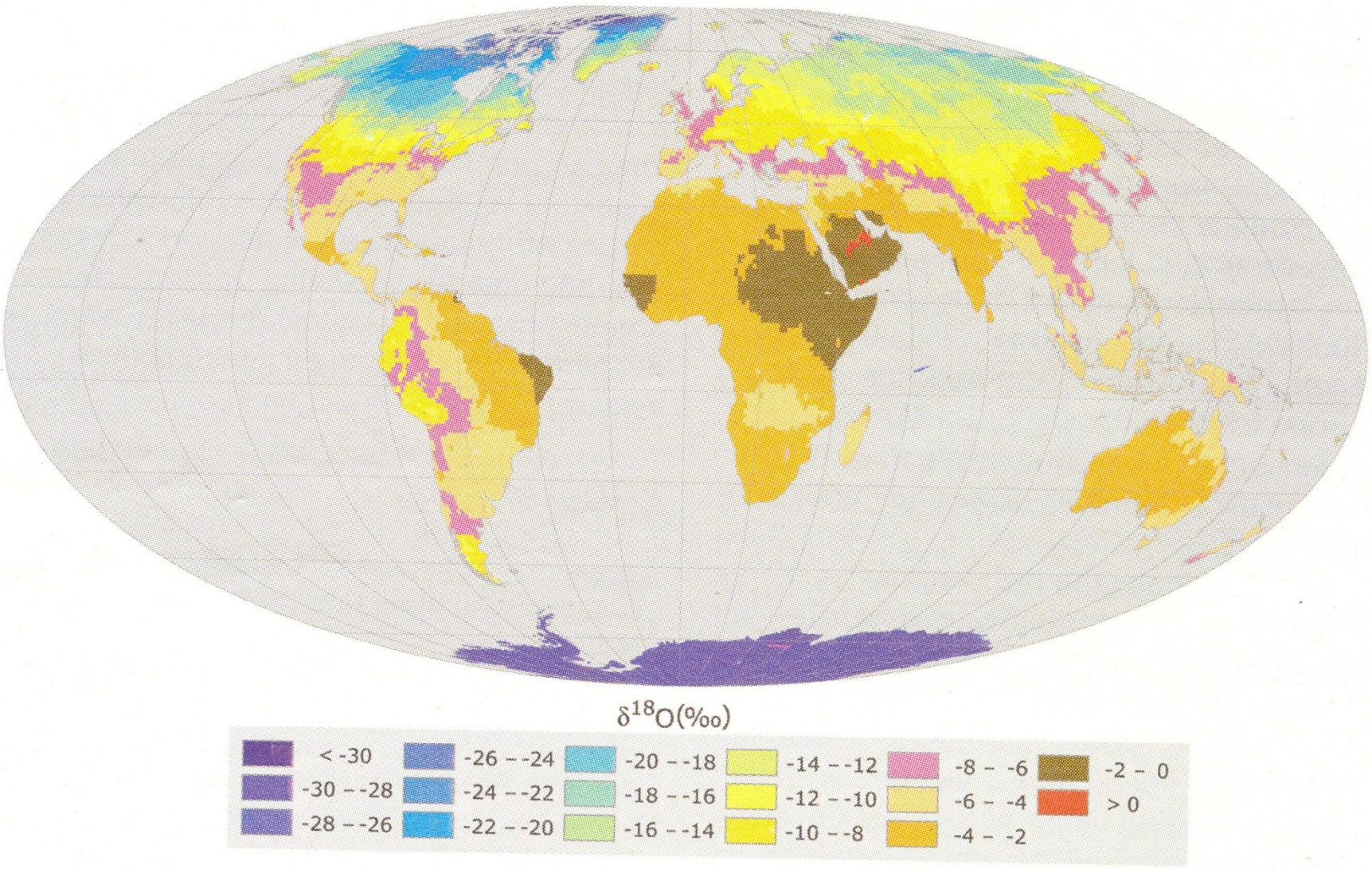
The Breakaways, Coober Pedy, South Australia

$$\delta^{18}O_{SMOW}\,(\text{in } ‰) = \left(\frac{{}^{18}O/{}^{16}O_{sample} - {}^{18}O/{}^{16}O_{SMOW}}{{}^{18}O/{}^{16}O_{SMOW}} \right) 1000$$

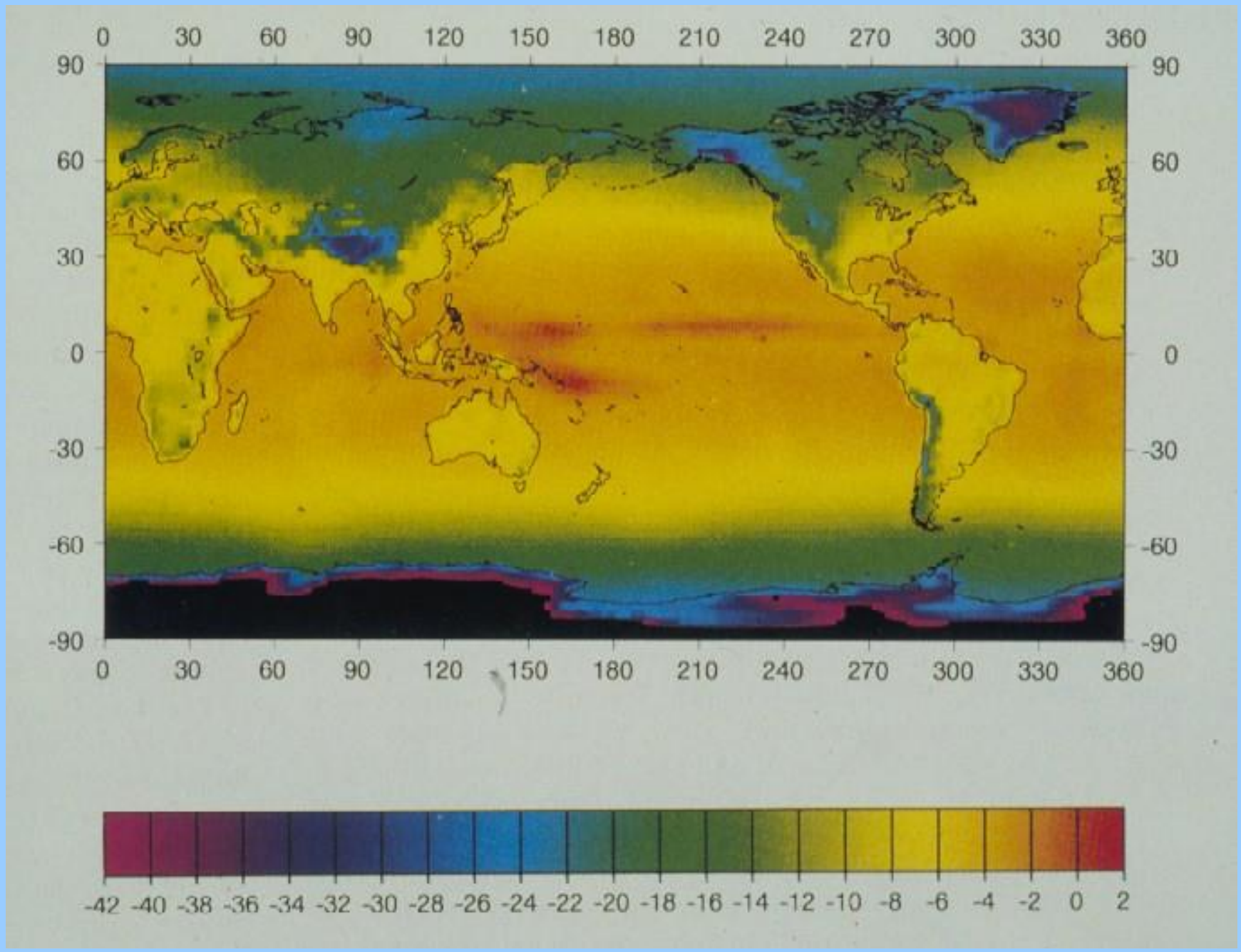

0
-10
-20
-30
-40
δ 18O
Barbados 1s
Gough 1s
Valentia
Dublin
Copenhagen
61°N Grennedal
70°N Scoresbysund
66°N Angmagssalik
Goose Bay, Labrador
75°N Upepnavik
71°N Umanak
South Greenland
North Greenland
85°S Horlick Mtns.
South Pole
-50
-40
-30
-20
-10
0
10
20
30
Mean annual air temperature (°C)

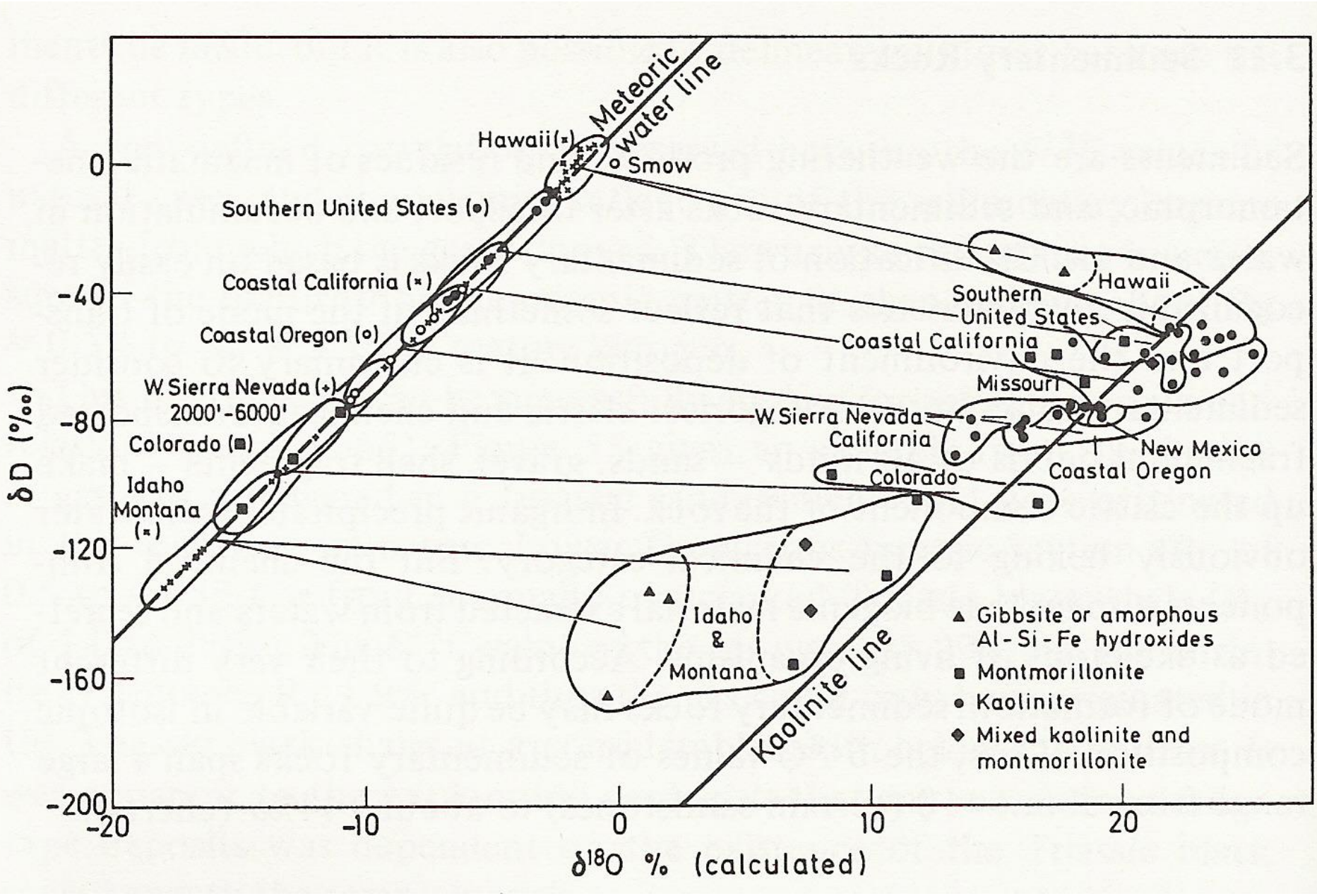

100
0
-100
-200
-300
δ D (‰)
-50
-40
-30
-20
-10
0
10
20
δ ¹⁸O (‰)
SMOW
Closed basins
δ D = 8 δ O¹⁸ + 10

Craig, 1961

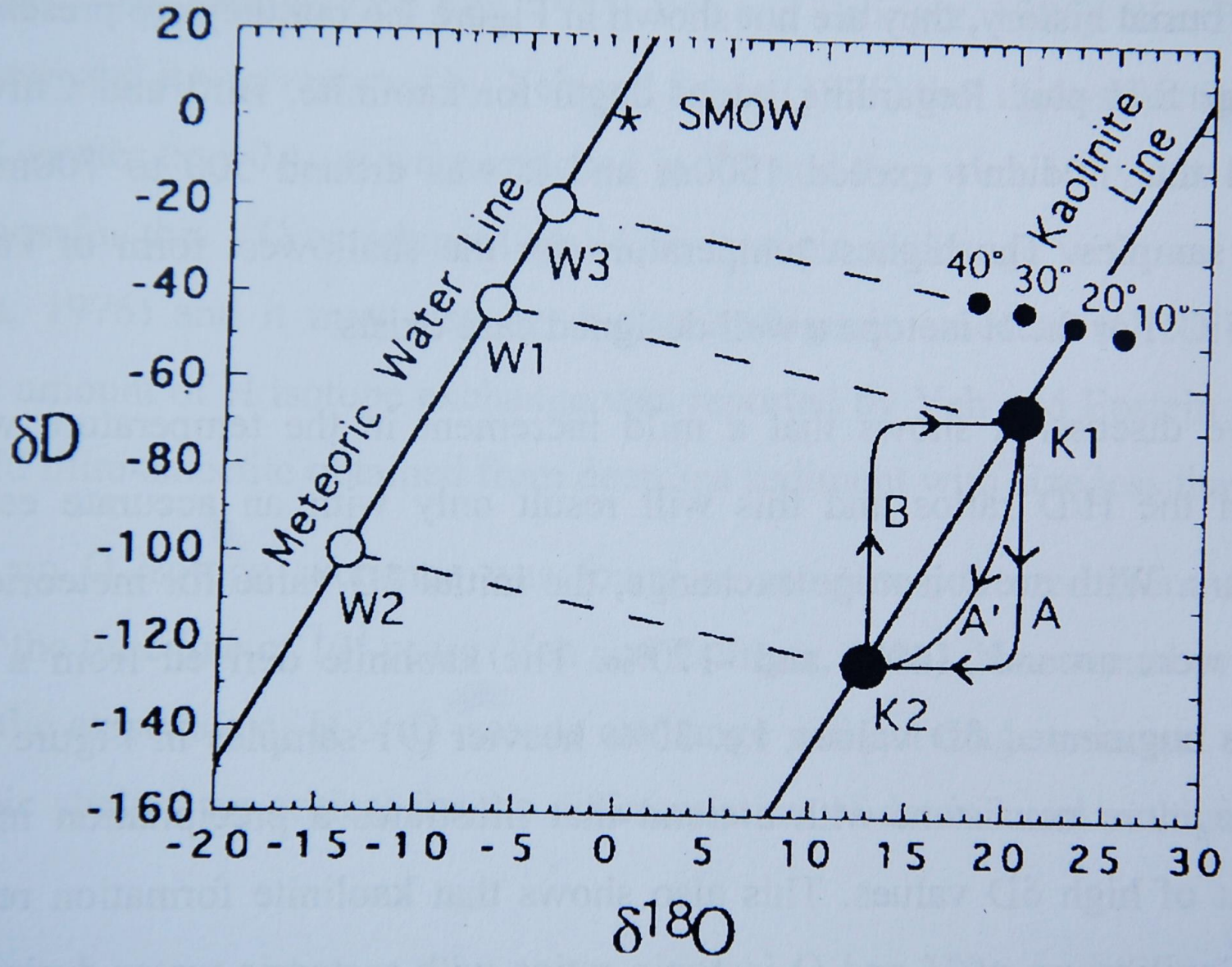


2007-http://www.iaea.org/water/


0 30 60 90 120 150 180 210 240 270 300 330 360
90 60 30 0 -30 -60 -90
-42 -40 -38 -36 -34 -32 -30 -28 -26 -24 -22 -20 -18 -16 -14 -12 -10 -8 -6 -4 -2 0 2

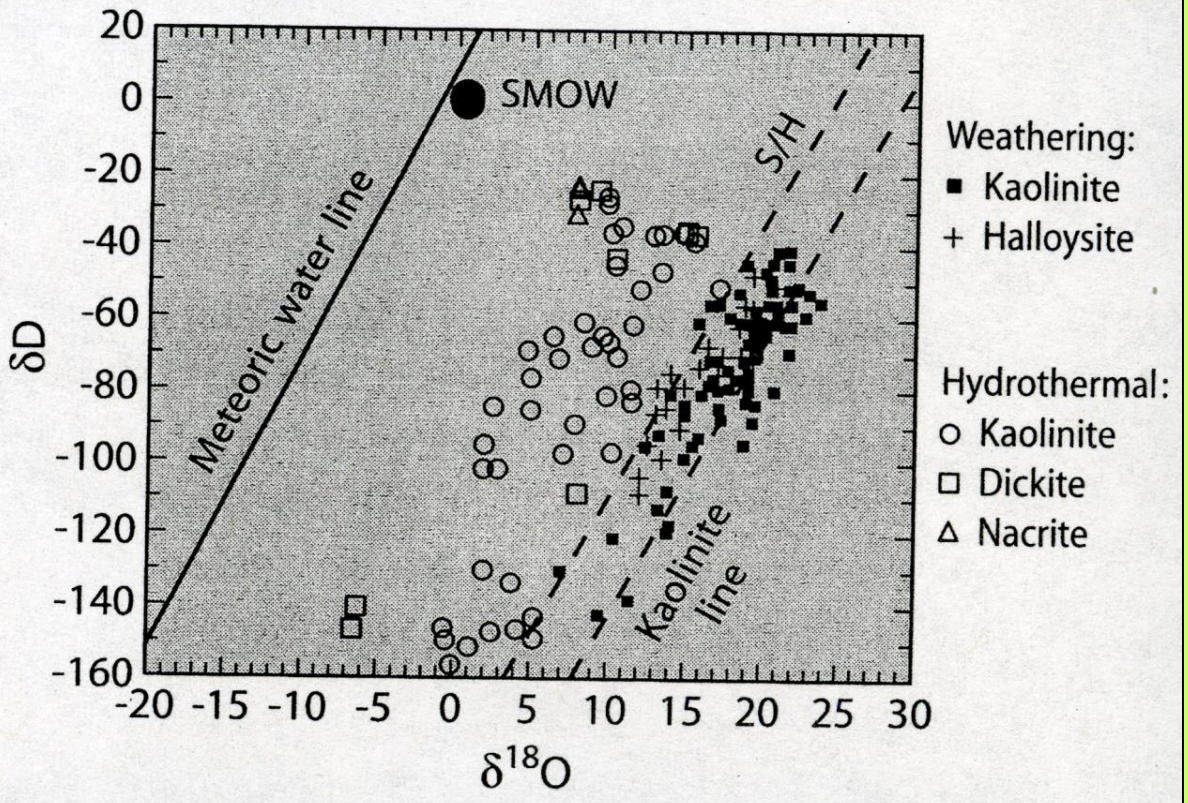


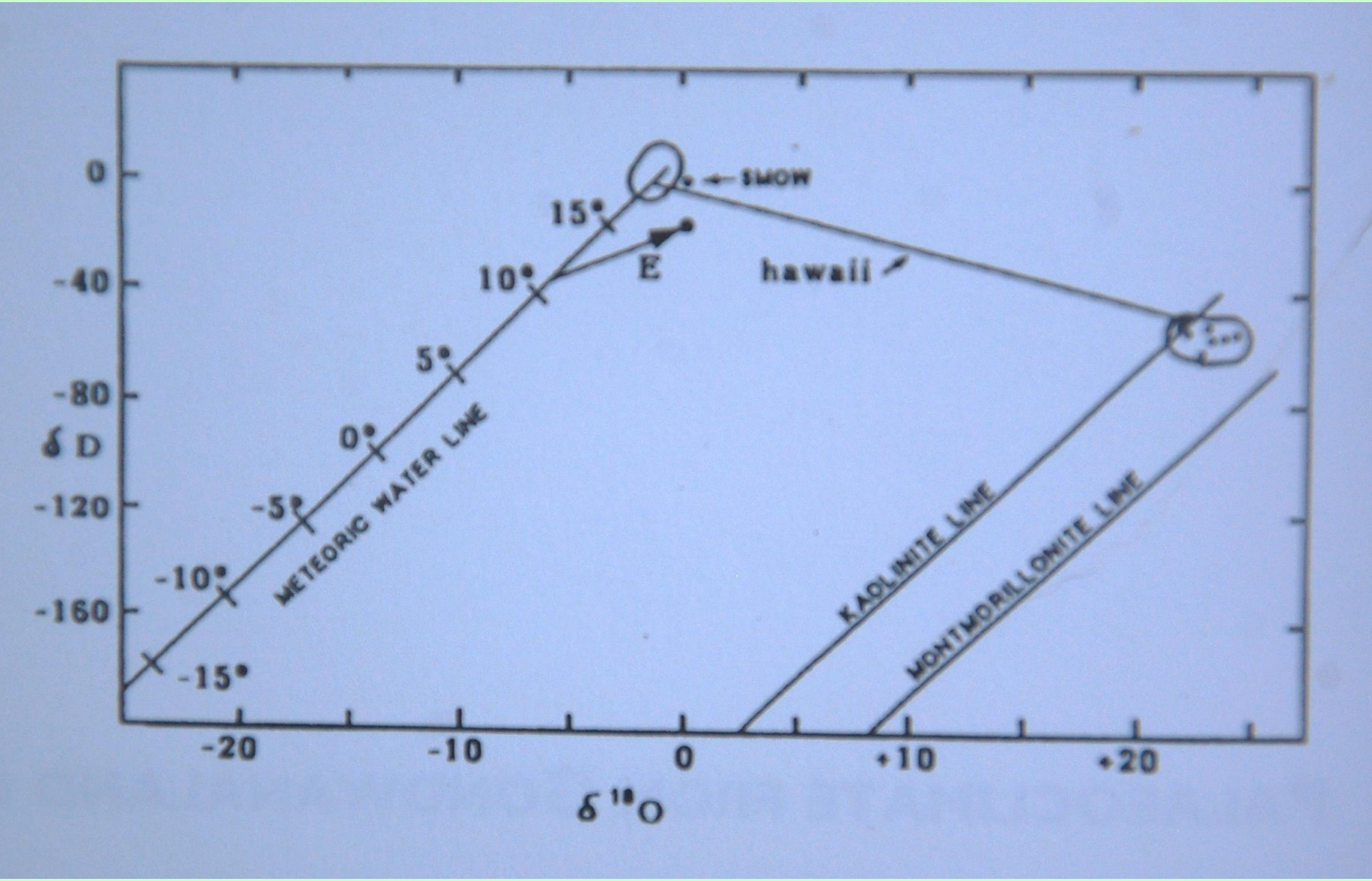
Lawrence and Taylor, 1971 Oxygen fractionation is +27 per mil



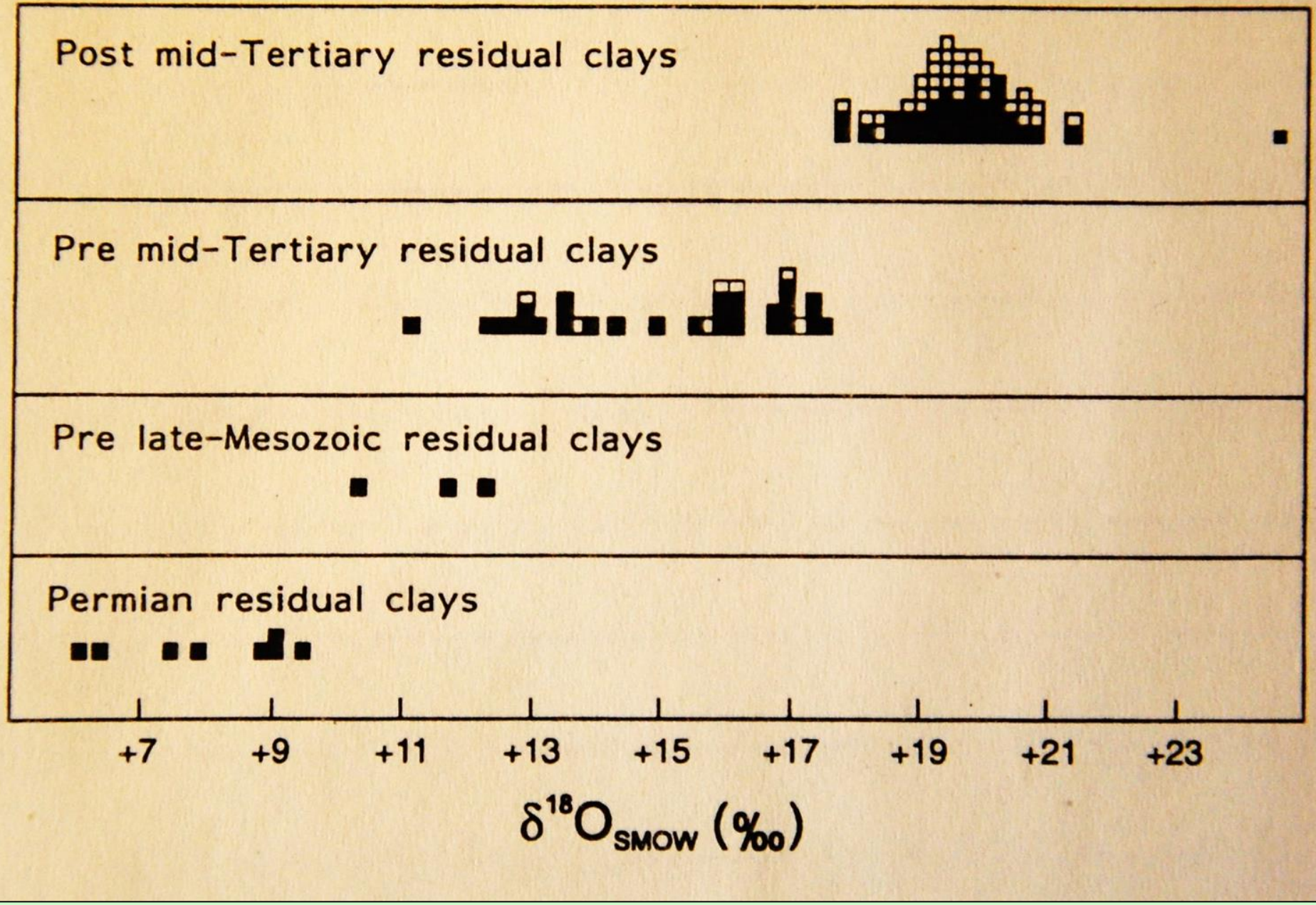
(Sheppard and Gilg, 1996)

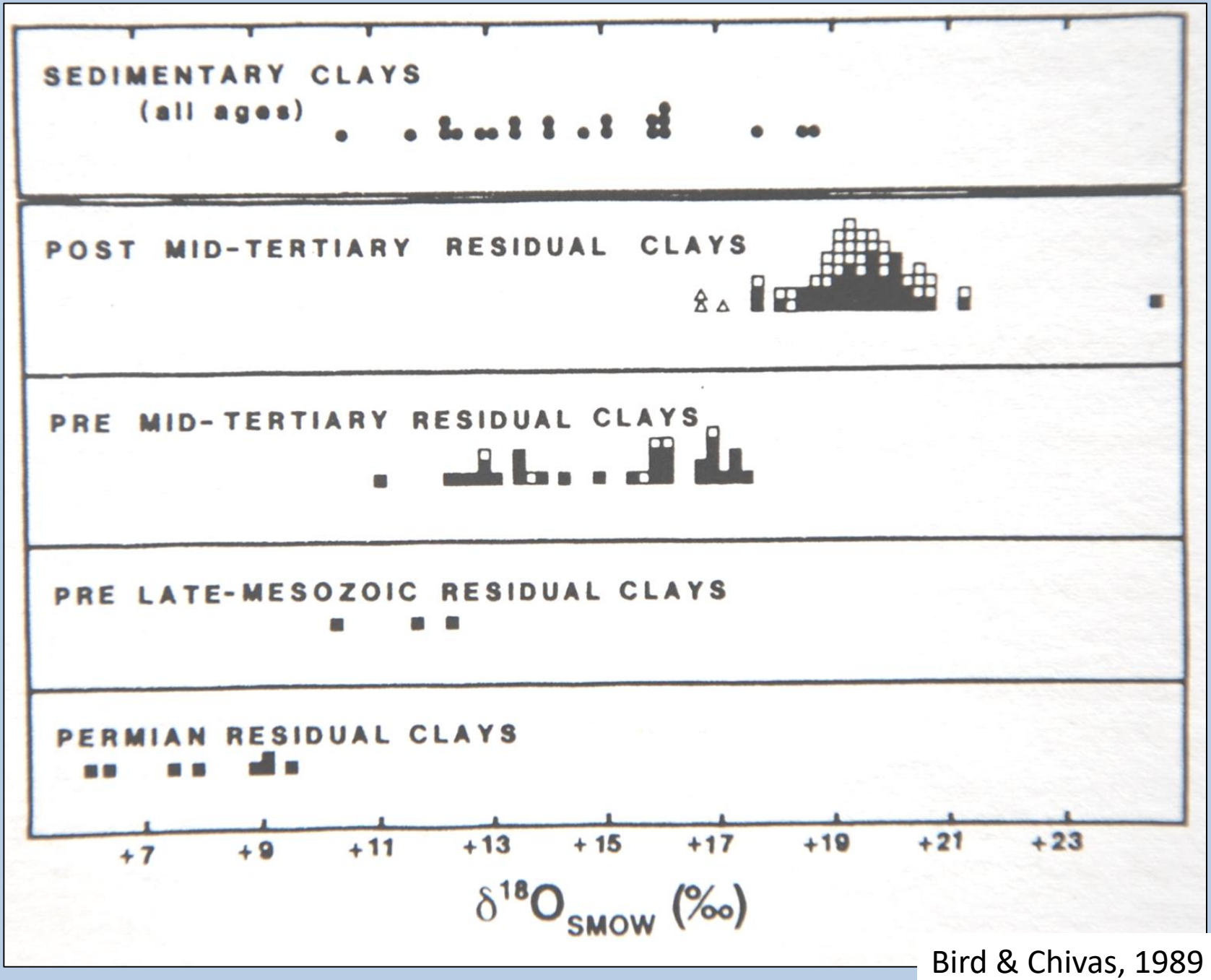
Fig. 65. Compilation of δD and $\delta^{18}O$ values for kaolinites and related minerals from weathering and hydrothermal environments. The Meteoric Water Line, kaolinite weathering line, and supergene/hypogene (S/H) lines are given for reference. (After Sheppard and Gilg 1995)



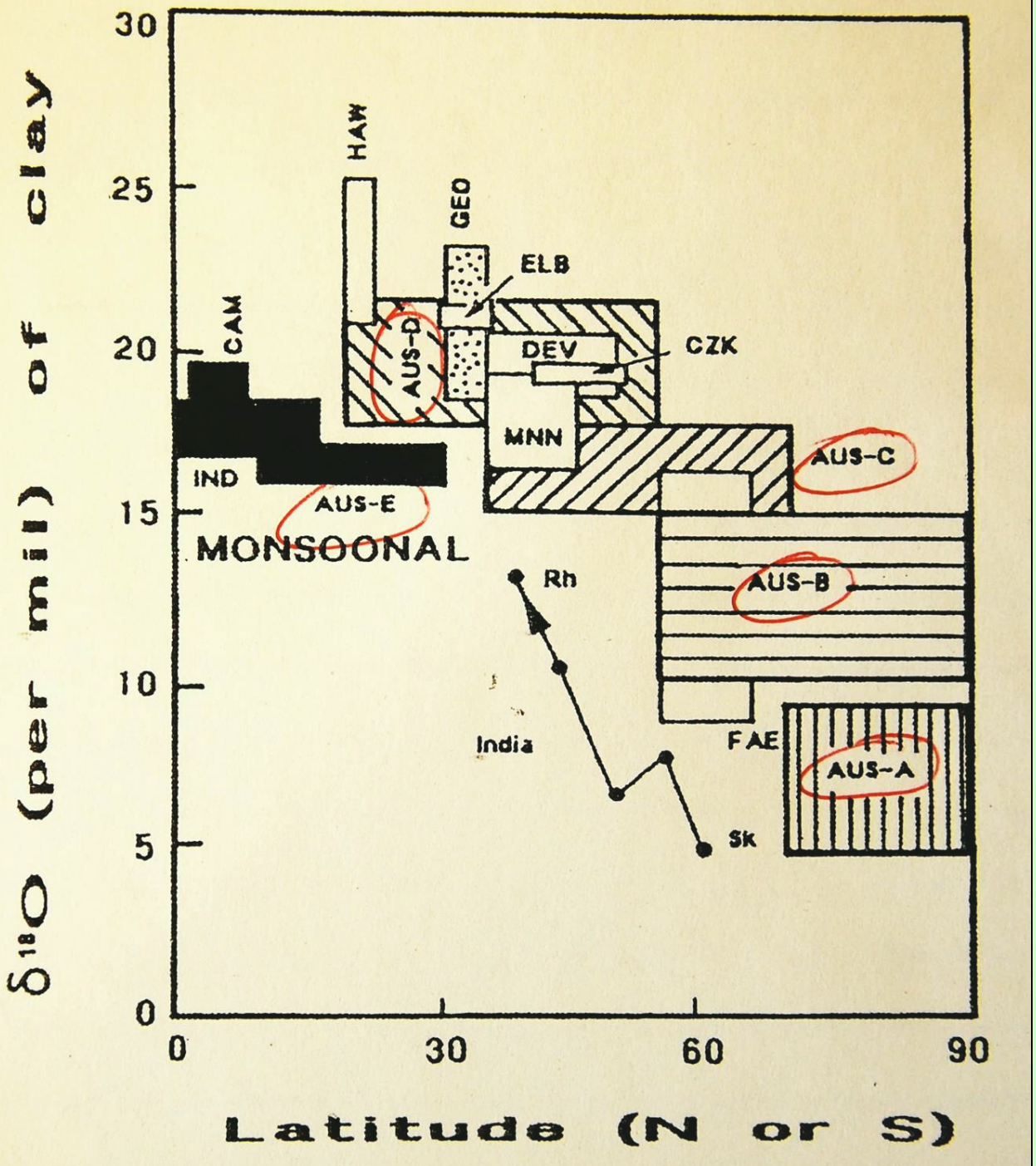


(Chivas and Bird, 1995)


Post mid-Tertiary residual clays
Pre mid-Tertiary residual clays
Pre late-Mesozoic residual clays
Permian residual clays
+7
+9
+11
+13
+15
+17
+19
+21
+23
δ18OSMOW (‰)



Bird & Chivas, 1989

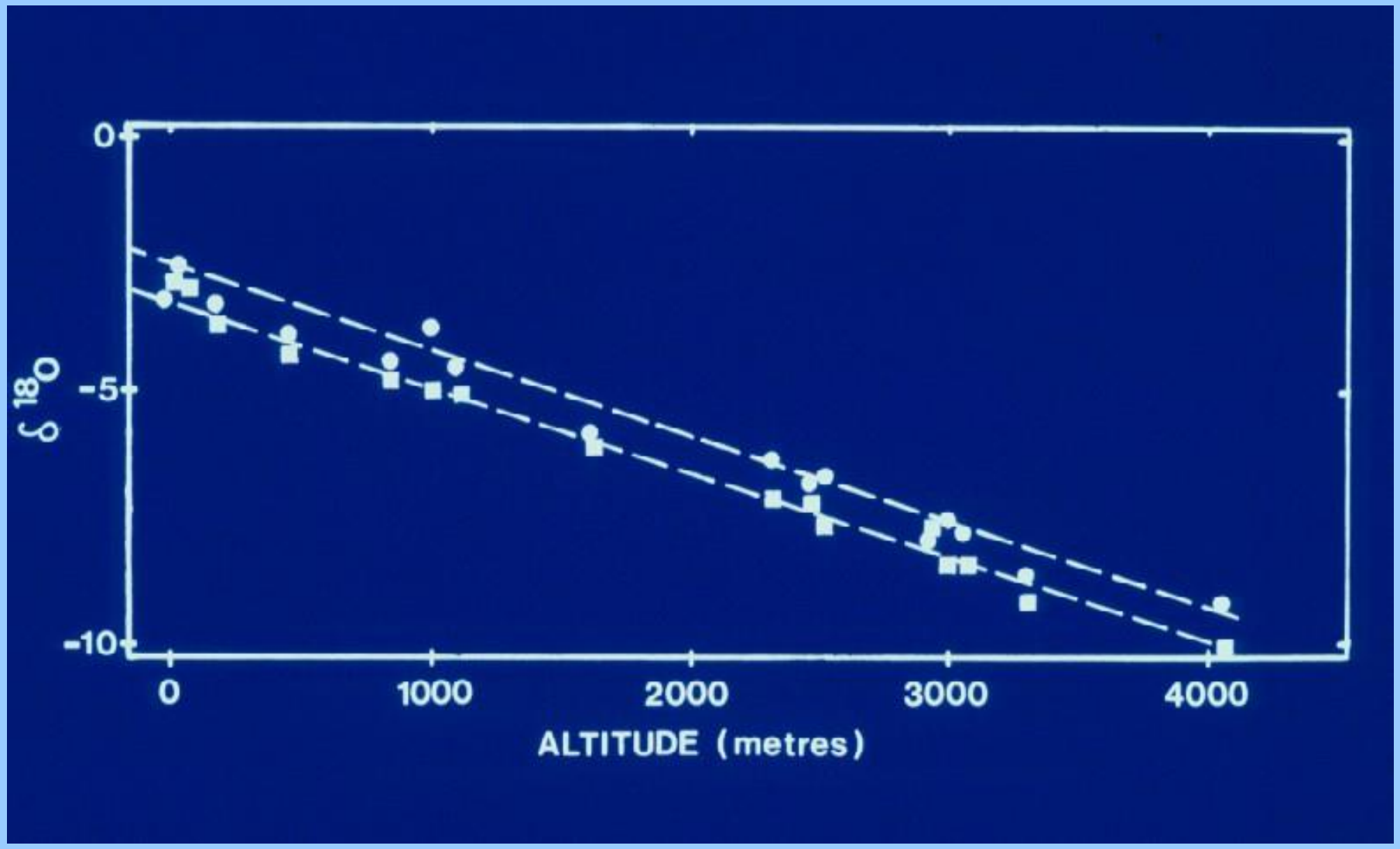

30
25
20
15
10
5
0
δ18O (per mil) of clay
0
30
60
90
Latitude (N or S)
HAW
GEO
ELB
CAM
AUS-D
DEV
CZK
MNN
IND
AUS-E
AUS-C
MONSOONAL
Rh
AUS-B
India
FAE
AUS-A
Sk

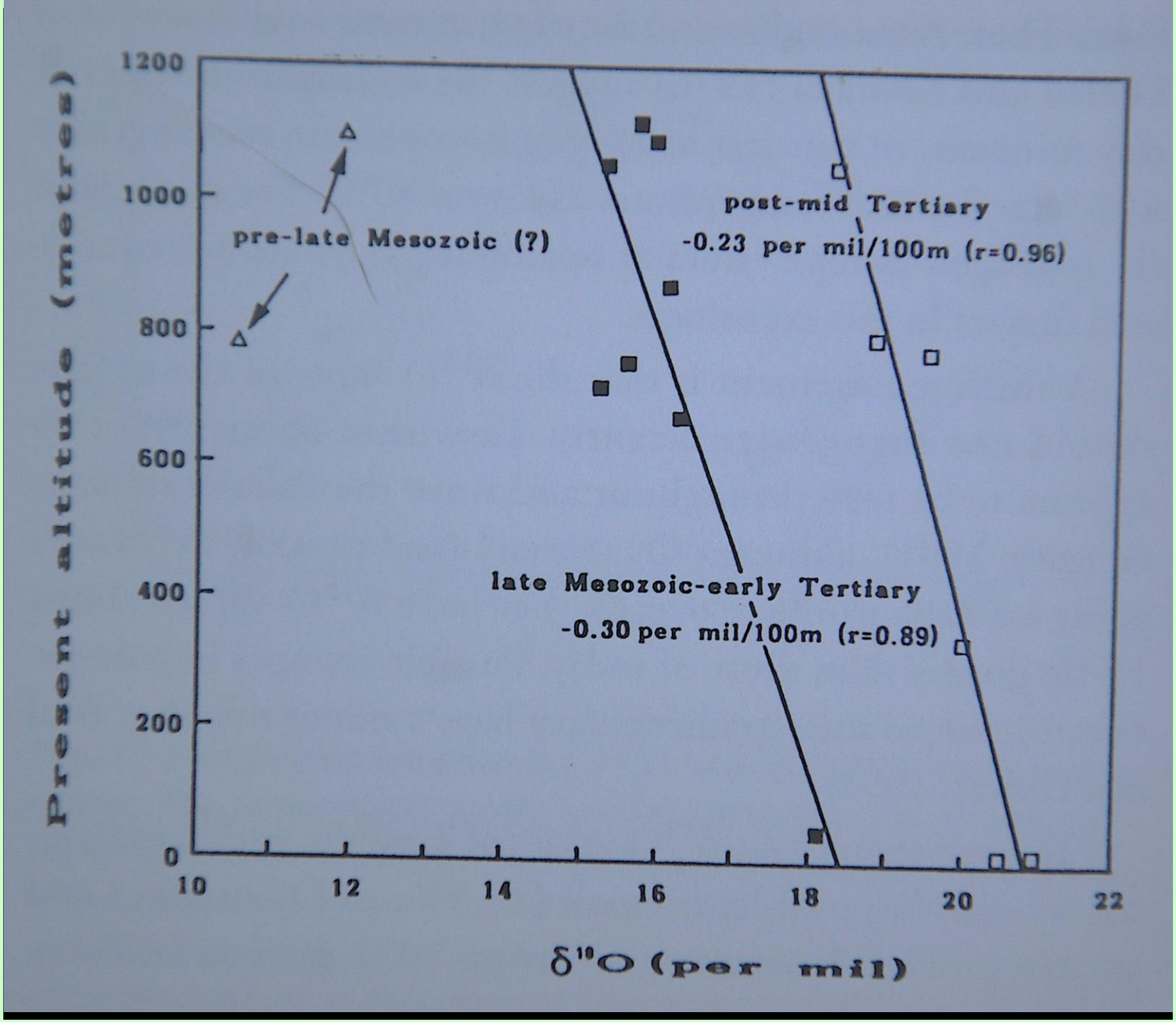
Principal Conclusions of $\delta^{18}O$ Studies

Excluding monsoonal regions to the north, it is possible to distinguish profiles formed in –

- Late Mesozoic – Early Cenozoic = $\delta^{18}O$ +15 to +17.5‰
- Post-mid-Cenozoic weathering profiles = $\delta^{18}O$ >+17.5 ‰

Also identified remnants of earlier phases of deep weathering (pre-late Mesozoic: Early Cretaceous or Jurassic?) with $\delta^{18}O$ +10 to +15‰ indicating weathering in cool to cold and presumably humid climate


0
-5
-10
$\delta^{18}O$
0
1000
2000
3000
4000
ALTITUDE (metres)



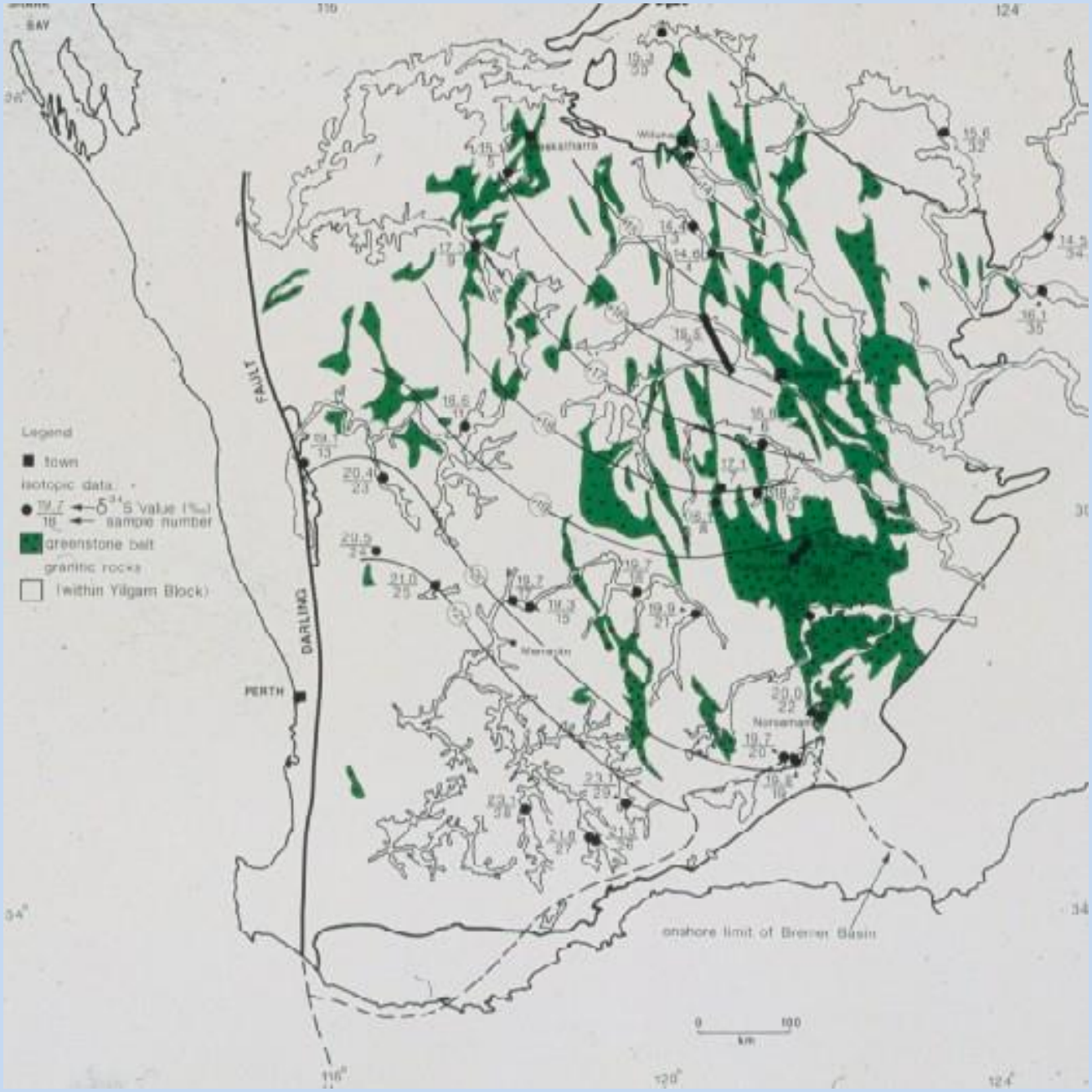
(Chivas and Bird, 1995)

Stable Isotope Studies and the Timing of Weathering Events

Bird & Chivas (1993) *Australian Journal of Earth Sciences*, **40**, 345-358

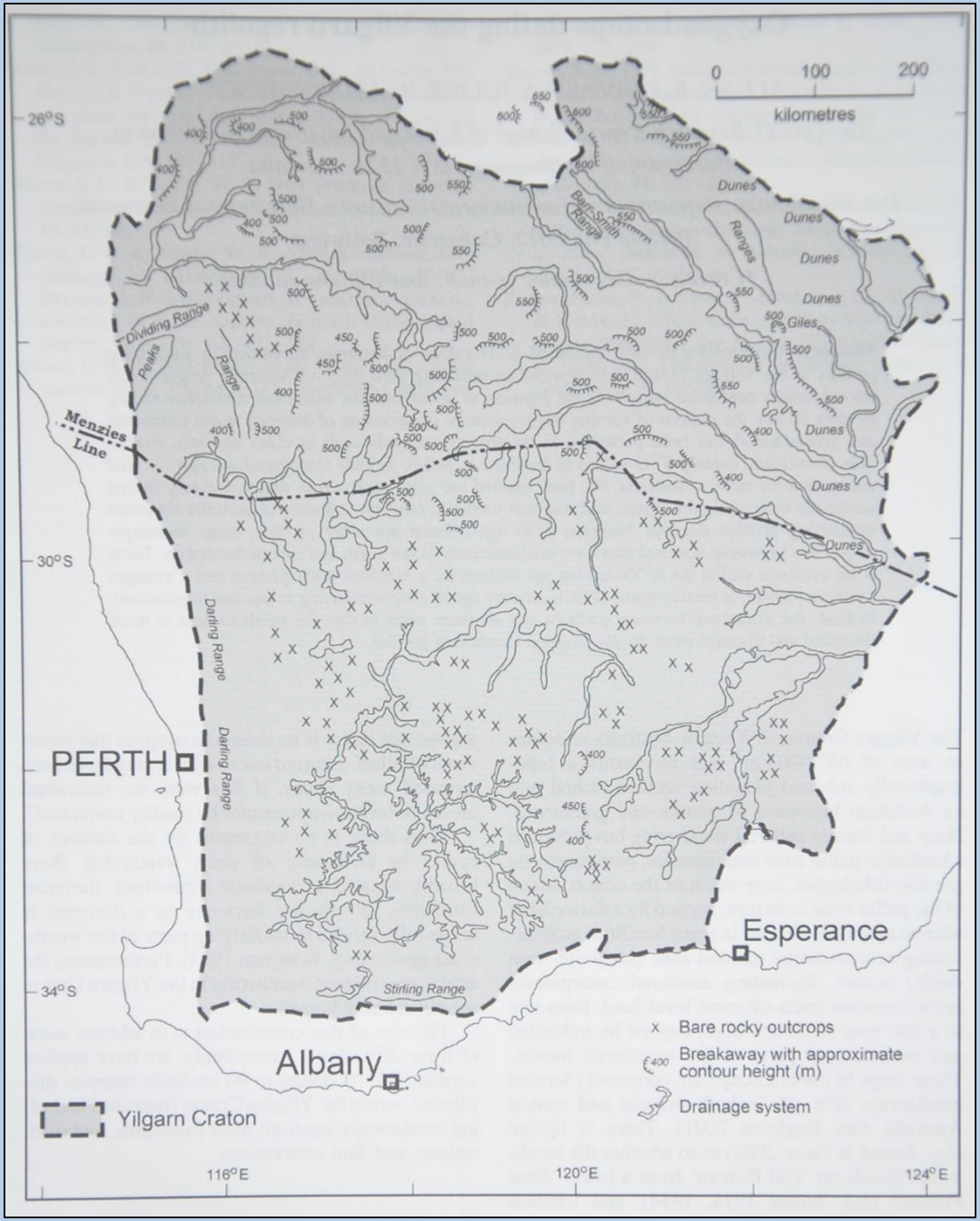
$\delta^{18}O$ ($^{18}O/^{16}O$) measured in authigenic clay minerals as a parameter of weathering (clay formation) age (isotopic fractionation)

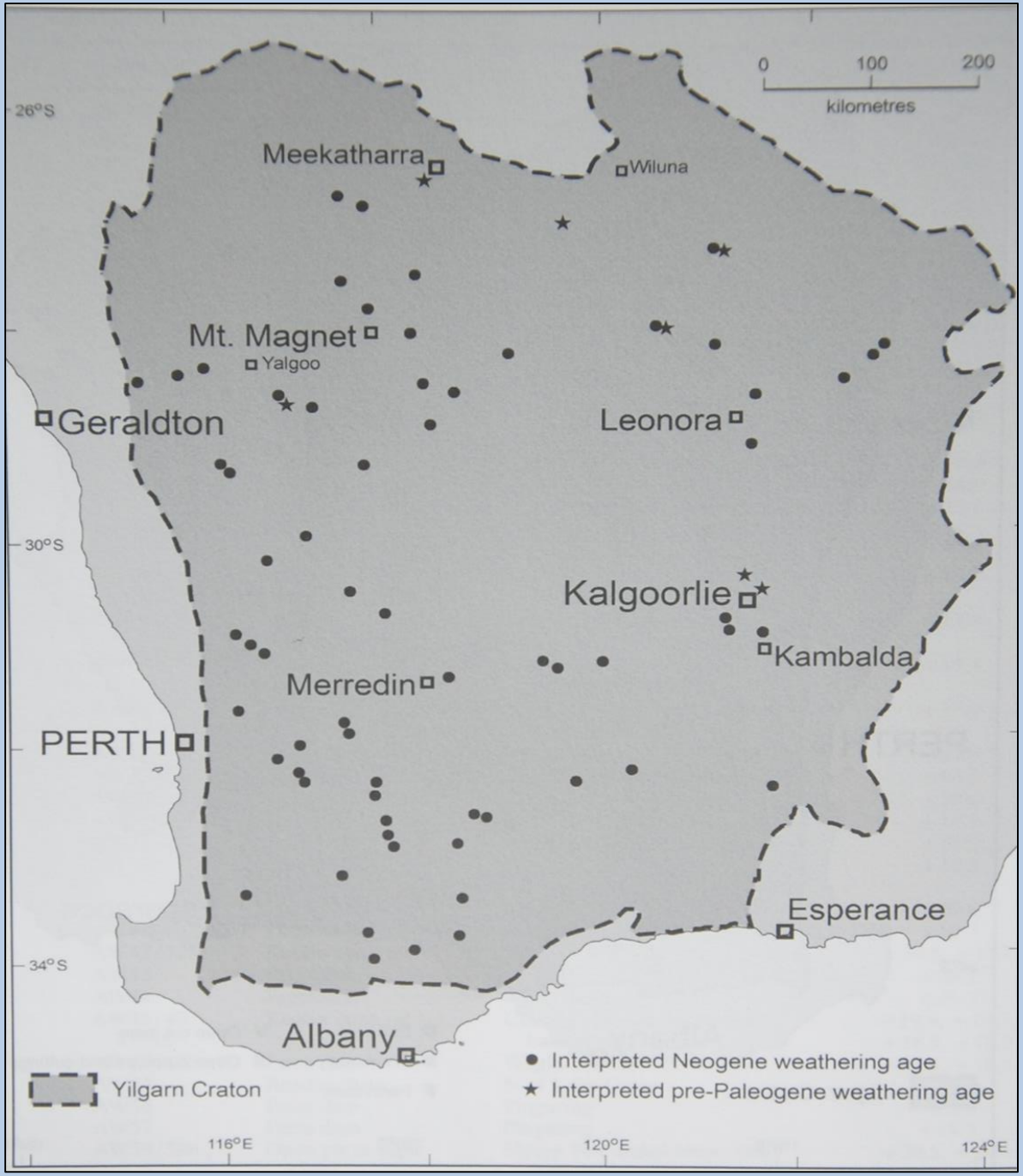
$\delta^{18}O$ ratio reflects the changing isotopic composition of the meteoric waters in response to changes brought about by the northward movement of the continent since middle Cretaceous time (c. 95 Ma)


Legend
town
isotopic data:
δ34S value (‰)
sample number
greenstone belt
granitic rocks
(within Yilgarn Block)
FAULT
DARLING
PERTH
onshore limit of Bremer Basin
0
100
km

Hyden-Norseman Road

Merredin, Western Austral. Granite substrate, Yilgarn Craton (Archaean)


0
100
200
kilometres
26°S
30°S
34°S
116°E
120°E
124°E
Dividing Range
Peaks
Range
Menzies Line
Darling Range
Darling Range
Stirling Range
Barr Smith Range
Ranges
Dunes
Giles
PERTH
Albany
Esperance
Yilgarn Craton
Bare rocky outcrops
Breakaway with approximate contour height (m)
Drainage system


0
100
200
kilometres
26°S
Meekatharra
Wiluna
Mt. Magnet
Yalgoo
Geraldton
Leonora
30°S
Kalgoorlie
Kambalda
Merredin
PERTH
Esperance
34°S
Albany
Yilgarn Craton
Interpreted Neogene weathering age
Interpreted pre-Paleogene weathering age
116°E
120°E
124°E

The range of $\delta^{18}O$ values for kaolinite from weathering profiles from the Yilgarn craton:

Most are in the range +22 to +17 and are indicative of a Neogene age.

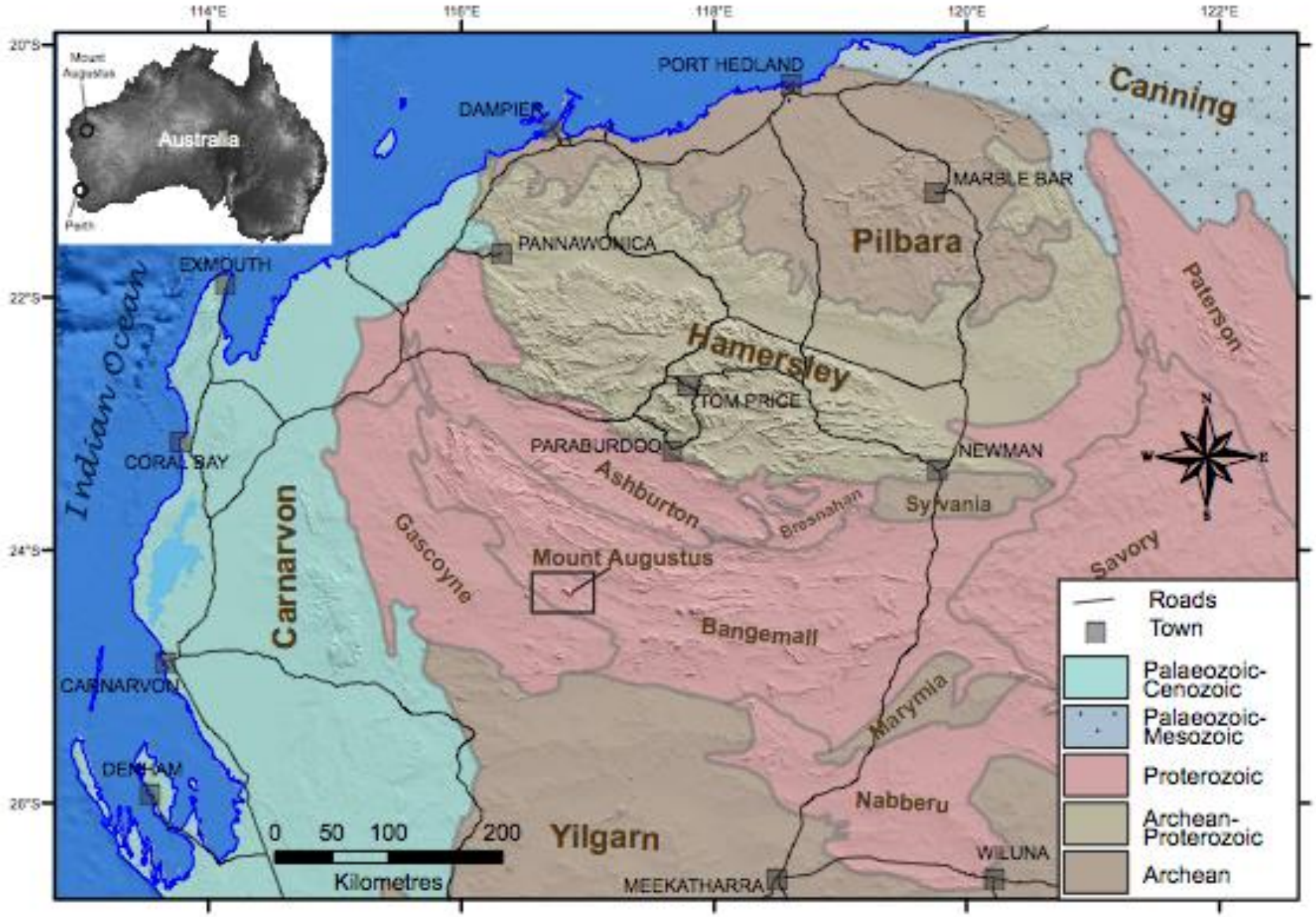
Some are in the range +15 to +17 and are plausibly of Late Cretaceous to Palaeogene age (Kalgoorlie, Lawlers, Mt Percy, Bluff Point)

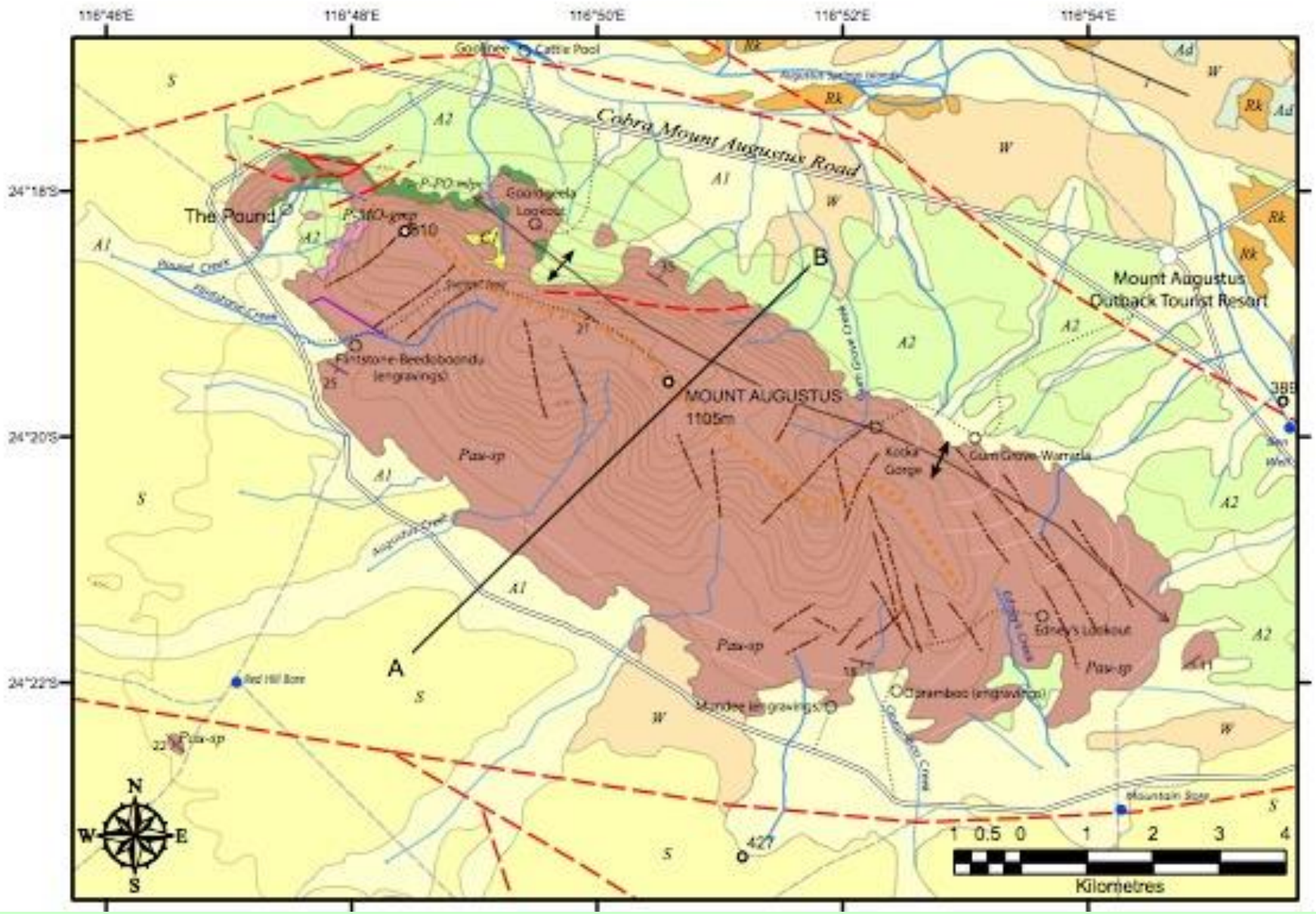
A few have even lower values:
Scuddles, south of Yalgoo (+14.6 per mil)
Bronzewing, Discovery pit (+14.5 per mil)
Meekatharra (+13.2 per mil)

and are also of 'old'age, either as above or potentially older (Jurassic?)

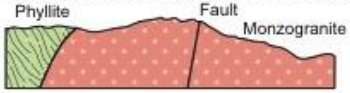
No known Permian kaolinites were measured (none was sampled)


Burringurrah, or Mount Augustus, Western Australia
(15 km)

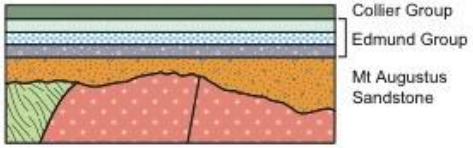

114°E
116°E
118°E
120°E
122°E
20°S
22°S
24°S
26°S
Australia
Mount Augustus
Perth
PORT HEDLAND
DAMPIER
MARBLE BAR
PANNAWONICA
EXMOUTH
CORAL BAY
CARNARVON
DENHAM
TOM PRICE
PARABURDOO
NEWMAN
Sylvania
Mount Augustus
Indian Ocean
Carnarvon
Gascoyne
Ashburton
Bresnahan
Hamersley
Pilbara
Canning
Paterson
Savory
Bangemall
Marymia
Nabberu
Yilgarn
MEEKATHARRA
WILUNA
0 50 100 200
Kilometres
Roads
Town
Palaeozoic-Cenozoic
Palaeozoic-Mesozoic
Proterozoic
Archean-Proterozoic
Archean


116°46'E
116°48'E
116°50'E
116°52'E
116°54'E
24°18'S
24°20'S
24°22'S
Cobra Mount Augustus Road
The Pound
MOUNT AUGUSTUS
1105m
Mount Augustus
Outback Tourist Resort
Kooka Gorge
Edney's Lookout
Red Hill Bore
Mountain Bore
A
B
N
S
E
W
1 0.5 0 1 2 3 4
Kilometres

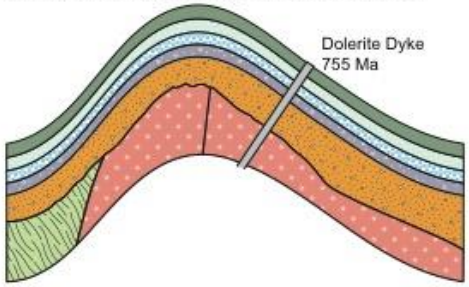
A) Monzogranite of Moorarie Super-Suite (1830-1780 Ma) and Pooranoo Metamorphics (1680 Ma) affected by Mangaroon Orogeny (1680-1620 Ma). Erosion of monzogranite



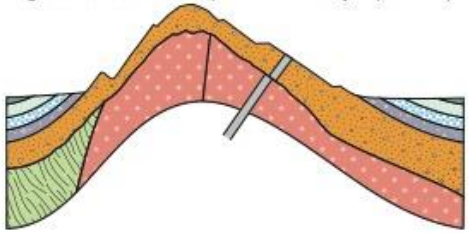
B) Deposition of Mount Augustus Sandstone (~1620 Ma), Edmund Group (~1465 Ma) and Collier Group ~1070 Ma.



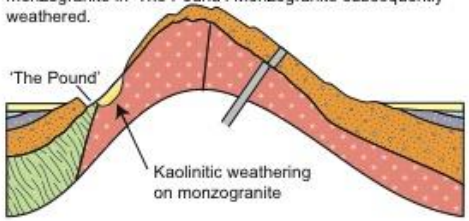
C) Folding - Edmundian Orogeny 1030-950 Ma and intrusions of Mundine Well Dolerite Suite dolerite dyke (755 Ma).

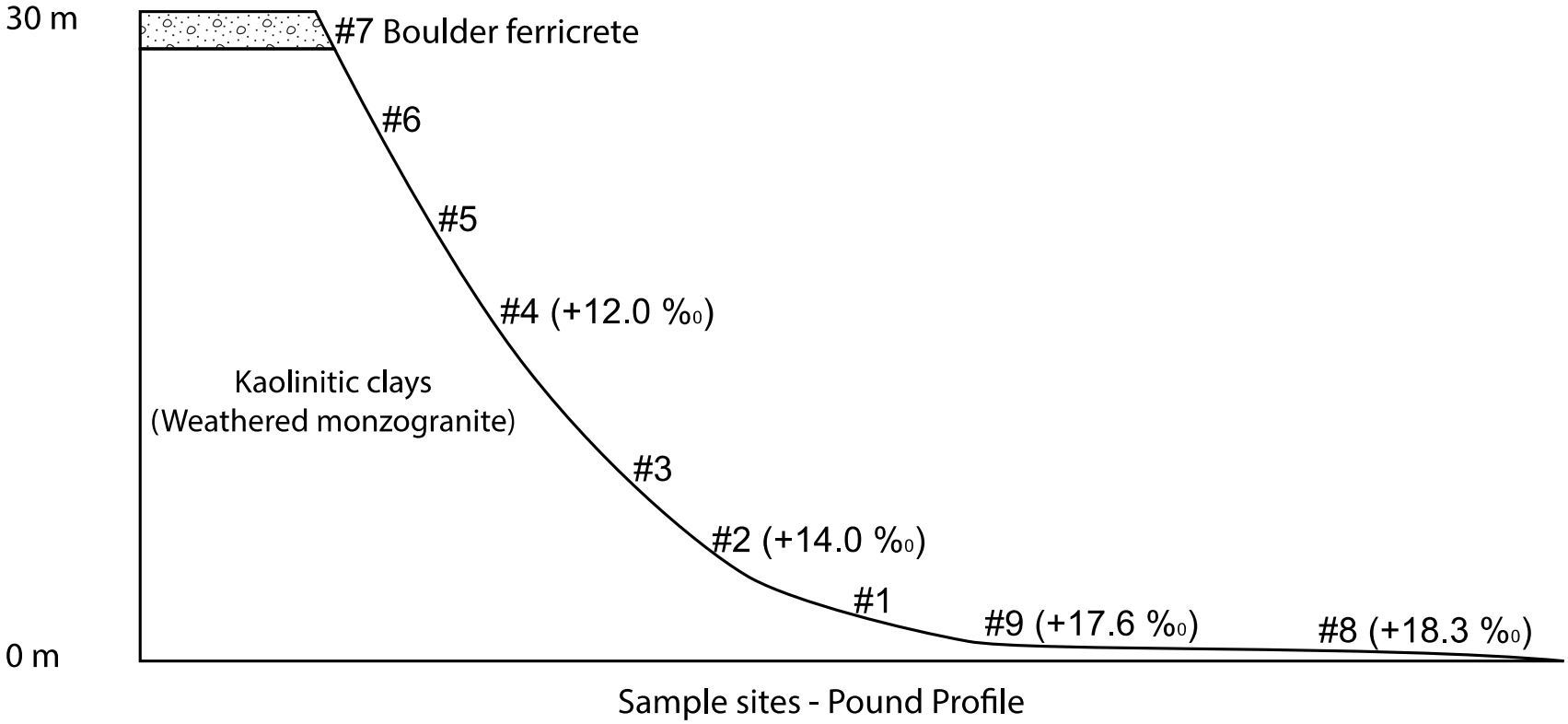


D) Erosion of Edmund Group rocks and some of Mount Augustus sandstone. Disruption of dolerite dyke (~570 Ma)



E) Further erosion of Mount Augustus Sandstone exposing monzogranite in 'The Pound'. Monzogranite subsequently weathered.




30 m
#7 Boulder ferricrete
#6
#5
#4 (+12.0 ‰)
Kaolinitic clays
(Weathered monzogranite)
#3
#2 (+14.0 ‰)
#1
#9 (+17.6 ‰)
#8 (+18.3 ‰)
0 m
Sample sites - Pound Profile

The flank of the Burrungurrah inselberg or monolith has been exposed to sub-aerial weathering for a long period. The progressively deepening weathering profile has the following approximate ages:

+12.0 and +14.0 per mil = Mesozoic and/or Paleogene

+17.6 per mil = Paleogene and/or Neogene

+18.3 per mil = Neogene

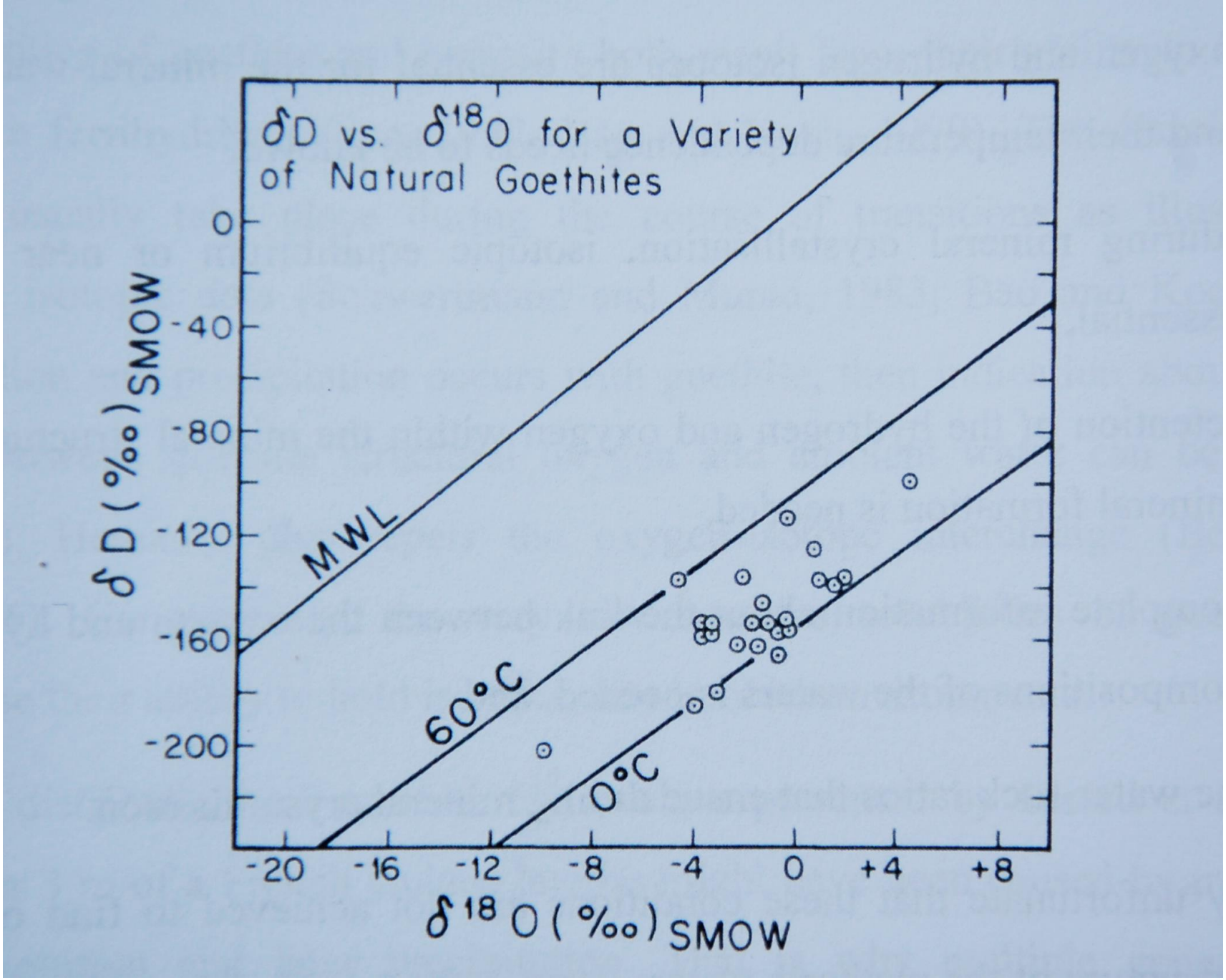
A feature in the landscape for approximately 150 to 100 Ma ?

Deep and intense weathering is not necessarily restricted to 'tropical' latitudes.

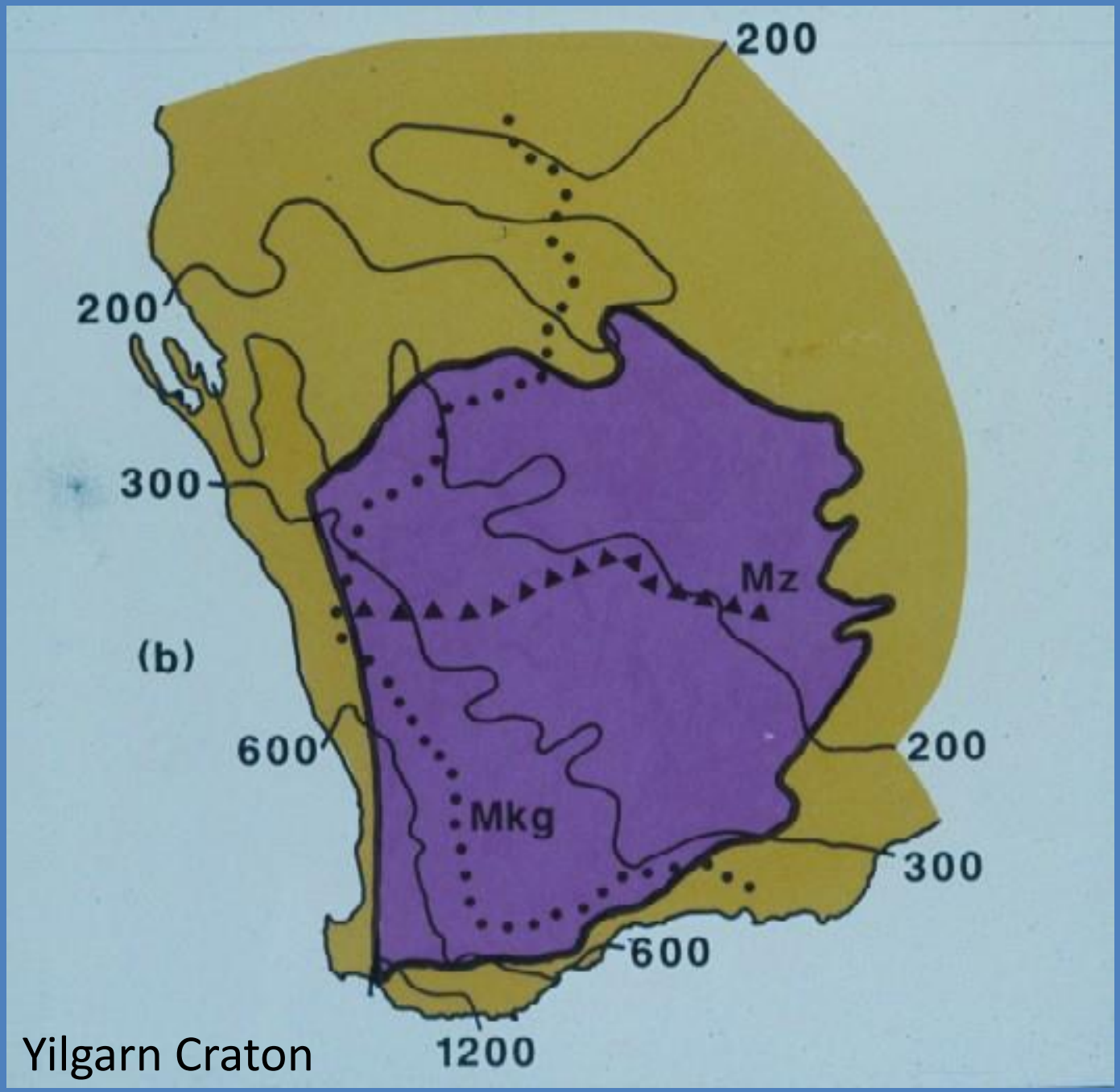
Time/ temperature/ water availability are interchangeable as factors in forming weathering. Tectonic stability is key in preserving weathering profiles.

Australia moved to lower latitudes before the Quaternary glaciations and escaped continental glaciation which, in many other continents, removed earlier weathering profiles.

However, some remnants of deep weathering are preserved, for example, in the Minnesota valley, Sweden, Finland, Scotland, Faeroe islands and are indicative of past weathering when the latitudinal temperature gradient was less than today.


δD vs. δ18O for a Variety of Natural Goethites
0
-40
-80
-120
-160
-200
δD (‰)SMOW
MWL
60°C
0°C
-20
-16
-12
-8
-4
0
+4
+8
δ18O (‰)SMOW

(Yapp, 1987)



Yilgarn Craton

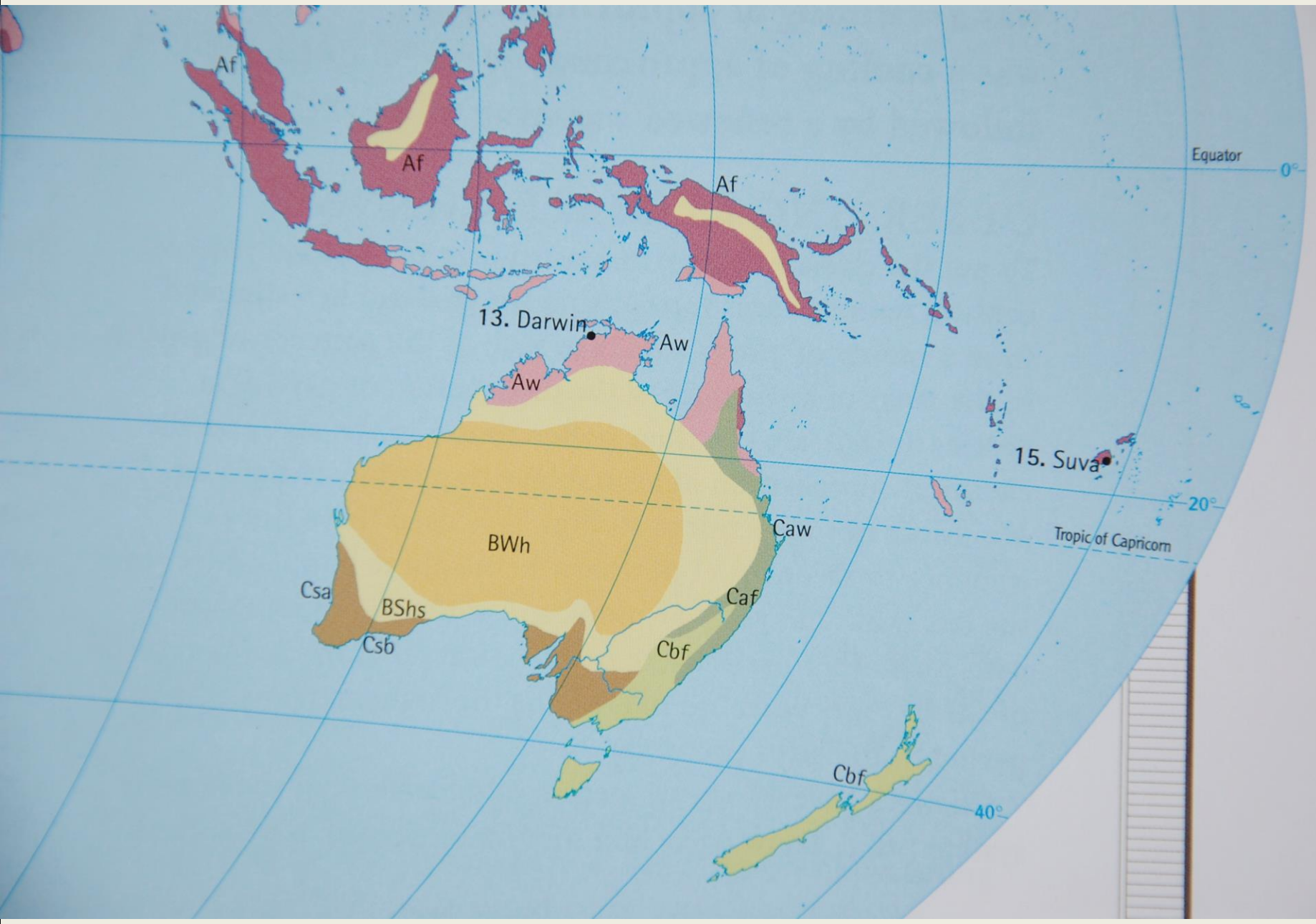
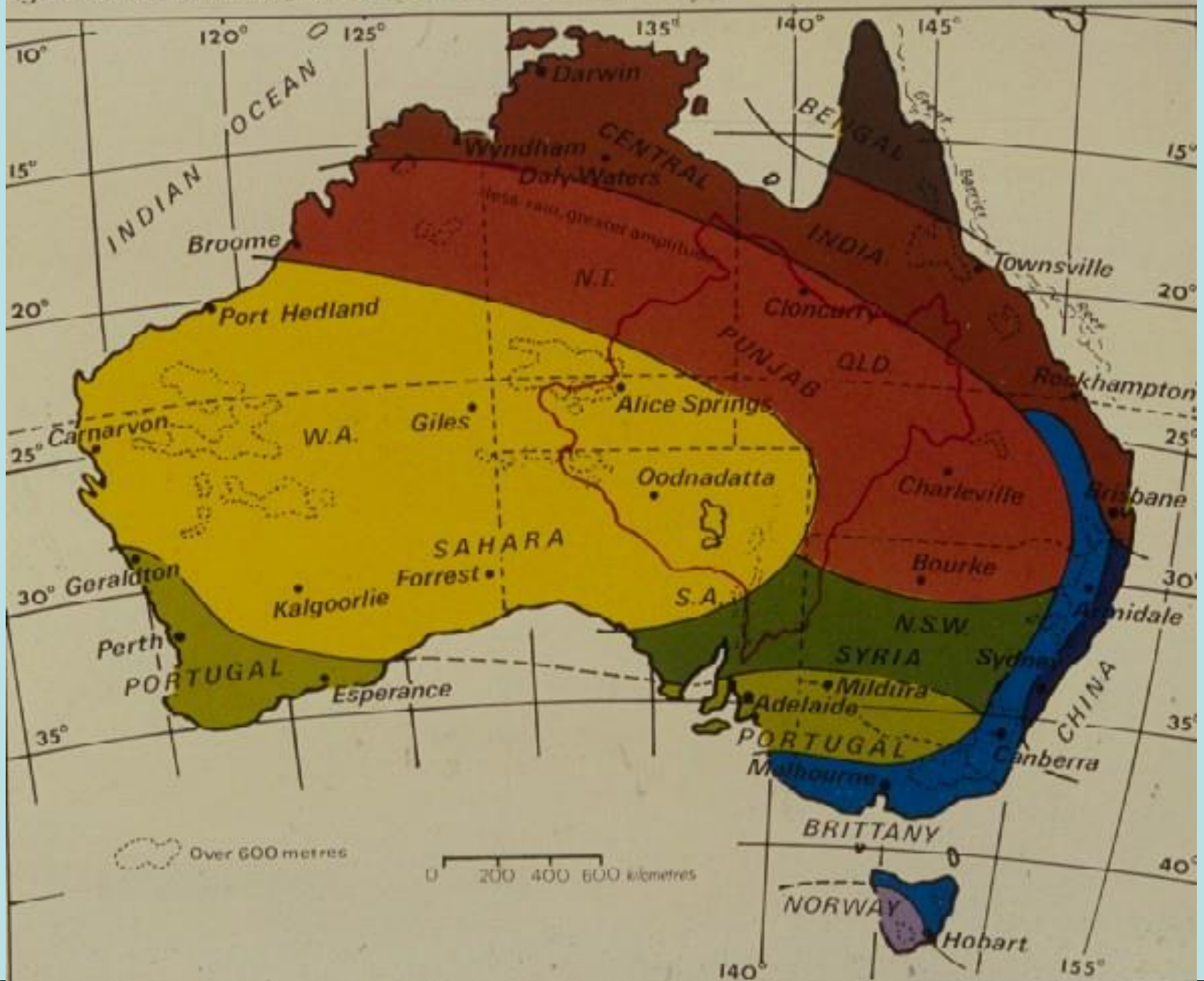
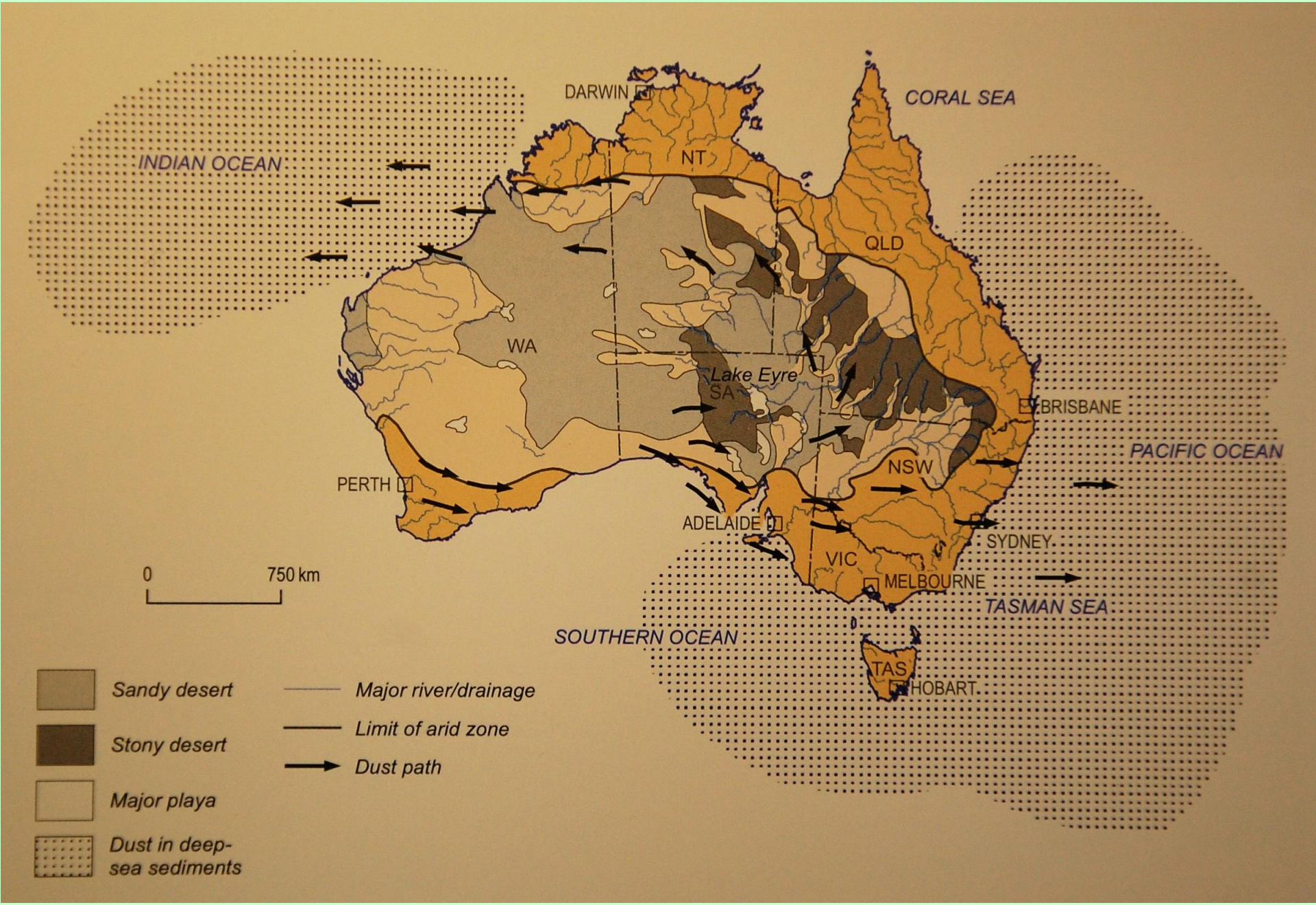
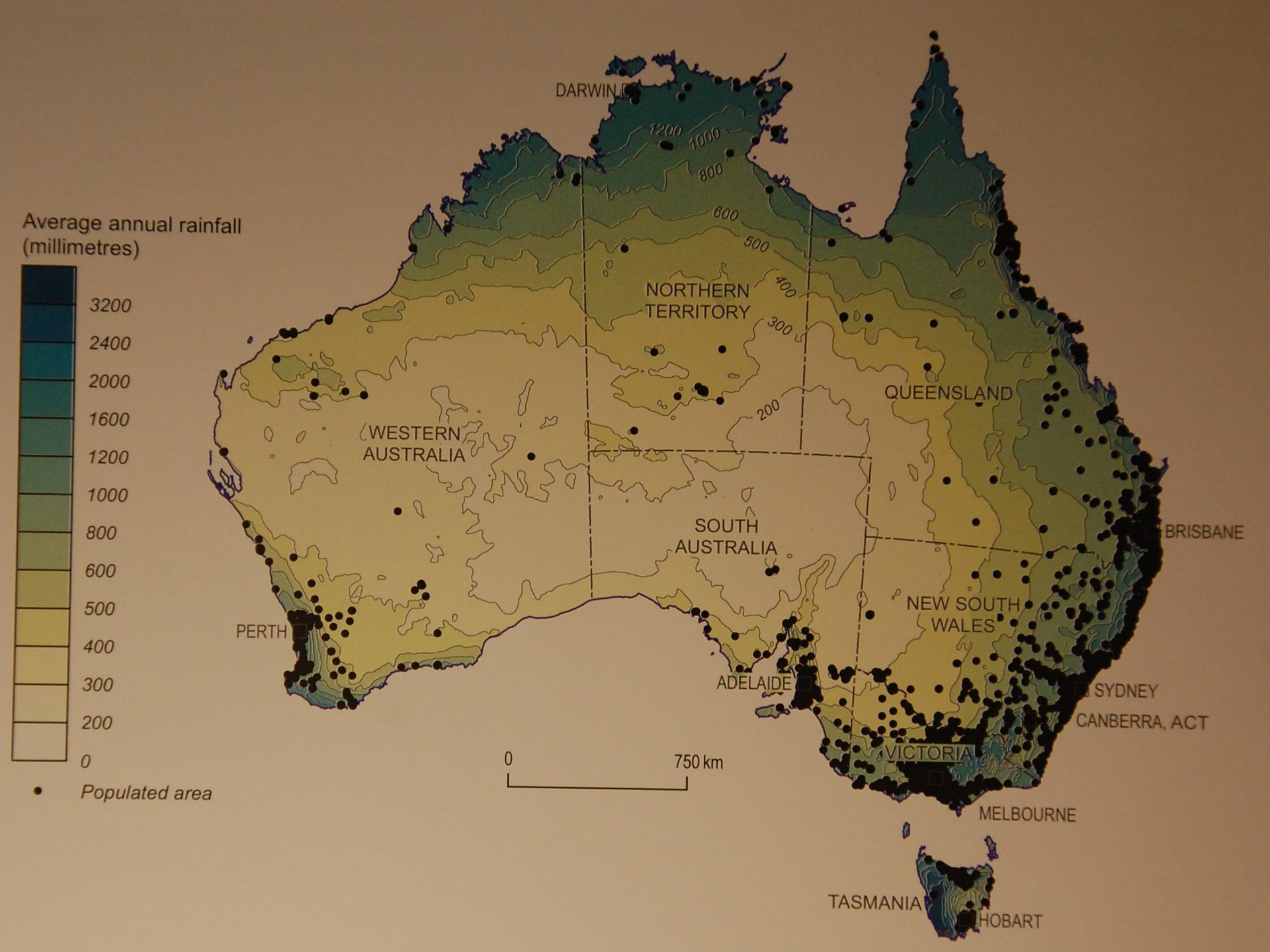

Af
Af
Af
Equator
0°
13. Darwin
Aw
Aw
15. Suva
20°
Tropic of Capricorn
Caw
BWh
Csa
BShs
Csb
Caf
Cbf
Cbf
40°

Figure 3. Climatic regions (after de Martonne, 1948)




ARAFURA SEA
Torres Strait
0
750 km
DARWIN
Gove
Weipa
CORAL SEA
Joseph Bonaparte Gulf
Gulf of Carpentaria
Kimberley
NORTHERN TERRITORY
INDIAN OCEAN
Atherton Tablelands
Great Barrier Reef
Tennant Creek
Tanami Desert
Gunpowder
Mount Isa
Mount Goldsworthy
Great Sandy Desert
Pilbara
Fortescue River
Pannawonica
Robe River
QUEENSLAND
Great Divide
PACIFIC OCEAN
Diamantina River
Cooper Creek
Fitzroy River
Gibson Desert
Lake Amadeus
Uluru (Ayers Rock)
WESTERN AUSTRALIA
Wingellina
Simpson Desert
SOUTH AUSTRALIA
Wilgie Mia
Tirari Desert
Great Victoria Desert
Lake Eyre
Strzelecki Desert
Coober Pedy
Balonne River
BRISBANE
Lake Torrens
Nullarbor Plain
Koonalda
Lake Gairdner
Yarrakina
Darling River
PERTH
Avon River
Broken Hill
Cobar
Menindee
Great Australian Bight
NEW SOUTH WALES
Eyre Peninsula
Ophir
Jenolan Caves
Young
Sydney Harbour
Hallet Cove
ADELAIDE
Riverline Plain
Lake George
SYDNEY
Georges River
Murray River
CANBERRA, ACT
Shoalhaven River
Murray Canyons
VICTORIA
Mount Kosciuszko
Glenelg River
SOUTHERN OCEAN
MELBOURNE
Bass Strait
TASMAN SEA
TASMANIA
Cradle Mountain
Lake St Clair
HOBART
Sandy desert
Stony desert
Major playa
Longitudinal dune systems
Major river/drainage
Limit of arid zone

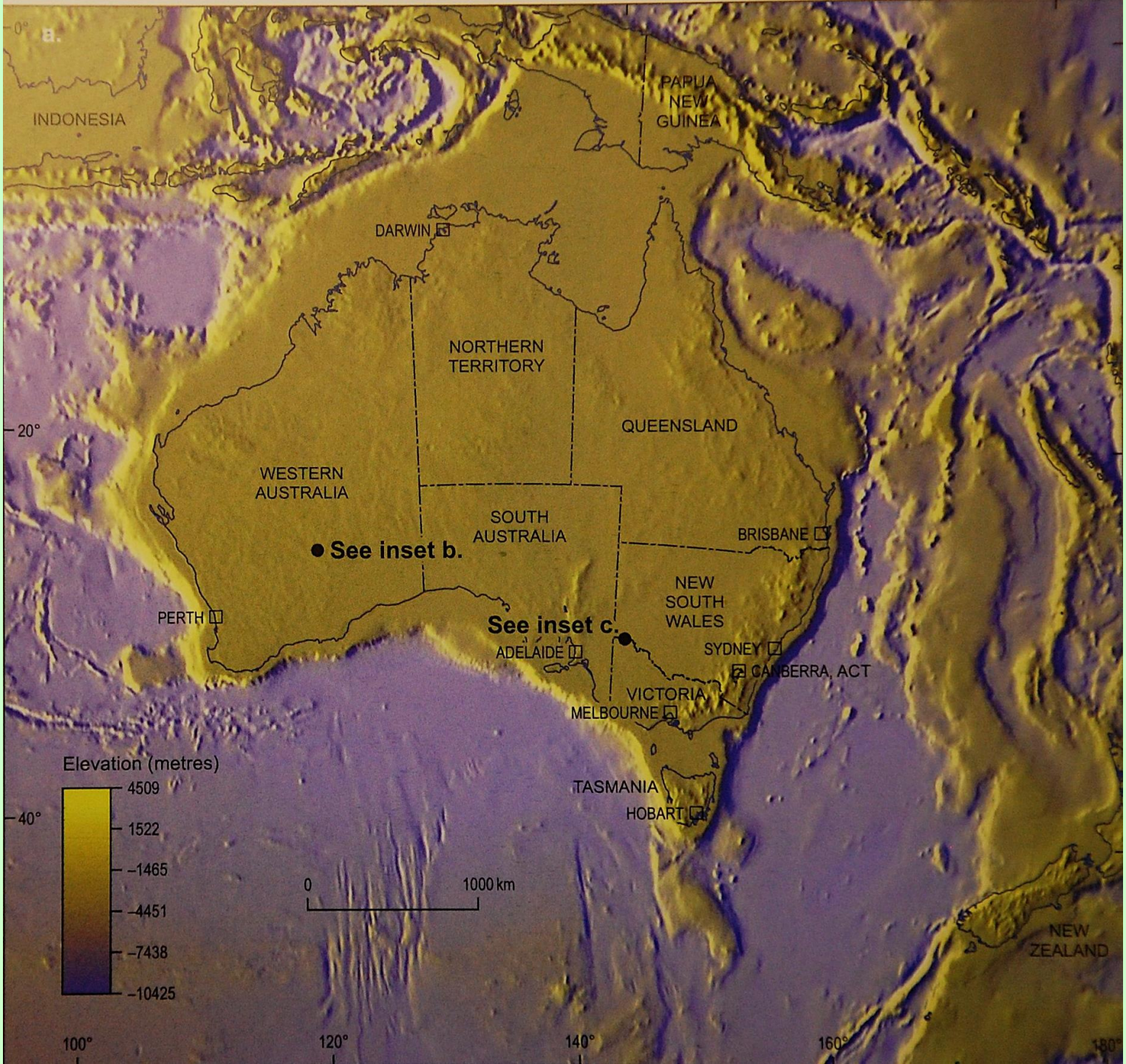

DARWIN
CORAL SEA
INDIAN OCEAN
NT
QLD
WA
Lake Eyre
SA
BRISBANE
PACIFIC OCEAN
NSW
PERTH
ADELAIDE
SYDNEY
VIC
MELBOURNE
TASMAN SEA
SOUTHERN OCEAN
TAS
HOBART
0
750 km
Sandy desert
Stony desert
Major playa
Dust in deep-sea sediments
Major river/drainage
Limit of arid zone
Dust path

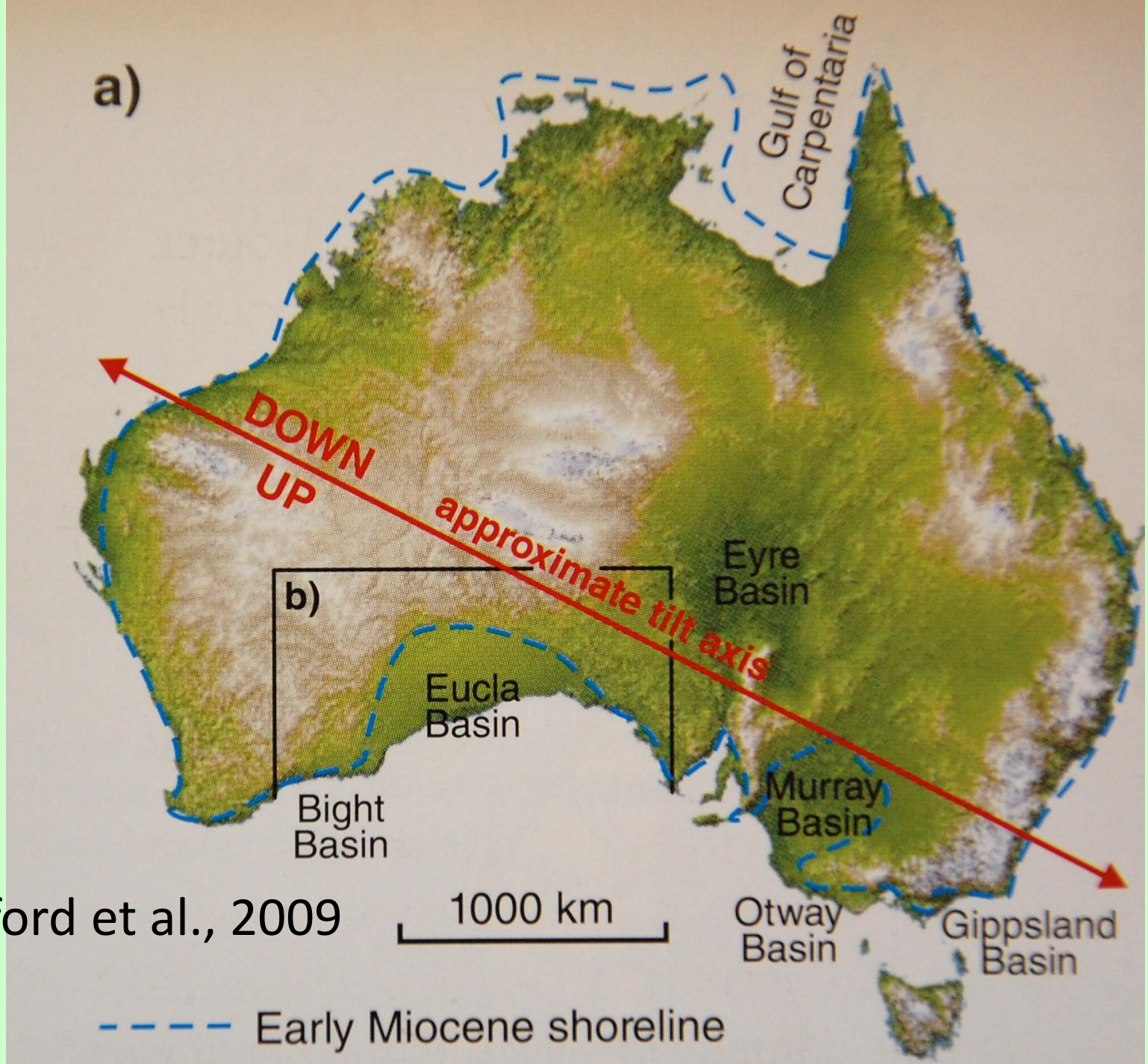

Average annual rainfall
(millimetres)
3200
2400
2000
1600
1200
1000
800
600
500
400
300
200
0
Populated area
DARWIN
1200
1000
800
600
500
400
300
200
NORTHERN TERRITORY
QUEENSLAND
WESTERN AUSTRALIA
SOUTH AUSTRALIA
NEW SOUTH WALES
VICTORIA
TASMANIA
PERTH
ADELAIDE
BRISBANE
SYDNEY
CANBERRA, ACT
MELBOURNE
HOBART
0
750 km


a.
ARAFURA SEA
Torres Strait
CORAL SEA
DARWIN
Joseph Bonaparte Gulf
Gulf of Carpentaria
INDIAN OCEAN
Broome
Great Barrier Reef
NORTHERN TERRITORY
QUEENSLAND
PACIFIC OCEAN
WESTERN AUSTRALIA
Great Escarpment
Carnarvon
Lake Eyre
BRISBANE
SOUTH AUSTRALIA
EUCLA BASIN
See inset c.
Wollomombi Falls
NEW SOUTH WALES
PERTH
Darling Escarpment
See inset b.
Great Australian Bight
MURRAY–DARLING BASIN
ADELAIDE
SYDNEY
CANBERRA, ACT
SOUTHERN OCEAN
VICTORIA
Mount Kosciusko
MELBOURNE
0
750 km
Bass Strait
TASMAN SEA
Bland Basin
Plateau edge
Major river/drainage
TASMANIA
HOBART

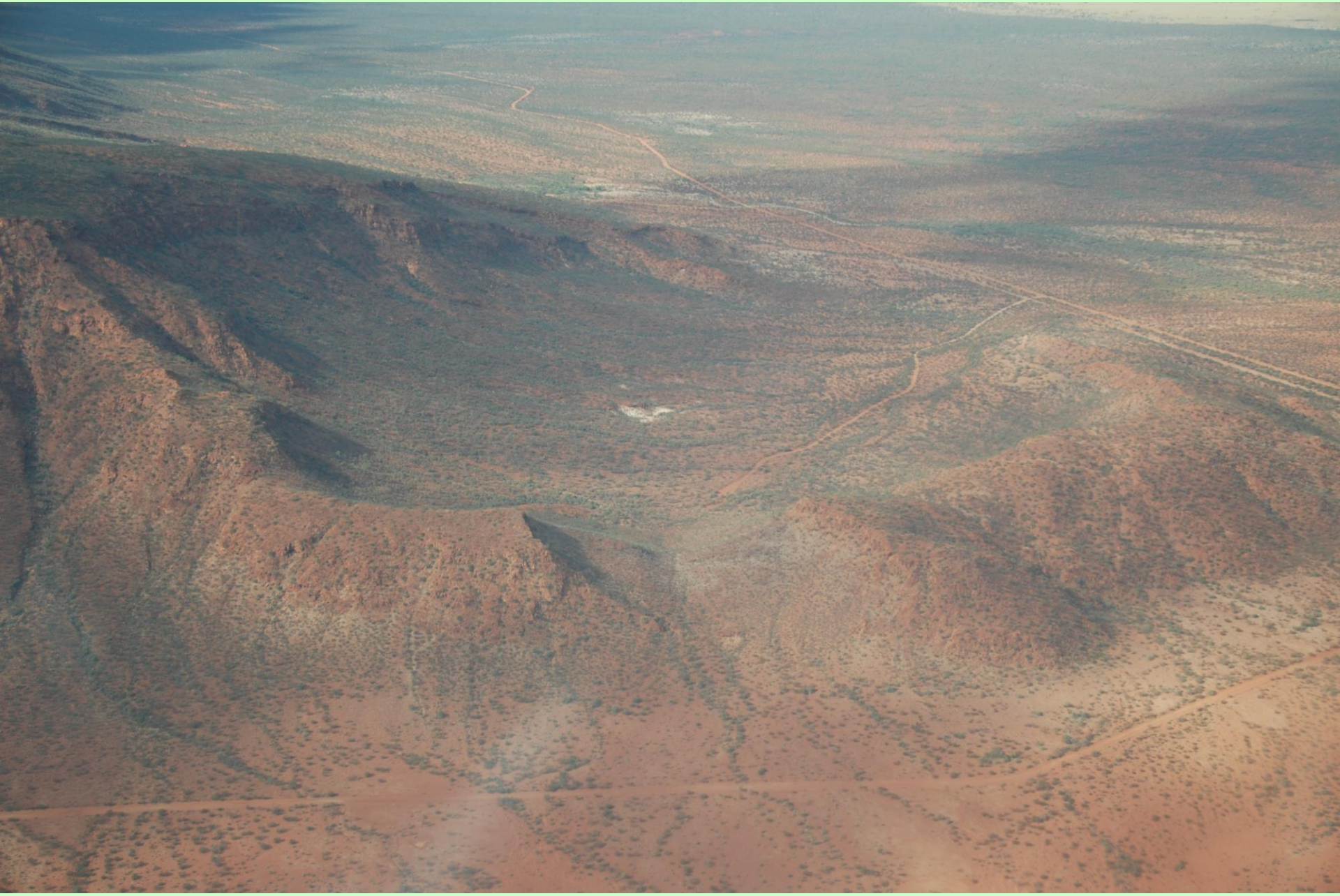

0
750 km
DARWIN
Jim Jim Billabong
Flora River
Katherine
Gulf of Carpentaria
Great Barrier Reef
Burdekin River
Halls Creek
NORTHERN TERRITORY
Pioneer River
Great Divide
Port Hedland
CANNING BASIN
Great Sandy Desert
Karratha
Oakover River
Woodie Woodie
Chichester Range
PILBARA CRATON
TI TREE BASIN
QUEENSLAND
Alice Springs
Simpson Desert
GREAT ARTESIAN BASIN
Callide Creek
Uluru / Ayers Rock
Birdsville
Bundaberg
Gascoyne River
WESTERN AUSTRALIA
Warrego River
Condamine River
Lockyer Creek
Carnarvon
Wiluna
Oodnadatta
Mulka
Cunnamulla
BRISBANE
OFFICER AND EUCLA BASINS
SOUTH AUSTRALIA
Lake Eyre
Laverton
Richmond River
Geraldton
YILGARN CRATON
Bourke
Namoi River
Kalgoorlie-Boulder
Darling River
NEW SOUTH WALES
PERTH BASIN
Broken Hill
Menindee Lakes
Nyngan
Cudgegong River
Hastings River
PERTH
Lachlan River
Newcastle
Mildura
SYDNEY
ADELAIDE
MURRAY BASIN
Murray River
CANBERRA, ACT
VICTORIA
Goulburn River
Mount Gambier
Daylesford
MELBOURNE
Morwell
Thorndale
GIPPSLAND BASIN
Mornington Peninsula
TASMANIA
HOBART
Aquifer type
Porous, extensive, highly productive aquifers
Porous, extensive aquifers of low to moderate productivity
Fractured or fissured, extensive, highly productive aquifers
Fractured or fissured, extensive aquifers of low to moderate productivity
Local aquifers, of generally low productivity

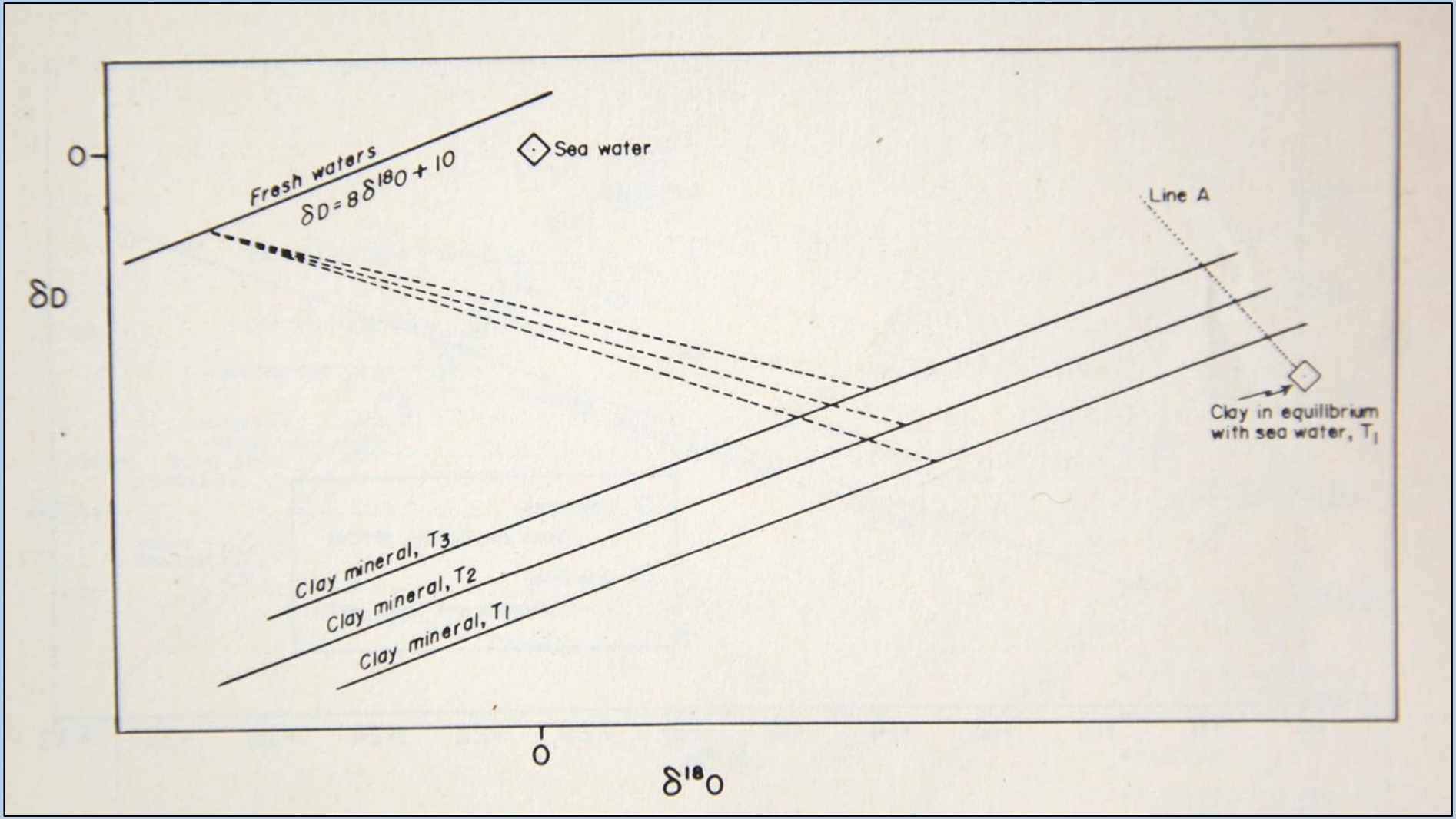

0
750 km
Last Glacial Maximum
Ashmore Reef
Scott Reef
Montgomery Reef
Joseph Bonaparte Gulf
DARWIN
Wessel Islands
Torres Strait
CORAL SEA
Gulf of Carpentaria
INDIAN OCEAN
Broome
Port Douglas
Cairns
Paluma Shoals
Townsville
Great Barrier Reef
Bowen
Mackay
NORTHERN TERRITORY
Desert or no drainage to the sea
QUEENSLAND
Port Hedland
Dampier
Exmouth
Ningaloo
PACIFIC OCEAN
Rockhampton
Gladstone
Tropic of Capricorn
WESTERN AUSTRALIA
Shark Bay
Bundaberg
Fraser Island
Noosa Heads
Kalbarri
Geraldton
BRISBANE
Gold Coast
Tweed Heads
SOUTH AUSTRALIA
Coffs Harbour
Murray–Darling Basin
NEW SOUTH WALES
PERTH
Fremantle
Last Glacial Maximum
Esperance
Great Australian Bight
Newcastle
Lord Howe Island
Margaret River
ADELAIDE
SYDNEY
Taupo Bank
Albany
Kangaroo Island
Ulladulla
CANBERRA, ACT
Robe
VICTORIA
SOUTHERN OCEAN
MELBOURNE
Warrnambool
Torquay
Port Fairy
TASMAN SEA
Bass Strait
Launceston
TASMANIA
HOBART
Coastal drainage basin
Murray–Darling Basin
Major river/drainage
Approximate coastal position during the Last Glacial Maximum—21 ka

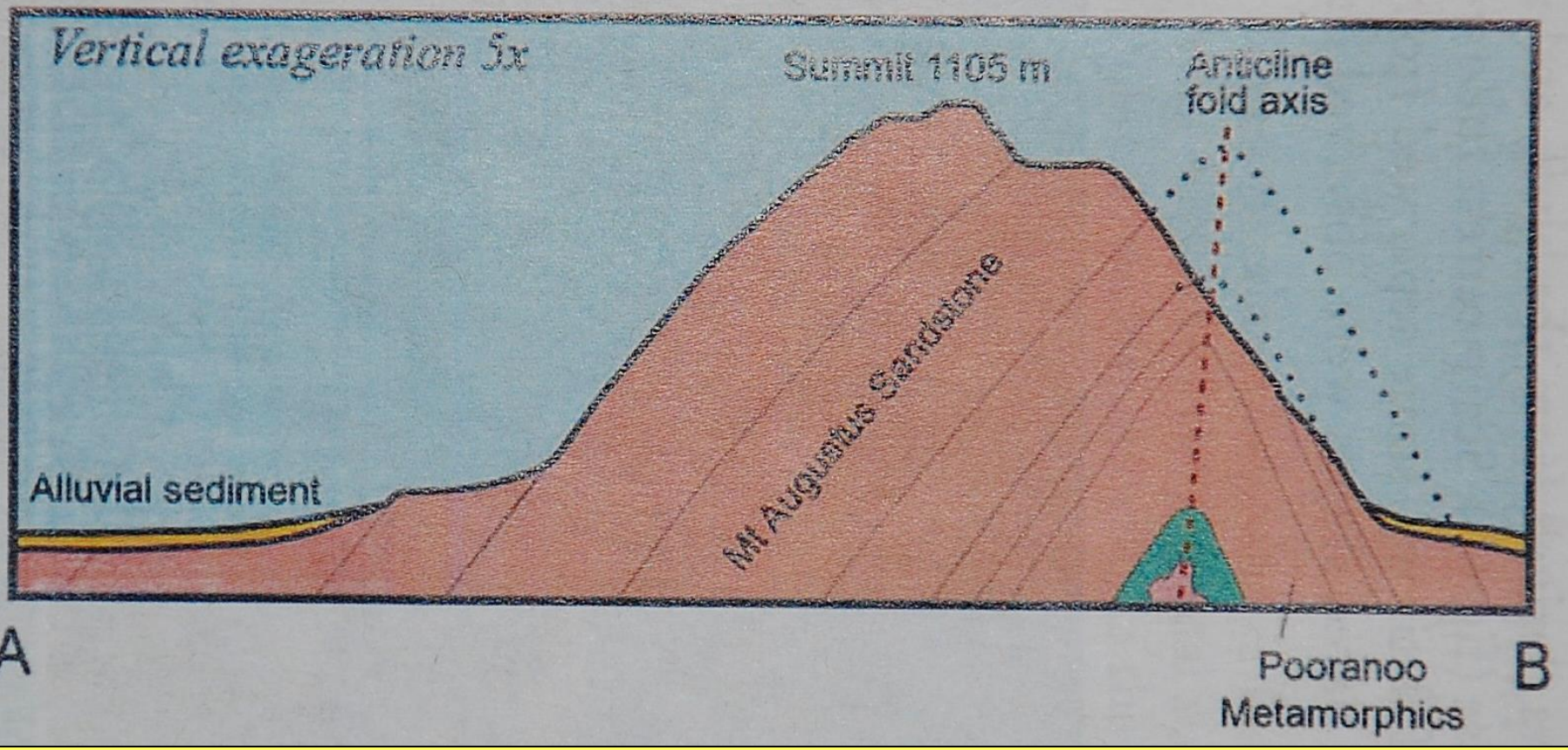

INDONESIA
PAPUA NEW GUINEA
DARWIN
NORTHERN TERRITORY
QUEENSLAND
WESTERN AUSTRALIA
SOUTH AUSTRALIA
BRISBANE
See inset b.
NEW SOUTH WALES
PERTH
See inset c.
ADELAIDE
SYDNEY
CANBERRA, ACT
VICTORIA
MELBOURNE
TASMANIA
HOBART
NEW ZEALAND
Elevation (metres)
4509
1522
–1465
–4451
–7438
–10425
0
1000 km
20°
40°
100°
120°
140°
160°
180°

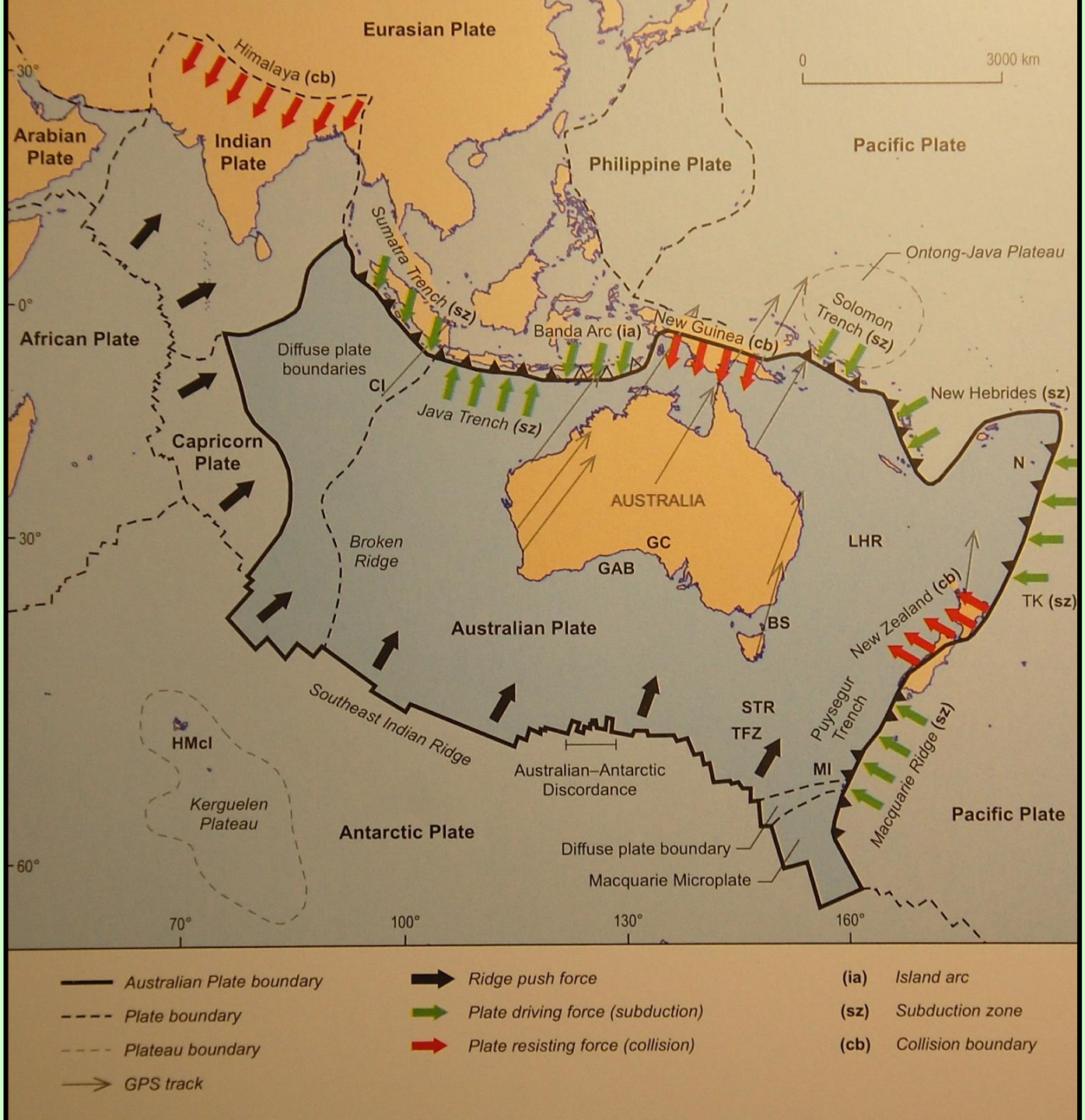


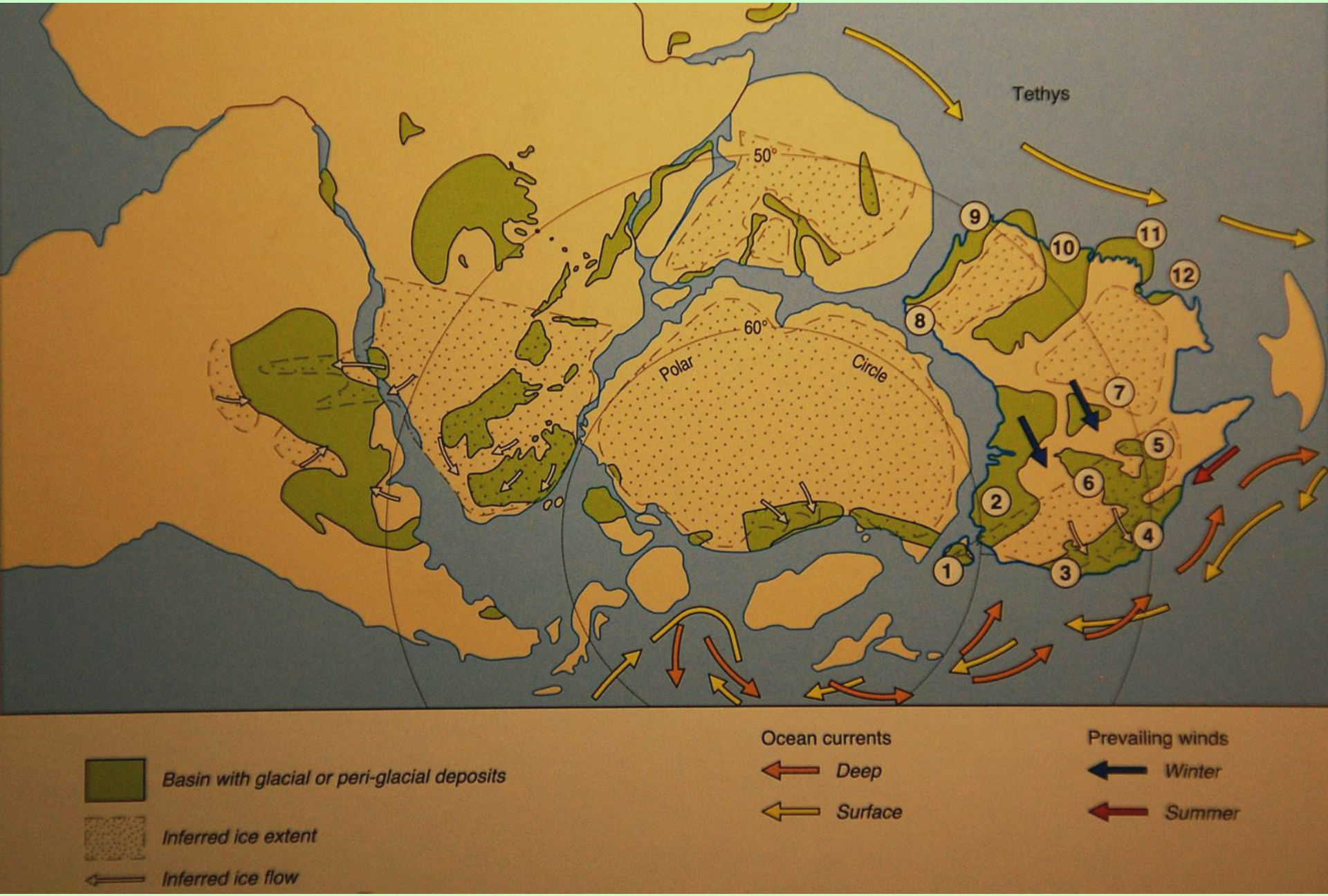
Sandiford et al., 2009



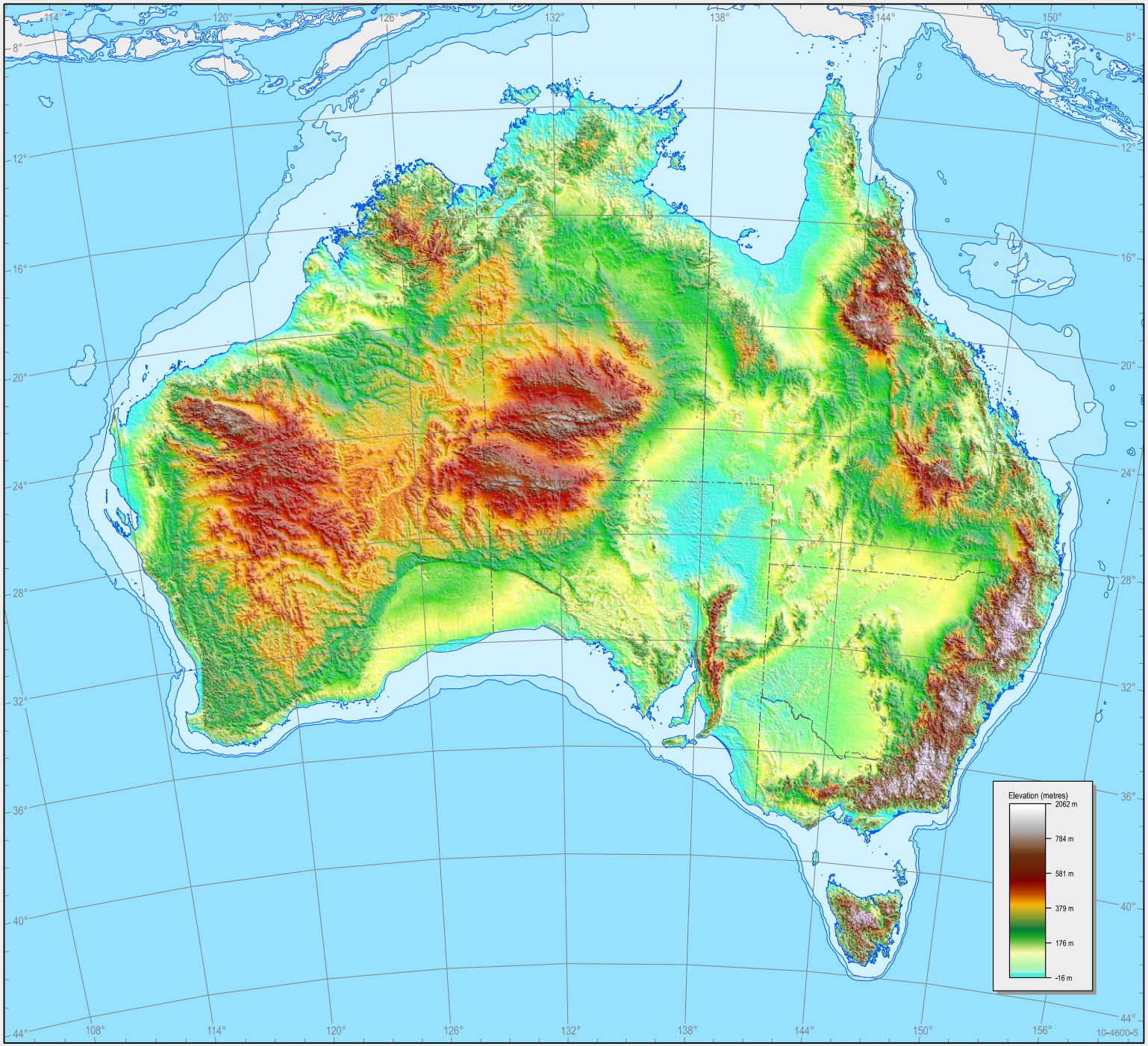

0
δD
Fresh waters
δD = 8δ18O + 10
Sea water
Line A
Clay in equilibrium
with sea water, T1
Clay mineral, T3
Clay mineral, T2
Clay mineral, T1
0
δ18O

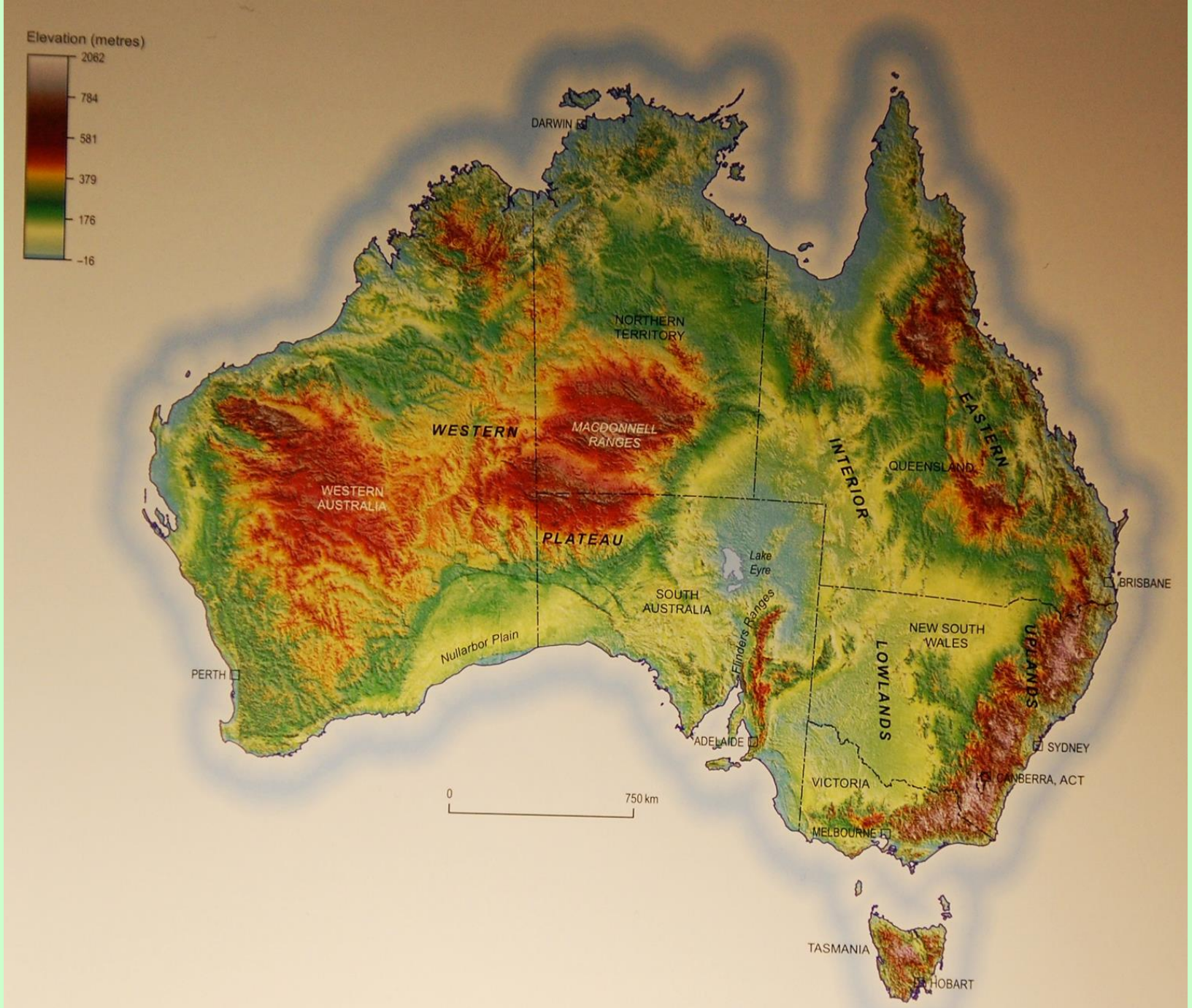

Vertical exageration 5x
Summit 1105 m
Anticline
fold axis
Mt Augustus Sandstone
Alluvial sediment
A
B
Pooranoo
Metamorphics


Eurasian Plate
Himalaya (cb)
Arabian Plate
Indian Plate
Philippine Plate
Pacific Plate
0
3000 km
30°
0°
30°
60°
70°
100°
130°
160°
Sumatra Trench (sz)
Ontong-Java Plateau
Solomon Trench (sz)
Banda Arc (ia)
New Guinea (cb)
African Plate
Diffuse plate boundaries
CI
Java Trench (sz)
New Hebrides (sz)
Capricorn Plate
AUSTRALIA
N
GC
GAB
LHR
Broken Ridge
TK (sz)
New Zealand (cb)
Australian Plate
BS
Puysegur Trench
STR
TFZ
Southeast Indian Ridge
HMcI
Australian–Antarctic Discordance
MI
Macquarie Ridge (sz)
Kerguelen Plateau
Antarctic Plate
Pacific Plate
Diffuse plate boundary
Macquarie Microplate
Australian Plate boundary
Plate boundary
Plateau boundary
GPS track
Ridge push force
Plate driving force (subduction)
Plate resisting force (collision)
(ia) Island arc
(sz) Subduction zone
(cb) Collision boundary

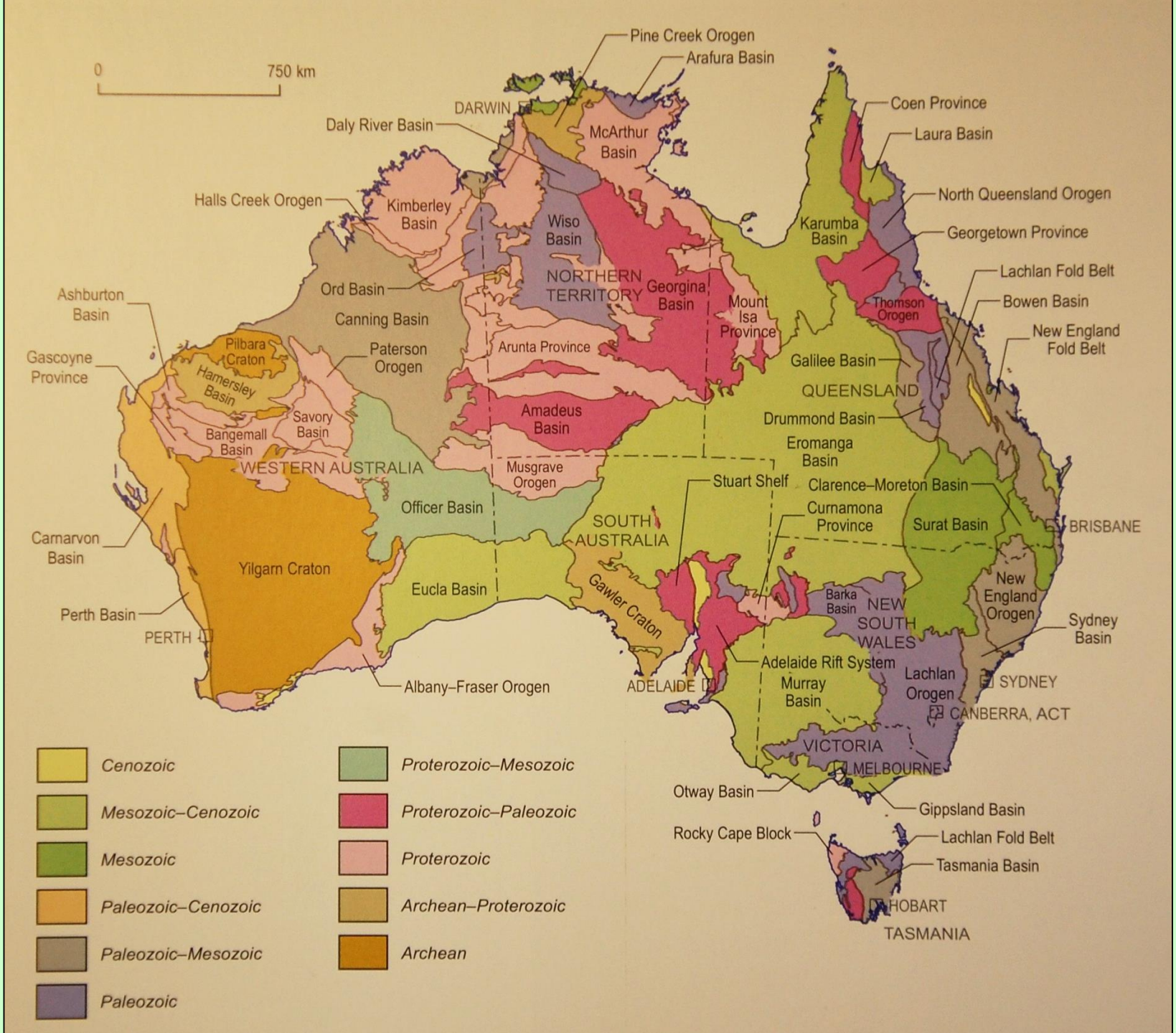


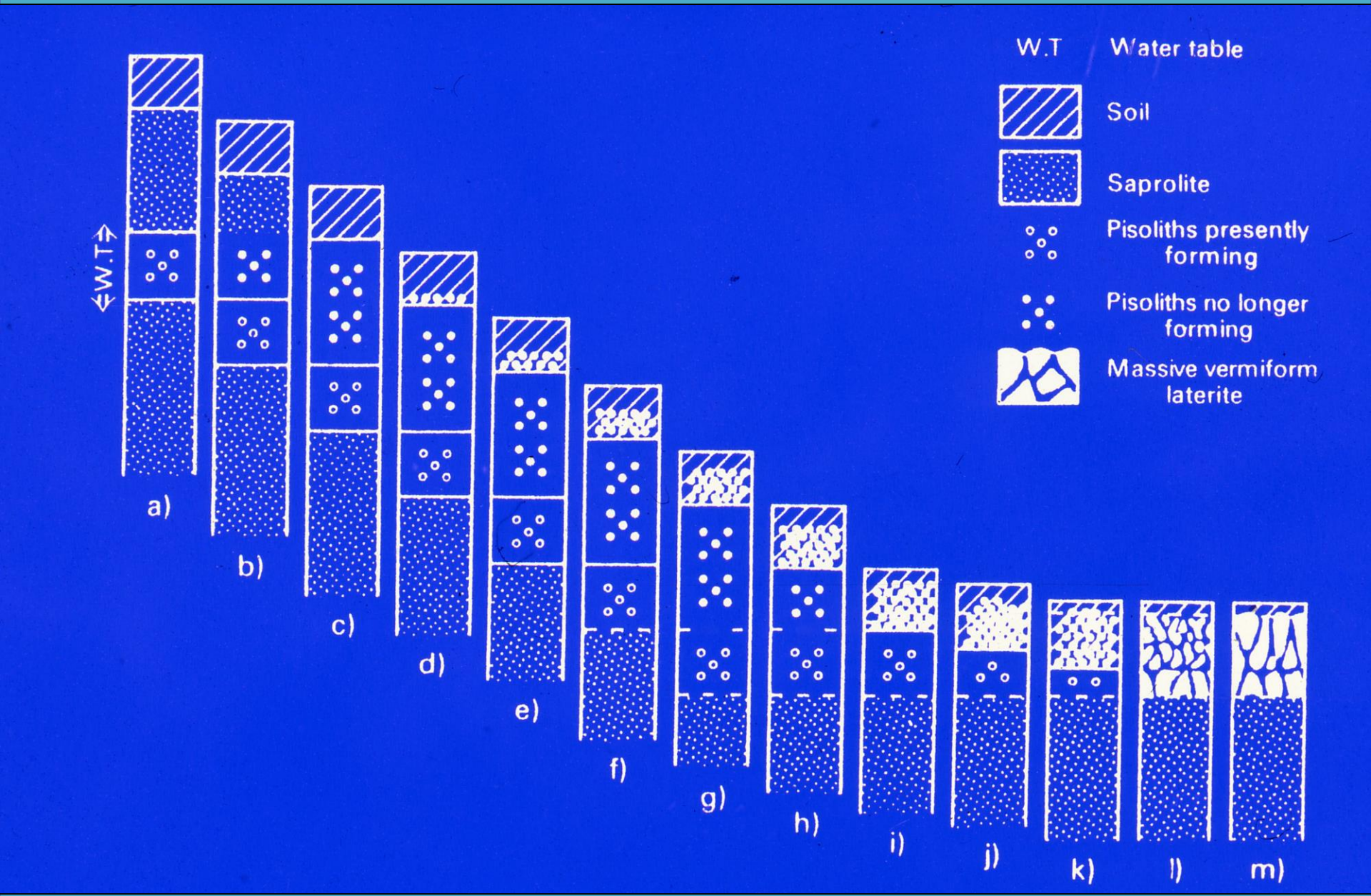
Late Carboniferous – Early Permian (approx. 300 Ma)

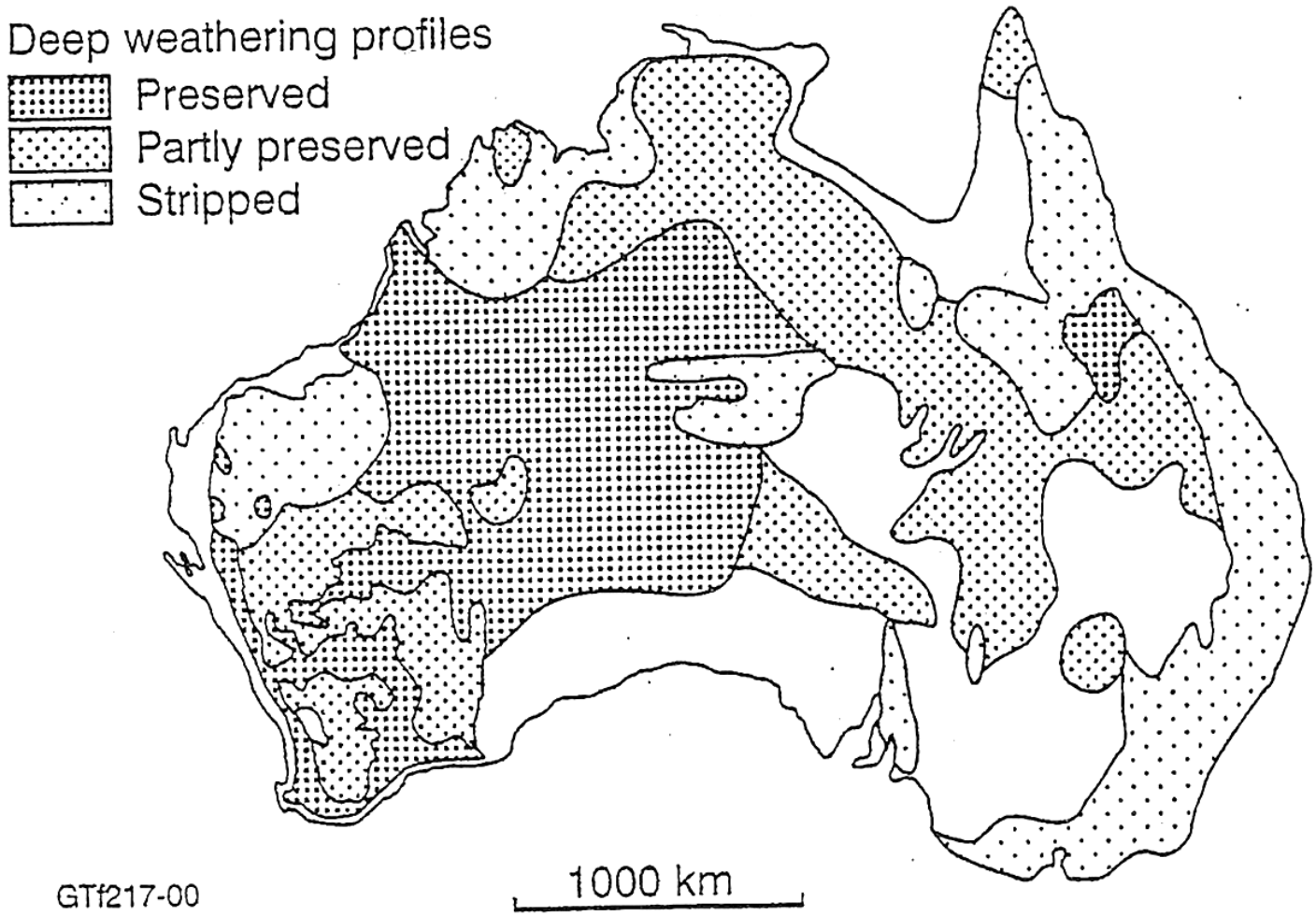

Elevation (metres)
2062 m
784 m
581 m
379 m
176 m
-16 m
114°
120°
126°
132°
138°
144°
150°
8°
12°
16°
20°
24°
28°
32°
36°
40°
44°
108°
156°
10-4600-5

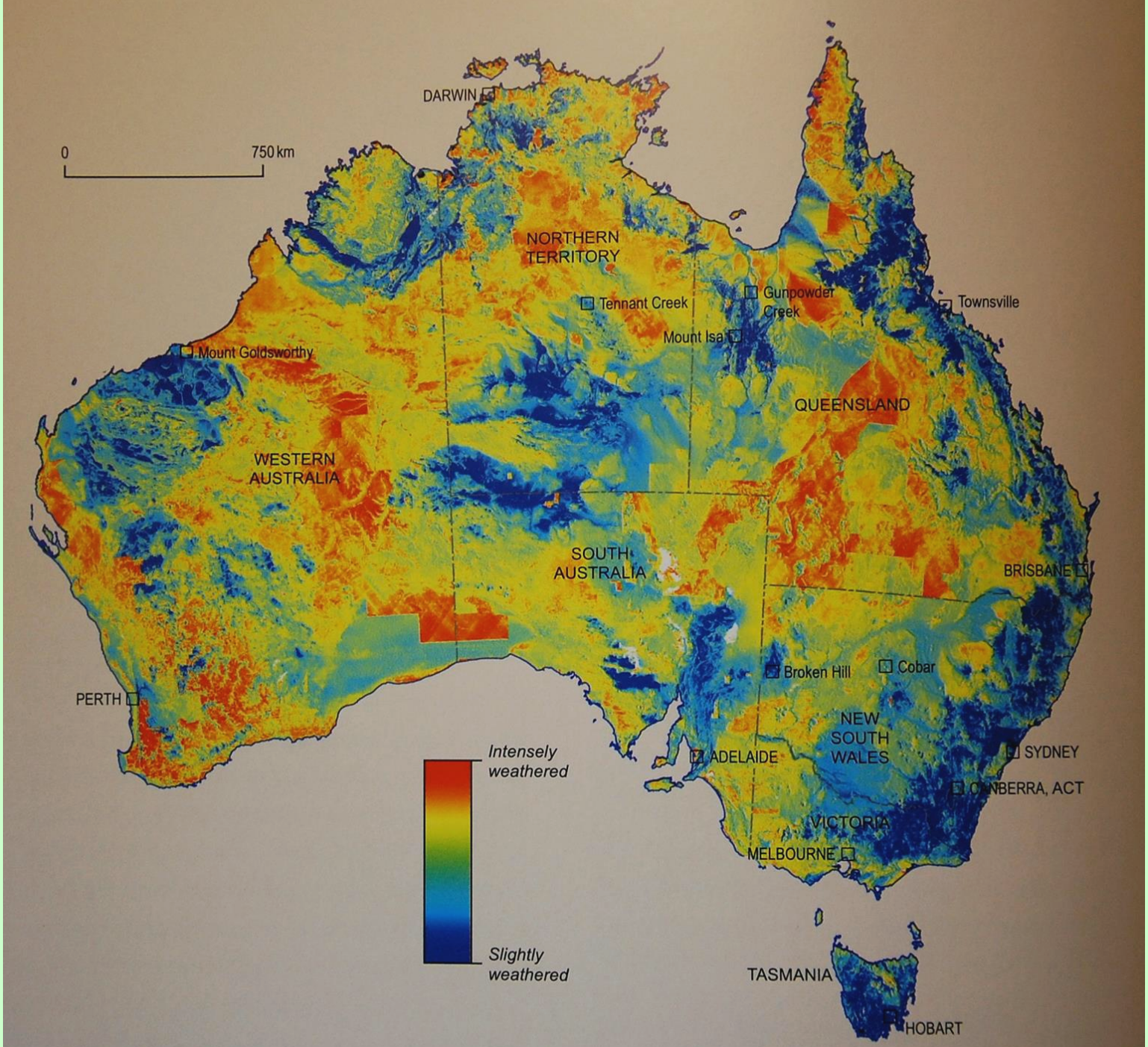


gure 1.5: Digital elevation model of Australia, showing the main physiographic features of the continent.

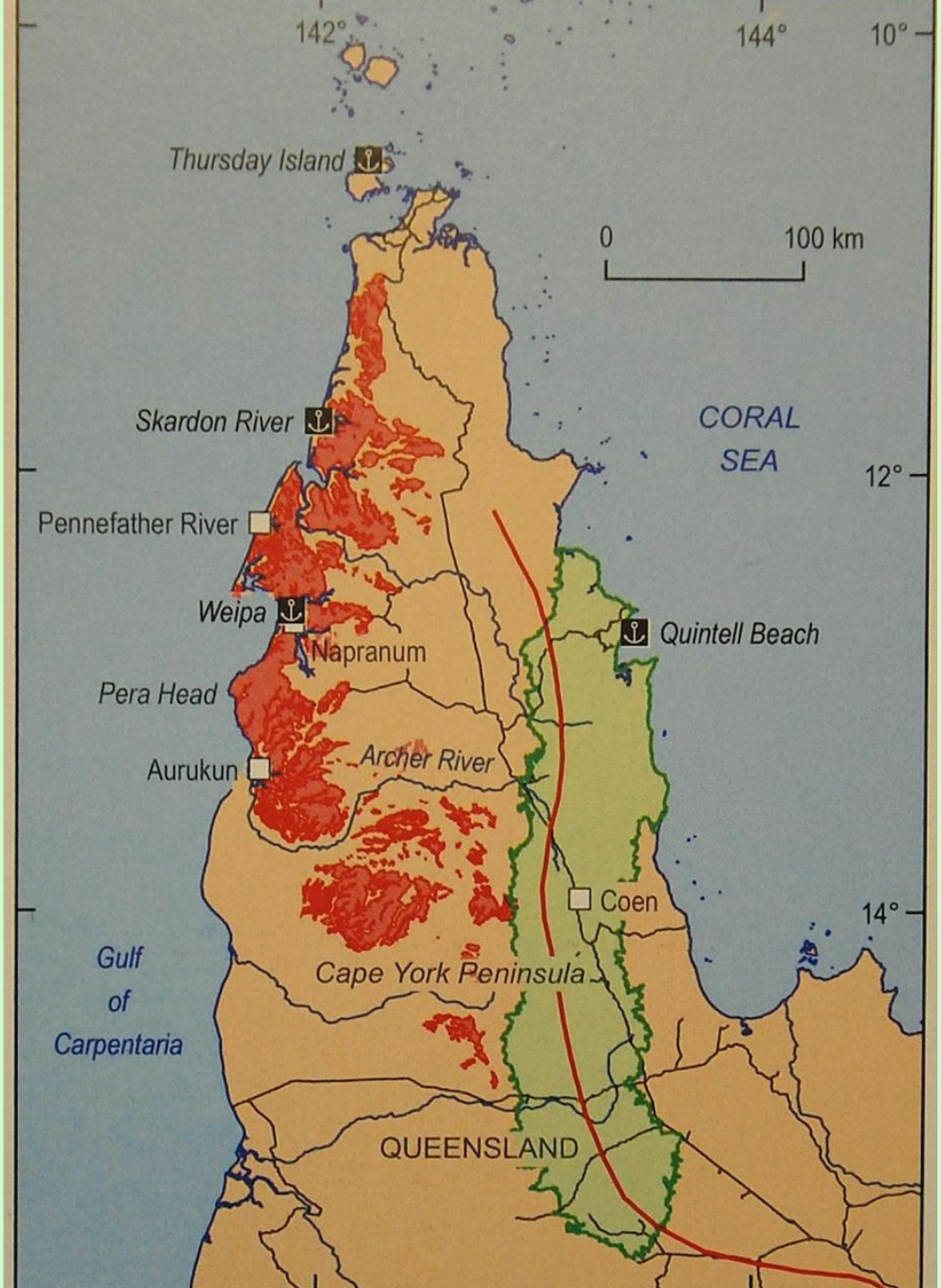

0
750 km
Pine Creek Orogen
Arafura Basin
DARWIN
Daly River Basin
McArthur Basin
Coen Province
Laura Basin
Halls Creek Orogen
Kimberley Basin
Wiso Basin
Karumba Basin
North Queensland Orogen
Georgetown Province
Ashburton Basin
Ord Basin
NORTHERN TERRITORY
Georgina Basin
Mount Isa Province
Thomson Orogen
Lachlan Fold Belt
Bowen Basin
Canning Basin
Gascoyne Province
Pilbara Craton
Hamersley Basin
Paterson Orogen
Arunta Province
Galilee Basin
New England Fold Belt
QUEENSLAND
Amadeus Basin
Drummond Basin
Savory Basin
Bangemall Basin
Eromanga Basin
WESTERN AUSTRALIA
Musgrave Orogen
Stuart Shelf
Clarence–Moreton Basin
Officer Basin
Curnamona Province
Surat Basin
BRISBANE
SOUTH AUSTRALIA
Carnarvon Basin
Yilgarn Craton
Eucla Basin
Gawler Craton
Barka Basin
NEW SOUTH WALES
New England Orogen
Sydney Basin
Perth Basin
PERTH
Adelaide Rift System
Albany–Fraser Orogen
ADELAIDE
Murray Basin
Lachlan Orogen
SYDNEY
CANBERRA, ACT
VICTORIA
MELBOURNE
Otway Basin
Gippsland Basin
Rocky Cape Block
Lachlan Fold Belt
Tasmania Basin
HOBART
TASMANIA
Cenozoic
Mesozoic–Cenozoic
Mesozoic
Paleozoic–Cenozoic
Paleozoic–Mesozoic
Paleozoic
Proterozoic–Mesozoic
Proterozoic–Paleozoic
Proterozoic
Archean–Proterozoic
Archean


W.T Water table
Soil
Saprolite
Pisoliths presently forming
Pisoliths no longer forming
Massive vermiform laterite
⇐W.T⇒
a)
b)
c)
d)
e)
f)
g)
h)
i)
j)
k)
l)
m)


Deep weathering profiles
Preserved
Partly preserved
Stripped
1000 km
GTf217-00


DARWIN
0
750 km
NORTHERN TERRITORY
Tennant Creek
Gunpowder Creek
Townsville
Mount Isa
Mount Goldsworthy
QUEENSLAND
WESTERN AUSTRALIA
SOUTH AUSTRALIA
BRISBANE
Broken Hill
Cobar
PERTH
NEW SOUTH WALES
ADELAIDE
SYDNEY
CANBERRA, ACT
VICTORIA
MELBOURNE
Intensely weathered
Slightly weathered
TASMANIA
HOBART

Weipa, Queensland



Bauxite

Coen Inlier

Road

River

Great Divide

Town/location

Port