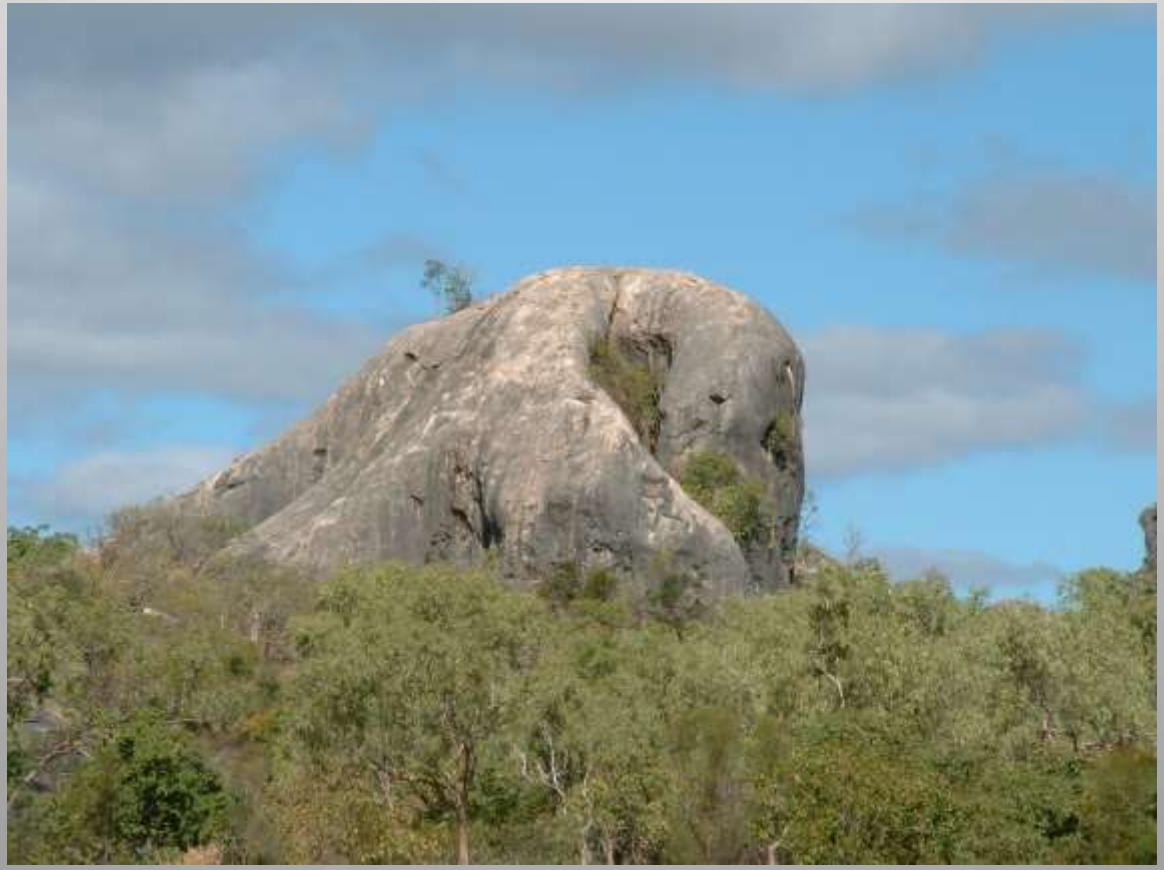
CHILLAGOE REGION EARTH HISTORY



John Nethery BSc, Dip Ed, CP (Geo)

AUSTRALIAN PALAEO-GEOGRAPHY from the PROTEROZOIC (2000mA) through to the HOLOCENE (10kA)

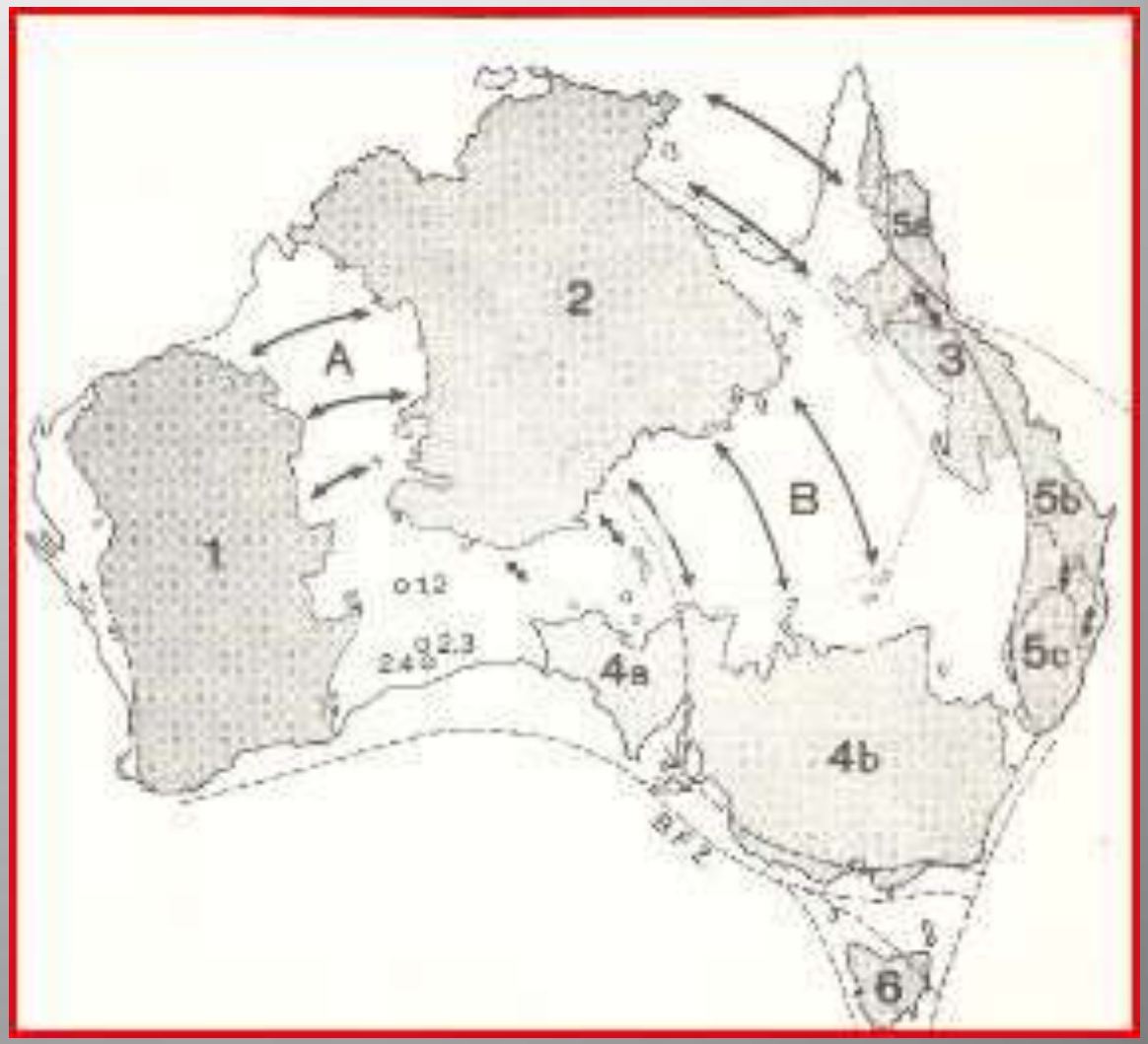
Orientation and Position of continents were dependant on:

Plate tectonics

Pole position

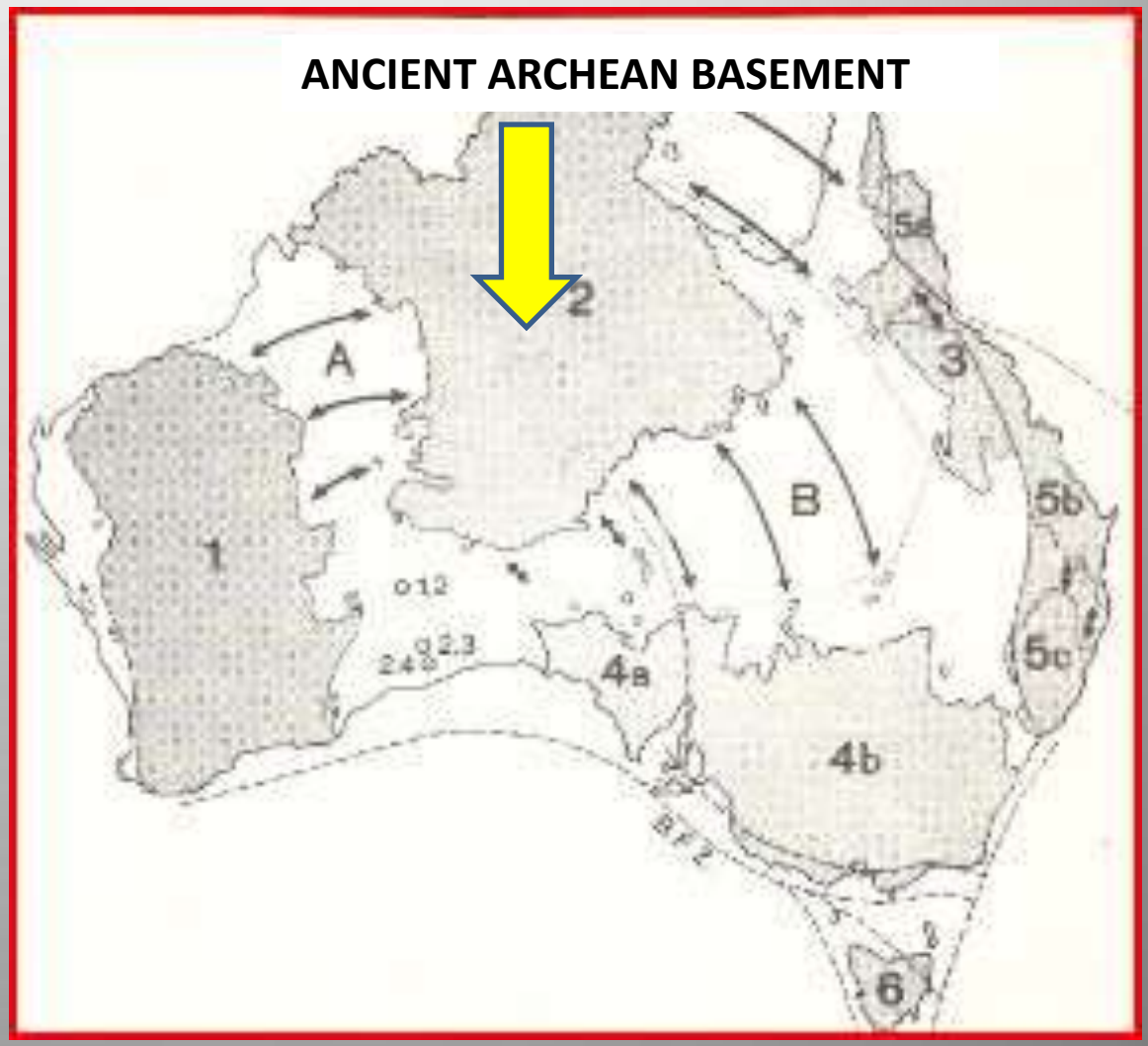
Proterozoic Period (2500 – 590My)

- Much of Australia was shallow sea
- E Aust may have Archean - Prot basement
- E Aust was joined to USA ?
- Georgetown Block may have been in the Gulf (image from Harrington 1974)



Archean Period (4500 – 2500My)

- E Aust may have Archean - Prot basement
- E Aust was joined to USA ?
- Georgetown Block may have been in the Gulf (image from Harrington 1974)



Proterozoic Period (2500 – 590My)

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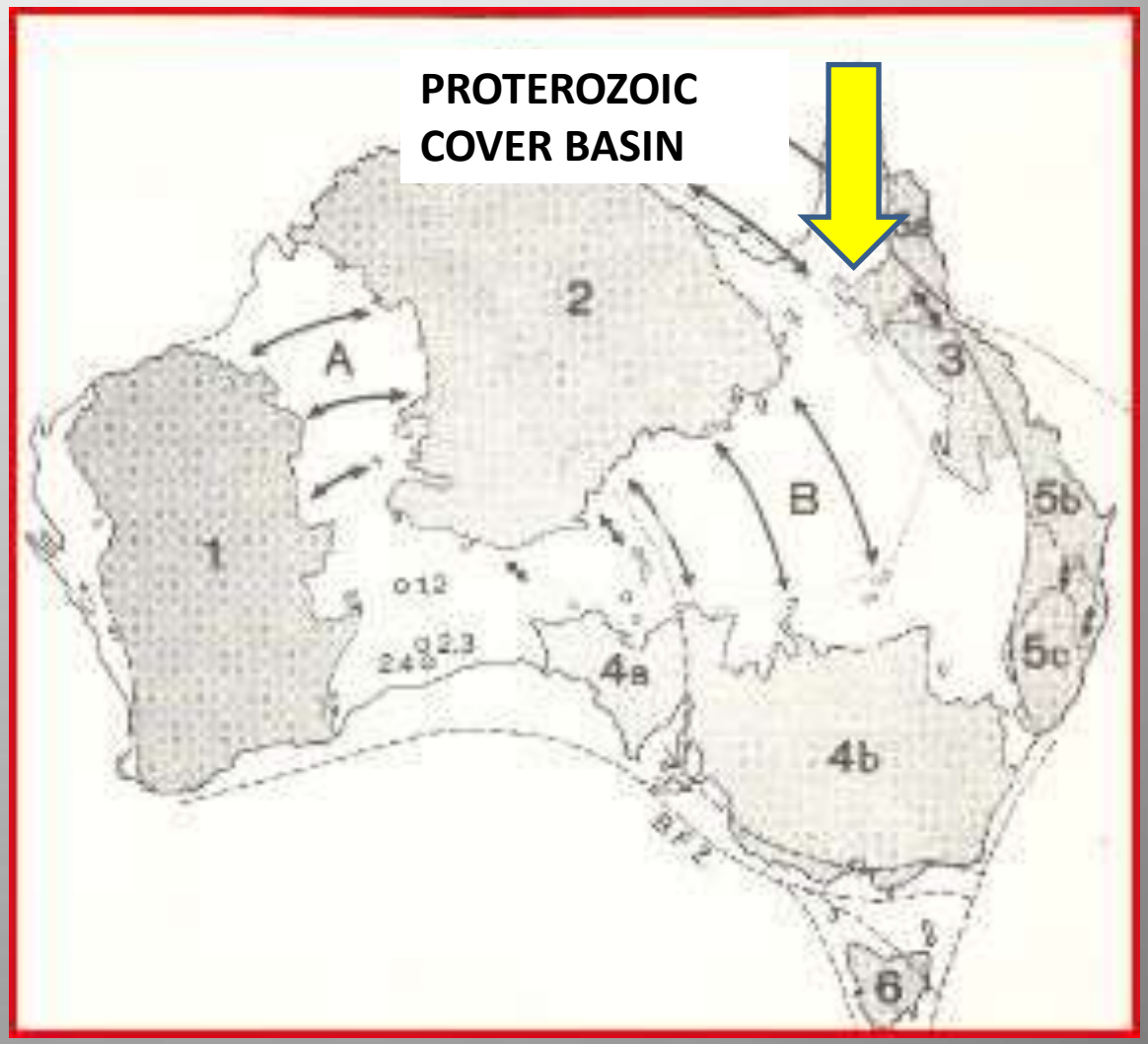
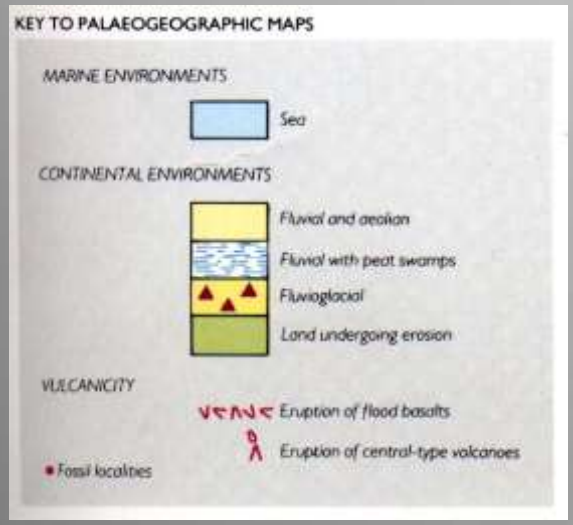
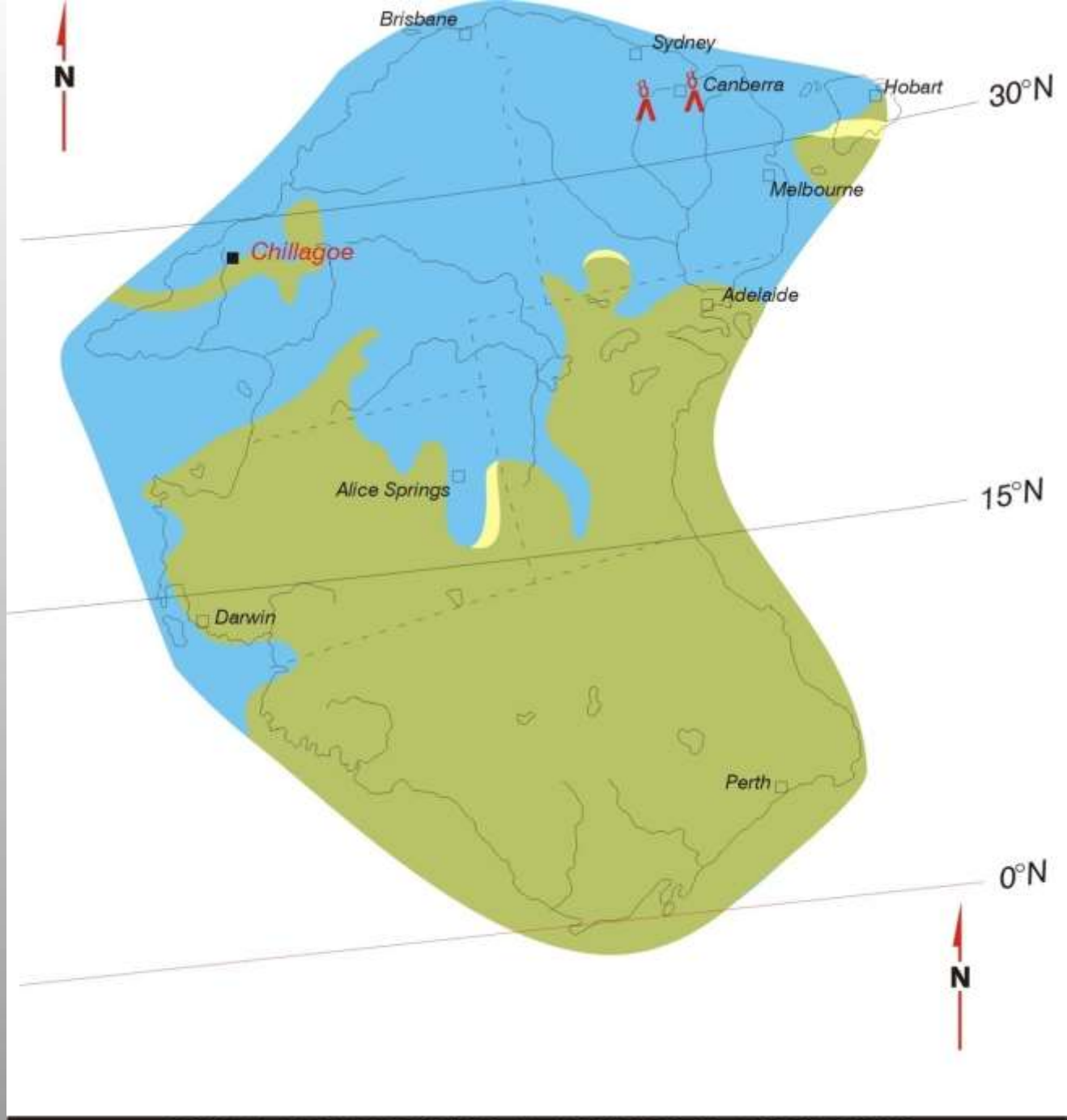


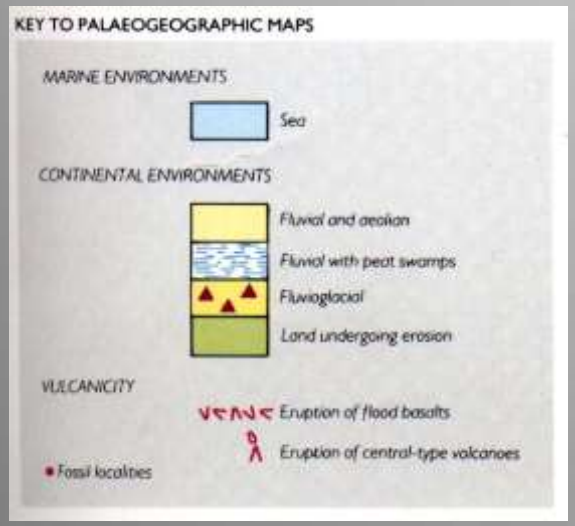
Cambrian Period (590 – 505My) (images after Mary White 1994)

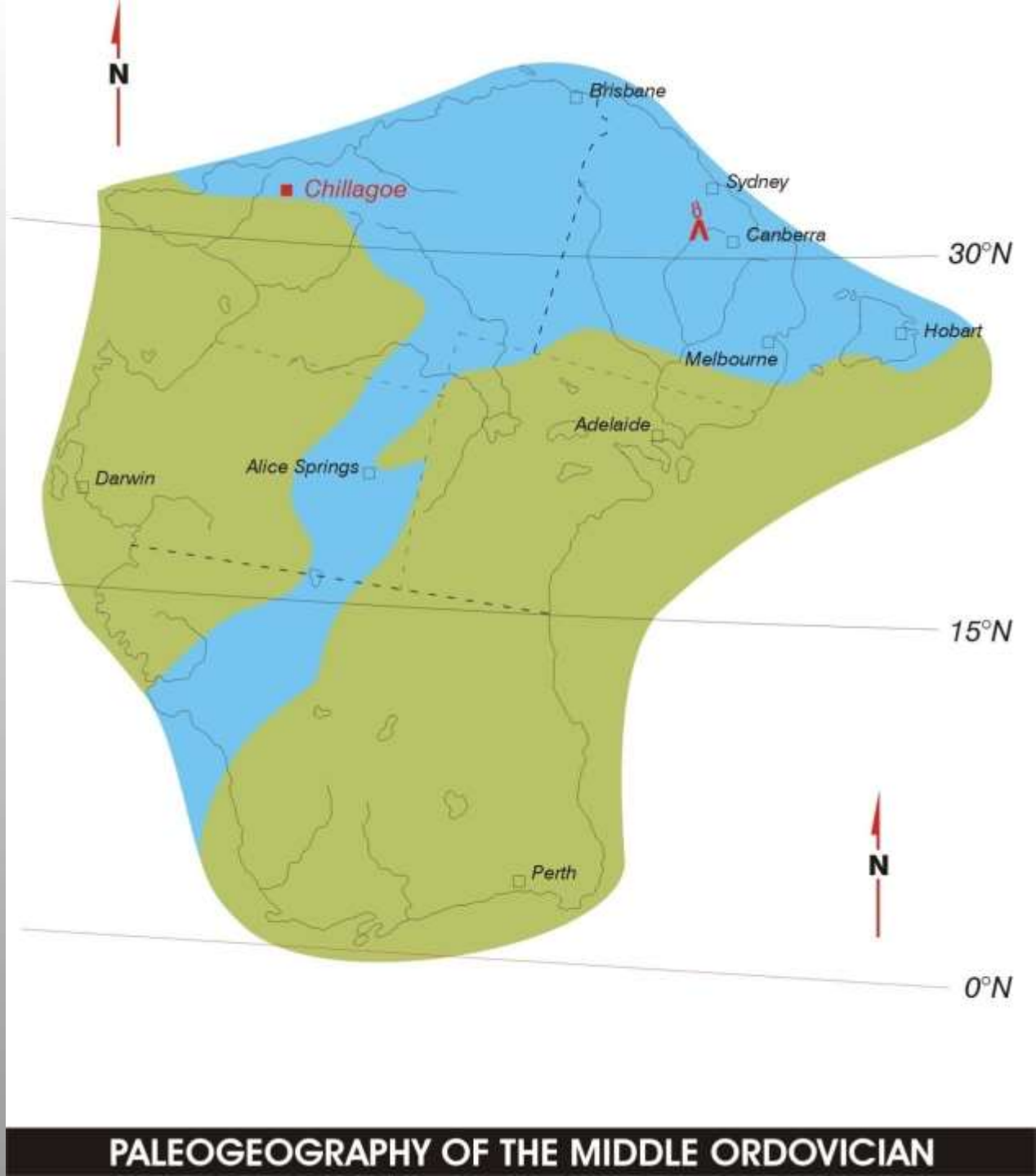




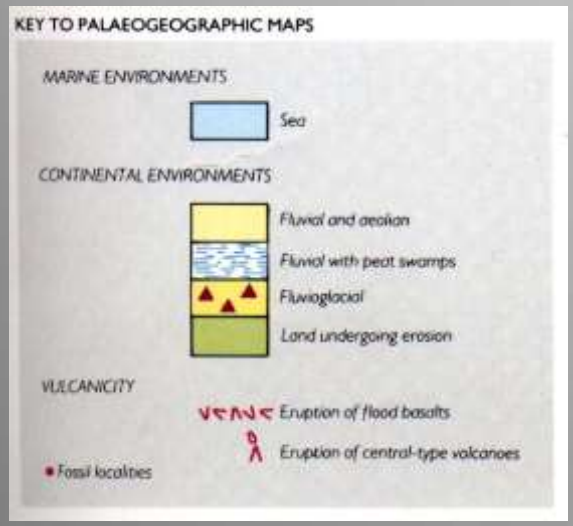
PALEOGEOGRAPHY OF THE LATE CAMBRIAN

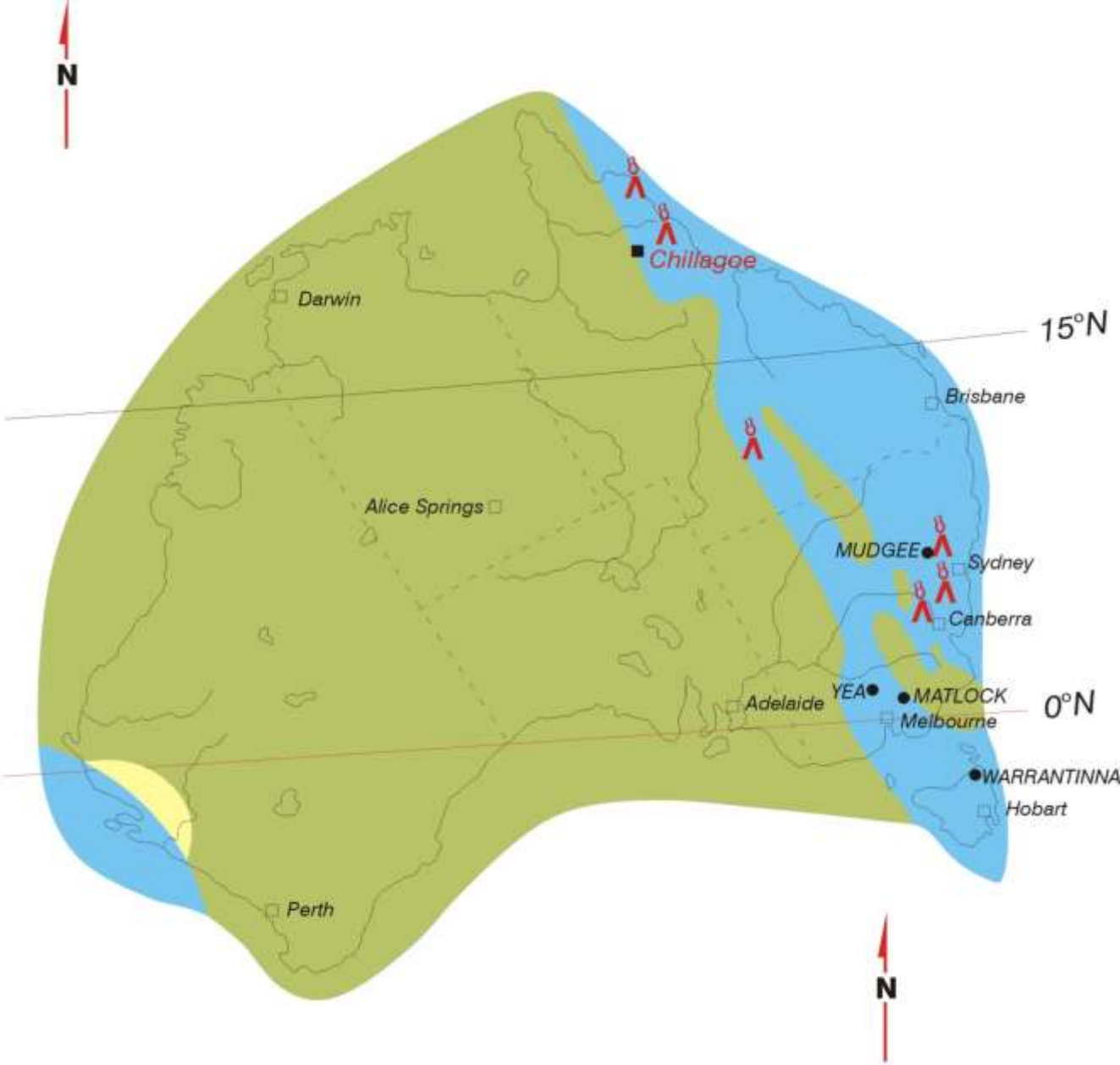
Ordovician Period (505 – 434My)





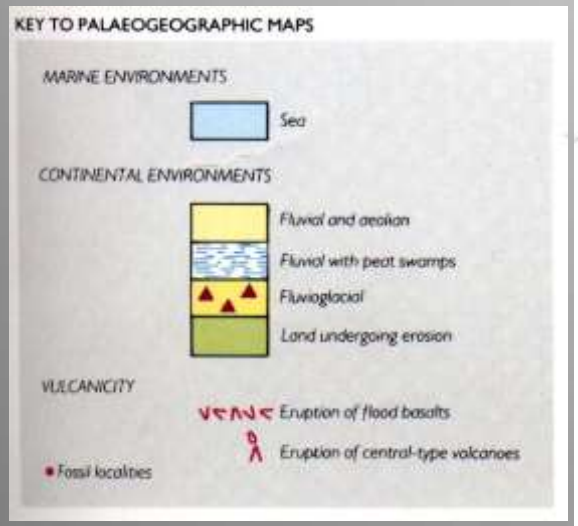
Silurian Period (434 – 408My)

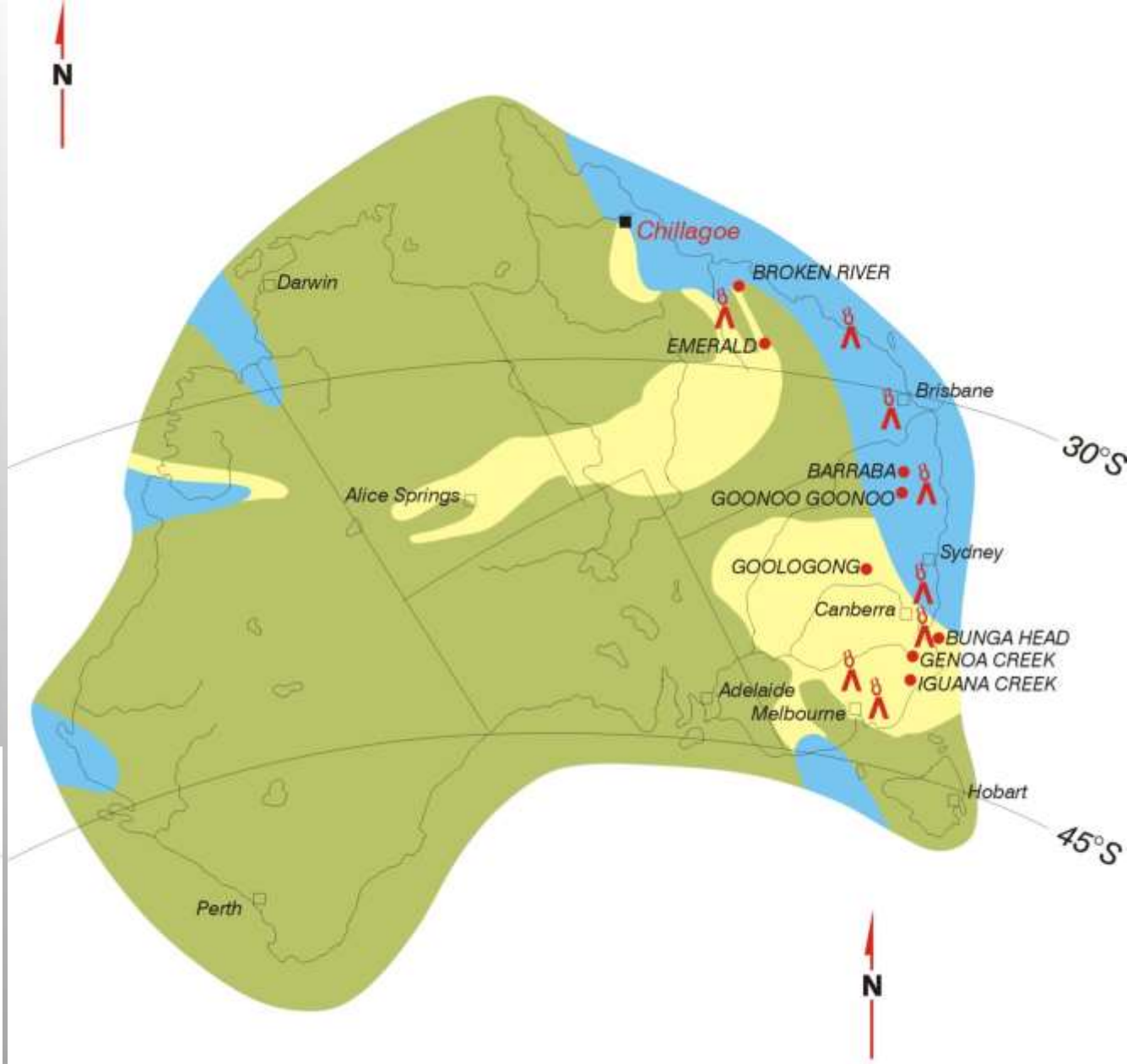




PALEOGEOGRAPHY OF THE LATE SILURIAN

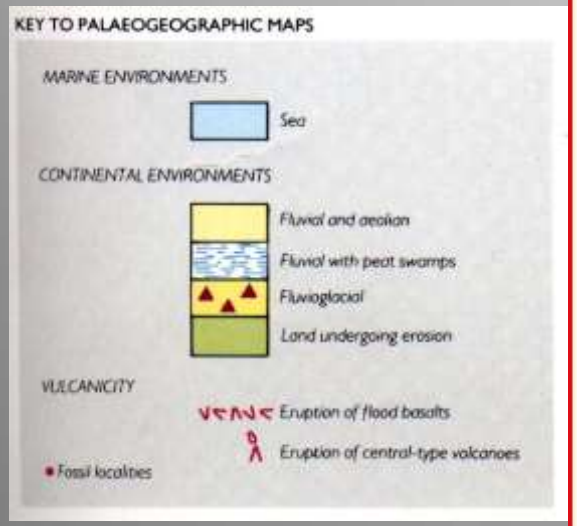
Devonian Period (408 – 354My)

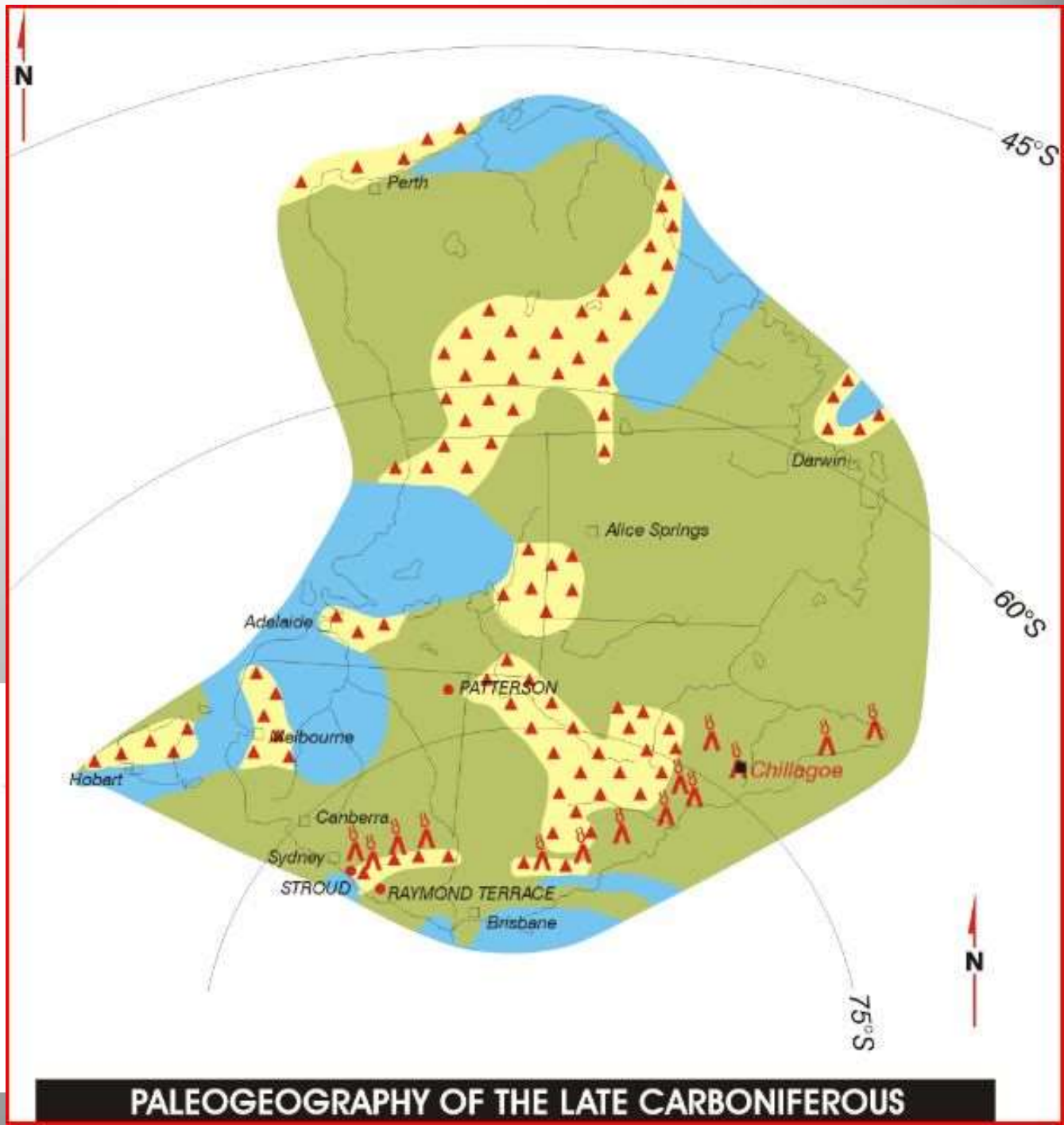




PALEOGEOGRAPHY OF THE LATE DEVONIAN

Carboniferous Period (354 – 286My)

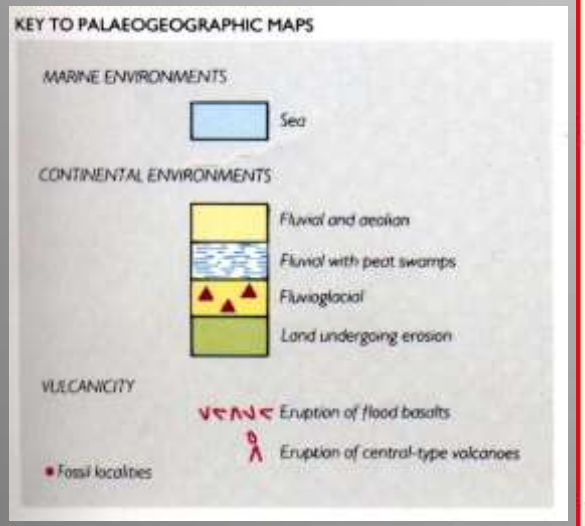


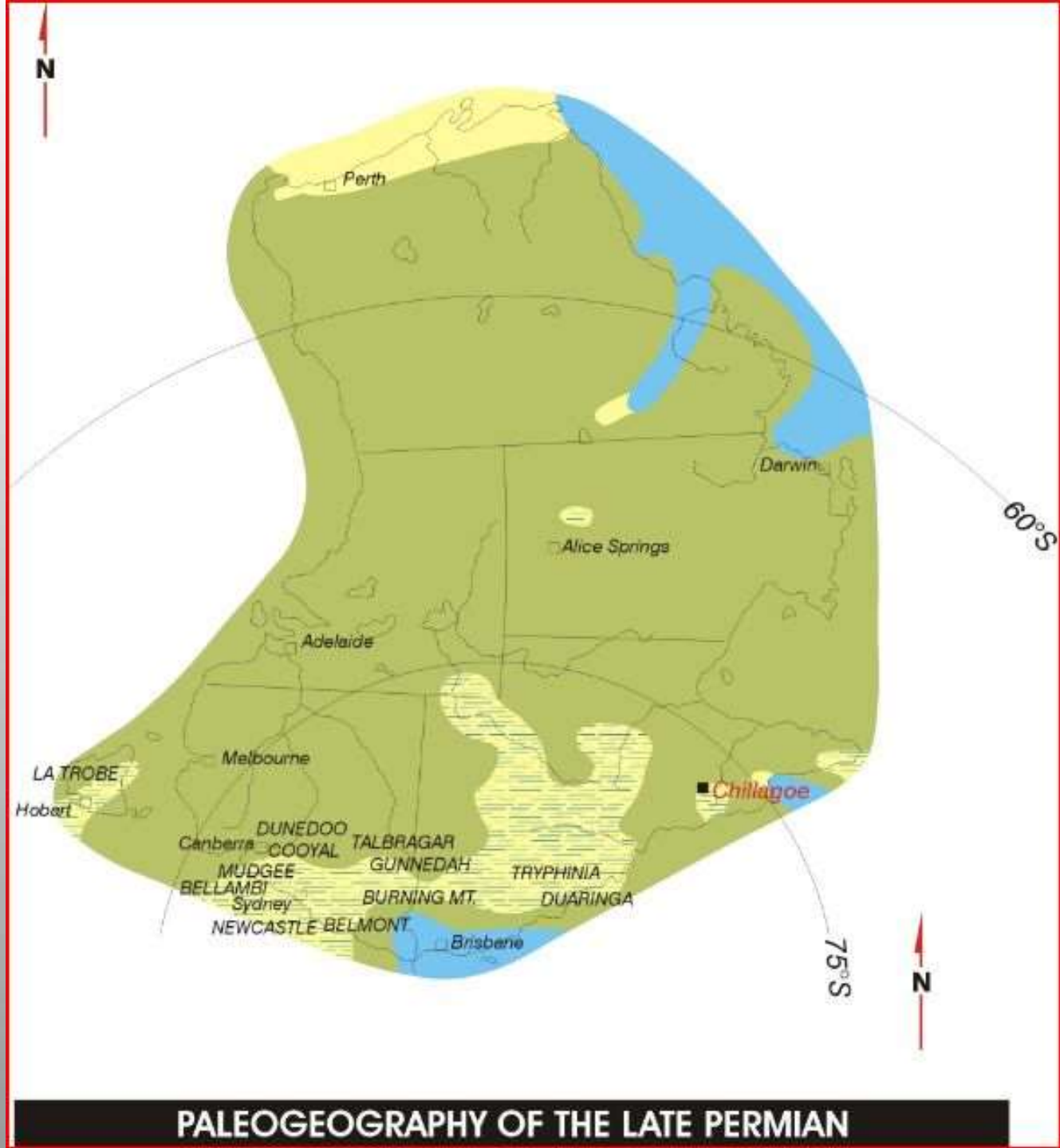


Permian & Triassic Periods

(286 – 248My)

(248 – 213My)

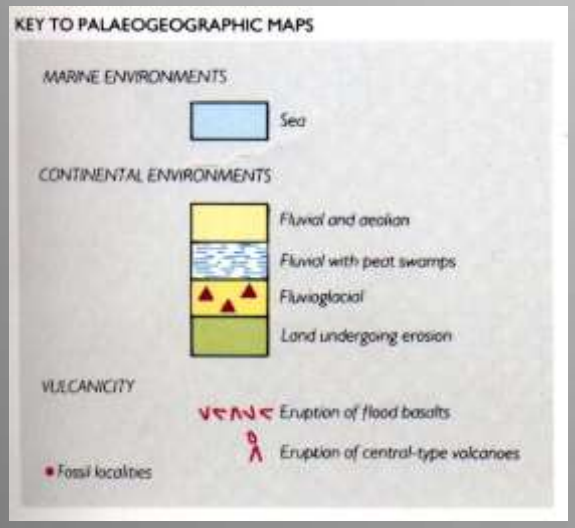


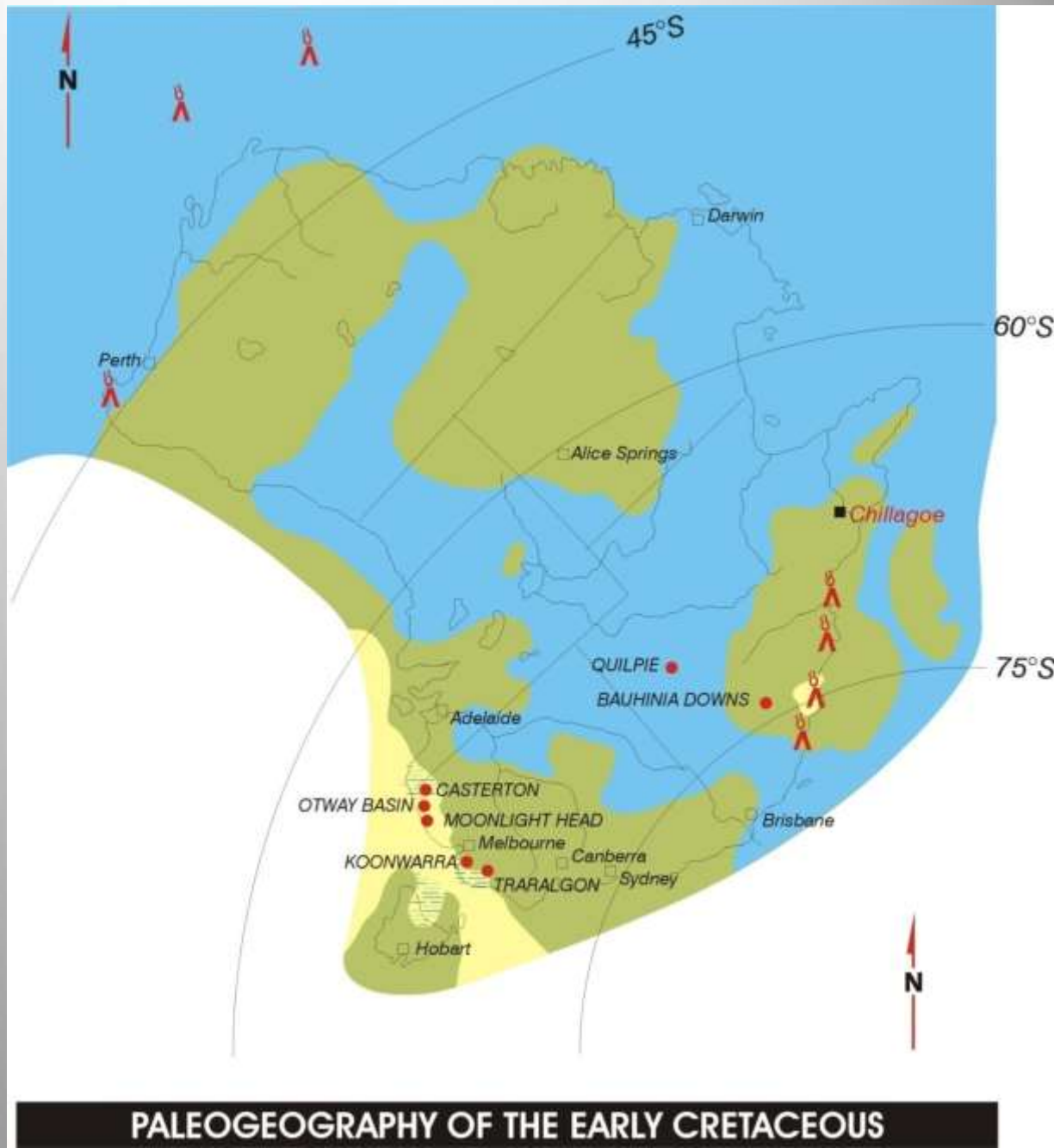


Jurassic & Cretaceous Periods

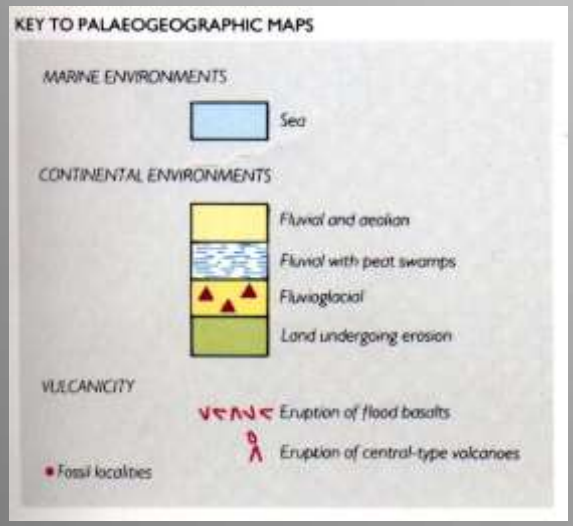
213 – 144My

144 – 65My

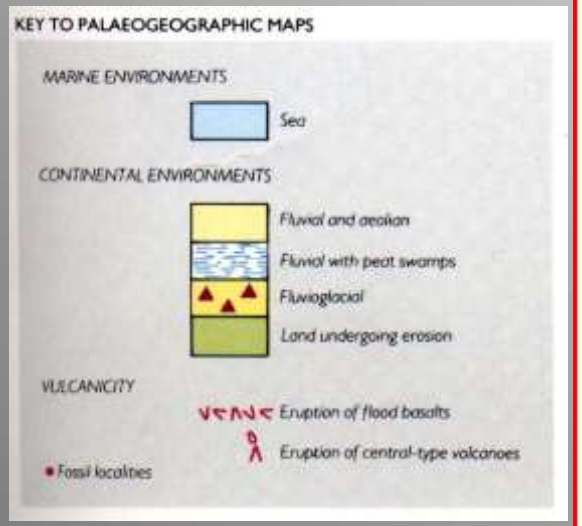


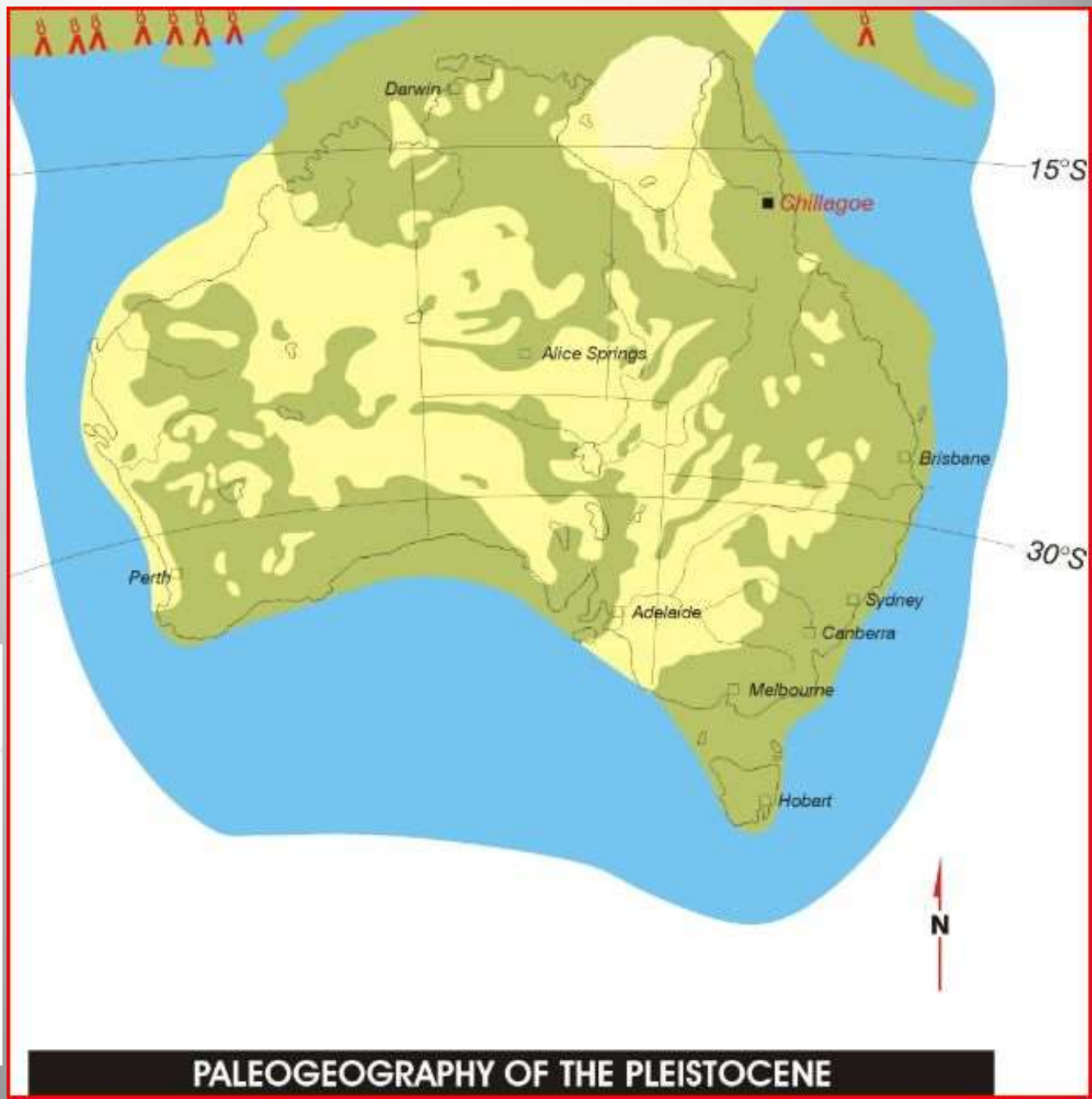


Tertiary Period 65 – 1.8My



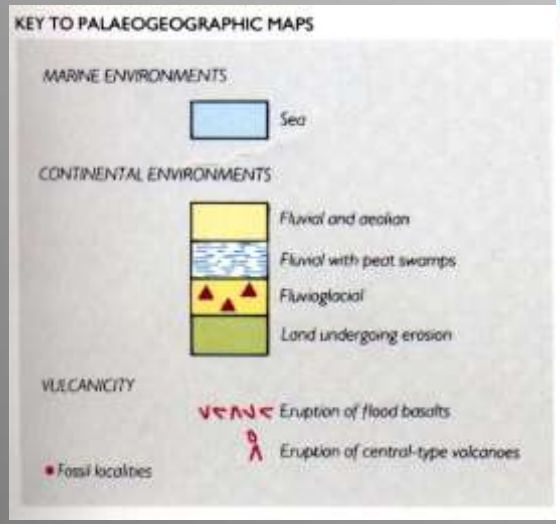
Quaternary Period (Pleistocene Epoch) 1.8My – 10,000y





Quaternary Period (Recent Epoch) 10,000y - 0

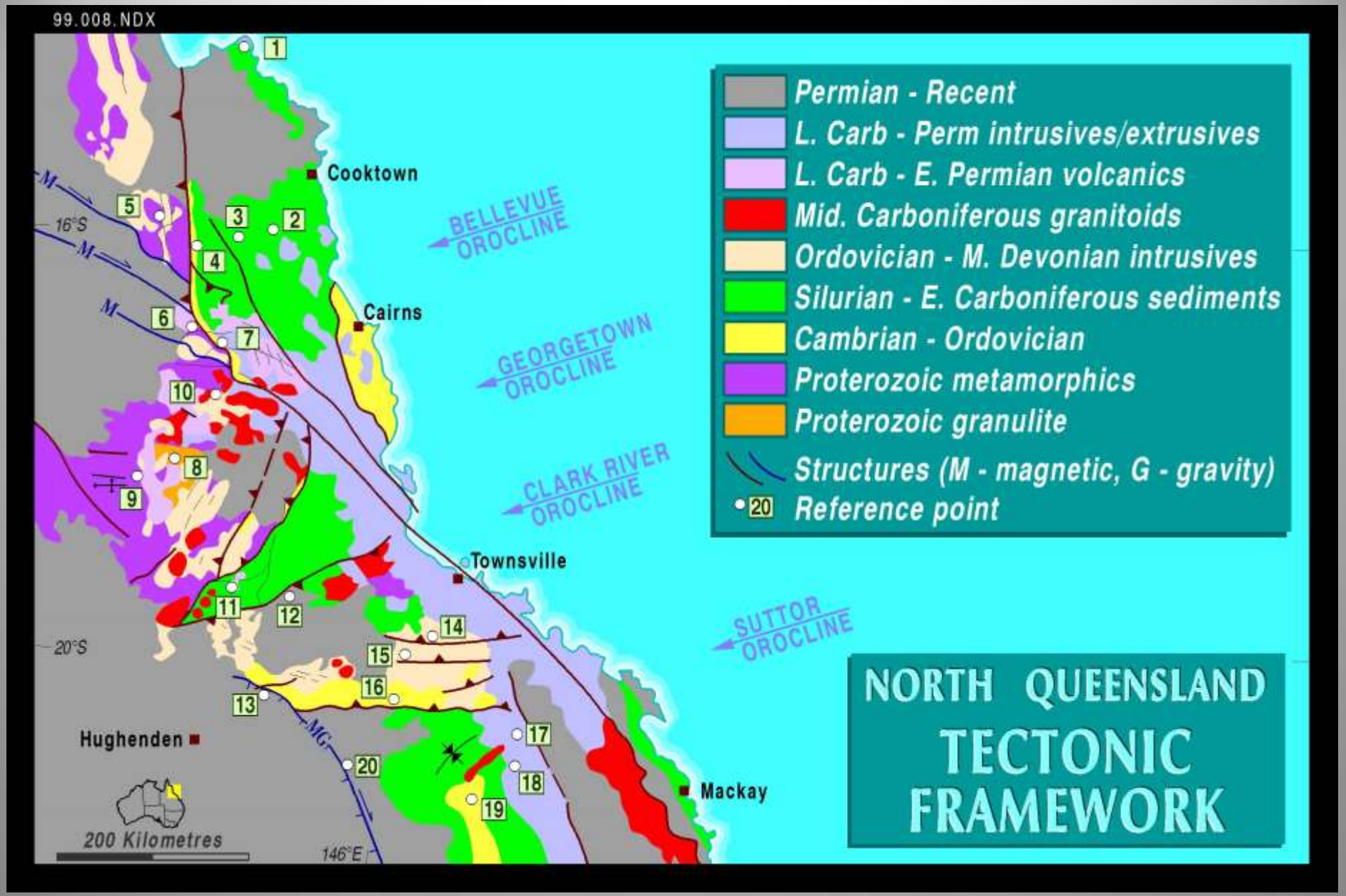
PALEOGEOGRAPHY AT 12000 YEARS AGO

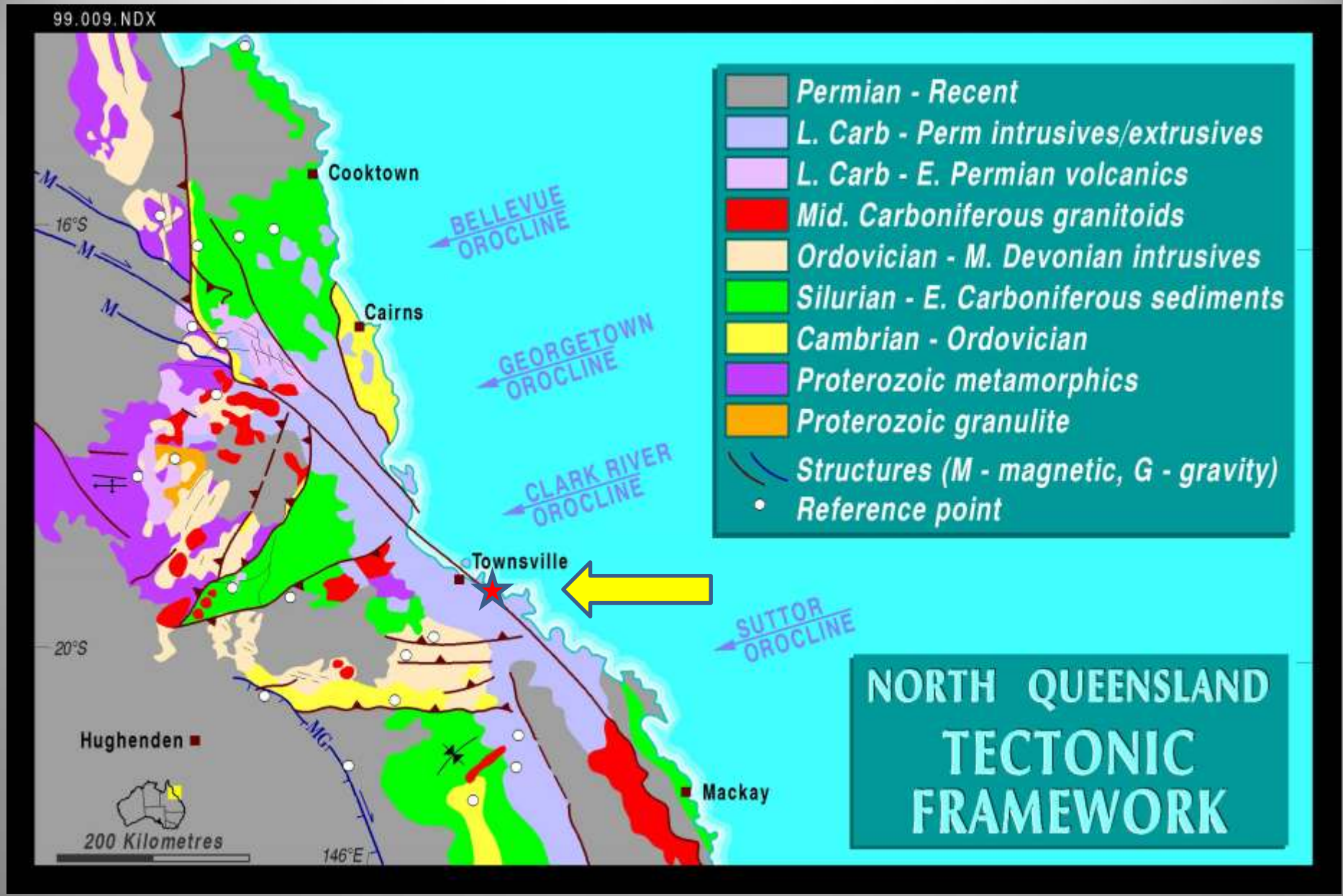


CHILLAGOE
IN THE CONTEXT OF NORTH-EAST QUEENLAND

THE TECTONIC FRAMEWORK

- A summary of the Geographic distribution of the various Precambrian through to Recent packages
- The major fault – systems bounding those packages


99.008.NDX
Permian - Recent
L. Carb - Perm intrusives/extrusives
L. Carb - E. Permian volcanics
Mid. Carboniferous granitoids
Ordovician - M. Devonian intrusives
Silurian - E. Carboniferous sediments
Cambrian - Ordovician
Proterozoic metamorphics
Proterozoic granulite
Structures (M - magnetic, G - gravity)
20 Reference point
Cooktown
Cairns
Townsville
Mackay
Hughenden
BELLEVUE OROCLINE
GEORGETOWN OROCLINE
CLARK RIVER OROCLINE
SUTTOR OROCLINE
16°S
20°S
146°E
200 Kilometres
NORTH QUEENSLAND
TECTONIC FRAMEWORK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Permian - Recent
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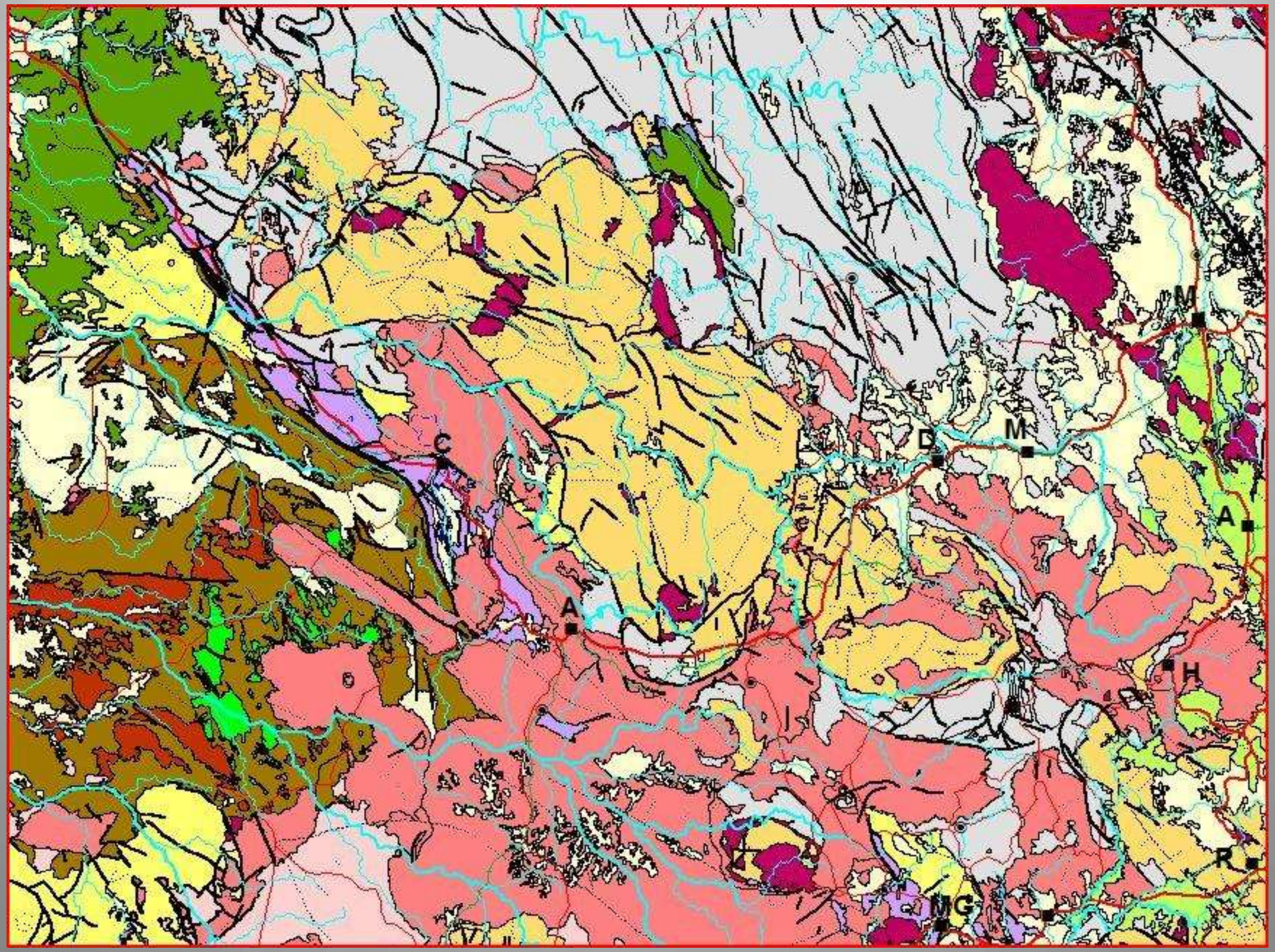
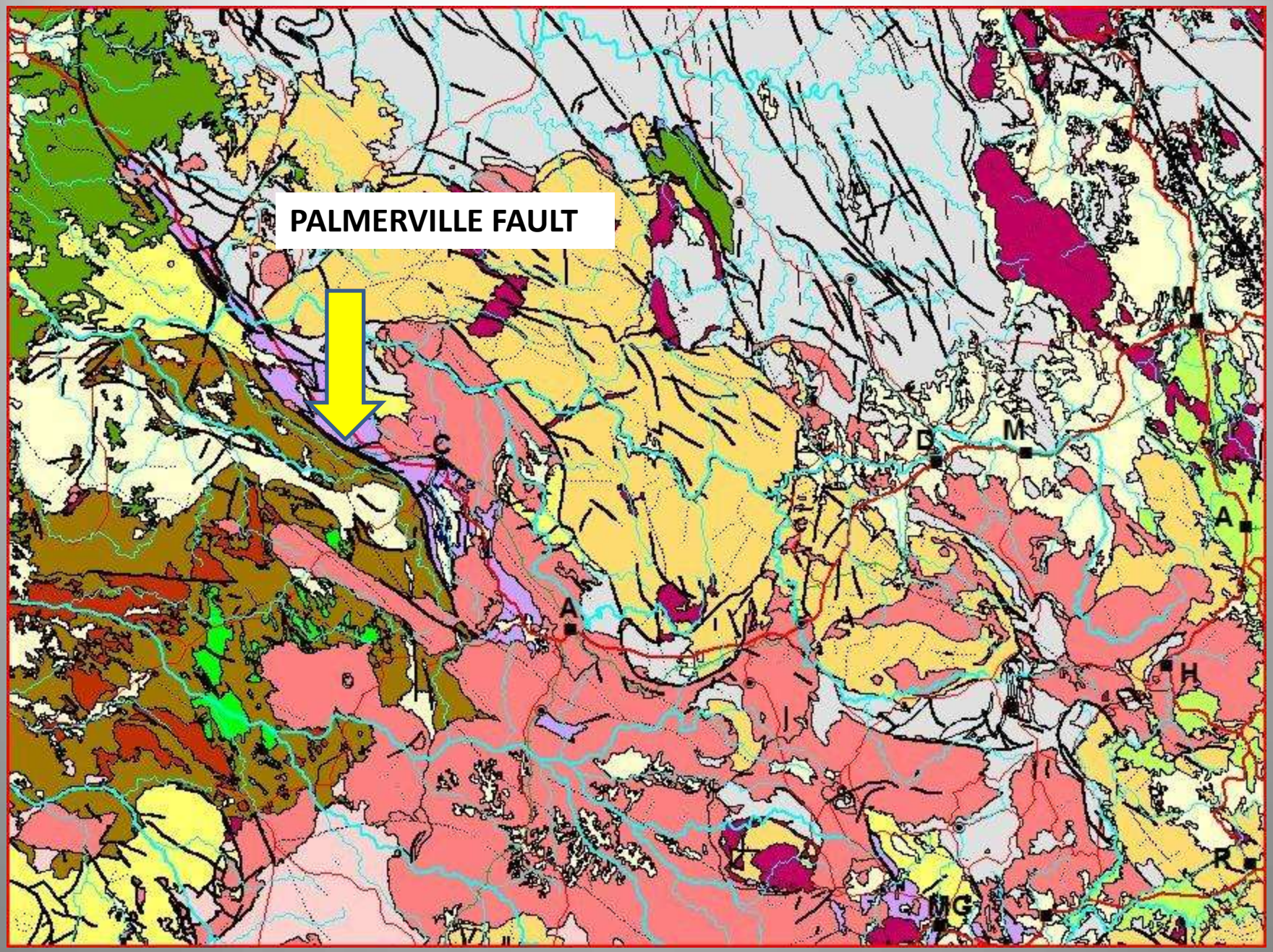
SUTTOR OROCLINE
16°S
20°S
146°E
200 Kilometres
NORTH QUEENSLAND
TECTONIC FRAMEWORK

A DISTRICT VIEW


M
D
M
C
A
A
H
R
NG


PALMERVILLE FAULT
C
A
D
M
M
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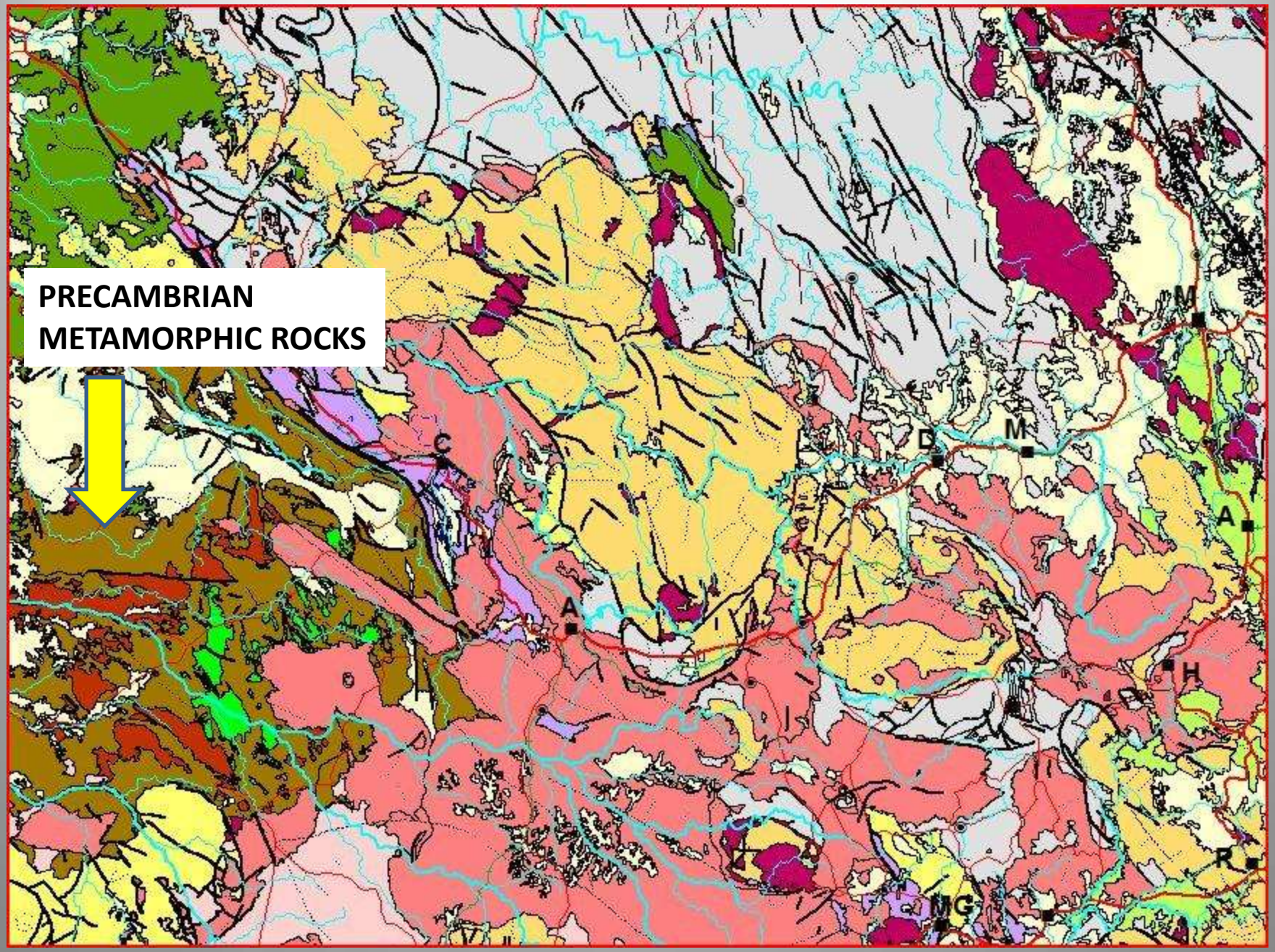
H
R
NG


PRECAMBRIAN
METAMORPHIC ROCKS
C
D
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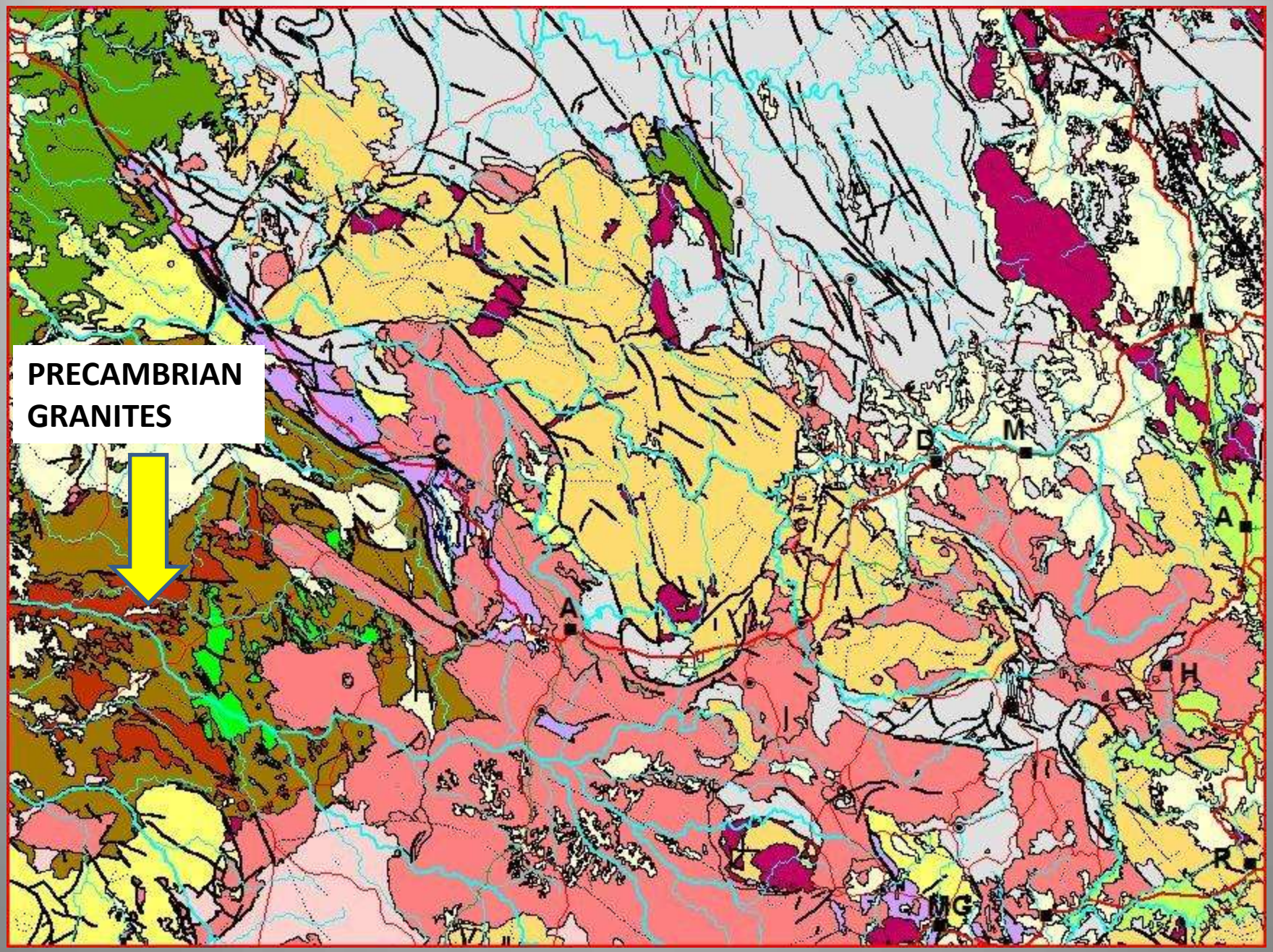
PRECAMBRIAN
GRANITES
C
D
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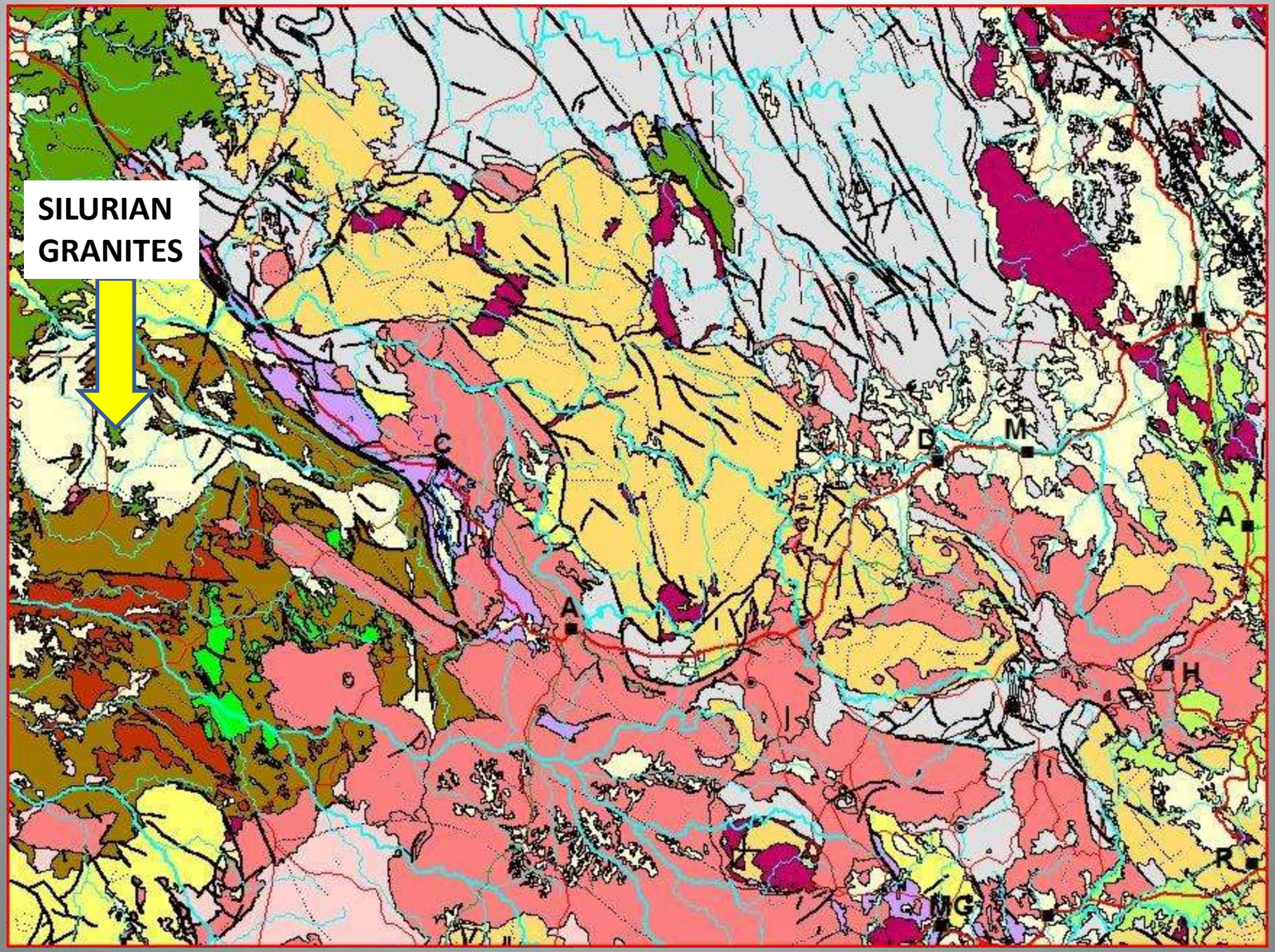
SILURIAN
GRANITES
C
D
M
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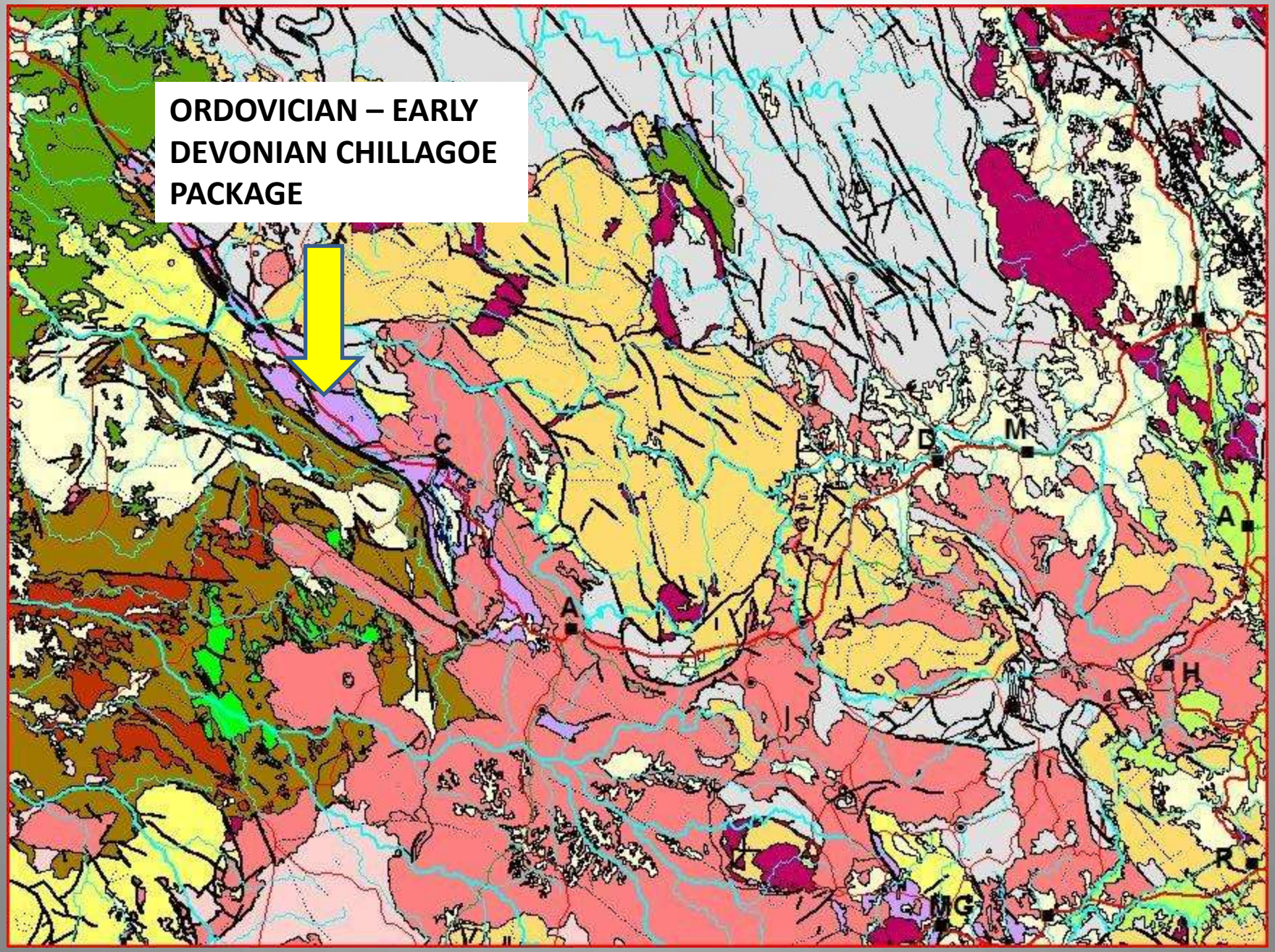
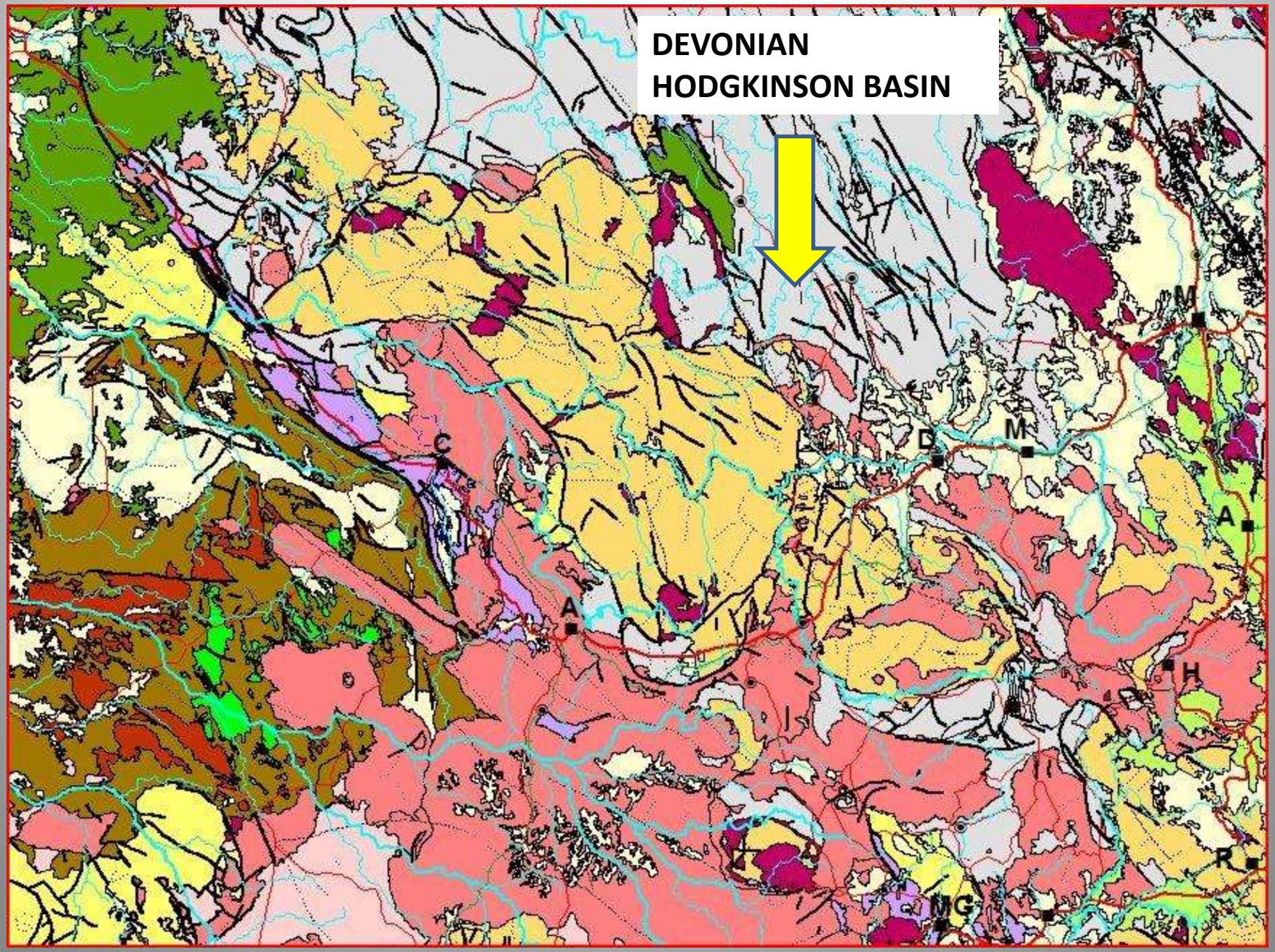

ORDOVICIAN – EARLY DEVONIAN CHILLAGOE PACKAGE
C
A
D
M
M
A
H
R
G


DEVONIAN
HODGKINSON BASIN
C
D
M
M
A
A
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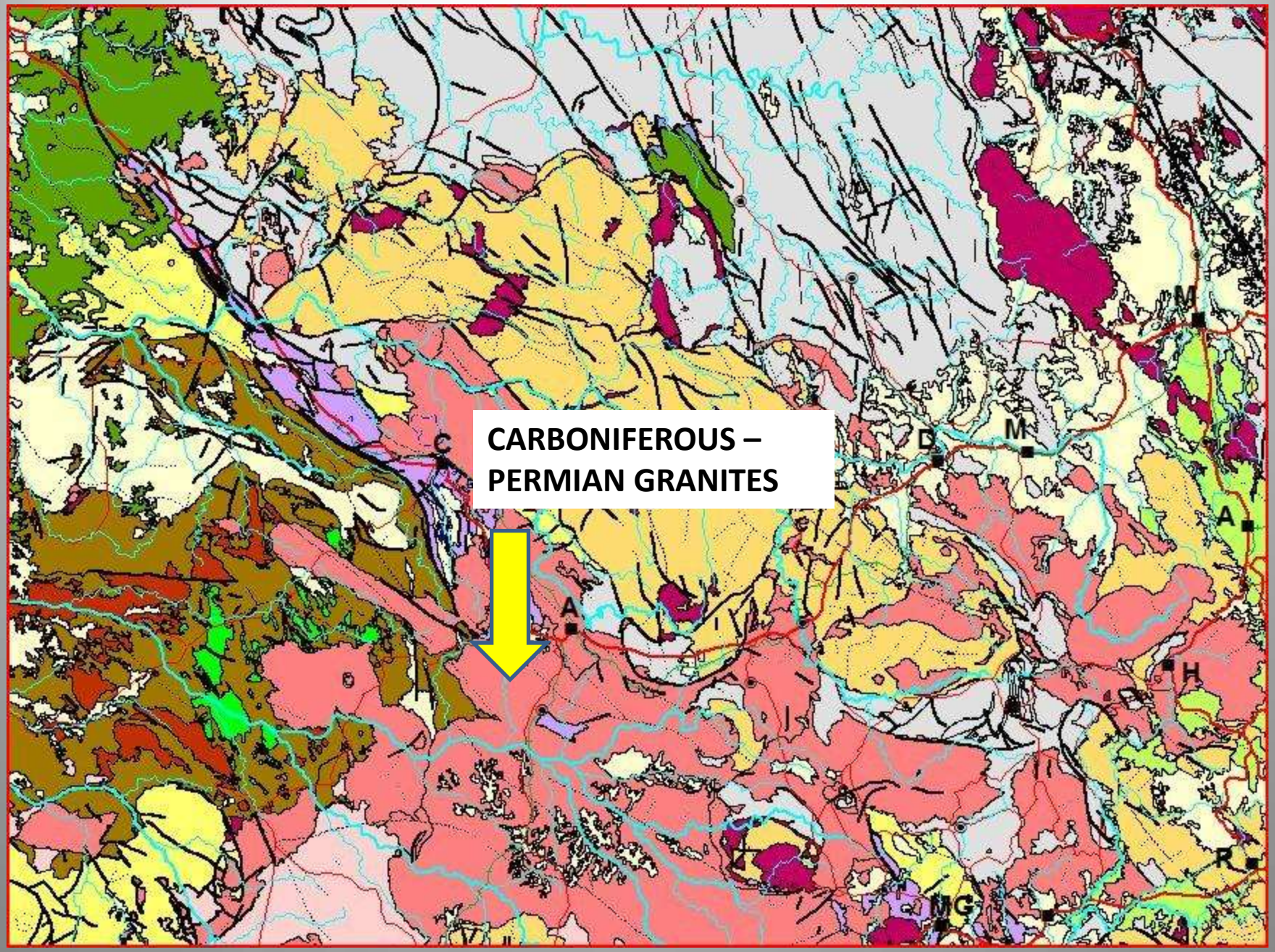
NG


CARBONIFEROUS –
PERMIAN GRANITES
C
D
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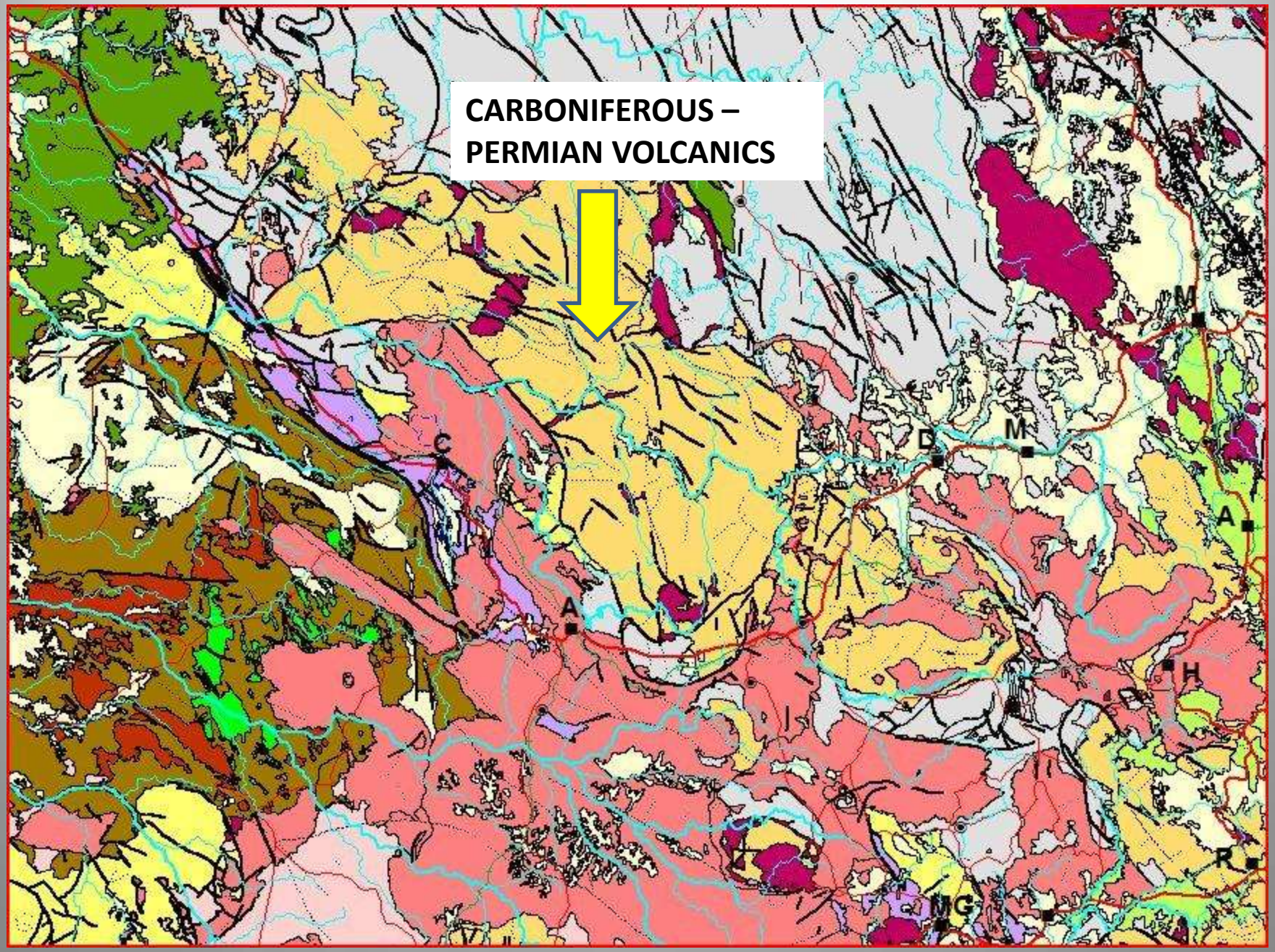
A
A
H
R
G


CARBONIFEROUS –
PERMIAN VOLCANICS
C
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M
A
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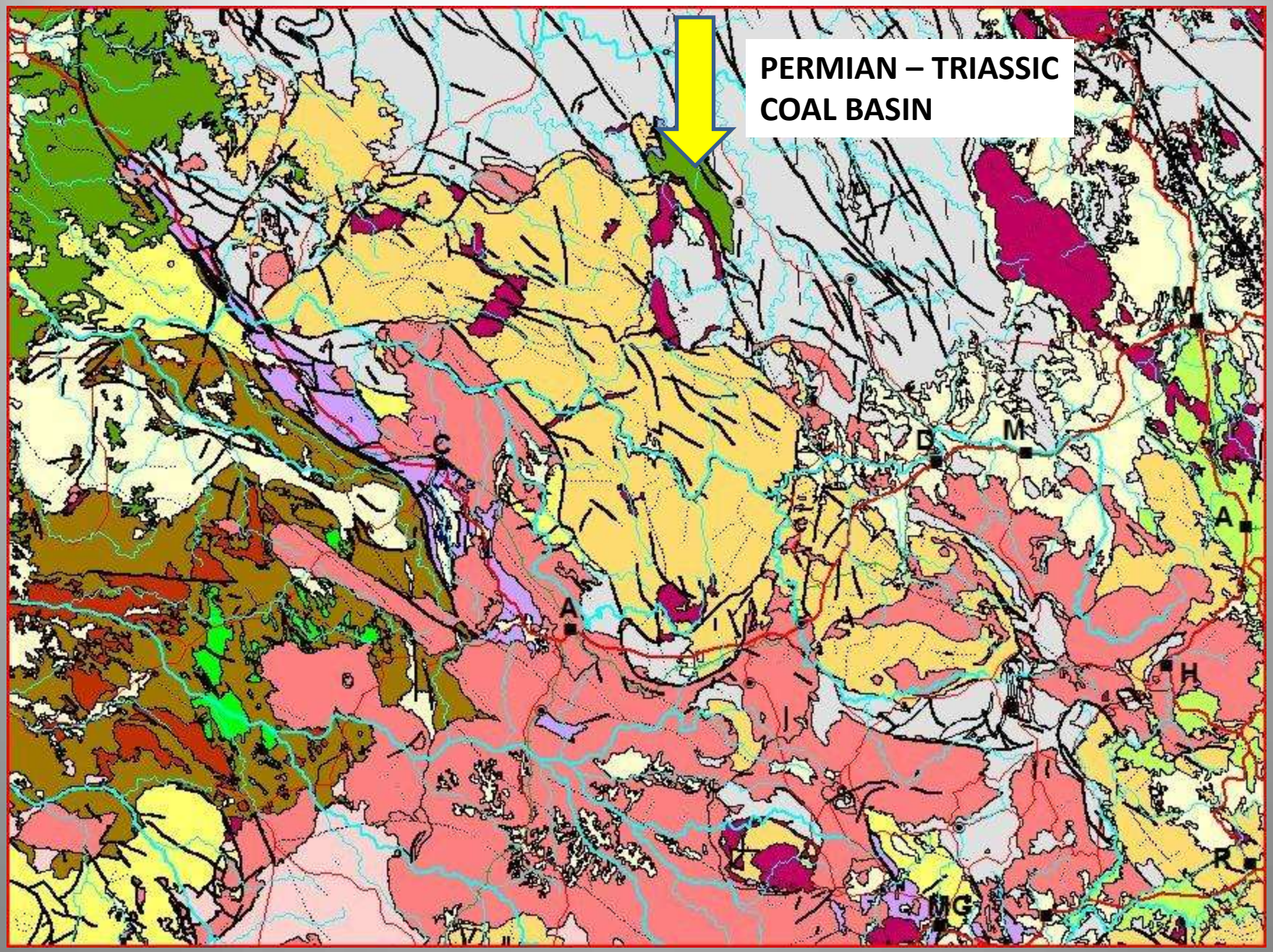
NG


PERMIAN – TRIASSIC
COAL BASIN
M
D
M
C
A
A
H
R
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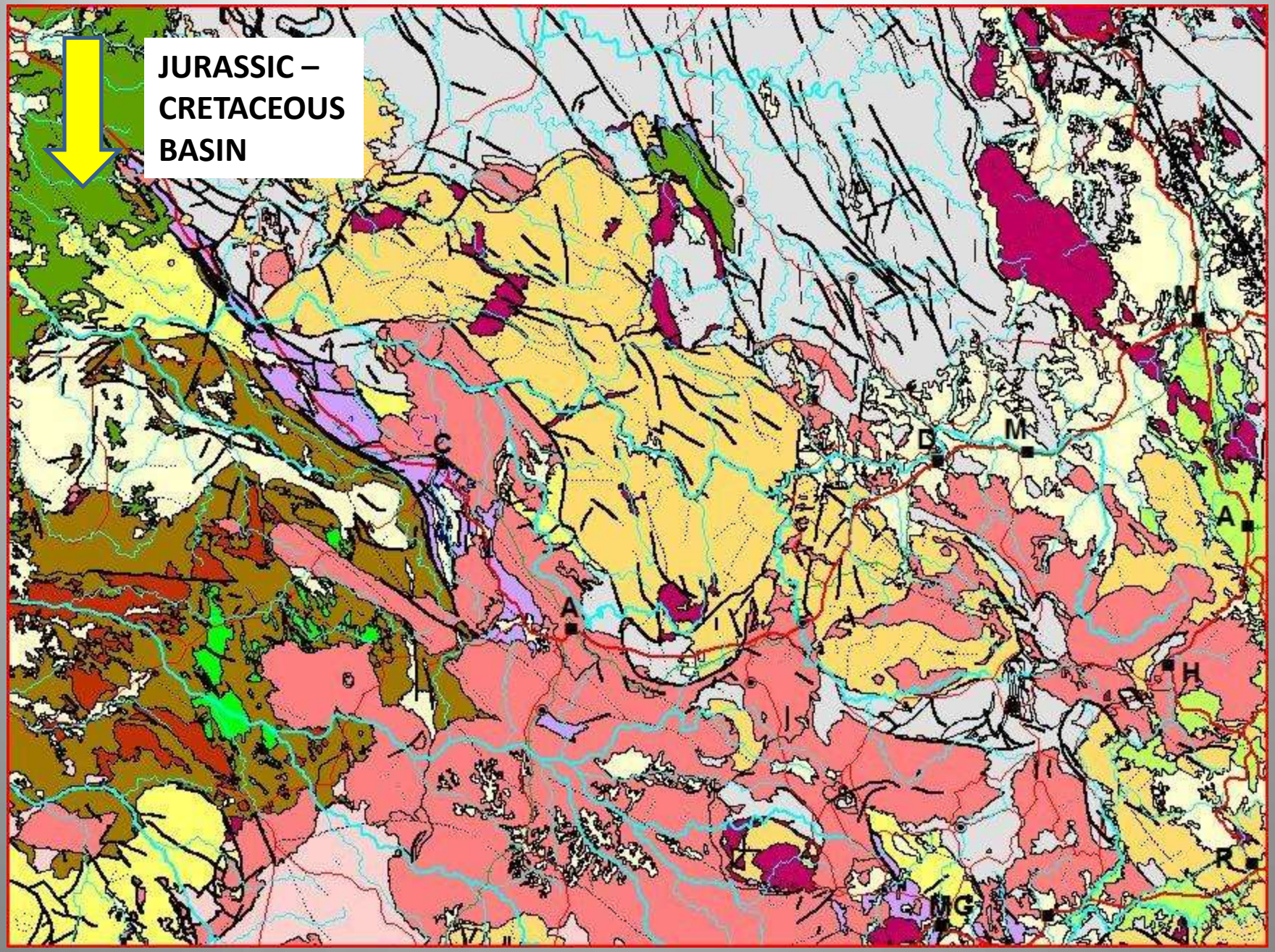
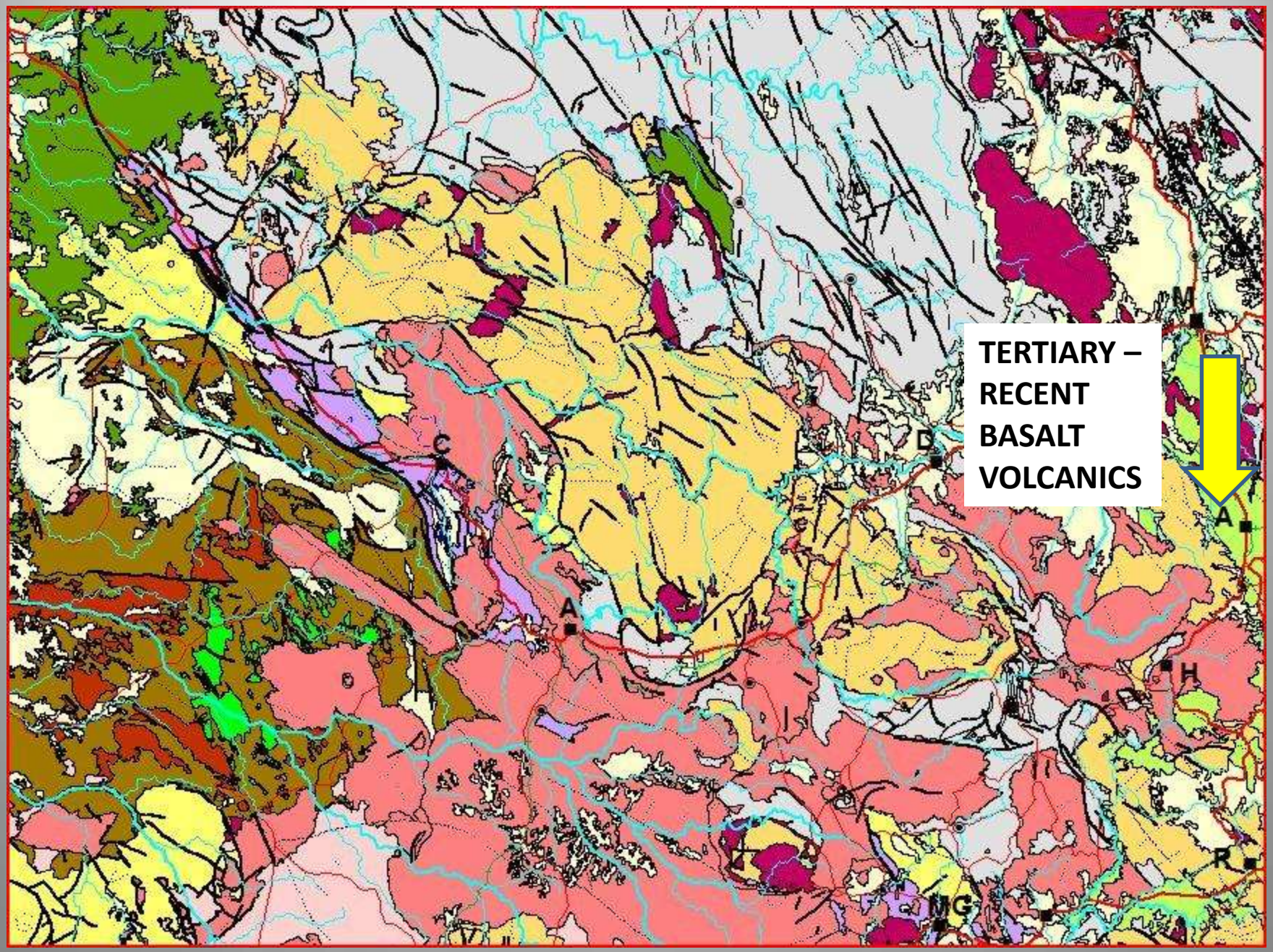
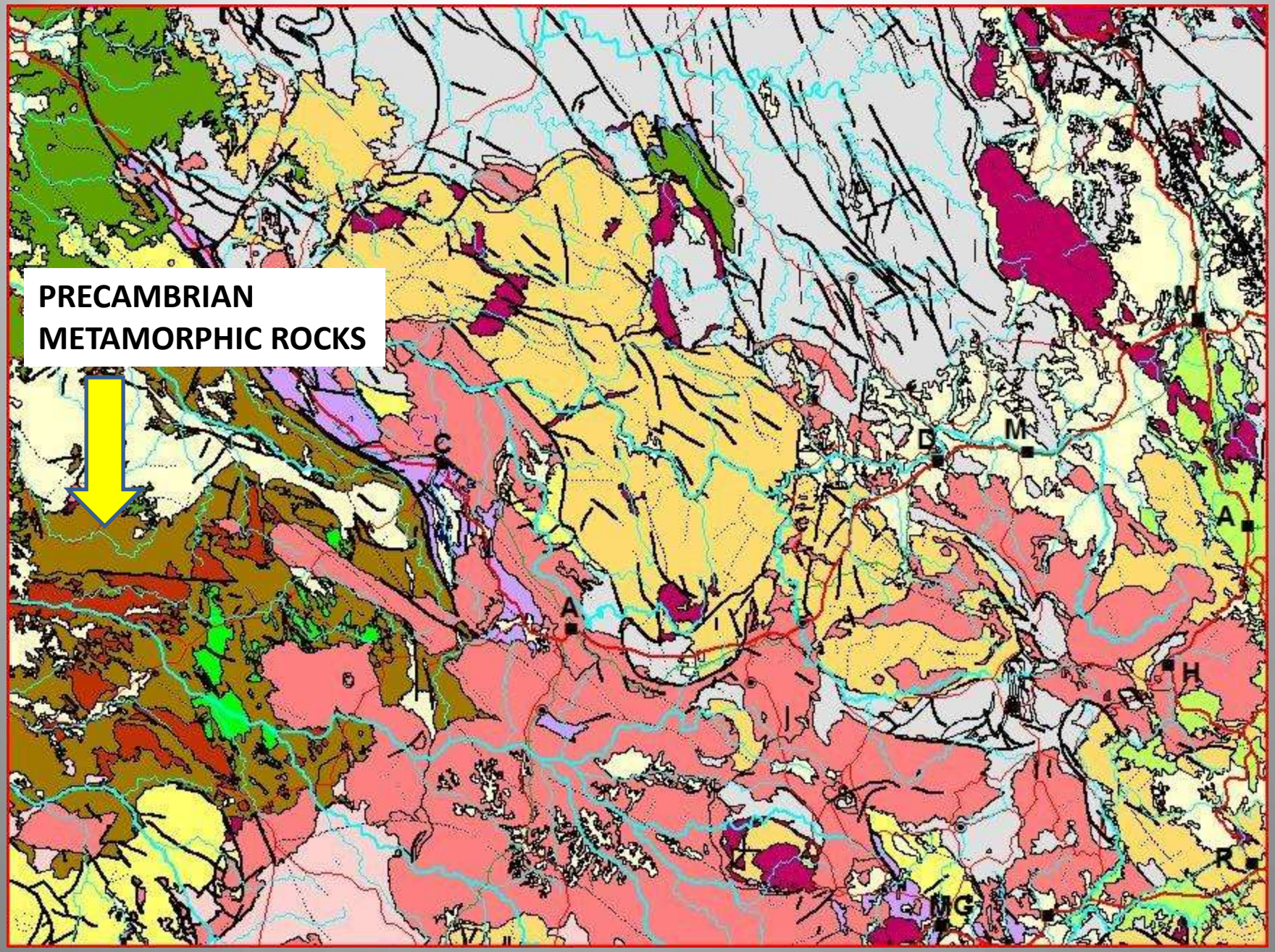

JURASSIC – CRETACEOUS BASIN
M
M
D
C
A
A
H
R
G


TERTIARY – RECENT BASALT VOLCANICS
M
D
C
A
A
H
R
NG

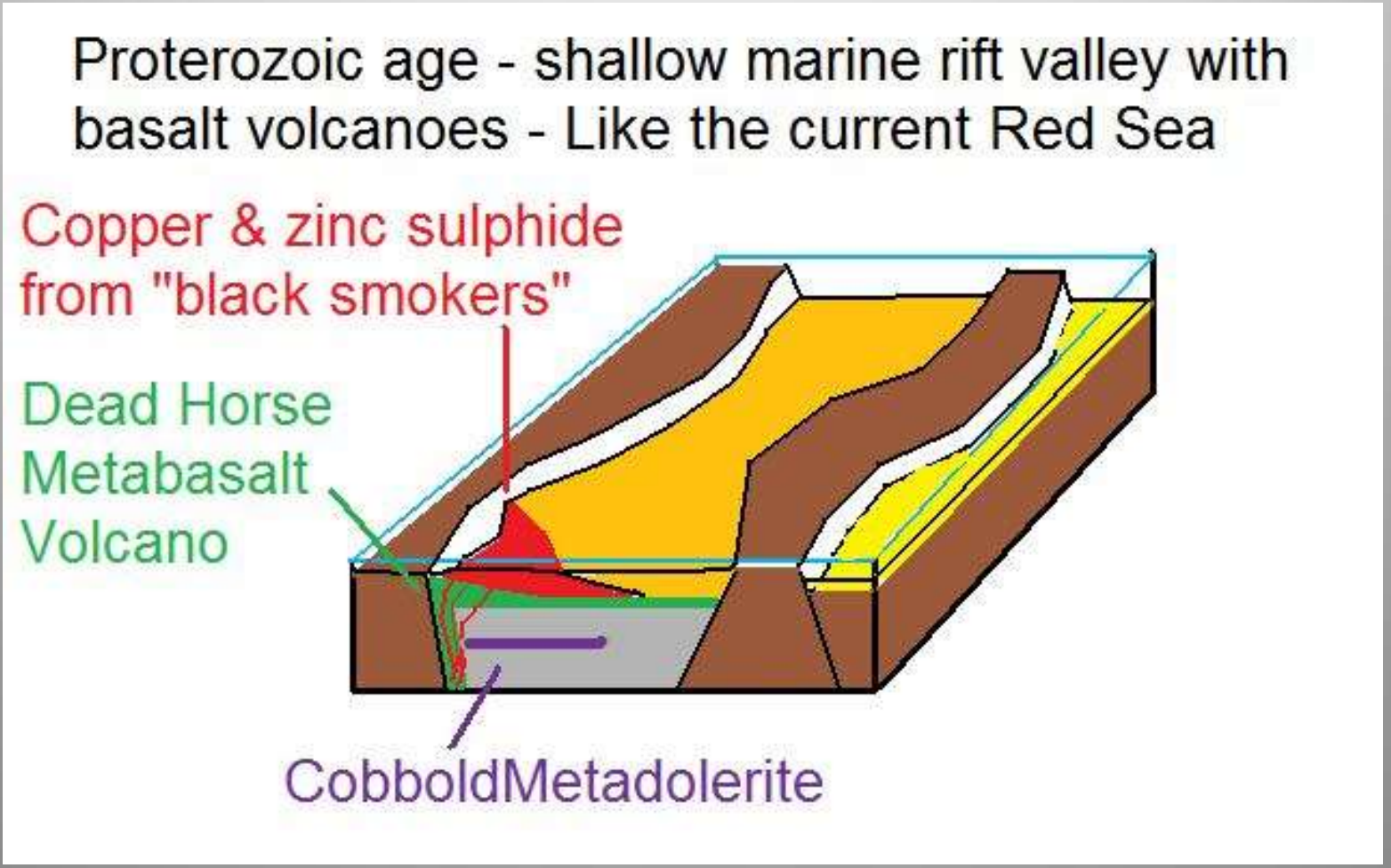
PROCESSES of the PROTEROZOIC


PRECAMBRIAN
METAMORPHIC ROCKS
C
D
M
M
A
A
H
R
G

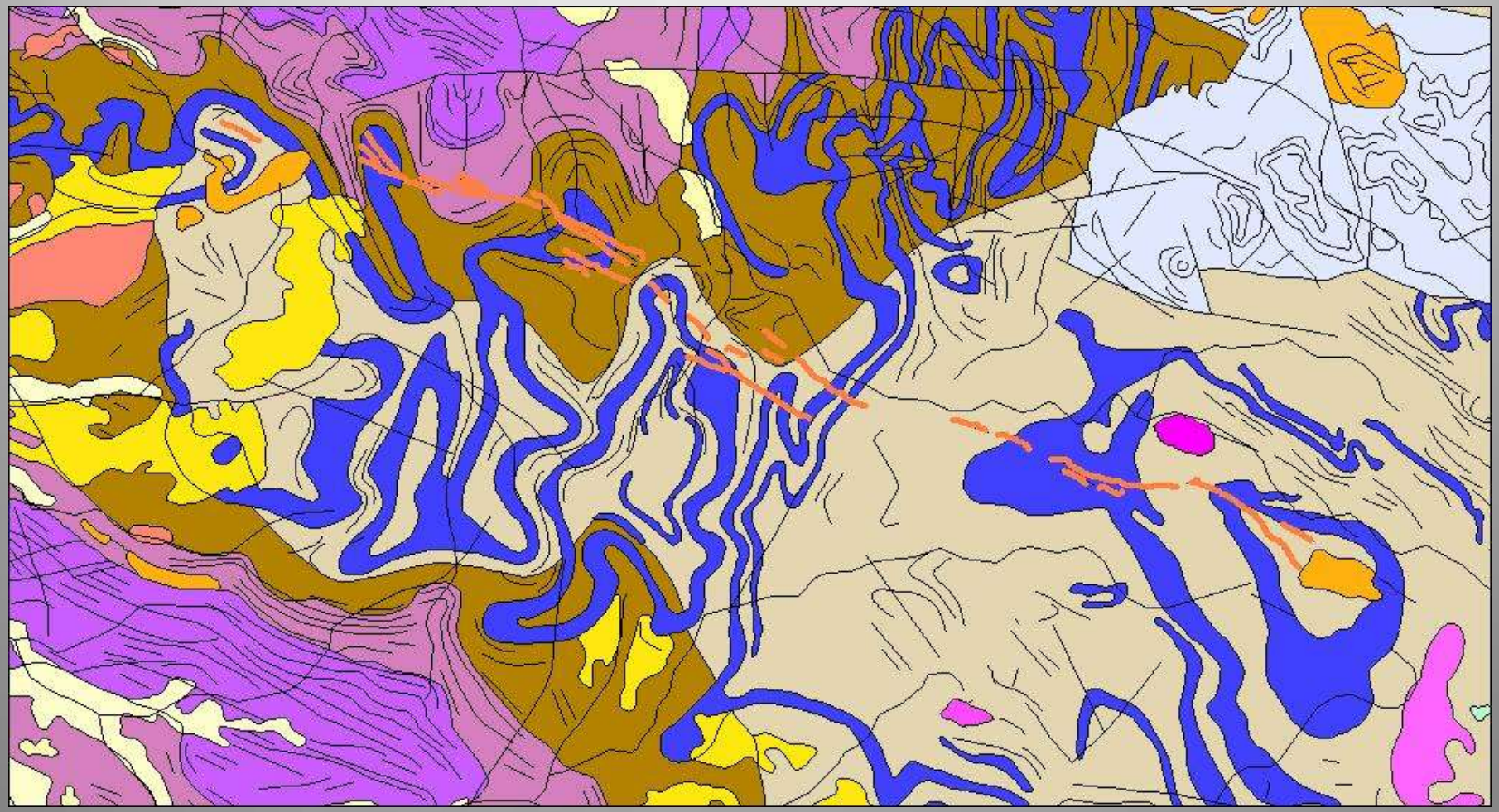
DESCRIBE USING SCHEMATIC BLOCK MODELS & VERTICAL SLICE SECTIONS

See Chillagoe hub display for detail of Block Models

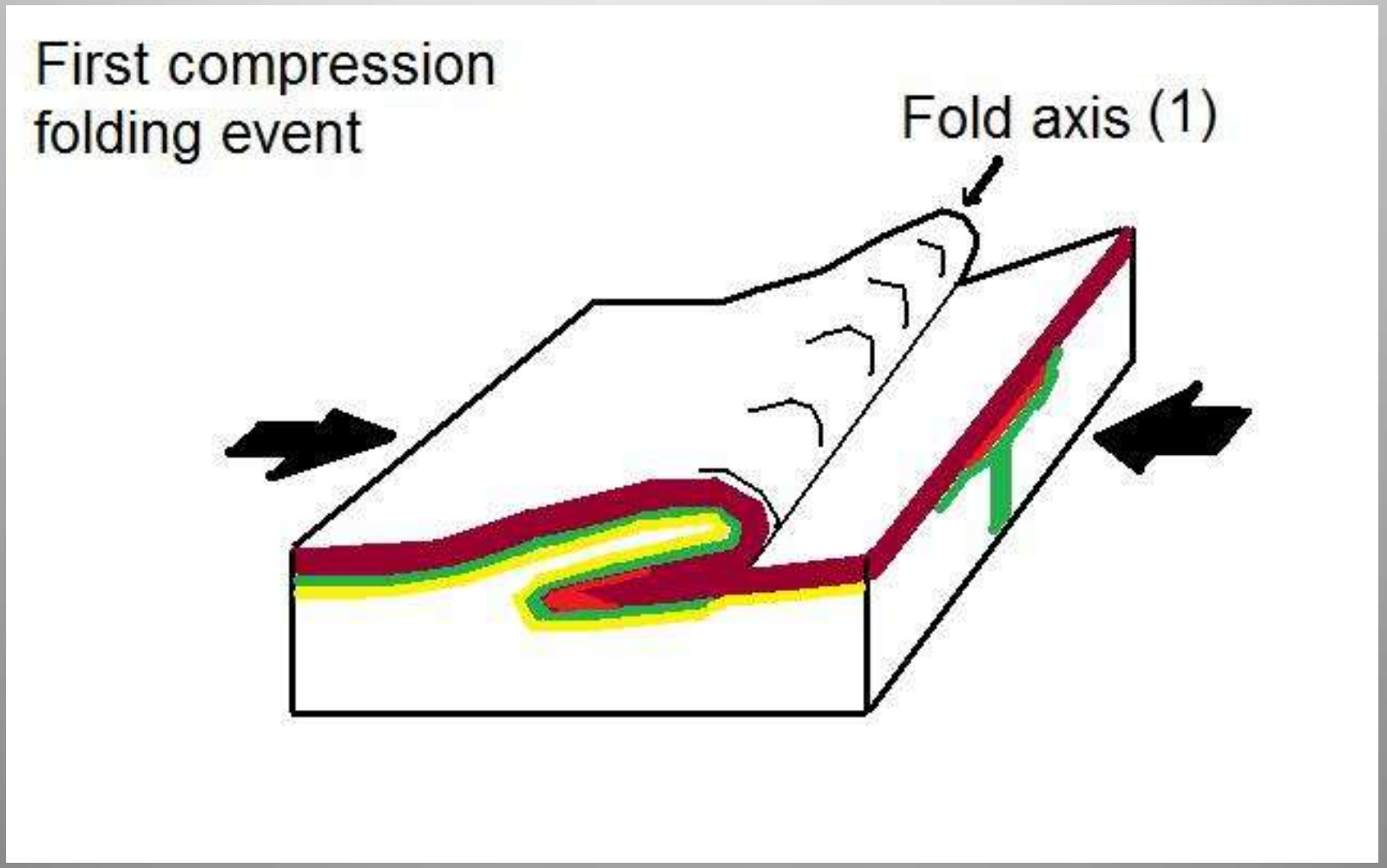
Georgetown Block rocks 1800My – equivalent age, composition & deposit process to Broken Hill & Mt Isa Blocks



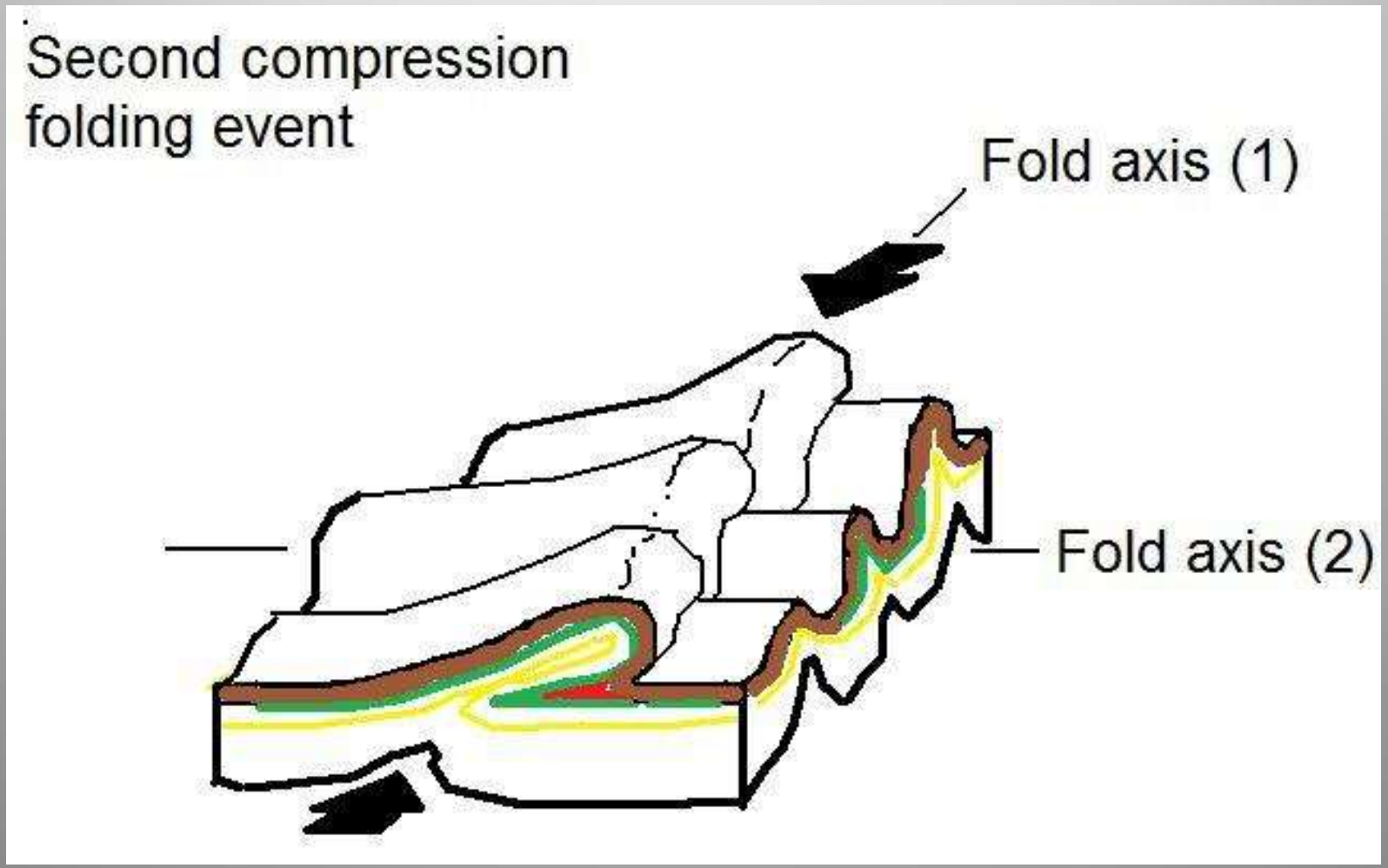
Complex folded pattern of metamorphic rocks – Shallow marine sediments with basalt / dolerite volcanic flows and intrusions



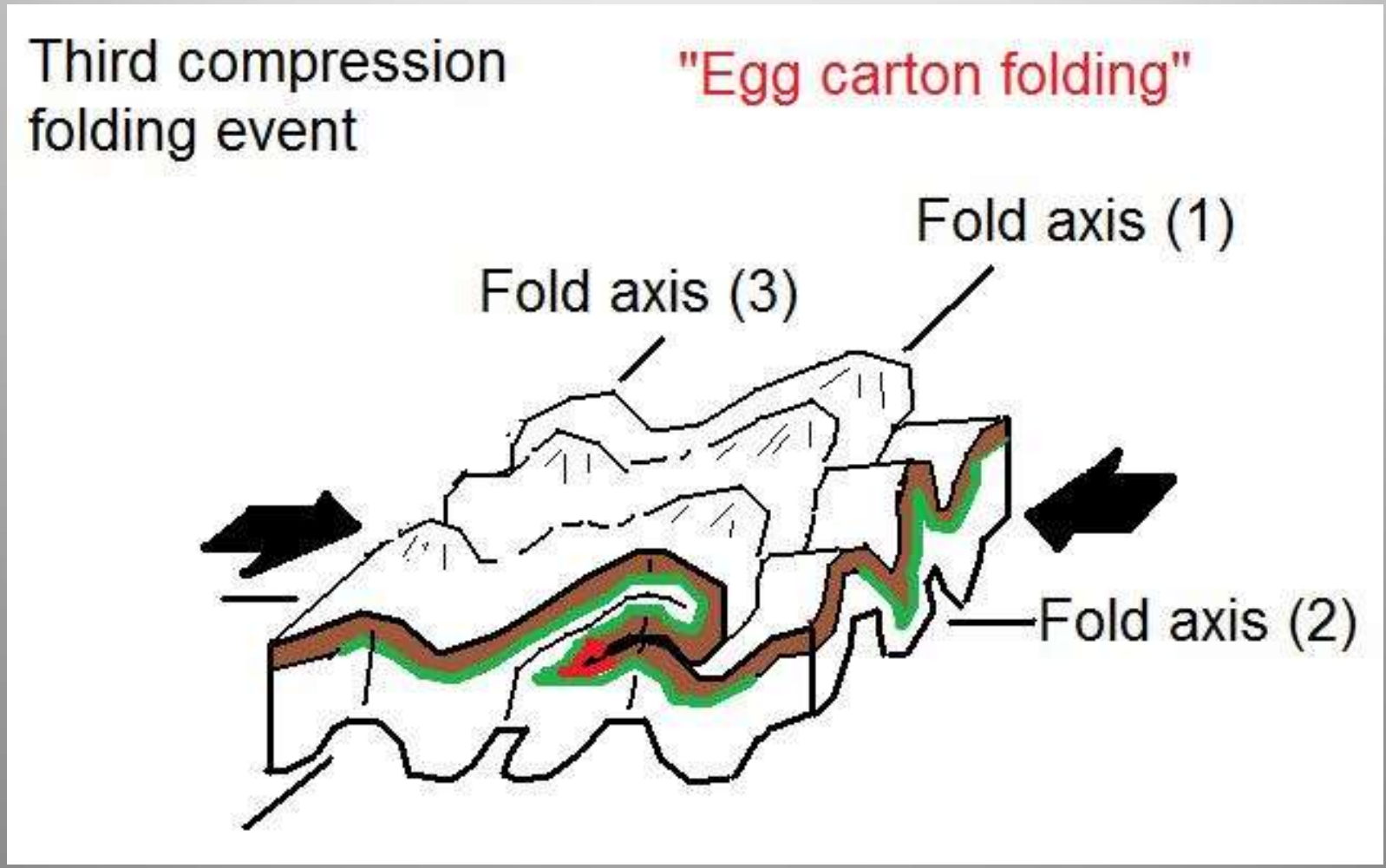
Deeply buried & metamorphosed. Event 1 - E to W compression with horizontal nappes

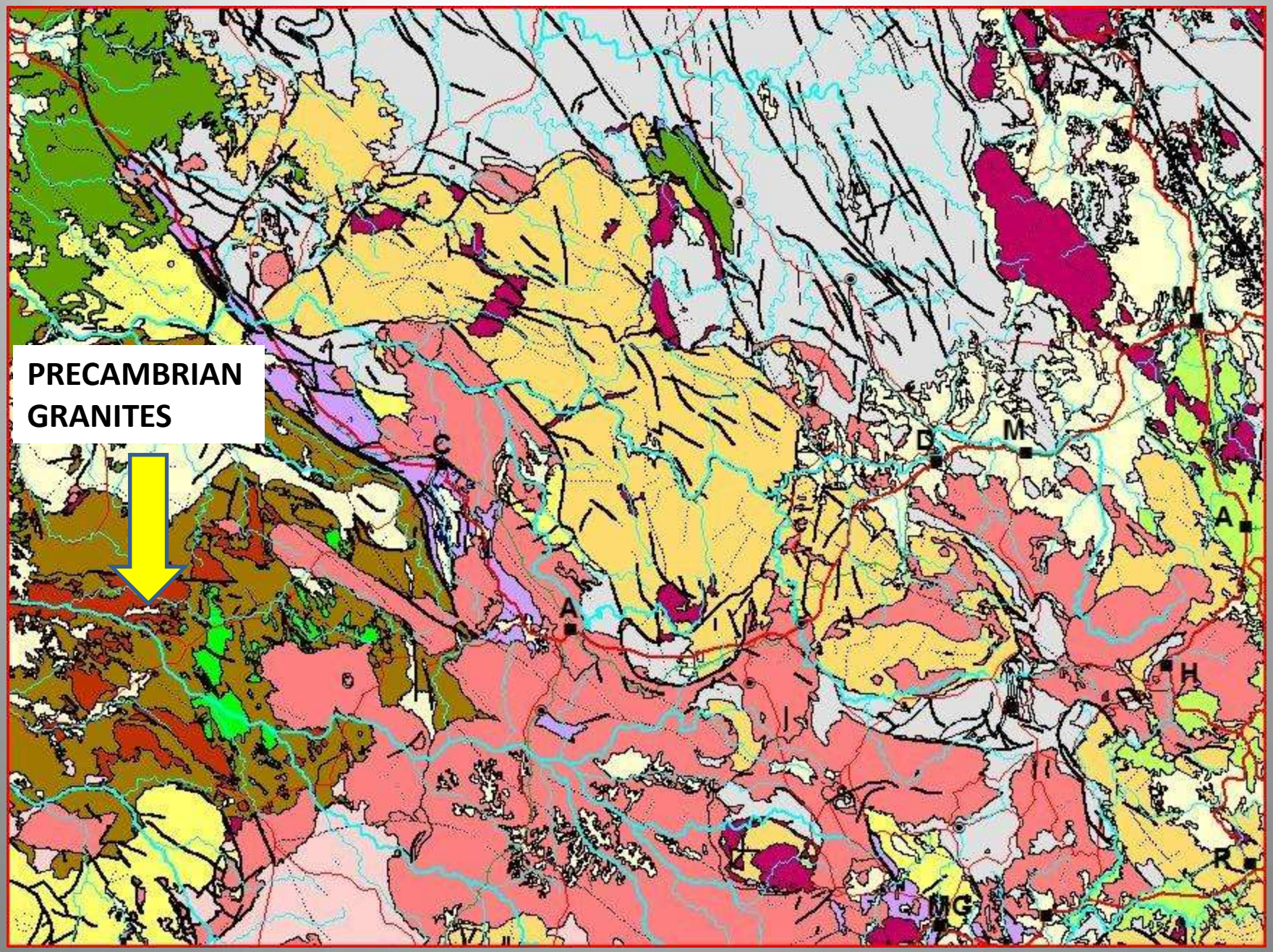


Event 2 – N to S compression produces East-trending fold axes



Folding Event 3 – E to W compression producing complex fold pattern




PRECAMBRIAN
GRANITES
C
D
M
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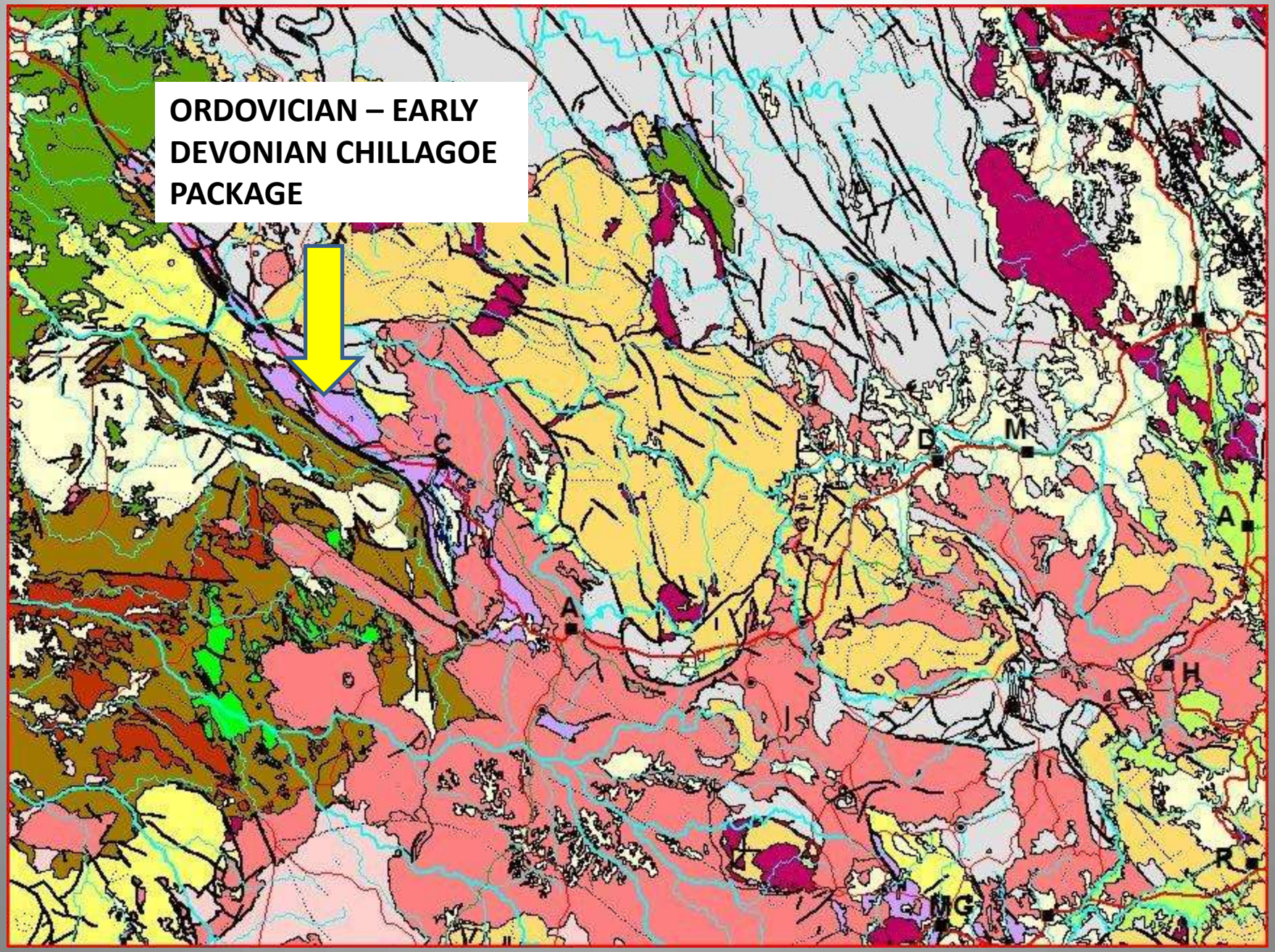
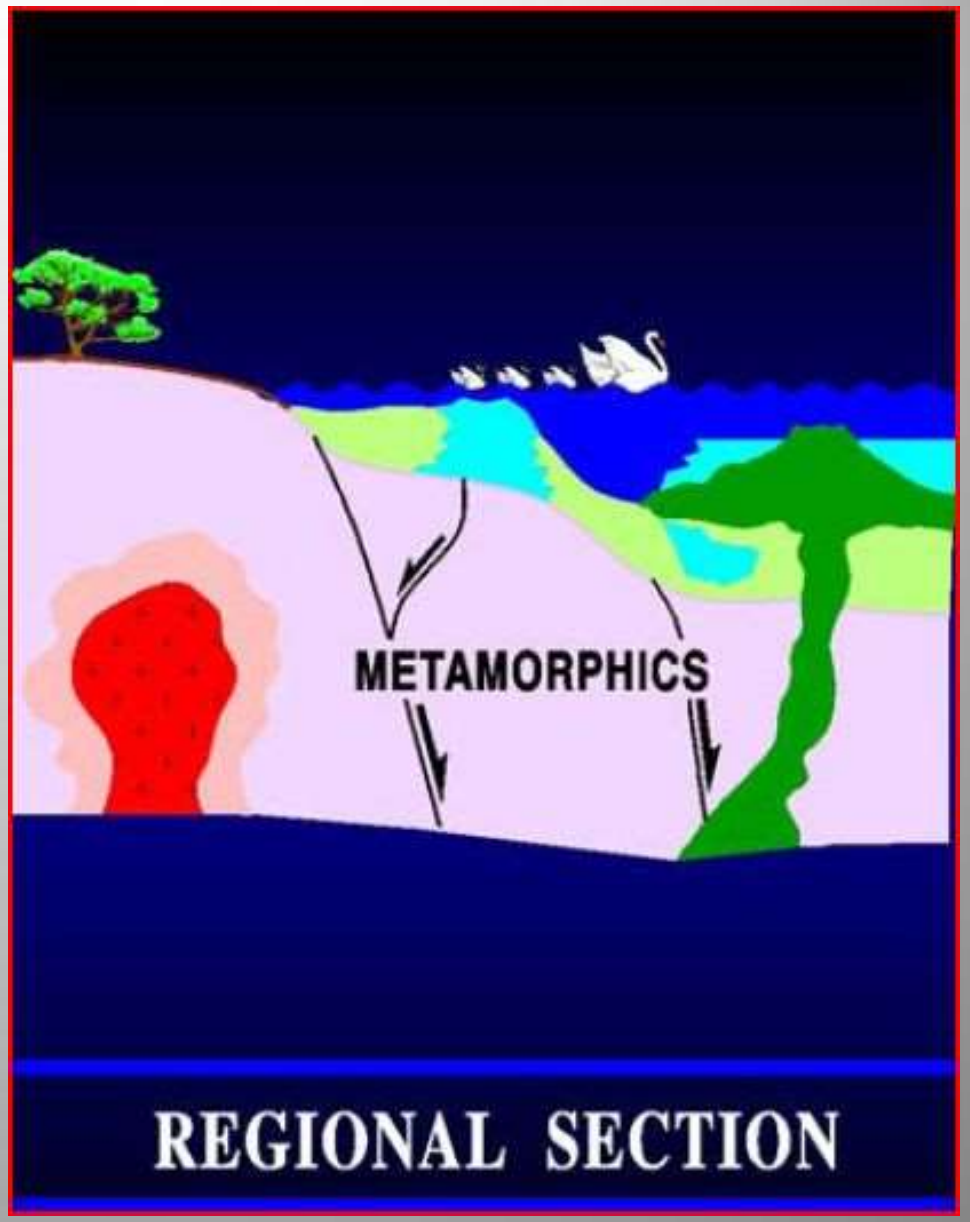
PROCESSES of the PALAEOZOIC


ORDOVICIAN – EARLY DEVONIAN CHILLAGOE PACKAGE
C
A
D
M
M
A
H
R
G


Barron River Metamorphics
Palmerville
Hodgkinson Basin
Georgetown Block
Chillagoe
Mt Garnet
Greenvale
Charters Towers
Anakie Block
Mt Coolon
Drummond Basin
N
Carboniferous to Permian igneous & volcanic rocks
Silurian to Early Carboniferous
Cambrian to Ordovician
Proterozoic lower grade rocks
Proterozoic high grade rocks
MARINE RIFT VALLEY OPENING
ORDOVICIAN - MID DEVONIAN
(470 - 370 Million Years)
SINISTRAL TRANSTENSION

VERTICAL SECTION OF THE PERIOD 470Ma TO 370mA Ordovician to Early Devonian

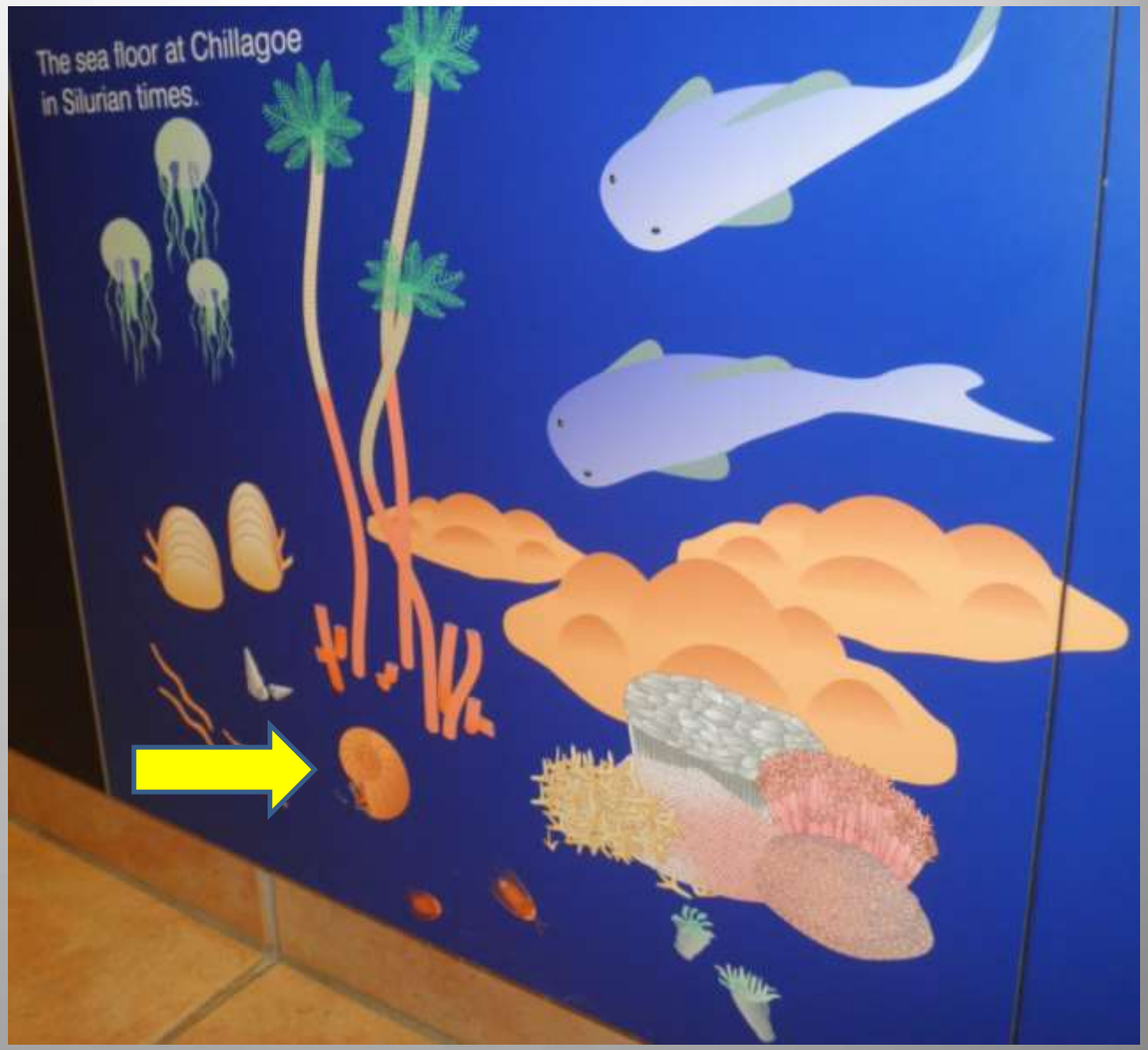


SILURIAN REEF SPECIES

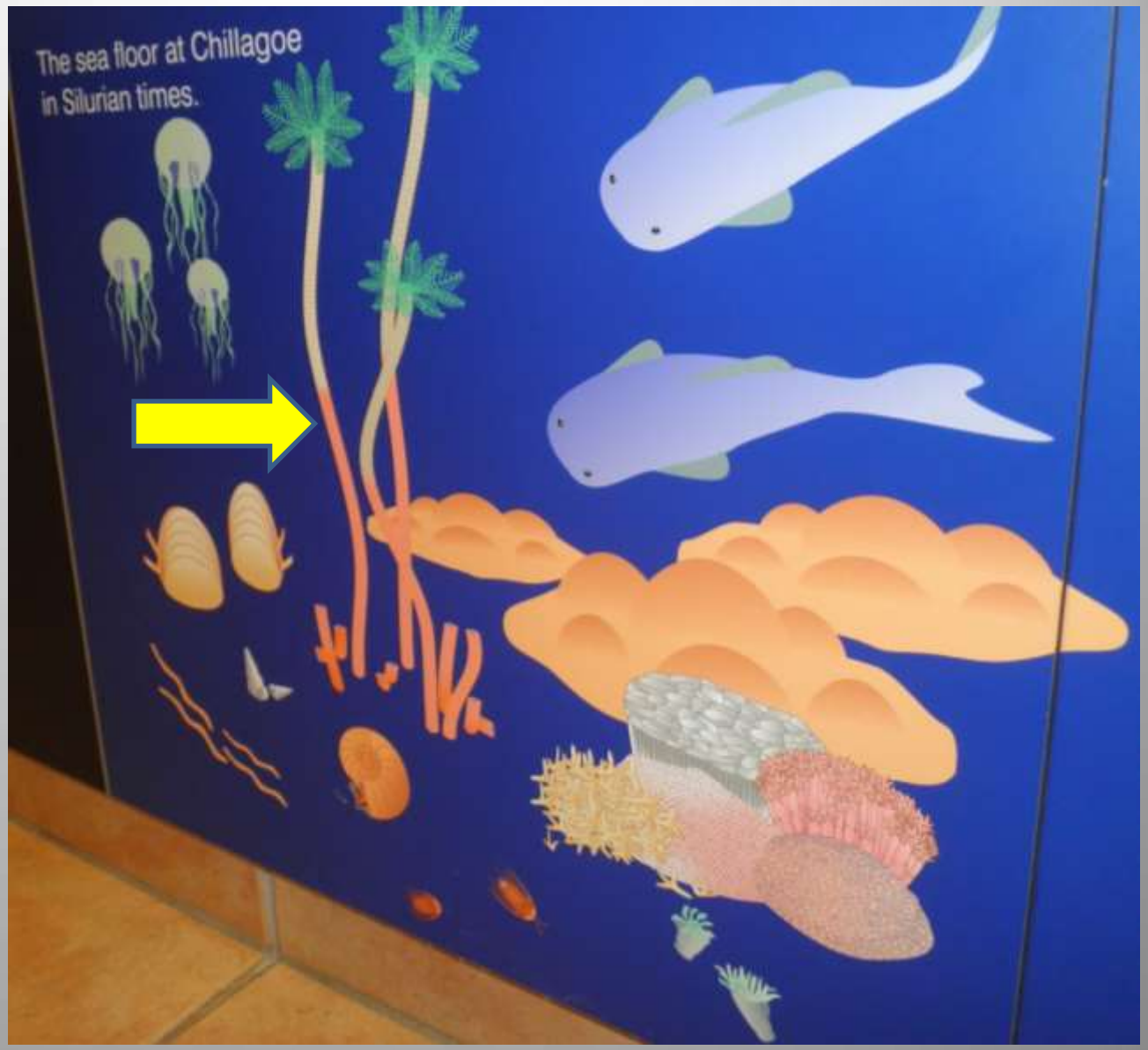
CORALS
Colonial
&
Solitary

Brachiopod (Bivalve)

Gastropod

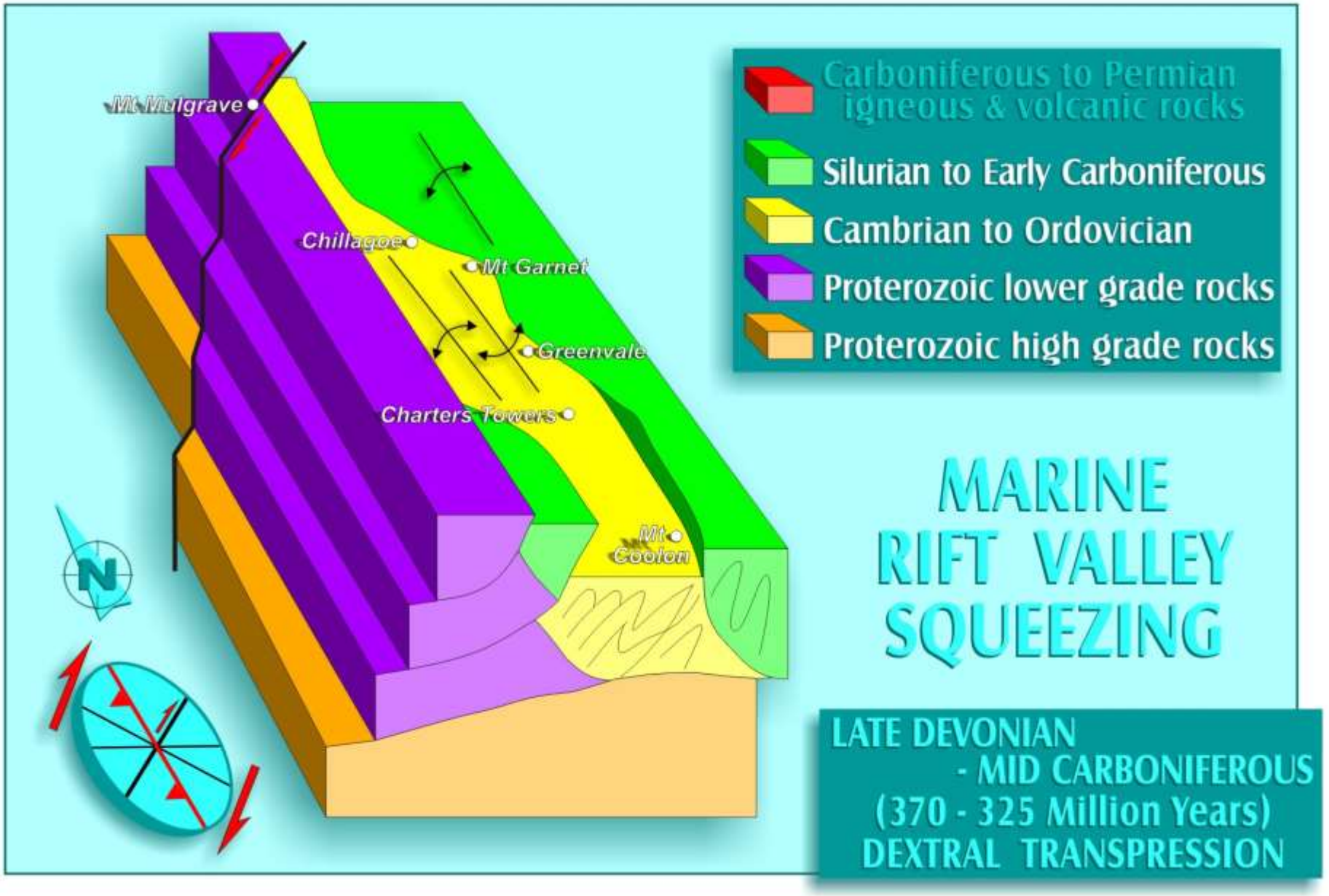


CRINOIDS

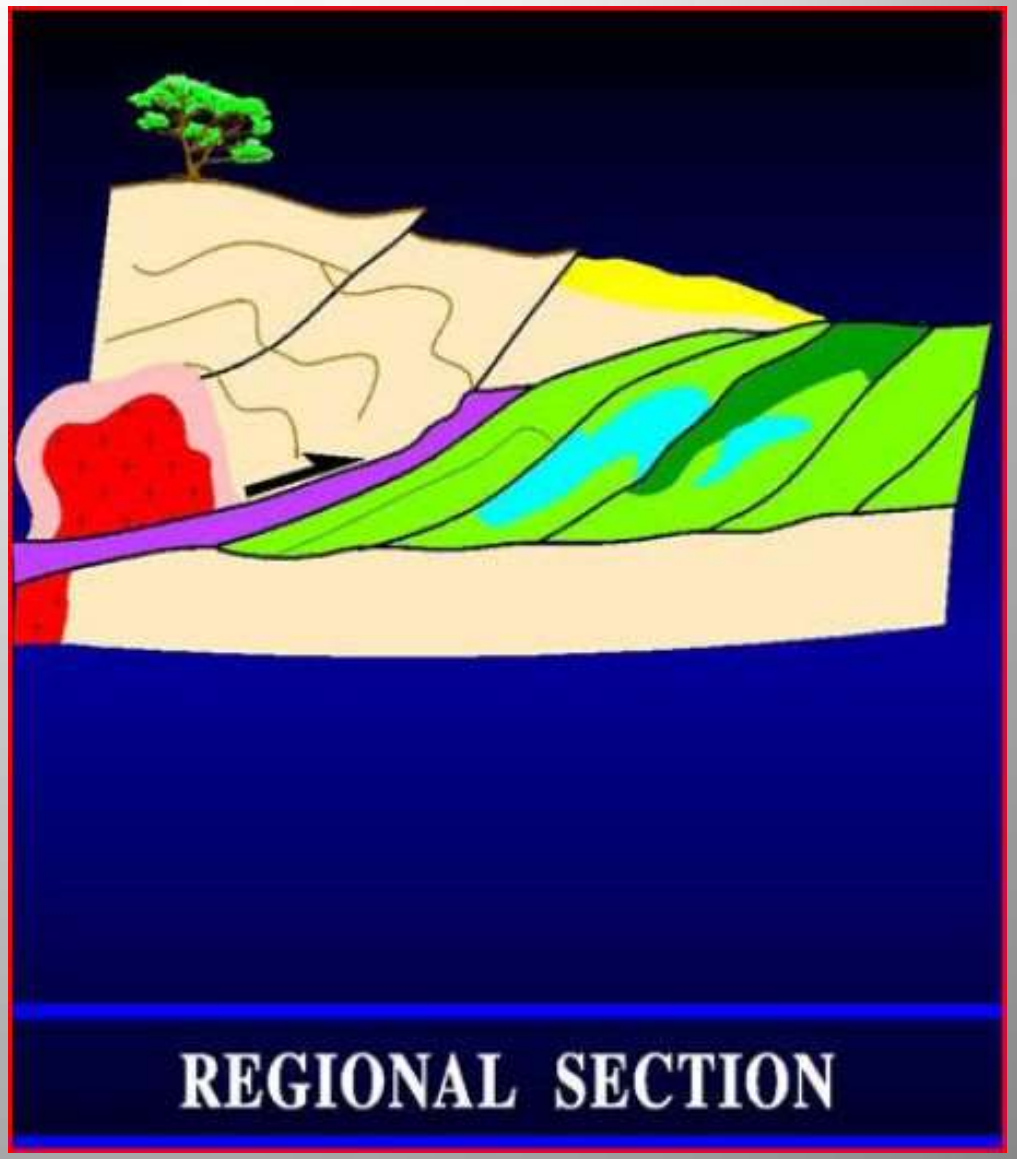


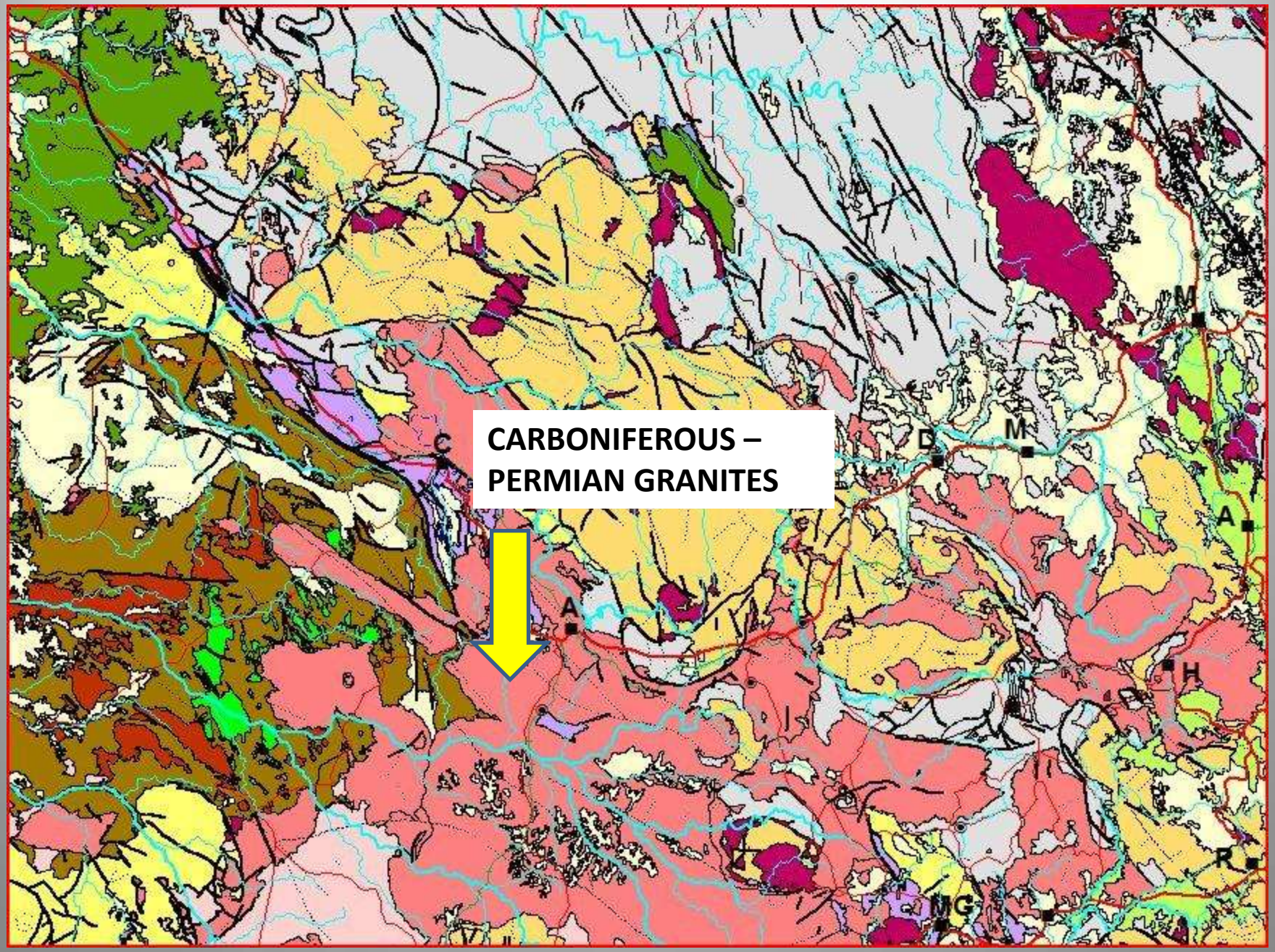
Solitary coral

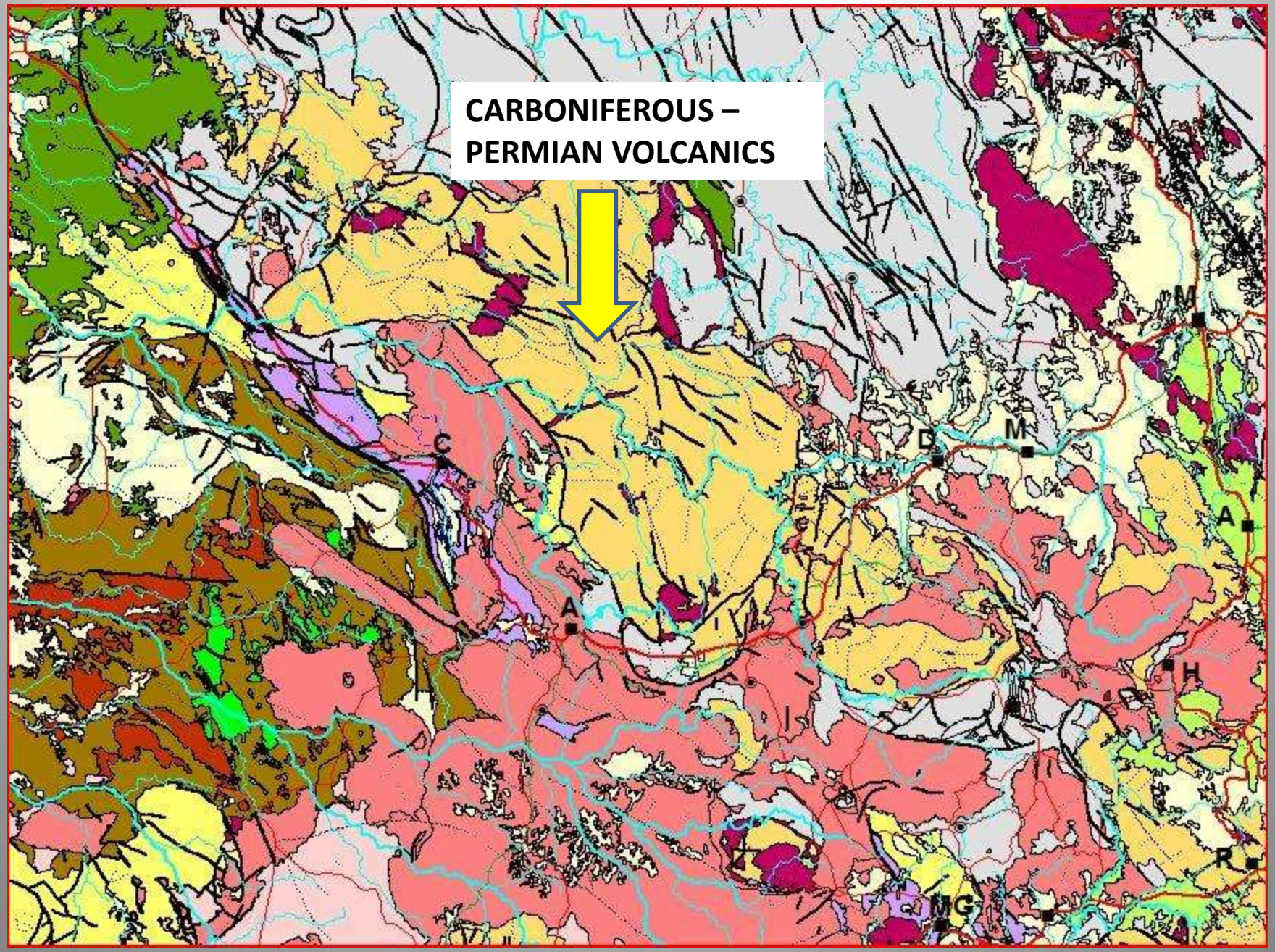
Colonial Coral


Carboniferous to Permian igneous & volcanic rocks
Silurian to Early Carboniferous
Cambrian to Ordovician
Proterozoic lower grade rocks
Proterozoic high grade rocks
Mt Mulgrave
Chillagoe
Mt Garnet
Greenvale
Charters Towers
Mt Coolon
N
MARINE RIFT VALLEY SQUEEZING
LATE DEVONIAN - MID CARBONIFEROUS
(370 - 325 Million Years)
DEXTRAL TRANSPRESSION

VERTICAL SECTION OF THE PERIOD 370Ma TO 325mA Late Devonian to Early Carboniferous

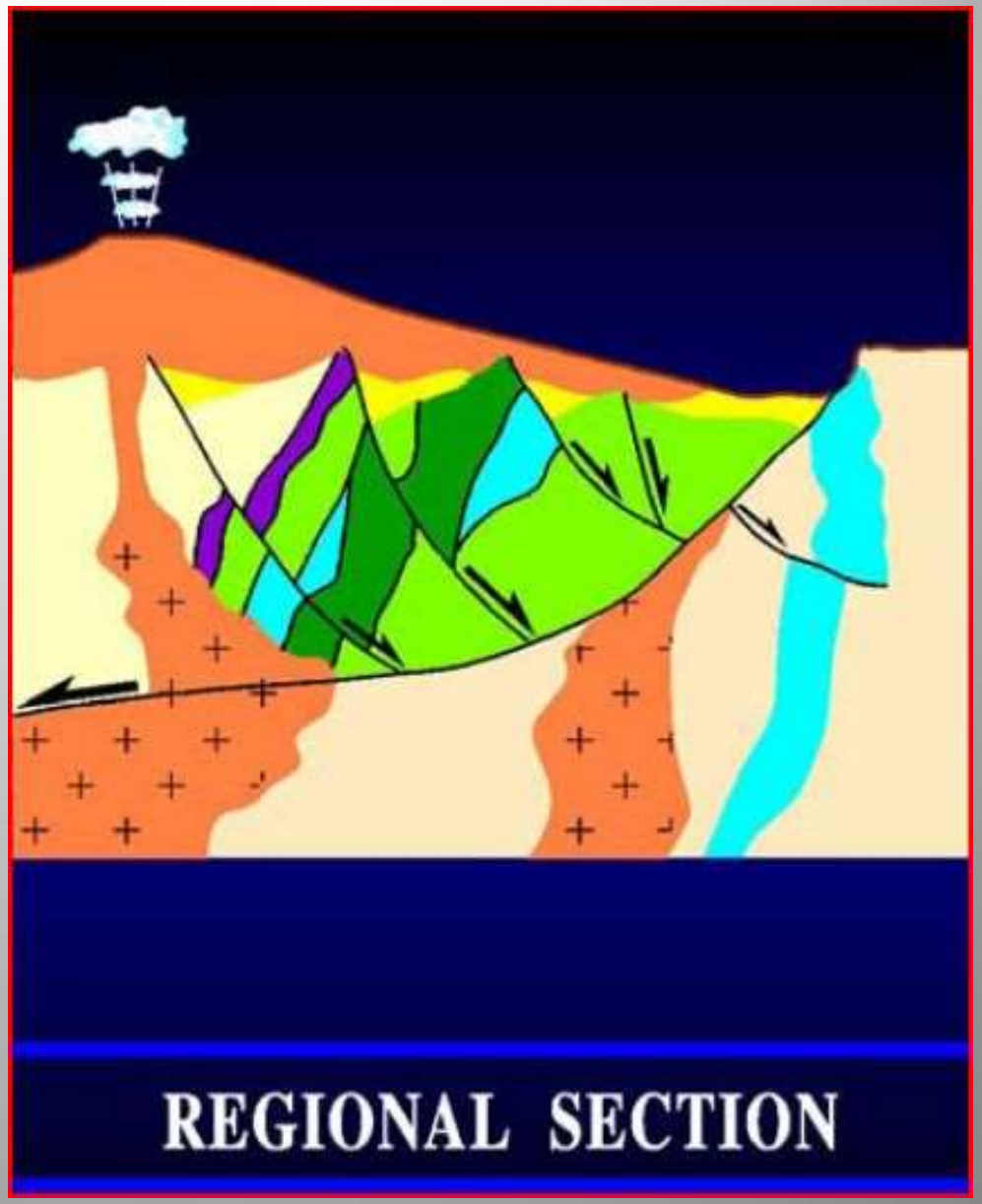


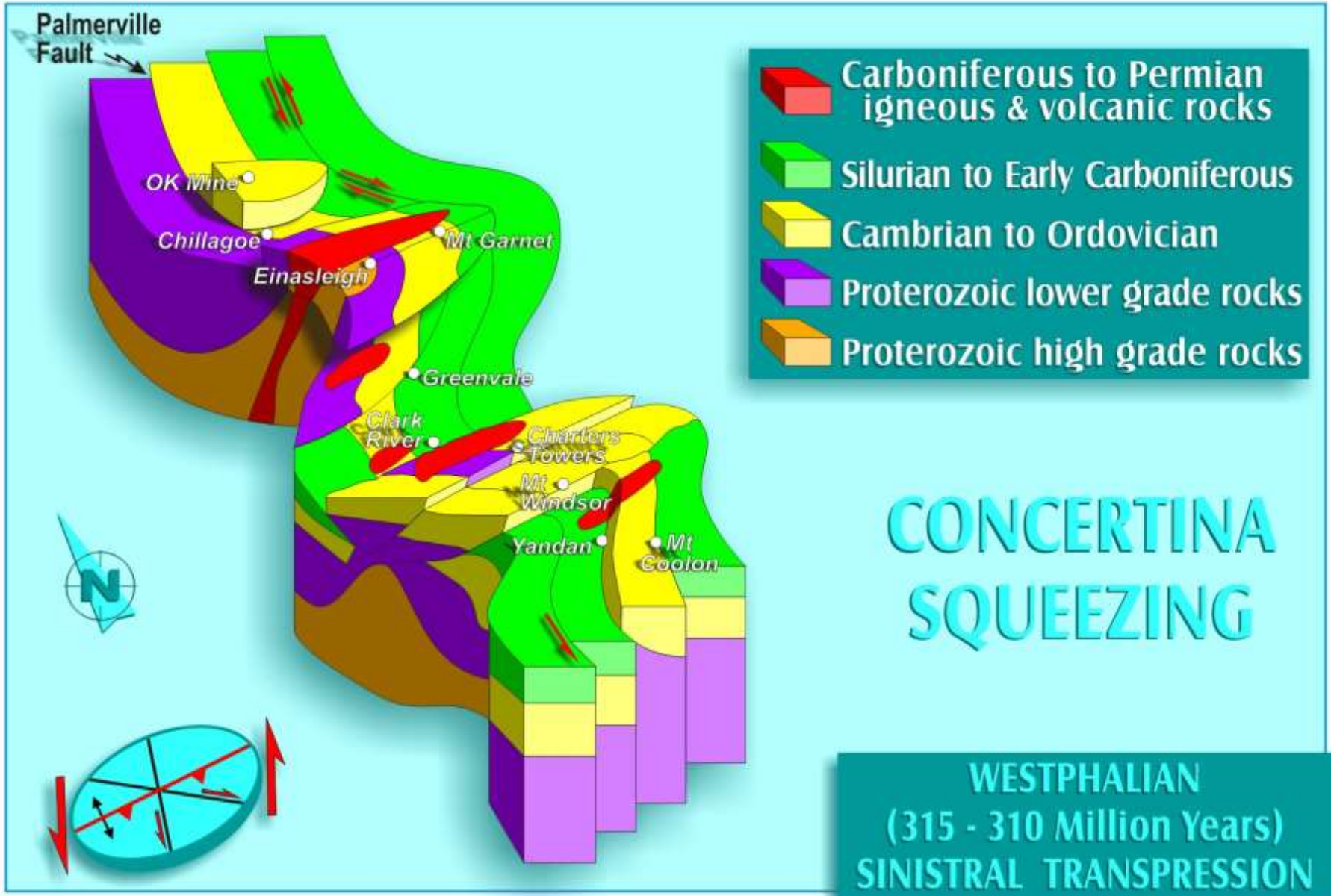

CARBONIFEROUS –
PERMIAN GRANITES
C
D
M
M
A
A
H
R
G


CARBONIFEROUS –
PERMIAN VOLCANICS
C
D
M
M
A
A
H
R
NG

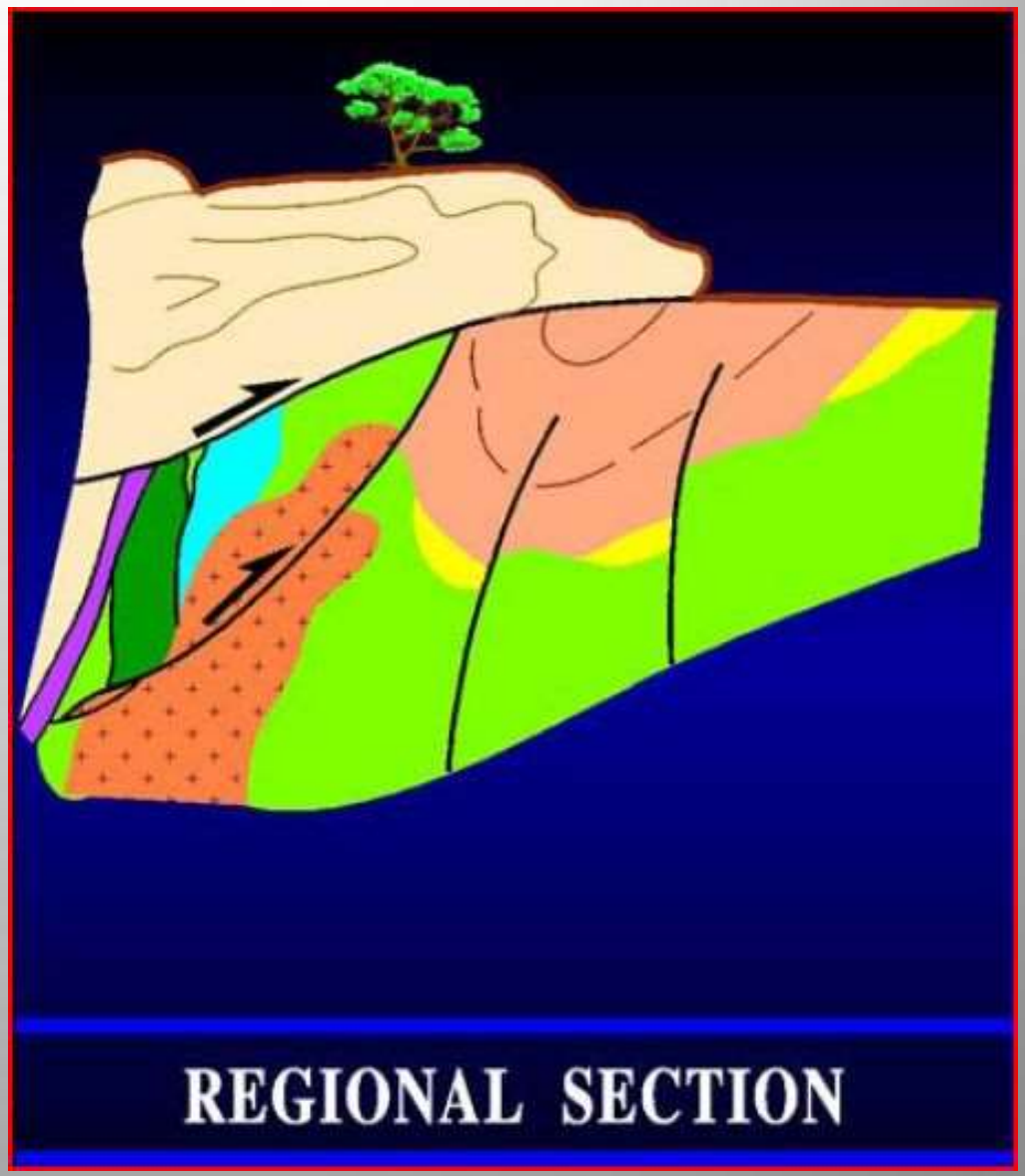

Carboniferous to Permian igneous & volcanic rocks
Silurian to Early Carboniferous
Cambrian to Ordovician
Proterozoic lower grade rocks
Proterozoic high grade rocks
N
EXTENSION, MAGMA RISE & VOLCANOES
NAMURIAN
(325 - 315 Million Years)
STRESS LULL

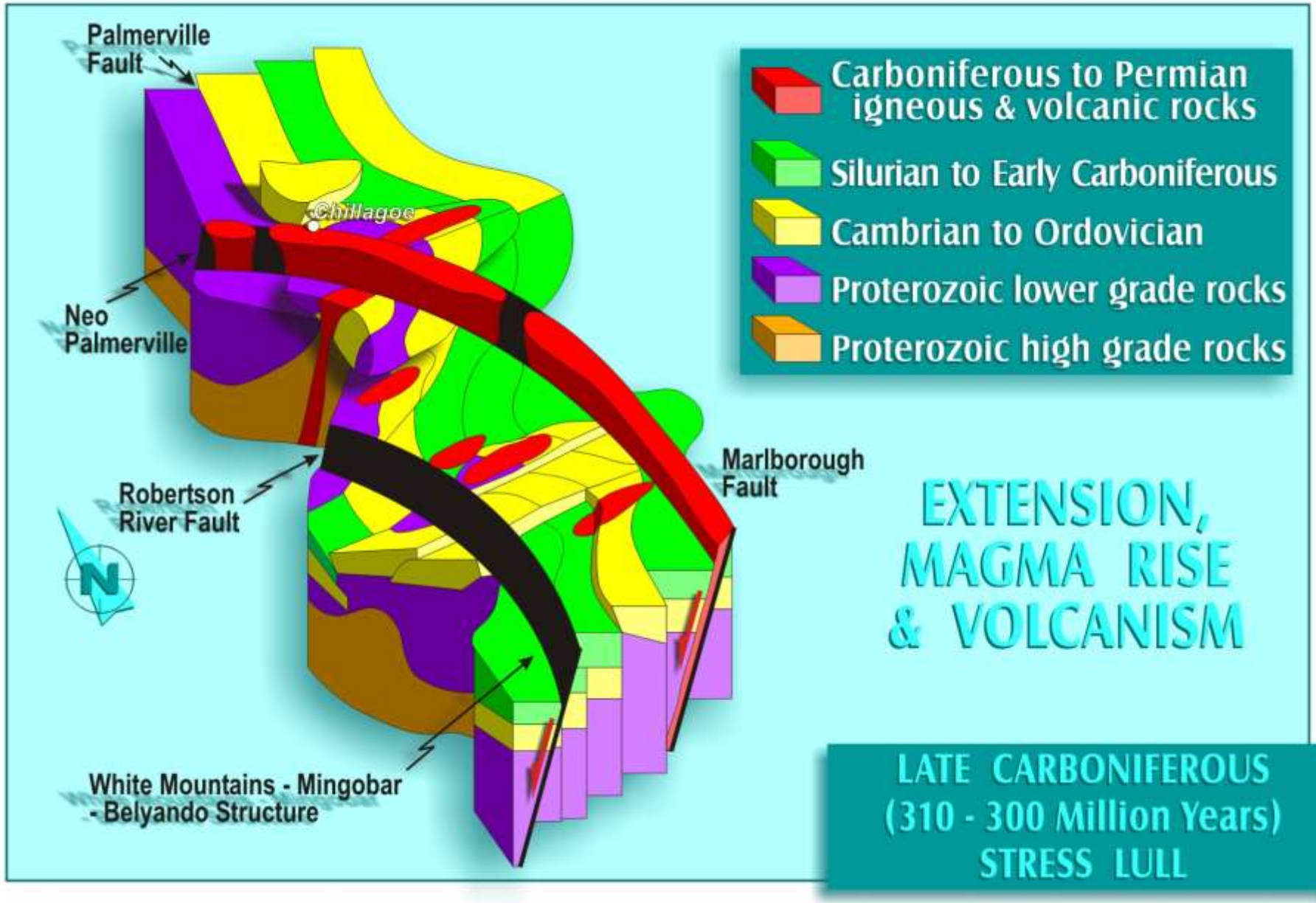
VERTICAL SECTION OF THE PERIOD 325Ma TO 315mA Namurian



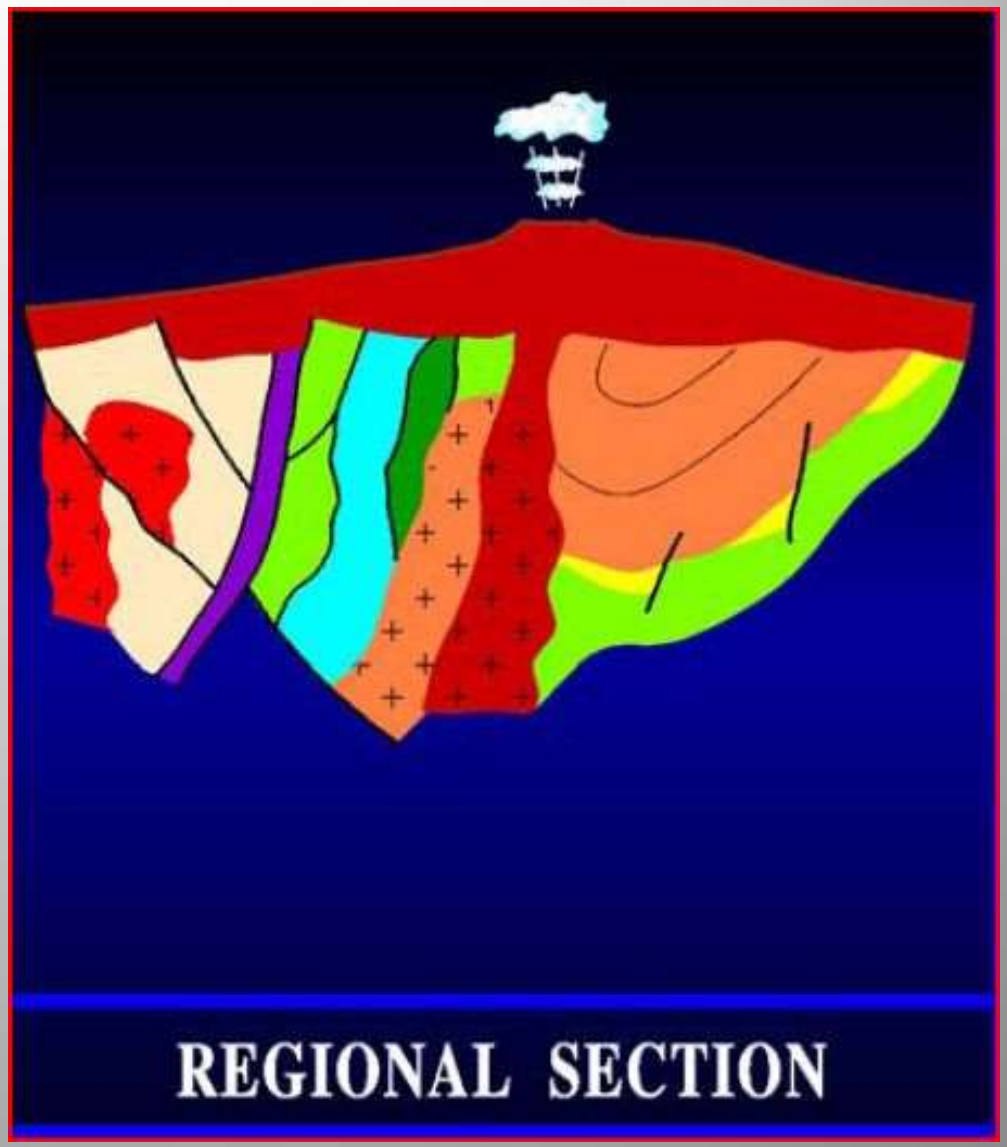

Palmerville Fault
OK Mine
Chillagoe
Einasleigh
Mt Garnet
Greenvale
Clark River
Charters Towers
Mt Windsor
Yandan
Mt Coolon
N
Carboniferous to Permian igneous & volcanic rocks
Silurian to Early Carboniferous
Cambrian to Ordovician
Proterozoic lower grade rocks
Proterozoic high grade rocks
CONCERTINA SQUEEZING
WESTPHALIAN
(315 - 310 Million Years)
SINISTRAL TRANSPRESSION

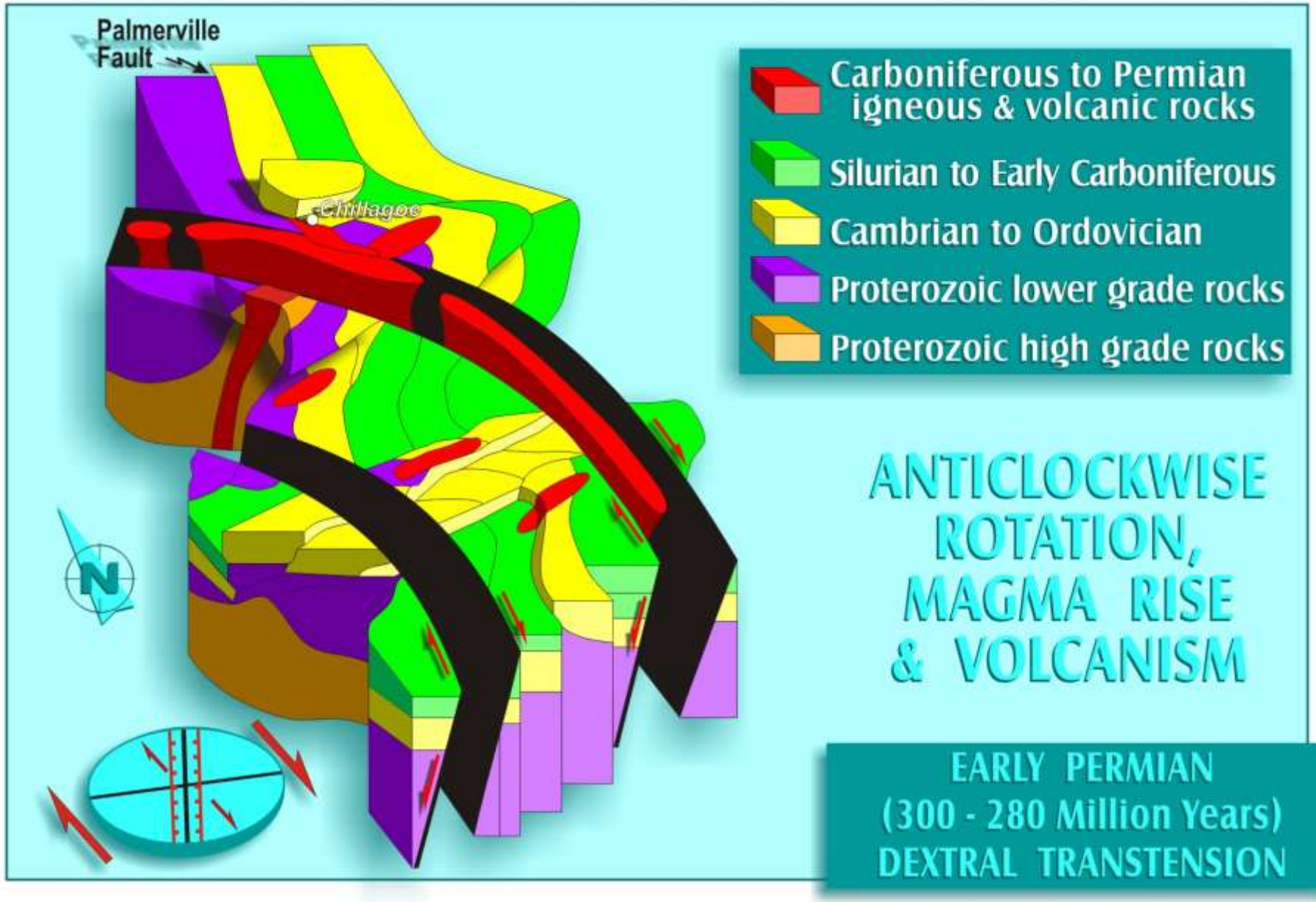
VERTICAL SECTION OF THE PERIOD 315Ma TO 310mA Westphalian



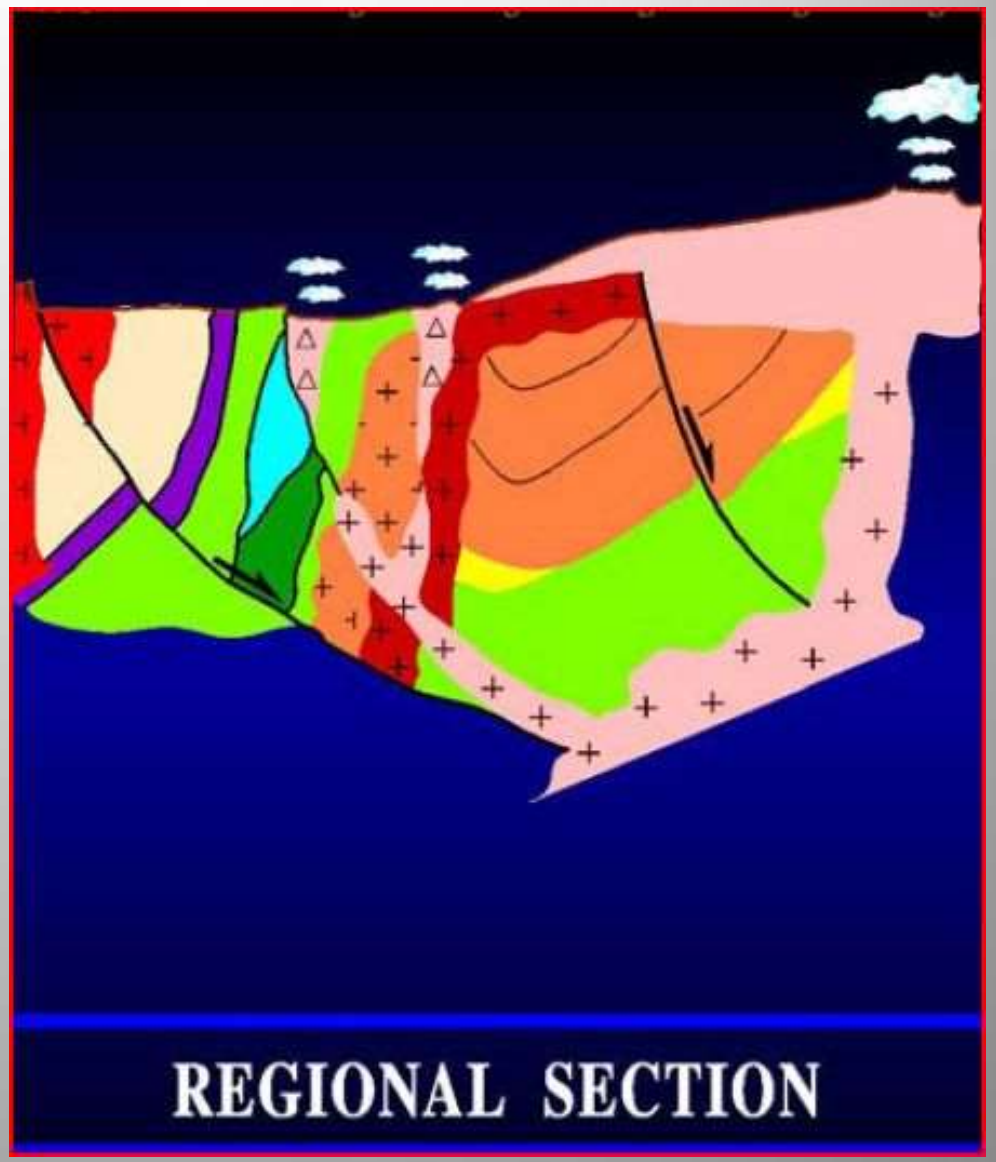

Palmerville Fault
Chillagoe
Neo Palmerville
Robertson River Fault
Marlborough Fault
White Mountains - Mingobar - Belyando Structure
N
Carboniferous to Permian igneous & volcanic rocks
Silurian to Early Carboniferous
Cambrian to Ordovician
Proterozoic lower grade rocks
Proterozoic high grade rocks
EXTENSION, MAGMA RISE & VOLCANISM
LATE CARBONIFEROUS (310 - 300 Million Years) STRESS LULL

VERTICAL SECTION OF THE PERIOD 310Ma TO 305mA Late Carboniferous




Palmerville Fault
Chillagoe
N
Carboniferous to Permian igneous & volcanic rocks
Silurian to Early Carboniferous
Cambrian to Ordovician
Proterozoic lower grade rocks
Proterozoic high grade rocks
ANTICLOCKWISE ROTATION, MAGMA RISE & VOLCANISM
EARLY PERMIAN
(300 - 280 Million Years)
DEXTRAL TRANSTENSION

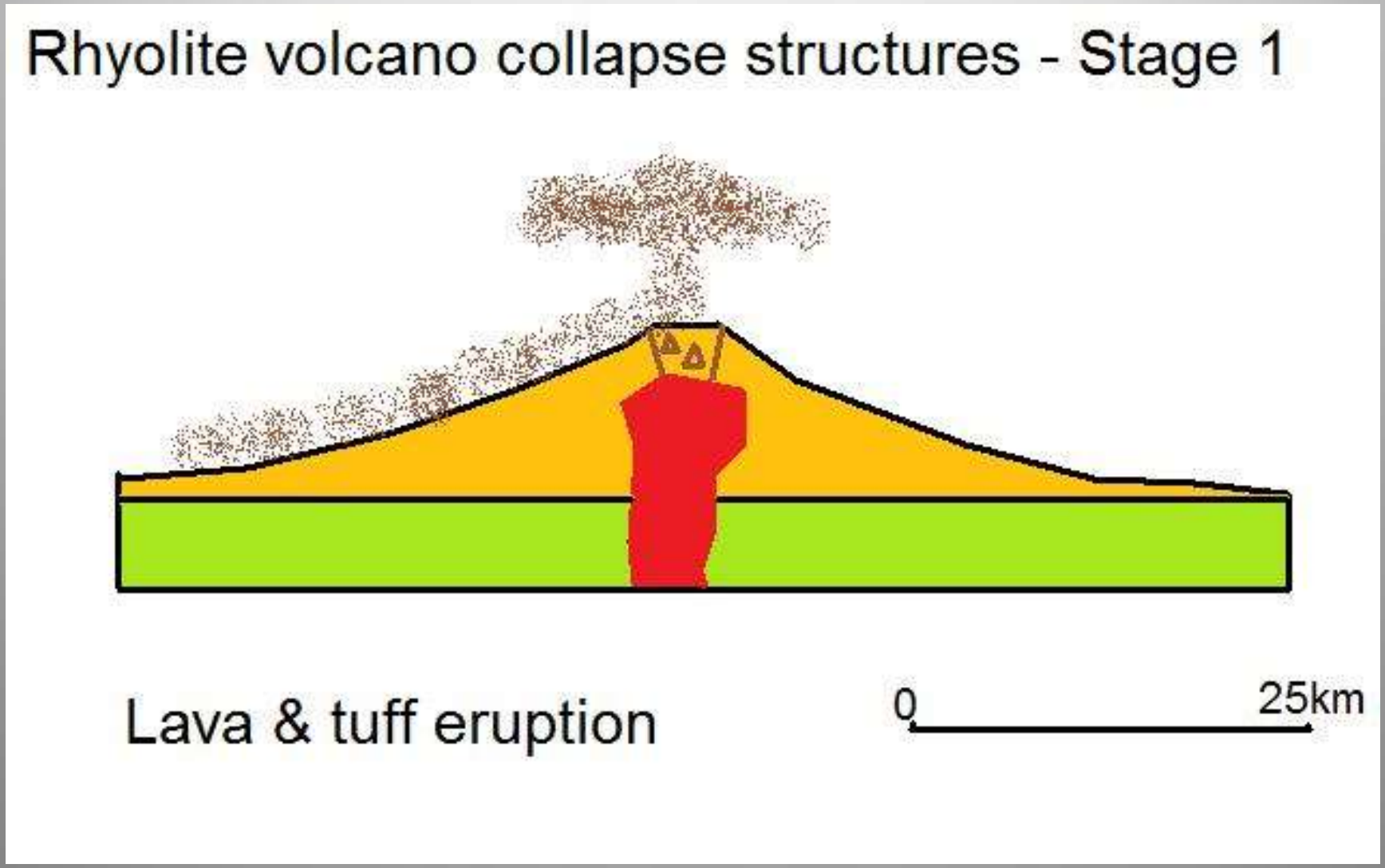
VERTICAL SECTION OF THE PERIOD 305Ma TO 280mA Early Permian



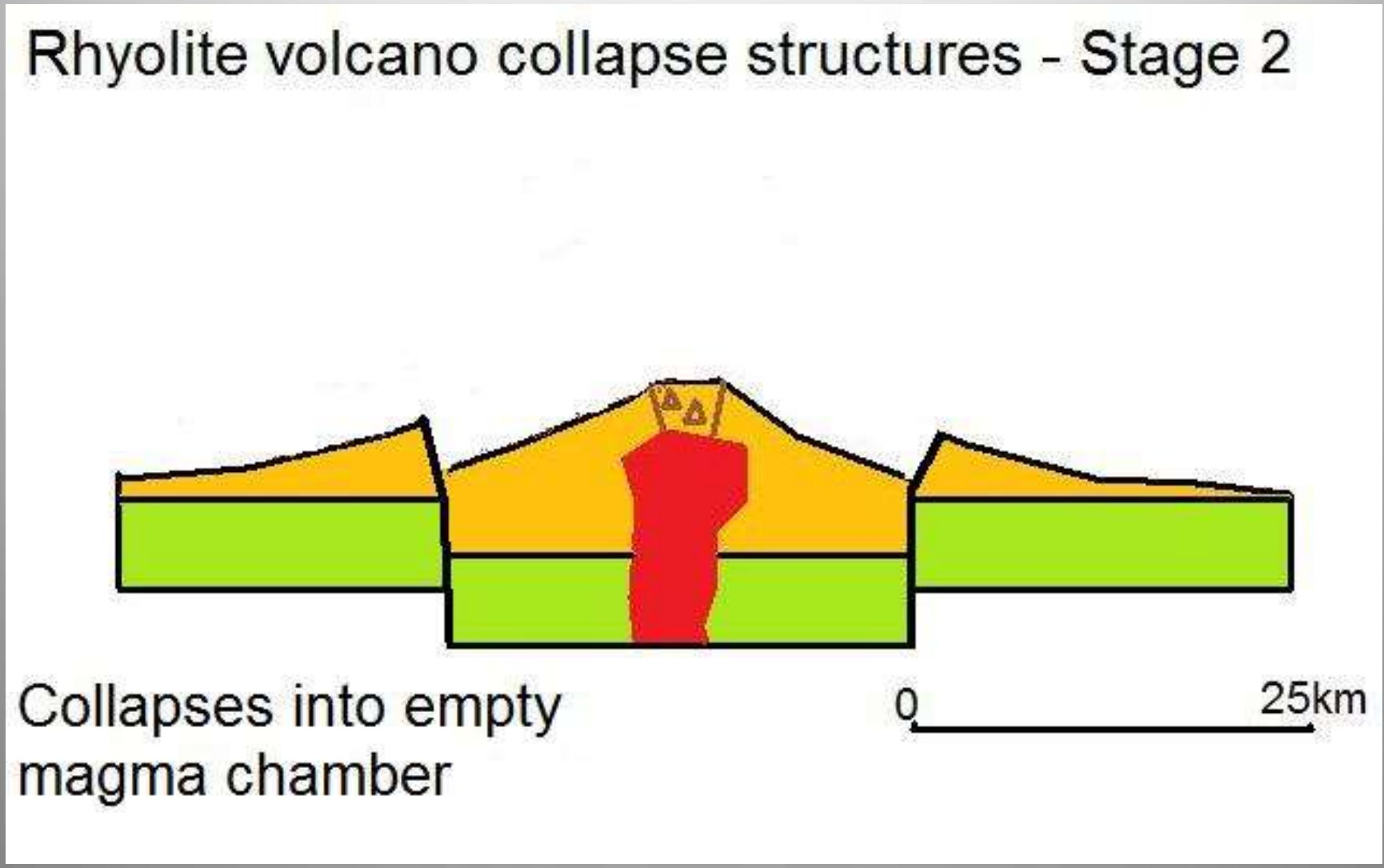
Carboniferous – Permian Volcanic topography

- Sub-circular *calderas*
- Linking collapse rifts trending north
- Dark green in south is capping of Cretaceous basin sediments

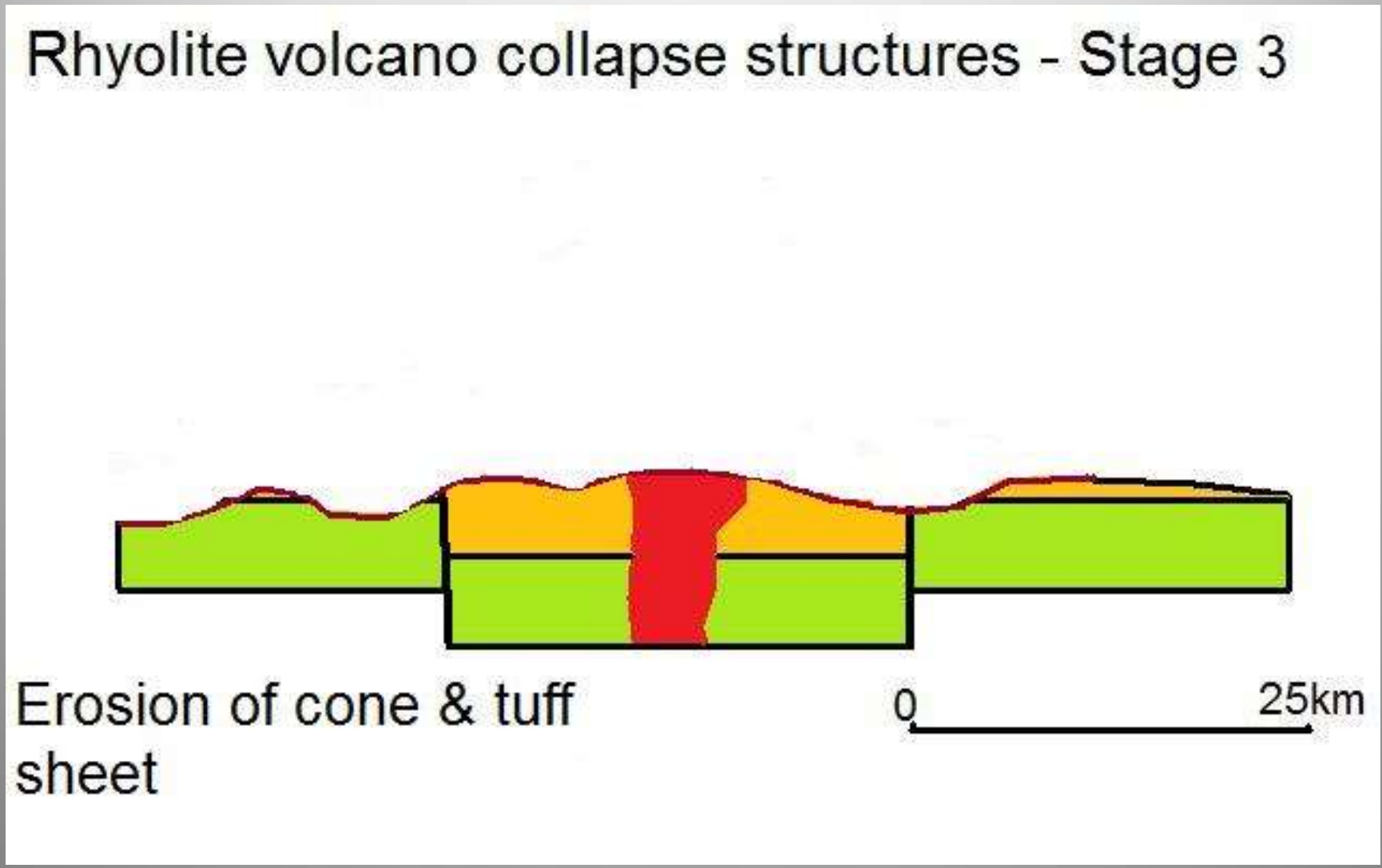
Volcanic rock covered much greater area – remnants are the *calderas*



Caldera collapse follows magma eruption



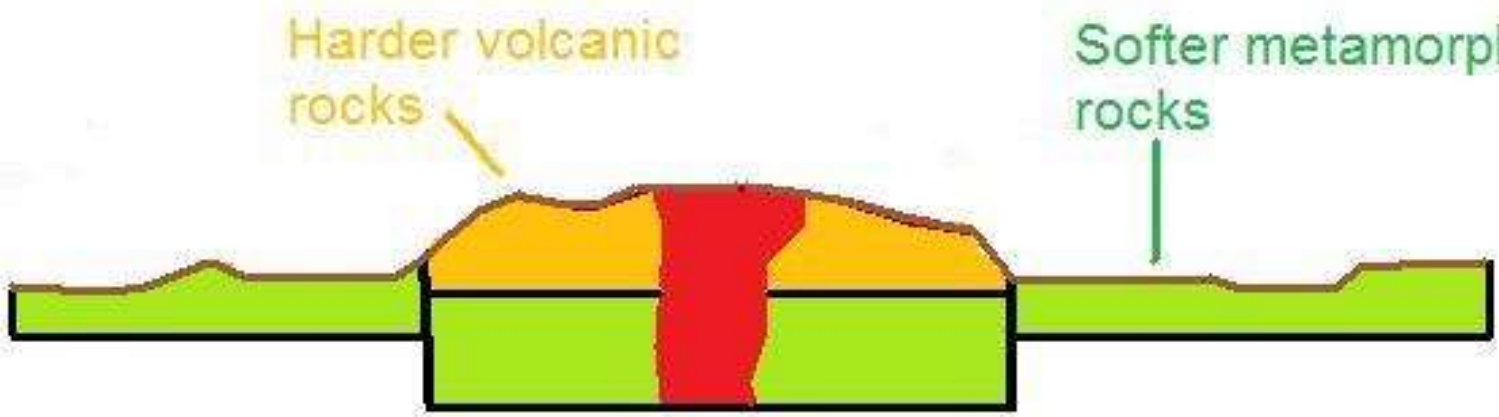
Long term erosion strips the volcanic edifice



Calderas now remain as positive topography

Rhyolite volcano collapse structures - Stage 4

e.g Newcastle Range



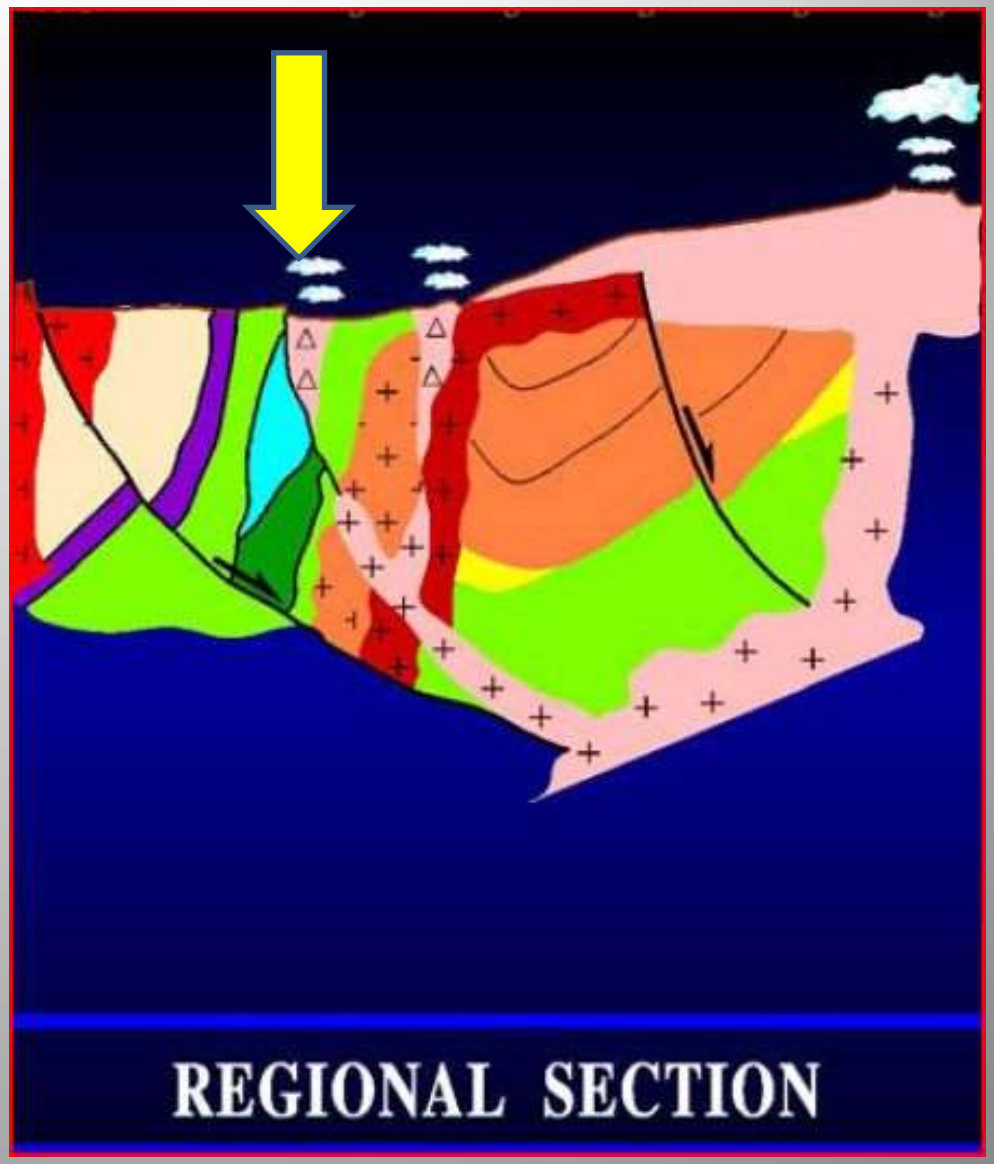
Topographic reversal

Sub-Circular calderas are preserved

Early Permian Karst-related breccias:

- Collapse breccia at Red Dome has geothermal eruption origin in limestone host rocks
- Acidic fluids in steaming mud-pots above sub-volcanic igneous intrusions
- Hydrothermal clay, fumerole tubes, layered sulphide deposits and sinters confirm this origin
- Current surface is same as 290 M years ago
- Age dating confirms the 290 M year date

The 1st stage of KARST was related to the acid hot spring & mudpots, preserved by a sheet of volcanics about 305Ma to 280mA



Mungana KARST fill in drillcore

Karst breccia in surface exposure

Acid hot spring & mudpots,

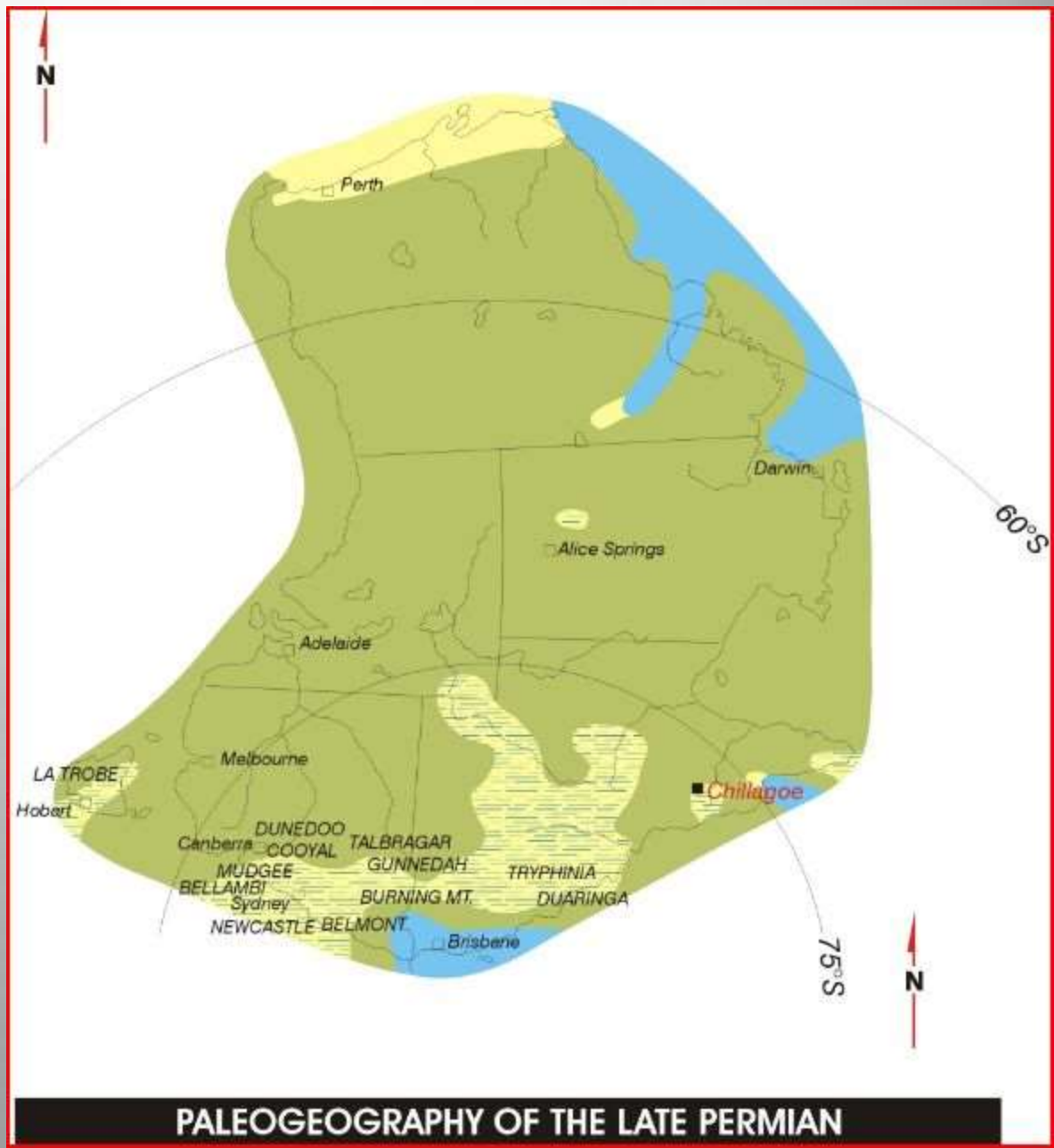
Fumerole tube

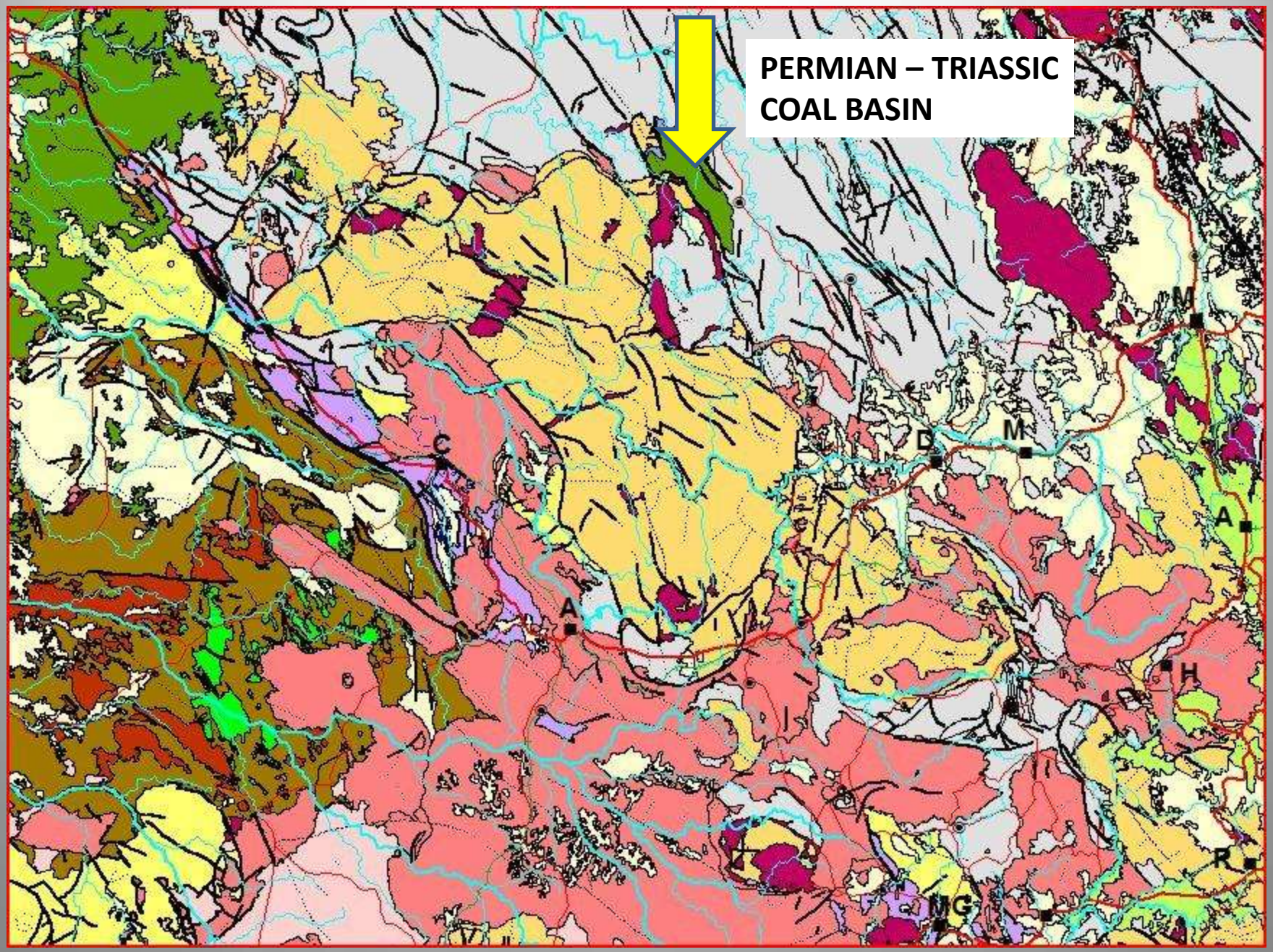
Brecciated & fluidised sinter

PROCESSES of the MESOZOIC

LATE PERMIAN – EARLY TRIASSIC

- South Pole still off Brisbane
- Orientation 90 degrees to current attitude
- Cold climate but warming
- Peat swamps extend along E coastal regions
- Peat buried and compressed to form coal



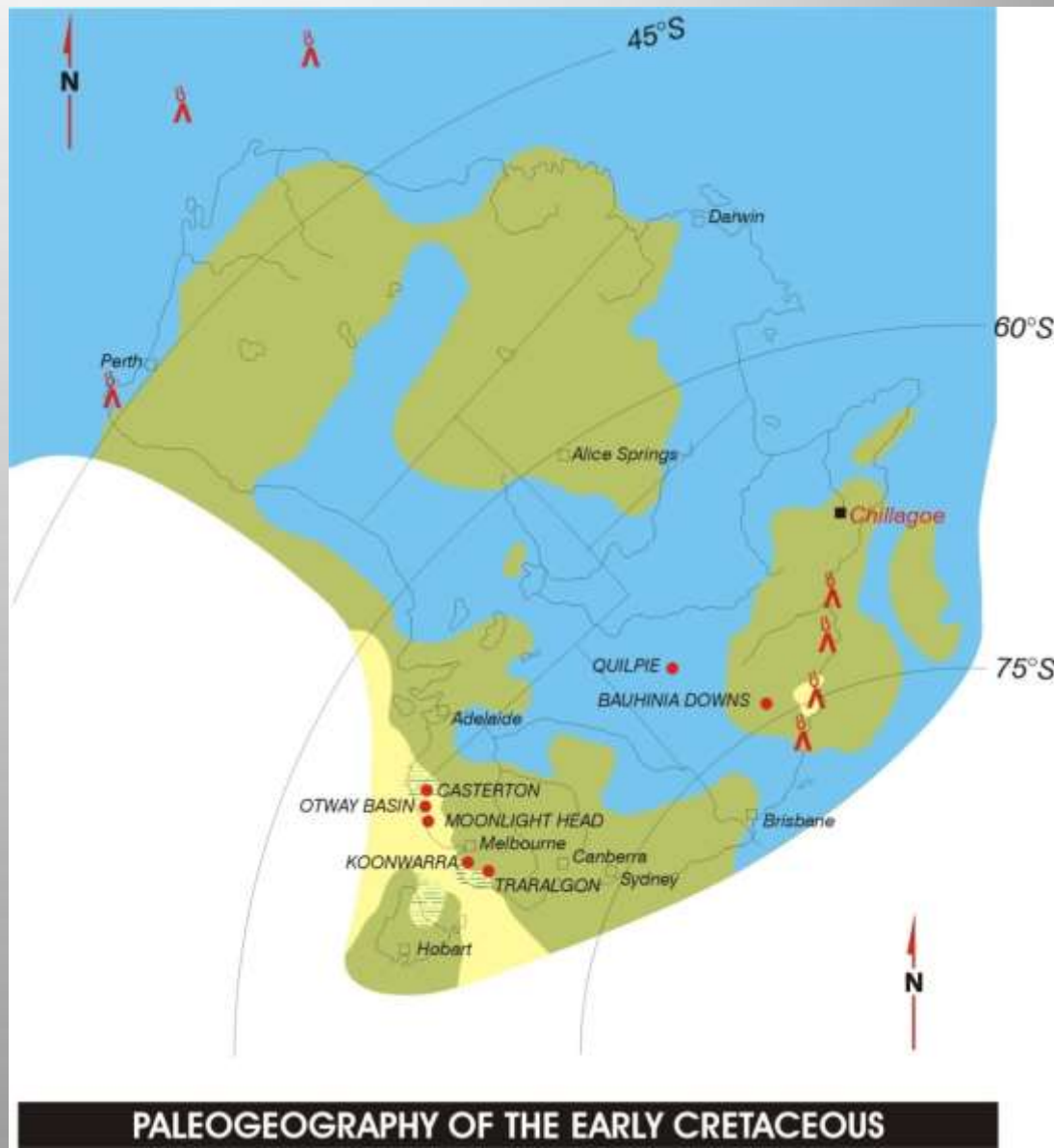

PERMIAN – TRIASSIC
COAL BASIN
M
D
M
C
A
A
H
R
G

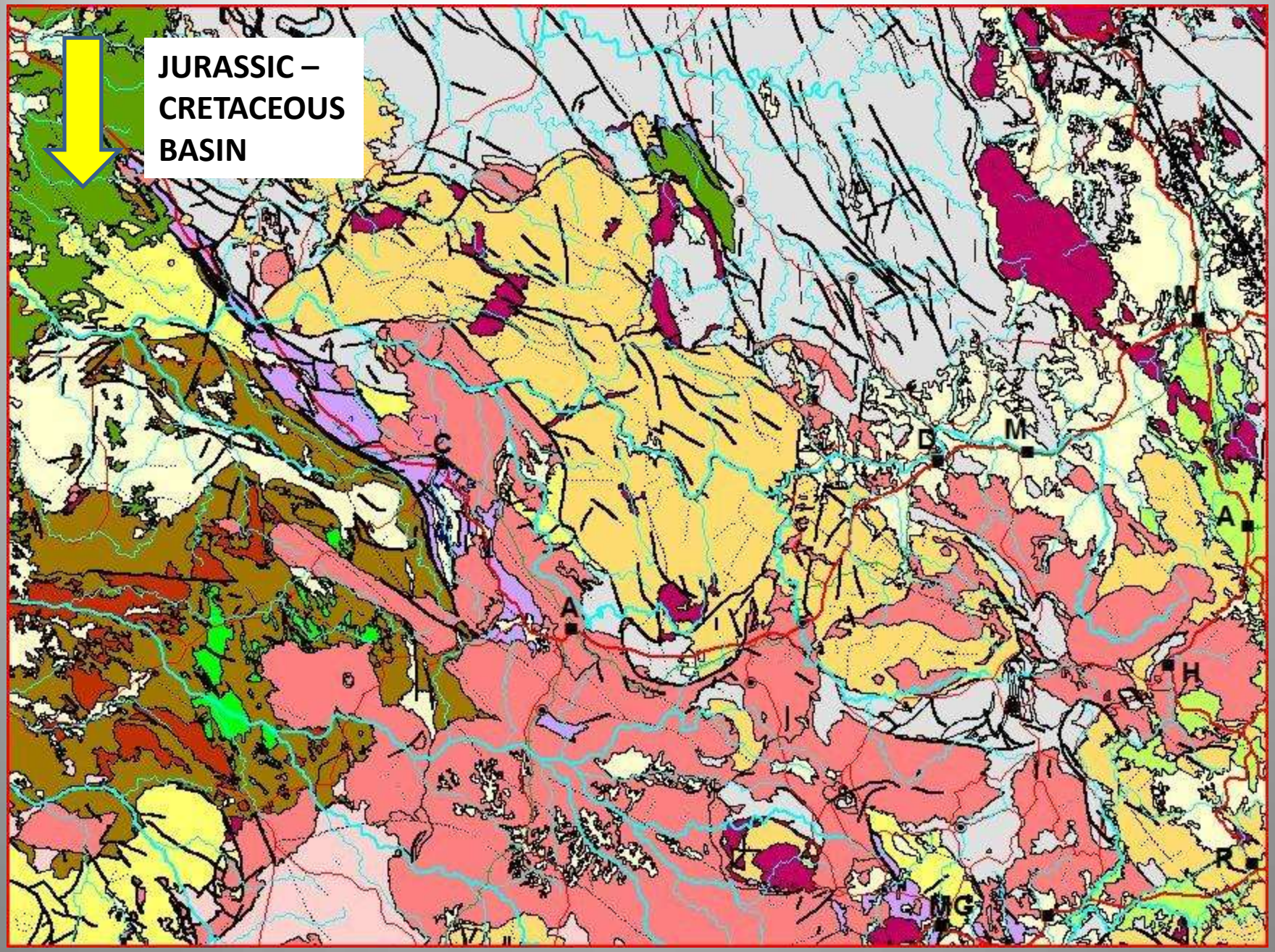

Triassic
Pepperpot Sandstone
Permian
Mt Mulligan Coal Seam
Carboniferous to Permian
volcanics
Devonian
sandstone, siltstone, shale
Tyrconnel
N
MT MULLIGAN
BASIN
LATE PERMIAN - TRIASSIC
(255 - 240 Million Years)
EXTENSION

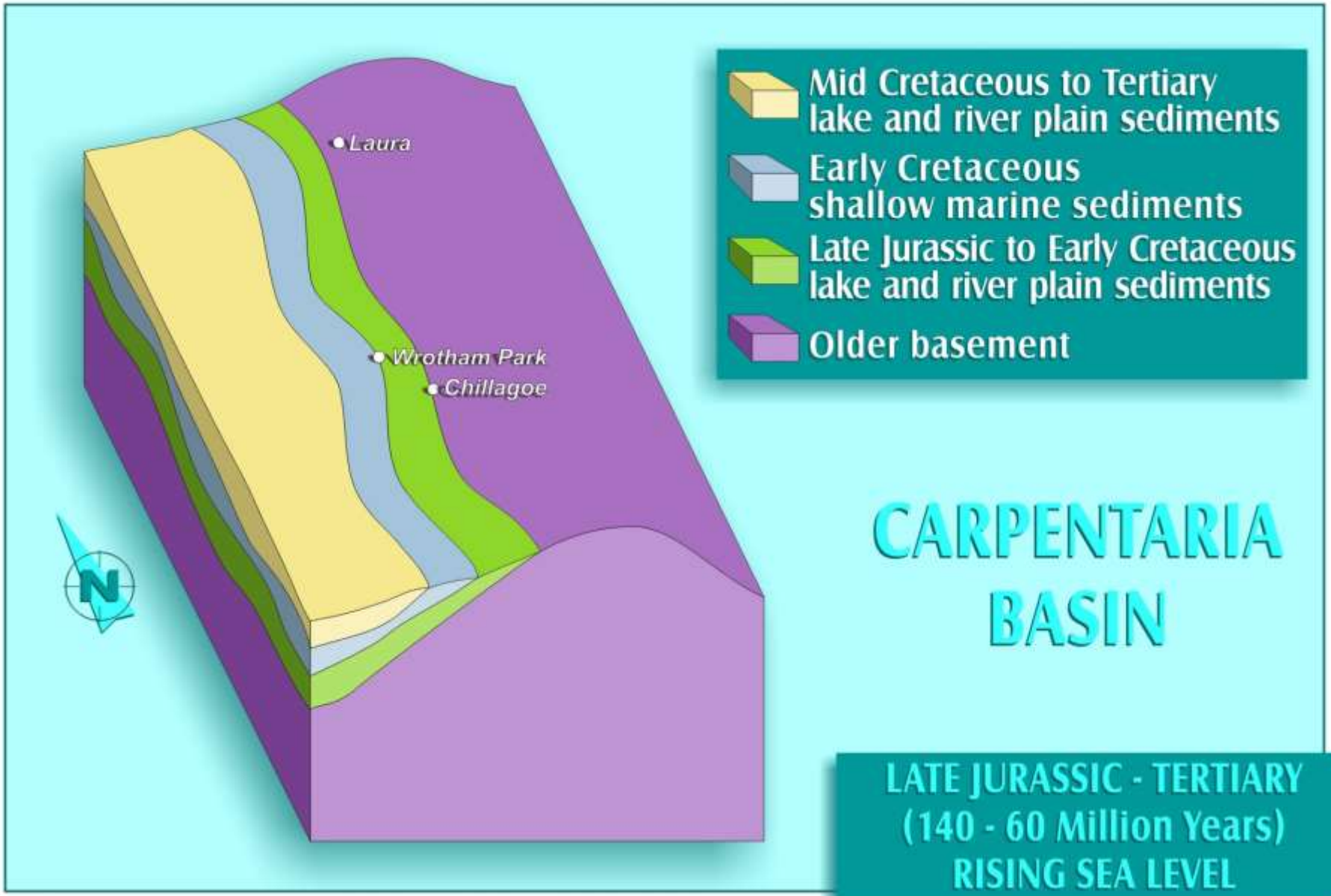
East face of Mt Mulligan near site of abandoned coal mine

LATE JURASSIC - CRETACEOUS

- Major inundation
- Commences with fluvial deposits (river deltas, lakes)
- Becomes marine in E Cretaceous
- Sea level rise of ~300m
- Fluvial again in Late Cretaceous




JURASSIC – CRETACEOUS BASIN
M
M
D
C
A
A
H
R
G


Laura
Wrotham Park
Chillagoe
N
Mid Cretaceous to Tertiary lake and river plain sediments
Early Cretaceous shallow marine sediments
Late Jurassic to Early Cretaceous lake and river plain sediments
Older basement
CARPENTARIA BASIN
LATE JURASSIC - TERTIARY
(140 - 60 Million Years)
RISING SEA LEVEL

Cobbold Gorge, Robertson R

- Hampstead SS – Jurassic basal fluvial unit
- Downfaulted on SW side of Robertson River Fault
- Note pattern of faults and close stress jointing

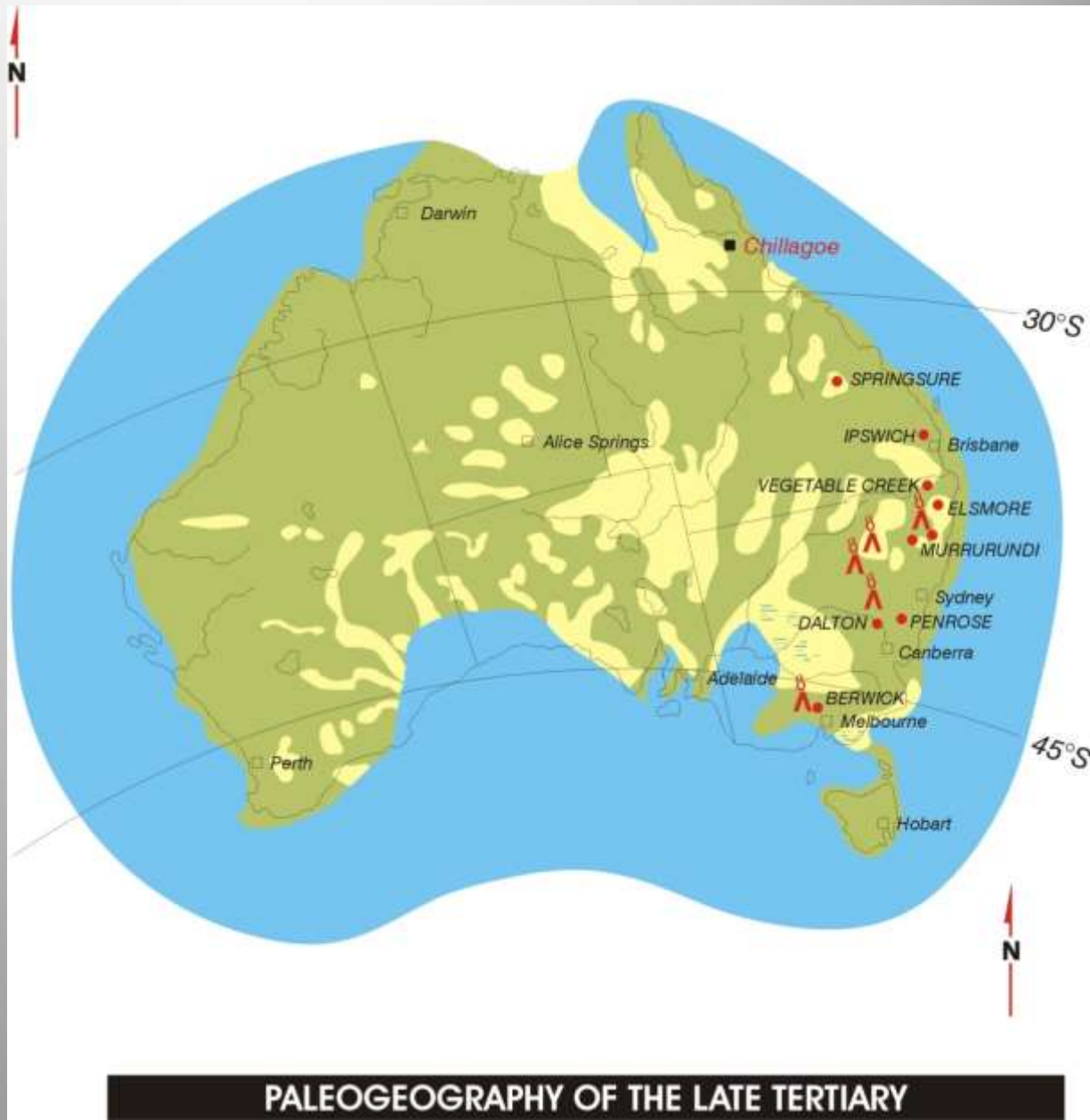
Sandstone about 10m thick as mesas

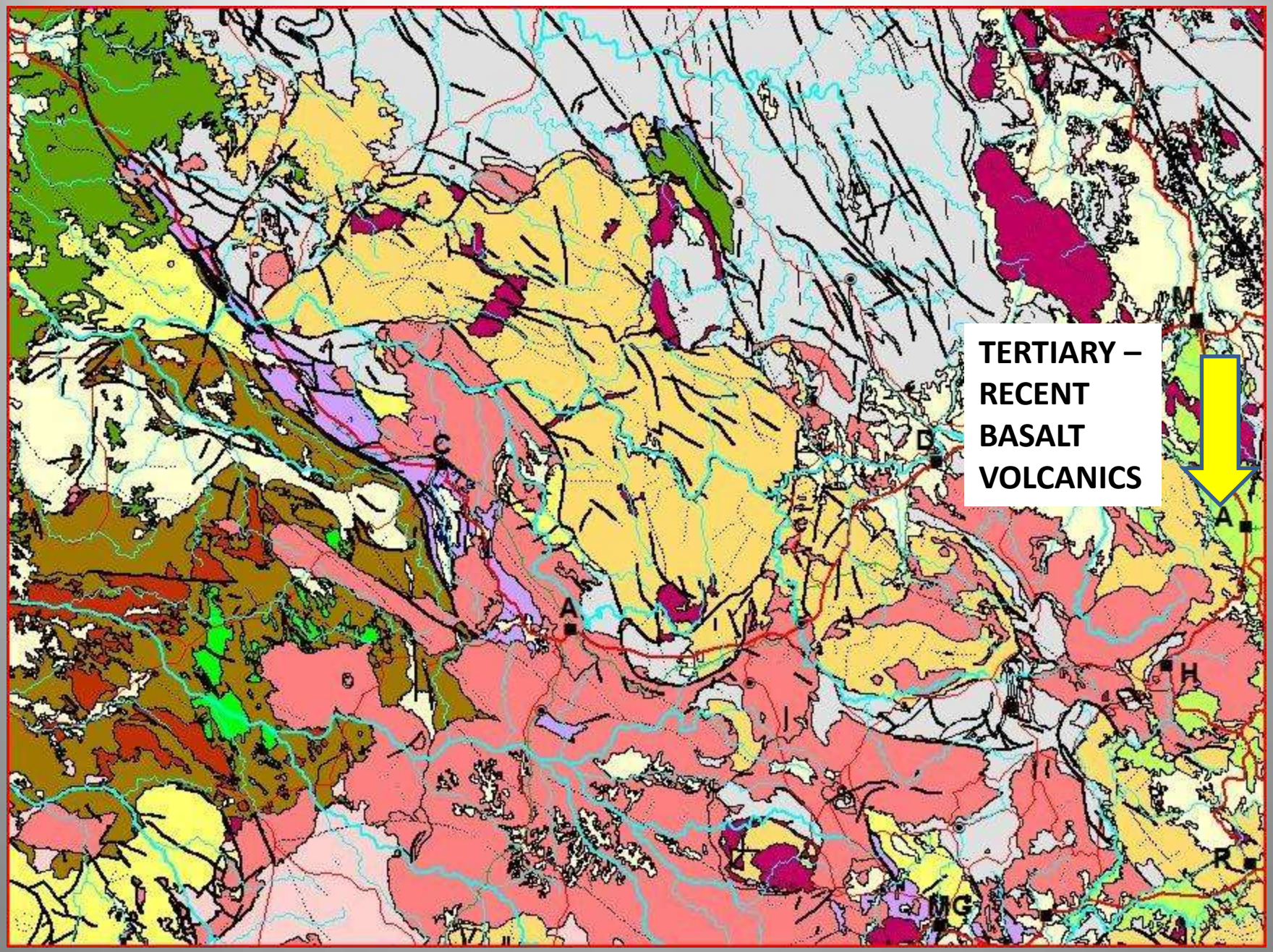
Cretaceous - Elasmosaurs

Cretaceous - Ammonites

TERTIARY

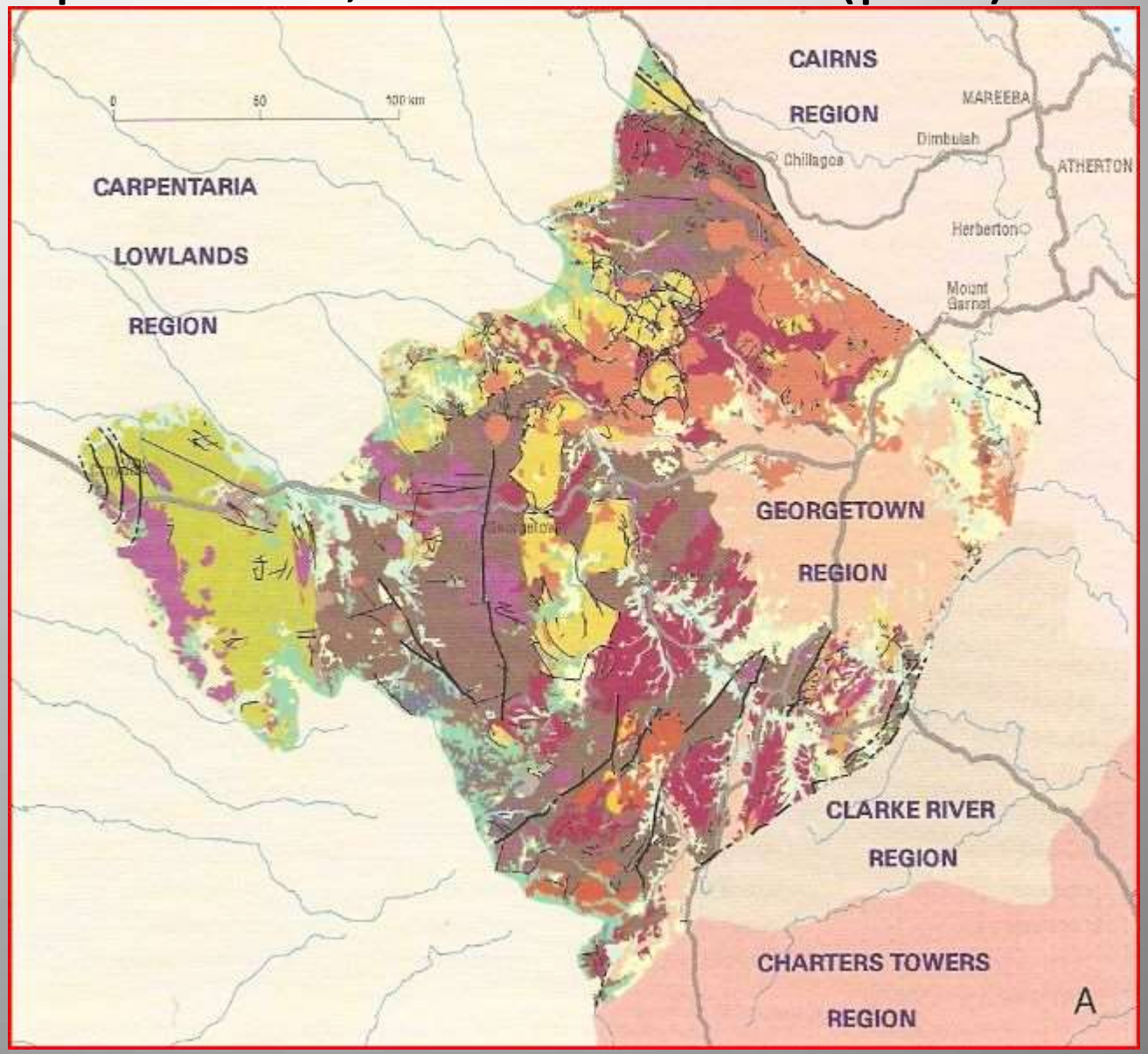
- Australia has rotated 90 degrees
- Drifting north
- Drying out
- Mainly fluvial sediments – Minor marine in south



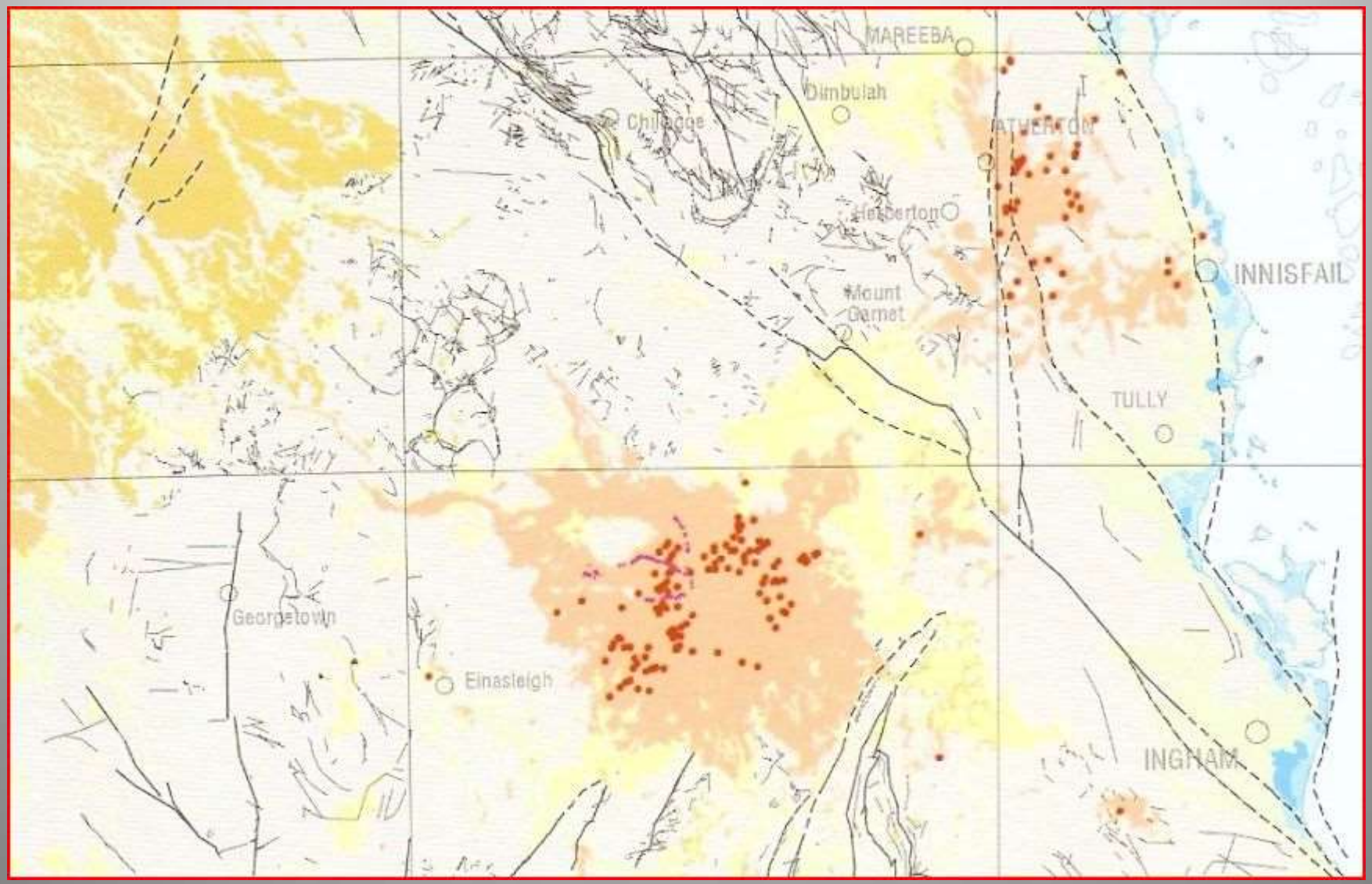

TERTIARY – RECENT BASALT VOLCANICS
M
D
C
A
A
H
R
NG

Recent geology: McBride, Atherton & Chudleigh Volcanic Sub-provinces; all basalt lavas (pink)

- Low viscosity basalt flows
- A west flow from Undara extends 160km to Van Lee & is longest young flow on Earth
- Noted for lava tubes



Dozens of individual cones in each field, with preferred NE alignment. Lava tubes to 50km



Undara lava tube

Undara Volcanic National Park
Photo courtesy of Tamara Vallance.

Atherton Sub-province; Seven Sisters *scoria* cones within *graben* confined field

Satellite image shows flow of Undara Basalt down the ancestral Einasleigh River, to 160km from Undara Crater source vent

Plate 3.3. Landsat TM image, southeast corner of RED RIVER, approx. 1:250 000 scale. See facing page for geological interpretation. Principal features are Proterozoic metamorphics, Silurian granites, Carboniferous–Permian volcanics and intrusions, Mesozoic sediments, early Cainozoic fluvial channel, and late Pleistocene lava flow. Image has been high pass filtered, contrast stretched, and colour-balanced (red: bands 5–4; green: bands 7–6; blue: band 3) to enhance lithologic and regolith differences and suppress fire burns.

Coral limestone reefs showing typical fluted “karst” weathering

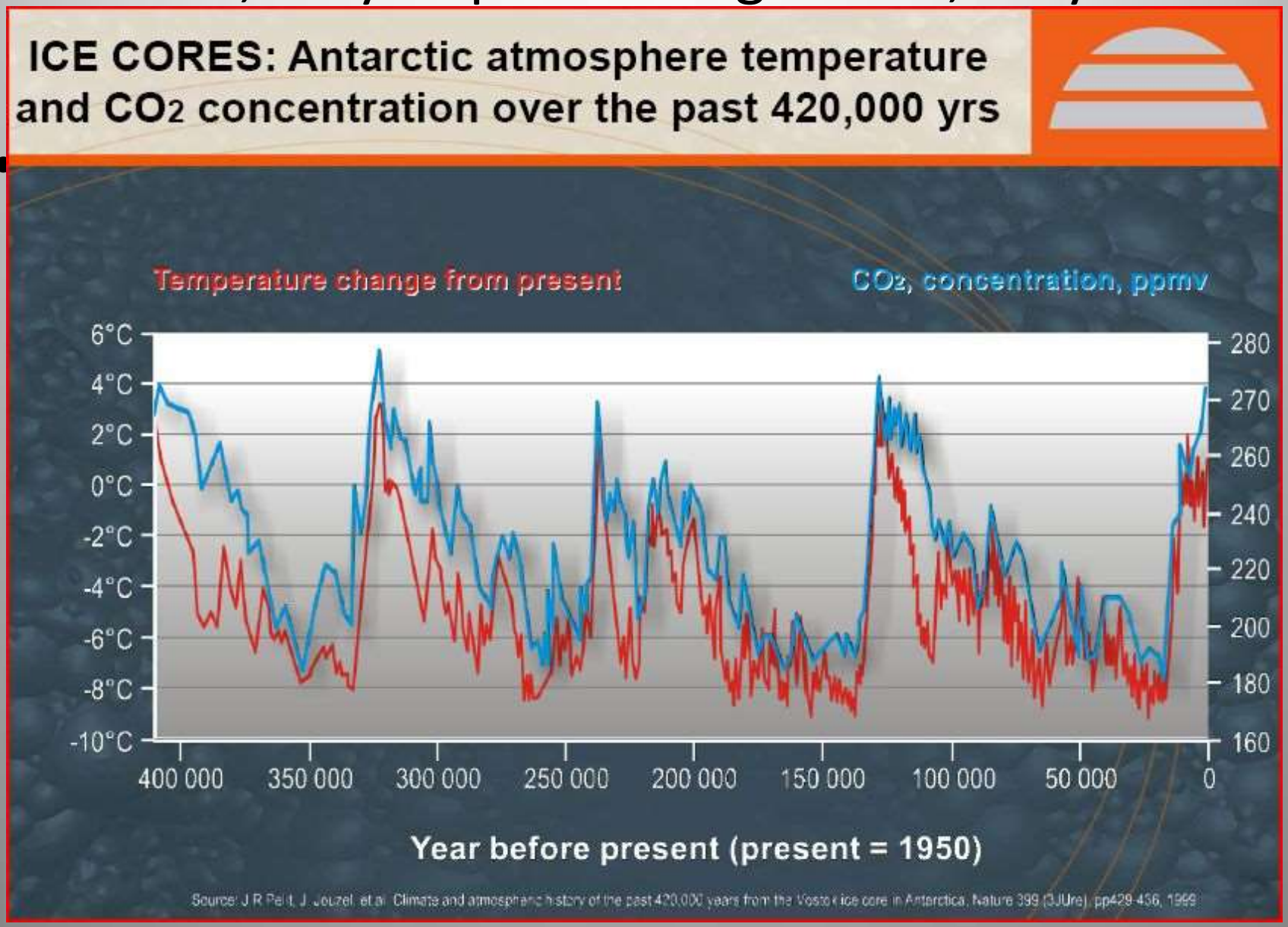
Ancestral crocodile caste from Chillagoe speleothem

QUATERNARY (RECENT)

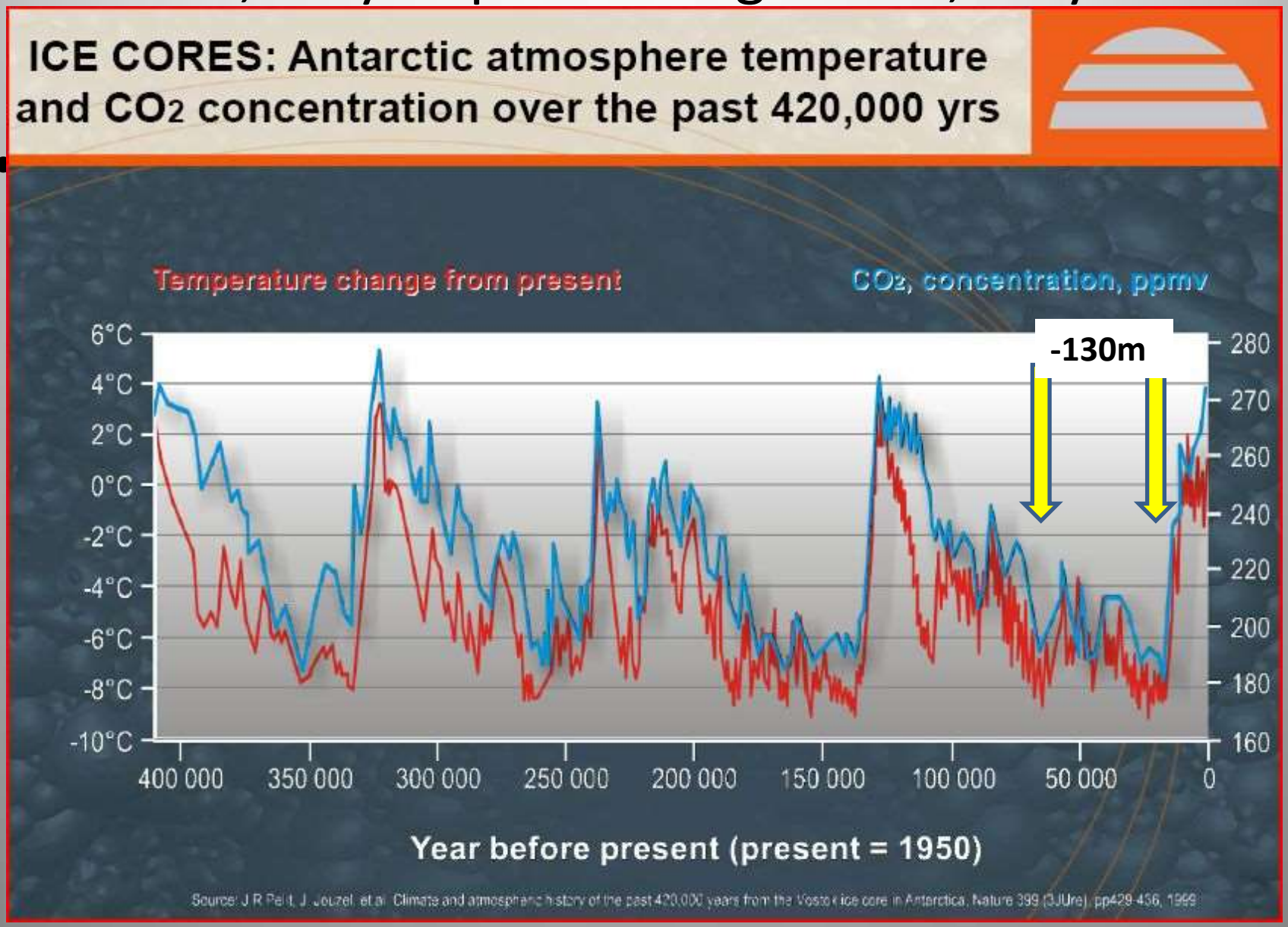
- "Hot Spot" volcanoes and *graben* confined fields in NQ & Victoria – SA 1My to 15,000y
- Peak of last Ice Age was 15,000y but lasted from 100,000y to 12,000
- Sea level still 130m lower at 12,000y ago
- Lake Carpentaria – fresh to brackish at that time
- Linkage to PNG


Land bridge to
Papua New Guinea
Palmerville
Fault
Koyamyama
Laura
Cairns
Lake Carpentaria
Mareeba
Chillagoe
Atherton
Kurumba
N
Sea and lake
Great Barrier Reef
Coastal flood plains
Basalt volcanoes
Older rocks
YESTERDAY'S
VOLCANOES &
INLAND LAKE
RECENT
(12,000 Years ago)
ICE AGE - LOW SEA LEVEL

12 degree change temperature from peak Ice Age 15,000y to peak Interglacial 6,000y

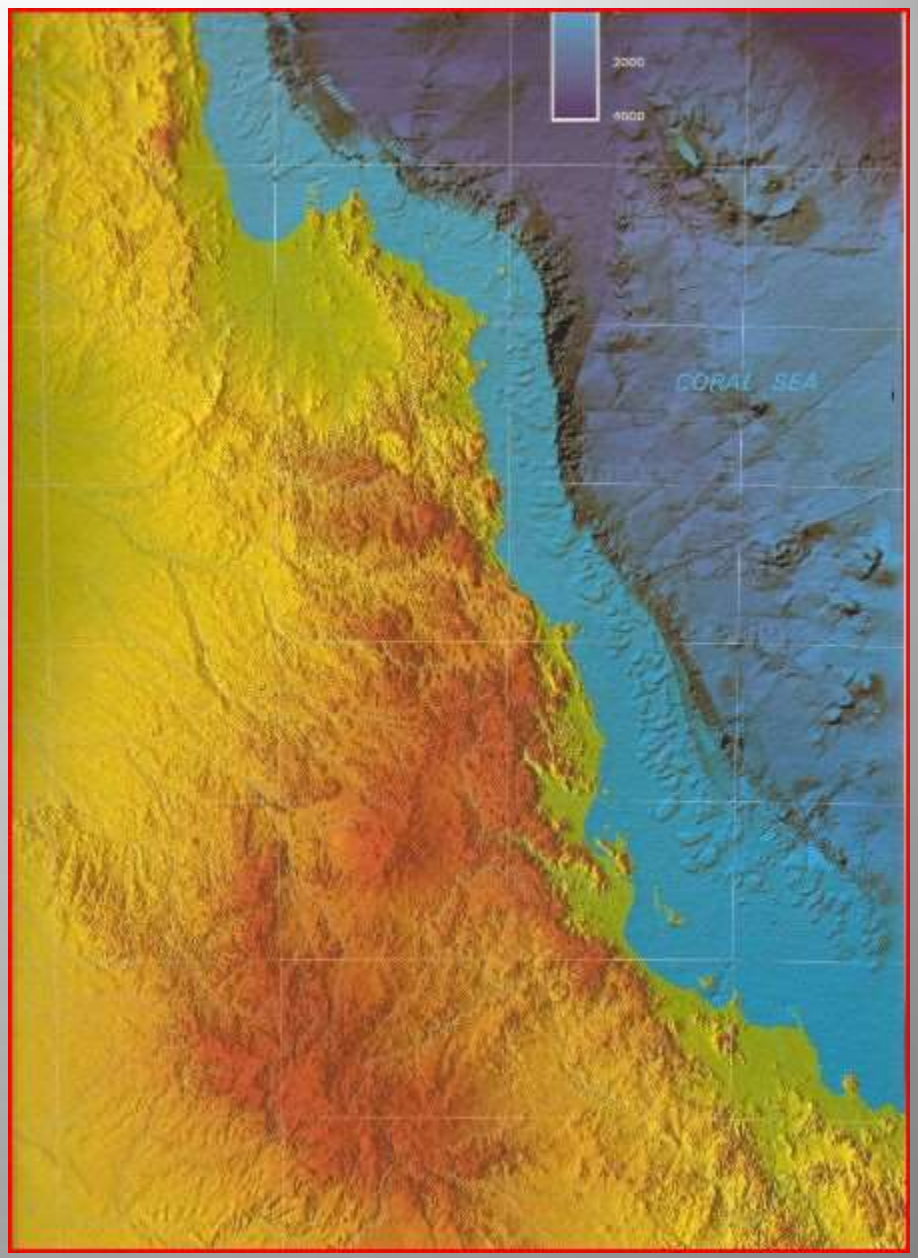


12 degree change temperature from peak Ice Age 15,000y to peak Interglacial 6,000y



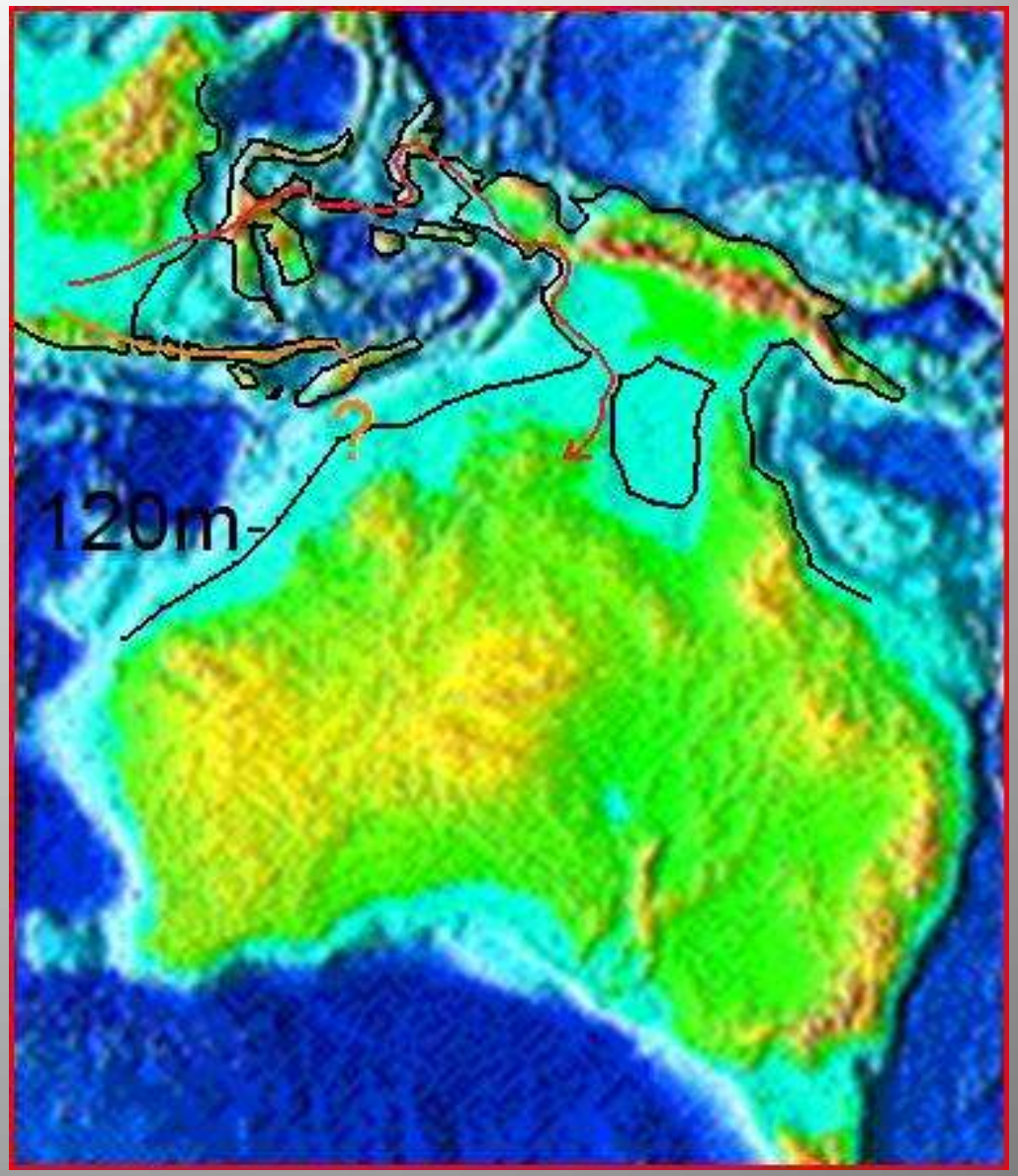
Coastal change since 12,000ybp

- Great Barrier Reef grew 50 - 100km offshore as a fringing reef
- Reef has grown & kept pace with sea level rise of average 1cm/y
- At 6,000ybp sea level was 2m higher and coastal plains were mangrove swamps



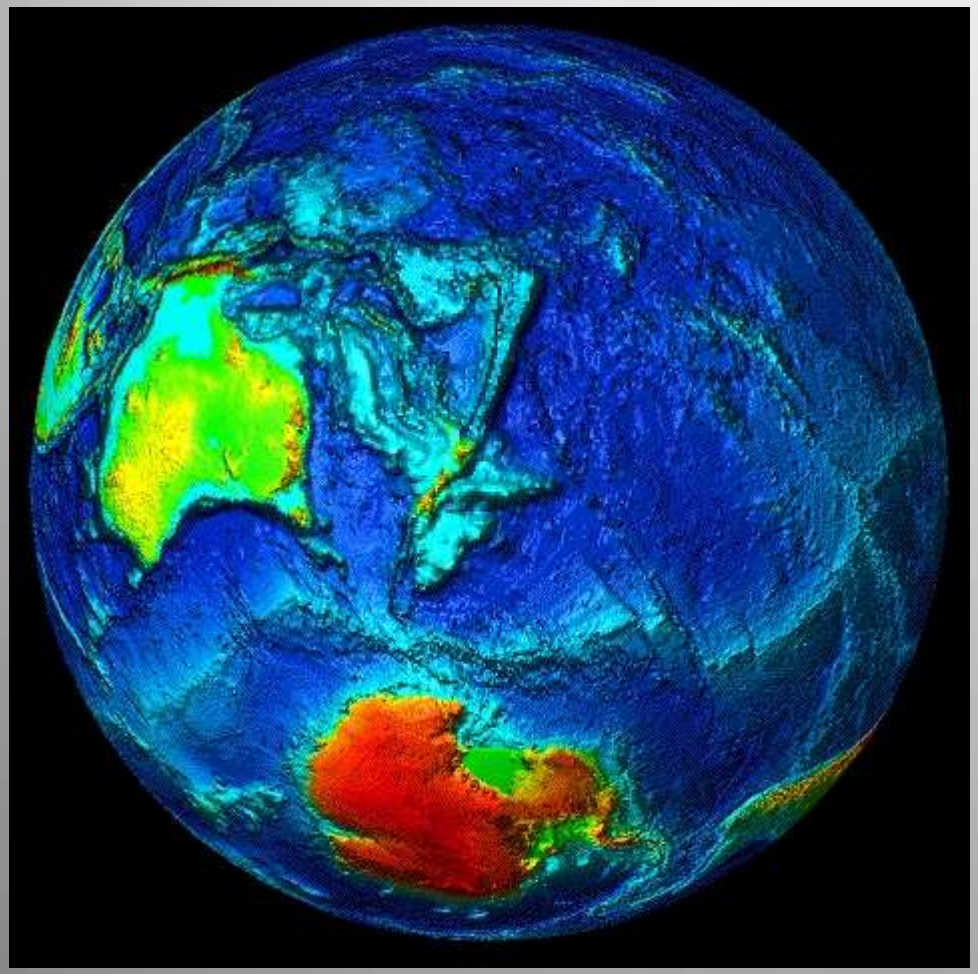
How did Aboriginal peoples arrive? Boat from Timor or walk by landbridge?

- The Timor Gap was still +200km when sea level was 130m lower between 100,000y and 12,000y
- More likely an “island hop” with maximum 50km sea gaps from Java > Kalimantan > Sulawesi > Maluku > Halmahera > Irian Jaya then walked along coastal plain and lake shore to Australia



Coral limestone reefs showing typical fluted “karst” weathering

SUMMARY



- 1800ma history of constantly varying climatic and tectonic settings
- Main events in Proterozoic,

  Silurian –

  Devonian, Carboniferous – Permian,

  Jurassic –

  Cretaceous

  Tertiary –

  Quaternary