KARST DEVELOPMENT AT NARACOORTE, SOUTH AUSTRALIA: WHEN? WHY? & HOW?

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QuickTime™ and a
GIF decompressor
are needed to see this picture.

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Limestone Coast 2004

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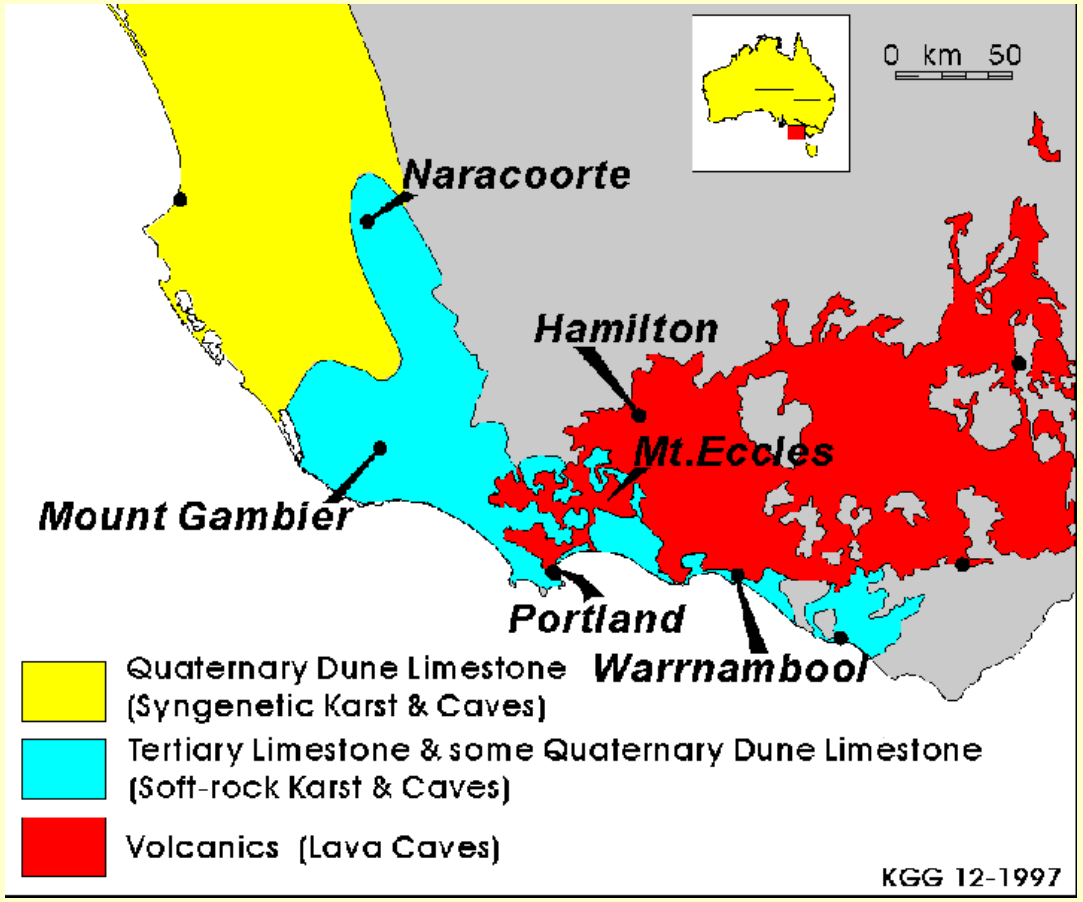
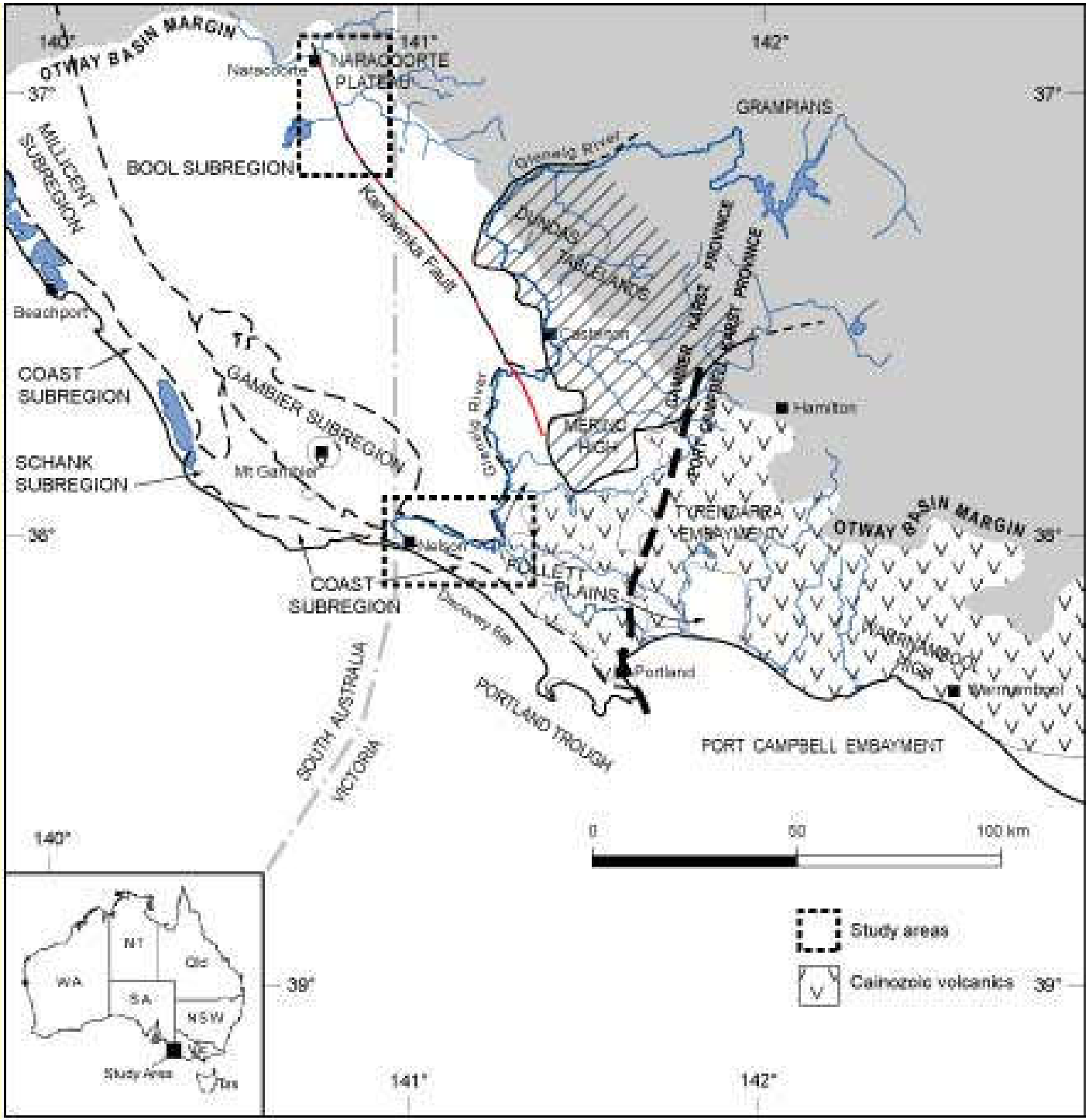
- Naracoorte Caves WH National Park

Location:

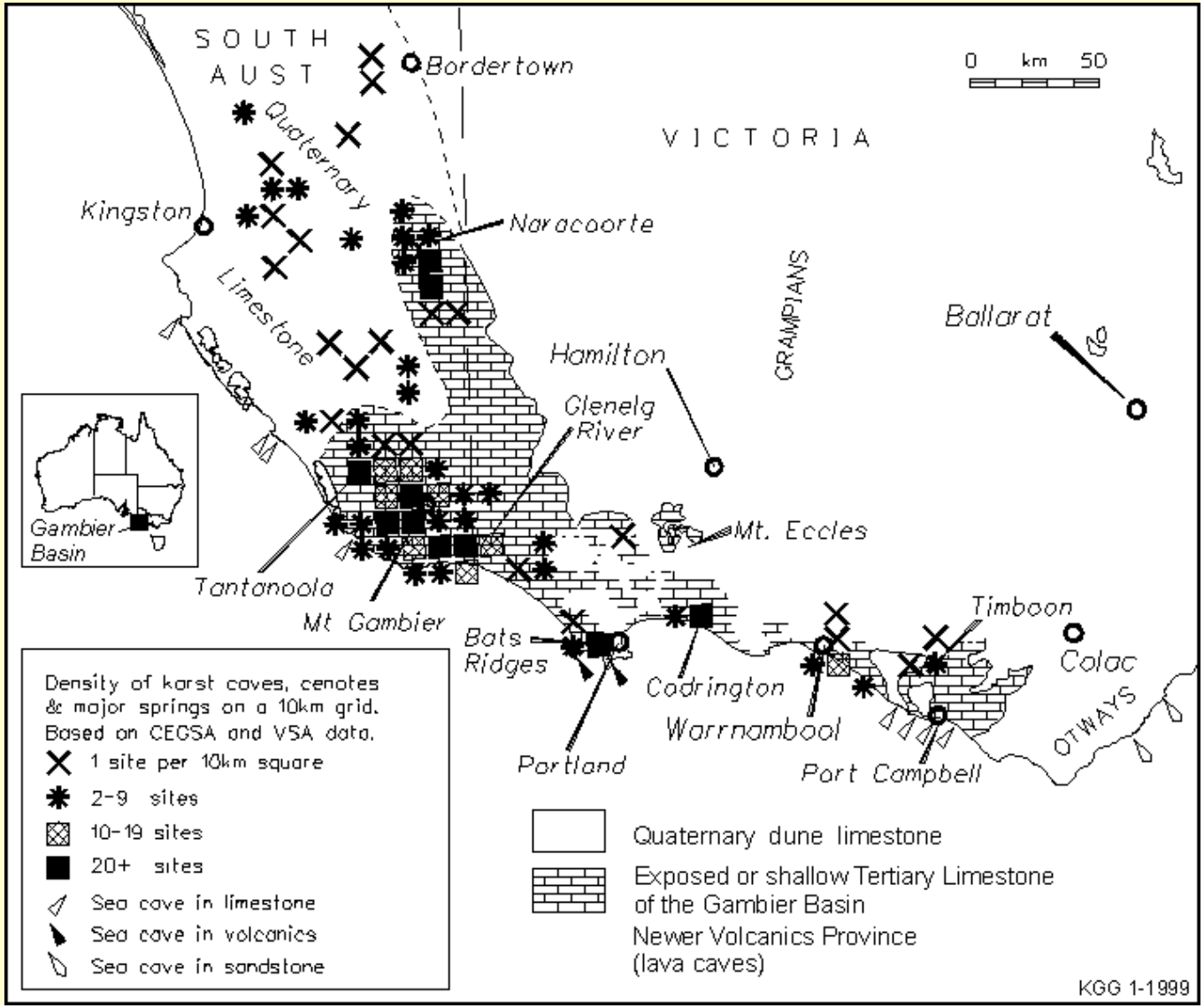

0 km 50
Naracoorte
Hamilton
Mt.Eccles
Mount Gambier
Portland
Warrnambool
Quaternary Dune Limestone
(Syngenetic Karst & Caves)
Tertiary Limestone & some Quaternary Dune Limestone
(Soft-rock Karst & Caves)
Volcanics (Lava Caves)
KGG 12-1997

Gambier Karst Province

- Southeastern karst province of South Australia (Marker, 1975) and the Glenelg River karst area west of the Kanawinka/Jones Ridge escarpment of western Victoria
- NW/SE major jointing pattern
- Extensive systems
- Dense and complex karst development in specific areas
- Glenelg River shows extensive interaction with karst systems


OTWAY BASIN MARGIN
NARACOORTE PLATEAU
Naracoorte
BOOL SUBREGION
MILLICENT SUBREGION
Kanawinka Fault
GRAMPIANS
Glenelg River
DUNDAS TABLELANDS
GAMBIER KARST PROVINCE
Castlemaine
Beachport
COAST SUBREGION
GAMBIER SUBREGION
Mt Gambier
Glenelg River
MERINO HIGH
Hamilton
SCHANK SUBREGION
PORT CAMPBELL EMBAYMENT
OTWAY BASIN MARGIN
FOLLETT PLAINS
COAST SUBREGION
Discovery Bay
Portland
SOUTH AUSTRALIA
VICTORIA
PORTLAND TROUGH
WARRNAMBOOL HIGH
Warrnambool
PORT CAMPBELL EMBAYMENT
140°
141°
142°
37°
38°
39°
0
50
100 km
NT
Qld
WA
SA
NSW
Vic
Tas
Study Area
Study areas
Cainozoic volcanics

Karst Distribution:



Karst Host Lithology:

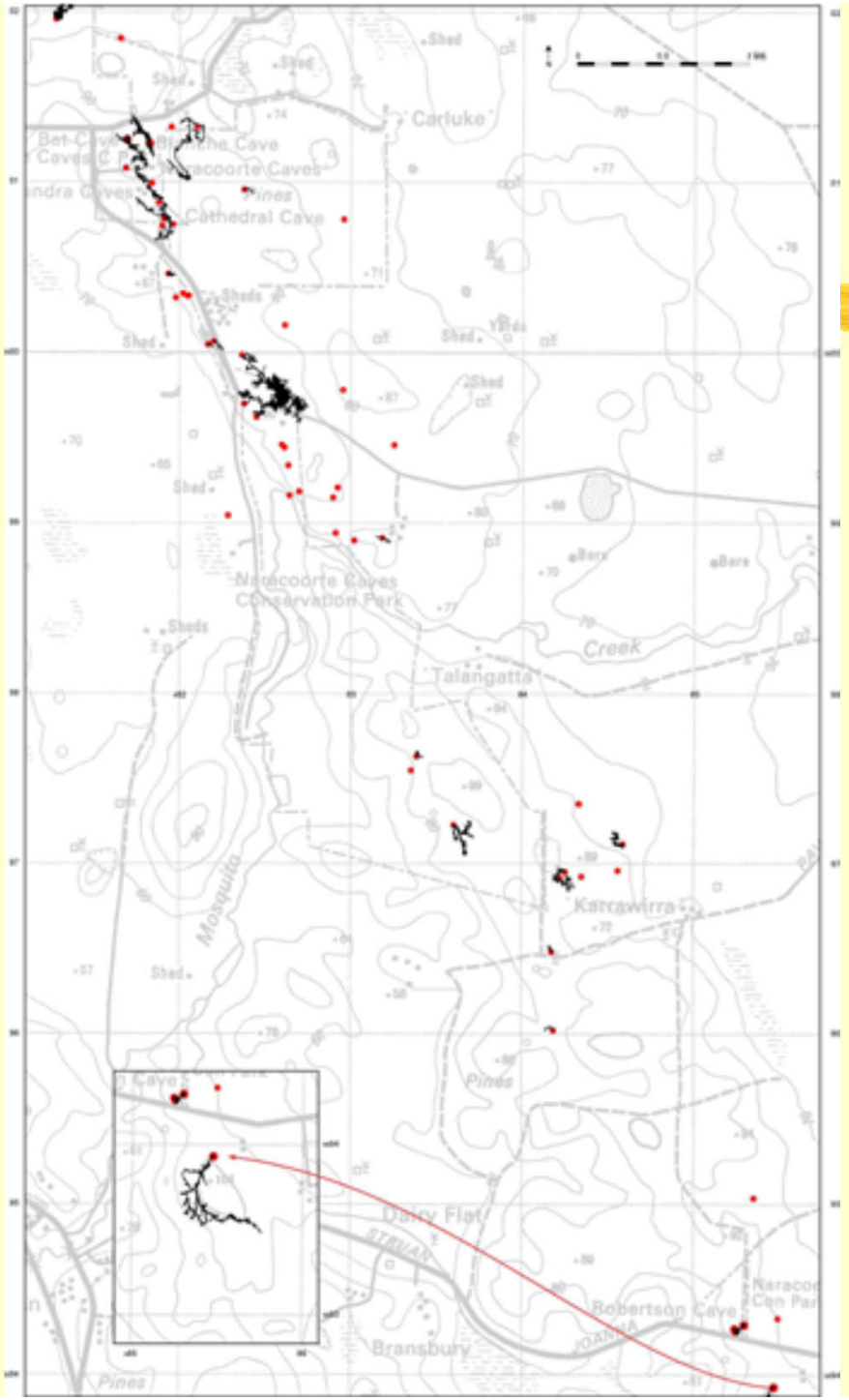
- Marine Gambier Limestone
- Overlain by Bridgewater Group aeolianites
- Cool water carbonates
- Well-sorted bioclastics
- Variable purity and cementation
- Jointed
- Younging to the east

Naracoorte Karst Characteristics

- Karst is concentrated on the East Naracoorte Ridge.
- Passages generally aligned NW/SE
- Caves have single conduit, branchwork or maze passage plans
- Most caves are small
- Some caves are anomalous eg Sand Cave

Naracoorte Karst Characteristics

- Horizontal flat systems
- Phreatic spongework
- Domed roofs with bell holes
- Collapse common
- Collapse and solution pipe entrances
- Fossiliferous sediments
- Sand cones
- Redissolved speleothems



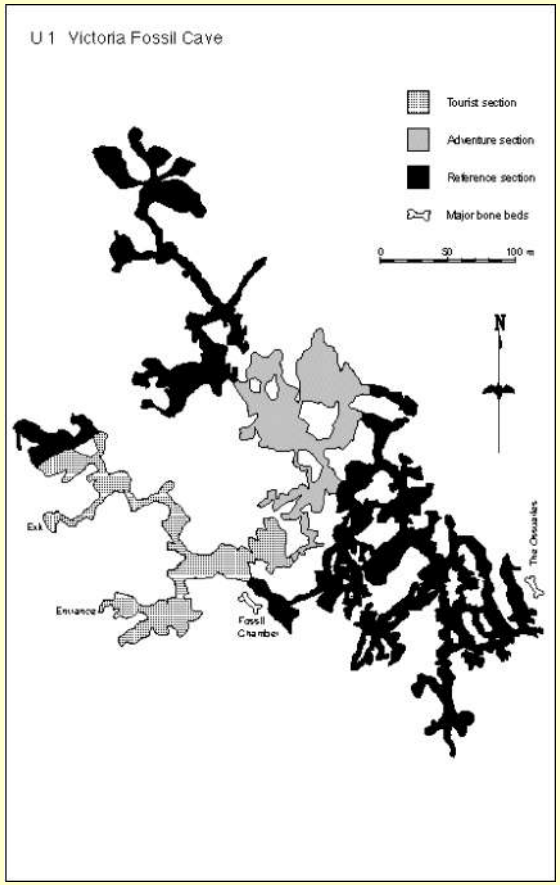
Caves

- Naracoorte Caves area:
only major caves marked

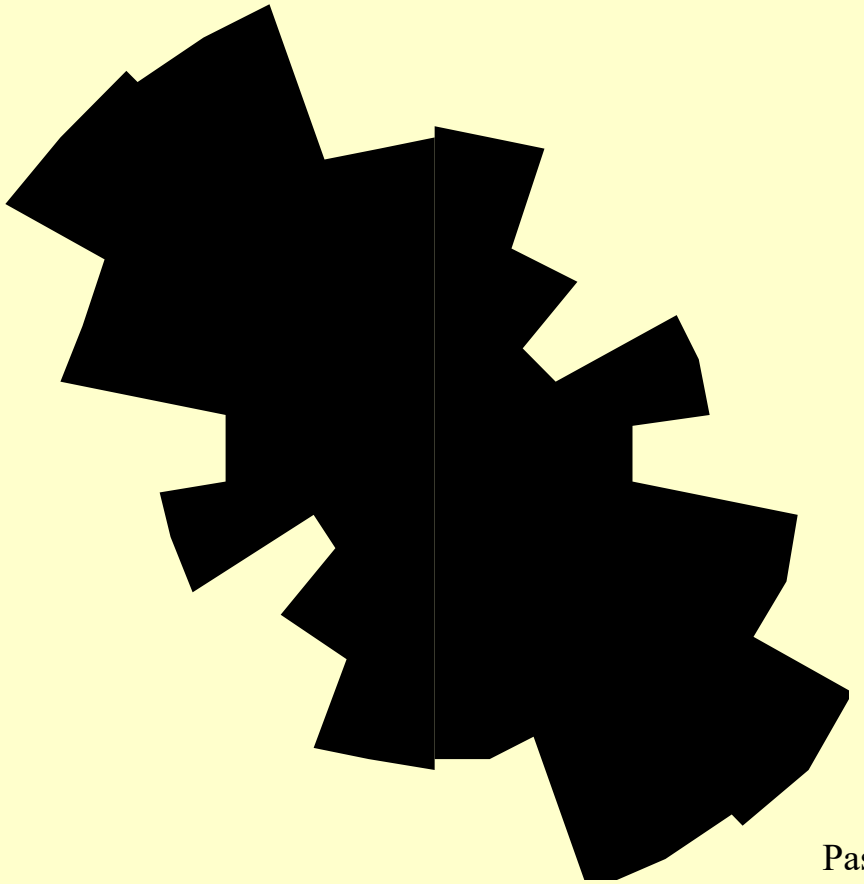
- Caves concentrated along the East Naracoorte Ridge

Passage Plans

- Single Conduit e.g. Blanche Cave
- Branchwork e.g. Sand Cave
- Loose Maze e.g. Victoria Fossil



Passage alignment



- Passages are generally aligned NW/SE with a minor direction at right angles to this.

Passage Direction 5U22 Bat Cave

Collapse

- Collapse features common
- Collapse entrances and debris piles in the caves

Dolines

Sediments

Sand cones common in some caves

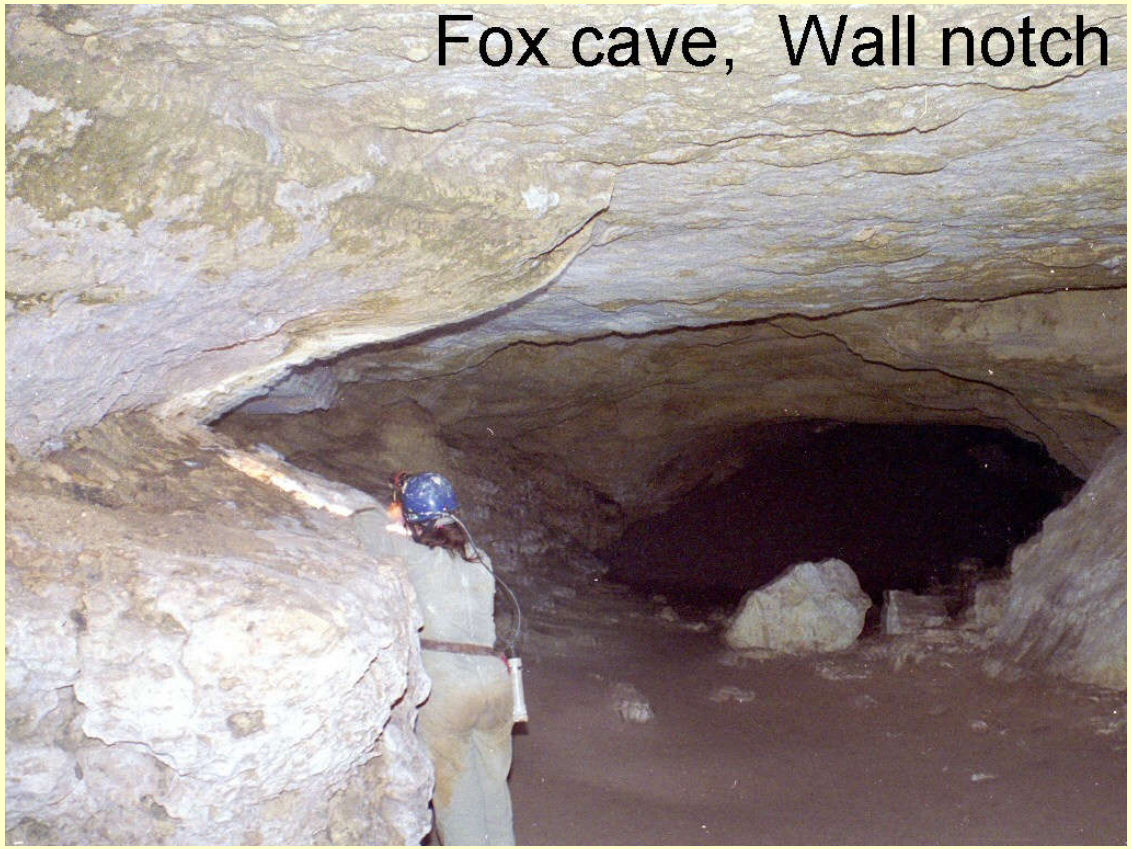
Sand cone Sand Cave Joanna 5U 16

Ledges and notches

- Some ledges and notches are due to differential solution of bedding

Ledges and notches

- Some notches are due to water still stands



Fossiliferous sediments

- Extensive Pleistocene fossiliferous sediments

Initial Solution:

Where ?

- Inland from the East Naracoorte Range
- Main area of cave development is the old estuary of Mosquito Creek
- Less cave development occurs where dune blankets the Gambier Limestone

Initial Solution:

How ?

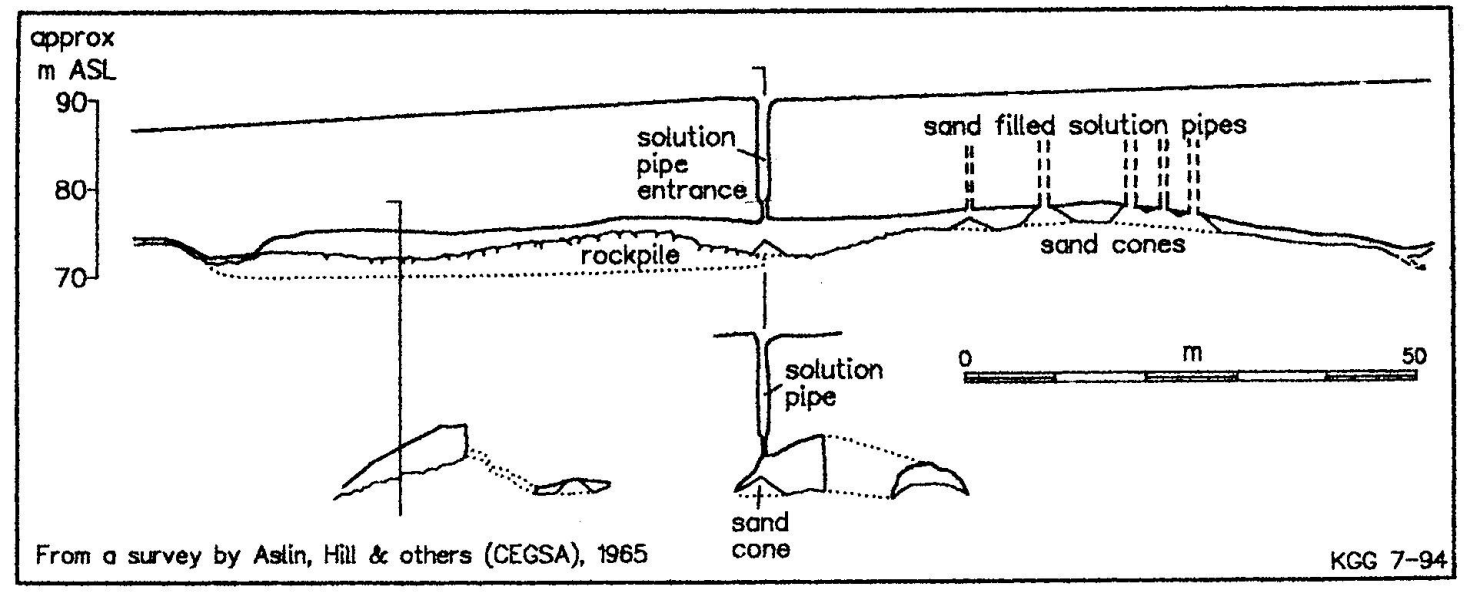
- Just below water table
- Solution from groundwater flow
- Flow enhanced by joint development due to tectonic movement on the fault

Initial Solution:

When ?

- High Sealevel between 1.1 Ma & 850 ka
- Fault movement
- Groundwater conditions favourable

Horizontal systems



Brown Snake Cave: extensive horizontal system with solution pipe entrance.

Solutional Modification:

When ?

- While caves drained as sea level dropped
- Between ~850 Ka and 800 Ka

Phreatic spongework

- Well developed in many large caves

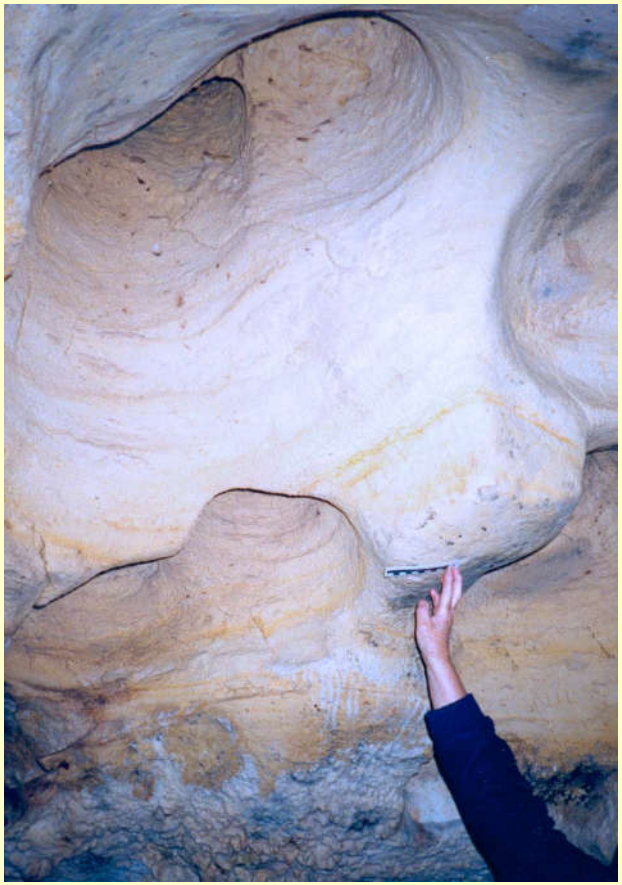
- Mainly developed in particular levels of the caves

Solutional Modification:

Where ?

- Walls and ceilings of caves
- Solution pipe formation

Bell Holes



- Roof domes often have spectacular bell holes formed by focussed meteoric water

Solutional Modification:

How ?

- Still stands of ground water as caves drained e.g. notches
- Surface infiltration e.g. bell holes

Collapse:

When ?

- As caves drained due to lowering of groundwater and lower sealevels
- 750-850 ka
- SL at base of West Naracoorte Range

Collapse:

Where ?

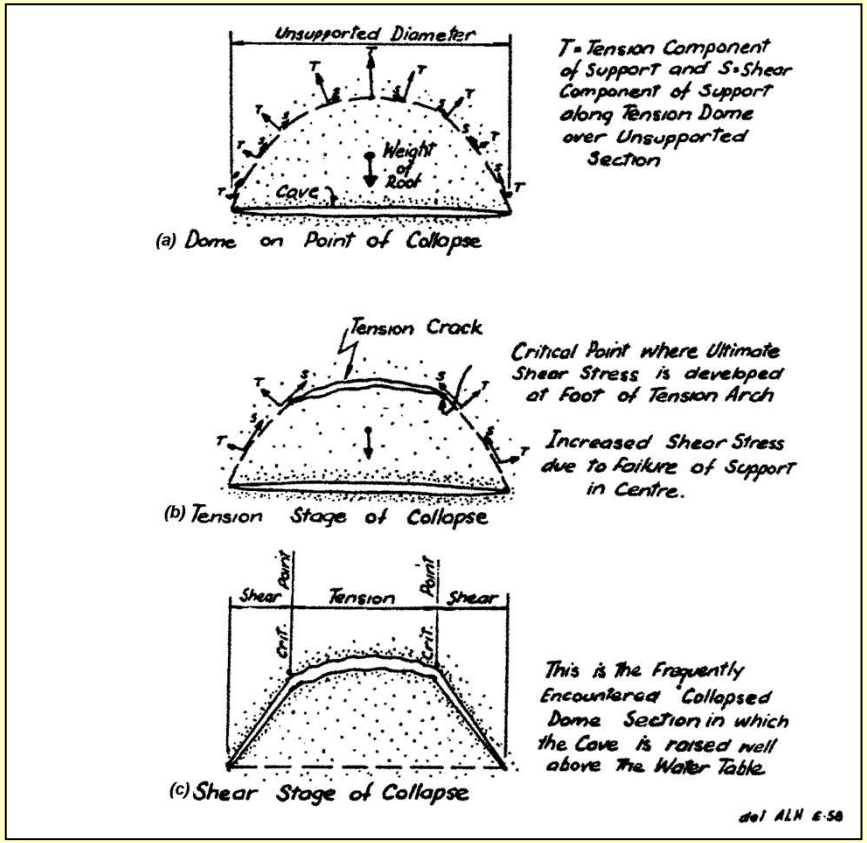
- In caves formed behind the East Naracoorte Range
- Large chambers e.g. Victoria Fossil, Wet, Blanche, Bat and Alexandra Caves

Entrances

Collapse:

How ?

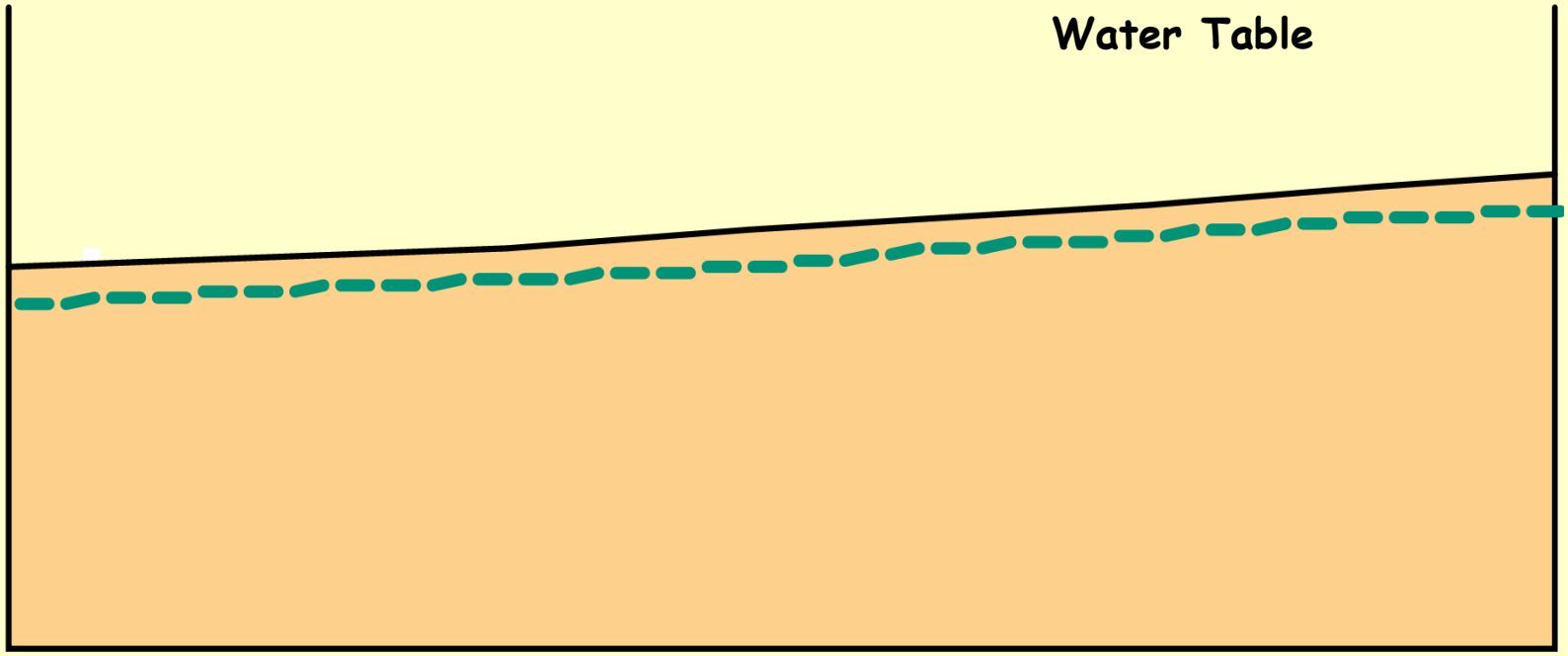
- Draining of caves resulted in the removal of buoyancy.



Landscape Evolution:

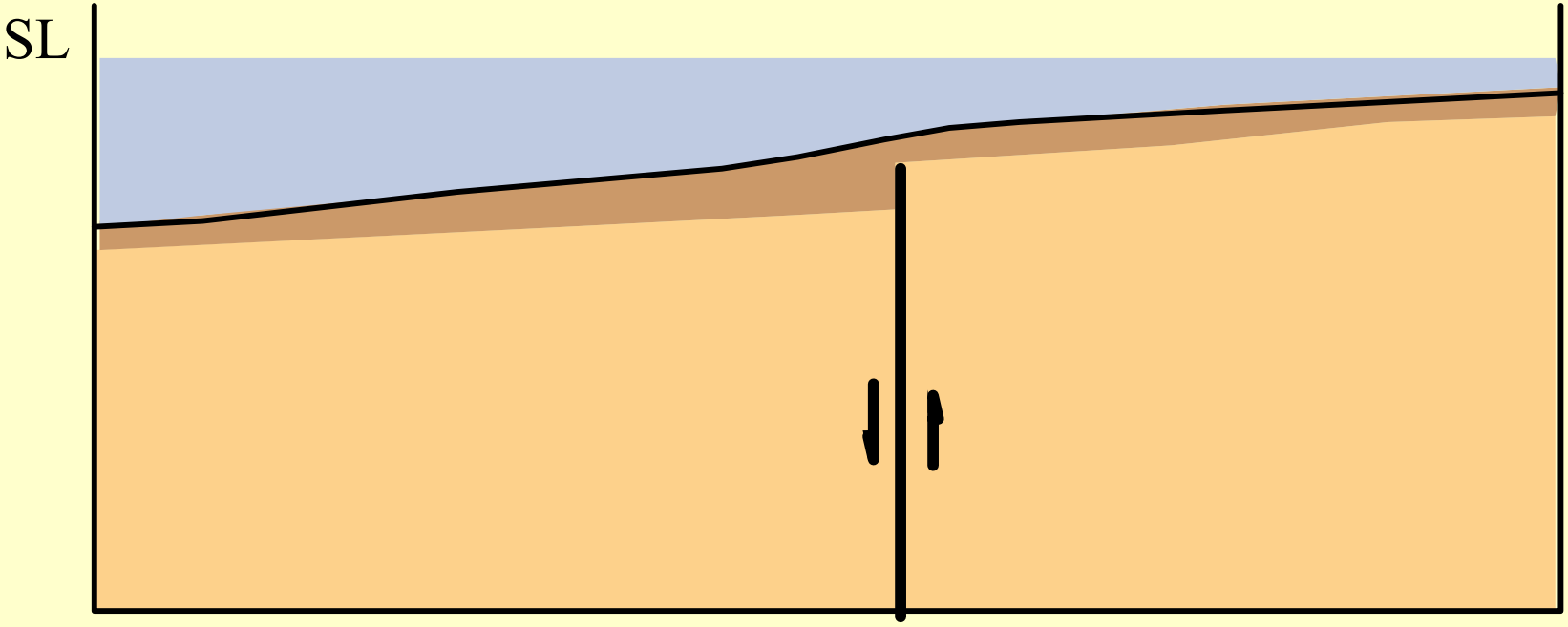
Late Miocene: 15 - 8 Ma

- Subaerial weathering but limited karst development
- Marine transgression ~ 8 Ma



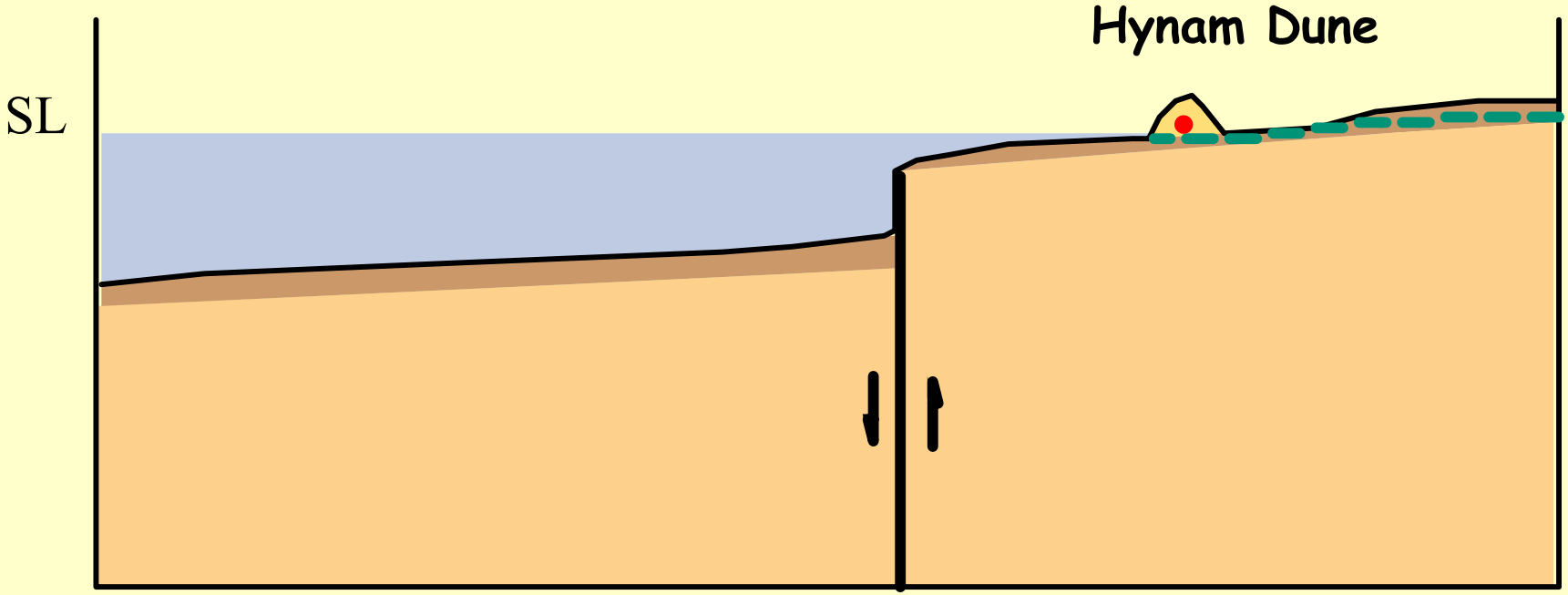
Early Pliocene 2- 6 Ma

- **Maximum SL ~ 7 Ma**
- **Tectonic movement on the Kanawinka Fault**
- **Any previous karst flooded by sea**
- **Deposition of Pliocene sands**



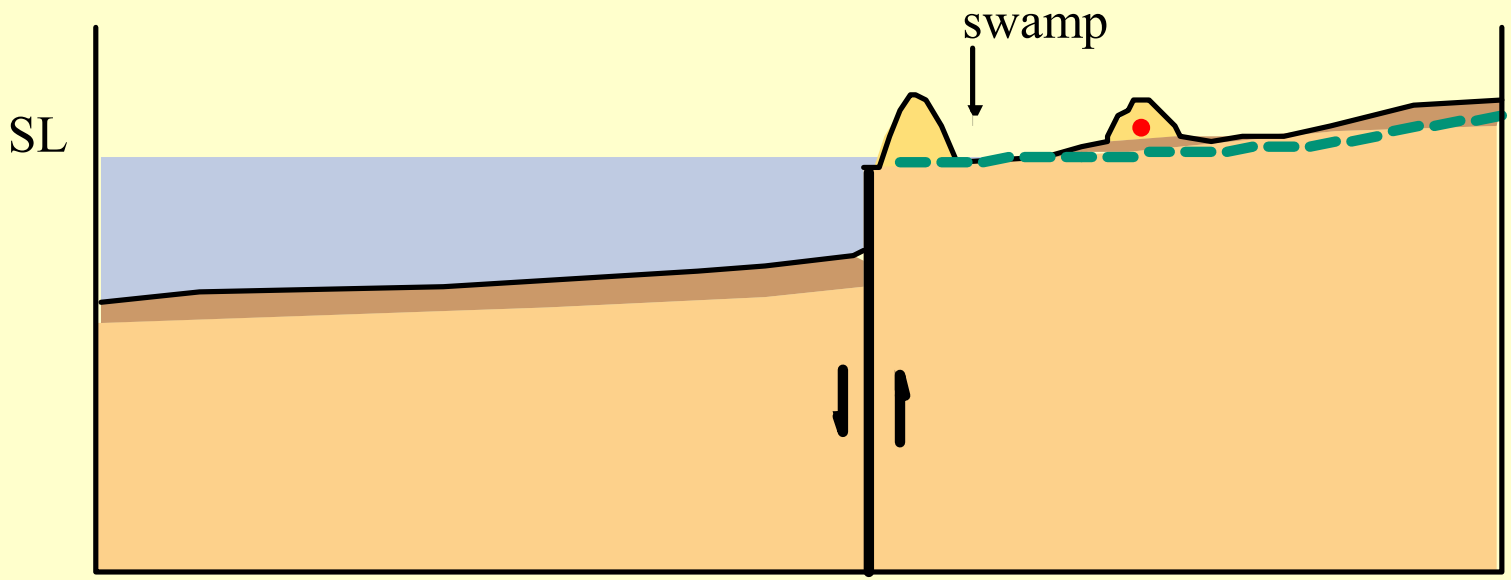
Late Pliocene

- Marine regression and deposition of calcarenite dunes
- Fault movement
- Karst development associated with joint development



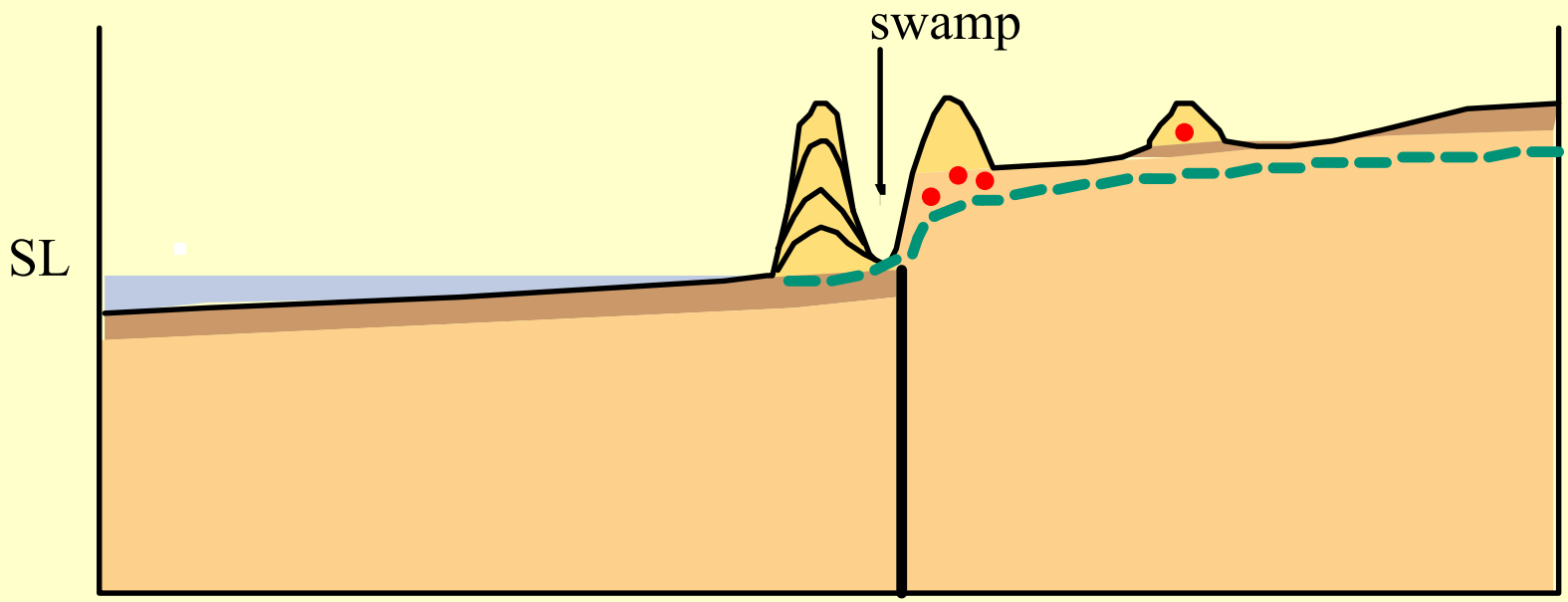
1.1 Million Years

- Deposition of East Naracoorte Range
- Intermittent tectonic movement
- Swamp behind dune and estuarine conditions in main caves area
- Cave formation along watertable



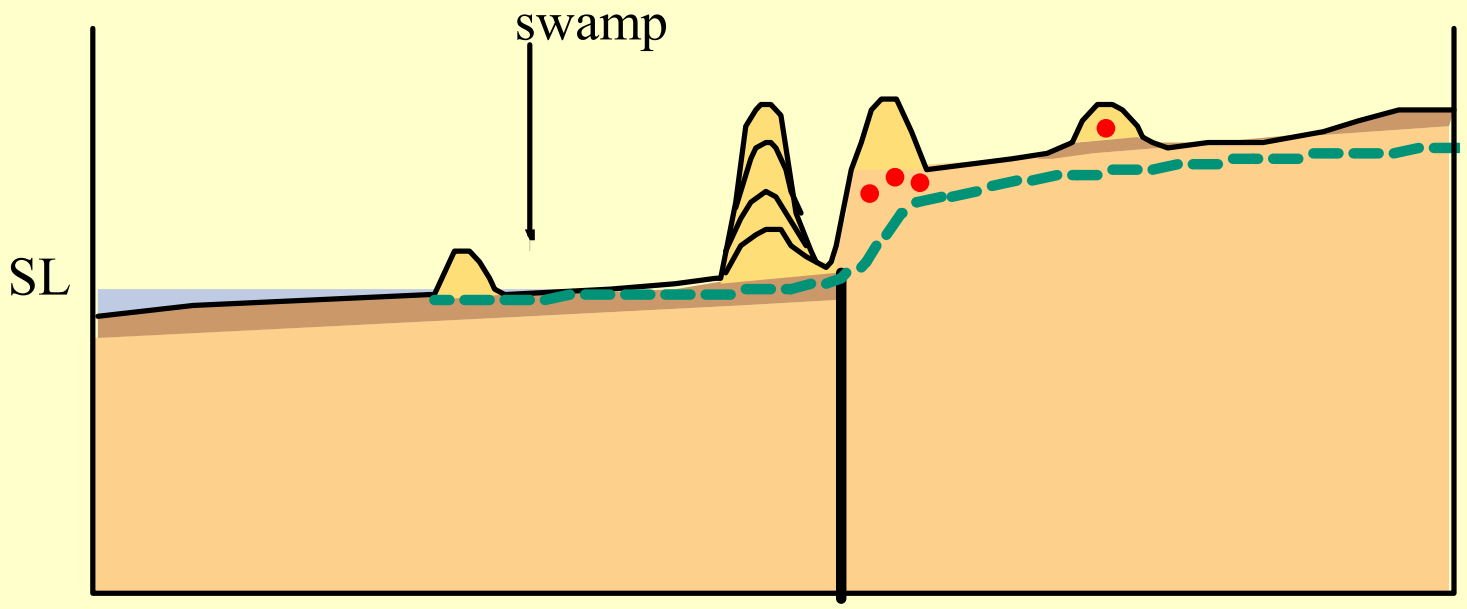
750 - 800 Ka

- **Bruhnes-Matayama Magnetic reversal**
- **Sealevel drops & deposition of West Naracoorte Range**
- **Caves drain as watertable drops as a result of lower SL**
- **Incision of Mosquito Creek**
- **Collapse occurs due to loss of buoyancy**



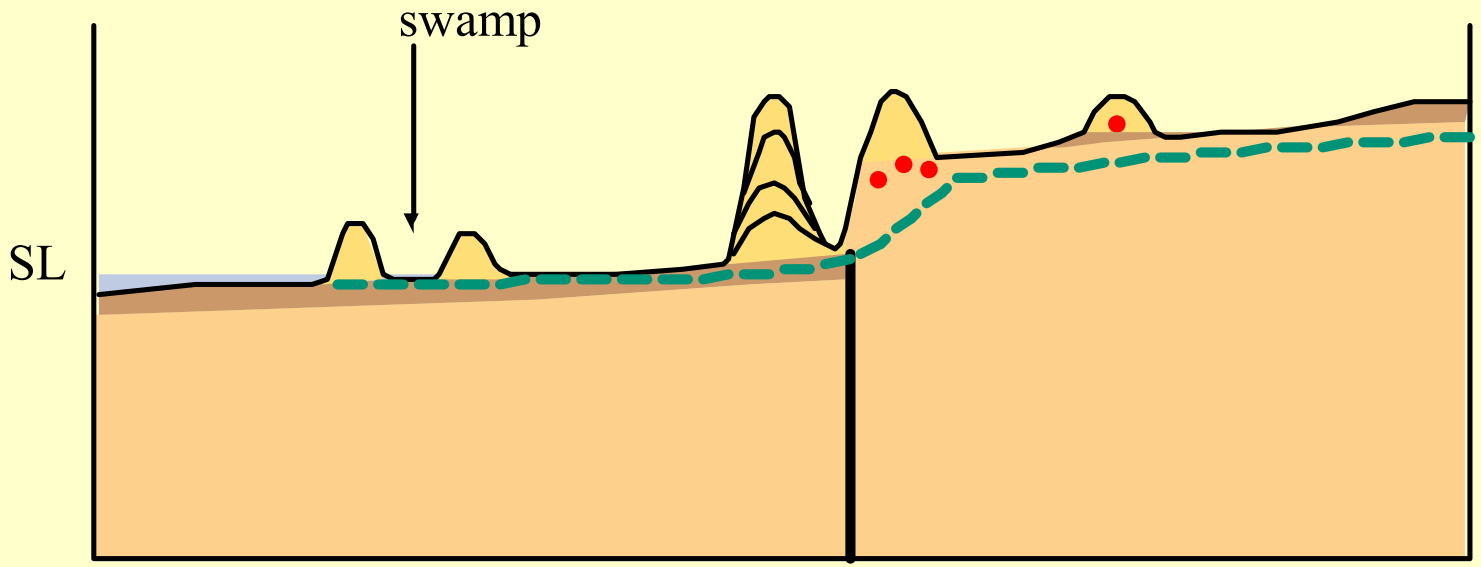
750 - 550 Ka

- Collapse continues and removal of debris as caves drain
- Upwarping continues
- Sea level fluctuates; deposition of more dunes
- Modification of caves e.g. solution pipe formation
- Clastic and fossiliferous sediments

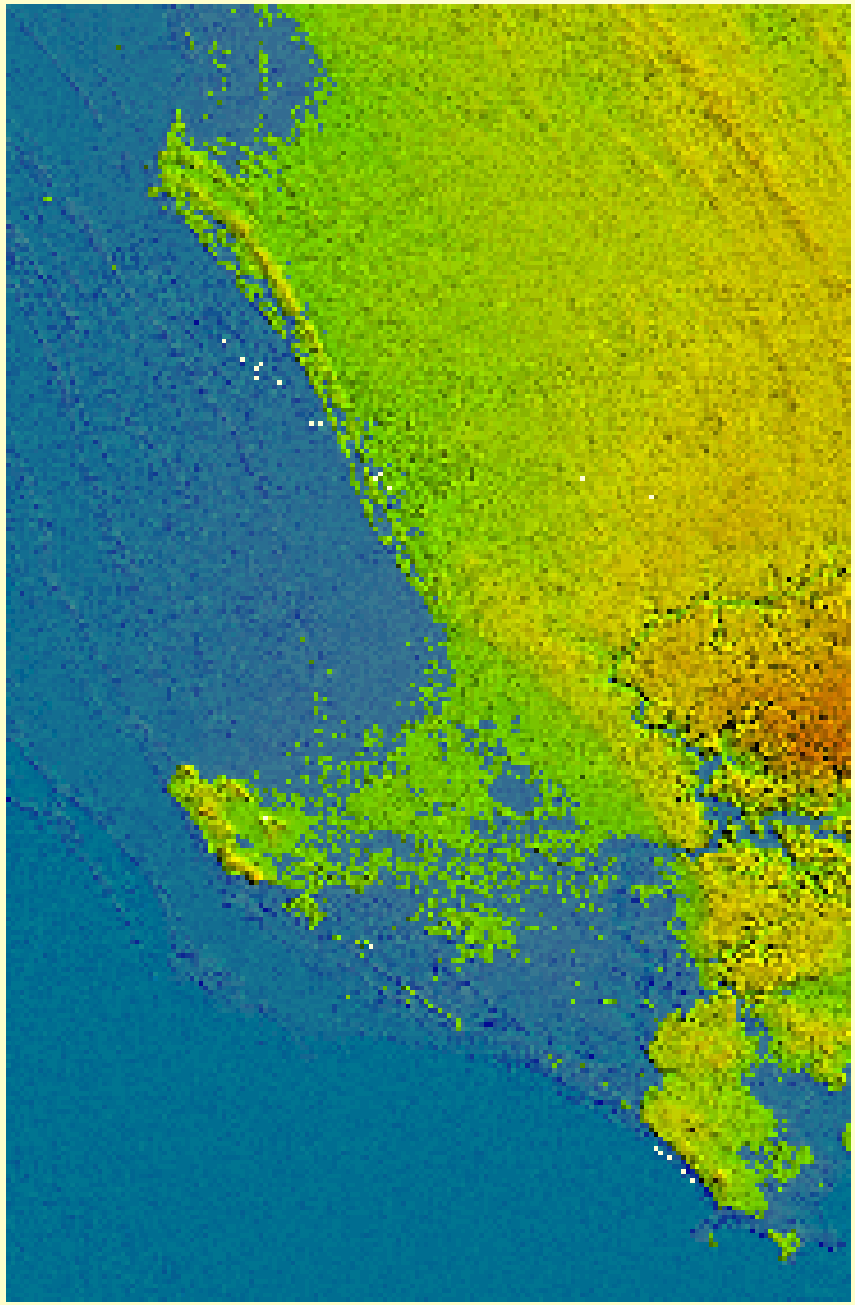


550 - 50 Ka

- Surface lowering especially where Gambier Limestone is not covered by dunes
- Lower SL and dune development
- Alternating wet and dry periods
- Solution pipe development
- Sediments fill caves



Digital Elevation Model showing 70 m Sea Level

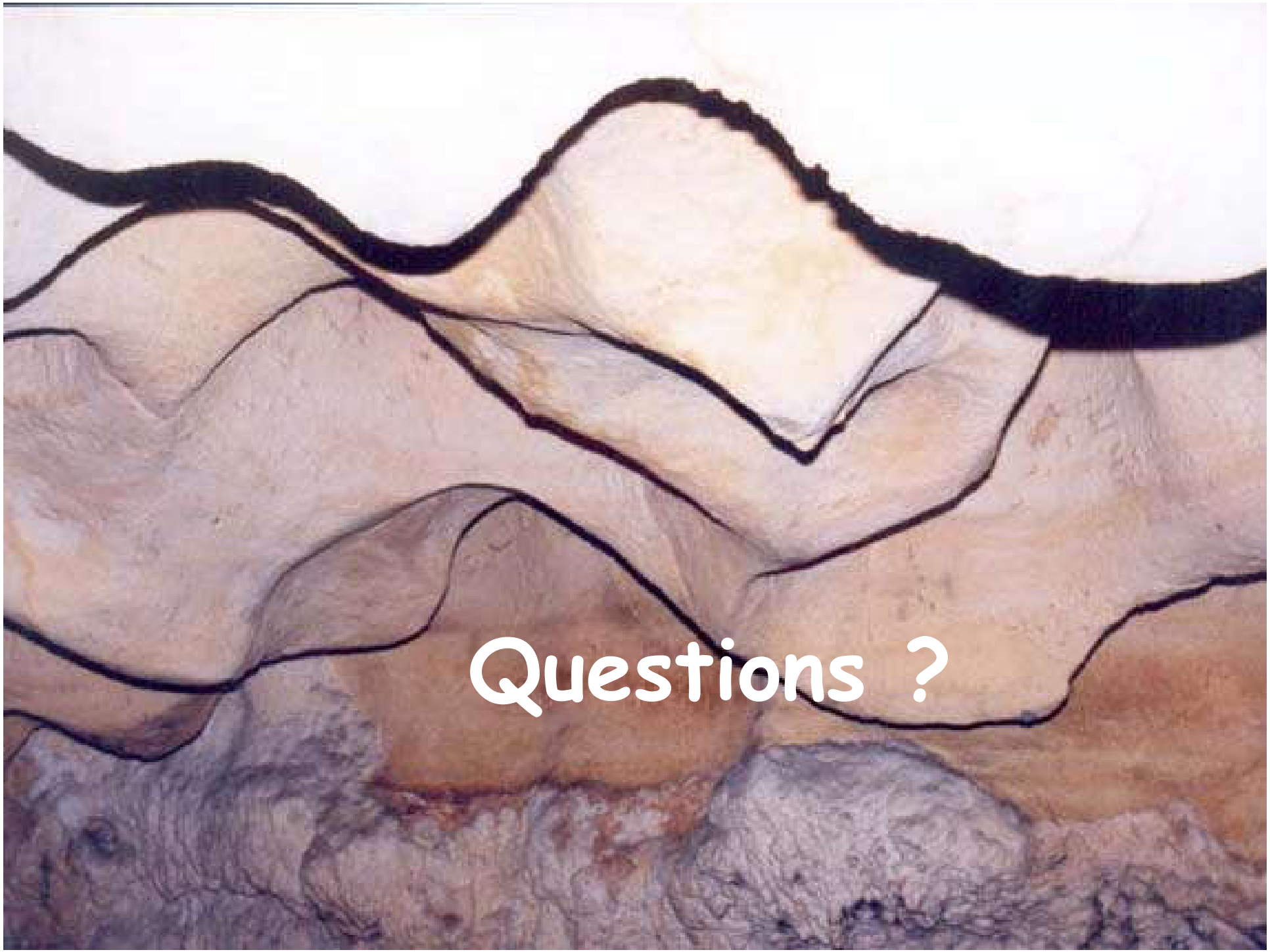


Conclusions:

- Cave development at Naracoorte began between 1.1 Ma and 800 ka
- Conduit formation was related to ground water conditions in a coastal environment
- Ground water conditions were influenced by the incision of Mosquito Creek and movement on the Kanawinka Fault
- Major cave development was related to estuarine and back swamp conditions

Conclusions:

- The caves drained when the West Naracoorte Range was deposited and major collapse was the result.
- The caves have never been flooded again
- Solution pipes formed later than the main caves
- Infilling of caves by clastic sediments and speleothems reflects the cyclical wet and dry phases of the Pleistocene


Questions ?