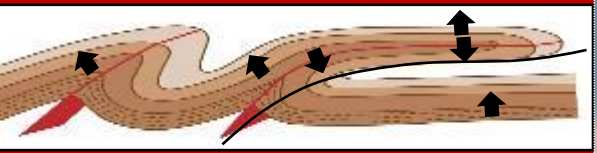
Cliffs along the Cryogenian Coast record a vast stretch of geologic time and the fascinating history of three major Glacial events. The rock sequences get progressively younger from NE-SW laying out a *Deep Time* trail.

- 2000 million years ago this area was a deep ocean basin; thick sediments were deposited, and small (micro)Plates or Cratons drifted and jostled across the earth's surface.
- 1500 million years ago some Cratons collided with basin sediments. Folding and metamorphism created tough crystalline gneisses. Some rocks melted and this created magmas and gigantic volcanic eruptions.
- 1000 million years ago mantle currents began to break the Craton apart, and over the next 400 million years, formed the Adelaide Rift Superbasin. This coast sits astride the Rift margin and displays pebble conglomerates, sandstones, and shales as well as glacial debris from the "Cryogenian" period of Earth history,when vast iecaps & glaciers covered the Earth.

- SW along the coast, Ediacaran Period (635m.y.) sediments and Cambrian (540m.y.) limestones & muddy sands can be found in the cliffs and shore platforms.

A monumental plate collision at 500m.y. stacked the rock formations on top of each other to form a vast mountain chain 1000's of km long. Many rocks were stretched and squashed, while at the contact zone enormous sheets of rock were bent (folded) and turn upside down in large overfolds, known as nappes (meaning tablecloth). The mountains were named the Delamerian Mountain Chain after the small village of Delamere just inland from here.



300m.y. ago and more recently at 2.5m.y. two more global glacial events occurred. The Permian glacials include thin clifftop red & yellow sands, while more recent Pleistocene glacial events show sea level changes with perched valleys, caves & raised beaches; whilst from 65000 years ago the first peoples of this area would have experienced these great sea level changes at first hand. Then Colonel William Light arrived from England in 1836.

Topsy Turvey Tectonics

Topsy Turvey Tectonics

Rocks & landscapes along this coast reveal an astonishing record of global geological events and changes spanning almost half the age of our Planet Earth, from 2 billion years to the present day. It also displays remarkable rocks from the Cryogenian Snowball Earth period (ca. 720–635 million years ago) and the roots of the Delamerian Mountains which formed 500 million years ago.

Fold here

Crystal-rich Rocks from Deep beneath ancient Mountains

Ground-up Debris from Grinding Glaciers

Sheared Schists & Stretched Pebbles

Stranded Cliff Caves and High and Dry Beaches

....Why is this all Topsy Turvey?

Fold here

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Fleurieu Geotales

Charting the Geoheritage of the Cryogenian Coast

Cruise through Vast Ages of Deep Time

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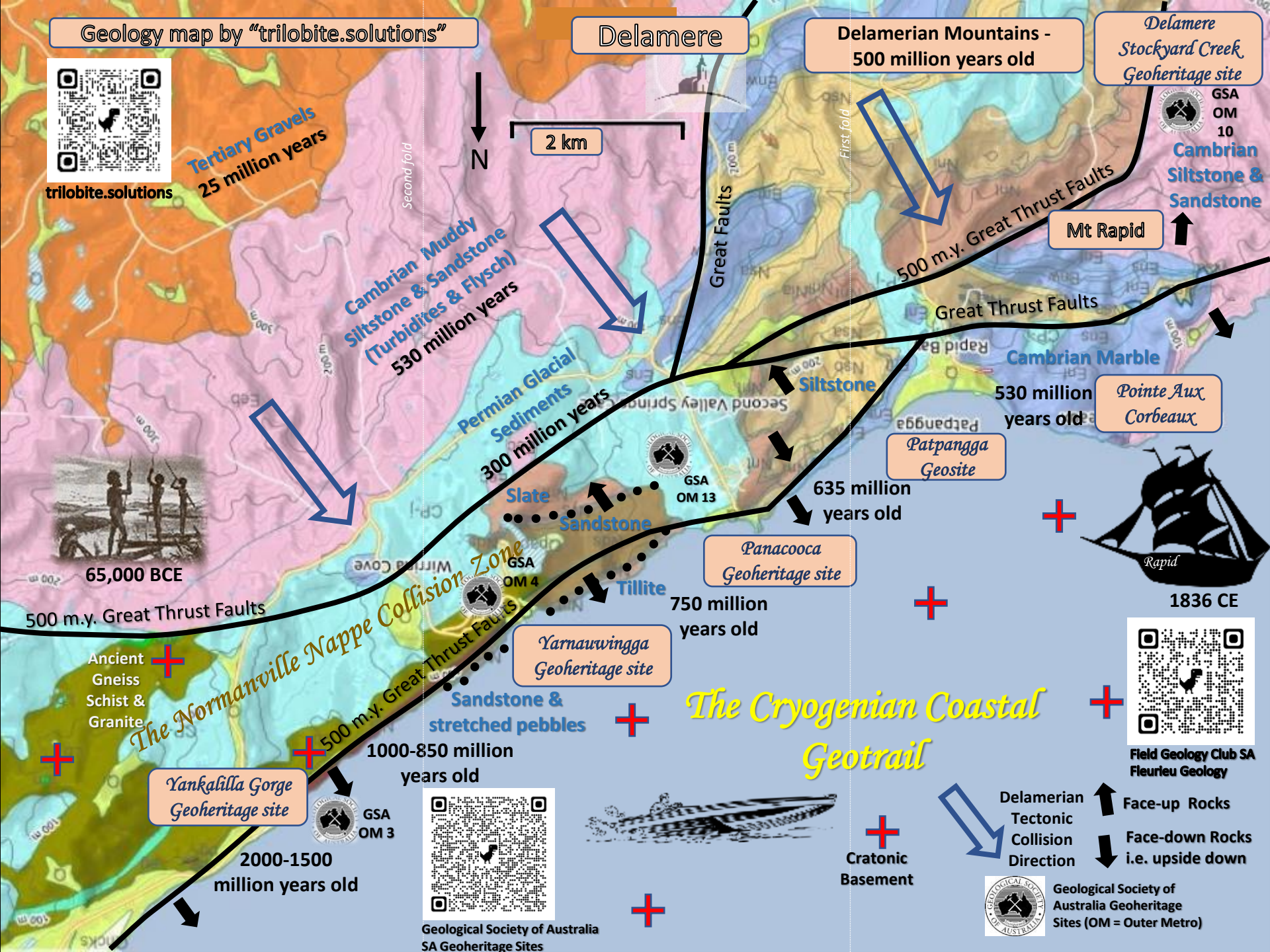
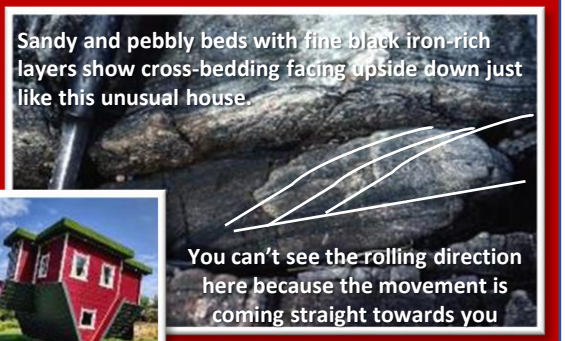

Geology map by "trilobite.solutions"
Delamere
Delamerian Mountains - 500 million years old
Delamere Stockyard Creek Geoheritage site
GSA OM 10
Cambrian Siltstone & Sandstone
trilobite.solutions
Tertiary Gravels 25 million years
N
2 km
Second fold
First fold
Great Faults
Mt Rapid
500 m.y. Great Thrust Faults
Great Thrust Faults
Cambrian Muddy Siltstone & Sandstone (Turbidites & Flysch) 530 million years
Permian Glacial Sediments 300 million years
Siltstone
Cambrian Marble
530 million years old
Pointe Aux Corbeaux
Patpangga Geosite
635 million years old
GSA OM 13
Slate
Sandstone
65,000 BCE
GSA OM 4
Tillite
750 million years old
Panacooca Geoheritage site
Rapid
1836 CE
500 m.y. Great Thrust Faults
The Normanville Nappe Collision Zone
Yarnauwingga Geoheritage site
Ancient Gneiss Schist & Granite
Sandstone & stretched pebbles
1000-850 million years old
The Cryogenian Coastal Geotrail
Field Geology Club SA Fleurieu Geology
Yankalilla Gorge Geoheritage site
GSA OM 3
2000-1500 million years old
Cratonic Basement
Delamerian Tectonic Collision Direction
Face-up Rocks
Face-down Rocks i.e. upside down
Geological Society of Australia SA Geoheritage Sites
Geological Society of Australia Geoheritage Sites (OM = Outer Metro)



Sandy and pebbly beds with fine black iron-rich layers show cross-bedding facing upside down just like this unusual house.

You can't see the rolling direction here because the movement is coming straight towards you

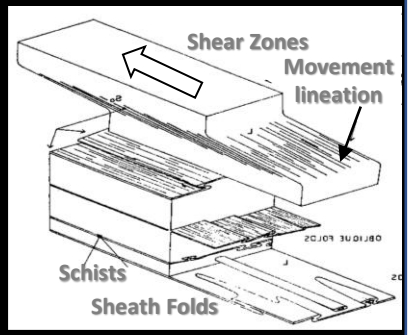
Rolled augen porphyroclasts and sheared "mylonite" schists at the Little Gorge beach

Fold here

Small augen (eye-shaped) inclusions in schists called porphyroclasts consistently show the rolling direction

Curious buckles and warps called Sheath Folds form like these famous ones from Spain. Similar geological processes occurred in Little Gorge

Ductile or pliable faults are called Rotational Shear Zones. The fault movement is spread over wide distances and small rolling structures occur. This Gorge has a fabulous array of rotation & rolling structures.



Highly sheared mylonitic gneiss & schist on the Lady Bay beach at low tide

Fold here

Ancient pebbles at the base of the Adelaide Superbasin sediments were stretched and sheared by colossal forces beneath the Delamerian Mountains Great Collision

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Geoheritage Site (OM3 - Outer Metro)

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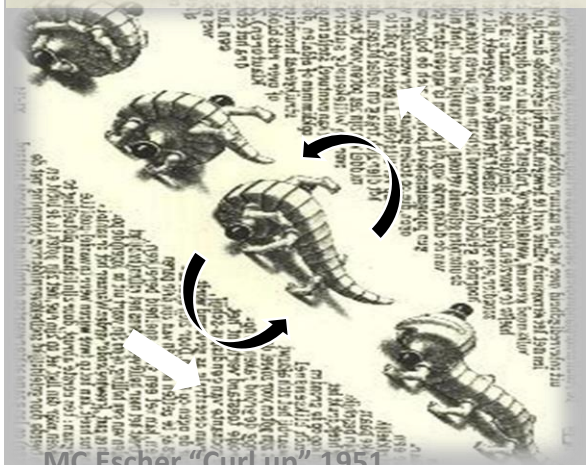
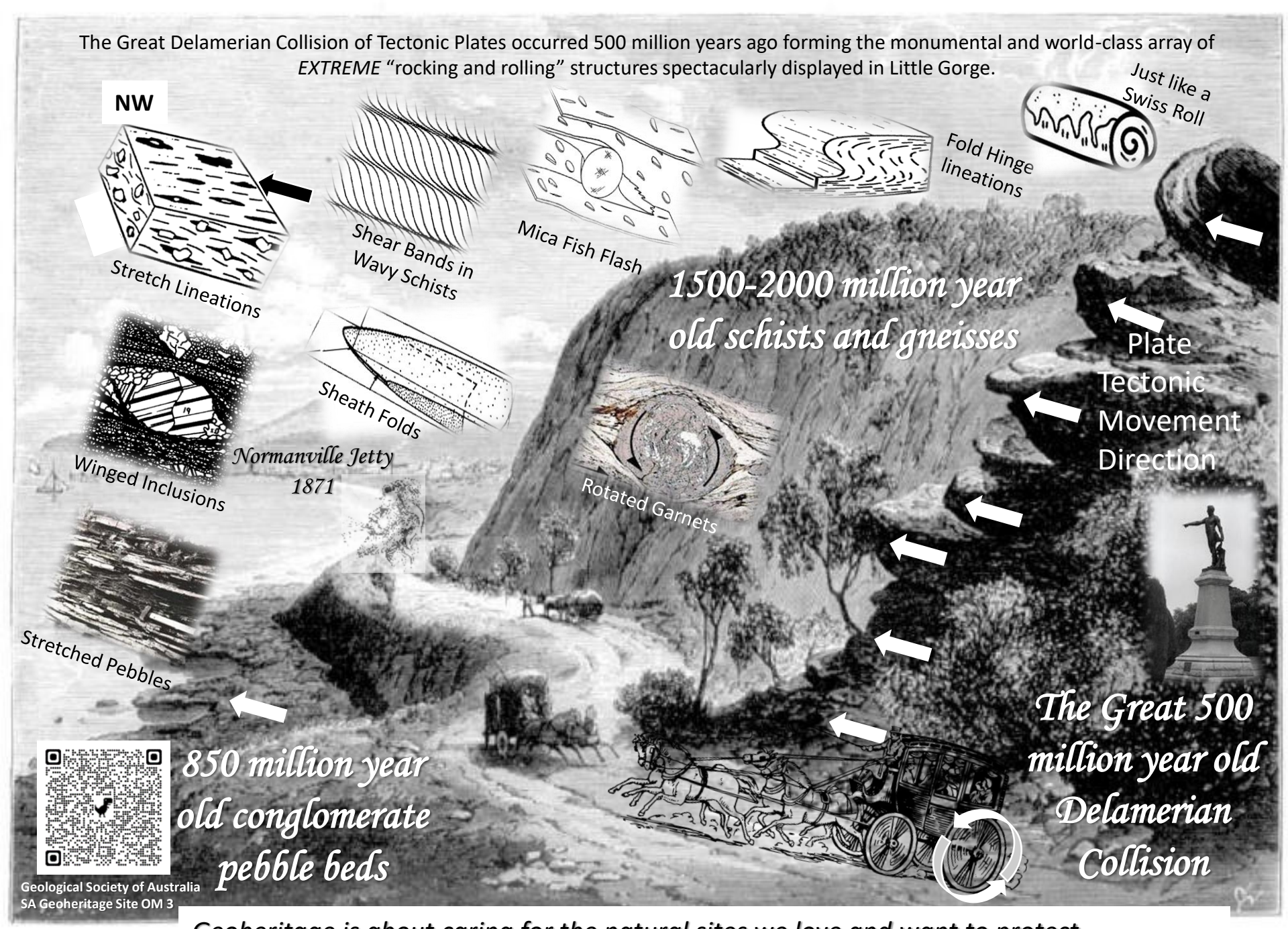
Little Gorge Geoheritage site The Great Collision

Let's do.....EXTREME Rock & Roll



MC Escher "Curl up" 1951

The Great Delamerian Collision of Tectonic Plates occurred 500 million years ago forming the monumental and world-class array of *EXTREME* "rocking and rolling" structures spectacularly displayed in Little Gorge.



Geological Society of Australia
SA Geoheritage Site OM 3

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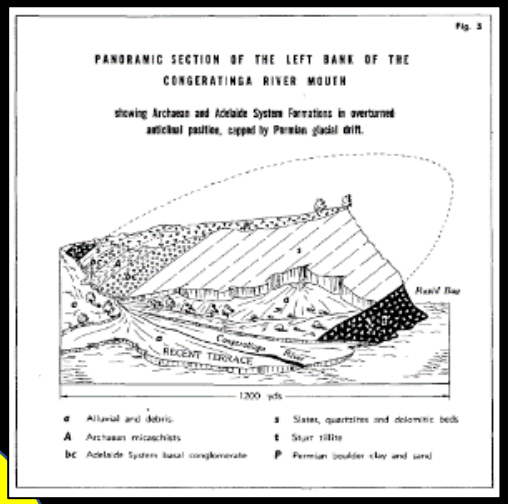
The steep cliffs on the south side of Congeratinga Beach, as seen before the Marina development, reveal a complex variety of squashed rocks like the "fold" below, produced during the spectacular Delamerian plate Great collision, which caused the folding and thrust faulting.

This exposure in an ancient cave in the cliff-face shows an identical pattern to the large-scale overfold seen on the cliffs. The top limb of the fold is thicker & facing right way up, while the lower limb is sheared, thinned and inverted (upside down).

Fold here

Bruno Campana showed that rocks at the Congeratinga Beach were upside down (facing down) on the steep seaward side. The faint curved trace projection above the cliffs shows what the overfolds might have looked like.



Wirina Cove Marina

Fold here

Adelaide University Geology students hang on to the overturned topsy turvey beds below the main thrust fault.

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Geoheritage Site (OM4 - Outer Metro)

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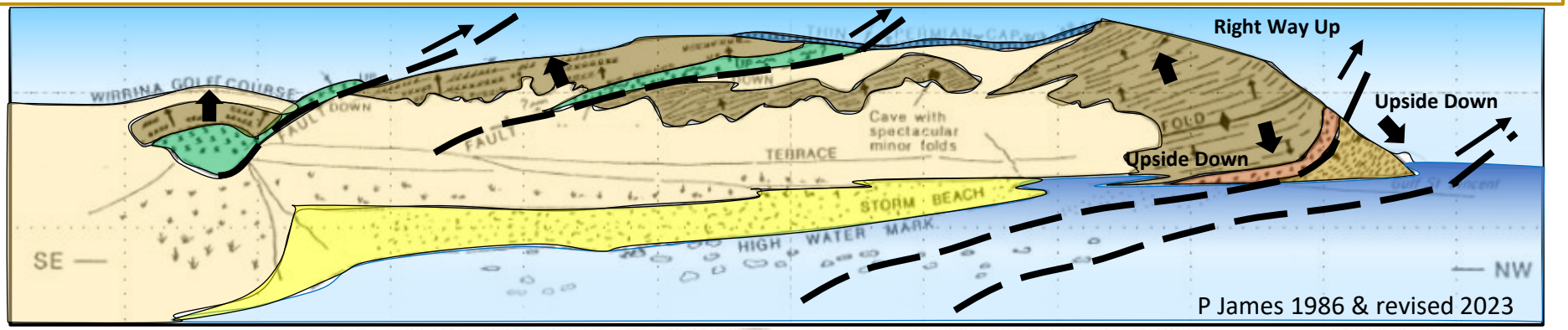
Yarnauwingga/Wirrina Geoheritage site

A Tale of Two Tillites & the Normanville Nappe's Turned-Up Nose

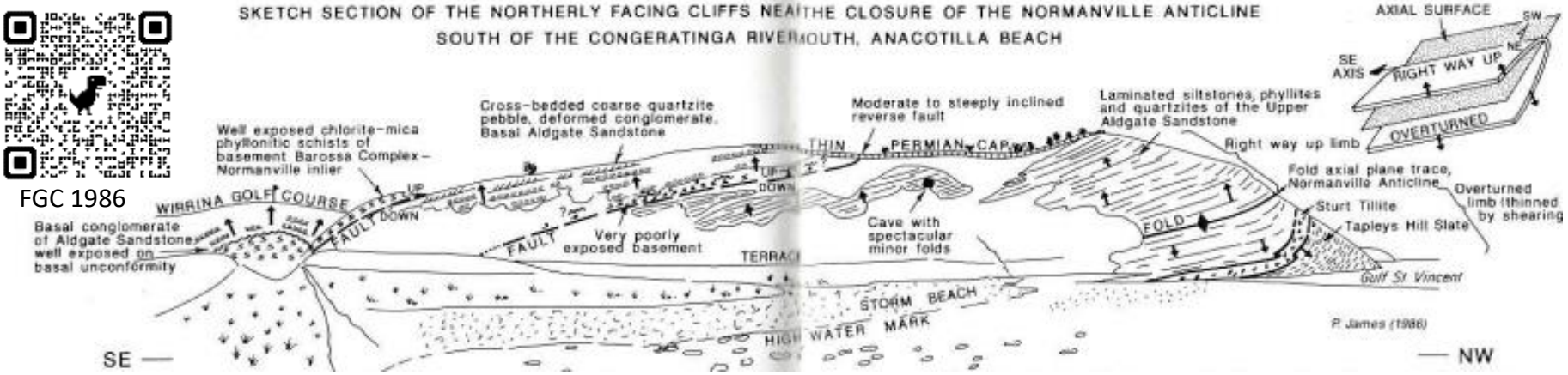
Yarnauwingga meaning "bald (hills) waterhole"

Yarnauwingga Geosite (*Third Valley, Poole's Flat, Wirrina Cove*)

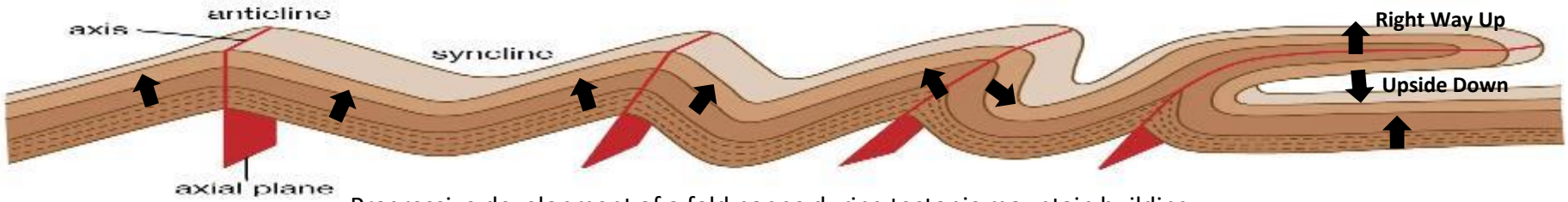
"Reinterpreted section across the Normanville Nappe's Turned-Up Nose"



FGC 1986



A Field Guide to the Coastal Geology of the Fleurieu Peninsula – The Field Geology Club of South Australia Inc. Hasenohr & Corbett, Eds. 1986



Progressive development of a fold nappe during tectonic mountain building

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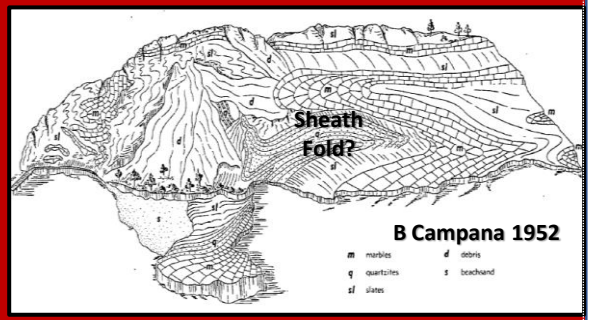
Elegantly harmonic wave-like folds occur in the black (muddy) & white (limy) striped slates from this cliff. They form by a combination of brittle overthrusting (where the rocks break) within the cliffs and by intense ductile shear. Ductile rocks can flow like honey when they are hot. Most South Australians know of the famous folds from Second Valley.

Bruno Campana - was an amazing Swiss Field Geologist who worked for the SA Geological Survey. He mapped and sketched the spectacular flat-lying folds at Panacooka and from his training in his native Alpine Mountains he recognized their origin as resembling nappe structures. He later worked for Rio Tinto in WA together with Lang Hancock where they pioneered the development of the world class Hammersley iron ores.



Campana knew that the correct way to observe fold styles was to look at them perpendicular to their fold axes! Which explains why he went to great lengths to recreate his famous cliff sketch as if made elevated and obliquely from offshore, like we can now do with drones (but long before drones existed).

Fold here

Panaccoca Cliffs are dangerously steep and friable, with a long history of unforeseen rescues. But their wondrous structural rock features hold the secrets of how the Delamerian Mountains were formed 500 million years ago.

The small "thrust" fault where the rock has broken is visible in this cliff near the jetty and is part of an overlapping series of faults called "imbricates". This repeated fracturing was first identified here clearly by Bruno Campana. Reg Sprigg & Douglas Mawson had already recognized thrust faulting as important on the Peninsula.

Fold here

The coastal rocks have a very strong slaty lineation (see arrow) which shows the SW trending direction from where the Delamerian plate collision and thrusting movements came 500 million years ago.

Curious buckles and warps called "Sheath Folds" form during intense squashing and shearing of rocks, like these famous ones from eastern Spain's Cap de Creus. The central quartzite lobe on Campana's sketch may be one of these.

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Geoheritage Site (OM13 - Outer Metro)

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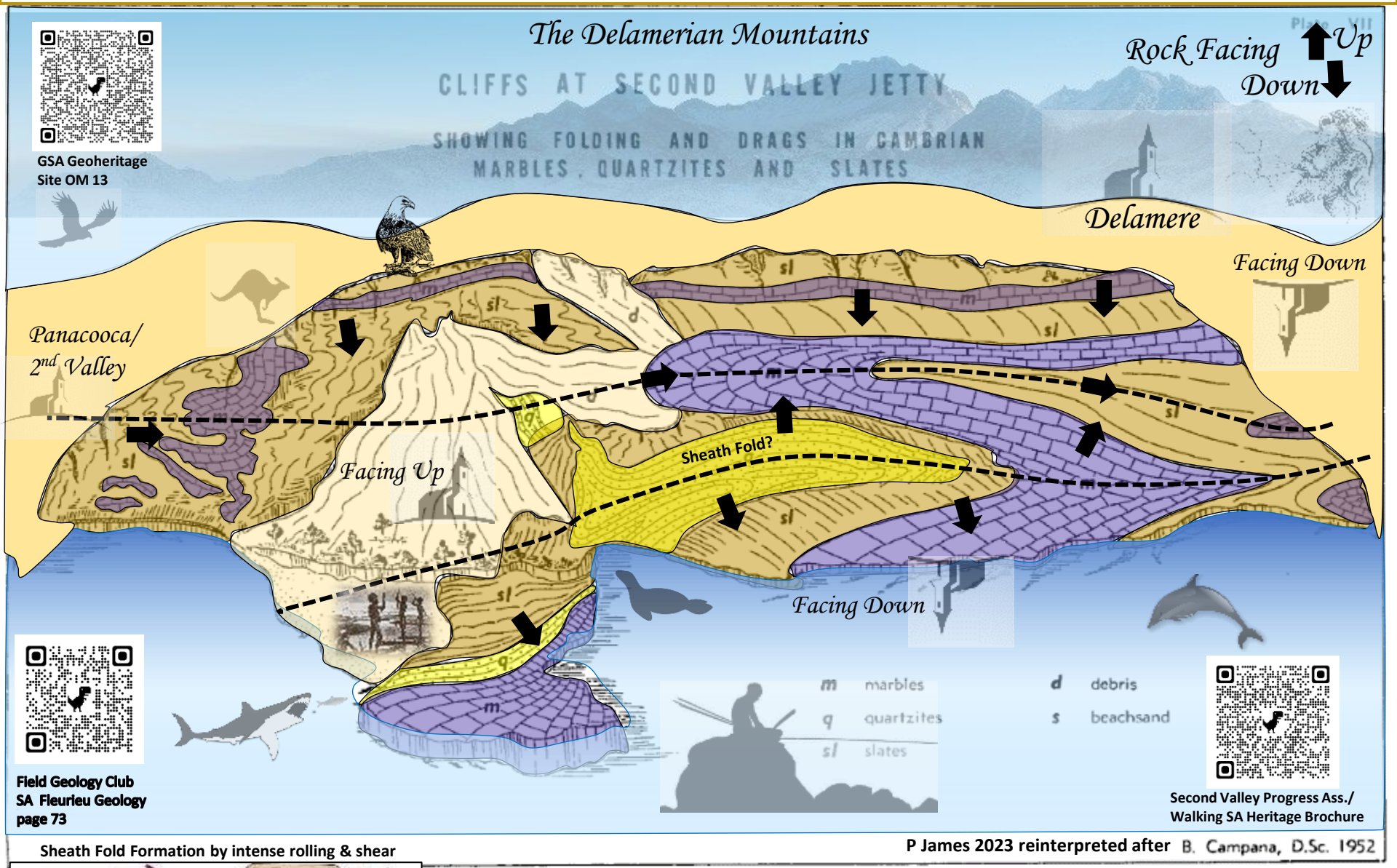
Panacooca/Second Valley Geoheritage site

Fabulous Folds & Sheared Slates

Panacooca meaning "At the head of the valley are two marble hills, one on each side, and at the foot of each hill is a beautiful spring of fresh water".

Panacooca (Second Valley) Geosite



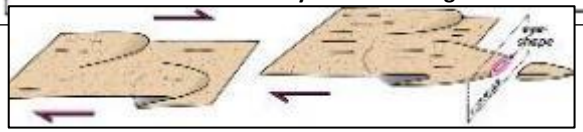
GSA Geoheritage Site OM 13

Field Geology Club SA Fleurieu Geology page 73

Second Valley Progress Ass./ Walking SA Heritage Brochure

P James 2023 reinterpreted after B. Campana, D.Sc. 1952

Sheath Fold Formation by intense rolling & shear



A Tectonic Nappe is a large sheetlike body of rock that has moved more than 2 km above a thrust fault from its origin.

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Andersons Marble Quarry in Rapid Bay 1950

Perched cave well above high water mark formed at earlier high sea levels

Intertidal littoral cave formed by erosion along fractures and joints by extreme hydraulic pressure generated by waves

While Leafy Dragons glide effortlessly beneath the water

Fold here

Kids (for scale) whilst scrambling alongside giant ptygmatic folds in sheared marble layers.

Ptygmatic folds (ptygma, Greek meaning anything folded) form when harder calcite marble veins buckle within softer black slate during intense shear

Fold here

Metamorphism and shearing of limestone produces an unusual fine-grained calcite texture called a mylonitic marble (after Greek *mylos* to mill)

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Patpangga/Rapid Bay Geosite

Leafy Dragons Dance in Underwater Caves with Marvellous Marbles & Ptygma Enigmas

Patpangga meaning "South Place"

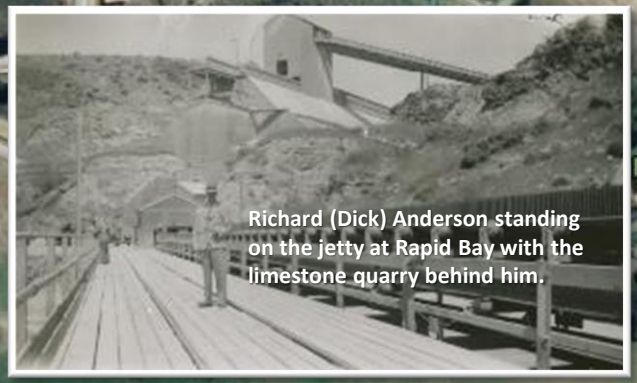
Rapid Bay played a significant role in the establishment of Adelaide from colonisation to the Quarry that provided essential resources for the 1940 war effort

Colonel William Light was tasked with surveying the new colony of South Australia, on the ship "Rapid" and landed here on 8th September 1836. He described the area as a 'little paradise.' Rapid Bay was almost chosen as the capital of South Australia because it had "a good harbour, a good source of freshwater, expanses of arable land an abundant supply of building materials."

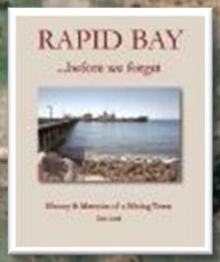
Field Geology Club of SA
Fleurieu Geology, p.77

- Major limestone deposits were discovered by BHP in 1925 and the Quarry began in 1940, when World War 2 had just started, and there was increased demand for steel production.
- A road was dug into the hillside to the level of the proposed quarry floor.
- Limestone was excavated by explosives & shovel, then trucked up the hill, dropped into the primary crusher and descended the slope through many different processes until it reached seal level, where it was transported along the jetty onto ships
- Adelaide Brighton Cement took over the Quarry in 1982

Rapid Bay Jetty



Richard (Dick) Anderson standing on the jetty at Rapid Bay with the limestone quarry behind him.



Sources, photos and text Des Lord "Rapid Bay.....Before We Forget" 2018 and "Jim's Urbex" website 2021 (see QR)