'Geo-Log'
2017

Journal of the Amateur Geological Society of the Hunter Valley

'Geo-Log' 2017

Journal of the Amateur Geological Society of the Hunter Valley Inc.

Contents:

President's Introduction.

Hello members and friends.

This past year has ushered in a few changes. Firstly, Ian Rogers after ten years of dedicated service as secretary decided it was time for a rest handing over the secretary's job to Richard Bale who was Vice President. This then saw Terry kingdom elected as Vice President.

Sue Rogers also decided to forgo her job as Minute Secretary, but not before shepherding the new committee through major constitutional change. With both Ian and Sue's stewardship along with Dave Atkinson's helpful advice, we negotiated this exercise seamlessly. So on behalf of all involved in the administration and membership of the society, we thank you.

We also welcomed new members to our society with most bringing very impressive skills and qualifications. And indeed Dr Janece McDonald jumped into the deep end and put herself up to run a very successful multiple day activity to Wombeyan Caves in the Southern Highlands.

The past years activities proved to be quite varied and educational. We revisited Winnie Bay in very hot conditions and we ran an exploration day to the northern end of Number One Beach at Seal Rocks. Winston Pratt ran a class style activity on fossils. We travelled to Lithgow, then out to White Cliffs and Tibooburra for a 3-week excursion to acquaint our selves with the Tibooburra Inlier and Thomson Fold Belt. Then down to Moruya on the South Coast to examine major deformation of sedimentary structures and igneous intrusions associated with the Narooma Accretionary Complex and Lachlan Fold Belt. And finally Janece McDonald, who ran her first activity to the Wombeyan Caves.

I congratulate all the leaders on these well-run activities. The logistics and organisation in running these activities consume much time and resources. In cases like Tibooburra, it was a two-year exercise to plan, reconnoitre and run the excursion. And to the members who came along and supported these activities, thank you as your involvement makes it all worthwhile.

Many thanks also goes to the social committee who organise and run the Soup & Slide night and the end of year Christmas party. An enormous thanks also to Ian and Sue for their generosity in opening their home yet again for these social activities and committee meetings throughout the year.

Next years activities are shaping up to be as varied and exciting as last years program, leading the society from strength to strength.

And last but certainly not least, to Ron Evans a huge expression of appreciation for compiling and producing another excellent Geo-Log. Your efforts and excellent work do not go unnoticed, thank you.

Chris Morton.

Winney Bay

Leader: Barry Collier.
Date: Wednesday 11th January 2017.
Attendance: 14 members.

The last visit any members of the Society made to Winney Bay was an unscheduled trip organised by Chris Morton in February 20123 to show geologist Chris Herbert some of the area's enigmatic sedimentary structures. Chris had promised a good day weatherwise but by the time we had assembled at the head of the track the weather had turned atrocious. The rain was torrential and the wind so strong that umbrellas were mangled in seconds. Not much was seen that day!

Again the weather threw extraordinary conditions at us, with in excess of 40°C forecast for the Valley and the humidity almost unbearable. In reality the trip should have been cancelled, but the turnout under such conditions was equally as extraordinary.

The usual parking space around the water tower beside Cape Three Points Road in Avoca, at the head of the walking track down to Winney Bay, was fenced off due to tank repairs so the group assembled in the small parking bay off Endeavour Drive nearby. Here we found that the track had been closed by local Council due to the extreme fire risk so we drove three kilometres south to Captain Cook Lookout just north of Copacabana where there was ample parking. This lookout is a new addition to the local attractions and at an elevation of 110 metres provides a superb view southwards over Copacabana and down the coast beyond *(photo 1)*.

Before setting out on the walk some cars were taken a few hundred metres further down Del Monte Place Drive and left there so we could return via the new stairway up from Winney Bay.

From the car park at Captain Cook Lookout we set out on a narrow but well-trampled track through

1. View south over Copacabana from Captain Cook Lookout.

2. Liesegang rings in sandstone.

coastal heath which took us adjacent to the cliff edge around First Point headland and past several magnificent viewpoints, one overlooking a narrow gorge the walls of which showed great examples of Liesegang banding in the sandstone *(photo 2)*.

The track then descended quite steeply to an elevation of around 30 metres and continued through dense littoral rainforest to a cleared grassy area which was once the site of a market garden. The total distance from the carpark was around 1.5 kilometres.

The rock platforms and cliff sections around Winney Bay comprise Triassic sediments within the Terrigal (formerly Gosford) Formation. Lying at the top of the Narrabeen Group immediately below the Hawkesbury Sandstone, these rocks were laid down as a series of overlapping distributary river channel, overbank (floodplain) and lake deposits.

The first area to be visited lay in the lower cliff section at the north side of the Bay where river channel and lake bed deposits lay exposed in section. The purpose here was to examine the siderite (ironstone) bands precipitated from river water on top of laminated lake bed shales. However the group was to be disappointed. The unusual spherical radial crystal aggregates referred to by some as "Guilielmites" (Byrnes, et.al., 1977) which on previous visits had been beautifully exposed along the underside of the siderite bands were this time found to have been totally destroyed by salt crystallisation. The absence of any significant periodic rainfall to wash away salt-laded spray had resulted in the complete disruption of the crystal aggregates. Fortunately on a previous visit with the Australian Museum in February 2010 I had been able to remove one extraordinary specimen *(photo 3)*.

These unusual crystal aggregates occur scattered along the underside of the siderite layers and project

3. Spherical radiate groups of fluorapatite embedded in the underside of a siderite horizon. Specimen is 17cm across. Brian England specimen (R591)

4. Siderite band containing the crystal aggregates shown in photo 3 with lake bed shales below and distributary channel sands above. Section approximately 1 metre across.

down into the underlying shales *(photo 4)*. X-ray powder diffraction (XRD) analysis by staff at the Australian Museum suggest the composition of the aggregates is close to fluorapatite but the crystal morphology does not match any of the apatite group species, nor was any chemical analysis carried out to confirm the XRD result. So the true nature of these features remains in doubt.

The main features of interest on the extensive rock platforms around the central part of the Bay are the magnificent exposures of trough crossbedding *(photo 5)* and in a nearby cliff face a vertical section through a series of overlapping trough crossbeds was found *(photo 6)*. A diagrammatic representation of these features is shown in *photo 7*. Unlike normal planar point bar crossbeds which build up over a flat surface, trough crossbeds are laid down in erosional troughs in the river bed with the individual layers concave toward the down current direction.

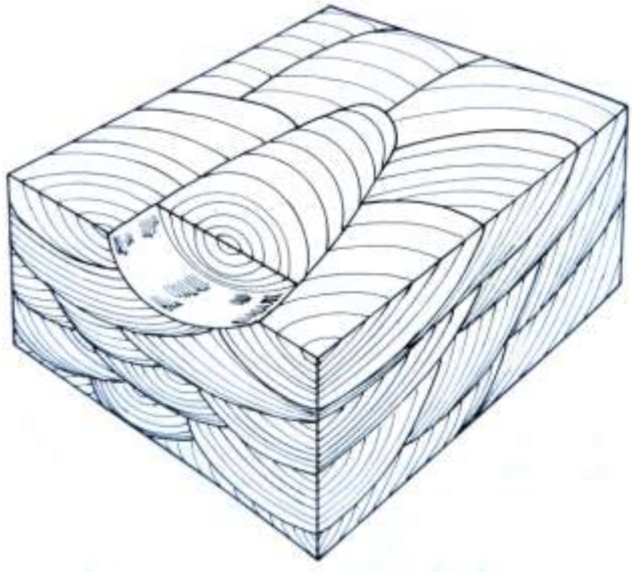
The same cliff line displayed a section through a meandering sand-filled distributary channel cutting in and out of the cliff face. Above this lay a distinct band of dark grey ripped-up mud clasts enclosed in sandstone *(photo 8)*. These distinctive layers form when a flood rushes over a dried-up lake bed, rips up the desiccated surface layer, and redistributes the fragments over the adjacent flood plain. Several such layers can be seen around Winney Bay, indicating that periodic dry periods followed by significant flooding was part of the climate regime at that time. Some of these ripped-up clasts are large (up to one metre) and often lie isolated in the enclosing sandstone *(photo 9)*. One clast in particular *(photo 10)* retains the desiccation cracks formed on the lake bed and these became filled with sand during transportation to form small "sandstone dykes" which have subsequently been deformed by vertical compression and lateral displacement along bedding planes in the shale. Some of the siderite horizons also show disruption and transportation by floods *(photo 11)*.

Nearby on the rock platform a specific thin layer of even-grained fine sandstone shows abundant small pits *(photo 12)*. Their origin remains unexplained but certainly the periwinkles which occupy each pit play some part. Spectacular Circular structures of concretionary origin are also present here *(photo 13)*.

Near the south side of the Bay a spectacular metre-wide basalt dyke is exposed in the rock platform and adjacent cliff face *(photo 14)*. The dyke shows pronounced cooling joints at right angles to its margins as well as prominent longitudinal joints. There is also a thin heat affected zone in the sediments adjacent to the dyke and the sedimentary bedding on either side shows slight displacement indicating that some movement had taken place along the host joint either before or during intrusion of the basalt. The basalt in this dyke is unusual, containing small vesicles formed by outgassing of water and carbon dioxide from the magma, suggesting that the dyke may have been emplaced very close to the then land surface. There the confining pressure would have been considerably reduced enabling the dissolved gases to be released like the bubbles in an uncorked bottle of soft drink before the magma cooled and hardened. This dyke also clearly shows the effect of land-based weathering where the minerals in the basalt have been converted to clays above the water table (lowest extent of weathering) making the top deeply weathered section impossible to distinguish from the enclosing sandstones at a distance. The dyke is thought to be around 100Ma and associated with the opening of the Tasman Sea, when stretching of the rocks resulted in deep open joints extending down to the mantle.

South of the basalt dyke beds of fine even grained

5. Trough crossbedding on the rock platform.



7. Diagrammatic representation of trough crossbeds in horizontal, transverse and longitudinal section. From Pettijohn (1957).

6. Vertical section through a succession of overlapping trough crossbeds in the cliff face near Photo 5. Section approximately 1.5 metres across.

8. One of the layers of ripped-up mud clasts formed by sudden flooding over a dried-up lake bed. Section is approximately 1 metre across.

sandstone show excellent examples of honeycomb weathering *(photo 15)*. A nearby major joint leads across the pavement to a narrow vertical cleft in the adjacent cliff *(photo 16)* – a future sea cave under construction!

We continued south along the rock platform to a small raised bench. Here in the cliff face on previous visits we had come across an intriguing sedimentary structure which at the time resulted in much discussion (See Geo-Log 2008, page 30). It was then assumed to have been the result of river bank collapse but subsequent investigations have shown it to be a dewatering structure formed when pore water in the sandstone had been forced upwards through a point of weakness due to the increasing weight of overlying sediment. Unfortunately on this visit the structure lay hidden behind a thin crust of adhering salt and sand, but a photograph of how it appeared in August 2008 is shown in *photo 17*.

On previous visits by the Society some had gone further south, negotiating a narrow ledge between a 20metre drop into the pounding surf and a dangerously unstable overhang. But those who went on to explore that area on its trip found the features they'd seen before obliterated by a major rock fall.

The heat and humidity was getting to everyone and as we took shelter against the cliffs just south of the entry point before undertaking the arduous climb up the new concrete stairway and back to the cars, someone noticed something quite unusual. Water seeping from natural soaks in the shales had resulted in the development of a spectacular group of goethite/calcite flowstones and stalactite formations *(photo 18)*, a sign that there had been no significant rainfall for some time. That would have totally destroyed these structures.

A car shuffle at the top of the stairway allowed drivers to return to their cars at Captain Cook Lookout. Several people retreated to a café in Copacabana, where, although it was past closing time, the young girl behind the counter obliged with not so perfect iced coffees. But they were cold and wet and revived everyone sufficiently for the drive home.

Report by Barry Collier with geology by Brian England.
Photographs by Brian England.

References:

BYRNES, J.G.; RICE, T.D. and KARAOLIS, D. (1977). *Guilielmites formed from phosphatized concretions in the Ashfield Shale of the Sydney area.* Records of the Geological Survey of New South Wales, 18(2), 169-200.

PETTIJOHN, F.J. (1957). *Sedimentary rocks*. Harper and Row, New York.

11. Dismembered siderite lens with fragments separated and reoriented by floodwater. Section about 1m across.

9. One of the layers of ripped-up mud clasts formed by sudden flooding over a dried-up lake bed. Section is approximately 1 metre across.

12. Small potholes in rock platform.

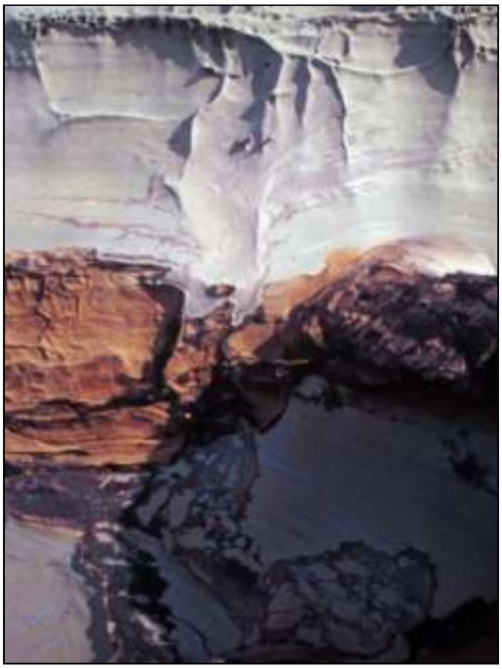
10. Ripped up mud clast retaining desiccation cracks, later filled with flood sand. Note compression of the shale but not the sand infills, which have distorted to overcome compression.

13. Concretionary structure in fine sandstone on rock platform.

14. Basalt dyke in rock platform and adjacent cliff.

16. Incipient cave development along a major joint.

15. Honeycomb weathering developed in dense even-grained sandstone bed.



17. Spectacular dewatering structure in sandstone as it appeared in August 2008.

18. Group of goethite/calcite stalactites forming under a narrow ledge in the cliff from seepage. Field of view is about 15cm across.

Seal Rocks

Leader: Chris Morton.
Date: Wednesday 8th February 2017.
Attendance: 11 members.

An exploration of a rocky headland on the northern end of Number One Beach, Seal Rocks.

Although the Society has conducted five activities to Seal Rocks, we have never examined the rocky headland at the northern end of Number One Beach. This is not surprising considering the dangers that are clearly present from the sea. This area can only be accessed at very low tides preferably during January, February or March when there are seasonal king tides.

The safety issues along this coastline cannot be emphasized enough. Some of the hazards that should be kept in mind are the wet slippery and weed covered rocks, rogue waves that may inundate the area, and a 100m section of beach that is completely covered with smooth rounded and sometimes algae-covered rocks. that range in size from 1.5m to football size. Some are loose and unstable in places and easy to roll when stood on (a fall here could have dire consequences). Also the ever-present danger of falling rocks should not be discounted. So it makes traversing this beach section particularly challenging and dangerous.

Geological setting.

The strata examined during this exploratory trip are Carboniferous (Visean, Westphalian), and occupy the stratigraphic interval between the Nerong Volcanics and the Alum Mountain Volcanics (Engel, 1962). They make up the transgressive basal part of a small forearc rift basin in the southern New England Fold Belt that has been informally termed the Myall Trough (Skilbeck, 1982 and Leitch, 1982). Depositional environments range from non-marine and tidal shore zone to shelf and base-of-slope (Boyde 2005).

The Yagon Siltstone constitutes a wholly marine and rapidly deepening succession deposited in response to a marine incursion into the eastern Myall region. Most of the formation (fossiliferous or bioturbated siltstone and mudstone) was deposited below wave base in outer parts of a marine shelf, but at times there were incursions of sand and volcanogenic debris (Violet Hill Volcanic Member) because of storm-generated currents (Skilbeck 1982) or outbursts of volcanism. In the east Skilbeck recognised three major sedimentary systems of shelf fossiliferous siltstone and interbedded sandstone, followed in easternmost sections by sediments deposited within a submarine fan. Three facies recognised within the fan include:

- A proximal inner fan to canyon mouth succession of slumped shelf sediments interbedded with siltstone.
- Superfan lenses of course sandstone and conglomerate.
- Overbank deposits consisting of thinly bedded sandstone graded sandstone, siltstone and minor conglomerate.

A shelf system of siltstone and mudstone constitute the upper part of the formation. Two brachiopod zones are present within Yagon Siltstone. The *Marginirugus barringtonensis* Zone in lower parts of the formation and the *Levipustula livis* Zone in middle to upper parts of the succession. Conodonts from within the *M. barringtonensis* Zone suggest late Visean (Early Carboniferous) to late Namurian (late Carboniferous). (Geology of the Camberwell, Dungog and Bulahdelah 1:100,000 sheets, 1991).

Many features indicate that during sedimentation in the forearc basin seismic activity occurred creating NW-SE extensional stresses, which produced fractures along where highly fluidised sands, rich in volcanic detritus could be emplaced. Slumping of some sandstone units also took place at this time as a result of this activity. The reason for the extensional features occurring oblique to the trend of the forearc basin is not known. However, paleomagnetic studies have revealed that block rotation has taken place in other parts of the basin. Thus the current trend of the extensional structures may be a result of rotation produced as a result of oblique convergence (Boyde 2005).

The outing.

The trip from the Central Coast and the Hunter region was living up to the weather forecast of very hot and humid with 80% chance of rain. However by the time we arrived at Yagon Camping Area within the National Park the skies had cleared, allowing us to enjoy a nice morning tea. During this we were entertained by the local wildlife in the guise of at least 6 goannas roaming the camping area scavenging for food scraps in the fire pits. Two had discovered an unattended pan that belonged to some unsuspecting camper *(photo 1)*. By the time they were chased away the goannas had totally disrupted the contents of the pan onto the ground. Also capturing our attention was a Golden Whistler *(photo 2)* and many Blue Wrens flitting around in the trees and edges of the picnic area.

From here we ventured down to Submarine Beach which was named after the Royal Australian Navy submarine "K-9", that never fired a shot in anger, but is linked to one of the most daring raids of World War II, when three Japanese mini-submarines breached Sydney Harbour's defenses.

Although the subs were aiming for the US ship 'Chicago', they sank the converted ferry 'Cuttable', killing eight Australian sailors. It was hit by a torpedo,

1. Goanna enjoying the contents of a bait bucket.

2. Golden Whistler.

which actually passed underneath 'K-9', and the impact of blowing up the 'Cuttable', severely damaged the 'K-9', shaking loose machinery and damaging parts of the hull. The submarine lies in the tidal zone of Submarine Beach where the vessel ran ashore on 8 June 1945, after slipping the tow of its transport, on a voyage to Brisbane. The beach was named in honour of the vessel's resting place. This beach was originally known as Fiona Beach following the loss of the iron steamer Fiona in 1882. (Office of Environment and Heritage. http://www.environment.nsw.gov.au/)

Here we examined the marine fossils preserved in the steeply tilted almost vertical indurated mudstone that makes up Yagon Gibber Headland *(photo 3)*, which was laid down during the Carboniferous. Many fossils such as Spirifers, Productoids, Fenestella, Crinoids and others can be found here mostly in mould form *(photo 4)*. Then we returned to our vehicles for an early lunch and to relocate to Number One Beach in time to access the rock platform for a 1:30 pm low tide.

The walk along Number One Beach was interrupted when we came to where persons unknown had sectioned off a part of the beach with piles of stacked/balancing stones, creating an interesting diversion *(photo 5)*. From here a short walk brought us to the tilted rock platform where the relentless ocean has eroded the rocks to reveal many structural features. It is immediately apparent that this section of the coastline is quite remarkable. One of the first of many features is the tessellated pavement of the moderately dipping siltstone that was laid down during the Carboniferous. Adjacent to this, is a horizon containing well developed dewatering structures as well as intraformational slumping, and laminated siltstone.

Overlying this are thick parallel beds of Yagon Siltstone that are dipping west. Nearby a prominent shear zone is exposed in the cliff *(photo 6)*. It is very noticeable that on the southern side of the shear zone the siltstone beds are completely absent. There also seems to be a vertical igneous dyke abutting the shear zone. Moving up the ramp you climb onto a quartzite knoll, at the very edge of which is a small patch of fossilised worm burrows that has been exposed where the thin tessellated siltstone has been removed. Crossing the knoll and stepping down the tiered rock to a platform of siltstone, gives access to an interesting feature. Unlike the lower tessellated siltstone, this siltstone has developed a blocky surface that has been weathered at the edges giving it an spheroidal appearance.

3. Yagon Gibber Headland - steeply dipping mudstones containing Carboniferous marine fossils.

At this point you have arrived at a vantage point that gives you commanding views up and down the coast. And what a wonderful vista it is. To the south the beautiful blue ocean, golden surf washed beach, and the green swathed hills stretch back towards the steeply dipping rocky headland at the end of Number One Beach. Above this is the ever-present Sugarloaf Point Lighthouse that stands proudly silhouetted against the sky that has billowing clouds that threaten off in the distance, giving this scene a distinctly sultry attitude. Dominating the view to the north are the rocky cliffs that we wanted to explore. They stand firm against the relentless power of the sea; the cliff tops and eroded slopes are fringed with verdant bushland.

From this position you can view the spectacular vertical profile of the weathered cliff face that towers above Number Two Beach *(photo 7)*. The sequence of sandstone bedding, probably Koolanok Sandstone, which overlies the Yagon Siltstone, is quite dramatic. The prominently weathered columnar structure of the sandstone *(photo 8)* and the ferruginous concretion banding is stunning. Such is the weathering, that in many columns you can imagine all sorts of artistic features from faces to animals.

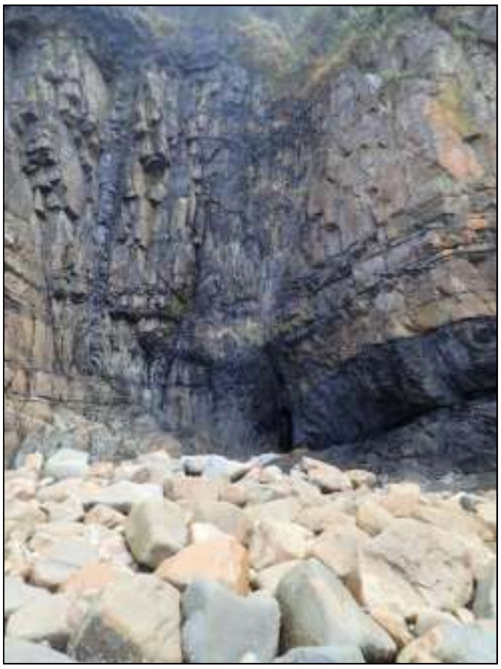
This structure is described as "ferruginous (limonitic or goethitic) joint fills. These have formed by groundwater percolating through the rocks over a long period of time, and dissolving iron from the rocks it travels through. The iron is precipitated out along the conduits the groundwater used to move toward the surface, in this case fractures or joints. It could also use fault planes. These are sub-horizontal fractures, which the iron-rich groundwater could have laid along for lengthy periods, precipitating the iron oxides out slowly so that they form concretionary layers". (Bob Brown 2016).

However it does not explain the nodular patterns that dominate the courser sandstone layers immediately above the Yagon Siltstone. This probably began, as dilation cracking that resembles crazy paving between the ferruginous bedding layers, and may be due to weathering by salt crystallisation at the edges creating the nodular effect. Also towards the centre of the escarpment is a 500mm wide vertical dilation dolerite dyke. Further consideration should be given to the environmental and climatic conditions in respect to the delivery of the sediment that make up the sandstone layers. The upper layers may be ash-derived sandstone from Violet Hill eruptions, which may explain the columnar structure.

4. Fossils of Brachiopods (Spirifers), crinoid stems and Bryozoans within the mudstone.

Another feature of this area is the boulder-strewn beach (Number Two Beach) below the cliff face. Boulders range from 1.5m down to football size and are unstable in places; these rocks are well rounded and have spent many years being sculptured by the surf. To gain access to the northern end of this beach, one must traverse these smooth slippery boulders, or through the surf on the lower sandy section. It must be emphasised that this is one of the most dangerous aspects of this activity. To travel further along the platform a 10m gutter covered in Cunjevoi (sea squirts), Cabbage weed (*Ulva* or sea lettuce), knee-deep water and the odd wave must be negotiated.

5. Collection of rock figures constructed by tourists visiting the area.



6. Shear/fault zone deeply weathered due to fine jointing of the rock. Note the dyke on the left side. Also note how the black mudstone (lower right) does not appear to the left.

7. Bands of sandstone (Koolanok Sandstone) above a layer of dark Yagon Siltstone mostly hidden by the rock beach.

8. Incredible weathering patterns in the Koolanok Sandstone sitting above the black Yagon Siltstone.

A brief report of the geology beyond this point.

Between Sandbar Beach and Number One Beach at Seal Rocks are five small pocket beaches. They occupy 2km of east-facing coast and range in size from 125m to 275m. All are backed and bordered by forested hills rising steeply to over 100m, and are only accessible by foot or boat. These beaches receive increasing protection from Sugarloaf Point, with waves averaging 1.2m at the northern Number Five and 1m at the southern Number Two. The beach also grades from one dominated by rips against the headlands at Number Six and Five, to a continuous bar and often no rips at Number Four and Three, to a reflective cobble beach fronted by rocks reefs at Number Two (Short 2006).

Once this obstacle has been negotiated, you experience a complete change in the structural environment. Firstly the angle of the siltstone platform has changed and is not as tilted. The prominent siltstone bedding planes are evident in the cliff face, with two distinct submarine channels in the sandstone that lies above the siltstone. Continuing on you come to magmatic dykes, shear zones, and in particular there are twin sandstone dykes that are quite prominent. At the end of this platform you come to another gutter, which on a previous occasion brought exploring to a halt. To cross this beach/gutter meant wading through chest high surf; on this occasion the tide was extremely low and the gutter was filled with sand so I did not get my feet wet.

Climbing onto a short rock platform heralds another change to the structure. A prominent fault and shear zone is evident before descending a tiered rock pool swathed in pink coralline algae, cunjevoi and cabbage weed (*Ulva* or sea lettuce) to the beach. Along the back of this 300m beach the rock walls display a variety of soft-sediment deformation structures. Outcrops exposing numerous examples of intraformational soft sediment and primary structures, along with ball and pillow structures, slump structures, unconformities, chaotic folding, dismembered sandstone layers, chaotically bedded mudstone within boudin-like masses of sandstone and erosional channels *(photos 9 to 13)*. These are probably the result of gravity-driven downslope processes in deep water. *(Complex depositional processes leading to these structures are summarized in Figure 1 on page 13)*.

The most surprising feature is at the end of this beach where an eroded column (stack) stands proud *(photo 14)*. This weather-beaten rock has stood defiantly for thousands of years against the persistent onslaught of the sea. I feel fortunate to have witnessed it. Within this silent sentinel you notice the contorted bedding that stands testament to the forces that affected these sedimentary layers 300 Ma when the east coast of Australia was developing.

9. Intraformational slumping and folding with an erosion surface on top, boudins and lamination.

10. Dewatering structure - water-laden sand was squeezed up through less saturated muds.

11. Complex section of fine-grained rocks showing jointing, faulting, convoluted bedding, dewatering structures and lamination.

14. Isolated stack.

Using an old cliché, "Time and tide waits for no man" has never been more important here. Because if you miscalculate you could be stranded with no way out. So with this in mind I beat a hasty retreat to the safety of Number One Beach. I cannot stress enough that this excursion should be carefully planned well in advance, considering tides, swell height and under no circumstances attempt this without 2 or 3 people that have good knowledge of the what the sea can throw up at you.

Report by Chris Morton and edited by Brian England.
Photographs by Chris Morton and Ron Evans.

Reference:

Geology of the Camberwell, Dungog, and Bulahdelah 1;100,000 Sheets 1991.

RON BOYD. (2005) Field Excursion notes - *Carboniferous Forearc Basin, Myall Trough.* (Material from Greg Skilbeck and Robin Offler).

C. GREGORY SKILBECK (2006). *Carboniferous Depositional Systems of the Myall Lakes District of NSW.*

SHANMUGAM, G. (2003). *Deep-marine tidal bottom currents and their reworked sands in modern and ancient submarine canyons.* Marine and Petroleum Geology 20, 471–491).

A. D. SHORT (2006). *Beaches of the New South Wales Coast. A guide to their nature, characteristics, surf and safety.* Sydney University Press, University of Sydney.

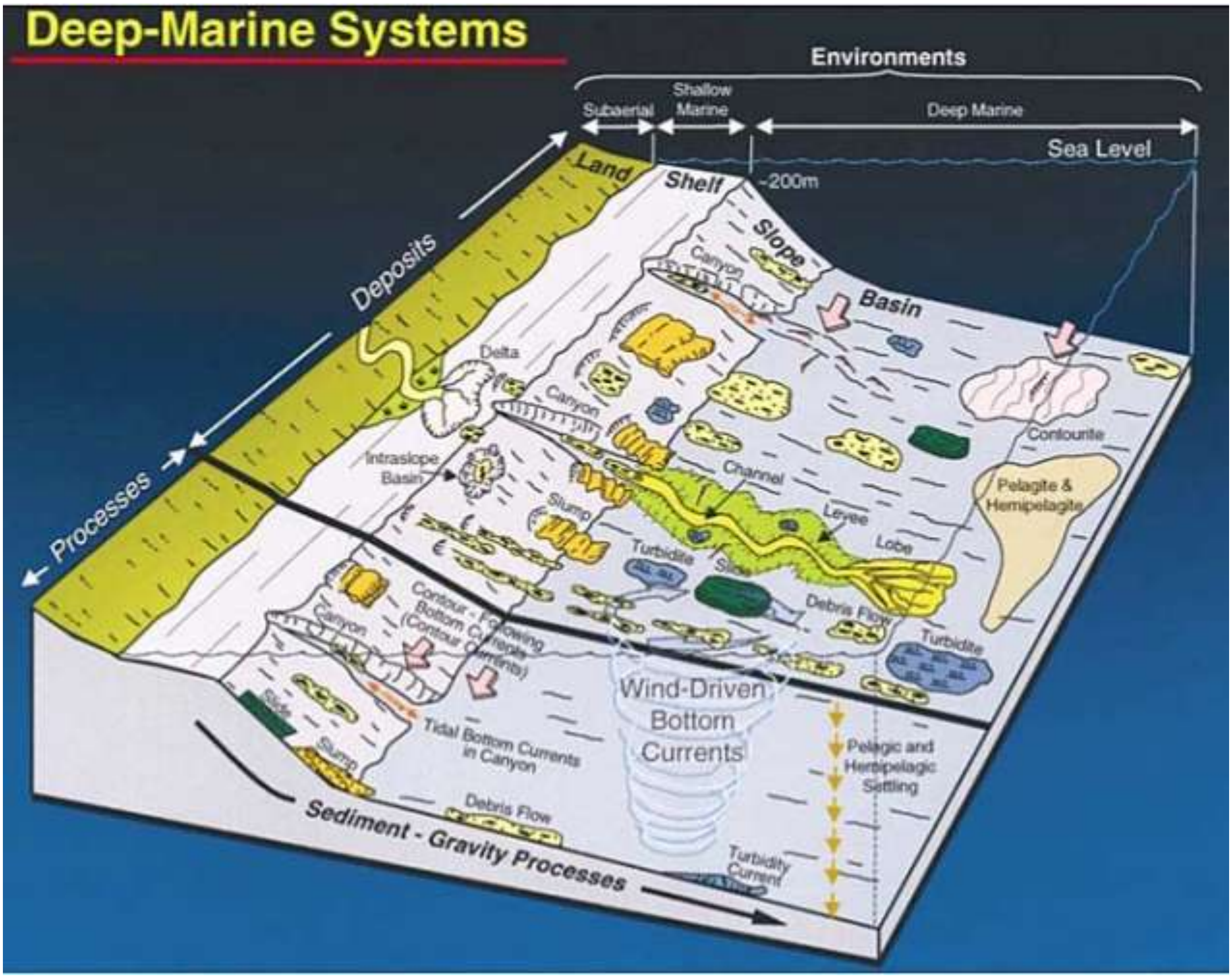


Figure 1. Schematic diagram showing complex deep-marine sedimentary environments occurring at water depths deeper than 200m (shelf-slope break). In general, sediment transport in shallow-marine (shelf) environments is characterized by tides and waves, whereas sediment transport in deep-marine (slope and basin) environments is characterized by gravity-driven downslope processes, such as mass transport (i.e., slides, slumps, and debris flows), and turbidity currents. (Reproduced from Shanmugam, (2003).

12. Disrupted sandstone strata near the stack possibly due to slumping and debris flow.

13. A concave erosion channel filled with lighter coloured sandstone possibly due to debris flow.

Belmont Wetlands Walk

Leader: Sue Rogers.
Date: Thursday 23rd March 2017.
Attendance: 15 members, 1 visitor.

Background.

Belmont Wetlands State Park (BWSP) was established in 2006 as the 10th State Park in New South Wales. The former BHP site, which has over 4kms of beach frontage between Belmont and Redhead, is under the management of a Community Trust Board. The board plans and directs the remediation and enhancements of the park to ensure environmental values are sustained and public access is improved. The 549 ha site comprises seven coastal wetlands including the largest single open water wetland in Lake Macquarie and is host to a diverse range of over 170 species of native wildlife. The wetlands are a critical environmental feature as they filter storm water and slow its flow prior to entering the sea and Lake Macquarie.

Geology.

The coastal area of Lake Macquarie is comprised of a 1 kilometre wide belt of Quaternary dune sand which overlies sedimentary rocks of the Newcastle Coal Measure. The majority of soils at BWSP are deep (up to 50 metres), well drained siliceous sands with some acid peats associated with the wetland areas. However, as a result of past mining operations traditional soil profiles have been significantly disturbed. Mined areas generally occur throughout the centre of the site between the Fernleigh Track and a 100 metre setback from the site's eastern boundary.

Three different mining processes have occurred at BWSP in the past; coal mining, dredge mining of minerals and construction sand mining. Each of these operations has impacted on BWSP in different ways:

1. Coal mining was carried out beneath the site through two seams, the Victoria Seam at a depth of approximately 197 metres and the Borehole Seam at 265 metres. The mine is now closed and the airshafts associated with the colliery have been sealed. During mining operations overburden spoil and coal chitter were used to surface quarry pit floors and some filling with mine waste material has occurred around the southern wetland margins.
2. The minerals rutile, zircon, monazite and ilmenite were mined in the hind dunes east of the wetlands from the late 1950s to 1967. Approximately 3% of the site's sand was removed during this process.

1. Paperbark forest, common in the area.

3. Extraction of sand for the construction industry commenced in the mid-1970s and continued until BHP vacated the site. Large quantities of sand were removed from the site during this period. A number of abandoned quarry pits remain across the site, the largest of these is known locally as 'The Cauldron'. Two disused mine ventilation shafts (No.3 and No.4 airshafts) are located within BWSP.

The Outing.

Participants met at the site office at 9am and were introduced to John Gibley, his wife, Caroline, and Site Manager, Alissa Rogers. John showed photos of the site from when he was employed as a Field Services and Nursery Supervisor before leading the group along the loop bush walking track. Along the way John discussed many of the onsite projects he and Caroline have achieved in retirement including numerous man-hours clearing rubbish, planting trees, pruning, and hand and chemical weeding in order to revegetate the site and reduce erosion. The level walk through the natural vegetation enabled us to view various banksias, palms, tree ferns and rare trees, such as Woody pears with fruit as well as paperbark forests *(photo 1)*. John pointed out various points of interest including where it took Caroline and him 5 years to eradicate an area overgrown with lantana, a clearing reserved for the local Koori group to teach their culture to the younger generation *(photo 2)*, a forest of coastal tea tree that is being replaced with other species and where the rutile dredger operated.

We then came to the steep degraded sand dunes where John discussed the damage that occurred in the construction sand-mining years and the damage from 4WD vehicles and quad bikes *(photo 3)*. Thanks to the recent rain, the dunes were easier to transverse than what they normally are. The green army corps had been busy here with many plantings to help stabilise dunes and rehabilitate the mined areas *(photo 4)*. We left John and Caroline and headed to the lookout to photograph the coastal views over nine mile beach before venturing down to the windy beach *(photo 5)*. We stopped for

2. Aboriginal cultural area.

3. John discussing sand mining history.

4. Area of sand dune being revegetated.

morning tea in a sheltered spot before returning to the site office at our scheduled time of noon via the beach track. Many colourful fungi growing beside the track were photographed *(photo 6)*.

We then drove to Cullen Park for our picnic lunch over-looking the many yachts surrounding the Lake Macquarie Yacht Club.

Nine participants were available to complete the afternoon's walk from Belmont Railway station to

5. Climbing an active sand dune next to the sea.

6. Colourful fungi beside the track.

Jewells Railway station along the Fernleigh track *(photo 7)* through the western end of BWSP. This railway was extended from Redhead to Belmont in 1916. It was opened to traffic on the 23 December 1916. The last passenger train to Belmont ran on 22 March 1971 and the railway was closed in December 1991. It was later converted to a bike/walking track, now known as the Fernleigh Track. Our walk took us from the former rail platform at Belmont through a wetland forest of paperbarks and swamp mahogany. We diverted off the track to complete the wildflower walk *(photo 8)* before rejoining the track and walking the remaining 500 metres to the Jewells platform.

We managed to squash into the cars and return to Belmont station to pick up the cars left there before enjoying afternoon tea at McDonalds Café in Belmont.

7. Fernleigh Track, an easy scenic walk.

8. Colourful coastal banksia flower.

Report by Sue Rogers.
Photographs by Sue Rogers.

Further Reading.

http://www.crownland.nsw.gov.au/__data/assets/pdf_file/0010/644698/Belmont_PoM.pdf

http://www.visitlakemac.com.au/images/documents fernleigh_track2012.pdf

Lithgow Excursion

Leader: Brian England.
Date: Thursday 27th to Sunday 30th April 2017.
Attendance: 21 members.

Thursday 27th April.

Everyone had arrived safely at the Lithgow Van and Tourist Park in Bowenfels by early evening. At 8pm introductory talks covering the weekend activities were presented in the camp kitchen.

Some snippets from Lithgow's history.

Ever since the Blue Mountains were crossed from Sydney, the area of the City of Greater Lithgow has been a place of settlement as well as a staging post on the way to the western plains. The original town of Bowenfels on the Great Western Highway quickly declined in importance as the adjacent industrial town of Lithgow began to develop, but the old town still contains a wealth of architectural heritage.

Lithgow came into being because of its coal deposits and through its connection to the coast by rail with the opening of the Zig-Zag Railway in 1869. In the following 5 years it became a boom town. Coal production increased and in 1874 James Rutherford (the American owner of Cobb & Co) thought it a good idea to construct a blast furnace near the coal mines using iron ore contained in clay bands among the coal seams, supplemented by supplies from Clarence, Mount Wilson and Blayney. But Rutherford's furnace was unprofitable and in 1884 he brought in two drays of gunpowder and blew it up. His enterprise called the Eskbank Iron Works Company failed, but the associated foundry and rolling mill continued using railway scrap iron to make rails, and remained in use till 1932.

There was almost a 25-year gap in large-scale iron smelting in Lithgow until the first steel produced in Australia was made at William Sandford's Eskbank plant on 25th April 1900 using iron ore from Carcoar. This was the precursor of Hoskins Iron and Steel, the ruins of which are now contained in Blast Furnace Park.

Because of the abundant coal in the valley, three separate companies smelted copper ores here, including the Lloyd Company who railed partly processed copper from its Burraga mine, and the Great Cobar Company who brought its blister copper all the way from Cobar. Only the Lloyd Company survived World War I.

Friday 28th April.

Members departed the Caravan Park in a 6-

1. Kink fold in Permian coal measures.

vehicle convoy at 8:30am with the temperature hovering at just 3°C. Otherwise the day was clear and sunny with a forecast maximum of 13°C but with no wind to add a chill factor, so in all quite pleasant.

Nineteen kilometers north of the Information Centre we turned left off the Castlereagh Highway towards Portland, passing by the massive coal-fired Mt. Piper Power Station fed by mines in the Western Coalfield.

About two kilometers along the Portland Road we pulled into a cutting exposing a spectacular kink fold in Upper Permian sediments *(photo 1),* then continued on to Portland, a large sprawling country town.

The Devonian age Portland Limestone is situated very close to Portland. It was the first limestone deposit to be quarried on a large scale in Australia for cement making and has been worked more or less continuously since 1889. It was the only fully industrialized lime producer, establishing its own private rail system to service the quarry and works area and move cement to

2. Limestone breccia.

3. Portland lime kilns.

the main line, which had reached Portland in 1883.

The cement works closed in 1991 after almost 18 million tonnes of limestone had been quarried over a period of 90 years. The buildings are now heritage listed.

The surrounding rocks comprise quartzite, mudstone and conglomerate which along with the limestone are strongly folded and faulted, resulting in spectacular breccias *(photo 2).* These rocks have been intruded by the Bathurst Granite and by quartz/feldspar porphyry. To the east, they are overlain by Permian sediments of the Sydney Basin (Lishmund et.al, 1986).

Before driving down Williwa Street into Portland town center we turned right onto the Mudgee-Cullen Bullen Road then left onto Limestone Creek Road after about a kilometer and continued on down Creek Road, which took us to within a few tens of meters of what must be the most spectacular bottle limekiln ruins in Australia *(photo 3),* once used by the Cullen Bullen Lime Company. In their rush for the best vantage points people scattered like cockroaches when a light is turned

4. Overlooking Portland quarries.

on, some even ignoring the danger keep out signs on the roadside fence. A little further up the road Barry thought he'd found some fossils in a small limestone cutting, but these proved to be weathered flowstone, although a few brachiopod sections were seen in one boulder.

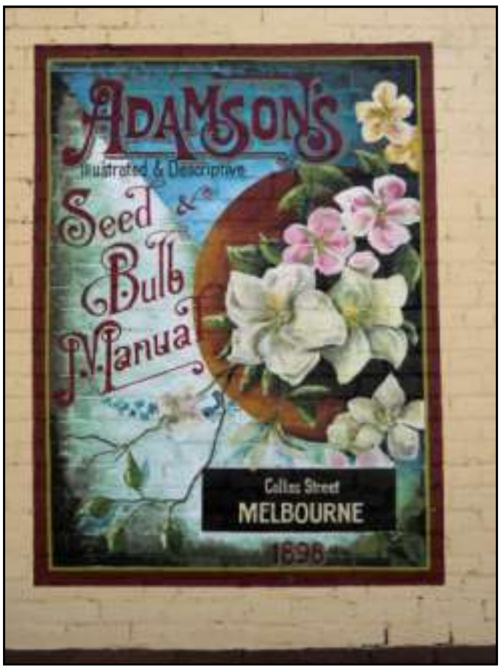
From the limekilns, the road was unsealed and soon passed on the northern side of the immense open pits of the Portland limestone quarries, now filled with water and providing foreground for views south towards the cement works and the town beyond *(photo 4)*.

Entering Williwa Street from the south we were held up by a huge truck trying to back out of Cullen Street. Quite a challenge for the driver! Once in Cullen Street we parked beside the sports ground then set out on foot to explore the unique artwork adorning walls around the shopping precinct in Wolgan Street and the laneways running off it.

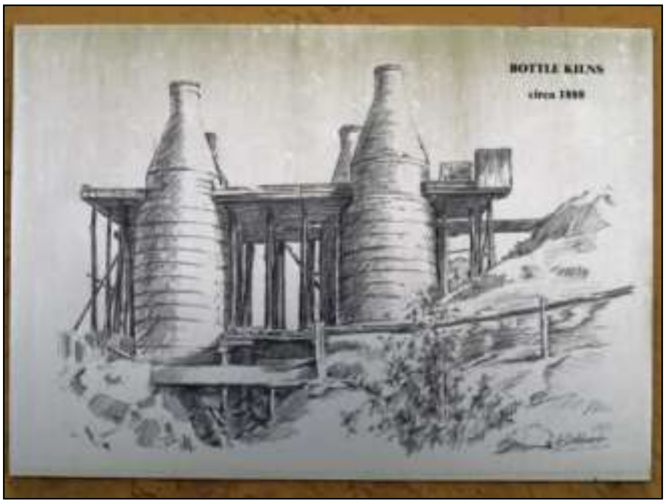
In 2001 Ron Bidwell, a sign writer by trade, together with other artists created vintage advertising signs dating from 1895 to 1945 on local shop walls. Apart from the redback spider *(photo 5)* and horses on the toilet block near the park, historic brand names included Uncle Toby's oats, Arnott's biscuits, Early Kooka stoves, Portland Cement, Adamsons seed and bulb manual *(photo 6),* Goanna Salve, Toohey's Ale, Kinkara tea, Mothers Choice flour, Bushells tea, and Federal safety matches. These are quite unlike the Kurri murals and brought back childhood memories for most of us. One finely executed line drawing depicted the historic limekilns in operation *(photo 7)*.

Morning coffee was very much on the agenda and taking guidance from a local emerging from the supermarket we assembled in dribs and drabs at the Williwa Café inside the Coronation Hotel. But the lone young barmaid could simply not handle the sudden influx of thirsty walkers and ended up running out of both coffee mugs and cakes!

5. Redback spider mural.



6. Adamson's seed manual.



7. Drawing of the Portland bottle kilns.

8. Lunch, Sunny Corner Picnic Reserve.

9. A bunch of brown fungi growing on a pine stump.

We moved on at 11:45am, driving back south along Williwa Street, into Lime Street and turning right onto the Sunny Corner Road at the top of the hill. On the eastern outskirts of Sunny Corner, we pulled into the Sunny Corner Picnic and Camping Reserve for lunch *(photo 8)*. We found this a very pleasant place to pause and relax. Nearby Elaine found a magnificent example of brown fungi sprouting from the base of a large weathered pine tree stump *(photo 9)*.

On the northern edge of the Reserve a pile of bricks marks the site of the Public Smelter (1885) built to treat silver ores from the smaller mines around Sunny Corner. This venture failed due to the poor quality of the colonial-made firebricks used to line the furnace. These simply melted and had to be replaced every two days!

We departed the picnic area at 1pm and continued on through the scant remains of the town to Silver Street. A few hundred meters down this dirt road we parked the vehicles in a large cleared area once used to stockpile limestone used during the rehabilitation of the Sunny Corner mine to line runoff channels to act as a buffer against acid mine drainage. On the way in it was difficult to ignore the abundance of large red-topped fungi (Fly Agaric - *Amanita muscarice*) sprouting from the pine needle carpet on the forest floor.

Before venturing on foot down to the Sunny Corner mine ruins historic site a brief introduction was given to the geology of the deposits and history of mining, with a number of old photographs of the workings in the 1880's shown around so comparisons could be made between past and present.

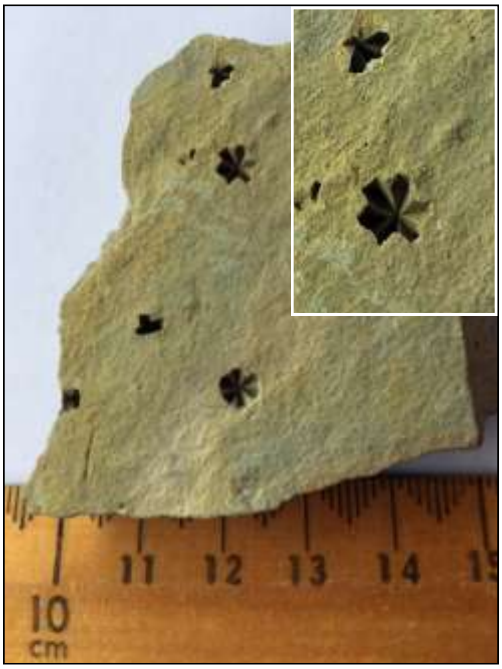
Gold was found at Mitchells Creek (now Sunny Corner) in 1852 and by 1856 miners had located auriferous quartz reefs. By 1881 assays had shown the oxidized ore at Sunny Corner to be rich in silver, with values between 10 and 60 ounces per tonne of ore. In 1884 the Sunny Corner Silver Mining Company was formed and the first American smelter was in blast on 27th August the same year. This was the first time silver had been successfully smelted from ore in Australia. But by 1903 there were only small scale operations in progress, the last ending in 1922. Most of the buildings and houses in the town were dismantled and moved to the new nearby cement town of Portland. In 1984 the mine area was declared a historic site by the Department of Lands. Then in 1985 the ruins were classified by the National Trust (Powys, 1989).

10. Silver King slag dump.

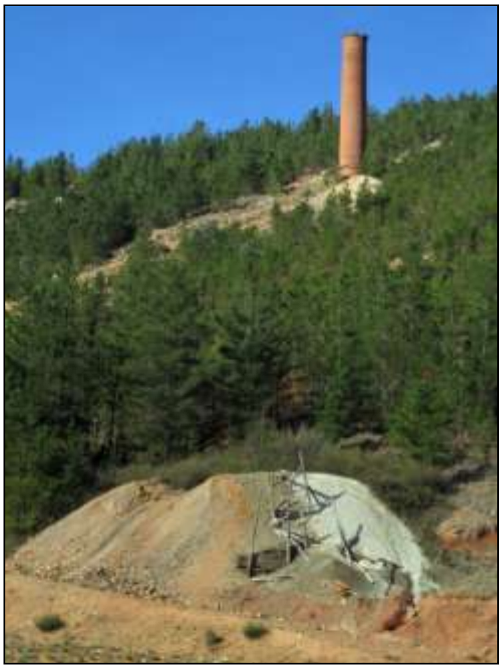
The orebodies at Sunny Corner had a similar origin to the ore at Captains Flat, visited by the Society on the Canberra-Cowra excursion last year. The ore is volcanic hosted massive sulphide (VHMS) deposited by sea floor hydrothermal vents during the Middle Devonian to Early Silurian. The host rocks have been subjected to low grade regional metamorphism and the ore horizon has been broken up into short lengths by faulting so that there is no continuity in the ore, enabling a number of separate mines to operate concurrently.

Silver in the primary (sulphide) ore was contained in the minerals tetrahedrite and galena but above 30 meres depth the sulphides had been naturally oxidized and the silver was scavenged by secondary minerals in the resulting gossan which was easily smelted to extract the silver.

Everyone was asked to wear high visibility vests before starting out, not just for safety but to ensure everyone could be easily seen in the densely forested steep terrain. Being a gazette historic site, no hammers were allowed. Having seen an overview of the mine area from Dark Corner Road on the other side of Daylight Creek on a reconnaissance trip over Easter it appeared as though the whole expanse of mine dumps below the Silver King mine at the top of the gully had been destroyed by very recent rehabilitation. So, it was with some apprehension that I led the group down towards the Silver King. But I was pleasantly surprised to see the old slag dump *(photo 10)* still intact and only the dangerous open pits and collapse areas immediately below filled and leveled. This had exposed a large area



11. Moulds in argillite after pyrite and twinned arsenopyrite have crystals have been leached out.



13. Remains of Glassons adit with Sunny Corner smelter chimney behind.

of freshly broken argillite, some containing moulds after pyrite and twinned arsenopyrite crystals *(photo 11)*. However the interesting patch of secondary post-mine minerals described by Hager, et.al. (2013) and remnant silver-rich oxidized ore once exposed at the top of the flying fox near No.1 level had been destroyed.

The Silver King was the next most important to the larger Sunny Corner mine. At peak operations, it had three smelters operating and employed 150 men, producing a total of 8 tonnes of silver, compared to the 100 tonnes produced by the Sunny Corner mine over its life. The Silver King closed in 1890 because it ran out of ore, having mined right to its boundary with the adjacent Sunny Corner mine. It was hence unaffected by the 1892 fall in the silver price (Powys, 1989).

The rehabilitated area below the Silver King mine made the initial climb down the steep gully to the remnants of the Sunny Corner Smelter relatively easy, but beyond that the path became much more difficult down the lower dumps composed of loose argillite blocks. We were forced to find an easier way through the adjacent bushland. Observed on the way down were two enclosed instrument packages placed over drill holes down to No. 4 adit level by the Department of Primary Industries to monitor acid mine drainage. Adit No.4 itself had been sealed by broken rock and clay and a small dam constructed to hold back solids escaping from groundwater coming through the blockage. On previous visits this adit appeared to be the major source of acid mine drainage causing serious pollution in Daylight Creek below the old workings.

12. Remains of aerial tramway between the Sunny Corner mine and smelter.

14. Wall of the slag-block boiler house at the Sunny Corner smelter.

15. View of the boiler house with dumps of the Silver King and Sunny Corner mines in background.

16. Site of the Nevada mine. Note slag heap in distance.

Down the north side of the lower dumps lay the scattered remains of the aerial ropeway which transported ore from the Sunny Corner main shaft at the top of the ridge down to the smelters just above Daylight Creek *(photo 12)*.

At the base of the dumps we reached the old access road which took us past Glassons adit (1919) *(photo 13)* and across a small gully to the remains of the slag block boiler house (1890) *(photos 14 & 15)*. Just to the north of this lies ironwork which was part of the 1919 smelter rebuild. It was pleasing to see that rehabilitation of the mine dumps in the steep gully below the Silver King had not altered the classic view south up the gully from the boiler house *(photo 15)* nor the view east to the Cornish chimney completed in 1891.

Photos taken in 1884 show the mine ridge to still be heavily wooded by native forest. But extensive exploitation of local timber for underground mine supports began to denude the hillside. The rabbit warren of underground workings had by then become a veritable forest of timber. By 1886 open roasting was being used as a pretreatment to drive off most of the sulphur and zinc from the difficult to smelt sulphide ore that had begun to be encountered at deeper levels. This had a devastating effect on the remaining vegetation. By 1891, just before the Sunny Corner mine closed, forest cover on the ridge had all but gone and photos taken in 1963 when I first visited the area show the hillside the be completely bare except for a single pine tree. But by 1985 pine trees had begun to encroach from the surrounding plantations begun in 1947, and continue to do so. Between the Sunny Corner and Nevada mine, 2 kilometers to the north, native regrowth has largely hidden the scattered tunnels and shafts associated with small mining operations and prospects.

On the way back up the gully some people paused at the gate to photograph spectacular fungi on the floor of the forest. The group were back at the vehicles at 3:25pm, leaving just enough time to drive down Dark Corner road to the remains of the Nevada mine before darkness set in. The remains of the Nevada smelter lie on the banks of Daylight Creek just as the 4WD track crosses it and is marked only by small scattered heaps of slag *(photo 16)*.

We trudged up the vehicle track following the tramway to the Sunny Corner mine to where recent roadworks had intersected one of the auriferous quartz reefs. Nearby, down the slope into the creek, could be found small chunks of sulphide ore comprising galena, sphalerite and pyrite. Scrambling back to the cars along the side of the ridge on the east side of the creek we tried to re-locate the colorful gossan I had uncovered on my last visit. But that appeared to have been obliterated by a new 4WD track pushed down from the top of the ridge. However, other examples of gossan were found beneath the new track.

The Nevada mine was worked between 1884 and 1892, but there were problems in smelting the ore from the very start and a huge amount of capital was poured into various experimental processes. The orebody was first worked by Mr. La Monte who took over the lease from the Hemsworth brothers in 1884. La Monte named his mine after his home state in the USA. He was the person responsible for the successful smelting of silver from oxidized ore at the Sunny Corner mine. The Nevada was taken over in 1890 by Lewis Lloyd, owner of the Estbank Smelting Works in Lithgow. Lloyd decided to work the mine for copper rather than silver and it prospered for several years. Half the ore was sent to the Lloyd Smelter and the other half smelted at the mine to produce copper matte to be refined in Swansea (Wales) and Frieburg (Germany). The mine was idle between 1893 and 1901 when the Sunny Corner mine acquired the Nevada and connected the two mines by a tramway along Daylight Creek. The mine lay completely abandoned by the end of 1919 (Powys, 1989).

Today nothing remains of the enormous amount of equipment and plant that once covered the site. Anything of use has been carted away except for a few large pieces of iron that were perhaps too big to be moved. Only a slag dump scattered by roadworks and a few filled shafts along the ridge line bear witness to a period of extravagant expenditure.

We left the area just on dark and took a different route back to the Great Western Highway, some pausing for coffee at Maccas in Lithgow before returning to camp.

At 8pm the group were given an introduction to oil shale, its nature and origin.

What is Oil Shale, that strange rock that burns?

Typically, over 80% of torbanite consists of volatile hydrocarbons. Because of this the rock can be lit easily with a match and its combustion leaves very little ash. It belongs to a group of organic-rich sedimentary rocks which also includes bitumen-impregnated rocks and coals. Oil shales can be of terrestrial, laccustrine or marine origin. Those of laccustrine origin can be subdivided into lamosite and torbanite, with torbanite forming in fresh water and brackish lakes due to the buildup of algae of the *Botryococcus* family. Terrestrial oil shale or cannel coal, which is often confused with torbanite, is composed of resin spores, waxy leaf cuticles and the corky tissue of plant roots and stems. It characteristically forms in coal swamps and bogs so is often associated with coal seams. In contrast torbanite is seldom directly associated with coal, the only exception in this state being at Joadja where it occurs directly above the Lithgow Seam.

All the torbanite seams in New South Wales occur at various levels within the Permian Upper Coal Measures, with the torbanite at New Hartley/Airly lying just above the Irondale Seam. Below the coal measures lies the Permian Upper Marine Series while above them are Triassic sediments of the Narrabeen Group (Pells & Hammon, 2009).

Historical Background to the Shale Oil Industry at New Hartley and Torbane.

The Wallerawang to Mudgee Railway, the first section of which opened to Capertee on 15th May 1882, encouraged a wave of settlers and prospectors. Large areas of the Capertee Valley were cleared for grazing. Then above the banks of Genowlan Creek below the eastern escarpment of Airly Mountain, a workable deposit of torbanite was found in 1883 by Bulkeley, Larkin, Massey, Melliday and Nicholson. They took up shale leases but lacked the finance to develop a mine and their leases were cancelled due to lack of work. The leases were taken up almost immediately by a German syndicate called the Genowlan Shale Company and adits were driven into the seam below Airly Mountain. Export shale was sent to Germany for gas enrichment as early as 1883, the product being taken from the mine in horse and bullock wagons to Capertee Station. Soon a small rambling village called Airly appeared – a group of primitive slab, bark, and corrugated iron huts clustered near the shale adits. Homes were placed wherever the land was flat enough to erect a building. Only one of these remains, a quite substantial house on the western bank of Genowlan Creek called Airly House which once acted as Burnett's farmhouse and is now used as an occasional weekend retreat by the current owner.

The Genowlan Shale Company prospered for a few years but was devastated by the state-wide bank collapse of the early 1890's. In 1895 the company's assets were acquired by the Australian Shale Syndicate Limited who, in May 1897, leased the operations on tribute to the Australian Kerosene Oil and Mineral Company. Their first move was to arrange with the Railways Department for construction of a siding on the Wallerawang-Mudgee Railway. This opened on 10th June 1897 and in September the siding was named Torbane – a name that originated in Scotland where it was associated with the bog head coal called torbanite.

The operation was again taken over in 1908 by the Commonwealth Oil Corporation. But by 1914 the mines were idle, brought about by the political withdrawal of the Shale Oil Bounties Act which expired on 30th June 1913. The Commonwealth Oil Corporation went into liquidation in 1912 and its interests were purchased in 1916 by the Commonwealth Oil Federation. The shale they mined was sent to Newnes for retorting and to the railway gas works at Macdonaldtown near Sydney. Mining ceased in 1918.

Meanwhile the deposits along the northern escarpment of Airly Mountain had been worked in a small way from around 1883. In January 1893 the area was leased by F.W. King and in August 1896 that lease was taken over by the New South Wales Shale and Oil Company. They had been operating shale mines at Hartley Vale along with retorts and an oil refinery. But these deposits were nearing exhaustion and the company moved their operations to the Capertee Valley, calling their new lease New Hartley.

A private township was established to the northeast of the retorts adjacent to the shale adits and the company also constructed a standard gauge railway to connect the retort area with the main Wallerawang-Mudgee line at Torbane Siding. This was opened in June 1898. The retorts at Torbane were designed to treat low grade shale that was too poor for export. The first tank wagon of crude oil was dispatched to Hartley Vale refinery in December 1900. The company had a contract to supply the Australian Gaslight Company with one million tons of crude oil annually for a period of 10 years. All this oil was sent to Hartley Vale for fractional distillation.

East of the Torbane retorts lay the northern spur of Airly Mountain and this had to be crossed by a narrow gauge skip haulage tramway to bring the shale from the New Hartley mines on the eastern side. No torbanite had been found or indeed occurs on the Torbane side of the mountain. The transported shale was offloaded at a picking table sheltered by a long galvanized steel shed, where "pickey boys" hand graded the lumps of shale. The skip tramway, once over the spur, followed along the horizontal outcrop of the shale where adits had been driven into it.

17. First stone hut, New Hartley.

18. German miners hut, New Hartley.

In May 1906 the New South Wales Shale and Oil Company's properties and works were purchased by the Commonwealth Oil Corporation, which then dominated the shale and oil industry. In April 1911 25,000 gallons of oil were dispatched to Darling Harbour for the Royal Australian Navy destroyers HMAS Parramatta and HMAS Yarra. This oil was retorted at Torbane and refined at Hartley Vale.

During 1911 industrial turmoil closed the Torbane works for over 7 months. Although work recommenced the following December, shale mining at New Hartley was winding down and the company began to concentrate on developing the industry at Newnes. However in 1912 the Commonwealth Oil Corporation went into liquidation and by July 1913 the retorts were being dismantled brick by brick for re-erection at Newnes. The shale mines were in operation again in February 1916, the shale being railed to Newnes. But by June 1918 shale mining at New Hartley had ceased. By April 1920 the company buildings at New Hartley were being dismantled and the materials sent to Newnes.

Further dismantling of the plant took place in 1925-6, the fire bricks recovered being sent by rail to the oil refinery near Duck River at Clyde. By 1973 little was left at Torbane apart from the Manager's house which is still being used as a farm house (Eardley et.al., 2000; Pells and Hammond, 2009).

Saturday 29th April.

After surviving an overnight temperature of -1°C, the group left camp at 8:35am in a convoy of six vehicles and headed north on the Castlereagh Highway, but this time continuing on to Capertee and there turning right onto the Glen Davis Road. Five kilometers to the east of Capertee we took the Airly Gap Road (now unsignposted) into the Mugii Murum-Ban State Conservation Area. We continued up past Airly Gap camping area to the start of the Tramline Trail at the foot of Mount Airly, just beyond Airly House, the last remaining building in Airly Village.

On the Society's first visit to the New Hartley ruins in 2012 we had great difficulty finding the track in. The area, including Mount Airly and Mount Genowlan (on the eastern side of Airly Gap) had been gazetted as a conservation area in 2011 to ensure preservation of the natural and historic features while still allowing underground coal mining to proceed in such a way as to not cause surface deformation or cliff collapse. The SCA adjoins Centennial Coal's Airly mine lease. But no improvements to access had been made. The old track would have severely taxed even the largest 4WD. However National Parks had recently remade the road, naming it the Tramline Trail. Reports as recently as 12 months ago had described it as trafficable by most vehicles.

Based on this advice we decided to drive in as far as the second ventilation chimney. All our vehicles had at least reasonable off-road capability, but just a few hundred meters in we were faced with an unexpected problem. After heavy rains last year and without follow up maintenance by National Parks the trail had begun to deteriorate into a series of deep washouts and exposed boulders. We had no alternative in the interests of time and safety but to turn around. Then the real challenge, how to turn 6 vehicles on a track only one vehicle wide and with no room to turn. It took over an hour to get all vehicles heading back towards Airly House and parked off the trail. Now the only means of access was on foot and there was only enough time left to go as far as the ruins of the Managers house.

It is interesting to note that recent maps of Mugii Murum-Ban State Conservation Area show a locked gate at the start of the Tramline Trail, but at present no such gate exists!

Within a few hundred metres we came to the first ruin, a small roofless two-roomed stone hut *(photo 17)* tucked between large sandstone boulders on a tiny area of flat ground enclosed by rampant vines. Then, one by one, other ruins appeared out of the thick scrub. Next was the German miner's hut *(photo 18),* dominating a small clearing atop a sandy rise overlooking the densely-wooded valley of Genowlan Creek. Now minus its roof, but with most of its concrete-rendered brick walls and even some of the timberwork around the windows still intact, it was obviously a significant building and in fact

19. Primitive miners hut, New Hartley.

is one of the icons of the old village. It even had an outdoor oven up against one wall!

A little further up the trail we noticed a narrow path heading off to the left into the scrub. What lay at the end of it after only a few meters left us spellbound. Here, sheltered in a hollow dug beneath a huge almost flat-lying sandstone slab, stood the epiphany of a miner's hut *(photo 19),* its walls made of stacked sandstone blocks grouted with mud. Exploring inside was discouraged by the presence of a large nest of defensive wasps at the entrance, but in the dim light it seemed quite roomy. An old rug lay spread across the dirt floor and an array of pots and pans were neatly arranged at one side near a fireplace *(photo 20).* Outside the entrance there was even once a well-manicured lawn covering a small rectangle of level ground cleared from the bush. The view north from the hut was mesmerizing! Another much larger and more palatial

20. Relics left by departing miners inside the hut.

21. David at the miners hut window, New Hartley.

miner's hut was found nearby, again built of rock and mud under a deep sandstone overhang. This one even had windows *(photo 21).* How many more are hidden in the scrub no-one knows!

It seemed the large tilted sandstone slabs scattered over the steep slopes of the mountain had provided prime real estate opportunities for some of the miners! They only needed a little ingenuity (or desperation) to quite quickly turn them into a livable home. These rough shelters would have been cool and comfortable, if somewhat cramped, during the hot summer months. But they provided little protection during the cold winters when snow often covered the ground outside for days on end. It would have been a hard life!

The old road continued more or less on the same level towards the northeast around Airly Mountain. But the shale band and associated sediments remained hidden by sandstone boulder scree and very dense vegetation. Only fleeting glimpses of the spectacular sandstone cliffs along the top of Airly Mountain could be seen through the trees. This contrasts sharply with old photographs of the area when the mines were active. Then the cliff line was clearly and constantly visible from the road and the village, dominating the scenery and providing a dramatic backdrop that the miners probably cursed rather than admired because of its occasional instability.

The next ruin was that of the Manager's house. Again nestled on a cleared grassy knob, this time looking back over the majestic sandstone cliffs of Genowlan Mountain, all that remained was the massive stone fireplace and brick chimney. A shelf in the fireplace was adorned with ancient bottles, pots and pans. All lay broken, battered and corroded, having reached well beyond any form of useful life. But it all set

22. Power station ruins, Glen Davis.

23. South wall of Capertee Canyon.

the scene for some dramatic photographs, with the cliffs of Genowlan glowing yellow in the early morning sun and the sky above dotted with fluffy white clouds.

Sadly we had to turn back at this point. With a 2pm appointment at the Glen Davis ruins further exploration would have to wait for another time. We left the area amazed at what we had seen and were careful to disturb nothing, hoping that other visitors in the future would do the same.

We drove back across Airly Gap at midday and headed east towards Glen Davis through the spectacular Capertee Canyon, with views of Patoney's Crown to the south from several different angles revealing it to be a long narrow mesa. As we approached Glen Davis the canyon began to close in between spectacular walls of Triassic Sandstone, the forested lower slopes hiding the Late Permian sediments hosting the torbanite seams.

We reached Glen Davis at 12.35pm and drove to the large bushland park at the south end of Market Street for lunch. A pleasant surprise here was the presence of a new toilet block and community kiosk where we could treat ourselves to an ice cream! These additions are in response to an increased tourist awareness of the spectacular scenery and historic shale works ruins.

The decision to build a new town and oil refinery in the Capertee Valley saw the complete abandonment of the town and oil shale works at Newnes as well as the Wolgan Valley Railway. Much of the plant and homes (and families) at Newnes were transferred at great expense to the Capertee Valley and re-erected at Glen Davis.

Mining ventures at the head of the Capertee Valley proved the extent and richness of the shale seams and led to the formation of National Oil Pty. Ltd. and the establishment of the town of Glen Davis in 1937, in the later years of the Great Depression. The Company was raised from joint Government and private investment. The new town and works were built on the premise that modern technology using the new plant would ensure the industry would continue to flourish, rather than to continue to use the outdated plant at Newnes in the next valley to the south.

However, the outbreak of war in September 1939 meant that the new plant ordered from Estonia would never arrive! So the Company had no choice but to use the old plant transported from Newnes. This sowed the seed for the future decline of Glen Davis. The war brought frantic activity at Glen Davis and during 1940 the Capertee Railway Station was the busiest country station in New South Wales due to the sheer tonnage of equipment passing through from Newnes. The largest road transporter in Australia was also used to transport items up to 60 tons. The town was named after G.F.Davis, manager of National Oil.

Closure of the mines and works came in 1952, before which the miners staged a sit-in in the mine drive for 22 days. But to no effect. The final death knell came after the disastrous flood of 18th August 1952. But the fate of Glen Davis had been sealed for some time before that event. It was a case of history repeating itself. The site was continually beset by industrial disputes, rising labour costs and eventually fierce international competition. There were also continuing technical problems with the retorts, seasonal lack of water to drive the plant and insufficient supply of shale from the mines to allow continuous operation. As a result, Australia's first attempt at self-sufficiency and operation of a completely Australian owned oil industry died. In 2001 the Geographical Names Board stripped Glen Davis of its postcode and declared the town no longer existed! (Taylor, undated).

Seventeen of our members assembled at the entrance to the old works along with several other visitors. Here we were met by our guide Alex, who provided a brief background to the site before we re-boarded our vehicles and drove in to a parking area closer to the ruins. Here Alex gave us more of the history before we ambled off down the concrete

24. Shale retorts, Glen Davis.

roadway into the works.

I had last visited Glen Davis in 1967 as part of a WEA geology course in Bathurst. Then the area was totally bare and the ruins stood in stark contrast to the magnificent enclosing sandstone cliffs and thickly forested slopes beneath them. Since then vegetation has continued to regenerate, tall trees and scrub partly masking the ruins, each structure suddenly appearing in turn like a ghost from a more glorious past as we approached.

Beyond the remains of the tank farm, enclosed by low containing walls and still smelling strongly of hydrocarbons, we came upon the skeletal remains of the enormous workshop, one of the first structures built in 1939. Immediately opposite lay the high walls of the boiler house and engine room (power station) *(photo 22)* standing in defiance to the progress of time below the southern wall of the Capertee Canyon near its narrowest point *(photo 23)*.

Then came the retorts *(photo 24),* transported brick by brick from nearby Newnes when the outbreak of WWII meant that the new retorts from Estonia would never arrive. We were able to walk beneath the structure and observe the chambers *(photo 25)* in which the torbanite was heated to above 750°C to volatilize the oil it contained. This was then condensed into a substance resembling crude petroleum.

26. Shay boiler and Welsh chimney.

Just beyond the retorts lay the chaotic pile of bricks and concrete that was once the shale loading station. But the greatest surprise on the entire site emerged on the hillside close to the eastern boundary of the site. Here the boilers of two of the Shay locomotives that once operated on the Wolgan Valley Railway had been set on a platform to provide steam to the retorts. Only one remains today, its hulk rusting beside a perfectly preserved welsh-style brick chimney *(photo 26)*.

At the eastern end of the ruins Alex unlocked the boundary gate into Gardens of Stone National Park and we made our way up the road to the site of the shale mines overlooking the refinery. Here we explored the ruins of the bath house *(photo 27),* the lamp room and the two adits driven into the shale band. The mine bench also provided a commanding view down the ever widening valley towards Mount Genowlan.

The tour finished at 4:10pm and everyone agreed that the $15 fee per person was well spent. Before leaving Glen Davis we made a brief visit to the hillside

25. View up into the heating chambers of the shale retorts.

27. Ruin of the bath house, Glen Davis.

on the southern side of town where a band of spectacular concretionary limonite had been found by our group on a previous visit. This was quickly relocated and specimens removed *(photo 28)*.

We left Glen Davis at 4:35pm and arrived back at camp by 5:30, time enough to shower, change and regroup at Lithgow Workies for dinner at 7pm.

Sunday 30th April.

After the pressure of the last two days, today was a more relaxed program with a delayed start at 9:30am. At 9 degrees, it was a bit warmer this morning, with early cloud cover later clearing.

The day began with a brief visit to Blast Furnace Park, conserved and landscaped as an important industrial heritage site by the Greater Lithgow City Council as a 1988 Bicentennial project.

The site was originally developed by William Sandford as an integrated ironworks in 1906. These works were taken over by Charles Hoskins in 1908 to become Hoskins Iron and Steel Company Limited. Hoskins expanded the works with the addition of a second blast furnace and operations continued through World War I., supplying significant amounts of steel to the small arms factory established in 1911 only three kilometres from the furnaces. However soon after the war ended, when it was realized that sea transport was the most economical way to move heavy materials, the Company decided to move iron and steel making from Lithgow to Port Kembla. While Port Kembla was still in the planning and building stage the Lithgow plant was kept going only to attain the maximum profit. Then in November 1928, the Lithgow blast furnaces ceased production. Lithgow was left without its greatest employer to face the Depression of the 1930'3. The move had come almost without notice and signaled the failure of Lithgow as an industrial centre (Jack & Cremin, 1994; McKillop, 2006).

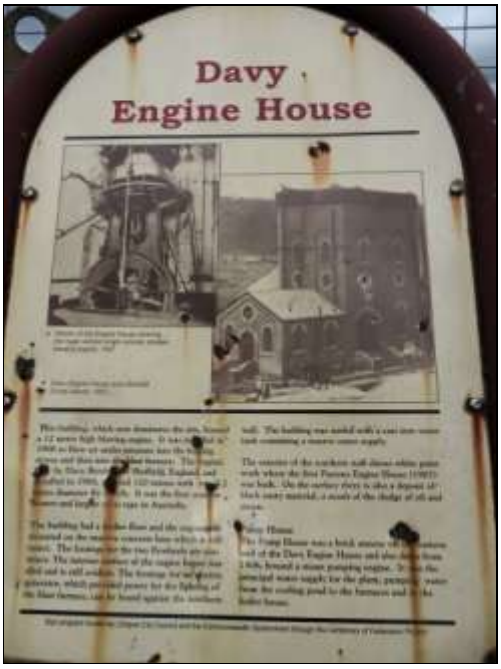
28. Concretionary limonite from Glen Davis. Center specimen 7cm across.

29. Engine house, Blast Furnace Park.

The overwhelming bitterness of the community on the closure of the iron industry had a powerful and lasting affect on its attitude to industrial heritage. The site was quickly stripped of useable machinery and any remaining iron, including the blast furnaces and blowing engines, was cut up and taken away for scrap. Fortunately, attempts to demolish the buildings were only partly successful. For many years in the town's view the site was a "humiliating eyesore" which had to be destroyed. It had become a painful reminder of abandonment. The site's value as a memorial to two generations of ironworkers and the infant Australian iron and steel industry was ignored and went unrecognized until only recently when it was almost too late.

Stanford's massive engine house remains as a poignant memorial, once a very fine industrial building which housed the magnificent 120 tonne Davy engine, imported from Britain and carried in sections from Sydney on specially-built railway trucks to be assembled on site over a period of 6 weeks. It was a major industrial showpiece!

As we approached the site, on a prominent rise overlooking eastern Lithgow, we were disheartened to see it had recently been enclosed by an impenetrable high wire fence. Peering through the wire we were just able to make out some of the wording on small notices erected at an unreadable distance inside the fence, to the effect that this was a "Hazardous Site". With access denied we had to be satisfied with photos taken through the mesh of the abandoned engine houses *(photo 29)*. The classic photo of the skull of the blast furnace framing the engine house, often called the most dramatic scene in the Lithgow valley, was no longer possible! Even the explanatory signs forming part of the Fire and Forge Trail had deteriorated *(photo 30)* showing an almost total disregard for this critical part of Australia's industrial history and its long-term



30. Sign, Blast Furnace Park.

32. Gothic garden house in the grounds of Estbank House.

preservation. A notice wired to the fence told disappointed visitors that “During 2015/16 Lithgow City Council will commence restoration and remedial works to the major brickwork structures….and the construction of raised walkways, viewing platforms, formed pathways and interpretive signs to allow safe visitor access.” One obviously disgruntled visitor had summed up his disgust by adding “Now 2017 and nothing has been done”. Perhaps the Council and people of Lithgow are again looking on this site as a symbol of abandonment and as a result are ignoring their important industrial history.

A walk around the adjacent Lake Pillans Wetland, originally constructed to store cooling water for the blast furnaces, filled in time before the group went on the Estbank House *(photo 31)* in nearby Bennett Street.

Thomas Brown, founder of coal mining in Lithgow, built Estbank House and lived there with his wife Mary till 1881. Brown was the Magistrate at Hartley and a Scottish Presbyterian teetotaller. To our surprise, he was also a collector of mineral specimens and other natural curiosities. The Gothic garden house *(photo 32)* was built as a natural history museum. Apparently he was told by Mary to get his rocks out of the house! Sound Familiar?

In 1882 the house was occupied by James Rutherford, operator of the Estbank Ironworks. Between 1892 and 1908 William Sandford, manager of the Eastbank blast furnace resided there. The Grange, as it was known then became accommodation for Estbank ironworks staff. The Managers of Hoskings Iron and Steel, which had taken over and expanded the Estbank Ironworks, then occupied the site till 1928. After the steelworks closed in 1929 the house was divided into flats. During WWII it was a home for workers at the Small Arms Factory.

In 1948 Eric Bracey, owner of Bracey’s Store in Lithgow, bought the house from Australian Iron and Steel for the Lithgow District Historical Society and furnished it with items from the Bracey Collection, reflecting the period in which the Browns lived. After restoration, the house was opened to the public on 21st November 1966. Lithgow City Council has managed

31. Estbank House.

33. Stables, Estbank House.

Estbank House since 2003.

Our group was given an excellent guided tour of the house after which we were free to roam the beautifully maintained grounds, visiting the stables *(photo 33),* blacksmith's shop and pottery museum. This was built in 1993 of sandstone from Barton Park near Wallerawang and houses the nationally significant Lithgow Pottery collection. This was the first Australian pottery to create its own glazes. Machinery displayed in the grounds include a Buffalo Pitts and Marshall steam engine and "Possum" the saddle tank steam locomotive. This was built by Manning Wardle & Co., Leeds, England in 1912. She worked at the steelworks until transferred to Port Kembla in 1928. In 1969 she was returned to Estbank.

Several options were available for lunch. Some had a picnic in the grounds of Estbank House, others returned to camp and some were given little choice but to dine at Maccas. The only requirement was to be at the entrance to the State Coal mine by 1:30pm.

Early in the 19th Century Europeans first entering the Lithgow valley noticed outcropping coal seams. In 1838 that coal was being used for lime burning. By the 1850's coal was being mined for domestic use on Andrew Brown's property.

Following the construction of the Great Western Railway through Lithgow in 1869 large scale coal mining commenced and within a few years five collieries had opened, three of them remaining in production till the latter part of the 20th Century. A total of 17 collieries have mined the seams of the Lithgow valley since 1850. All have been underground mines in what has become known as the Western Coal Field.

The State mine worked the Number 7 or Lithgow seam, 82.35 meters below the surface and lying near the base of the Upper Coal Measures just above the top of the Upper Marine Series, all of Late Permian age.

The opening of the Victorian State mine at Wonthaggi in 1909 prompted the New South Wales State Government to explore the possibility of opening its own coal mining operation and a site on the Newnes

34. Lamp house reconstruction at State Coal mine museum.

35. Bath house at State Coal mine museum surrounded by machinery.

Plateau north of Lithgow was selected by the Inspector of Coal Mines. The mine would only supply Government enterprises so as "not to trespass on the field of private enterprise". Mine development was commenced in 1916 but was abandoned in 1917 due to changes in Government priorities. Work resumed in 1921 under the control of the Department of Railways and production commenced in 1922. However, the location of the mine's headworks at the head of Mort's Gully on the outskirts of Lithgow created ongoing problems with coal handling, mine ventilation and transport that were to plague the mine for its entire working life.

During the 1920's the Lithgow State mine became a recruiting and training ground for future leaders of the communist movement, many workers seeing this as a stage for remedying their many grievances. They had been disillusioned by the Great War and the failure of modern socialism to improve their lives.

Especially in its latter years the State mine, despite being the largest producer in the Western Coal Field, had a chequered history, with falling coal prices, competition and industrial disputes all playing a part in the uncertainty of continued operation at various times. The finale came on 31st October 1964, after severe flooding of the mine followed torrential rains in the preceding June. (Christison, 2009).

In 1976 the site was purchased by Austen and Butta Collieries. Then in 1990 the owners handed over the remaining structures to the City of Greater Lithgow. Dick Austen presented the land to Council for $1 and his partner Angelo Butta provided the dollar! Restoration work has been progressing ever since.

Assembling at the former mine offices we were met by our guide John. After paying the ridiculously low entry fee we were left to our own resources and free to explore anywhere north of the railway yard. This site remains a working railway with the associated dangers. The yard was crammed with locomotives and rolling stock, some bearing logos we had not seen before, including Southern Short Haul Railway and Green Railway. Only the huge workshop building where railway hardware was being restored was securely locked and out of bounds.

The office building contains a small museum set out in several rooms, one depicting a lamp room *(photo 34).* Other rooms held collections of miners lamps and other paraphernalia related to the history of the State mine. Some paused to watch a film showing early underground operations, including the extraordinarily demanding task of installing mine timbering.

Around the grounds and in the bath house *(photo 35)* lay dozens of items of mining machinery old and new, showing the gradual increase in sophistication necessary to keep the mine operating. Also in the bath house, in a small side room set up as a cinema, we sat in amazement as we watched the Spectra presentation "Fire in the mine", a modern-day adaptation of the Peppers ghost illusion. Marion Curry, wife of a miner *(photo 36)* moved in and out of the stage props sharing her poignant stories of the everyday dangers faced by the miners. This alone was worth the visit.

The visit ended at 2:45pm and this brought to an end a long weekend that proved so successful that even I was surprised. Chris summed up what we had seen by saying "Well, that's another itch scratched!" Most people stayed in Lithgow Sunday night and headed off home on the Monday.

Report by Brian England.
Photographs by Brian England and Ron Evans.

36. The Spectra Pepper's Ghost illusion at the State Coal mine.

References.

CHRISTISON, R. (2009). *Lithgow State Coal Mine. A pictorial history.* The City of Greater Lithgow Mining Museum Inc.

EARDLEY, G.H. and STEPHENS, E.M. (2000). *The shale railways of New South Wales.* Australian Railways Historical Society, New South Wales Division.

HAGER, S.L.; LEVERETT, P. and WILLIAMS, P.A (2013). *The silver mines of Sunny Corner, New South Wales.* Australian Journal of Mineralogy, 17(1), 45-51).

JACK, I. and CREMIN, A (1994). *Australia's age of iron.* History and archaeology. Oxford University Press.

KNAPMAN, L. (2010). *Glen Davis.* A shale oil ghost town and its people 1938-1954. Halstead Press.

LISHMUND, S.R.; DAWOOD, A.D. and LANGLEY, W.V. (1986). *The limestone deposits of New South Wales.* Geological Survey of New South Wales, Mineral Resources No.25, Second Edition, page 84.

McKILLOP, R. (2006). *Furnace, fire and forge. Lithgow's iron and steel industry, 1874-1932.* Light Rail Research Society of Australia.

PELLS, P.J. and HAMMON, P.J. (2009). *The burning mists of time.* Writelight Pty. Ltd.

POWYS, V. (1989). *Sunny Corner.* A silver town of the 1880's. Crawford House Press, Bathurst.

TAYLOR, G.J. (Undated). *The Glen Davis story.* Published by the Author.

What Fossil is That?

Leader: Winston Pratt.
Date: Sunday 24th June 2017.
Attendance: 11 members.

2. Specimens of animal fossils set out for examination by participants.

3. Specimens of Brachiopods.

Eleven members participated in the 'What Fossil is that?' day on a cool but sunny Sunday at Jan & Winston's home in Umina.

A set of pre-reading notes had been distributed a few weeks before the event. The day commenced by a review of the notes by briefly describing and showing fossil specimens of some of the major animal groups mentioned in the notes.

Trace fossils, microfossils and vertebrates fossils were excluded except for Ostracods from the microfossils as specimens visible with the naked eye were available and fish fossils from the vertebrates were also included as the Gosford area has produced many Triassic fish fossils.

The aim of the day was to provide as much 'hands on' experience as possible, particularly with material as found in the field.

The animal groups were presented in trays and included: trilobites; graptolites; rugose corals; tabulate corals; scleractinian corals; bryozoans; echinoids; crinoids; brachiopods; bivalves (clams & pectens); gastropods and cephalopods *(photos 1 & 2)*.

The plant groups were presented in Period order and included plants from the Silurian, Devonian, Carboniferous, Permian, Triassic and Jurassic Periods. The group then were able to examine each of the various fossils presented as they circulated amongst the trays containing the fossils.

Morning tea was the next item on the agenda. After Morning tea the group was provided with another set of notes, this time presenting more detail on fossils commonly encountered in the Triassic and Permian strata of the Sydney Basin, the Devonian and Carboniferous strata of the south-eastern Tamworth Trough and the Silurian and Devonian strata of the Yass area.

Again the notes were used to guide identification of the fossil specimens presented. As both Corals and Bryozoans are difficult to identify in the field and the plant floras are relatively simple, there was strong emphasis on the marine brachiopods and clams.

The specific fossils presented included: the Brachiopods *Marinirugus, Rhipidomella, Terrakea, Echinalosia, Notospirifer, Ingelarella, Trigonotreta, Alispirifer* and *Cyrtospirifer*. The Clams *Chaenomya, Vacunella, Myonia* and *Eurydesma*. The Gastropods *Keeneia* and *Peruvispira*. The Corals *Favosites, Haylisites, Heliolites, Phaulactis, Zaphrentis, Streptelasma* and *Lithostrotion (photo 3)*.

Again the group were able to circulate and examine the fossil specimens presented in the trays *(photo 4)*.

On the way to Lunch everybody was given the opportunity to try and identify the 'Mystery Fossil' in a

1. Specimens of animal fossils set out for examination by participants.

block which contained a side view and a plan view of two specimens of the same fossil and this added to the confusion *(photo 5)* (although both views had been described in the pre-reading notes). All good fun and some twigged and got the correct answer.

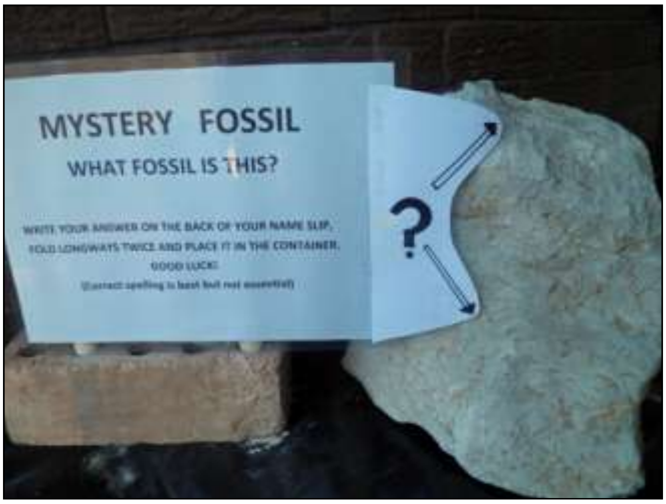
After lunch the group circulated between 16 trays of specimens from several locations, some of which are now inaccessible, mostly from local areas including: Allandale; Raymond Terrace; Mulbring; Kitchener; the Myall Coast, together with material from the Yass area, East Gippsland and the Lorne Basin *(photo 6)*.

Some transected and etched coral specimens from the Yass area were able to be viewed under a large illuminated magnifying glass *(photo 7)* and many people found the series of artists impressions of ancient seascapes and landscapes very interesting.

Now that the notes have been prepared, the fossil material collected and organised and the layout presentation determined, it would be possible to hold the event again in the future, but next time having the fossil group phase on one day and the fossil identification phase on another day a few weeks later.

Report by Winston Pratt.
Photographs by Winston Pratt.

4. AGSHV members examining fossil specimens.



5. "Mystery" fossil, which some participants correctly identified.

6. Fossil specimens from a variety of locations.

7. Etched fossil specimen for viewing through a large illuminated magnifying glass.

Moruya Coastline Geology

Leader: Barry Collier.
Date: Monday 18th to Friday 22nd September 2017.
Attendance: 29 members.

Geological Background.

The rock outcrops visited along the coastline from Mullimburra Point in the south to Lilly Pilly Beach in the north form the easternmost part of the Lachlan Orogen, a vast province of folded middle Cambrian to late Devonian rocks in central New South Wales bound from west to east by the Murray, Eromanga, Surat and Sydney Basins (Branagan and Packham, 2000). This province is also known as the Lachlan Fold Belt and represents a period of intense mountain building involving three principal tectonic events.

During the Ordovician (485-444Ma) the Australian craton (a stable land mass) was still attached to Antarctica and a huge volume of sediment was being eroded from the continent and deposited in a deep ocean basin as a series of turbidites. During the Ordovician to early Silurian an oceanic tectonic plate was pushing against the Australian craton during a period of subduction, forming the Narooma Accretionary Complex to which most of the rocks seen in this coastal section belong. A line of volcanoes (a volcanic island arc) developed off the coastline as a direct result of this subduction. Around 444-428Ma subduction ceased and the oceanic sediments were squeezed and uplifted during the Benambran Orogeny.
The Australian craton remained attached to Antarctica during the Silurian and Devonian and island arc volcanism continued off the coastline. Large volumes of igneous rock were intruded between 428-385Ma, including the Moruya Tonalite (379Ma), part of which is exposed at Bingie Bingie Point.

Massive compression around 380-370 resulted in major uplift, faulting and folding across the Lachlan Orogen. This Tabberabberan Orogeny effectively fused the eastern part of the newly-formed crust onto the older Australian land mass. Further significant deformation occurred at around 340Ma in the Kanimblan Orogeny.

The massive mountain ranges formed by these major tectonic events have since been worn down by erosion, with the sediments deposited in the surrounding basins.

By around 95Ma (in the Cretaceous) several microplates had begun to rift off from eastern Australia, initiating the opening of the Tasman Sea in the period 90-52Ma. This process resulted in many of the coastal features now seen in the Moruya-Batemans Bay region.

During the development of the Lachlan Orogen Australia drifted from tropical to polar latitudes and is now drifting northwards again at 7 to 10 centimetres a year towards Indonesia and Papua New Guinea.
So, the rocks around Moruya bear witness to massive changes in both climate and landforms over a period of almost 500Ma!

Monday 18th September.

Most people travelled down to Moruya, arriving in time for a 5pm meeting in the camp kitchen at the Riverbreeze Tourist Park at which the activities for the next three days were discussed.

Tuesday 19th September.

The first site to be explored was Bingie Bingie Point *(photo 1)* in Eurobodalla National Park south of Moruya. This prominent exposed rocky headland is reached by a short undulating track over coastal dunes. The importance of this site relates to the unusual range of igneous rock types exposed, the principal ones being the Tuross Head Tonalite (a quartz diorite), a plagioclase -rich granitoid forming part of the Moruya Batholith, and a gabbroic diorite of the Bingie Bingie Suite. The tonalite is crowded with enclaves (xenoliths) of approximately the same mineral composition, all showing a strong preferred orientation trending 330° and dipping steeply (*photo 2)*. The quartz diorite has clearly intruded the gabbroic diorite.

Apart from these two intrusive rock types the main attraction is the large number of igneous dykes of varying compositions. Most prominent is the huge aplite (microleucogranite) dyke 3.5m wide intruding the quartz diorite near the north-eastern extremity of the headland *(photo 3)*. The whole complex was subsequently intruded by several basaltic dykes *(photo 4)* of two main types. All follow the dominant east-northeast joint direction in the older intrusives. One set is dacitic in composition (contains free quartz) and Devonian in age. The other dykes are Cainozoic in age and contain abundant large plagioclase crystals. The central dyke is very unusual in that it contains recognisable crystals of red garnet along

1. Bingie Bingie Point.

2. Tuross Head Tonalite containing aligned xenoliths.

4. A pair of basalt dykes cutting across the older aplite dyke.

with amphibole, labradorite, biotite and olivine. One basaltic dyke immediately to the east of the aplite intrusion contains spectacular enclaves of rounded hornblende and large angular fragments of white quartz to 10cm across.

Tearing the group away from this fascinating outcrop proved difficult but the time had come to move on to the next site, Mullimburra Point. Barry first led up to the picnic area where there were toilets nearby. We had morning coffee here before venturing off. A short track to the end of the headland provided a spectacular view down onto another (or possibly the same) aplite dyke on the rock platform below, but access was deemed too difficult for the group as a whole. An unmarked lookout on the southern side of the headland allowed views to the south towards Mount Dromedary and a sea stack of vertical thinly bedded Adaminaby Group sediments on the beach below *(photo 5)*. The rocks under our feet here were distinctly metamorphic with a fine schistose appearance. A pod of whales was clearly visible off the point as we walked back to the cars.

Moving off to the northern side of Mullimburra Headland we clambered over the rough granite rock platform to reach a classic example of tectonic melange, with large angular blocks of banded sea floor chert embedded chaotically in other sediments *(photo 6)*.

The Caravan Park at Congo Point provided the venue for a picnic lunch. Here we saw more whales (or perhaps those seen at Bingie Bingie Point were just a bit slow) and hooded plovers with chicks. This species is listed as vulnerable in the Commonwealth and critically endangered in New South Wales, so seeing them here was a bonus.

After lunch the group walked around the sea cliff at Congo Point. This is one of the few exposures of the Coila Basalt, at 29.1Ma (Bembrick, 1972) the youngest volcanic rock on the south coast. Very surprisingly the basalt is deeply weathered, with rounded core stones of relatively fresh rock irregularly scattered throughout completely weathered rock displaying the most amazing patterns *(photo 7)*. This is most unusual since other outcrops of this basalt and the much older (Permian) basalts around Kiama show no such alteration. Several flows are evident and in a small embayment in the cliff line near the north-western end of the exposure was evidence of one flow "bulldozing" wet lake bed sediments into a narrow pile of broken up mud clasts rimmed by basalt pillow structures *(photo 8)*. Layers of ash fall deposits up to 10cm thick are also present. These contain fragile plagioclase 'stars'.

It was low tide and out on the rock platform we came across large expanses of polygonal cooling cracks in a lower basalt flow *(photo 9)*. The Coila Basalt is

3. Pale coloured 3.5m wide aplite dyke intruding the Tuross Head Tonalite.

5. Vertically inclined thinly bedded metamorphosed Adaminaby Group sediments forming small stacks.

6. Banded sea floor chert in Melange at Mullimburra Head.

9. Polygonal cooling cracks in a basalt flow on the rock platform at Congo Point.

7. Rounded cores of relatively fresh rock in deeply weathered Coila Basalt observed in the headland at Congo Point.

8. Pillow basalt confining an area of 'bulldozed' lake bed sediments, Congo Point.

sandwiched between coastal sandstones deposited when the region was colder and wetter and lay around 2000 kilometres to the south (Journeys in Australia's coastal wilderness. Earth History pamphlet).

With time to spare before the farmers markets in Moruya at 3pm, we drove to Toragy Point at South Moruya Head. Here no track could be found to the rock platform below, but interesting folding could be seen from the head of a deep narrow chasm cutting back into the cliff line. A historic cemetery at the parking area provided interest for some.

At 5pm, after the markets, the group sat around Terry and Laurel's van for a chat and nibbles before dinner.

Wednesday 20th September.

It turned out another beautiful day with a light westerly wind in the morning, turning light easterly in the afternoon. There were very few clouds and the maximum of 21°C was perfect for walking.

Our first stop for the day was Broulee Island Nature Reserve. A short walk from the car park brought us to a crescent beach on the south side of the sand spit connecting the island to the mainland. At the end of the beach we crossed the spit to the north side of the island.

The original intention was to walk the rock platform right around the island but the tide was too high to allow this. So, after following a rough track through grass to the island's north-east side we ended up walking on loose gravel on the beach face behind the rock platform and making brief sorties out onto the wet rocks. The rock platform on the north-east and eastern side of Broulee Island is composed of the same Coila Basalt we saw yesterday at Congo Point, but here it was not weathered to any great extent. This outcrop of the basalt is unusual in that it contains vesicles up to 8cm across lined by botryoidal siderite *(photo 10)* and occasionally agate/microcrystallised colourless quartz.

The Coila Basalt occurs as disconnected outcrops over an area of 450 square kilometres between Mogo

10. Large vesicle within Coila Basalt lined with botryoidal siderite.

13. Coila Basalt hillocks on rock platform, Broulee Island.

and Bodalla. The type section occurs near Coila Lake, after which the rock was named (Bembrick, 1972).

Areas of the rock platform showed horizontal sections through exceptionally large polygonal cooling columns up to 2 metres across *(photo 11)*. These crack networks have resulted in two distinctly different weathering and erosion patterns. At the northern side of the island at the start of the rock platform and adjacent to the beach the basalt forms curious basin-like features resulting from individual cooling columns showing a hard exterior zone and relatively softer, more easily eroded core *(photo 12)*. Further south and well away from the shoreline the reverse is true, with the centre of the columns standing proud as hillocks up to 0.5 metres tall separated by more easily eroded areas immediately adjacent to the cracks *(photo 13)*. This difference may simply be due to terrestrial versus marine erosion.

Towards the end of the beach o the southern side of Broulee Island sandstones of the overlying Paleogene (Tertiary) Meringo Creek Formation show areas of spectacular Liesegang rings *(photo 14)*, a common feature in porous rocks subjected to periodic weathering. Large flat slabs of white quartz pebble conglomerate along the shoreline suggest Broulee Island is capped by conglomerate.

From the Broulee Island carpark, we drove around to the surf club where we had morning tea on

11. Large polygonal cooling joints within a flow of Coila Basalt on the rock platform on Broulee Island.

12. Coila Basalt basin structures, rock platform, Broulee Island.

14. Colourful Liesegang rings within sandstone on Broulee Island.

15. A contented seal sunning itself on a rock near the Broulee Island carpark.

17. Rock from beach at Barlings Beach showing extraordinary leach patterns.

their front lawn after having the rare privilege of watching a seal sunning itself on a large boulder at the roadside *(photo 15)*, totally undisturbed by the presence of people.

The next area to take our attention was the sea cliffs and rock platform at the eastern end of Barlings Beach and nearby Barlings Island, although a deep narrow channel prevented access to the latter. The rock succession here is similar to that at Melville Point, visible across the bay, but is far more complex, with the chert bands strongly disrupted and apparently little preservation of bedding. The rocks here belong to the late Cambrian to early Ordovician Adaminaby Group, here forming part of the Narooma Accretionary Complex. Particularly near the island, the rock layers have been strongly disrupted in a tectonic melange associated with an Ordovician to early Silurian subduction complex.

Of some interest to those who recognised it was the presence of a 10m thick basalt unit at the eastern end of the beach. The basalt is almost unrecognisable, having been converted by regional metamorphism to greenstone, largely a mixture of clays and quartz. This basalt was associated with a seamount that had been accreted to the Ordovician-early Silurian subduction complex (Stokes, et.al., 2014).

For the photographers there was an additional treat in store here in the form of extraordinary weathering patterns in beds of the black to dark grey Narooma Chert in the sea cliffs and on rock platforms *(photo 16)*. These patterns are due to groundwater leaching along stress crack networks. Brian England picked up an astonishing house brick size specimen on the beach *(photo 17)*. Tight almost isoclinal folding was seen in the cliff and platform near the eastern end of the outcrop area but these features were almost impossible to photograph due to the nature of the light *(photo 18)*. A relaxed picnic lunch was enjoyed in the huge park beside the Tomaga River in Tomakin before driving up to Guerilla Bay.

We drove to the end of Guerilla Bay Road and after parking eight vehicles with some difficulty so as not to block residential access we walked down to the beach and southwards towards the headland. Fortunately, the sea was calm and the tide quite low so everyone was able to access the spectacular arch on the north side of the headland *(photo 19)*. Some managed to rock hop through the arch from the seaward side to the tiny rocky beach in the sinkhole on the landward side, formed by the partial collapse of a large sea cave.

The rocks enclosing Guerilla Bay are Ordovician cherts, slate and greywackes of the Wagonga Group.

16. Leaching patterns along stress fractures in black Narooma Chert on rock platform, Barlings Beach.

18. Tight isoclinal folding in Wagonga Group rocks, Barlings Beach.

19. Natural arch eroded through Wagonga Group metamorphic rocks at Guerilla Bay.

These rocks also form part of the Narooma Accretionary Complex and have been squeezed, broken and bent by compression, with many examples of tight folds, abundant faults and tectonic melange (Stokes, et.al., 2014).

The group then drove north to a parking area at the end of Bay Drive and from there walked down to the beach and then northwards to a small un-named bay north of Guerilla Bay. Here we were able to walk out to a small island tied to the mainland by a sand spit, where examples of folding and melange were easily recognised, as well as more spectacular examples of leach patterns. From this island there were great views north over the water to Jimmies Island as well as back across the bay to the arch we had just visited. Deep caves at the north side of this little bay were also explored and some took the rough track to the cliff top for great views.

On the return drive to camp at Moruya we pulled in for afternoon tea at the Quarry Picnic Area opposite the locked entry gate into the Moruya Granite Quarry.

The first quarry here was opened in 1864 by Henry Ziegler to supply stone for monuments and churches in Moruya. The stone was also used for the columns and steps of the GPO in Sydney and the base of Captain Cook's statue in Hyde Park around 1868. It was also used for the Martin Place Cenotaph. In 1876 parts of Ziegler's land were resumed for a Government quarry to provide armour rock for the northern breakwater and river bank protection. From 1925 to 1932 the Sydney Harbour Bridge contractor Dorman Long used the quarry for the cladding stone on the pylons and piers (40,000 pieces) and for crushed stone used as aggregate in the concrete. This was all transported to Sydney using three steamers made at the Newcastle State Dockyard.

At a meeting in the camp kitchen after dinner Brian gave a talk on the possible reason for the very deep weathering of the Coila Basalt exposed at Congo Point. This served to demonstrate how a few simple observations at a site can lead to a plausible (but not proven) scenario as a basis for further investigation.

20. Massive quartz dyke at Malua Bay.

Thursday 21st September.

Another 8:30am start saw us heading north along the Princes Highway and turning right on Broulee Road, then left onto George Bass Drive. First stop was Mossy Point, midway between Broulee and Tomakin, but unfortunately the tide was too high to access the rock platform, so we would return later in the day. Moving north to Malua Bay the tide was still high but falling, so that eventually everyone was able to reach the end of the rock platform south of the beach.

Rock outcrops in this section of coastline again comprise Adaminaby Group sediments bent and disrupted in a tectonic melange. But the main feature here was the massive north-south trending dyke of dense white quartz over a metre in width and standing like a great wall at the back of the rock platform *(photo 20)* which was strewn with large blocks plucked from the dyke by wild seas. The rock platform displayed intricate and disrupted folding *(photo 21)* and, further back towards the beach, yet more spectacular leach patterns kept the photographers busy .

After morning tea in the picnic area behind the beach at Malua Bay we drove the short distance south to Pretty Point Bay. After only a short walk southward along the beach we came to what was easily the most interesting rock platform encountered on the entire trip. Barry complained later that none of the geologists in the group explained what was going on here but I think we were so gobsmacked by the variety of what we saw that an overall explanation seemed impossible at the time.

Again, the rocks exposed here form part of a tectonic melange within the Narooma Accretionary Complex. Following the platform for several hundred metres revealed astonishing examples of intricate leach patterns, sub-parallel kink folds *(photo 22)*, faulting,

21. Leach patterns and disrupted folding within Adaminaby Group metasediments.

honeycomb weathering, and a really spectacular block of folded chert/black shale totally different from anything else in the melange *(photo 23)*. Also present were numerous examples of sub-parallel white quartz veins, including one superb example of en-echelon veins *(photo 24)*. These structures are used by geologists to determine the direction of stress applied to rocks during deformation. From here we drove back to Malua Bay and had lunch in the main park opposite the take away food shop.

After lunch we returned to Mossy Point to find the tide sufficiently low to allow full exploration of the rock platform, referred to by Barry as the "railway cutting" and "marshalling yards". And that is exactly what this site resembled. Access to the platform was via a deep narrow cutting excavated by erosion of a bed of softer rock, even with two bands of harder rock providing the "tracks" *(photo 25)*. This led us into an area of tight folds and accompanying faults *(photo 26)* as well as some of the most amazing honeycomb weathering seen anywhere.

From Mossy Point we returned to George Bass Drive and headed north to Tomakin and on to Melville Point, an isolated rocky outcrop between Tomakin Cove and Barlings Beach. Firstly we drove up to the lookout above the rock platform and then down to the parking

23. Block of folded chert in mélange at Pretty Point.

area adjacent to the northern side of Melville Point. With the tide reasonably low we then walked around the headland from the north side.

The rock platform and sea cliffs here provide the only known exposure of the contact between cherts of the Wagonga Beds and the overlying slate and greywacke sequence of the Adaminaby Group which outcrops along much of the coastline between Eden and Batemans Bay (Percival, 1985). The contact was originally considered to be unconformable but more recent work found no evidence of an unconformity.

The thinly bedded Wagonga Beds are very tightly folded *(photos 27 & 28)* and display alternate black and white layering, providing spectacular photographs. Most people ventured right around the edge of the outcrop, finding a small but spectacular cave on the southern side. Backtracking to the vehicles revealed even more spectacular structures that were missed on the first traverse. On the way back, Barry noticed a large rock pool in which several sea hares were grazing on

22. Kink folds at Pretty Point.

24. En-echelon quartz veins.

25. Walking through the "railway cutting" at Mossy Point.

28. Tightly folded cherts belonging to the Wagonga Beds at Melville Point.

seaweed. Two of these fascinating tiny creatures appeared to be mating. David Attenborough eat your heart out!

After returning to camp to clean up the group spent a very pleasant evening at the Moruya Bowling Club. It was pizza night, so those who ordered pizza got a full-size pizza for $15 and a free bottle of wine! What a great way to end the trip!

Report by Brian England.
Using a detailed framework provided by Barry Collier.

26. Tightly folded metamorphic rocks, Mossy Point.

27. Folding in Wagonga beds, Melville Point.

References:

BEMBRICK, C.S. (1972). *The Coila Basalt.* Geological Survey of New South Wales. Quarterly Notes, Number 9, 2-7.

BRANAGAN, D.F. and PACKHAM, G.H. (2000). *Field geology of New South Wales.* New South Wales Department of Mineral Resources.

PERCIVAL, I.G. (1985). *The geological heritage of New South Wales. Volume 1.* New South Wales National Parks and Wildlife Service. Site 13, pages 36-37 and Site 14, pages 38-39.

STOKES, N.; FERGUSSON, C.L. and OFFLER, R. (2014). *Backarc basin and ocean island basalts in the Narooma Accretionary Complex: setting, geochemistry and tectonics.* Australian Journal of Earth Sciences.

Watagan Highlights

Leader: Chris Morton.
Date: Saturday 20th October 2017.
Attendance: 18 members.

This activity was designed to explore some of the little known but spectacular lookouts in Watagans National Park that are hidden away from the main access roads, along with some of the more popular tourist destinations. We visited 8 lookouts all together with vistas to all points of the compass, from rural to lakes and ocean views. We touched on the history of timber getters and enjoyed the beauty of the forest and scenery.

Geology and landscape.

The Watagan National Park is characterised by sedimentary formations of the Narrabeen Group and Hawkesbury Sandstone, with some smaller areas of Quaternary Alluviums. Common rock types are sandstone, claystone, siltstone and conglomerate.

Watagans National Park protects important areas of remnant forest ecosystems at the head of major water catchments. Some areas remain untouched and have not been significantly logged, and contain important biodiversity values and intact natural landscapes.

The Awabakal and Darkinjung Aboriginal peoples are the original inhabitants of the Watagans area. The Darkinjung, Koompahtoo and Awabakal Local Aboriginal Land Councils (LALCs) and the Traditional Awabakal Descendants represent Aboriginal interests in the area today.

European settlement in the region was driven by the need for coal, agricultural land and timber. By the 1820-30s timber removal was common place, including harvesting of red cedar. Hardwoods were harvested for gold rushes, coal mining, railway line construction and the associated building boom, turning the resources of the ranges into a valuable commodity.

1. "Geerings shop".

2. The Wishing Well on Martinsville Road.

The activity.

We commenced the day's activity at 8:30am, opposite the fire station in Cooranbong on a fine sunny morning. Given the consistent welcome rain of the day before that replenished dams and tanks and freshened up the dry parched countryside after a long dry spell, I would not have been surprised if we had some cancellations. But not our intrepid members, as all that had booked in were eager to tackle what are in many cases unmaintained tracks.

After a short introduction and safety briefing we drove through the picturesque Martinsville Valley that was first settled by William & Sarah Martin in 1853. We stopped at what was Geering's shop *(photo 1)* at the turn off into the forest. Geering's shop at Martinsville originally began as a mill that manufactured 'Felloes'. Felloes are the outer circle of wooden wheels that is attached by spokes. The mill then became a general store in 1903 and closed in 1955 when it became the Watagan Inn, a teahouse for tourists visiting the State Forests as they were then.

Continuing on we came to the 'Wishing Well', as it is named *(photo 2)*. The wishing well was built over a natural spring. It was known and used by the Aborigines long before Europeans. For more than a century it was just a roadside spring used by early timber getters and travellers who traversed this road to come and go to Wollombi. The moss covered sandstone rock next to the well has a variety of inscriptions dating back to 1888.

Morning tea was enjoyed at our first lookout for the day at the end of Bowmans Road, which overlooks the Congewai Valley *(photo 3)*. From our vantage point views of rich verdant fields with healthy cattle stretch out down the valley, along with oxbow lakes and a meandering stream that divides the Congewai valley. At our morning tea spot, a beautiful *Cymbidium suave* orchid with a number of flowering spikes *(photo 4)* was happily

3. Looking into the Congewai Valley from the end of Bowmans Road.

5. A magnificent stand of *Xanthorrhoea malacophylla*.

growing in a dead stump. This was a pleasant distraction for the photographers and plant lovers amongst us.

A brief explanation was given on how the Marines whose job it was to guard the convicts of the First Fleet became some of the first settlers in the area. NSW Corps and the Marines of the First Fleet were all hand picked volunteers, lured by offers of discharge and land grants in the new colony after 3 years service. Marines saw extensive service in theatres of operation as far afield as North America, India and the Caribbean. Many of the First Fleet Marines were former tradesmen displaced by the Industrial Revolution, and their skills helped to build the young colony (Naval History Society of Australia. The Marines of the First Fleet).

From here we drove back to the main road where after a few kilometres we turned onto Rope Road and continued onto Long Point Lookout. Halfway along this road we were delayed for a short period of time while we removed a small tree that had fallen across the road.

Before reaching the lookout we stopped to admire a spectacular stand of *Xanthorrhoea malacophylla (photo 5)*. These impressive plants can grow to be 3 to 4 metres high. Many had flower spikes on them increasing their height by another metre or two. From here we drove a hundred metres to Long Point Lookout, also giving panoramic views over Congewai Valley *(photo 6)*.

After some time admiring the view we returned to our cars and drove to Boarding House Dam, where the timber getters camped in tents during the week, before returning via bush tracks to their homes on the weekends. Hence the name Boarding House Dam.

Thomas Barnier who was a local timber getter was the first to build a sawmill in the Watagan area. Barnier dammed off the creek that runs through this small valley in the early 1900's, to source water for his men and bullocks *(photo 7)*. There was a boarding house of sorts built nearby and run by what is described as a no nonsense feisty lady. This establishment also acted as a place for timber getters to be taken to when hurt or injured before they were taken back to civilisation to be treated. The boarding house area was the longest-serving and largest logging camp in the Watagans.

This is also the site of the stunning 110 metre long Moss Wall *(photo 8)*. The mossy and delicate ferns that cover the wall are a part of a 20-minute walk that commences at the Boarding House Dam picnic area. It passes through a cool gallery rainforest featuring lilly pilly, coachwood, grey myrtle, and follows a gently flowing creek that features beautifully sculptured rock pools, moss and fern covered boulders with water gums that have grotesque root systems. Many of the rainforest trees have *Bulbophyllum* orchids *(photo 9)* and delicate

4. Flower spikes of *Cymbidium suave*.

6. Looking southwest from Long Point Lookout into the Congewai Valley.

7. Boarding House Dam.

8. The "moss wall", low sandstone cliff covered with several species of moss.

9. Small *Bulbophyllum* orchids in flower, growing on a tree near the moss wall.

ferns clinging to their trunks along with elkhorn ferns perched high in the canopy.

After a pleasant walk and picnic lunch we continued along the forest road to Georges Road. Georges Road traverses a long narrow ridge that runs in a westerly direction. There are many locations along this track that present magnificent views to the north. None more so than Narrow Place Lookout, which is on the edge of an escarpment with a sheer drop of about 80 metres. From this point there are outstanding views across Quorrobolong, Cessnock, Kurri Kurri, Ellalong Lagoon, Broken Back Ranges and Barrington Tops. In the sandstone at the edge of the escarpment there is a number of sharp grooves. These are the result of wire ropes that were used to recover stolen and dumped vehicles from the bottom of the 80 metre cliff.

Continuing on, our next destination was 125r Lookout. However to some it is also known as Jew Boy Lookout. So named after the Jew Boy Gang, a bushranger gang that terrorised an area between Tamworth and the Hawkesbury around 1839/1840. This unfenced lookout on a narrow point high above Congewai Valley with its perpendicular sandstone walls gives stunning views across the valley. Mount Warrawalong is prominent to the southwest *(photo 10)*. Mount Warrawalong was last visited by the AGSHV in 2006. It is no longer accessible.

Returning along the same track to Georges Road, we turned left and drove to what is called a 'Log Tossing Site'. Before mechanisation the quickest and easiest method to get cut logs off the mountains to the sawmills below was to spear or roll them down a chute that was cut and cleared from the side of the hills. Bullocks dragged the logs parallel to the ridge and when the log reached the desired spot, the bullock was spun around at right angles. This swung the log endways over the precipice. A wooden pin was knocked out of the chain dragging the log, allowing the log to plummet down the hill. At the bottom it was dragged to the sawmill for processing.

Not far from this site brought us to the end of the track. So returning the way we came, we drove to McLean's lookout where an east/northeast aspect presented us with views to the ocean over Mulbring, The Gap and Mount Sugarloaf *(photo 11)*. As time was against us we did not linger for to long.

Our next stop was Heaton Lookout. This lookout is considered by many to be one of the more spectacular views along the coast of New South Wales. The escarpment is some 330 metres above the plains below, giving a 180° view spanning from Stockton Beach in north to Terrigal in the south. From our vantage point we could also view the entire Lake Macquarie system with its 365 kilometre shoreline and Pulbah Island, along with Tuggerah Lakes, Budgewoi Lake and Lake Munmorah. Thomas Barnier and his two sons discovered this lookout when they were looking for a site to build a sawmill and a road, after first venturing up to this area in 1899. This site was named after the small

10. Congewai Valley from 'Jew Boy' Lookout (125r). Mt. Warrawalong is the flat-topped hill top left.

11. Coastal plain as seen from Mclean's Lookout.

12. Admiring the view from Monkey face Lookout, the last lookout visited on our Watagan ramble.

settlement of Heatonville that could be seen from the lookout. Heatonville, a one-time timber settlement was just south of The Gap, now officially known as Freemans Waterhole. (Source: Tumblebee Number 1, February 1997).

The final stop for the day was at Monkey Face Lookout *(photo 12)*. This lookout is quite special to Barbara Dunn, one of our members. The lookout overlooking the valley gave Barbara an excellent opportunity to share some family history, and the interesting facts on how this lookout obtained its name. Barbara's grandfather bought a property named Wonga Hill and started a sawmill in 1900 at the end of the valley below the lookout near Martinsville. He was a dairy farmer (unsuccessful) and an orchardist.

Logging was in full swing by the 1920's. His two eldest sons ran two bullock teams bringing logs out of the Watagans from about 1910. As a part of this operation they had a number of bullocks that were used to drag timber logs to the mill for processing. One of these bullocks by the name of Monkey, displayed a somewhat dejected, pessimistic attitude and was a serial absconder. So when he went missing, which was often, Barbara's uncles always found him on a flat area, just below the face of the lookout…. So! This is the true story of how Monkey Face lookout came to get its name. They began the second sawmill in 1947.

This brought a very enjoyable day to an end. All that was left was to drop those who were car sharing back to their vehicles at Cooranbong.

Report by Chris Morton.
Images and editing by Ron Evans.

References & Resources.

Watagans National Park and Jilliby State Conservation Area Plan of Management.

Watagans National Park. NSW National Parks and Wildlife Service.

PRATT, Winston. *Summary of Jew Boy Gang.*

Red Triangle Slug *(Triboniophorus graeffei)* found at the Moss Wall.

Mittagong Weekend

Leader: Sue Rogers and Brian England.
Date: Friday 3rd to Sunday 5th November 2017.
Attendance: 11 members.

Geological background.

Compared to some of the other areas visited by the society this year (notably Tibooburra and Moruya) the geology of the Mittagong region is mercifully simple.

The dominant feature both geologically and geographically is the massive dome of microsyenite (Bowral trachyte) called Mount Gibraltar ("the Gib" to the locals) overlooking the towns of Bowral to the south and Mittagong to the north. This was intruded as a mass of molten magma around 180 million years ago (Jurassic age) to form a flat based dome like structure called a laccolith. This intrusion lifted up the Hawkesbury sandstone and overlying Ashfield shale of the Triassic Wianamatta Group to form a high mountain, most of which (around 4 kilometres) has since been eroded away.

The slopes around the Gib comprise outcrops of Ashfield shale which weathers to a rich soil, hence the magnificent gardens and parks in Bowral and Mittagong.

In lower areas the underlying Hawkesbury sandstone is exposed. The Narrabeen Group, which normally underlies the Hawkesbury sandstone, does not occur in the Mittagong - Bowral area, although it is present on the lower slopes of the Nattai Canyon to the north.

The coal seams exploited by the Fitzroy iron works comprise semi-anthracite formed by thermal metamorphism of normal bituminous coal by nearby Jurassic age syenite intrusions. The coal seams belong to the Permian Illawarra coal measures.

The last of the local rocks to be laid down was Paleogene (tertiary) basalt exposed on the higher areas. This forms part of the extensive flows that extend east beyond Moss Vale to Robertson. The source of the flows is unknown.

1. Stones used in a Chilean Mill.

2. *View from inside Box Vale tunnel.*

Friday 3rd November.

The trip commenced with a meeting in the camp kitchen at Mittagong Caravan Park to discuss the itinerary and geology of the area.

Saturday 4th November. Mittagong.

We set off at 8:30am for the Highlands Marketplace Archaeological Site situated in the carpark of the Big W shopping centre. This was the site of the first iron smelter in Australia unearthed in 2005 when the foundations for the shopping centre were dug. The many signs explained the operations of the Fitz Roy Ironworks that were named after the Governor of NSW, Sir Charles Fitz Roy. The ironworks commenced in 1848 following the discovery of iron ore in 1833 when the road south to Mittagong was being built. Clay bricks were made at on-site kilns with clay treated at the Chilean mill *(photo 1)*. Coal and limestone were obtained locally so a small cupola furnace commenced operation in 1849. Puddling furnaces, a tilt hammer, rolling mills and other workings were installed enabling the production of three tons of iron daily. Workers lived in tents while the village of Nattai was established.

In early 1863, on what is now Ironmines Oval, construction of a large cold-air blast furnace was undertaken by hand using local sandstone and bricks. With workshops and a foundry, the new furnace was fired up in July 1864 but did not function to expectations as its inner linings collapsed and was soon shut down. This was rebuilt as a hot-air furnace in the following year. It was blown-in again and production commenced. The cast iron smelted was stockpiled or went to the older site for rolling into rails and other products. An order of 54 large cylinders for a bridge at Gundagai was fulfilled.

As around 70 extra men were employed from 1863, there was additional demand for housing. This and ongoing difficulties in raising capital led the directors to decide to release for sale a significant easterly portion of the company's large land holdings. Ebenezer Vickery and other directors planned a model township and the name 'New Sheffield' was adopted for a town comprising quarter-acre lots set around a square and with land reserved for a Wesleyan church and school. The town was laid out with streets 20 metres wide and 10 metre wide lanes.

There was much jubilation when the hot-blast furnace was fired up on May 24 1865, and the Iron Works directors marked the occasion by laying the foundation stone for the Wesleyan church and by releasing the first lots of the sub-division. A luncheon for over 300 guests completed that day's celebrations.

We walked past Iron Stone cottage, a sandstone building that is the only above ground remains of the Fitz Roy Ironworks. At the entrance to Aldi we viewed further artefacts in the glass cabinets that were discovered when Aldi was built in 2010. We then walked to the Blast Furnace foundations and Ironmines Cairn and tablet of polished trachyte, erected in 1948 to commemorate the centenary of the founding of the iron works.

Our next stop was for morning tea at the head of the Box Vale Walking Track. We then drove to Kell's Creek to commence the walk along the historic railway line to Nattai Gorge through the boulder and fern cuttings and into the 84 metre tunnel *(photo 2)*. We viewed the box cart loading area over the old coal mine. A coal deposit was found on the Nattai River in 1851. The Nattai Coal Mining Company attempted to exploit this in 1878 but lacked the capital required. The Mittagong Coal Mining Company Limited took over the project and in 1888 completed the 6km standard gauge railway line that left the main line south of Mittagong station and terminated at Nattai Gorge, some 160 metres above the coal mine. The mine closed in 1896 having produced an average of about 1000 tonnes of coal p.a. All plant and equipment were removed and bush fires destroyed the railway sleepers and trestle bridges.

3. Waratah beside the Box Vale Track.

4. Picnic area beside Lake Alexandra.

The Box Vale walking track passes through bush based on Hawkesbury sandstone. At the edge of Nattai Gorge outcrops of Narrabeen sandstone occur. The surrounding terrain is steep and rocky with minimal top soil. At the beginning of the track the trees are stunted and sparse. We saw evidence of many wombats and spotted many different spring wildflowers *(photo 3)*.

We then drove to Lake Alexandra, a man-made lake which started life as a dam supplying water for engines hauling coal to the Fitzroy iron mines almost 140 years ago for lunch surrounded by ducks *(photo 4)*. After a circuit of the lake we drove up Mount Alexandra and did the short but steep 200 metre descent to the Coke tunnel *(photo 5)* which was used to bring coal in for the local iron works. The brave then ventured down towards another old coal mine site and walked alongside the Nattai River to the caravan park.

Sun 5th November. Berrima and Bowral.

We departed at 8:30am for the short drive to Berrima Camping Ground. Berrima was established in the 1830s during a time of great exploration and expansion in New South Wales. In 1829 Surveyor

5. David at the Coke tunnel.

6. Wingecarribee River at Berrima.

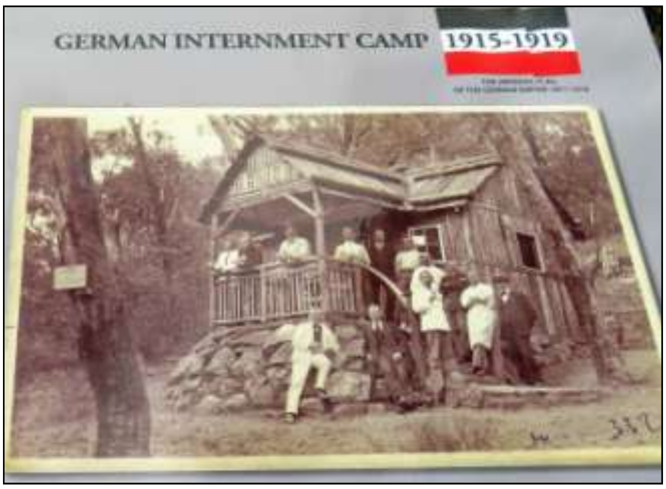
8. All that remains of Alsteburg.

General Major Thomas Mitchell camped near the site of the present bridge over the Wingecarribee River while surveying the route for the Great South Road. He advised Governor Bourke that here was an ideal town site, and surveyor Robert Hoddle submitted a plan for the village which was approved in 1831 by Governor Bourke.

By 1840 Berrima had a Court House and a Gaol, and it became the administrative centre for the southern districts. The village prospered as it became a convenient stopping point for the passing traffic. However the railway reached Mittagong in 1867, but bypassed Berrima. One by one, Berrima's 13 inns closed until only the Surveyor General remained. Over the years the population shrank. The gaol closed in 1909, but it was re-opened in 1914 during World War I as it was used to house mariners and internees, plus a number of prisoners of war from the German raider SMS Emden. After the war it was abandoned until 1948 when it became the Berrima Training Centre, a minimum security correctional centre.

We completed an enjoyable 1.8km easy walk to discover what the German merchant seamen built along the Wingecarribee River while interned at Berrima gaol. Of all the Australian WWI internment camps, Berrima was the only one not to confine internees within the camp perimeter. The 329 internees were merchant naval captains, senior officers, the senior executives from German shipping companies with offices in Australia, and a small number of prisoners-of-war from the German light cruiser SMS Emden, which had sunk the HMAS Sydney. They were permitted to leave the gaol from 6am and return for roll call at 6.30pm after which they were locked in for the night. As they were not required to work they put their energies into recreational pursuits. The Wingecarribee River *(photo 6)* was their playground. One of their first projects was to build a bridge over the river, which they then dammed to obtain better depths adjacent to the gaol. The river banks were soon adorned with stone and wooden huts, substantial log villas and gardens for day time recreation. Boat building was pursued with passion using bush timber or scrap metal from an old mine. To celebrate the Kaiser's birthday regattas were held and the boats were decorated with great imagination and skill. These events were well attended by the villagers and guards. Inside the gaol the internees built a theatre and performed fortnightly.

Following the departure of the internees in 1919, the boats, villas and gardens gradually disappeared and the river became badly overgrown by willows. In 1998 the National Trust, using local volunteers started to clear the river and banks and in doing so unearthed remnants of the internees' constructions along both banks of the river, but particularly the right bank *(photos*



7. Signpost showing Alsteburg.

9. Cold and wet lunch stop at Corbett Gardens.

7 & 8). Clearing and replanting with native species continued to 2009.

We then had free time to explore the attractions of this well preserved Georgian village. Morning tea was enjoyed at one of the many cafes before going to either the sound and light show at the Court House, Harper's Mansion and beautiful garden, the museum to discover more of Berrima's history or browsing the many gift shops. We then drove to Corbett Gardens, Bowral for lunch in the park just as the weather started to close in *(photo 9).* The park boasts a huge array of tulips and colourful springtime bulbs, shrubs and trees.

Our next walk was the Heritage Trachyte Quarries circuit walk half way up Mt Gibraltar. The microsyenite forming Mt Gibraltar is composed of the alkali feldspar sanidine plus lesser pyroxene (aegirine-augite). The rock is noted for veins of sanidine/pyroxene pegmatite up to 3cm wide.

The microsyenite was quarried for a hundred years, 1886-1986, for stone for many grand public buildings including Sydney landmarks such as Challis House, Martin Place, National Mutual Building, George Street, Queen Victoria Building George Street, ANZAC Memorial, Hyde Park and public works such as Hawkesbury River Bridge at Brooklyn, our National library in Canberra and Australia House in London. The trachyte was used for road making in the 1830s but when the railway line reached Bowral it meant the trachyte could be quarried commercially as the stone could be transported by rail. The timber on the mountain was used to fire the steam engines and for pit props in the nearby mines. In 1919, Joshua Stokes, a local councillor, purchased 32 hectares on the summit to create a nature reserve. During the 1930s depression relief funds were provided to workers to construct the Scenic Loop Road, lookouts and picnic shelters. Over time the council has purchased the rest of the land including the quarries and various volunteer groups have been systematically weeding the reserve and restoring the native vegetation.

Although hard to work with, microsyenite is sought by architects and builders as it is hard and fine grained and takes a beautiful polish. It is without cracks or flaws and blocks of virtually any size could be obtained *(photo 10).* We saw where one large boulder had been recently removed for transport to the National Rock Garden in Canberra.

10. Barry said Wow!

We then drove to the top picnic area and walked out to Bowral lookout but the mist prevented us from seeing the views so we decided it was time to return to our vans.

After refreshing ourselves we visited local historians Greg and Leonie Knapman. Leonie spent her childhood in the shale oil refinery town of Glen Davis and despite her minimal formal education, has written several excellent books on Glen Davis and Joadja. She was our guide when the Society visited Joadja in in August 1998. We were privileged to view her collection of rocks and minerals plus a large number of polished stones.

This was followed by dinner at Mittagong RSL, the site of where bog iron ore was first discovered in Australia. This was a great ending to an enjoyable weekend.

Report by Sue Rogers.
Geology by Brian England.
Photographs by Sue Rogers and Elaine Collier (photo 2).

Reference and Further Reading.

BRANAGAN, D.F. and PACKHAM, G.H. (2000). *Field geology of New South Wales.* Mineral Resources NSW.

http://www.fitzroyironworks.com.au/

http://www.higround.com.au/docs/THFitzRoy.pdf

https://images.bookeasy.com.au/website/images/southernhighlands/Fitz%20Roy%20Iron%20Works%20Heritage%20Circuit%202015_A4.pdf

https://images.bookeasy.com.au/website/images/southernhighlands/2015%20BOX%20VALE%20WALKING%20TRACK.pdf

http://www.rabbitte.com.au/TreksandClimbs/tracknotes_box_vale.htm

http://berrimavillage.com.au/

http://www.environment.nsw.gov.au/heritageapp/ViewHeritageItemDetails.aspx?ID=5060563

Wombeyan Caves Field Trip

Leaders: Janece McDonald & Lawrie Henderson.
Date: Monday 6th to Friday 10th November 2017.
Attendance: 23 members.

Wombeyan Caves Karst reserve is located within the Southern Highlands 77km north of Goulburn. Access is by the Wombeyan Caves Road from either Mittagong in the east or from the Goulburn-Oberon Road in the west.

Wombeyan Caves -Early History.

Prior to European settlement the area was inhabited by people from the Gundungurra Aboriginal language group and it is thought that Wombeyan means 'grassy flats between two mountains'.

The first Europeans to discover the Wombeyan Caves were John Oxley and John Macarthur in 1828. Oxley was exploring the area. Macarthur, an established merino breeder, was travelling with Oxley hoping to find suitable land to expand his grazing empire. Oxley, Macarthur and their party camped near the current site of the kiosk and during the night the horses strayed downstream and when the explorers went searching for them they discovered the Victoria Arch (the entrance to the Fig Tree Cave). Oxley and Macarthur documented the caves' existence but did not explore them.

In 1842, Reverend Denning was the first European to explore the creek section of Fig Tree Cave. It wasn't until 1865, with the appointment of Charles Chalker as first caretaker, that the system was explored in any detail. Chalker discovered nine major caves many of which are inaccessible and are closed to the public.

The Caves were originally shown to visitors by candlelight and magnesium flares. In 1928, three of the caves were lit by electricity, but because of difficulties involved in maintaining lights and paths in the Fig Tree Cave, this cave was not illuminated until 1968 and then opened to the public *(photo 1)*. The Caves House was burnt down in 1935 and has not been replaced.

Geological Setting - What is karst?

Karst is a landscape produced by solutional weathering, resulting in a unique set of small-scale features such as rillenkarren, runenkarren, grikes and large-scale formations such as dolines, sink holes, sinking streams, blind valleys and cave systems. The bedrock is primarily limestone or marble ($CaCO_3$), dolomite ($MgCa[CO_3]_2$) or Gypsum ($CaSO_4.2H_2O$). These rocks are susceptible to solutional weathering via the slightly acidic rainfall and enhanced by soil CO_2, producing stronger carbonic acid (H_2CO_3).

The main body of the Wombeyan marble is a white/ creamy coloured saccharoidal marble with yellow veining; other colours include white, blue-grey and

1. Now and then looking into Victoria Arch from the entrance (Wombeyan Caves by Harden S Melville 1846 [htpp://www.thepictarzm.club/share/BZmiMzgqhk]). The arch is shown with several aborigines standing near the entrance, and the description claims that the caves are coloured in a very curious manner, having the most vivid and beautiful hues of pink, green and yellow.

yellow. The limestone was deposited in a shallow marine environment during the Silurian. A karst surface existed during the Early Devonian and was buried by volcaniclastics during the Early to Mid Devonian. The oldest volcaniclastics filled submerged fissures, grikes and other karst features with sediment composed of particles of quartz porphyry. Marmorisation (limestone metamorphosed to marble) is suggested to have been caused by emplacement of the Late Devonian Columba Granite intrusions and other small mafic intrusions such as gabbro.

Day 1. Monday 6th November .

AGSHV Members arrived during the day, most coming from the Mittagong weekend trip *(photo 2)*. After setting up, the group met in the beautifully designed and marble constructed common room, part of the Barmah buildings. Janece welcomed all and gave a power point presentation explaining karst processes and landforms, cave formations and palaeoclimate research at Wombeyan. Because of a huge storm early Monday morning, the land lines were out and power had been cut to the show caves impacting on the schedule. Resultantly, the programme became very elastic!

Day 2. Tuesday 7th November.

The group met at the Kiosk and then walked up the path to the meeting point to wait for Gabby, one of the Discovery guides, for a visit to Junction Cave. The lighting was thought not to have been affected by the storm, but unfortunately that was not the case. The group continued a walk from the cave entrance down to Wombeyan Creek where we stopped for morning tea *(photo 3)*. Wombeyan creek is a sinking stream, originating on the volcanics above Wombeyan waterfall. The site where we stopped was about 5km from the waterfall, after the exit point from Figtree cave and about 200m from Mares Forest creek. The stream was dry but showed much evidence of recent debris and flow into Mares Forest Creek (which flows into the Wollondilly river).

3. Morning tea in Wombeyan Creek bed.

After a short walk up the hill we joined the Mares Forest Creek walking track to the arch cave known as Tinted Cave *(photos 4 & 5)*. Tinted Cave, referred to as an in-and-out cave, was formed by Mares Forest Creek as it cut its gorge by meandering sideways forming several lateral erosion caves. Tinted Cave was an old show cave and has three entrances at water level which we did not explore. From the cave there are magnificent views of Mare Forest Creek Gorge. This gorge is one of several up to 50m deep. Several caves efflux into the gorges. Erosion notches and many solutional features are visible.

Just starting to bloom was the Chalkers wattle *(Acacia chalkeri)*, named in recognition of Charles Chalker and his brother Thomas Michael Chalker, who were the keepers of the caves from 1865 until 1925. Abundant birdlife was seen including New Holland honey eaters and mistletoe birds in the kurrajong trees and yellow box gums. The group lunched at the top of caves' hill near the caves tour meeting place. Here, numerous tuffa deposits indicating the flow of an ancient Wombeyan Creek can be seen *(photo 6)*.

The group continued walking over Guineacor Hill *(photo 7)* with Richard being the bush basher extraordinaire! The site of the meteorological station used by Janece and colleagues in their hydrochemical research was explored. Janece explained how rainfall

2. Sign on road to Wombeyan Cave Karst Conservation Reserve.

4. Tinted cave perched above Mares Forest Creek and Gorge.

5. A view from Tinted cave looking downwards along Mares Forest Creek. A spectacular column can be seen.

7. Intrepid explorers on Guineacor Hill.

amount and intensity were logged and related to cave drip water discharge and, how dust samples were collected from multi-directional collectors and analysed to discriminate between terrestrial (continental) and maritime air mass signals. A large doline was viewed *(photo 8)*.

The group continued walking to meet the incoming road from Taralga arriving back at camp late afternoon after an approximately 9.5km walk.

Day 3. Wednesday 8th November.

The electrician was not due to arrive until Thursday (so no cave lighting), so went to the Wombeyan Quarry sites. Within the Caves Reserve are several marble quarries first quarried in 1915 and continuously mined under different leases until 1997.

The creamy white marble was quarried by Melocco Bros. for building stone and later by Steetly Industries for crushed marble industrial products. The mining of marble ceased, mainly because of decreasing demand and environmental concerns.

We drove first to the modern quarry *(photo 9)* (disused for about 15 years). Many beautiful samples of the saccharoidal marble were admired. The quarry is under remediation by Steetly Industries. Its now part of the Wombeyan Karst Conservation reserve and is managed by the NPWS *(photo 10)*.

A short drive back to the original quarries and morning tea partaken. At this site there is a fenced storage area of numbered marble blocks, kept for future use on building sites which used Wombeyan Marble. Lawrie gave a short talk about the quarrying methods and equipment used. The original crane could be seen, designed to be steam-driven, it was converted to pneumatic *(photo 11)*. A small abandoned quarry on the other side of the road was filled with sawn blocks *(photo 12)*.

The group moved down the hill to view two small quarries, both abandoned early in their life due to inconsistency in marble quality because of extensive fracturing and presence of grikes and caves. Abandoned equipment was visible in these quarries *(photo 13)*.

We moved down to the largest and most spectacular of the quarries: as Janece commented “a karst hydrologist’s dream”. At this site, although fracturing and grikes are present, large viable blocks of marble were able to be quarried. One comment overheard…. ”if I die now I’ll be happy - this is magnificent!” The extent of the quarry and range of features able to be seen exposes the “black box” beneath the surface, showing the incredible sub-surface

6. Lunch under a casuarina and among ancient tufa deposits.

8. Doline on the side of Guineacor Hill looking towards the NPWS offices and kiosk.

9. Janece talking to the group in Steetly's Quarry, now disused and undergoing rehabilitation.

12. Small unviable quarry showing waste marble blocks cut using augers.

10. Rehabilitation works underway in Steetley's Quarry, now part of Wombeyan Karst Conservation Reserve.

13. Close-up of some of the abandoned machinery.

11. Lawrie explaining the workings of the original quarry. Behind is the crane and stock marble blocks (labelled and numbered) if required for replacement on current sites built with this material.

architecture. From a speleothem palaeoclimatologist's point of view, the complexity of infiltration pathways is exposed, allowing for more accurate interpretations (*photos 14, 15, 16 , 17*). The group walked back to the vehicles and able to able to observe the equipment from a lower point *(photo 18)*.

After lunch at the camp site, most of the group commenced the walk to Wombeyan waterfall. The walk follows a pathway beside Wombeyan creek, tracing its path from the dry bed on marble substrate (sinking stream) to a flowing stream on volcanic derived bedrock. The water fall, which tumbles over a rough red granite wall, was reached after walking approximately 4km along a trail of increasing elevation. After resting at the waterfall, a pathway was found to climb over the ridge to the next valley known as Hockeys Gully. Once down into this valley we were again on karst and several small quarries were explored. These quarries again show the difficulty in finding a viable site where marble could to be quarried *(photo 19)*.

Walking along the road back to camp, Janece pointed out an interesting feature. The exposed road cuttings and hillside sediments are all comprised of small angular rock fragments. The explanation suggests that these slope deposits are the result of freeze-thaw

14. The main early quarry dating from the early 1900"s.

17. Brecciation, an interesting feature commonly found in Wombeyan Marble.

15. The group inspecting quarry features, including the magnificent grikes and fractures (dark patches).

18. Looking upwards to the crane and enclosure where Lawrie spoke re the quarrying methods and workings.

16. Ron, Brian and Sue discussing intricacies of revealed sub-surface marble.

19. Quarry in a gully being explored by the group. Several small caves were able to be entered. The marble here is too fractured and contains too many small caves to be quarried viably.

20. Periglacial slope deposits in Hockeys Gully.

23. Team "Leftovers" in deep discussion.

21. The "Quiz master", Lawrie Henderson.

24. Team "Genii" pondering a poser (at least some are!).

22. Team "Doline", the "Wooden Spooners" with their valuable and other useful prizes.

processes (solufluction) during periglacial conditions and dated at approximately 20,000 years BP *(photo 20)*.

That evening, the group met in the Common room to take part in "the Great Wombeyan Trivia Quiz", a production by Lawrie Henderson. Three groups were picked by ballot and names chosen - Doline, Genii and the Leftovers. Quiz master Lawrie, resplendent in his genuine Turkish fez and tie bow, laid down the rules of which there were NONE, and began to test the brain power and mental agility of AGSHV members, many found to be wanting *(photos 21, 22, 23 & 24)*.

A great fun night was had despite all thinking the questions to be too hard! The evening was taken out by the Leftovers, followed by the Genii, with Doline coming in 3rd and being awarded wooden spoons.

25. Spectacular decorations in Kooringa cave.

26. Janece explaining the equipment used to study drip water hydrochemistry.

27. Phreatic tube in Fig Tree cave. Also visible is a log brought into the cave under extreme flow conditions.

Day 4. Thursday 9th November.

Today the electrician arrived at Wombeyan and the morning was spent as free time, waiting for word to be able to enter the caves. The news was not good but David Smith (Caves Manager) and David (electrician) were able to switch all the lights on in Kooringa Cave and most in Fig Tree Cave. At 1.00pm after lunch the group headed up caves hill to the first stop, Kooringa Cave.

Kooringa Cave is a small collapse chamber and there is much evidence of fallen marble blocks, many with cave decorations After a steep narrow descent of 76 steps the space opens to a flat area of approximately 12m x 8m. This cave is highly decorated with stalagmites, stalactites, straws, flowstone, columns, shawls and rimstone pools. The group thoroughly enjoyed the spectacle and even Barry got a tired finger from photography! Here, Janece had monitored two drip sites over several years, taking measurements of discharge (rate) and hydrochemistry and relating to recharge (precipitation). These results produced a seminal paper (McDonald et al, 2004), the first world-wide to relate conclusively the relationship between recharge excess/deficit with drip water chemistry *(photos 25 and 26)*. Hand-held torches showed many of the speleothems to glow bright pink.

On exiting Kooringa, the group headed down along the path to Fig Tree cave. This cave is set up as a self-guided tour when as the tourist passes through the cave sensors light up the formations and an explanation is given. Due to the electrical failure this feature was not available. In contrast to Kooringa, Fig Tree Cave has much evidence of being formed over time by a down-cutting Wombeyan creek. Features in the cave includes phreatic tubes (phreatic cave passages or phreatic tubes formed below the water table by water flowing under pressure), meander incuts, half tubes and perched gravel and cobble stream deposits in the upper chambers of the cave. The saddle above Victoria Arch represents the level of Wombeyan creek when it last flowed on the present surface to meet Mares Forest Creek, approximately 48m above the present entry point of the creek into the cave. The observable stream paths show evidence of flood debris while the stream is currently dry. However, an underground stream has been detected and has been explored in extreme drought conditions under dropped water table conditions *(photo 27)*.

On exiting the cave at Victoria Arch, extensive scalloping can be seen on the stream carved walls. These result from water turbulence: the faster the flow, the smaller the scallop. This is an amazing cave showing multiple phases of cave development, multiple changes in sea levels and tectonic uplift.

In the evening the group met in the dining room to partake of a dinner catered for by Lisa, a chef from Taralga. This was a fitting finale to a great week exploring a spectacular karst landscape under superb weather conditions. Thank you to all who took part.

Lawrie and I enjoyed the experience and your company, and we look forward to more trips with AGSHV.

Report by Janece McDonald.
Photographs by Janece McDonald, Lawrie Henderson, Ron Evans and Chris Morton.

References:

http://taralgahistoricalsociety.com.au/THS%20NEWSLETTER%202,%202015.pdf

http://www.aussietowns.com.au/town/wombeyan-caves-nsw

ELLIS, R. (Editor) (2004). *Caves and karst of Wombeyan.* Sydney Speleological Society, Occasional Paper No. 13.

McDONALD, J., DRYSDALE, R. and HILL, D. (2004). *The 2002-2003 El Niño recorded in Australian cave drip waters: Implications for reconstructing rainfall histories using stalagmites*. Geophysical Research Letters, 31.

McDONALD, J. (2005) *Climate controls on trace element variability in cave drip waters and calcite - a modern study from two karst systems in SE Australia*. (unpublished PhD thesis, University of Newcastle).

McDONALD, J. and DRYSDALE, R. (2007). *Hydrology of cave drip waters at varying bedrock depths from a karst system in southeastern Australia.* Hydrological Processes Volume 21, 13.

Wombeyan Caves (1982). Sydney Speleological Society Occasional Paper No. 8.

Trip leaders Janece and Lawrie resplendent in their trivia-quiz regalia.

Participating members of the AGSHV negotiating Guineacor Hill where it overlooks a doline.

Geological Tour of White Cliffs and the Milparinka-Tibooburra Inlier Geological Safari 2017

Sunday 6th to Friday 18th August

Leaders: Chris Morton & Ron Evans.

Attendance: 28 Members.

Introduction.

So the adventure begins. Adventure! Yes! This remote area with its, in some places very rough outback roads with corrugations, bull-dust, gibbers and sharp rocks that have the propensity to puncture tyres and damage vehicles, contains extraordinary geology that spans the ages from the Cambrian through the Cretaceous to the present.

White Cliffs and Tibooburra are iconic Australian locations that many people may want to, but never get to visit. So we conducted the society's annual safari to these two areas to investigate the scenery, history and geology of this so-called "Corner Country".

The safari started from White Cliffs, exploring Peery Lake, discovering ancient aboriginal engravings along the shore of this ephemeral lake, tool-making sites and active mound springs, possibly Australia's rarest landforms. A fascinating tour of a working opal mine was also undertaken.

Tibooburra-Milparinka's geology and history is quite involved and surprising. The rocks range in age from the Paleogene to the Cambrian. The Thomson Orogeny has affected many of the rocks (folding, faulting, metamorphism, intrusion) before deposition of sediments during the Cretaceous.

Tibooburra is characterised by outcrops of granodiorite boulders. The magma that formed the granodiorite was intruded some 420mya through Cambrian sediments. The Tibooburra Inlier is the name given to this region of outcrop. Today, this region is somewhat higher than the surrounding country forming the Tibooburra Dome. Weathering and erosion has exposed much of the geology in the Tibooburra-Milparinka Inlier area.

During the safari, we examined some of the significant geological features within and surrounding the Tibooburra Inlier/Dome.

Early prospectors discovered and won small amounts of gold in this harsh but scenically beautiful country. We walked in their footsteps to see where and how they laboured, lived and barely survived.

To obtain the full benefit of the Milparinka area, we also acquainted ourselves with Charles Sturt's 1844/45 Central Australian Expedition by visiting the site where he was marooned for 6 months, and where James Pool, Sturt's second in command lies buried. We climbed Mount Poole to the stone cairn Sturt's men built on its summit to relieve boredom, but which subsequently became a memorial to James Pool.

White Cliffs Geology.

Surface exposures of rocks at White Cliffs are limited to hills of sparsely outcropping Cretaceous sedimentary rocks with a local capping of hard, bouldery Paleogene silcrete. Opal diggings coincide with these hilly outcrops, as the prospective Cretaceous rocks are only preserved on hills, having otherwise been eroded away. Gibber plains and sand plains, with local areas of alluvium along major watercourses, cover the low areas of the field.

Viewed from several kilometres away the major geological features are clearly evident. Flat topped, mesa -like hills are capped with erosion-resistant silcrete, their slightly northern downward dip indicating local tilting of the land surface since the Paleogene period. The contact between the Cretaceous and Paleogene rocks can be found just below the tops of these flat ridges. This contact is an unconformity, the land surface during the tropical Paleogene period prior to it being covered with the sand and gravel that is now silcrete. The rocks below this surface are white, with local brown iron oxide accumulations close to the unconformity. Further down the slope the iron oxides become less abundant despite the white rocks remaining constant. This indicates that iron was leached from the Cretaceous rocks by groundwater movement and was then carried upward and deposited near the Cretaceous-Paleogene unconformity, which would have been covered by a blanket of sand and gravel during that time. The movement of silica through these leached rocks led to the formation of opal in the Cretaceous rocks, and silcrete in the Paleogene sands.

History of White Cliffs.

Opal was initially discovered in 1884 by a shepherd on Momba Station, at what was to later become known as White Cliffs. Those original pieces of "coloured glass" were the surface indications of the frustratingly elusive, yet incredibly rich deposits of opal amongst the white Cretaceous sandstones of this remote area. It was not until 1889 when four kangaroo shooters observed the brightly coloured stones that there was any thought of mining. One of these men, Charlie Turner, dispatched a sample to Adelaide for examination. The shooters became the first opal miners in this area, taking out two twenty-acre (8 hectare) claims.

By 1894, not long after the rudimentary village of White Cliffs came into existence, many deserted adits (a horizontal mine entrance) and man-made caverns were converted into homes. These living conditions were vastly preferable to the climatic extremes suffered by those living in the corrugated iron dwellings elsewhere. The trappings of civilisation soon followed with the increasing population. A post office was established in 1893, a school in 1895, along with a hospital and a doctor and a dam was constructed for water. By about 1897 around 1000 people were present on the opal field.

Intensive mining continued until World War I when the market slumped and many men went to war, resulting in the virtual abandonment of the field. Since then mining has been relatively sparse. Total production of opal is unknown, but conservative estimates report well in excess of $150 million worth of opal with much of this produced prior to 1911.

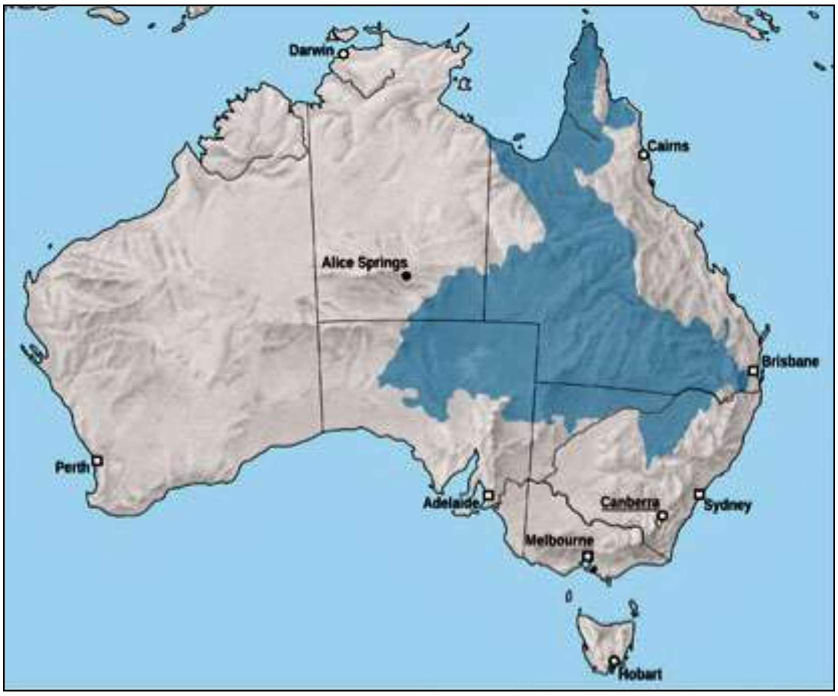
Opal Formation.

There have been a number of theories to explain the origin of opal. The most strongly favoured is the deep weathering model that involved silica mobilisation during weathering. This model proposes that deep, acid weathering altered the original feldspars in the sandstones to kaolin, liberating silica. The silica-rich ground water migrated downward via fractures and other permeable pathways until it reached an impermeable barrier. In most cases this barrier was provided by claystone lenses, though voids after fossils eroded away and various fractures also acted as fluid traps. Once trapped, the water evaporated, creating a silica gel. Microscopic silica spheres then precipitated from the gel to form opaline silica. Where the spheres were of uniform size and were regularly packed, precious opal was formed. Where the spheres were variable in size and not regularly packed, potch, or common opal, developed.

The weathering event that produced the opal-forming silica occurred during the Paleogene period. There is no consensus on the age of opal formation, with various researchers suggesting that this event took place during major weathering between 65 and 55 million years ago or in association with warping and silcrete formation about 24 million years ago.

<u>Day 1</u>: Sunday 6/8. White Cliffs.

We began at the White Cliffs Caravan Park with a meeting and get together at 5pm in the camp kitchen. Old friends and members were introduced to our four new society members, Janece McDonald, Lawrie Henderson and Irene and Alan Richardson. Chris welcomed and briefed everyone on what to expect during the excursion and made suggestions on tyre pressures and other safety tips to make the driving as comfortable as possible. We then settled in for some light refreshments and shared tales of our travels to our starting point.



The Eromanga Basin is a sedimentary basin that formed during the Jurassic and Cretaceous, and is part of the Great Artesian Basin.

Terrestrial sequences of Jurassic age, then shallow marine sequences in the Early Cretaceous, and in the Late Cretaceous, sequences ranging from paralic to fluvial and lacustrine, are characterised in the basin.

A large part of the Rolling Downs Group was subjected to Chemical weathering during the Late Cretaceous, with a second phase of weathering occurring during the early Paleogene.

Geologic Time Scale

Eon	Era	Period	Epoch	Age(my)
Phanerozoic (Visible Life)	Cenozoic (Recent Life) (Age of Mammats)	Quaternary	Holocene	0.01
			Pleistocene	1.8
		Paleogene (Tertiary)	Pliocene	5.3
			Miocene	23.0
			Oligocene	33.9
			Eocene	55.8
			Paleocene	65.5
	Mesozoic (Middle Life) (Age of Reptiles)	Cretaceous		145
		Jurassic		200
		Triassiac		251
	Paleozoic (Ancient Life)	Permian		299
		Pennsylvanian		318
		Mississippian		359
		Devonian		416
		Silurian		444
		Ordovician		488
		Cambrian		542
Proter-ozoic (Early Life)	Oldest Known Life			2500
Archean	Oldest Known Rocks			3800
Hadean	Age of the Earth			4600

<u>Day 2</u>: *Monday 7/8. Opal mine tour and Peery Lake.*

Our first destination was the Red Earth Café where we were booked in for an underground mine tour at 8:30am. This early start was necessary due to the size of our group. Our tour leader Graeme, the owner of the mine and proprietor of the cafe, was a little reluctant to start so early, as it was his normal day off. However in true outback style he was full of enthusiasm. The Red Earth Café has an exceptional collection of opal and historic paraphernalia on display, which he mostly had mined or collected in his underground mine a short distance away.

Graeme's presentation describing the different examples of opal was informative, but also very entertaining. His prized specimens are what are known as pineapples. Pineapples are double pseudomorphs, the first calcite after ikaite, (calcium carbonate hexahydrate - $CaCO_3.6H_2O$) formed in cold water less than 4°C during the Cretaceous and then opal replacing the calcite *(photo 1)*. Pineapples can fetch up to and beyond $45,000.

1. Opal 'pineapple', Red Earth Café.

2. Large rounded concretion situated within opal bearing sediment.

4. Peery Lake from lookout situated on an outcrop of Cambrian quartzite. Numerous mound springs were found around the small island far right.

We then followed Graeme in our vehicles to where, after a safety briefing and the issue of safety gear and torches, we descended into his mine. The mine is a labyrinth of tunnels and shafts in Cretaceous sediments, with a few no-go areas, which are deemed dangerous due to unstable roofs. We were shown in-situ opal seams, the best clay bands in which to find opal, along with the different strata and the fault lines that are deemed optimal for the localisation of opal. A common unwanted feature in the clay are dropstones that were shed from ice rafts. These rocks have more of an affinity to the igneous rocks around Cobar or South Australia, and are totally foreign to this area. A number of unusual concretions are also present*(photo 2)*.

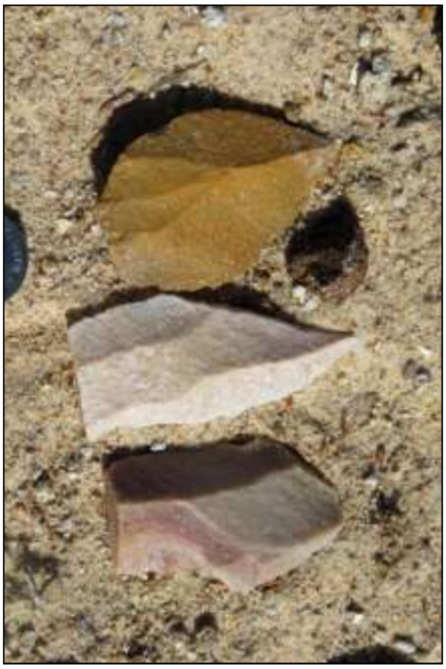
The discussion on the methods used for mining in the early history of the area was a nice introduction to his modern mining methods. These days although pick and shovel are still used sparingly, an air driven digger is mostly used to remove large areas of earth. A compressor on the surface supplies the air, so it is very quiet at the digging face. For the delicate digging and removal of opal a common screwdriver is the tool of choice. Graeme allowed some of our members to try their luck with a screwdriver in the hope of finding some prized opal *(photo 3)*. He thought it was great that others dug for him. Where else would you pay a mine owner to find opal that would have to surrendered if some was found. Our tour leader could only be described as a likeable, irrepressible wag that delivers an interesting, educational tour. At one stage he even had Brian slithering through a small opening into a disused chamber to examine past diggings, where Grant Pearson mined Brian's opal pineapple. Grant was the former owner of the lease over 20 years ago.

On conclusion of our mine tour that ran well over time, we drove 53 kilometres to Peery Lake picnic area. The route was through mostly undulating treeless plains, along a rough, dusty unsealed road. We had to slow every now and then to negotiate intermittent tree lined creeks. Some of the creeks had reddish-brown muddy water in them due to a rare recent rain event. Because morning refreshments were missed as a result of the extra time spent at the mine tour, an early lunch was devoured with relish upon reaching the picnic area under what was a sparkling sunny blue-sky day with a light breeze.

Peery Lake is an ephemeral waterway that was fortunately totally dry allowing us to roam freely around this impressive feature. The stroll along the track through sparse spindly vegetation to the lookout that

3. Terry digging for opal using a screwdriver.

5. Petroglyphs of Emu feet chipped into sandstone that has been polished by water running off the hill behind.



6. Aboriginal stone artifacts found on both islands seen in photo 4.

takes in the length and breadth of Peery Lake *(photo 4)*, to some would seem quite featureless. However to our observant geologists this is far from the fact. Crossing a dry streambed with many rocks and stones of various sizes. Brian and Ron pointed out that these were lag deposits, the equivalent to the paleo lag deposits we regularly see in the sandstone beds back in the Sydney Basin.

An easy climb up to the lookout brought more features to interpret. The Cambrian quartzite rocks display excellent sheet exfoliation, which led to a discussion on how this phenomenon occurs. It was explained that during the cold freezing nights of the desert the rocks become very cold and contract, then in the morning when the sun raises the exterior temperature of the rocks they expand leaving the sub surface cold, which allows the outer surface to delaminate creating an onion skin effect. This is one of the many ways that erosion wears down mountains.

7. Sandstone showing honeycomb weathering as well as convoluted bedding.

Lake Peery Mound Springs.

Lake Peery Mound Springs are the largest and most active complex of mound springs in NSW. This lake is a water bird haven and when full it will hold water for several years. When dry, Peery Lake is the only location in NSW where Great Australian Basin (formally known as Great Artesian Basin) mound springs are visible in a lakebed. Mound Springs occurred in Lake Peery when water from the Great Australian Basin reaches the surface through fault lines in overlying rock. The mounds were formed from the sediments and salts that were deposited by the spring water as it evaporated. (Geological sites of NSW).

There are two groups of mound springs (active and extinct) that occur at Peery Lake, on the western and eastern shorelines. The western group consists of more than 20 individual springs, some of which are no longer flowing. The extinct springs are by far the larger structures, reaching 100m in diameter and 2m in height. Mounds of active springs vary in size from 3m to 15m in diameter and reach up to 2m in height. The eastern group is made up of more than ten mostly extinct spring outlets. (Geological sites of NSW).

These rocky mound springs build from the top, often forming pools. The springs support unique micro ecosystems, which in turn support rare plants and fauna that are thought to be surviving remnants of an earlier period when the area was part of a tropical environment. (Geological sites of NSW).

A permanent and secure source of water, the springs were vitally important to the Ngiyeempaa and Paakantyi Aboriginal people living in the area and are considered culturally significant. Peery Lake features in stories such as Kuluwirru Dreaming, which chronicles the creation of the Peery landscape and Darling River and describes the reasons for the lake being emptied at various times. (Geological sites of NSW).

At the bottom of the hill around the edge of the dry lake there are flat water smoothed rocks, which to the observant explorer display many Aboriginal engravings, from Emu tracks *(photo 5)* to kangaroo foot prints as well as turtles and boomerangs. Unlike the engravings in the sandstone country we are familiar with where they are grooved, these were chipped out of the patina that forms the surface of the rock. This surface polish is possibly the result of sediment-laden water rushing down the sides of the hill situated above the engravings.

Proof of early Aboriginal habitation was everywhere. This was evident in the discovery of many stone artefacts including stone flakes and tools such as cutting blades made from silcrete and a few spear points, some finished and some that were not quite complete *(photo 6)*.

Some of the surrounding rocks displayed interesting bedding structures, from cross-bedding to convoluted bedding from slumping, as well as honeycomb weathering *(photo 7)*.

Honeycomb weathering is a common surface phenomenon affecting a variety of rocks in a range of environments. Wind promotes evaporative salt growth between grains on a rock surface, resulting in the development of small, randomly distributed cavities.

After a period of time examining and photographing these features, we strolled across the dry lake bed disturbing the kangaroos resting amongst the saltbush, bluebush and samphire that dominate the lake floor (Samphire is a native succulent also referred to as sea asparagus, swamp grass, salicorne or glasswort) to view and examine the mound springs, which was the main purpose of the visit here. *(photo 8)*.

The springs we examined showed healthy microbial activity. Some mounds sprouted trees and bushes, grasses and sedges.

Returning to our vehicles we noticed that a very large mound had different geology to the other mounds. This mound is older and inactive. Evaporation from the artesian mound springs created deposits of calcium carbonate and other water borne minerals (evaporite) over many millennia.

This completed an active but very interesting day. All that was left was to drive back to camp and ready ourselves for the trip to Tibooburra in the morning.

Geological setting of Tibooburra-Milparinka: Thomson Orogen.

The Mount Poole, Mount Browne, Warratta and Tibooburra inliers in the Tibooburra–Milparinka area mostly consist of strongly cleaved, greenschist facies phyllites intruded by monzo-dioritic dykes, sills and stocks.

The Mount Browne and Mount Poole inliers contain the Depot Glen Formation: a turbidite sequence metamorphosed from low greenschist up to mid-greenschist facies (along the eastern margin of the Mount Poole Inlier). Felsic tuff in the formation has been dated at 504.5 ± 2.6 Ma. It has been strongly deformed and metamorphosed during the Delamerian Orogeny (≈505 - 498 Ma). The Warratta and Tibooburra inliers contain the Jeffreys Flat and Easter Monday formations, respectively. Tuffaceous mudstones in the Easter Monday Formation have been dated by sensitive high-resolution ion microprobe (SHRIMP) U–Pb at 497.2 ± 2.6 Ma. Provenance appears broadly similar among the inliers, with sub-arkosic to lithic compositions and detritus suggesting mixed continental sources including acid volcanics and sandy immature sediments, in addition to a more distal plutonic/metamorphic terrain. The continental provenance and shallow marine setting of the Late Cambrian sedimentary rocks suggest deposition on a continental platform or shelf. This sedimentation closely followed the Delamerian Orogeny, and the source of the detritus may have been from the Delamerian highlands to the west. The main deformation event recognised in the Warratta and Tibooburra inliers is characterised by strong penetrative cleavage, concertina-style folding and steep reverse faulting.

Reverse faults parallel to quartz vein networks occur on the eastern event was contemporaneous with the Benambran Orogeny in the Lachlan Orogen.

The final ductile deformation event recognised in the area occurred in the Benambran, and resulted in refolding of earlier folds, quartz vein networks and cleavage. The event is characterised by kink-banding and mesoscopic F2 chevronic folding in discrete domains. Minor tension quartz-calcite veins have injected along kink bands and as minor en-echelon arrays in monzodiorite sills/dykes, but limited rock-chip assays suggest they are not auriferous.

Late Palaeozoic.

Although there is little direct evidence for Permian glaciation within the Thomson Orogen, it is likely to have been an important aspect of the geological and landscape history. During these times, the region was at very high latitudes and the global climate was cold, resulting in much of southern Australia (which, at that time, was part of Gondwana) being covered by a continental ice sheet. The transport of boulders composed of bedrock types from beyond the region has been attributed to glacial activity at this time, and glacial and fluvio-glacial deposits may have provided an important component of the sediments subsequently reworked within the landscape.

HILL, S.M.; GREENFIELD, P.G.; GILMORE, P.G. and REED, W.J. (2008). *A guide for mineral exploration through and within the regolith in the southwestern Thompson Orogen, NSW*. CRC LEME.

8. Active mound spring next to a small, tree-covered island and an old mound spring still active, top right.

Moon setting at Granites Caravan Park Tibooburra.

9. Granodiorite tors exhibiting exfoliation were commonly seen beside the walking track.

11. Exploring the geology present within the contact zone, such as slaty cleavage, dykes, pegmatites.

<u>Day 3</u>: *Tuesday 8/8. Drive to Tibooburra.*

<u>Day 4</u>: *Wednesday 9/8. Granites Margin Walk.*

Another warm sunny cloudless day with a slight breeze that turned quite brisk by 9:30 am greeted us. This was ideal for our Granites Margin Walk at Dead Horse Gully, which is part of the Sturt National Park.

The Granites Margins Walk is a part of Bob and Nancy's Tibooburra Inlier Tour. National Parks have developed self-guided walking tracks amongst the weathered granodiorite tors *(photo 9)*. This gave us the opportunity to examine the characteristics of the Tibooburra Granodiorite, with microleucogranite (aplite), pegmatite and diorite dykes that formed as a result of the long slow cooling process whilst the granodiorite was becoming crystalline.

The margins of the granodiorite body are surrounded by metamorphosed sedimentary rock that had been compressed into slaty cleavage by strong folding and then recrystallised by contact metamorphism adjacent to the granodiorite into hornfels around 421Ma (Silurian). The sedimentary rocks were deposited in a deep ocean 496Ma (Cambrian). These dates have been determined from zircon crystals separated from volcanic rock. Preserved structure within the rocks indicates that deposition of the sedimentary rock was in a deep sea beyond the continental shelf.

Some interesting features are easily seen on the Dead Horse Gully Walk *(the name was attributed to the carcases of two dead horses that were found in a dry creek bed)*. Spectacular weathered granodiorite tors towered above us and tenacious vegetation with names like Dead Finish *(Acacia tetragonophylia)* that clings to life with barely any water (I think the name says it all).

A large diorite dyke was evident not only by its colour, but by the obvious way it was weathering and vertical fracturing, which is very different to the weathering granodiorite.

We scrambled up a short rise onto a saddle, where a vantage point allowed us to look down across the contact between the granodiorite intrusion and metamorphosed slaty rocks *(photo 10)*, and farther afield to the surrounding Cretaceous countryside with its undulating barren plains and mesa's (jump-ups) off in the distance.

An easy short walk from this point brought us to the contact zone where slaty rocks *(photo 11)* were intruded by pegmatite dykes *(photo 12)*. The pegmatites contained crystals of feldspar, quartz, hornblende and tourmaline as well as muscovite. Some distinct folding

10. Cambrian rocks within the contact zone in foreground with folded Cambrian slaty rocks forming hills.

12. Tourmaline crystals within a pegmatite were common within the contact zone.

was also evident. Many photos were taken along with many questions to Ron and Brian, who helped us absorb and understand the geology of this remarkable area.

A morning tea break was held back at the car park where discussions regarding the geology and the trip took place, along with stories of past events. A short distance away is a mock gold mine that National Parks has set up to give the visitor an insight as to what the early miners had to endure. Those of our group who had not been here before decided to have a walk around the site, while the rest went their separate ways to fill in the rest of day, that had been put aside for sight seeing.

Day 5: Thursday 10/8. Day 1 of the Tibooburra Inlier Tour.

Todays activities were quite varied. The weather was similar to previous days being cool and sunny with a slight breeze that increased in strength to quite blustery by lunchtime, and then abating as the afternoon progressed.

Kicking off early, we drove north along the Silver City Highway to an escarpment where we examined an unconformity. The contact between the Cretaceous sedimentary rocks and underlying Cambrian slates represents approximately a 350 million year interval *(photo 13)*. Crumbly and bleached Cambrian slates at the bottom of the escarpment display evidence of prolonged weathering in a wet environment, which occurred before the deposition of the Cretaceous sedimentary rocks that outcrop at the top of the escarpment in what is known as the Eromanga Basin. It is apparent that during the Jurassic and Cretaceous the conditions were much wetter with an abundance of groundwater that produced deep weathering of older rocks. This is so different to the desert conditions of today.

13. Brian standing over the Cambrian/Cretaceous angular unconformity, a time break of some 350 my.

14. Part of an ironstone concretion showing a botryoidal surface.

Close to the top of the escarpment, horizontal layers of sandstone and conglomerate outcrop. This is where the contact between the underlying folded Cambrian slates and Cretaceous rocks occur forming an angular unconformity. So the question is, where have the sediments from the intervening period gone? Answer: either no deposition occurred during this period or there was a long period of erosion.

Upon climbing to the top of the escarpment we found the ground was covered with fragments of ironstone concretions. The concretions are formed from groundwater carrying soluble iron oxide percolating through fractures and joints in the Cretaceous rocks, then as erosion occurs they fragment and accumulate on the surface. Some of these concretions are still intact and rattle when shaken. These are known as rattle stones. This occurs when a pebble or similar collects mud or clay; this then becomes a nucleus that allows colloidal iron oxide to attach, over time building up to form a concretion. As time goes by the mud or clay dries and turns to dust allowing the pebble to rattle when shaken.

Two in our group, Richard and Chris are the proud owners of the only rattle rocks found. However many of the other ironstone fragments take on their own identities, with weird and wonderful shapes *(photo 14)*.

From here we drove to the Whitta Brinna Fault, which can be best seen along Whitta Brinna Road *(photo 15)*. This site provides evidence of relatively recent fault movement in the region. There is evidence of repeated movement since the Cretaceous along a number of major faults in the Tibooburra-Milparinka area. The evidence includes tilted Cretaceous rocks, successively elevated erosion terraces along fault scarps, and veins emplaced adjacent to the faults within the Cretaceous rocks.

Moving on to our next stop adjacent to Whittabrinna creek, we come to a typical marine

Cretaceous sandstone and conglomerate, which has been exposed by erosion along the banks of the creek. *(photo 16)*.

We spent some time here, but not before an enjoyable morning tea. However this allowed some of our members to escape and wander far and wide to follow their other passions such as botany, photography and to seek out some of the local fauna such as lizards and insects. Getting them back was like herding cats. You get one in the pen, and while you try and catch another the first one escapes again. Hilarious!

The marine sandstone here is typically similar to what we see when sediments that have been washed, well sorted and deposited on beaches as fine-grained sands. This contrasts with the terrestrial sediments (which comprise of coarse quartz pebbles) that overlie the marine sandstone in this area.

A number of cobblestones and boulders that are totally foreign to this area are scattered around the surface. These are dropstones from ice rafts that calved from glaciers that possibly floated up from South Australia or southern New South Wales. This indicates polar conditions at the time of deposition. Also seen here were large spectacularly banded limonite concretions. Some fine examples of the Sturt Desert Pea *(Swainsona formosa)* were also sighted. These along with a small patch in Tibooburra were the only examples of the desert pea sighted.

From here we agreed to meet at 1pm in Tibooburra to continue the days activities. Some returned to camp for lunch, while others stopped at Sturt's memorial park, where a replica of Sturt's boat and interpretation boards celebrating Sturt's mission to the interior to discover an inland sea in 1845 are on display. Ironically he was only 100 million years too late to discover the Eromanga Sea.

15. Whitta Brinna fault.
Note how the exposed bed of
Cretaceous sandstone dips some 45°
to the south-west.

16. Cretaceous quartz pebble marine conglomerate.
Note the large glacial erratic within the rock.

After lunch we travelled east along the Wanaaring Road for a short distance, then we turned onto a two-wheel dirt track to find another unconformity. This unconformity has Paleogene strata overlying Cretaceous rocks. The site is known as Quarry Hill *(photo 17)*. This area was subjected to terrestrial depositional processes following the retreat of the Cretaceous ocean. Over a 40 million year period of changing conditions, large areas of Eromanga Basin Cretaceous rocks were eroded away before the next major depositional phase in the Lake Eyre Basin. Depositional processes in the basin began about 60 million years ago. At this time wet tropical conditions affected the majority of the country. Sediments were eroded from the margins of the basin to be redeposited within the basin.

Halfway up the hill conglomerate bedding represents the base of the Paleogene strata. This represents the 40 million year unconformity between the Cretaceous and the Paleogene.

Plant fossils have been found within the Cretaceous sandstone at the base of the hill. However we had no luck in finding any.

Back to the main road we continued east to a

17. Quarry Hill. The dark top of the hill is composed of Paleogene sandstone overlying paler Cretaceous rocks. Note the lag deposit of white quartz pebbles.

18. Outcrop of unusual Cambrian hornfelsic sandstone, the result of thermal metamorphism by contact with a nearby granodiorite intrusion.

20. Asymmetrical ripples in sandstone exposed in the creek below Black Stump Dam.

prominent hill where we examined as unusual metamorphosed sandstone. These Cambrian sandstones and mudstones have been converted to hornfels by contact with an intrusion of granodiorite on the western side of the hill. The metamorphosed sandstone occurs as brown outcrops of various shapes on the hillside. On inspection, the chocolate coloured sandstones display bedding planes but fresh broken samples, where they can be found, have dark grey sugary surfaces with sparkling quartz, typical of hornfels *(photo 18)*.

Continuing to the summit we found numerous quartz dykes crisscrossing the hill. Further inspection showed that many of the dykes were comprised of pegmatites. Large crystals of orthoclase along with tourmaline, hornblende, muscovite and quartz were the most obvious minerals present within the pegmatites.

The afternoon turned out to be very warm (32°C) so at this point we decided to retire and return to camp for refreshments.

But before doing so, some of group detoured back to a granodiorite outcrop near Quarry Hill where a feature known as the "loaf" is situated. This rock has weathered in an unusual way. The granodiorite tor is an elongated rock that has been weathered along parallel vertical joints to look like a sliced loaf of bread *(photo 19)*.

This little area was fascinating and because not only "the loaf" which looked as though it had been dissected by a large sharp breadknife, the adjacent rocks on either side also displayed similar parallel joints.

<u>Day 6</u>: *Friday 11/8. Day 2 of the Tibooburra Inlier Tour.*

We headed west today along the ubiquitous dirt roads with overcast sky and strengthening wind conditions. After lunch the skies cleared and the wind abated to a very pleasant afternoon.

Our first stop was a dry creek bed near Black Stump Dam in which early Cretaceous terrestrial to marine transition sediments (calcareous sandstones, siltstones and some conglomerate) are exposed. These rocks belong to the Cadna-owie formation.

The most obvious and striking feature on the creek bed below the dam were inter-tidal ripples *(photo 20)*.

This area west of the Tibooburra shows no sign of alteration, unlike the Cretaceous rocks closer to Tibooburra inlier. At first inspection these ripples that formed during the Cretaceous are quite impressive, however further examination of the lower reaches of the creek showed exposures of other surprising geological features. Ample evidence of bioturbation such as worm

19. 'The loaf", a granodiorite tor weathered along equally spaced vertical joints.

21. Worm burrows exposed on sandstone forming the creek bed.

burrows *(photo 21)* was quite prominent along with many examples of fractured cone-on-cone structures *(photo 22)*.

We had to be very mindful and be reasonably careful at this site, because it served as a watering hole for the sheep and other station animals that rely on this area as their only source of water. So it was incumbent on us not to spread out too much, as it would scare the animals away. In the end though this did not happen, as the 100 metre stretch of dry creek bed kept everyone totally enthralled with not only the features already been mentioned, but many other unusual patterns in the creek bed that need thorough investigation, including suspected glendonites and strange dendritic structures. This would not be possible on a trip like this, besides the geologists amongst us were to busy answering questions to make detailed observations.

Time was getting away from us, and it was time to leave, so while everyone else was returning to the cars, Terry Kingdon and Elain Collier found some intact cone-in-cone structures that everyone else had missed, so it was agreed by Brian England and myself that we would return on one of our free days to have a better look.

After what seemed a short time, that turned out to be near 2 hours, we returned to our vehicles to head to our next stop. As we drove off, Brian England saw an Australasian Bustard hiding beside a roadside bush.

This poor bird must have wondered what was going on when its serenity was upset, what with 7 vehicles and twenty-eight people all trying to take pictures and capture a glimpse of it. But we felt very privileged to have seen this somewhat rare and secretive bird.

We arrived at our next stop back towards Tibooburra where there is an outcrop of granodiorite and diorite. Although this outcrop seems small compared to the Tibooburra granodiorite, this and two other intrusive outcrops are deceptively large. They are similar in size under the surface cover soil and Cretaceous rocks. This is confirmed by magnetic data collected across the region.

*The **Australian Bustard** is a very large, heavy-bodied, ground-dwelling bird up to 1m tall. The larger male has a wing-span of up to 2.3 m. It has a stately, erect posture, prominent black cap, and long legs. The head, neck and breast are white, with dark grey specks. The upper surface of the wings and tail are brown with fine dark patterns. There is a bold black and white patch on the lower edge of the wing.*

The Australian Bustard mainly occurs in inland Australia and is now scarce or absent from southern and south-eastern Australia. In NSW, they are mainly found in the north-west corner and less often recorded in the lower western and central west plains regions. Occasional vagrants are still seen as far east as the western slopes and Riverine plain. Breeding now only occurs in the north-west region of NSW. (http://www.environment.nsw.gov.au/threatenedspeciesapp) (NSW Office of Environment and Heritage).

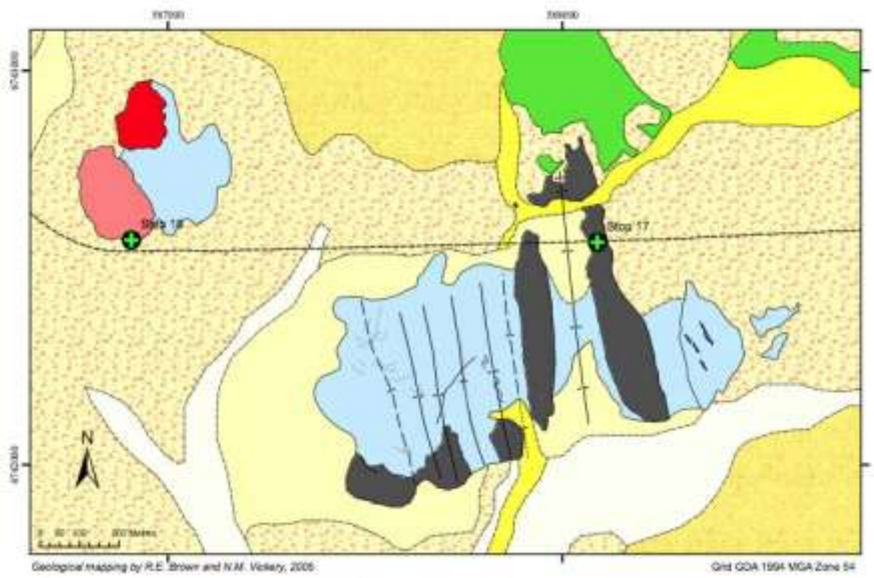
22. Cone-in-cone structures within calcareous sandstone.

The granodiorite is exposed as large tors and boulders at the northern edge of the ridge *(photo 23)*. The diorite is a black to dark green, finely crystalline rock. It is strongly magnetic and includes zircons, which enable dating of the crystallisation at 421 million years (Silurian). This age is identical to the Tibooburra Granodiorite.

More recent data shows that this intrusion is an offshoot from a major magma chamber two kilometres deep. The Tibooburra Granodiorite is an offshoot to this same chamber. The rock adjacent to the granodiorite has been metamorphosed by the intrusions. Hornfels are apparent. Metamorphosed sandstone is plentiful with typical characteristic blocky character and a reddish colour.

Morning tea was beckoning, however we had one more stop at a significant volcanic sandstone site before we could stop. A number of volcanic sandstones occur throughout the Cambrian rocks of the Tibooburra inlier, which are quite distinctive in outcrop. These volcanic sandstones with a composition similar to rhyolite are typically very hard. The external weathered surface is a pale greyish colour with a pinkish tinge from desert varnish, while freshly fractured surfaces are grey *(photo 24)*.

23. Granodiorite tors with diorite outcropping on the rounded hill seen in the distance.



Distribution of volcanic sandstone. There are few other indicators in these rocks to suggest that folds such as these are present. Mapping illustrates the complex folding which is present in the immediate area as defined by the outcrop distribution of the volcanic sandstone.

Dates of 496 million years (Cambrian) were determined from contained zircon crystals. Laboratory studies and examination of these rocks in outcrop show deposition took place in a non-volcanic Cambrian sedimentary environment by a process of slumping down what was possibly the continental slope. This unusual volcanic sandstone was derived from volcanic activity around 80 million years before the Silurian Tibooburra Granodiorite was emplaced. The distinctive and unique character of these rocks also makes them useful for mapping the large folds within the Cambrian rocks.

Not before time we stopped at a picturesque dry sandy, pebbly creek bed for refreshments *(photo 25),* which allowed the photographers in our party to fulfill their artistic passions by capturing images of river red gum trees (*E. camaldulensis*) that have been bent, stunted and contorted into majestic shapes that are ubiquitous in this desert climate.

Our next stop after driving through the dry sandy creek bed, then along a two wheel track that threads its way through the mostly baron rolling hills covered with quartz gibbers and ironstone rocks was an unusual mound consisting of Cambrian slates *(photo 26)*. This unusual perplexing landform is a hemispherical structure that is surrounded by Cretaceous rocks. There are several other similar landforms like this in the Tibooburra region. One close to Tibooburra has reportedly appeared and grown over recent history.

There are many suggestions why they are occurring but there is no single theory that can explain this phenomenon. However they are probably eroded Cambrian rocks that were covered with Cretaceous sediments that are in turn being eroded away, leaving the Cambrian rocks at the surface. This can be related back to our first stop yesterday where we had a 350 million year unconformity.

Continuing on through this ancient barren landscape we arrived at Tunnel Hill and Nuggety Gully.

24. Very hard, fine grained volcanic sandstone of Cambrian age.

25. Herbert enjoying his morning tea next to an ancient river red gum tree.

26. Chris and Ellen examining the rock present in an unusual mound of Cambrian slate.

28. Ironstone and quartz pebbles preserving much of the original pre-Cretaceous land surface.

At this stop we observed some of the oldest Cretaceous sedimentary rocks in the region. Following the opening up of the Eromanga Basin, the first rocks deposited were formed on land by extensive river systems similar to those in south-western Queensland today. These rocks along with a wide range of other sedimentary rocks were sourced from nearby Cambrian metamorphic rocks. Quartz veins were eroded into creeks and rivers, which is the source of the common white quartz pebbles and gibbers along with alluvial gold, that has been well sort after by many fossickers and the miners of years gone by.

The cliff exposures of sandstone and conglomerates are characteristic of sands and gravel deposition in perennial river channels. The wide range in size of rock fragments indicates intermittent periods of energetic water flow. The many sandy and gravelly river channels also indicate an anastomosing braided river system *(photo 27)*.

Scrambling up the steep and in some places crumbly hillside towards the summit, the conglomerate gives way to sandstones indicating less energetic rivers. Erosion over the eons has released many quartz, ironstone and transported igneous rocks that cover the surrounding countryside. These rocks act as a barrier to the sun and wind, protecting the soils from being blown away *(photo 28)*. This can be observed from the high vantage point at the summit of Tunnel Hill. Gold was also released from these hills. This is evident by the mining of gold in the surrounding creeks and gullies. There is also an abandoned adit in the base of Tunnel Hill. Hence the source of the gold is a two stage erosion process, first being eroded from quartz veins traversing the Cambrian metamorphics, then released from the Cretaceous stream-bed conglomerate by very recent to present day erosion.

Interestingly, the surface at the top of Tunnel Hill is weathered sandstone with outcrops of conglomerate with number of grevilleas and hakeas growing, which are absent on many of the surrounding hilltops. Spectacular caves are also present in the sandstone here.

A short drive saw us arriving at the ironstone-mantled hill, so named because the surface of this hill is almost entirely ironstone *(see photo 28)*. The reason is that iron is abundant in the Cretaceous rocks. Combine this with significant flow of slightly acidic groundwater that dissolves the iron, this then percolates through the rocks via joints and crevices, precipitating the iron hydroxide (goethite) into pore spaces, and crevices to form the concretions. The resulting ironstone being very resistant now armours the surface of the hill. Quartz pebbles unlike the iron in soluble form, have been eroded/

27. Early Cretaceous sandstones and conglomerates formed from river deposits.

29. Goethite concretion together with fragments of other concretions protecting the ground surface from erosion.

washed off to the ground below. This explains why there is so much quartz of various sizes at the base of many hills.

The surface of the ironstone-mantle hill still contains many concretions in the process of disintegration, but some are still intact enough to create interesting features*(photo 29)*. There are also many fragments littered over the surface with interesting patterns that are similar to those at the first unconformity site we stopped at on day 5 where the 350 million year unconformity was.

Negotiating the track in reverse we came to several metabasalt dykes. These metabasalts are not common in Cambrian rocks. The basalts intruded the sedimentary rocks before tectonic forces folded them and the basalt.

A picnic lunch was enjoyed at the earlier mentioned dry tree-lined creek. After lunch we drove back to the main road and continued on before turning off onto another minor track that led to the top of a small rise where we parked amongst outcrops of slates with slaty cleavage. At this stop we examined conglomerate that had been subjected to high pressure.

This conglomerate comprises volcanic rocks in what was a matrix of sand and mud that was laid down during the Cambrian before the intrusion of the granodiorite. Folding during the Silurian created intense pressure that formed slaty cleavage and in the process stretched and flattened the rocks within the conglomerate *(photo 30)*.

There are no similar volcanic rock types present within the Tibooburra inlier. It is assumed that the pebbles were derived from a distant landform, maybe a volcanic island that does not exist now. This may be due to same tectonic forces that originally began this process.

From here we again drove back along the track to the main road, where we continued on towards Tibooburra for seven kilometres to yet another two wheel track that winds it way along and through the ironstone and quartz strewn hills that are mostly devoid of vegetation. It makes you wonder how sheep and animals survive out here. This track, although similar to the others, has a small watercourse that over time has been subjected to erosion and requires a bit more care negotiating it, a small price to pay to experience this wonderful country.

30. Stretched and flattened pebbles within Cambrian conglomerate.

The track lead us to the Easter Monday gold diggings *(see photo next page)*. Easter Monday diggings are one of the more easier historical hand mining working areas to access close to Tibooburra. Gold was discovered here on the 18th April 1881, 3 days after the discovery of gold 16 kilometres south at the Good Friday diggings in the Womberinga Range.

Tibooburra Gold Discovery.

A rush of 800 men ensued. Most of these deserted the area within 10 days when it was realised that payable gold could not be found outside the initial discovery and 13 surrounding claims. The prospectors who continued working were able to average £6 per week per man up until the end of July. A group of prospectors (Foley and party) disappointed by the Easter Monday rush worked their way further west and found an area where they could obtain small amounts of gold, barely sufficient to pay for tucker [food]. However, on the 29th of April they were astonished to find a handsome 15. oz nugget, four-inches below the surface at the head of a small gully on their claim. This was the largest nugget found in the various diggings to that time. The discovery sparked the 'Big Nugget Rush' and the area became known as Nuggetty or Nuggetty Gully. Further work on the prospectors' Big Nugget claim and adjacent claims produced only fine-grained gold.

The population of the diggings throughout April was in a state of flux with many disappointed miners who had rushed the new finds returning to Milparinka in disgust or leaving the field altogether. A number of people almost starved, as there was no flour and potatoes were £40 per ton. New would-be miners continued to arrive despite unfavourable reports about the dry conditions and the increasing shortage of rations.

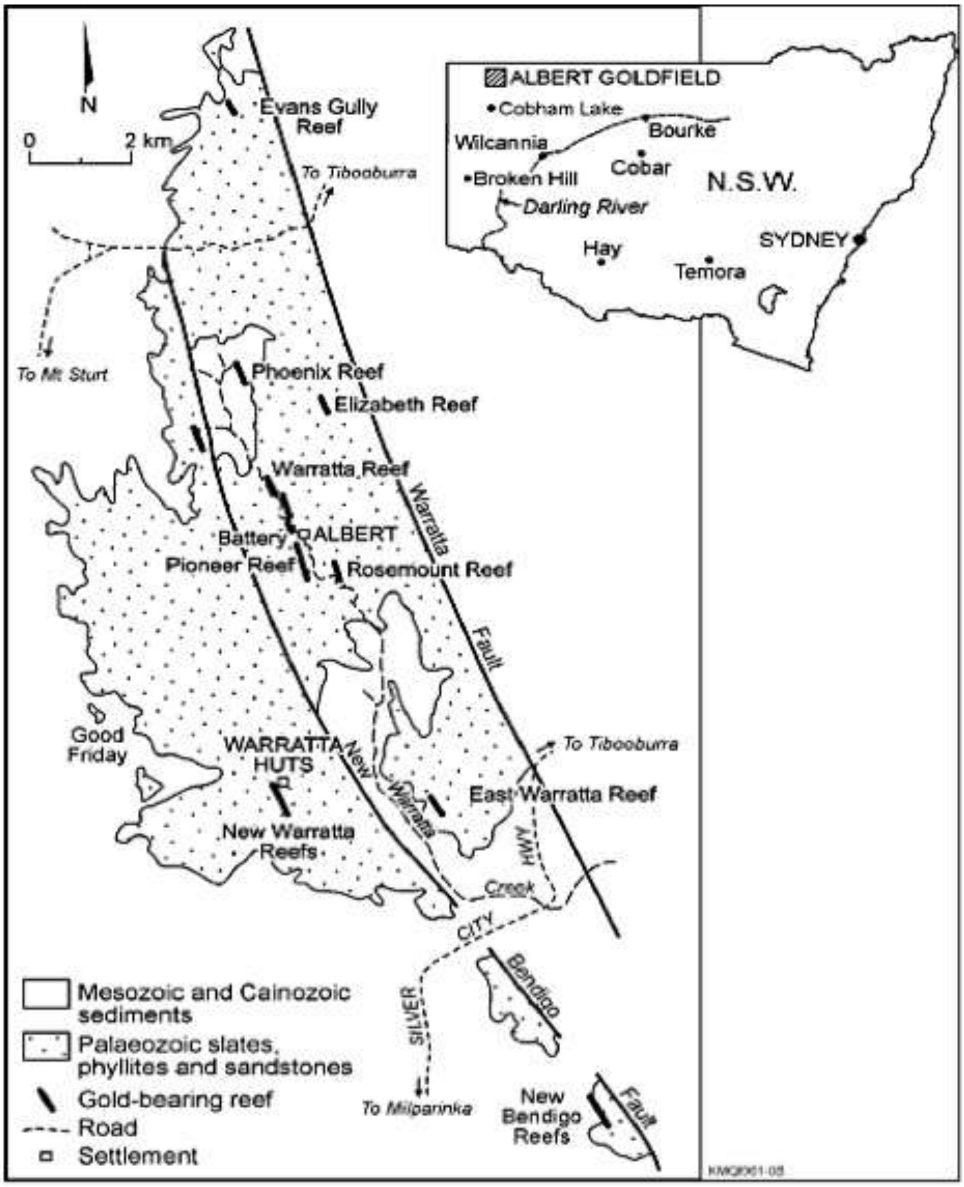
On the 30th of April a correspondent to the Town and Country Journal reported that:
"Four men reached the diggings naked and delirious the other day, and two other men died from thirst – one in the bush, and one at Mount Browne".

The history of the gold mining is far too extensive for this publication. For the interested reader I refer them to:

McQUEEN, K.G. (2007). *A Thirsty and Confusing Diggings:* The Albert Goldfield, Milparinka-Tibooburra, north-western NSW.

McQUEEN, K.G. (2008). *Abandoned Hopes.* Reef Mining on the Albert Goldfield, north-western NSW.

One of the more remarkable events of the trip occurred here. While the information regarding this stop was being delivered, Richard Bale noticed something glittering at his feet in the sunlight. Yes you guessed it. Richard had found a flake of gold around 3mm long. Needless to say gold fever struck our group.



Location of the Albert Goldfield and the main alluvial and reef workings. (Ken McQueen)
(Map collated by author from various maps held by Geological Survey of New South Wales).

No one listened to the instructions as everyone had heads down bum up looking for gold *(photo 31)*.

31. "Gold Fever!" Amazing the interest shown in the ground after a minute flake of gold was found.

Eventually we made our way across a dry creek, which displayed many areas where fossickers had been scouring out the bed of the creek, down to bedrock in

32. Rock walls of a crude miners hut at the Easter Monday gold diggings.

Easter Monday gold diggings.

the hope of finding gold. Beyond this is where the early gold miners survived *(photo 32)*. The miners lived a spartan existence with little food and very little water, which was a constant problem. Shelter for some was amongst the nearby granite boulders across a dry creek where the foundations and remains of what were grog shop, blacksmiths shop and some other structures stood. The old forge can still be made out, along with a dwelling chimney, plenty of broken bottles, pieces of porcelain crockery, broken cast iron cooking pots and lids along with hundreds of pieces of rusty wire.

33. Abandoned timber-lined mineshaft at Phoenix Reef.

This ended a fruitful day. All that was left was to retrace our steps and return to camp for well-earned refreshments.

Day 7: Saturday 12/8. Free day.

Day 8: Sunday 13/8. Cameron Corner.

Todays trip to Cameron Corner was an exercise for those who had not been to the corner before. So the few of us who had, decided to drive out to Jeffery's Flat, where the derelict site of the Pioneer reef on the Warratta Creek and associated diggings are located. More on this site later.

Greeting us on our drive out was a sparkling, cloudless but cool morning that warmed up nicely as the day progressed. The drive through Gum Vale Gorge is quite picturesque. The road follows a dry creek bed with beautifully shaped red river gums. The creek has cut a channel through a zone of slaty cleavage that we drove along for about three kilometres. We emerged into open valley with scant vegetation that is sandwiched between the Warratta Ranges, and the Warratta fault on our left. The road follows the Warratta Creek that runs the length of the valley. This is a rare experience, which was not lost on our small group of ten. Our first stop was the Phoenix Reef that has two mineshafts that are lined with timber and seem to be very deep *(photo 33)*. Goodness knows where they obtained the timber from, for there are no forests out here. One has a wire grate over it that does not seem to be anchored, while the other shaft is completely open. An old grave nearby was quite sobering and puts into perspective what these hardy miners suffered.

The only shade that could be had out here was in the tree-lined creek-bed. So we picked a spot at the junction of two creeks, drove into the creek and set up for morning tea. Two fossickers a little way up the eastern bank using metal detectors scanning for gold entertained us. One was very engaged in digging a hole in the rocky ground and every now and then he would wave his detector over where he was digging. We later found out that he found some very nice seam gold as well as nuggets.

From here we moved further into the valley onto the saddle of a ridge where we could observe much of the countryside and the contorted fault lines associated with the Warratta Fault *(photo 34)*.

Below this ridge was a derelict tumbled down stone structure, however we decided to bypass this for the moment and explore it on the way back out. From here we drove a short distance to the Pioneer Reef and its abandoned plant and stamp battery. There is so much to take in at this site, however utmost care should be taken, as with all these sites there are open and very deep mine shafts dotted around the area with no safety barriers or signs. To the historian and photographers this was a dream come true. Again, I refer the interested reader to Ken McQueen for full historical facts.

The mine site sits on the bank of Warratta Creek with three or four uncovered mine shafts. Terry dropped a stone in to gauge the depth of one of the shafts. By the time the stone reached the bottom, we guessed it to be at least 30 or so metres deep. The property owner had a pump hooked up to one of the shafts and was pumping water from it.

35. Remains of the stamp battery at the Pioneer Reef. Over the years various modifications were made, including conversion from12 to 8 stamps. The components were made by Martin & Co. of Gawler. and the Vivian & Co., Castlemaine Foundry.

The stamp battery *(photo 35)* and machinery area sat on large blocks of sandstone positioned to level and stabilize the ground where the otherwise steep bank of the beautifully shaded tree lined creek plunges off precipitously. This venture was a dismal failure apparently. An expenditure of £22,000 realised a return of just £6,000.

Two remnant stone structures on the banks of the creek not far from the plant and stamp battery caught our interest. Again some time was spent here

34. Warratta Ranges form an inlier composed of Cambrian slates. Note the distinct slaty cleavage.

36. *Di pretending to sit in a miners cage ready to be lowered down a mine shaft.*

38. Intact cone-in cone structure that consists of vertically stacked cones of calcite.

searching around while trying to piece the history together. We also drove our cars onto the creek bed for photographs under the river red gums with metamorphic rocks showing slaty cleavage in the background.

Many pieces of mining equipment remain in the vicinity, such as a miners cage that lowered miners down mine shafts *(photo 36)*.

We then drove back to the first tumbled down stone buildings we saw from the saddle. A rusting broken puddling machine *(photo 37)* was sitting beside the creek not far from the tumbled down building. This machine being new to some, allowed Brian and Ron to explain that they were used to crush small rocks and/or clay to ready them for sluicing, and they were usually operated by horse.

Across the creek and up the other bank is a dangerous shaft. Dangerous yes, because it slopes inwards with a slippery gravelly surface, so if you try to have look in and test the depth, you run the risk of plunging down the shaft. Brian dutifully warned every one to keep their distance. A short walk up and around the hill brought us to some more shafts, although these were not deep at all, in fact one was only 2 metres deep while another would have only been some 5 metres deep.

Hunger pangs were starting to bite so we moseyed back along the track to Gum Vale Gorge where we had lunch in the shade of the river red gums. A comment made by Brian was that the trip into Jeffery's Flat was worth the whole trip alone.

On the way back to camp we stopped in at the previous day's site where the Cretaceous ripples and shattered cone-in-cone structures were, in an attempt to find the intact cone-on-cone structures observed by Elaine and Terry.

Ron and Ellen along with the others continued on to camp to catch up on some washing and to do some shopping. When we arrived at the parking spot David and Di decided to stay at the car while Brian and I walked to the ripple site.

We did find the intact cone-in-cone structures we were looking for *(photo 38),* and a whole lot more that we were not expecting. Cone-in-cone structures are secondary sedimentary structures that form in association with deeper burial and diagenesis. They consist of vertically stacked cones of calcite.

Interestingly one of the most unexpected discoveries was suspected glendonites *(photo 39).* Glendonites are pseudomorphs of calcite after ikaite ($CaCO_3.6H_2O$). Once temperatures rise above 4°C the ikaite decomposes to a mush of water and calcium

37. Remains of a puddling machine near the creek that was used to separate gold from clay.

39. Suspected glendonite discovered in a creek bed.

carbonate. The resultant cavity is then infilled by a process that remains uncertain. Glendonites are climate indicators. They give us an insight into what the climatic conditions were at the time, in this case glacial. The true nature of these things remain to be explored.

We also found another features that we were not expecting to come across, some very good examples of fossilised algal structures *(photo 40)* and very unusual dendritic type structures superimposed on the surface of ripples *(photo 41)*.

***Fossil Algae*.**

Algae are very important fossils in helping geologists and palaeontologists to understand the ancient environments of depositions and ecosystems that existed in the geologic past. The kind of algae present in a rock can give the geologist some idea as to the depth of water in which the rock was deposited. Some wavelengths of light penetrate the water column deeper than other wavelengths. Different species of algae photosynthesize at different wavelengths of light. For example, red wavelengths of light penetrate deeper than blue wavelengths so a species of algae that used only red wavelengths would suggest it lived in deeper water. (Nebraska Invertebrate Fossils – Algae) (http://snr.unl.edu/data/geologysoils/fossils/nebrinvertAlgae.aspx)

40. Fossils of algal structures.

41. Dendritic structure in calcareous sandstone.

When Brian and I returned to the car, Di and David were some what chuffed at seeing two Australasian Bustards while they waited for us. This was the icing the cake I thought, but no it wasn't, Brian insisted that we have a coffee with him and Dave back in town.

Stopping at the general store beside Brian and David's digs, Brian ordered the coffee and we chattered while waiting. The coffee arrived and we started to enjoy our drink, but not David, who lent foreword to get the sugar. As he did the chair slipped from under him slamming his elbow down onto the table and knocking his coffee all over him. Needless to say we had a good laugh at David's expense. He then had to clean it up before purchasing another one. Surely that warrants a Numbat award.

Those who had to stay in Milparinka at the Albert Hotel due to the Kidney Car Rally, drove down to Milparinka from Tibooburra that afternoon and soon after arriving were treated to a magnificent sunset, which apparently was not seen at Tibooburra. The next morning they had to then return to Tibooburra for the start of that days activities, which was at Milparinka. This may sound confusing, but their accommodation that night was back at Tibooburra.

Day 9: Monday 14/8. Milparinka, Mt Poole, Depot Glen.

Today's exercise was a trip to the historic town of Milparinka, and Depot Glen to soak up the history and scenery. The weather was playing its part as well. It was perfect with a smattering of high streaky wind blown cloud, although at ground level it was only slightly breezy, the temperature reaching a warm 32°C by lunchtime.

We stopped at the replica of Poole's cairn at town's edge *(photo 42)* for a final briefing around 8:30 am. We then turned our group loose to explore the historic township telling everyone to meet at 10:30 am for morning tea at the park. We were later informed that Milparinka was the lunch stop for the "Kidney Kar Rally" between the White Cliffs and Tibooburra leg of the fund raising event. So it was going to get busy.

Milparinka is virtually a ghost town. The only buildings in town still operating are the pub (Albert Hotel) and the Court House with its ongoing restoration, and where volunteers conduct tours. Most of the ruins have interpretative signs and there are other signs dotted around the area explaining the history of the gold rush.

Before gold mining this area had a greater claim to fame. Not far from here is Depot Glen. This is where Captain Charles Sturt sought refuge. Sturt and his 15 men were on an expedition to find an inland sea in April 1845. Unbeknown to Sturt the country was experiencing a severe drought. The further he travelled the dryer it became. It was becoming very desperate as most if not all the water holes had dried up, save one, Depot Glen.

Fortunately they stumbled onto this body of

Milparinka.

Milparinka is a small settlement in northwest New South Wales, Australia. At the time of the 2006 census, Milparinka had a population of 55 people. Since 2014 this number has dropped to 10 inhabitants. Milparinka is on Evelyn Creek.

Gold was discovered in the 1870s and a rush commenced in 1880. The mostly male population peaked at 3,000 in January 1881. Cobb and Co coaches ran three times a week from Milparinka to Wilcannia, and by August 1881 the official gold escort had carried about 10,000 ounces of gold from the field, not to mention that which went privately.

In this arid region, water was so scarce that miners got their gold by dry blowing. Water was selling for one shilling per bucket and dysentery was rife, until in September 1881, on the recommendation of W.H.J. Slee, the New South Wales government authorised the drilling of a well. In December 1881 the government well struck water at 140 feet, which caused great relief to all. (The history of Milparinka is beyond this publication. I refer the interested reader to other sources).

water that Sturt estimated would last 12 months.

Sturt had in his command:
15 Men, 11 horses, 30 bullock, 200 sheep as well as 6 drays, 1 boat to sail the inland sea and a boat carriage.

A model of the expedition and its equipment can be seen in the Tibooburra National Parks office.

Protein was not a problem to Sturt and his party. Fresh vegetables and carbohydrates, and the lack of vitamins and minerals, were his greatest problem. Scurvy debilitated him and his men. As testament to Sturt's skills only one man perished from malnutrition.

To relieve the monotony of camp life, Sturt's men walked daily to the top of the nearby "Red Hill", now Mount Poole, to construct a stone cairn, 6.40 metres (21 ft.) at the base by 5.5 metres (18 ft.) high. This cairn later became a memorial to Poole, the only man not to survive.

43. At the start of the walk to the summit of Mount Poole which can't be seen from the start of the walk.

Before visiting Depot Glen it was suggested by Ellen that we visit Mount Poole, which really worked out well. So with this in mind we drove from Milparinka to Mount Poole along the dirt track that runs through Mount Poole Station. Mount Poole is the only prominent feature on the otherwise featureless quartz and silcrete gibber plains. In fact there is so much quartz on the ground that in places it looks like snow and a little off in the distance a massive outcrop of quartz is quite prominent, so large that it seems unnatural.

Arriving at the car park at the base of Mount Poole, we had plenty of time to scamper up the summit to where the cairn had been built *(photo 43)*. While most climbed the hill a few decided that they could do without the exercise and waited at the cars.

Passing through a gate you follow the sometimes-indistinct walking track up Mount Poole. After the initial steep climb across bouldery debris that had eroded from the crest of the hill, the slope levels off briefly. In this section there are weathered Cretaceous sandstone and mudstone amongst the silcrete boulders. These Cretaceous rocks form the body of the hill, with a hard, resistant capping of silcrete, a process that took place about 33 million years ago at a time when Australia was

42. Replica of Pooles' cairn at the edge of Milparinka.

44. View of the gibber plains surrounding Mount Poole.

subjected to a hot, wet environment. The underlying Cretaceous rocks were deposited more than 100 Ma.

Arriving at the top of Mount Poole you are greeted with the cairn built to by Sturt's men *(photo 45)* and a 360° panorama of what could only be described as a moonscape *(photos 44 & 46)* that except for the sinuous tree lined creeks that disappear off into the distance looks to be totally barren.

The only trees on the gibber plains in the vicinity of Mt Poole are the river red gums (*E. camaldulensis*) that line the beds of the ephemeral streams. The summit has two or three tenacious grevillea trees, somehow surviving in a very harsh environment, that rarely experience any rain or shade and are constantly battered by the strong winds, and during summer temperatures would reach the mid 40's to 50^{0} C.

Arriving back at the gate we encountered a strange 'electronic' sound (hum), which turned out to be wind vibrating the fence wire, that then reverberated in the hollow steel gateposts! A sort of natural violin.

By the time we returned to our cars it was time for lunch. So we drove back to where Poole's grave is located beside Preservation Creek *(photo 47)*. The shady tree lined creek with knee-high grasses was an excellent site for our picnic lunch where we spent a good forty-five minutes here.

This gave those of our group that had not been here before time to explore the creek and visit Poole's fenced off gravesite. Not used to losing men, Sturt was devastated at the death of his right-hand man, James Poole, an Irish surveyor. Sturt buried Poole beside Preservation Creek, a short distance from Depot Glen. His initials and year of death were carved into a beefwood tree.

People of nearby Mount Sturt Station erected a grave headstone commemorating James Poole. It is believed to have been erected around 1883.

Our next destination was Depot Glen on Preservation Creek, which is a tributary to Evelyn Creek. This is where Sturt and his men took refuge from the drought stricken country.

The common belief was, since there were rivers flowing inland, there must be a sea at the end of them. They were so confident they even dragged a whaling boat with them. But water supplies ran dry and drought conditions made them impossible to replenish, and for several months the group camped beside the water hole in what Sturt called a "rocky basalt glen", now known as Depot Glen. Sturt thought the rocks in this area were basalt.

This is a very interesting and beautiful place. From the car park you follow a well-used footpath through towering slates and phyllites *(photo 48)* to your left and the tall river red gums that shade and line the creek on your right. The water in the creek was quite low compared to last year's visit *(photo 49)*. However this

45. Cairn on the summit of Mount Poole is now a memorial to James Poole.

46. A battered grevillea tree providing a little shade on the summit of Mount Poole.

The Depot Glen Formation.

It consists of strongly cleaved metamudstone (phyllite), interbedded metasiltstone and subarkose sandstone (containing detrital muscovite), with minor quartz arenites and rare tuffaceous metamudstone (Greenfield & Mills 2009). They have been regionally metamorphosed to greenschist facies in the Demalerian Orogeny, with tight to very tight east-verging folds and a pervasive north-northwest striking cleavage defined by muscovite and rare biotite (Greenfield & Mills 2009). A population of zircons within a laminated felsic tuffaceous bed of the Depot Glen Formation has been dated by U–Pb (SHRIMP) at 504.5 ± 2.6 Ma as part of this project (Black 2006).

(Field guide for the Koonenberry Belt geological history and mineral systems excursion 2nd to 4th October 2009 GS 2009/0694 P.J. Gilmore, J.E. Greenfield and K.J. Mills)

47. James Pooles' grave and memorial at Depot Glen is located beside Preservation Creek.

gave us better access to view slabs of phyllite in the creek bed with some displaying crenulation.

Sturt is reported to have constructed an 'underground room' in Depot Creek. This was to store perishables, and for relief from the heat. However given the rocks that outcrop in this area, you would have think it may have been further down near where Poole's grave is located, where the ground consists of river sediments and would be easy to excavate.

From here instead of returning to Tibooburra along the Silver City Highway, we decided to travel the less maintained track via Mount Sturt Station. This is a minor road that is usually only travelled on by the property owners. This was also a part of the route for the "Kidney Kar Rally" from Milparinka to Tibooburra. Fortunately while we were visiting Mount Poole and Depot Glen the bulk of the participants had passed through. The only vehicles we saw were the sweepers that come through to pick up any breakdowns or stragglers.

The track runs north along the western side of the Warratta Hills, where in places prominent quartz dykes outcrop on the sides of the hills. Although the scenery is spectacular, it is far too vast for a camera to capture. Mount Poole with the cairn on top is very visible most of the way back to Gum Vale Gorge. The track becomes very rough in sections, and of course at one these rough sections the sweep vehicles for the "Kidney Kar Rally" caught up to us, so we pulled over and parked to let them by.

At the top of Mount Sturt the scenery with what looks like manicured grass covered the rolling hills and the blue skies with wispy white clouds stretch out before you in every direction. It is almost impossible to describe the beauty in a manner to do it justice.

Descending down towards Gum Vale Gorge the quartz dykes become more prevalent, with some large outcrops. With the day becoming late only a few stopped to photograph a large outcrop of quartz near the road. The rest of the group continued back to camp. This ended another full day.

48. Examining the outcropping phyllites and slates in Preservation Creek

49. The only water left in Preservation Creek, the place Sturt and his men camped.

Day 10: Tuesday 15/8. Free Day.

Today the members were left to their own devices to do what ever they liked.

Day 11: Wednesday 16/8. Day 1 of the Dome Tour.

The ***Tibooburra Dome*** *is a broad physiographic and geological feature which is developed approximately concentrically about the Tibooburra inlier. As the name implies, the Tibooburra dome is a raised area of rocks in a general dome formation. The dome has formed as a result of the slow upward rise of the relatively dense Cambrian rocks in the Tibooburra area. These rocks have arched upward due to pressure from the large volumes of relatively light Silurian granodiorite bodies within them. As the high-density metamorphic rocks can't simply move apart to allow the deeply buried granodiorite body to migrate upward, the rocks arch and fracture.*
(Geological Tour of the Tibooburra Dome Area from Bob and Nancy's Geotourism Site).

Today we explored the Gorge Loop Trail, which is a part of Sturt National Park, with some stops selected from Bob and Nancy's Dome Tour. The cool fine breezy morning was a welcome relief after yesterdays 34°C heat.

Our drive to the first stop for the day, like all roads around Tibooburra, commences with the granodiorite tors and boulders that are so distinctive of Tibooburra. As the granites gradually disappear you enter the rolling downs/gibber plains/Mitchel grass country with the ever-present tree lined ephemeral creeks. Sturt described this land as a 'stony, waterless waste". He did not have the luxury of today's modern 4-wheel drive cars, so he could not appreciate the beauty that we see.

Our first stop was at a columnar and pebbly silcrete cordillo. A walk of 250m to the escarpment from the road to where the columnar silcrete outcrop occurs is surfaced by many silcrete gibbers that in some places need care to negotiate. Those in our group with dicky knees decided to wait at the cars.

50. Cordillo silcrete capping on a small mesa displaying columnar jointing.

51. "Candle wax drippings" - globules of silcrete that formed during precipitation.

Silcrete is a duricrust formed when very fine, near -surface sand and gravel are cemented by water-borne silica (SiO_2) deposited by capillary action over a long period of time in an arid climate. The crystallisation of silica occurred in the pore spaces in what was originally quartz rich sand by migrating groundwater.

The Cordillo Pebbly Silcrete is typical of this rock type throughout the region. The very hard pebbly silcrete when fractured displays characteristics of conglomerate, or more to the point laterite. Significantly it shows silcrete pebbles were in existence prior to later silcrete deposition which forms the cement. Rivers and streams eroded previously existing silcrete, resulting in rounded pebbles and sand, which was then incorporated into sandstone that makes up this Cordillo Silcrete.

Another feature of the Cordillo silcrete is the columnar structure *(photo 50)*. This is typical of this rock and very common in the region. The movement of groundwater and precipitation has also created an interesting texture (dribbles) to the sides of the columns that resembles melted wax *(photo 51)*.

At our next destination near Mount Wood Station we were introduced to an unusual but significant geological phenomenon. Maghemite occurs as pebbles that are plentiful and unusual. Maghemite is a magnetic iron oxide mineral that has been produced by limonite/ goethite pebbles being subjected to higher than normal temperatures (>50°C) most likely from bush fires that

52. Maghemite pebbles are strongly attracted to a magnet demonstrating how magnetic they are.

would have raged during the drying of the continent.

A demonstration of collecting pebbles with a magnet *(photo 52)* prompted a number of us to collect samples to take home for show and tell with our friends, families and especially our grandchildren.

After morning tea at the picnic and camping area, which was near where we stopped for the maghemite, we continued along Mount Wood Loop Road to Stud Creek where we stopped to examine silcrete solution pipes. Stud Creek is located in a valley surrounded by barren hills. The creek has spindly vegetation with the odd distorted tree.

Silcrete solution pipes are most probably channel-ways that allowed deeper weathering and groundwater movement. Collectively, these features have created zones that allowed the passage of groundwater to migrate to or from the surface. Silica and iron over time and some other minerals precipitate into the pore spaces of the surrounding sandstone, resulting in the pipe like shape. These pipes being much harder than the surrounding sandstone resist erosion leaving them standing proud in vertical position.

Silicified pipe structures up to 2 metres tall and 1 metre wide occur within some profiles. There has been some speculation that these structures might be petrified trees, but it is more likely that they are silcrete solution pipes within weathered sediments *(photo 53)*.

Stopping at the Gorge Lookout gave us the opportunity to see the physiographic features of the area. The view north shows a series of truncated, discontinuous escarpments that gently curve northwest. Erosion has cut through the silcrete duricrust allowing the softer Cretaceous rocks to be exposed and eroded creating cordillos and mesas. Much of the fragmented pieces associated with the silcrete duricrust now make up the gibber plains.

It was also noted that many of the hills and mesas dip slightly to the east. This is a product of the Tibooburra Dome that gently slopes radially outwards from the centre of the dome.

The next section of our tour passed through the gorge below the lookout. The gorge is different from the barren rolling gibber plains. From the lookout we

53. Silcrete solution pipes expose by erosion of the enclosing sediment.

54. Skull-like ironstone concretion.

drove down into the gorge where the track parallels Twelve Mile Creek, where we noted Eucalypts and other hardy trees, along with some grasses before climbing back onto the plains to our next stop.

After a drive of around 11.5 kilometres following the creek line we stopped to examine Cretaceous mudstones. The soils at this stop by comparison are markedly different to elsewhere. The brown clayey glauconitic soil is a thin veneer over the rocks. The combination of muds and a warm shallow sea was conducive in producing glauconite. Glauconite is a soft iron and potassium rich mineral and is generally olive green to brownish green in colour.

This type of soil or clay responds to moisture by swelling. This soft soil is easily compressed when walked on. This may be attributed to the plentiful gypsum in the soil which helps break down the clay.

Abundant gypsum veins are present. Gypsum ($CaSO_4.2H_2O$) is common in arid environments. Calcium carbonate from shelly fossils and calcite cement between grains reacts with naturally occurring sulphuric acid to produce gypsum. The acid is produced from the weathering of pyrite within the mudstones, indicating a lack of oxygen in stagnant water (anoxic environment, probably in deep water).

Another feature here were a number of disintegrating ironstone concretions. These concretions displayed some interesting shapes. One in particular that took my fancy was shaped like a distorted skull *(photo 54)*.

Horton Park Homestead ruins was our destination for lunch. This now derelict building set beside a large dam and nestled under shady gumtrees was an ideal spot for a break *(photo 55)*.

This next part of the day would arguably be the best and most scenic part of the trip. The drive through the rolling downs totally devoid of trees accept for those in the dry water courses, and the weathered rounded hills displaying many colours from yellows to browns bathed in the afternoon sun that highlighted the colours, framed by the grey/green Mitchel grass standing against the blue cloud swept sky was beautiful. All the while dodging kangaroos and emus that were upset by our

***Horton Park** was once a part of the Mount Wood Pastoral Station, which in its prime comprised approximately 500,000 acres. There were two stages of occupation at Horton Park, beginning very early in the last century when a family called Halfpenny bought the block and erected the first cottage. They also built men's quarters, blacksmith shop, garage, woolshed and assorted yards and fences. In 1949 when their lease had expired, Horton Park became an outstation of Mount Wood. (Information board at station)*

presence. I am sure they had not seen a vehicle on this remote track that is well away from the main road for weeks. To experience this is worth the drive to our next destination in itself. However there was even better to come.

Approaching our final destination for the day gives very little away. But once you stop and cross the creek bed through the trees that help hide this feature, you are exposed to a kaleidoscope of colour which almost defies description.

This remarkable site is a variegated outcrop of Cretaceous sandstone that has been leached producing a spectacle of various colours and patterns *(photo 56)*. The colours in the cliff formations are amazing and vary from yellow to brown, with all shades of orange and red, depending on the time of the day. Present are silicified sediments, including a wide range of morphologies formed as a result of pedogenic and groundwater silicification and silicified saprolite, where weathered bedrock fabrics, such as quartz veins and inter-locking crystals, are preserved. Silicified saprolite is microcrystalline quartz, although opaline silica, with minor chalcedonic silica, may also be present (Hill et. al., 2008). Microcrystalline anatase and hematite may also be present. Silicified pipe structures up to 2 metres tall and 1 metre wide occur within some profiles and as freestanding exposures, one looking like a leg with attached foot. There has been some speculation that these structures might be petrified trees, but it is more likely that they are dissolution pipes or dewatering structures within weathered sediments. One of the most striking features was the presence of spectacular horizontal anastomosing veins of selenite or 'satin spar', a crystalline form of gypsum up to 10cm thick *(photo 57)*. Evidence of plant fossils are also present .

56. Chris at Rainbow Rocks. Note the large solution pipe he is standing next to, and the thick vein of gypsum under the pinkish top strata.

Dawn, Stan and Lawrie found it to difficult to negotiate the rocky creek bed, so some dead fallen branches were strategically moved, so they could be driven to the other side of the creek where they could enjoy the experience of this extremely remote feature. Some time was spent here clambering around the structure examining, photographing and generally enjoying this rare sight. Unfortunately the exposed area is highly weathered and hence very unstable. It may not last much longer.

This ended the days activity. All that was left was to stop at certain points on the way back to try and capture the beauty of the vast landscape.

<u>Day 12</u>: *Thursday 17/8. Day 1 of the Dome Tour.*

Our final day of activities was greeted by a beautiful cool sunny morning, with increasing winds as the day wore on reaching a pleasant 22° C.

After driving north onto the Jump Up Loop Road we stopped at Mt King dam. Mt King Station originally covered an area of 26,840 acres. In 1972 it was

55. Ron, Ellen, Barry and Elaine having lunch in the shade of the historic Horton Park homestead.

57. Anastomosing veins of gypsum seem to have been formed on top of probable lake sediments.

58. View across gibber-covered rolling downs to the edge of the silcrete-capped Cretaceous escarpment approaching Olive Downs Lookout.

the first of the areas homesteads to become a part of Sturt National Park and was dismantled in the late 1970's. The concrete floor of the shearing sheds and the rectangular metal water tank on the hill is all that is left. We spent 15 to 20 minutes here taking photographs and wandering around the dam identifying birds.

From here we drove along the scenic track to Olive Downs lookout where there are excellent views of the "Jump Ups" *(photos 58 & 60)* aptly named for the way they jump up from the surrounding downs, along with Mt Wood Hills and the southern end of Greys Range. From this vantage point you can see the layering and structure of the eroding flat-topped mesas and isolated cuestas. 100 million years ago this park was a part of an inland sea (Eromanga Sea). The Jump Ups represent the floor of the inland sea with preserved hard, resistant capping of Cordillo Silcrete. Sand, silt and clay were deposited in the Cretaceous shallow marine to freshwater environment. From this lookout a network of dry tree lined creeks stretch out before you *(photo 59).* The materials that are carried into the creek beds were the weathered eroded sediments from the margins of the Jump Ups and the escarpment we are standing on. The plains are composed of silcrete gibbers derived from the erosion of the Cordillo Silcrete.

After morning tea at Olive Downs camping area we drove back to the Silver City Highway. Turning south towards Tibooburra we stopped at a quarry 500 metres from the intersection. The quarry has been carved out of Cretaceous sandstone and displays some unusual features and colours. The indurated sandstone contains ripped up clay clasts, a result of flood action disturbing dried out cracked clay-pans and depositing the fragments in a lake. They were then intermixed with sand carried along in currents *(photo 61).* Differential leaching by groundwater has turned areas of normally grey rock almost white. Prominent veins of gypsum are also present, some as thick horizontal bands as well as

59. View south from Olive Downs Lookout. Note how many creeks draining the escarpment join forming the main drainage channels. The dark brown capping on the escarpment is silcrete.

60. Pallid sedimentary rocks rich in diatom remains overlain by a silcrete capping near Olive Downs Lookout.

62. Fossil of a scallop found within Cretaceous marine sandstone (Coreena member).

vertical seams where water has percolated through faults and joints.

The colour combination of the sediments is not what would normally be expected. Some of the colours are quite beautiful, none more so than a burgundy base with white polygonal shaped clay with orange and grey gypsum.

Moving on we stopped at Cretaceous marine margin sandstone on top of a low rise where excavated blocks lay. The blocks were disturbed by Telstra when they were cable trenching for communication lines in this area. These blocks contain marine fossils, such as scallops *(photo 62),* belemnites and crinoid stems. Further investigation shows abundant bio-turbation in the form of worm burrows.

Some sandstone here exhibit botryoidal load casts *(photo 63).* This is a consequence of load bearing on softer terrestrial sediments laid down prior to the sandstone being deposited. Noticeable tabular mudstone clasts can also be found incorporated into the sandstone, a result of wave action or currents disturbing mudstones, which are then redeposited within the sand.

We continued on towards Tibooburra turning left onto the Onepah Road. Then stopping on top of a low rise 8 kilometres along the road. At this point we examined and discussed calcareous concretions that outcrop in weathered Cretaceous sandstone. The concretions are formed from the nucleation of calcium carbonate around a particle of rock or some other nucleus. The concretions continue to grow while ever groundwater maintains a supply of concretionary material.

Broken concretions display lamina bedding. The brown colour is from iron oxides. A simple hydrochloric acid test by Ron confirmed the presence of calcium carbonate as the surface effervesced *(photo 64).* The presence of bedding within the concretions indicates that they formed within sediment not at the sediment water interface.

Most of the concretions are spherical, however some had amalgamated, giving them a dumbbell shape. The bulk of the concretions are underground. All have varying degrees of cracking, from hairline cracks to others that were in a state of total disintegration *(photo 65).* Surprisingly in an environment that is almost totally devoid of vegetation, life flourishes. We found gecko lizards sunning themselves on a few of the concretions *(photo 66).* Goodness knows what they survive on.

This brought an end to the organized activities, all that was left to do was to return to camp for lunch and ready ourselves for our return trip home, and prepare for dinner at the Family Hotel in the evening.

61. Leached, ripped up clay clasts within Cretaceous sandstone.

63. Botryoidal load casts forming into concretions not yet separated by weathering.

64. Effervescence on the concretion indicates the presence of calcium carbonate. Note the bedding laminae within the fragment of the concretion.

65. Spherical concretions in varying states of disintegration.

66. Small gecko sunning itself.

A reservation at the Family Hotel had been organised for the final evening to celebrate what turned out to be a very successful excursion. Those who had not left the day before enjoyed a few relaxing drinks before ordering our evening meals. This turned out to be a very pleasant surprise for Ron, Ellen, Di and myself. The members in a gesture of their appreciation for the hard work and organisation of the trip would not allow us to pay for our meals. They had taken up a collection, which covered the cost of the meal and a bottle of wine. This was totally unexpected and very much appreciated. However the celebrations did not end here as it turns out that it was Ron's 75th birthday, which Richard in a great speech pointed out, so all in all there was much to celebrate.

And finally to those who took part in this trip. Thank you for your patience and the way you conducted yourselves. For without you and your goodwill, given some of the early starts and remote places that we visited would not been a success. Both Ron and I enjoyed every minute of it. Thank you.

The traditional Numbat Awards and a new category, 'All Day Sucker' Awards given by David Atkinson.

Terry Kingdon: "Fortnight Kid" for always being late, and Coprolite kid, for obvious reasons

Brian Redmayne: "Joke of the trip". No one laughed.

Chris & Di: "Chick magnet". For attracting emu's and unsolicited approaches from Jillaroos.

Richard Bale: "Nugget award". For finding gold.

All Day Sucker Awards:

Stan: To use as a pacifier for dawn.

Ian: For if he ever catches up to Sue, he can give her one to slow her down.

Lawry Henderson: To give to Janece, for when she goes off.

Report by Chris Morton.
Photographs by Chris Morton and Ron Evans.

Edited by Ron Evans and Brian England.

Technical editing Brian England.

References:

HILL, S.M. (2008). *Tibooburra-Milparinka inliers, northwestern New South Wales: regolith and landscape evolution field sites.* CRC LEME School of Earth & Environmental Sciences University of Adelaide SA 5005.

HILL, S.M. and GIBBONS, S. (2008) *Regolith carbonates of the Tibooburra/Milparinka inliers, northwest NSW: characteristics, regional geochemistry and minerals exploration implications.* CRC LEME School of Earth & Environmental Sciences University of Adelaide SA 5005.

BOB AND NANCY'S GEOTOURISM SITE. *Geological Drive Milparinka-Depot Glen-Mt Browne.* http://ozgeotours.110mb.com

BOB AND NANCY'S GEOTOURISM SITE. *Geological Guide to the White Cliffs area.* http://ozgeotours.110mb.com

BOB AND NANCY'S GEOTOURISM SITE. *Geological Tour of the Tibooburra Dome area* http://ozgeotours.110mb.com

Geological sites of NSW. A division of Cartoscope Pty. Limited.

Sturts' Central Australian Expedition. Corner Country History http://outbacknsw.com.au/sturt-s-expedition.html

QR Code.

To quickly log into the Amateur Geological Society of the Hunter Valleys website, scan the code below with your phone or tablet or log onto www.agshv.com

QR Code Readers are free on the web.

Social Committee Report

When I was in the workforce I was often required to work in a team but the Society's Social Committee is by far the best team I have ever participated in.

Members have a quick planning session to plan the catering for the AGM/ Soup and Slides Night and the Christmas Party at a craft day. At the actual event the team work efficiently together to produce wonderful meals that are enjoyed by all. The committee seem to have the knack of being able to offer the desirable quantity and quality of food at each event.

The bi-monthly craft days continued to be well attended and many projects were completed during the year. The success of these has been observed by many of the husbands who often now join in for morning tea and then go on a walk together returning in time for lunch.

I would like to thank the Social Committee for the superb way everyone works together to achieve the end goal. It is the perfect example of how a team should function. The cooperation of the members is to be commended.

Sue Rogers
Convenor.

Publication Acknowledgements.

Geo-Log 17 is a collaborative publication with input from trip leaders who organise and conduct activities and then submit a report for inclusion in Geo-Log. Various members also provide photographs for inclusion in reports.

Geo-Log 2017 includes reports from five geologically complex areas requiring considerable research from leaders who organised and ran the outings. A big thank you to those members as well as other members who provided geological input during the activity.

A special thanks to Past President Brian England for the onerous job of checking geological accuracy in reports as he edits Geo-Log.

Life Member Ron Evans compiles Geo-Log and organises its publication by Lakemac Print, Speers Point.

Ron Evans.