'Geo-Log' 2015

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

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Contents:

President's Introduction.

Hello members and friends,

Every year seems to be more successful than the last and 2015 was no exception. Our membership reflects a continuing enthusiasm amongst the general community for the earth sciences and related activities. A background in geology is never a requirement for acceptance into the Society and members are strongly encouraged to take part regardless of their level of knowledge.

Although the original aim of our Society was the exploration and understanding of Hunter Valley geology and how it defines landforms and other aspects of natural history, we continue to widen our coverage well beyond the confines of the Hunter Region. Despite this it is becoming increasingly challenging to include new activities in the program each year. But our membership is growing and new members bring new ideas and new experiences from which everyone can benefit. Occasionally old areas are revisited, either for the benefit of new members or where the availability of new information has allowed a greater understanding of an area. For example, recent construction of an overpass connecting the completely revamped Bulahdelah Mountain Park to the Alum Mountain Track enabled us at last to run a much-anticipated re-exploration of the alunite mines and magnificent forest on Bulahdelah Mountain.

Our first extended field trip covering the geology of the Flinders Ranges in 1995 was so successful that similar trips have since taken place annually. This year's program included a three week tour of the geological features and other attractions in the Canberra-Cowra-Bathurst regions of New South Wales, ably organized, planned and run by Sue Rogers with the assistance of Winston Pratt who incorporated two days of fascinating pure geology!

We seem to benefit more and more each year from members' personal contacts and associations. Last year it was Professor Mike Archer who spent a full day with us at Riversleigh thanks to Joan Henley's close association with the Australian Museum during Mike's tenure. This year Laurel Kingdon's sister and husband granted us access to their property near Cowra to search for fish fossils and again through Joan we were treated to a talk in Canberra by Dr. Alex Ritchie on the Devonian fossil fish discovery near Canowindra. Alex also accompanied us on our day trip to Wee Jasper.

The Geological Survey of NSW received a grant to conduct a Newcastle Time Walk from Nobbys to the Bogey Hole during National Science Week. Two of our members were invited to assist in the planning of this activity, as well as to describe geological features during the walk. This is another sign of respect for our society.

Very special thanks go to the Social Committee for their rarely acknowledged input at events throughout the year, especially the soup and slides night and the Christmas meeting. The fare they provided at the Christmas meeting was simply mind-boggling! Thanks to Sue and Ian Rogers who yet again made their home available for these meetings. Grateful thanks also to our Treasurer Leonie Mills who diligently keeps our finances in order. Our Secretary Ian Rogers continues to get our very informative newsletters out in plenty of time for members to plan ahead and also oversees the Society website which provides a window into our activities and continues to attract much interest.

Thanks to those members who took part in organizing and running our activities and who contributed to this journal and especially to Life Member Ron Evans for his determination and dedication in putting together another great addition of the Journal that provides an invaluable resource for the future and which continues to draw accolades from both the scientific community and general public. I believe it has become the best journal of its type in Australia.

With very best regards,

Brian

Merewether Baths to Glenrock Lagoon Walk

Leader: Ron Evans.
Date: Saturday 28th February 2015.
Attendance: 15 members.

Early History - A Brief Explanation

A spot near the entrance to Glenrock Lagoon is probably the site of the first coal discovery in Australia. The find was made by a group of escaping convicts led by William and Mary Bryant. However, news of the discovery did not get back to the authorities in Sydney. It was not until 6½ years later that a young naval officer Lieutenant John Shortland, R.N. discovered and recorded coal near the entrance of today's Hunter River on the 9th of September, 1797. Traders soon started to exploit coal and cedar from the area.

Because of the important resources in the area, a permanent settlement was established in 1804 as a place of correction for troublesome convicts. Tunnels and shafts were driven and sunk all over the settlement, digging coal as far South as Glenrock Lagoon.

In the Glenrock area, a mine being worked during World War II broke into old convict mine workings. A huge tree trunk was found. Attached to it were chains, balls and chains and handcuffs used to secure convicts working the mine at the end of their days toil. The relics were removed but the great stump was buried as coal needed for the war effort was removed.

It was not until 1823, when Newcastle became a free township, that the cruel life of the convicts began to fade although these prisoners were employed in road making, constructing the breakwater to Nobbys (started in 1818) etc.

On the Burwood Estate (owned by the Scottish surgeon Dr. Mitchell), Burwood Colliery was established in the late 1840's on the southern side of Glenrock Lagoon. *(photos 1 & 2)* In 1850 Dr. Mitchell was authorised to construct a railway from his Burwood Colliery to a Newcastle wharf. In 1851 Dr. Mitchell expanded the Burwood Colliery at Glenrock by constructing a railway line to the Port of Newcastle to transport its coal to waiting ships. This railway line crossed the lagoon on its run to Newcastle and also serviced the nearby Glenrock Colliery. *(photo 3)*

Tunnels were dug through the cliffs under the present Merewether Heights. One was the "road tunnel" dug through the Victoria Tunnel Seam (along the line of the present Mitchell Street). By 1853 Dr. Mitchell and others had established the Newcastle Coal and Copper Company after an amalgamation of all working properties. All stores and provisions for workmen and the Company were taken through this road tunnel by bullock drays and horse. Two additional tunnels were constructed through the cliff just south of Merewether baths. The No. 1 tunnel or 'big tunnel' (*photo 4)* came out of the cliff just behind the present day amenity block. It was about 400m long. A second tunnel (about 200m long), the No. 2 tunnel, went through the cliffs adjacent to Smelters Beach.

The original tunnels were dug to accommodate horse and cart, not trains, hence them being narrower at the top *(photo 5)*. A small engine called the 'Coffee Pot' was used to haul coal along the line. The 'Coffee Pot' was a specially modified engine (vertical boiler, altered chimney, cut-down cabin, driver one end and fireman the other end) made small enough to pass through the tunnels at Merewether *(photo 6)*. Apparently no-one was allowed on the engine inside the tunnels. The engine was slowed to walking pace, the men jumped off, and jumped back on as the engine exited the No.2 tunnel & vice versa.

About 200m from the tunnel behind Merewether Baths were located coke ovens owned by the Newcastle Coal and Copper Company *(photo 7)*. They supported another industry in the early days, a copper smelter works. Dr. Mitchell leased some of his land to the Newcastle Coal and Copper Company. Their smelter works *(photo 8)* was located in Murdering Gully (not far from the second tunnel exit) on the present day Hunter District Water Board property adjacent to Burwood Beach (Smelters Beach, once called the Long Beach) as it is known today.

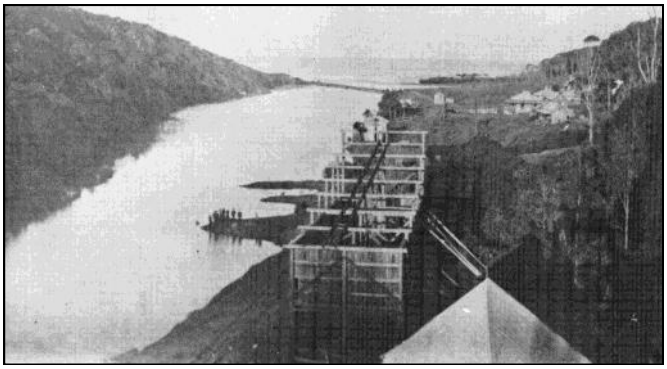
In the 1860's the company failed because of high transportation costs of the ore and poor smelter placement. As a result, the lease fell back into the hands of Dr. Mitchell and he subsequently established the Burwood and Newcastle Smelting Works. These works also quickly failed as the copper ore used came from the Currawang mine (SE of Collector on the NE side of Lake George) in which Dr. Mitchell had an interest. The ore deposit only lasted from November 1866 to May 1867, a period of 6 months. But prior to its closure the smelter was producing 20-30 tonnes of copper a week (Grothen, 1982).

Mitchell continued to lease portions of the Burwood estate, incidentally contributing to the development of the Newcastle District. In 1866, the first tannery in Newcastle was established at Flaggy Creek as well as Burwood Pottery and the Burwood Fire Clay and Brick Works.

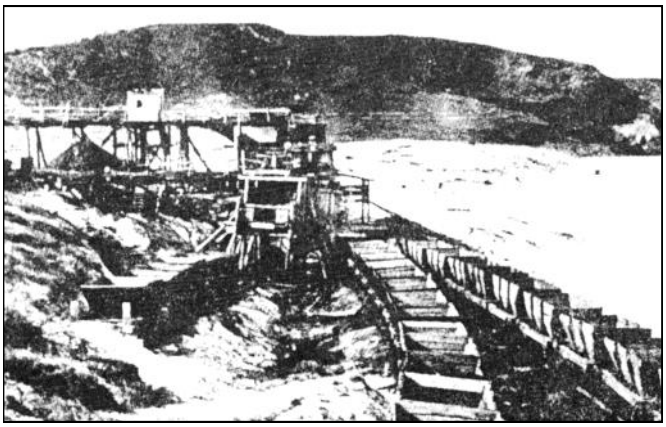
Geology

Magnificent exposures of the Lambton Sub Group, the lowest (earliest) part of the Permian age Newcastle Coal Measures can be seen in sea cliffs to over 60 metres high between Merewether Ocean Baths and Glenrock Lagoon. In the highest cliffs just to the south of the Ocean Baths *(photo 9)* there is an excellent section extending from the Yard seam exposed at sea level to the Dudley seam around 9 metres above and

1. Burwood Colliery in Glenrock Lagoon, 1888.



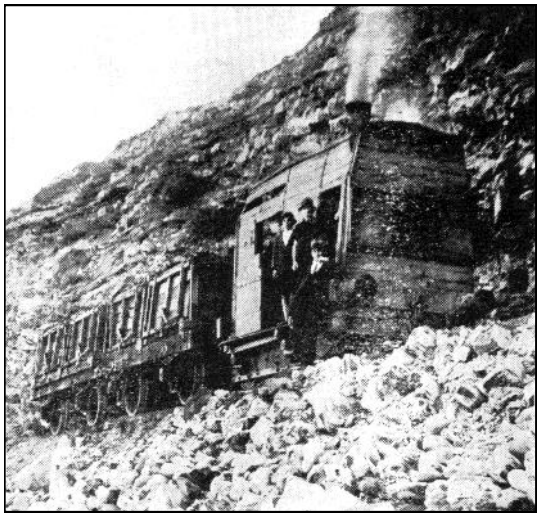
2. Coal storage bins, Glenrock Lagoon.



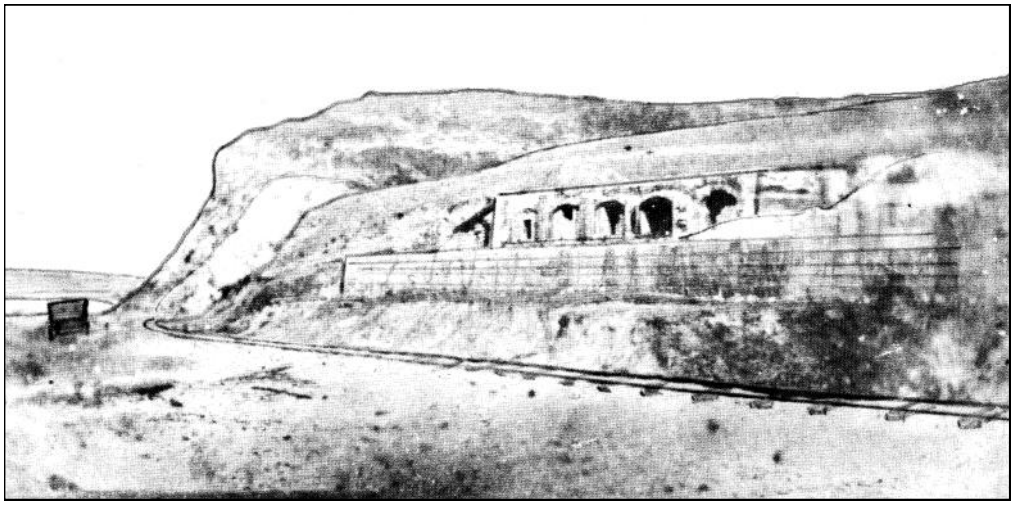
3. Looking along Smelters Beach from the Glenrock Mine with the Merewether Estate in the background. At the far right of the picture, No. 2 tunnel can be seen.

4. An excursion to Merewether in the 1900's showing No. 1 tunnel in the background. On the left of the photograph is where the Merewether Baths are today.

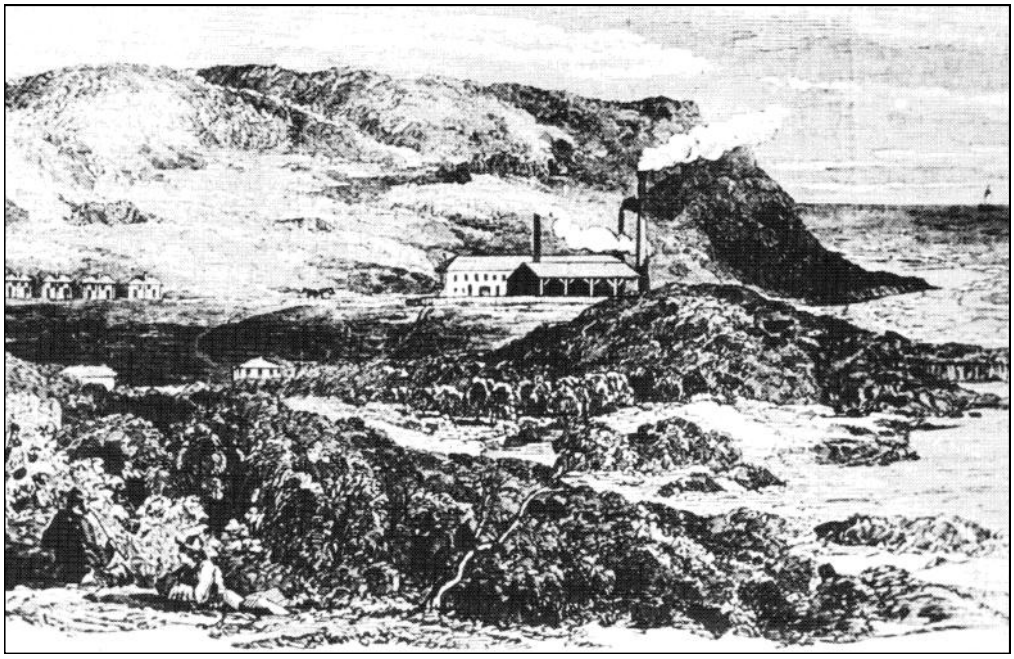
5. Northern exit of No. 1 tunnel. Note the narrow top - the tunnel was designed for horse and dray.



6. The "Coffee Pot", a vertical locomotive chugs past the cliff face of the present day Merewether Heights, in 1910.



7. The Burwood Estate Coal and Copper Company Railway Line (near the present day Merewether Baths) was the site of the Company's coke ovens that operated until about 1861.



8. The Burwood Copper Smelting Works.
The drawing was taken from the Illustrated London News on 11th February, 1854.

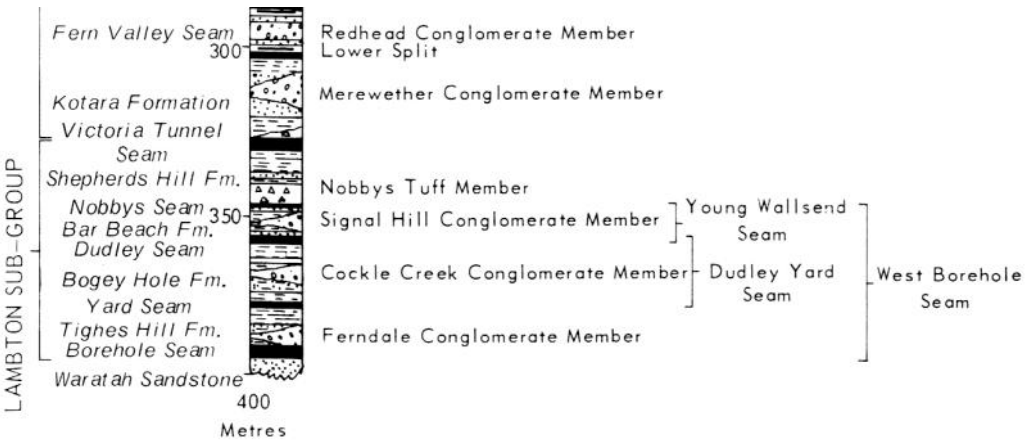


Fig. 1 Lower section of the Newcastle Coal measures showing the stratigraphy of the Merewether to Glenrock area.

then the Nobbys seam 12 metres above that, which is overlain by around 15 metres of Nobbys Tuff (formerly Nobbys Chert). Above the Nobbys Tuff is the Victoria Tunnel seam, which is overlain by the current-bedded Merewether Conglomerate, the lowest bed in the overlying Adamstown Sub Group of the Newcastle Coal measures *(Fig. 1)*. To the south this grades into shales and sandstones of the Kotara Formation. Edgeworth David described this cliff section as the finest of its type in the World. Towards the southern end of the cliff a normal fault with a throw of around 4.5 metres can be seen. The fault plane is easy to make out as it has provided a line of weakness along which a small V -shaped gully has been eroded, forming a small alluvial fan at beach level *(photo 10)*.

Unfortunately much of this excellent exposure is now covered by rampant vegetation. The scree slope below the cliff was once a prolific source of superb plant fossils including *Phyllotheca, Glossopteris* and *Gangamopteris,* which probably fell down from the Shepherds Hill Formation immediately above the Nobbys Tuff. Participants on this excursion were shown a superbly preserved beetle wing carapace, one of hundreds of insect fossils that have been found in the black coaly shales here.

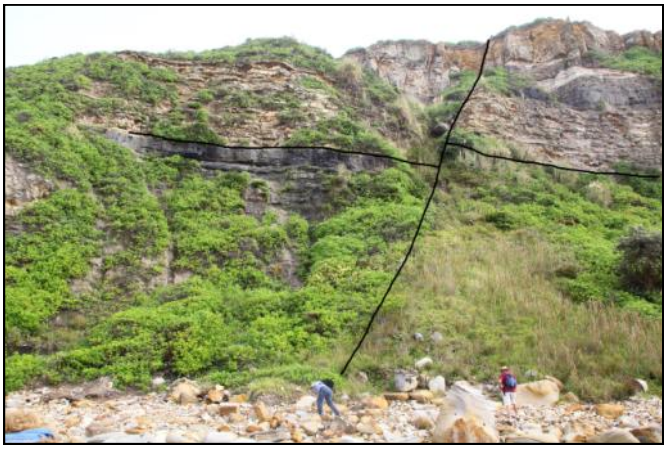
At the northern end of this cliff section, along the edge of a large rock pool, a shale band within the Bogey Hole Formation has been eroded out beneath a thick bed of sandstone representing a former stream channel. The shale contains oblate spheroidal bodies of limestone up to a metre across, showing spectacular cone-in-cone structures *(photo 11)* caused by the recrystallisation of the calcite under the effect of substantial vertical pressure resulting from the weight of the overlying rock. Typically the cones in these structures point upwards, providing what geologists call geopetal (way-up) structures.

Pebble lag (or strand lines) along the beaches to the south have produced fine examples of agate and silicified wood *(Dadoxylon)* in which the wood cell structure has been exquisitely preserved. Examples were shown to participants.

Many typical features of the Bogey Hole Formation can be observed on the rock platform here, including tessellated pavements and siderite sheets and nodules, the latter showing spectacular dehydration crack patterns *(photo 12)*.

Clambering from the beach up to the southern portal of Number 1 tunnel on the Burwood Colliery Railway we were able to see some of the few remnants of this long- abandoned industrial railway. A steel mesh fence bars entry to the partially collapsed tunnel *(photo 13),* several metres back from the original concrete cap and a single wooden pole, the only remnant of the portal structure. In the gully below the portal lies a small brick culvert, still in good condition. The rail embankment south from here to the northern portal of Number 2 tunnel is almost completely obliterated by vegetation, as is the portal itself.

9. Merewether cliff south of the ocean baths showing, from the base, the Bogy Hole Fm., Dudley seam, Bar Beach Fm., Nobbys Seam, Nobbys Tuff, Victoria Tunnel Seam, and at the top, Merewether Conglomerate.



10. Normal fault (marked) in the cliff just south of Merewether Ocean Baths.

11. Cone-in-cone structures within a shale band, Merewether.

At the southern end of this cliff section, at the north end of Burwood (Smelters) Beach, is a superb section through a meandering stream channel filled with cross- bedded sandstone passing in and out of the thinly bedded shales in the low cliff face *(photo 14)*. This sequence also lies within the Bogey Hole Formation.

From this outcrop we walked directly south along the beach to the low headland on the northern side of the entrance to Glenrock Lagoon. Along the back of this beach we noticed thick layers of heavy mineral sands thrown up by a recent storm and winnowed by wave action to form a glistening black natural concentrate. Where the sand bank had collapsed distinct layering could be seen *(photo 15)*. The black sand is probably largely ilmenite (titanium iron oxide – $FeTiO_3$) originating from the Paleogene basalts of the New England region, in which ilmenite is a common accessory. The source of other probable components (rutile, monazite, etc) is problematic. It is very unlikely that they eroded from the New England granites as was once thought, but are more likely to be the products of prolonged erosion, coming via the Mesozoic sedimentary basins (eg Clarence-Moreton Basin) from weathering and erosion of the Precambrian shield. Dumped into the ocean by rivers, the heavy minerals were moved along the coastline by longshore currents and repeatedly re-worked by storms (Herbert & Helby, 1980).

Reaching the northern end of the cliff section at Glenrock Lagoon, we were able to find remnants of the train-loading facility that once formed part of the Glenrock Colliery. Only piles of weathered coal and the rusted wheels and framework of coal wagons *(photo 16)* remain. A little further south the rusted remains of the track from Burwood Colliery can seen hanging out from the cliff a few metres above high water.

We paused for morning tea sitting on a bench of the lower split of the Nobbys seam near the southern end of the cliff *(photo 17)*. We then strolled northwards back to our vehicles, examining the geology along the way.

Both the upper and lower splits of the Nobbys seam can be seen here, separated by a dense cross-bedded sandstone bed which thins to the north as the two splits coalesce. Unexplained conical masses of tuff (tuffite) protrude from the base of the lower split in the Nobbys seam, with the coal strata deformed by differential compaction around them Thin, often discontinuous bands of tuff are present in the Bar Beach Formation sediments below the lower split, indicating that there were minor volcanic eruptions and ash distribution over the area prior to the deposition of Nobbys seam. At the southern end of this section load cast structures could be seen along the base of the sandstone bed immediately above the lower split of the Nobbys seam *(photo 18)* and these could be found along the entire length of the lower split exposure.

The cliff section north of Glenrock provides a superb section through the Nobbys Tuff, showing a

12. One of many large concretions on the Merewether rock platform showing dehydration crack patterns.

13. Southern entrance to No. 1 tunnel showing deterioration over the last 9 years.
Left: November 2006; *Right:* March 2015

14. Cross-bedded sandstone, originally a sand deposit within a meandering stream channel. Note the thinly bedded shales above and below the sandstone.

sharp demarcation between the lower 5 metres of flat-bedded water-transported tuff and an upper sequence of spectacularly slump-folded ash fall tuff *(photo 19)* in which the axes of the folds are said to strike parallel to the paleoslope (Herbert & Helby, 1980). The lower part of the Nobbys Tuff contains examples of small-scale cross beds, cut and fill structures, and ripple marks.

The sequence here exhibits a complex series of trough faults forming a complex graben *(photo 20)*. As a result of this faulting, strata high in the cliff at Merewether, such as Nobbys Tuff, have been lowered by around 21 metres to beach level. It was a finding of the drawn section of this faulting in an old text (Sussmilch 1914) that prompted us to visit this exposure. Unfortunately, weathering and marine erosion has rendered much of the section unrecognizable *(fig. 2)*.

Back at the northern end of Burwood Beach we headed up into the scrub in an attempt to find the site of the old copper smelter, but were thwarted by dense vegetation. Only a few lumps of slag *(photo 21)* and fragments of firebrick were found. However near the southern portal of the Number 2 tunnel NSW National Parks had recently erected excellent information boards depicting the history of the area.

We arrived back at the cars at 12:15pm.

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

References:

Grothen, J. F. (1982). *The History in and about Glenrock Lagoon*. Knight Bros. Newcastle NSW.

Herbert, C. and Helby, R. (1980). *A guide to the Sydney Basin.* Department of Mineral Resources. Geological Survey of New South Wales. Bulletin No.26, Part C. Excursion guide, 449-539.

Süssmilch, C.A. (1914). *An introduction to the geology of New South Wales.* Angus & Robertson Ltd., Sydney.

15. Deposits of heavy minerals within recently winnowed sand forming the berm, Smelters Beach.

16. Rusting remains of rolling stock near Glenrock Colliery on the Burwood rail line.

17. Morning tea next to a bench of sandstone. The upper and lower splits of the Nobbys seam are above and below the sandstone.

18. Spectacular load casts at the base of a sandstone bed on top of the lower split of the Nobbys seam.

20. A small graben formed by trough-faulting within the Nobbys seam and Nobbys Tuff at the northern end of the cliff section just north of the entrance to Glenrock Lagoon.

19. A wonderful example of a slump-folded ash fall tuff above horizontal beds of water transported tuff in the cliff just north of the entrance to Glenrock Lagoon.

21. Slag and a firebrick, evidence of the early copper smelter works at Burwood (Smelters) Beach.

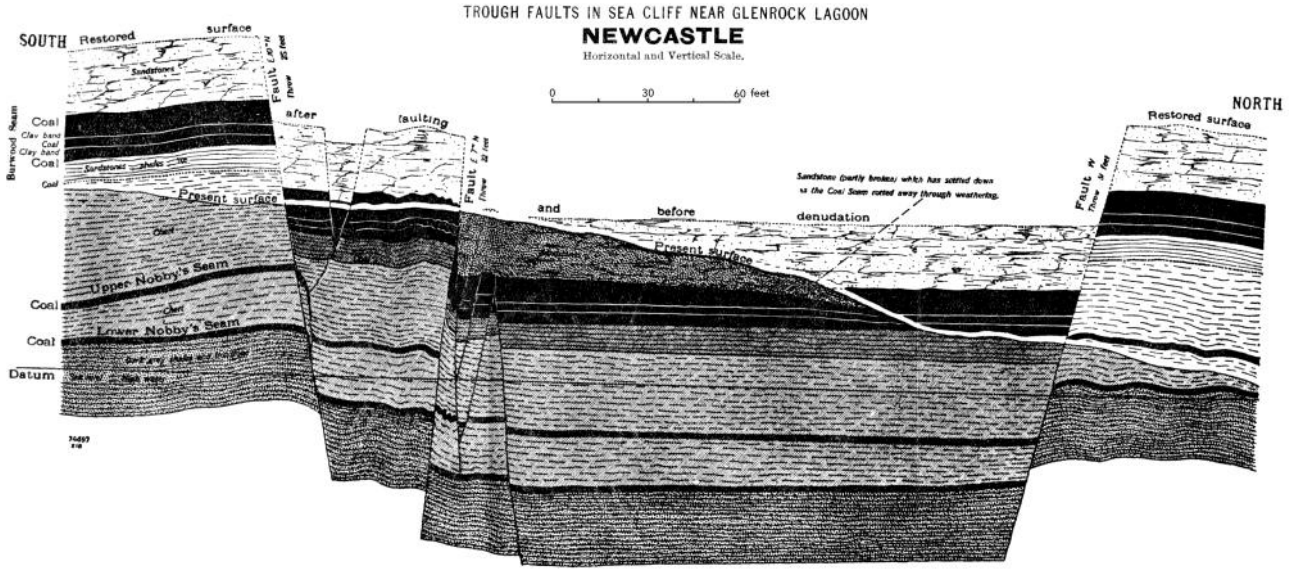


Fig. 2 Diagram showing the trough-faulting (grabens) in the sea cliff just north of the entrance to Glenrock Lagoon.
Fig. 52. Geology of NSW, C.A. Süssmilch (1914)

Chromite Investigation Trip Nundle NSW

Leader: David Atkinson, Brian England.
Date: Friday 27th to Monday 30th March 2015.
Attendance: 20 members, 1 visitor.

What is chromite?

Chromite is an oxide of chromium and iron belonging to the spinel group of minerals *(photo 8)* having the general formula: AB_2O_4 where A = Co, Cu, Fe^{2+}, Ge, Mg, Mn^{2+}, Ni, Ti and/or Zn and B = Al, Cr^{3+}, Fe^{2+}, Fe^{3+}, Mg, Mn^{3+}, Ti and/or V^{3+}. Pure chromite is $FeCr_2O_4$ but compositions may vary between magnesiochromite $MgCr_2O_4$ and chromite, hence the range in chromium content reported from different deposits. There are at least 22 members in the spinel group. Chromite is the only economic source of chromium and is also used in furnace refractories.

The Nundle deposit is one of several small podiform chromitites in New South Wales, most associated with discontinuous serpentinite outcrops along the Great Serpentine Belt extending between Port Macquarie and Warialda. After originally segregating from peridotite magma and forming pods in shallow depressions along the surface of the upper mantle at the base of sea floor ophiolite sequences, the chromite bodies have been dismembered and tectonically emplaced during injection of hydrated peridotite/dunite (serpentinite) along faults, such as we observed along the Peel Fault near Bingara on the 2013 Barraba-Bingara excursion.

At Chrome Gully (Chrome Hill) large lensoidal masses of chromite four or more metres in width have been opened up by a number of shallow shafts. The ore assayed between 37% and 47% Cr_2O_3. These masses occur within a small wedge of serpentinite confined between two bifurcating northwest-southeast trending faults, and at the junction of the serpentinite and an intrusive gabbro (Macnevin, 1974).

The Chrome Gully deposits were the first to be opened up in the Colony, 102 tonnes being mined in 1882. Earliest reports state that "On a high ridge about one mile (1.6km) northeast from Bowling Alley Point occurs a lode of almost pure chromite of variable thickness; in one place, at the junction of diorite and serpentine, it crops out on the surface 12 feet (3.7m) wide" (Wilkinson, 1886). "The outcrop…. is about 700 feet (214m) above Bowling Alley Point, and the apparent thickness of the vein is in one part some 40 odd feet (12m); one huge block of the mineral lying loose on the surface measures about 12 feet (3.7m) long by 6 feet (1.8m) high and 5 feet (1.5m) wide." A specimen from the locality is reported to have contained 64.72% Cr_2O_3 (Liversidge, 1888).

1. "Do you think this goes here Ian?" (new tent blues!)

Saturday 28th March

Everyone had set up camp in the Fossickers Tourist Park adjacent to the Nundle Visitor Information Centre in Jenkins Street by late yesterday although some were slower than others. *(photo 1)* A quilting group had booked out the Peel Inn and only one standard cabin was available at the Park so the majority of society members had brought their vans.

We set off in convoy at 9:30am, heading back through the town and along the main road northwards towards Tamworth. The Peel River crossing at Bowling Alley Point was in the process of being replaced by a high level bridge to allow the level of the nearby Chaffey Dam to be raised by 6.5 metres. The road back through Bowling Alley Point to Nundle was also being relocated higher up the ridge, well above the projected water storage level. We turned left after crossing the river, then to the right through the memorial gates of the Andersons Flat Cemetery after a few hundred metres. From the gate a dirt track wound through open eucalypt forest to the cemetery boundary fence where our leaders found themselves somewhat challenged mechanically in dealing with the cleverly contrived wire puzzle holding the gate to its anchor post. We followed the track through the cemetery to the eastern boundary fence where there was sufficient clear ground to park the vehicles. To build up energy for the steep climb ahead we had morning tea before leaving. *(photo 2)*

Climbing over the wire boundary fence without serious incident we headed off across the small floodplain of Chrome Gully to the base of the ridge on the northeastern side of the watercourse. Long grass covered the area but we were able to follow narrow cattle pads, thus avoiding the possibility of unwittingly treading on any snakes hibernating there. Scattered patches of blackberry vines offered the prospect of a tasty feast, but with little or no rain here in the past several months the pickings were limited to just a few tiny berries.

2. Morning tea stop next to Andersons Flat Cemetery.

As we climbed to the spine of the ridge we came to an old wire fence, but after 100 metres or so found a fallen dead tree that provided an easy crossing. *(photo 3)* Very soon it became obvious from the rocks under out feet that the ridge conformed quite closely to the wedge of serpentinite shown on the geological map. In fact the serpentinite outcrop appeared to define the location of the ridge set between Chrome Gully and an un-named tributary 150 metres to the northeast. We followed the increasingly steep spine of this ridge towards the peak known as Blackfellows Knob, pausing now and then to examine the variety of serpentinite-related rocks exposed, which included harzburgite and tremolite-rich rocks. There were very few actual outcrops, most of the surface comprising coarse angular scree almost entirely hidden by tufts of spikey spinifex grass. Great care had to be taken to avoid dangerously loose boulders, which could send the unwary tumbling down the steep slope into the gully below. Those people who had worn long trousers now considered themselves fortunate while those who had not had to quietly put up with the consequences.

About 300 metres above Chrome Gully David and I managed to relocate the prospecting adit we had found on our exploratory trip last year. Mature trees in the trench leading to the portal indicated that this excavation was quite old, probably dating back to the late 19th Century when gold prospecting was at its peak. To our group the adit proved very useful in exposing fresh highly sheared (schistose) serpentinite and at the back of the short adit a small pod of rodingite, almost pure grossular garnet. *(photo 4)* But there was no other mineralisation either in the cut or in the dump, so what the prospectors were looking for remains a mystery. It was unlikely to have been gold and had it been chromite they were either unlucky or had taken away every trace of it!

We plodded onwards up the now almost impossibly steep spine of the ridge, spurred on by the sight of several almost black outcrops rearing above the spinifex grass ahead. *(photo 5)* They were so dark it seemed certain that they were chromite. But each in turn proved to be just boulders of dark green serpentinite covered in lichen blackened by countless bushfires.

Through the scattered eucalypt and tortured angophora the views back to the northwest over Chaffey Dam and the surrounding hills were astounding. *(photo 6)* The lake was bordered by a wide expanse of brown mudflat, testimony to the scant rainfall in recent times.

Eventually the flat grassy floor of the saddle just north of Blackfellows Knob was reached, but still with no sign of chromite. Here we fractured into three groups, one staying under the shelter of a copse of angophora totally exhausted, the other two branching off to explore the geology. The group exploring further to the north along the boundary fence to investigate a promising dark outcrop, came back without finding

3. Safely over the fence and on the way up.

4. Small pod of rodingite at end of small adit.

anything of interest. Those who went south to the head of Chrome Gully were thwarted by thick undergrowth and dangerously loose ground on the steep northeastern slope, but were able to find quite a lot of chromite float in the soil. Walking back along the boundary fence to the saddle they came across numerous chromite fragments along what appeared to be the eroded remnants of a rough dray track.

Disheartened, everyone re-assembled at the copse of angophora, selected a comfortable bounder and commiserated over lunch. It had been a beautiful day, not too warm and excellent for bush bashing. But our primary mission had failed. Thinking back, there probably was no actual chromite mine, the prominent surface outcrops of the mineral having simply been broken up and carted away. Over 120 years of erosion had most likely completely obliterated any evidence of what would have been very shallow workings.

On the way back to the vehicles we took a different route, following the prominent ridge leading off to the northwest from Blackfellows Knob. This proved much steeper than the ascent and still with serpentinite scree underfoot. We were now on the southern wall of the valley of Sheep Station Creek and again the views over the surrounding countryside were stunning. Here occurred our only mishap of the day. Elaine attracted the wrath of a rather large ant which, objecting to our intrusion into its territory, took revenge by inflicting a very painful bite to her arm.

Towards the bottom of the ridge we turned to the south, gradually descending to the small floodplain of Chrome Gully and climbing over yet another fence just a few hundred metres from the cars. We relaxed over afternoon tea in the cemetery before returning to camp to prepare for a group dinner at the Peel Inn.

Report by Brian England
Photographs by Ron Evans (1, 2, 3, 6, 7)
Photographs by Brian England (4, 5, 8)

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Liversidge, A. (1888). *Minerals of New South Wales.* Trübner & Co., Ludgate Hill, London, page 107.

Macnevin, A.A. (1974). *Woolomin-Texas Block. Great Serpentine Belt.* In: Markham, N.L. and Basden, H. (Editors). *The mineral deposits of New South Wales*. Department of Mines. Geological Survey of New South Wales.

Wilkinson, C.S. (1886). Appendix C. *Report on the Hanging Rock and Nundle Goldfield.* Annual Report Department of Mines New South Wales for 1885, 135.

5. Up, ever up!

6. Chaffey Dam.

7. Slowly walking down a steep, slippery slope.

8. Specimen of chromite provided by B. England.

Broughton Island
a Day Trip

Leaders: John Hyslop, Brian England.
Date: Saturday 18th April 2015.
Attendance: 22 members.

At 114 hectares, Broughton Island is the second largest offshore island in New South Wales and lies about 3 kilometres offshore from Little Gibba (Dark Point). Lord Howe Island is the largest.

The excursion began at the d"Albora Marinas at Nelsons Bay around 8:45am. From there we were transported to the island by Let's Go adventures in a 22 passenger catamaran manned by a crew of two. En route we passed by Cabbage Tree Island before rounding Looking Glass Island *(photo 1)*, a remnant volcanic cone cut by dramatic fissures and caverns on the southern tip of Broughton Island. It was a warm fine day with high cloud and moderate seas on a 1.5 metre swell during the 50 minute voyage. We were ferried onto the beach at Esmeralda Bay by a rubber dinghy carrying 4 to 6 passengers each time *(photo 2)*.

Morning tea was enjoyed on the large wooden platform above the beach, during which Brian gave a briefing on what we could expect to see geologically. We then climbed up the sandy track past the toilets to level ground and followed the narrow but well-trodden path to the south above and behind the cabins, taking care to avoid the numerous mutton bird burrows which could quite easily cause serious injury.

Reaching a point above the first beach to the south of our landing point in Esmeralda Bay we forced our way down through the dense low vegetation to the shoreline *(photo 3)*. Here we found a vast array of volcanic rocks as rounded cobbles on the beach. It was from this beach that fossickers used to be able to collect thunder eggs, unusual examples of agate typical of silica-rich rhyolitic lavas. These were sawn and polished, then sold at gem shows as far away as Brisbane before collecting was banned by National Parks.

2. The first group being ferried to Esmeralda Bay.

From here it was decided to follow the coastal rock outcrops south in an attempt to discover the geology of that part of the island. But some people thought it looked a bit too rough and opted to return to the sandy ridge-top track that continued south along the peninsula towards Looking Glass Island.

Very little could be found on the geology of Broughton Island prior to our visit and apparently no detailed account of the island's geology has been published. National Parks New South Wales in their plan of management for the island correctly assign the underlying geology to the Myall Syncline, a prominent downfold comprising Carboniferous age (275ma) sandstones, siltstones and mudstones. The Newcastle geological sheet (1962) assigns the outcrops on the island to the Middle Carboniferous Nerong Volcanics, a series of rhyodacite (toscanite), dacite, andesite, ignimbrites, agglomerates, conglomerate, sandstone and siltstone. This is only partially correct, with Little Broughton Island and the eastern side of the main island comprising dark turbidic sediments cut by numerous Paleogene (Tertiary) basaltic dykes. These rock groups are obviously separated by the major northeast trending fault shown on the Newcastle geological sheet.

1. Looking Glass Island. Note the eroded fissure cutting through the island.

3. Forcing our way down a little used track to the beach with a rocky shoreline composed of rhyolitic lavas.

4. Ash/sediment strata dipping to the north.

6. Colourless quartz crystals within a thunder egg.

The Nerong Volcanics include a number of rhyodacite domes and plugs, which remained as prominent hills as erosion cut away the softer sedimentary rocks they intruded when sea level was much lower during the last ice age. When sea level again rose and stabilized around 6000 years ago these volcanic hills were left as offshore islands, including Cabbage Tree and Boondelbah Islands. Two, Yacaaba and Tomaree, have since been tied to the mainland by Pleistocene age sand spits.

Apart from an outcrop of fine white sandstone found on a previous trip on the highest point, the entire island appears to be covered by dune sands supporting low scrubby vegetation, with the only other rocks occurring as very narrow outcrops around the coastline.

Carefully selecting a path over the rough coastal outcrops we were initially confronted by coarse volcanic agglomerate before climbing down onto a second cobble beach composed of the same variety of volcanic rocks as before, but here many of the rhyolite cobbles showed intricate and spectacular flow banding. Beyond that second beach we crossed more coarse agglomerate, then bedded ash/sediment dipping steeply to the north and aligned parallel to the shoreline *(photo 4)*. Further south these rocks gave way to broad domes of flow-banded rhyolitic rocks crowded with small thunder eggs *(photo 5)* in layers aligned with the flow banding. Some of these eggs held central cavities lined by colourless quartz crystals *(photo 6*). Some of the zones of flow banding were indeed spectacular *(photo 7)*. Landward of these rocks lay a small lagoon rimmed by a tiny reedy wetland.

Dragging the group away from these extraordinary outcrops wasn't easy but they eventually continued south to a broad pebbly rock platform exposed by the falling tide. Here at the southern end of the peninsula we came upon the most astonishing volcanic agglomerate, composed of angular blocks of a variety of volcanic rocks embedded in flow-banded layers of ash *(photo 8)*. Some of these blocks reached over a metre across and many showed distinct hydrothermal alteration around their periphery *(photo 9)*. A few hundred metres to the south lay the imposing mass of Looking Glass Island *(photo 10)*, it's exploration on foot sadly thwarted by a deep marine gutter. This island appears to be a rhyodacitic plug and is the probable source of the spectacular agglomerates and rhyolites we had just crossed. The dip in some of the nearby outcrops appeared to conform to the probable slope of the original volcanic cone, but this remains to be confirmed.

Again, the variety of volcanic rocks revealed in the cobbles under our feet was astonishing *(photo 11)*. After an hour or so exploring this area we each found a comfortable boulder to sit on and enjoy a picnic lunch before returning along the coastline to rejoin the track behind the cabins. But before reaching Esmeralda Bay

5. Small thunder eggs with flow-banded rhyolite.

7. Fine convoluted flow-banding.

8. Spectacular outcrop of volcanic agglomerate.

10. Looking Glass Island.

we took a short diversion to Coal Shaft Bay hoping to find access down to the beach and some of the lava caves exposed along that section of the coastline at low tide. However, high cliffs of weathered pale-coloured rhyolite *(photo 12)* denied coastal access. As a bonus along this track we came upon prickly pear cacti bristling with ripe fruit. When the prickles are removed and the fruit split open they are filled with tiny fleshy seeds that can be eaten. But they are an acquired taste unappreciated by some and produce an indelible dark purple stain on anything they come into contact with, so beware!

We arrived back at Esmeralda Bay just as our transport back to Nelsons Bay came into view. We departed at around 3:30pm, speeding past the incredible caves and narrow clefts in Looking Glass Island *(photo 13)*. Similar clefts can be seen around the edge of monolithic Cabbage Tree Island as well as on the seaward side of Yacaaba and Tomaree. Many of these clefts follow faults. Next time we would demand a slower cruise past this spectacular geomorphology.

The seas were much calmer on the return journey so our stomachs could withstand coffee and cake at the Harbourside Café before heading home.

Broughton Island during the Anthropogene.

James Cook sighted the island from the ship Endeavour on 11th May 1770 and mistook it for a headland which he called Black Head. Port Stephens was surveyed by Commander William Broughton aboard HMS Providence in August 1795. "After its insularity was discovered it was renamed Broughton Islands, and so appears on the 1852 Admiralty Chart, Australia, East Coast. Broken Bay to Sugarloaf Point, from a running survey by Captain J. Lort Stokes, HMS Acheron, 1851."

According to the National Parks New South Wales Plan of Management "The area now covered by Myall Lakes National Park was occupied by the Worimi People whose territory extends south to Maitland and the Hunter River, north to Forster-Tuncurry, and as far west as Gloucester."… "The history of the island is colourful with periods of occupation and use including Aboriginal, exploration, commercial and recreational fishing, agriculture, scientific research and conservation. The environmental values of the island were recognized as early as 1862 when the island was reserved as a water and wildlife reserve." …"A settlement was established at Esmeralda Cove, on the southern side of the island, by commercial fishermen of mixed nationalities in the 1920's (EJE Group 2000). Seven huts remain at

9. Hydrothermal alteration around the edges of a clast within the agglomerate.

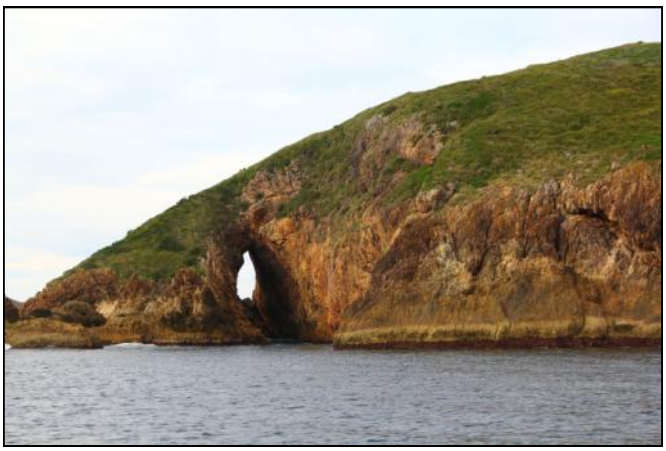
11. Volcanic agglomerate composed of a variety of clasts welded together by volcanic ash.

12. Coal Shaft bay bounded by pale weathered rhyolite. Looking Glass Island can be seen in the distance.

Esmeralda Cove. These have been substantially modified since the 1920s, particularly following severe storm damage in the 1970s. These huts have been the subject of controversy since 1972 when the island was gazetted as part of Myall Lakes National Park."

John Clarke, whose book Broughton Islanders has a particular emphasis on fishing, mentions that in around 1918 the island was settled on a semi-permanent basis by two groups of professional fishermen, Greeks who erected shacks in North Harbour, and a small band of Australians who set up their camp in East Harbour, Esmeralda Cove.

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



13. A weathered cleft on the western edge of Looking Glass Island.

Broughton Island Flora

We only saw about a third of the island on this visit and the overall vegetation was typical of most offshore islands, comprising a mixture of grasses, herbs and stunted shrubs. From photographs taken on previous trips it looks as though the rest of the island is similar.

An interesting feature is the lack of littoral rainforest compared with the amount we saw as we passed by Cabbage Tree Island and from what Barry has seen on Shark Island. His photographs from a previous outing indicated a small stand on the end of Providence Point.

On the walk to near Looking Glass Island we passed a stand of Tuckeroo and on returning noticed a stand of Corkwood, but both stands were relatively small.

An outstanding feature of the island is the amount of weeds including extraordinary amounts of Morning Glory, Prickly Pear, Buffalo Grass and Marram Grass.

During the last hour of the trip Barry turned on his recorder and observed 49 plant species, 15 of which were exotic.

Report by Barry Collier.

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Astronomy Night
An Educational Evening

Presenters: Paul Wickham, Chris Morton.
Date: Friday 1st May 2015.
Attendance: 19 members, 1 visitor.

Our club ventured along a different path for this activity, in a diversion from the usual outings where we traipse around the countryside looking at rocks, we tackled more sedentary pursuits by examining the Solar System. It was noticed from a newspaper article that one of our club members Paul Wickham was conducting an astronomy and stargazing night on the Central Coast. This did not go unnoticed by one of our group who approached Paul to conduct a similar night for the club. Although Paul at first was somewhat hesitant thinking that astronomy would not have much support from rock hounds, he was more than happy to conduct an evening with the emphasis on the formation of the Solar System and the geology of the planets.

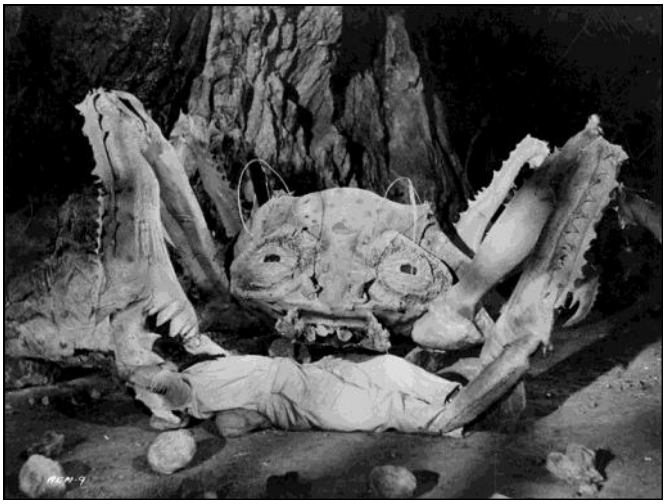
Unfortunately the weather on the night was not conducive to star gazing, as there was a major low-pressure system sitting to the north of us near the NSW/QLD border pushing in dirty weather giving little chance of star gazing, however this would not effect Paul's Power Point presentation. So members congregated at Life Member Ron Evans's home where he generously opened his doors to 20 sodden travelers.

The presentation started with silly myths and slices of old black and white films of space monsters destroying the earth before moving onto the beginning of the Universe 13.8 billion years ago with the expansion of the universe starting from a singular point of extremely high density. The explanation of the scale deep time was also discussed before moving onto the formation of our Solar System 4.56 billion years ago from a Nebular similar to the Crab Nebular. Within this Chris Morton was called upon to present a section on meteorites, comets and asteroids and their relevance to the geology from Carbonaceous Chondrites right through to stony meteorites. This subject proved difficult to compress into twenty minutes the time allowed, as there is so much knew information constantly being posted by scientific web sites like NASA that you could spend the whole evening on this subject alone.

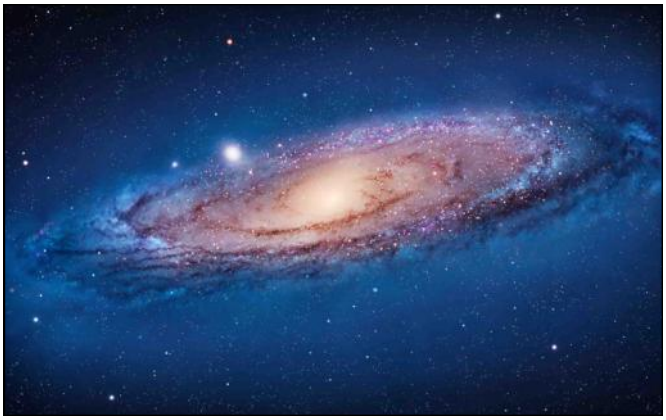
Paul resumed his presentation going onto explain the geology and make up of the planets and the their position in our Solar System, our position in the Milky Way Galaxy and the sheer mass of stars that make up an even more astounding amount of galaxies, and our predicted collision with the Andromeda Galaxy was very enlightening and left us with many questions. An attempt to set up the telescope during the parting of the clouds was thwarted when the clouds quickly reappeared and it started to rain. Paul offered to set up a night in the near future hopefully a fine night to observe some of the many features that adorn our night sky.

Although the weather was the demon on the night this decidedly different event was most enjoyable and educational and was generally accepted that there was a lot more scope for this type of activity. Paul's fears that our members would show little interest were overwhelmingly put aside by the enthusiastic thanks he received at the end.

Report by Chris Morton.



'B' grade movie monster from the 1957 film, Attack of the Crab Monster.



The beautiful Andromeda Galaxy, 2.5 million light years from Earth.

Hardrock Heaven
Cinema Paradiso Ettalong

Leader: Winston Pratt.
Date: Thursday 18th June 2015.
Attendance: 8 members.

In 1979, Jerry Altavilla, a local builder of Italian heritage, had a dream to bring the culture and lifestyle of the Mediterranean Region of Europe to the Central Coast. As no European Markets were in NSW, he began to make his dream a reality.

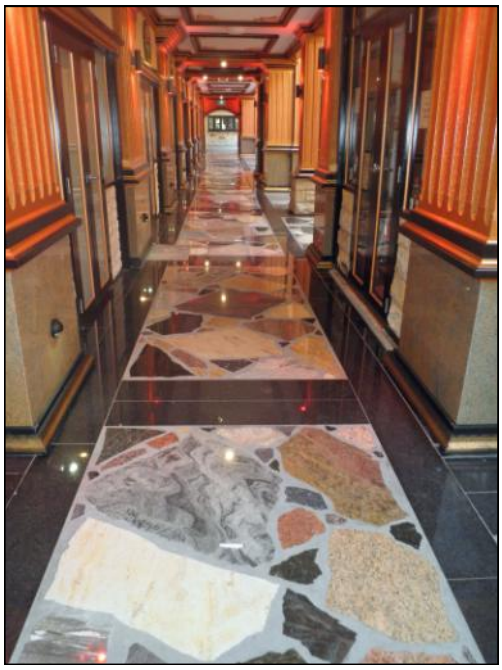
He commenced in 1979 by purchasing a haberdashery shop and divided it into 12 stalls, the beginning of the Ettalong Markets. Over the next three years he purchased and extended into the old ice works, two old houses, and the mini-golf site. Between 1983 and 1989 the acquisition of two more houses enabled the creation of 80 market stalls, piazzas and a stage in two buildings.

The next stage, commencing in 1983 was the development of the Sea Sand motel which expanded to a much larger complex with several restaurants and renamed Motel Paradiso in 1999.

In 1999, Jerry commenced the third stage, Cinema Paradiso, and by 2010 the complex had six theatres and an "Outdoor Screen" which seats 200 for a function or 80 for a movie in summer. The cinema complex regularly conducts film premiers, fundraisers, private hire functions and corporate conferences.

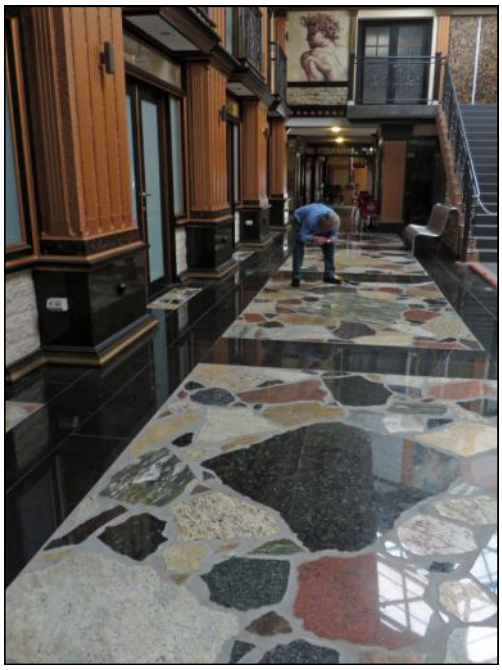
However, the most impressive feature of the complex is the wealth and variety of Southern European art works which adorn the walls throughout the complex and particularly in the cinemas which each has its own particular theme. The Renaissance paintings are the work of artist Simon Sawell *(photo1)*. The complex also has some beautiful sculptures and bass reliefs together with some beautiful leadlight windows many depicting local scenes and wildlife.

1. Cinema Paradiso façade, Ettalong NSW.

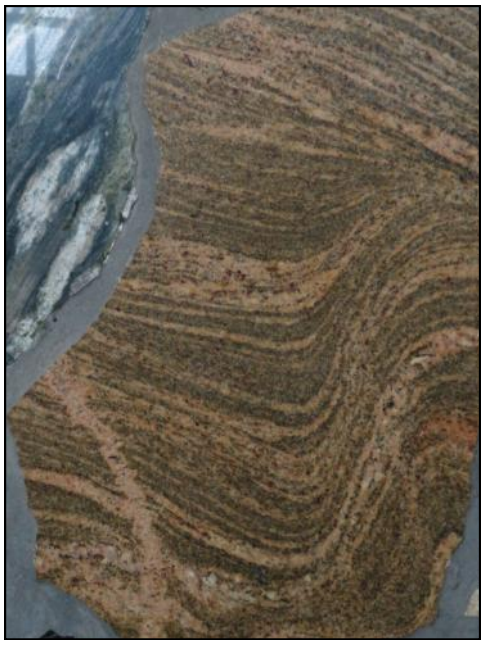


2. Entrance hallway to Paradiso complex.

Being a builder and having a network of contacts in building industry and also in the Italian community both here and overseas, Jerry has been able to obtain a great variety of slabs of polished dimension stone (stone which can be cut to specific dimensions and where suitable highly polished). These slabs have been used, in a 'crazy paving' style in most of the markets area with stunning results *(photo 2)*. There would be few places where such a wide variety of mostly igneous and metamorphic rocks polished so that their textures and details can be seen, and from worldwide locations can be viewed in such a small area.

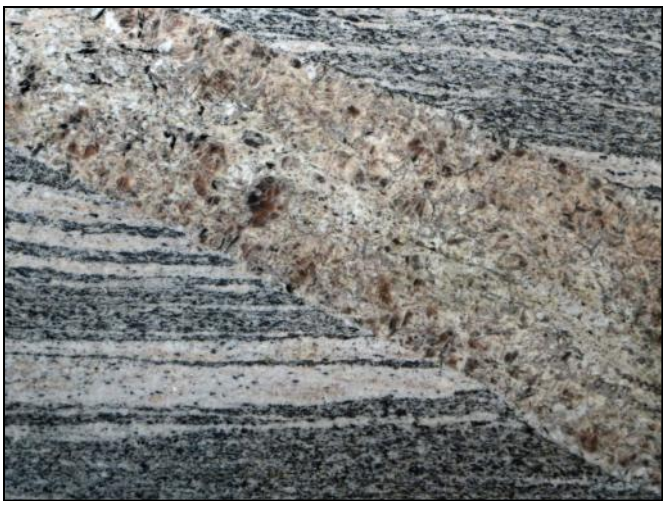


3. Hallway in Paradiso complex composed of a variety of polished rock.

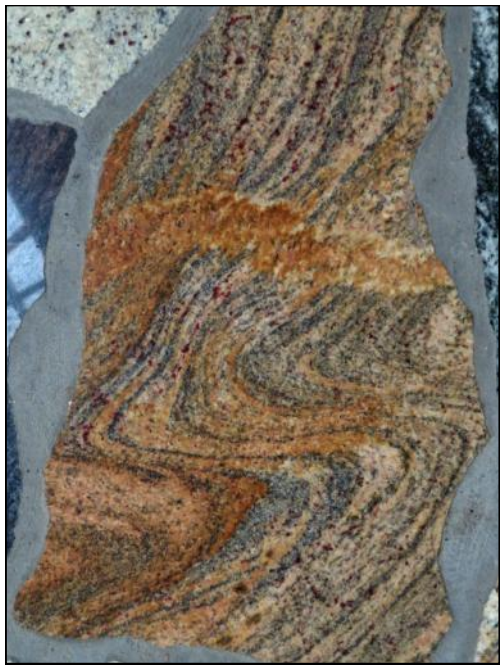


4. Folded gneiss.

5. Folded gneiss.



6. Pegmatite dyke in gneiss.



7. Folded gneiss.

On Thursday 18th June, eight of our club members gathered for a walk through the complex at a time when there were few people about, whereas on the weekends when the markets are operating a detailed viewing of the floors in the passageways would not be possible.

Brian England did a wonderful job in explaining details of many of the examples, much to the appreciation of the group *(photos 4, 5, 6,and 7).*

On leaving the Paradiso Complex the group had lunch at the Ettalong Diggers Club and then went for a walk along the newly constructed sea wall built with blocks of local sandstone, many with liesegang rings adding attractive patterns to the stone. The wall has been necessitated by the significant foreshore erosion in the past 50 years. In 1974 an East Coast Low caused storms, a storm surge and waves which breached the foredune and flooded the street behind. Recent storms have further eroded the foreshore and now necessitated the construction of a further seawall to the north-east.

Report by Winston Pratt.
Photos by Winston Pratt and Brian England.

The Second Great Numbat Mystery Tour

Leader: David Atkinson, Brian England.
Date: Saturday 11th July 2015.
Attendance: 12 members.

An intrepid bunch of 12 explorers assembled at Walka Waterworks and were briefed on the days outing with warnings of snakes and other hideous entrapments that awaited them on this grand tour of the Hunter and Paterson River Valleys.

The first stop on the tour was at the small Oakhampton cemetery. There was much 'tooing' and 'froing' but most found the answers to the 4 questions. Diane Kemp excelled herself by finding the most interesting grave, that of a young Oliver Cromwell. But do not get excited, his surname (Cooper) was obscured by soil.

From there we progressed to the Luskintyre Aviation Flying Museum, then on to the parachute club at Eldersleigh and then to Singleton via some perched river gravel near Glendon Brook.

At Singleton we marveled at their clock in the park and learnt what a Gnomon was but could not use the sundial due to poor light. From here we progressed to Col Fisher Park and took a hike to the river where calcite pseudomorphs of ikaite (glendonites) were seen languishing in the river bank keeping watch over some rather superb GIANT concretions amidst glacial drop stones and other effluvia. All flushed with success we went forth to follow the instructions to go back by the detours and view the massif of Cranky Corner!

Next stop was the Pound Crossing Bridge *(photo 1)* designed by UTS the SLT (Stressed Laminated Timber) construction is a marvel of technology.

From here we progressed to the beautiful St. Anne's Anglican Church at Gresford *(photo 2)*. Of note was the gravestone of Thomas Richardson which was hewn from labradorite. All were successful in answering the questions for this site.

The effluxion *(big word of the Day!)* of time prevented the tour progressing past the Beatty Hotel annex (cafe) at East Gresford where a rebellion was mounted, more cake and coffee ordered and awards demanded (Scores were obscured for border security reasons as we can not discuss operational matters!!)

Numbat Awards were as follows:

Best Results: ie most points scored – Richard and Maree with Leonie and Vic as runners up
Worst results: Col and Gail
Most Inventive Response: Col & Gail
Lost: Vic and Leonie
Totally Lost: Terry and Laurel
Best Geology: Dianne Kemp
Best Built Environment: Laurel
Best Lunch: (and by a country mile!) Dianne Kemp (I reckon somebody made it for her!!) *(photo 3)*

Photographic evidence supplied by Brian England, wonky words by the trip leader.

Report by David Atkinson.

1. Pound Crossing Bridge.

2. St. Anne's Anglican Church, Gresford.

3. Dianne's winning lunch.

Back of Bulga
Geological Tag-along Tour

Leader: Chris Morton.
Date: Saturday 8th August 2015.
Attendance: 19 members, 2 visitors.

The Newcastle area has many geological and historical sites. However our society has visited most if not all of them many times, so finding new and interesting activities in the local area can sometimes be challenging. Especially when you have such an experienced, knowledgeable, well-travelled and eclectic bunch of enquiring minded people. So stepping away from the norm we chose an area that is considered to be 4WD territory, the domain of the weekend warrior. With this in mind we rallied our members who own 4WD vehicles and plunged headlong into the northeastern section of Wollemi National Park. This area, although well-known by many, had never been explored by the Society.

Geology, Landforms, Soil and Catchments

Wollemi National Park lies on the western edge of the Sydney Basin and is covered by four sequences of sedimentary rocks. These are the Permian Coal Measures, the Triassic Narrabeen and Hawkesbury Sandstones and shales, and the Triassic Wianamatta Shales at the top of the series. The strata in this section of the Sydney Basin tilt upwards to the northwest. Erosion has worn away most of the Wianamatta and Hawkesbury series throughout the park to expose the underlying Narrabeen Group rocks.

The Narrabeen Group comprises sandstones and claystones which have given the characteristic dissected landscape of the Park which is dominated by many deep valleys, canyons, waterfalls and cliffs. Erosion by major watercourses over time has resulted in the towering cliffs of the Wolgan, Colo, Capertee and Widden Valleys. Underlying the Narrabeen Group are the Permian Illawarra and Singleton Coal Measures which are visible beneath cliff lines along river valleys such as the Capertee as well as the northern escarpment of Wollemi. These strata weather to rich deep clay loams and form steep vegetated slopes (Schon, 1984).

1. Anastomosing bed of the MacDonald River.

Tertiary (Paleogene) basalts are more common in the northwest of the Park with significant basalt peaks being Nullo Mountain, Kerry Mountain, Mount Coricudgy, Mount Pomany, Mount Coricudgy and Mount Monundilla. In many locations a number of extinct volcanic vents have weathered more rapidly than the surrounding sandstone. Similarly the cores of brecciated igneous rock have eroded to saucer-shaped depressions (eg Gospers and Davis Holes). These features are collectively called diatremes and are important botanical, interpretive and educational sites. Tayan Peak, a remarkable conical and symmetrical mountain near Glen Alice has been identified by Schon (1984) as a significant geological site in New South Wales. This peak provides a rare exposure of a Paleogene volcanic crater and shows well-exposed contact between the volcanic intrusion and surrounding rocks.

Small areas of alluvial deposits occur in the Park. These are more commonly associated with broader developed valleys. A significant example of alluvium occurs as a large outcrop of Quaternary age in the Mellong Swamp area adjoining the Putty Road. This consists of level areas of deep sands and clays with relatively rich soils, dissected by steep sandstone ridges.

Wollemi National Park incorporates and protects a number of relatively undisturbed water catchments. These make significant contributions to maintaining water quality in the Hawkesbury and Goulburn River Systems and to maintaining plant and animal habitat.

Meeting at the NPWS Depot at Bulga on the Putty road at 8 am on a clear 4 degree morning saw some light hearted dissent towards the leader who made it a point to remain aloof from any mutinous calls. The briefing was very brief as most were more interested in the inner warmth of their trusty 4WD steeds. From Bulga we drove south along the very winding Putty Road for 345 minutes to the Commission track that led us up into Wollemi National Park. The road, though rough at times, is typical of most forest roads.

Our first stop was on the bridge that spans the MacDonald River giving us the opportunity to acquaint ourselves with the processes of an anastomosing river system *(photo 1)* similar to, but on a much smaller scale than the river system that delivered the sediments that make up the sandstone country we were about to explore. Some people picked mandarins that were plentiful on the wild trees that had sprung up along the river banks. These were to make jam. From there we followed the transmission lines that run from the Hunter Valley power stations through to the metropolitan power grid.

The clearings beneath the power lines provided a

2. Mt Wareng (L) and Mt Yengo.

4. Cross bedding exposed on weathered sandstone .

great opportunity to view the surrounding countryside. At one particular spot we were confronted with the grand vista of Mount Wareng and Mount Yengo almost side by side *(photo 2)*. The dates of 34Ma for Mount Yengo and 31Ma for Mount Wareng (left) and their very close proximity to each other suggests that they formed from the same igneous source. A study of the rock on these peaks in thin section by two of our members (Ron Evans and David Atkinson) several years ago revealed it to be a teschenite, suggesting that these outcrops represent not a volcanic neck but a sill, as further evidenced by the presence of chilled margins. Teschenite is an analcime dolerite which can only form when the contained volatiles (mainly water) in the magma are trapped, resulting in the formation of the hydrated zeolite analcime as a major component. The rock thin sections also show that some differentiation occurred to produce layers of slightly different rock, again indicating a sill.

The sandstone spur from which we were enjoying this spectacle provided an interesting opportunity for the photographers to capture images not only of the rolling green hills that stretched off into the distance, but also of the many spring wildflowers emerging from their winter dormancy.

The concern was that we were spending too much time here so we moved on, only to stop some 2 to 3 kilometres up the track where there were some interesting weathered sandstone ramparts displaying spectacular honeycomb weathering *(photo 3)* and cross bedding *(photo 4)*. This proved to be another lengthy stop as there was much to photograph and discuss. Moving on much later than planned we ascended a narrow spur where in some places the ground plunged steeply on both sides of the road. Reaching the Hunter Range at Kings Cross we turned left (west) and headed for Sheep Skin Hut, which was to be our lunch stop.

However before lunch could be enjoyed we came upon one of the most interesting sandstone features on the trip. Stopping at the top of a short descent there were huge rectangular sandstone blocks which have separated along vertical joint planes and moved apart due to erosion around their base. This split rock proved too enticing and needed to be explored and photographed *(photo 5)*. The rocks are large enough to support their own ecosystem within the areas they sheltered. Adorning the rocks were native orchids (*Dendrobium speciosum*) swathed in ferns. Further up there were lovely views of the surrounding countryside through the trees. We also found a stand of woody pear.

There was so much to explore but time was our enemy. So reluctantly we returned to the vehicles. We drove 500 metres down the hill to a remarkable weathered sandstone feature that we christened paper wasp cave. The ceiling of this cave had a fair swag of paper wasp nests covering it. Luckily they were not at

3. Honeycomb weathered end of sandstone spur.

5. Large split block of sandstone.

6. Brown ironstone band supporting a sandstone roof.

home! The sandstone here showed many colours, from pink swirls to reddish-brown ironstone bands. Thick tessellated ironstone layers clung to parts of the ceiling. Whether this was the result of lakebed iron precipitation or iron minerals permeating through the rock is open for discussion. Below is more ironstone banding with one section displaying prominent weathered concretions. Directly adjacent to this cave is another cave where the sandstone has weathered away from both sides of a vertical ironstone band to form an arch *(Photo 6)*. Another smaller cave had a pretty pink hue to it. Between paper wasp cave and the split rock on top of the hill were a number of other honeycombed overhangs which also had to be explored *(photo 7)*. On one of the ledges in an overhang a large nest constructed of sticks was observed. Unfortunately it was too far out of reach for good images to be taken of it and we could not say what had constructed the nest. Was it a bird, or as someone suggested the nest of a lesser stick rat? However the major/lesser stick rats are considered to be extinct in New South Wales.

7. Stick-nest in a honeycomb weathered hollow.

8. Lunch beside Sheepskin Hut.

Hunger finally got the better of us, so on to Sheep Skin Hut for a much later lunch than expected *(photo 8)*. The hut is nestled in a steep isolated valley. Being protected from the harsh sun has allowed the gum trees to grow quite tall and the softer plants such as ferns to colonize the large rocks and grasses to flourish, giving it a very pleasant outlook. There is a rough tin shed with a traditional bush fireplace and chimney inside the dwelling plus a tin covered shelter thought to be for saddles and collars for the draught horses, working animals and stock.

Sheep Skin Hut – Historical Overview

Sheep Skin Hut was built by Arthur Halton, son of Neville Halton from Howes Valley in the 1920's and possibly completed by 1927. Jimmy Clark from Bulga owned the land and ran cattle on his large holding of possibly 600 acres. Jimmy assisted Arthur in construction of the hut and the materials were carried in 42 kilometres by packhorse from Howes Valley.

The galvanized iron sheeting used in the huts was initially supplied in 8 foot lengths but the sheets were cut in half so packhorses could carry 4 foot lengths. The huts were used as a camp for cattle musters prior to the 1960's with 2 to 3 visits a year.

The chimney was built from local stone, clay mortar and roofing iron. The ceiling inside was lined by sislecraft, a type of bituminous paper. There was a story of a tiger snake living in the roof at one time. The furniture included four poster iron bedsteads. For many years an old book was used to record visits.

Other facilities included cattle yards, fenced paddocks, a horse paddock of 15-20 acres and other areas fenced with post rail and wire.

Lots 3,4,5, and 6 were purchased by NPWS on 24th September 1982 from H. and B. Harris and reserved as part of Wollemi National Park on 24th December 1982. Various people including NPWS have carried out restoration work on the hut. The site and huts were damaged by motorbike camps in the 1960's.

With so much time used up in exploring, lunch had to be an eat and run affair. Some planned stops had

to be postponed for another time.

From Sheep Skin Hut we had a long drive to a little-known lookout, although there was one more stop along the way. This was at a rock cutting that displays a vertical section through an ancient stream bed. The consecutive sandstone beds here show scour and fill structures along with truncated cross bedding, foreset and topset beds. Although not large it is an excellent interpretive area.

The lookout appears suddenly and would not be present had it not been for clearing of undergrowth beneath power lines. Here were great views extending west to Mount Coricudgy down near Kandos *(photo 9)*. A 20 metre walk to the other side of the road gave stunning views to the north over the Hunter Valley all the way up to Barrington Tops and Mount Royal. Unfortunately the Mount Thorley/Warkworth open cut mine was in the foreground.

The shadows were getting very long and we had one more stop on the way out, plus a very steep hill to negotiate that required very great care. Arriving at California Hut *(photo 10)* with the light fading fast left us little time to do justice to this interesting place. The hut lies adjacent to a basalt diatreme and the site is part of the conservation area comprising Wollemi National Park. It is heavily forested with the surrounding slopes having significant rock outcrops and isolated large sandstone boulders. The area is also continuous with the northeastern extremity of the Greater Blue Mountains World Heritage Area.

California Hut

The history of California Hut and the property known as California, its owners and the hut's former uses are not well documented. Previous owners include the Hayes family from the 19th Century and Alex Mellis in the 1960's. The Rosser family purchased the property in the mid 1960's. The property became part of Wollemi National Park in 1984.

There are minimal views from California Hut as the site is located on the lower slopes of California Creek and is surrounded by higher ridgelines and bordering vegetation.

9. View west over the Wollemi NP towards Mt Coricudgy.

10. California Hut.

Discussion between Christo Aitken and Mark Rosser (1999):

The area was settled in the early 1800's and because of similarities with the topography of the gold fields of the west coast of America was known as California. Old Thomas Hayes, one of the first settlers, unsuccessfully panned for gold in the area. Hayes creek is named after him. The lease of the property passed to the sons of Thomas Hayes. A bark hut was built in the early years a little further up the hill from the existing hut, but was in very poor condition and overgrown when last seen a few years ago. The land was purchased by Donald Rosser (Mark's grandfather) from Alex Mellis in the mid 1960's but the transfer papers are dated 1970. The property had a natural spring, clover and good grazing. The existing hut was built by Donald Rosser possibly in the late 1960's on the original 50 acre block owned by Thomas Hayes, The property was not fenced. The hut was built as a single room. It was timber framed and clad with galvanized iron. It was originally build on the ground and later raised onto the brick piers.

The hut is located within previously cleared sections of California Precinct adjacent to Dry basalt diatreme forest to the east and Narrabeen East-Wollemi sheltered dry forest to the west. The understory to the north and south of California Hut was cleared as a result of grazing. The cleared areas are now regenerating from remnant vegetation and recruitment form adjacent vegetation communities.

The drive to our exit point was no less interesting than the rest of the day. The track follows a creek down the mountain that runs through a gallery rainforest *(photo 11)*. The white bark of the tall majestic mountain gums that lined the track guided us through an ever-narrowing track with low shrubbery crowding in on us. Eventually we arrived at the top of the last hill. For the inexperienced, looking down the track was quite daunting, as it is very precipitous with large deep rollovers that shed water off the track to stop erosion *(photo 12)*. After some cautious advice on how to tackle the descent, everyone made it to the bottom without incident, even though it looked quite fearsome in the fading light.

11. Majestic Blue Gums growing beside a creek .

Congregating at the exit gate of the park we chatted briefly about the day and bid farewell to those who were going on home. Others had accepted Jorge and Tanya's invitation to join them in a barbecue at their home which is only a kilometres from where the trip finished. This proved most enjoyable, especially for those who had travelled from the Central Coast, a 2 hour rive away. The invitation also included a bed if you wished, which was gratefully accepted by some. Even though individuals brought their own food and drink, Jorge had made Gluehwein to ward off the cold and a very nice homemade vintage from his own grapes. This along with their beautiful home and the lush green forest in the atrium topped off a very full but most enjoyable day. Thanks to Jorge and Tanya for your hospitality.

Report by Chris Morton with advice from Brian England
Photographs by Ron Evans and Brian England

12. The steep track down is straight as it follows a creek that formed after faulting. Water ran down the hill following the fault line to form the creek.

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National Parks and Wildlife Service.

Wollemi National Park Plan of Management.

Alum Mountain Bulahdelah

Leader: Ron Evans and Brian England.
Date: Saturday 19th September 2015.
Attendance: 16 members, 4 visitors.

Introduction

Alum Mountain Bulahdelah

Alum Mountain is the only known alunite deposit and source of mineral potassium (potash) in NSW.

Alunite or alumstone is a hydrated sulphate of potassium and aluminium, $KAl_3(SO_4)_2(OH)_6$. .

The mineral occurs in commercial grades in thin sheets along the upper crest of the Alum Mountain range. Its ore was quarried from faces where the alunite was formed between layers of volcanic rock. The rock strata in Alum Mountain are standing at about 85° as it is situated along the western limb of the Myall syncline.

The deposits at Alum Mountain are considered the largest in the southern hemisphere, and the largest above ground deposits in the world. It was also the first and only alunite deposit commercially exploited in the 19th century. Mined from 1878 to 1952, this was the longest time period for commercial extraction of potassium minerals in Australia.

Uses for alum include as a source of potassium for fertilisers, manufacture of detergents, soap, glass, ceramics, fireworks and matches, in tanning, and in metallurgical processes. The bulk of the alunite quarried from Alum Mountain was used in the textile industry in Manchester England where the alum was used as a mordant to fix dyes.

Geology of Alum Mountain

Alum Mountain lies on the steep eastern limb of the Myall Syncline within the Tamworth Belt. The syncline formed in the Mid to Late Permian during deformation of the New England fold Belt. The spine of Alum Mountain comprises a section through the 530m thick Early Permian Alum Mountain Volcanics (ranging in age from 296 to 280Ma) which comprise the Markwell Coal Measures, Lakes Road Rhyolite, Burdekins Gap Basalt and Sams Hill Rhyolite as the basal unit. It is the Sams Road Rhyolite (ignimbrite, crystal tuff, and breccias) which hosts the alunite deposits as lenses to 30 x 20 x 10 metres aligned parallel to bedding. The deposits formed contemporaneously with the extrusion of the Mount Alum Volcanics by advanced argillic hydrothermal alteration of the rhyolite at temperatures of less than 240°C under strongly acid conditions produced by the exsolution of H_2S and CO_2 from hydrothermal fluids from a magmatic source ascending steep fractures which intersected horizontal reactive zones of high porosity resulting in extensive lateral alteration comprising zones of alunite/kaolinite and dense massive kaolinite. Areas of intense silicification are associated with the alunite lenses (Jenkins and Nethery, 1992).

In 2007, during construction of the Bulahdelah Bypass, a 9 tonne block of alunite was recovered and retained by the Bulahdelah Historical Society. With the support of the local Worimi People they offered to donate the block to the National Rock Garden in Canberra. It will soon be transported there following a grant from the National Cultural Heritage Account (NCHA) (Pillans, 2015)

Mining at Alum Mountain.

Once ore was found (the best grades were mainly pink and white in colour) explosives were used to remove overburden and break up the rock. The alunite was then hand tooled into manageable pieces and packed into small horse drawn trolley carts.

The stone was then taken to the factory at the foot of the mountain using the inclined tramway (on a 30° slope) where loaded carts were sent down the steep line whilst it pulled up an empty cart. The stone was then either exported to England via the Myall River or manufactured into alum in the factory at the foot of the mountain.

The following process were involved:

a) Crushing and heating in a kiln to dehydrate and drive off sulphur dioxide.
b) Treated with weak sulphuric acid in lead lined tanks heated to boiling with steam jets.
c) Allowed to settle in the same tank before the clear solution was run off into crystallising tanks.
d) Cooling solution with constant agitation while alum crystallises out leaving sulphate of alumina in solution.
e) Collecting, washing and refining, recrystallising, crushing and packaging.

History of Mining at Alum Mountain

Phase 1: 1876-1926.

1876: Bulahdelah local John Cassidy found white alunite powder in a burnt out stump hole after a bushfire on Alum Mountain. After testing, it was found to be high-grade alum.

1878: Runcorn Alunite Company was formed and mining commenced. The ore was taken to the Myall River for transport to Hawkes Nest where it was exported via Sydney as ballast to Runcorn in England. It was used mainly in the textile industry (as a mordant-dye fixing agent) in the Manchester region.

1888: The Australian Alum Company took out

mining leases in November and injected considerable capital investment into the venture. The company started processing lower grade alunite on site while exporting the higher-grade ore to England.

1893: Alum manufacture for the domestic market ceased due to low demand. Export of ore continued and the company set up processing plants at the Runcorn end of the supply chain.

Late **1880's** to early **1890's**: Major infrastructure was established in Bulahdelah including horse-drawn tramways, tramway incline track, dumps, a dam, storage bins and a wharf on the Myall River.

Early **1990's**: The tramway was extended from the base of the incline trolley track down Church Street to the Myall River wharf.

1902: Maximum production of alunite with the highest annual production being 3,644 tons.

1910: Mining was hindered by difficulty in finding enough good grade ore to maintain production.

1914-1918: During World War I, difficulties in securing freight services resulted in low levels of production.

1926: Mining ceased. During the first phase of mining, 57,619 tons of alunite worth £207,726 ($447,902) was produced. This equates to an annual production of 1,600 tons with an average value of £5,770 ($12,441).

Phase 2: 1933-1952.

1933: The mine was sold to the Australian Alunite Syndicate (Alunite Ltd.)

1934: Some refurbishment of the mine infrastructure occurred and mining began aimed at the local market for artificial fertilisers.

1952: Rising freight costs made the mine uneconomical and it closed. During this second phase of mining, 9,852 tons of alunite was produced valued at £24.000 ($52,290), giving an annual production of 657 tons with an average worth of £1,601 (3,488).

The indirect economic importance of the mine was considerable because of the accessibility to steamer transport via the Myall River to processing sites in England or Melbourne. Mining was also a key financial investment in Bulahdelah along with the timber industry at the time. Despite this, the mine was a relatively small employer. In 1880, 20 men were employed, and by 1899, 11 men. By the 1940's employment had dropped to 4 or 5 men.

Alum Mountain, Bulahdelah, N.S.W.

A short story by Ted Baker.

Near the village of Bulahdelah 44 miles north north-west of Newcastle, lenticular to pipe-like masses of alunitec rock occur in a narrow range of hills consisting of sediments interbedded in rhyolite in their general strike and dip the alunitic masses are parallel to the meridional jointing of the range. Alunite was mined from 1878 to 1927, then again from 1934 to 1950, output about 72,165 tons. The maximum annual production was 3,644 tons in the year 1902. The mine closed down in 1952.

In mid 1952 Alunite (Aust.) Pty. Ltd., the only producer, ceased supplying the parent company, Sulphates Ltd., because of rising freight charges to Victoria There has been no production in recent years.

The natural phenomenon that is the Alum Mountain is the only known alunite deposit of potassium bearing minerals in N.S.W. The mountain is a mass of altered rock, possibly Trachyte or Rhyolite with associated sediments, some 900 ft. high and 3 miles long. It was first mined in 1878 when the Runcorn Alunite Company was formed.

The Runcorn Alunite Company mined from the centre of the rock face until 1883-84. All treatment was carried out at the mine; a railway line was built from the mine to the wharf where the treated alunite was taken by water to Windywopper where it was used as ballast in boats returning to England.

A new mining company was formed in 1888 and formed the 'Big Quarry' on the other side of the small mountain; this was worked until 1910 then being sold to the 'Australian Alunite Company' with its head office in Melbourne.

In 1908, Kimberly Quarry collapsed killing two, Charles Keel and Crocford.

The Ladysmith and Kimberly Quarries appear to be worked out as far as high-grade material is concerned, but there remains a quantity of lower grade ore, in the southern face of the small quarry at the back of the mountain. Irregular patches of pink coloured alunite are exposed and a fair extent of similar material is still below the floor.

The most extensive work on the mountain has been carried out at the Tunnel Quarry; it was worked underfoot to a depth of 30 to 40 ft. before a tunnel was driven below the floor to facilitate removal of the ore.

Prospecting work from the tunnel revealed two alunite bodies at a depth of 51 ft. below the floor, apparently some 1,200 tons of alunite were won from here and when mining ceased it was considered that there was a reserve of 5,000 tons available.

Alunite deposits have been worked in five major quarries and a number of smaller ones, there appears to be some confusion as to the naming of the various quarries and the names by which they are known locally have been adopted.

Big quarry: on the northern end of the mountain, and to the eastern side of the small mountain.

Ladysmith: on the western face at the northern end just past the incline line and past the boiler.

Kimberley: on the western face almost above the boiler and just south if it, with the tram line a little

further down, and south of the *Tunnel quarry:* This quarry is seen at the end of a double cutting going towards the central face of the mountain also on the western side, at the end of the vehicle road. A small tunnel enters the quarry. Through this tunnel one passes through a section of conglomerate rock before coming to the quarry face showing pink alunite.

Working along the old tramline to the south there are a number of un-named quarries, Myall quarry is to the left of the loop in the traffic road. The tramline goes on the end of the mountain escarpment overlooking the Myall River, where a tunnel and cuttings were worked.

Alunite is utilized mainly in the production of potassium sulphate fertilizer and of potash alum. Potash alum is used in the purification and filtration of water in the manufacture of paper and as a mordant in dyeing.

Alunite has been mined at Bulahdelah N.S.W. (formerly by underground methods, but in recent years by open-cut mining). Sulphates Ltd. in Melbourne used the alunite for the production of potash alum, which was distributed directly by the company and also through wholesale chemical firms.

The Outing

Participants met in the newly refurbished Bulahdelah Mountain Park *(photo 1)* at 9:00 am for morning tea followed by a background briefing on the activity by Ron and Brian.

Since the Bulahdelah bypass has been constructed, road access to the mining area has been closed meaning an uphill walk to the walking tracks through the abandoned mining area.

We then set off up the road, slippery in places, until we reached the now disused car park next to the mountain top trails after some 30 minutes of walking. Recent rain had refreshed the surrounding forest, which was quite beautiful in the morning light. Magnificent grass trees grew next to the walking tracks *(photo 2).*

Adjacent to the Carpark was a track leading to the Tunnel Quarry *(photo 3),* which followed the path of a tramline used to remove the mined ore. The area is overgrown, but one can get a sense of the difficult conditions miners worked in *(photo 4).*

The group then walked north towards the Big Quarry and Mountain Lookout that provide a wonderful view west over Bulahdelah. The track passed huge slabs of almost vertically folded rock on the way to the lookout *(photo 5).* Approaching the Big Quarry, a magnificent yellow specimen of a climbing orchid (*Erythrorchis cassythoides)* was found climbing up the burnt bark of a eucalyptus tree *(photo 6).*

On reaching Mountain Lookout (200m above sea level), we all admired the view over Bulahdelah and the surrounding countryside *(photo 7).*

After returning to the Carpark area (now a picnic area) we continued south following the abandoned tramway until, after a steep climb, we reached the Ted Baker Lookout for views south over the Myall River. Many rock orchids were in flower around the lookout, but were difficult to get close to as they were growing up on large blocks of rock.

Because time was getting away, we walked back down the road to Mountain park where we all enjoyed lunch and a cupper. Ian and Sue sprung a surprise on Ellen by providing a birthday cake (it was her birthday) and we all sang happy birthday after the obligatory candle blowing out and cake cutting ceremony *(photo 8).* All in all, a wonderful walk full of history and beautiful scenery. Thanks to Brian for his assistance.

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

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Signage in the new Bulahdelah (Alum) Mountain Park.

1. Refurbished Bulahdelah Mountain Park.

4. Remnants of the Tunnel quarry.

2. Grass trees growing beside the walking track .

5. Rhyolite, folded to be almost vertical.

3. Path of the abandoned rail tracks leading to the Tunnel quarry.

6. Climbing orchid.

7. Bulahdelah township viewed from Mountain Lookout situated on the northern end of Alum Mountain.

8. Ellen with her surprise birthday cake.

Dadoxylon stump at Ghosties Beach

Ghosties Beach Walk

Leader: Barry Collier.
Date: Thursday 26th September 2015.
Attendance: 17 members.

As Ron was unavailable to lead the planned November activity to Dark Point, I suggested an outing to Ghosties Beach on the lowest tide in November, the afternoon of Thursday 26th.

South of Catherine Hill Bay between the main Catherine Hill headland and Snapper Point lies a long series of sandy beaches. Half way along this stretch of coastline is Flat Rock Island/Point. To the north of this is Moony Beach and to the south Ghosties Beach.

At Ghosties Beach there is a rock platform exposed at low tide that contains numerous fossil tree stumps of the species *Dadoxylon* preserved in situ *(see photo bottom left)*. This is probably the same fossil forest horizon observed by Sussmilch (1922) below the Great Northern seam at Moon Island and in the old Government Quarry at Swansea. In this case, the host rock is Awaba Tuff in the Moon Island Beach sub-group at the top of the Newcastle Coal Measures.

Unfortunately, the tree stumps at Ghosties can only be observed during a very low tide, and for most of the time they are covered with sand.

There was tremendous beach erosion caused by the April 2015 storm and with so many high, southerly swells during winter, erosion actually got worse.

As it turned out the day chosen for the excursion was too late and although the beach erosion was still severe at higher levels, sand had started to come back at lower levels, so we were only able to see 5 fossil stumps. The temperature at Norah Head reached 39°C, so it was also not the most comfortable day for a 2km walk.

I had considered a detour on the return to the spectacular cave at DeSoto Inlet, but the sea was too big to safely take a large group around that section of the rock platform.

In spite of the conditions on the day, 17 people turned up for the activity. A small number only went as far as Flat Rock Island, while the rest had a quick look at the fossils and then headed off to the cave at the end of Ghosties Beach. It was really pleasant in the cave and we spent more time than expected there, before heading back to the cars and the Catherine Hill Pub.

Report by Barry Collier.
Photograph by Barry Collier.

Reference:

SUSSMILCH, C.A. (1922). *An Introduction to the Geology of New South Wales.* Angus and Robertson, Sydney.

Canberra, Cowra and Bathurst Geological Safari 2015

Thursday 8th October to Thursday 29th October 2015

Leaders: Sue Rogers, Brian England and Winston Pratt.

Attendance: Up to 29 members.

Date: Thursday 8th October to Thursday 29th October 2015.

This was a closer to home annual safari that gave members the option of attending for the whole three weeks or just for selected days, but most attended for the full three weeks.

1. The Cotter Dam wall from the viewing platform.

Thursday 8th October

Everyone made his or her own way to Eaglehawk Holiday Park at Sutton just outside the border into the ACT. New members, Ros and Shayne, were welcomed at a happy hour/information session at 5:30pm held in the enclosed camp kitchen. Singing 'Happy Birthday to Joan' and sharing a double sponge birthday cake concluded the session. It was a cool day and most of the women found the cold showers in the amenities unbearable. Despite numerous complaints about the lack of hot water in the ladies showers, it was not fixed during our stay so some women resorted to using the Men's showers, supervised by their husbands.

Friday 9th October

Leaving at 8:30am the group headed south-west to the Avenues Picnic area at the base of the Cotter Dam wall off Cotter Road. The dam is located in a valley eroded through volcanic rocks of the Silurian Walker Volcanics Formation (430Ma). The dam abutments and rock foundation comprise porphyritic rhyolitic ignimbrite, which shows a well-developed network of close-spaced intersecting fractures. These may have been an advantage, with the pressure of the dam wall and contained water acting to lock them in place like a three dimensional jigsaw puzzle.

The pure water of the Cotter River (a tributary of the Murrumbidgee River) is an important reason for why this area was selected as the site of Australia's national capital. The Cotter Dam was built between 1912 and 1916 before work started on Canberra so that early residents could have a water supply. The original wall height was 18.3 metres and was raised to 26.8 metres in 1951. After years of drought the dam was enlarged in 2012 with the current wall being 80 metres high and located 100 metres downstream from the original dam wall. The group strolled along the informative discovery trail that explained Canberra's water history, and provided a 16 metre wide viewing platform for photos of the dam wall, the trout hatchery and the pretty environment *(photo 1)*. A bus load of primary school children arrived at the Park and were allowed to play in the river. It was great to see the young enjoying the great outdoors.

The next stop was the Deep Space Communication complex at Tidbinbilla. The complex is one of only three tracking facilities in the world responsible for providing vital two-way radio contact with dozens of unmanned, robotic spacecraft that explore space. After an enjoyable morning tea on the Moon Rock Cafe's balcony overlooking the massive 64-metre wide dish-like antenna called Deep Space Station 43-DSS43, the group inspected the visitor's centre. An alarm sounded that signified that the DSS43 was going to move. It changed to a near horizontal position within a few minutes *(photos 2 & 3)*. Apart from the DSS43, a piece of moon rock that was collected by Buzz Aldrin and Neil Armstrong during the July 1969 Apollo XI moon landing was the subject of many photos. The rock is over 3.8 billion years old. Also on display were rockets, space probes, satellites, a full-scale replica of the Mars Exploration rover and astronaut food and spacesuits.

The convoy then drove south through Tharwa to Namadgi NP and stopped at the visitors centre to complete the short woodlands walk *(photo 4)*. The walk included stopping at "Gudgenby in a box" interpretive shelter, the original slab hut facade built at Gudgenby

2 and 3. The Deep Space Station 43 (DSS43) before and after it moved.

Station in 1845 and now a tribute to early European pastoral heritage. Lunch was partaken at the picnic table before gazing at the various displays inside the Namadgi visitor's centre.

The next stop was the Booroomba Rocks walk car park off Apollo Road. Most members completed the 2.5km return walk through tall forests that led to extensive outcrops of leucogranite (light coloured granite with predominate muscovite and subordinate biotite or amphibole) and tremendous views across the valley below. The granitic intrusions formed during the late Silurian Period (435-425 million years ago) and are collectively called the Murrumbidgee Batholith *(photos 5 & 6)*.

After driving a short distance the group parked at the Honeysuckle Creek picnic area to wander around the old tracking station *(photo 7)*. The tracking station was set up in 1966 to support NASA's Apollo space program and SkyLab program. It was responsible for conveying the first pictures of man walking on the moon to the rest of the world in July 1969. In 1974 the station was converted to enable it to support Voyager and Pioneer missions to outer planets. It was shut down in 1981 and the 26 metre dish was relocated to Tidbinbilla Deep Space Tracking Centre. Some members stayed to have afternoon tea at the camping ground while others made use of the toilet facilities and headed back to camp.

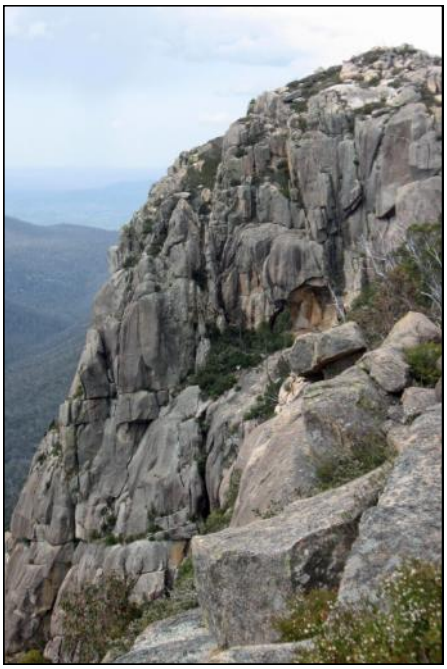
On the return journey to Eaglehawk most traversed over very wet roads where the storm that had threatened us most of the day had hit. It was amazing that it did not pour while the group were walking and that only light rain on the return journey was encountered. However around dinner time, the whole Eaglehawk area was without power and the group members who had dinner in the nearby restaurant completed their meal by candlelight.

Saturday 10th October

It rained during the night and our power was restored sometime after midnight. The itinerary was a free day to visit some of the many attractions our capital has on offer. Some visited Floriade, others investigated

4. Waterhole on the woodlands walk.

5. Group at Booroomba Rocks.



6. Cliff line at Booroomba Rocks.

some of the many museums, others visited friends and relatives. We could not find suitable parking at Floriade so went to the Botanical Gardens were we had lunch at the Floresco Cafe and strolled through all the spring blooms. The range of Australian natives in the gardens is spectacular as was the special display of art work made from pieces of wood *(photo 8)*. Lizards were found in many gardens and many different birds were sighted. The gardens contain over 6,300 species of native flora within it 35 hectares and is the only place in the world where you can see this diversity of Australian native plants in one location. The majority of the plants are linked to a herbarium specimen and recorded in a database, which provides accurate and accessible information to researchers. The National Seed Bank conserves seeds whilst the nursery staff propagates many rare and threatened species to supplement wild populations *(photo 9)*.

Sunday 11th October

The convoy left the van park at 8:30 and travelled

8. Example of wooden art work.

to Molonglo Gorge adjacent to the Kowen Pine Forest near Queanbeyan. The area comprises turbidites of the Ordovician Adaminaby Beds (Pittman Formation) around 5 kilometres thick deposited by mass flows down the continental slope into deep marine water. The source of the sediments was the elevated regions around Broken Hill, Antarctica and along the Macquarie Volcanic Arc that had evolved through central NSW. Down cutting of the Molonglo River kept pace with the tectonic uplift of the Cullarin horst block during the Late Miocene to Early Pliocene (10-5Ma). The block is bound on the western side by the Queanbeyan Fault and on the east by the Lake George Fault. A modern analogy can be found in the sediment now pouring out of the Amazon River and down the continental slope onto the floor of the Atlantic Ocean. (Branagan and Packham, 2000)

The different groups of plants that grow in the gorge are a result of microclimatic differences. The walking group came close to completing the 6.5 kilometre return walk to Blue Tiles picnic area. The trail followed the Molonglo River offering spectacular views of the gorge *(photo 10)*. In some places, the turbidites show spectacular folding. On the hillsides were eucalypts, acacia and black cypress pines, ferns and a range of wildflowers including paper daisies that were just opening.

After a late morning tea the group drove to

7. Members reading the history of the tracking station.

9. White Waratah.

10. Molonglo Gorge walking track

Foxlow Bridge *(photo 11)* just off the Captain's Flat road. This old wooden bridge has restricted use now being designed for horses and cart and not modern day transport. Close by was an outcrop of Kohinoor Volcanics, a component of the Hoskinson Group of rocks that are host to the ore bodies found further south.

The bounding faults, the Narongo fault to the west and the Ballallaba fault to the east were evident as the Captain's Flat rift valley narrows. The topography became more rugged and elevated as we approached the old mining village of Captain's Flat. The area lies in the 10 kilometre wide Captains Flat Rift, a fault-bound submarine trough bound in the west by sub-parallel faults running north-south, including the Lake George Fault. The eastern boundary is the Ballallaba Fault which follows the densely wooded ridge on the far side of town and continues north under Lake George. The area lay in a forearc setting off the coast of Gondwana. The volcanic and sedimentary rocks within the rift are Middle Silurian and are known collectively as the

12. Bar at Captain's Flat Hotel.

Hoskinson Group (426-420Ma). The underlying Kohinoor Volcanics comprise an 800m thick sequence of ignimbrites, rhyolites and andesitic tuff. They host the stratabound volcanogenic massive sulphide (VMS) orebodies of the Lake George mine which are wholly enclosed within the host strata on the western limb of a north-plunging synclinorium. The ores comprise layered masses of galena, chalcopyrite, sphalerite and pyrite deposited by hydrothermal vents on the sea floor rift over a period of 6-10Ma (418-408Ma) during the active volcanic phase of the rift's history in the Late Silurian and Early Devonian (Finlayson, 2008).

The town's name is believed to have come from a lazy white bullock called 'Captain' who grazed at the 'Flat' to escape work. The group had a late lunch in Wilkins Park, which is named after Mine Operations Manager, Bert Wilkins and was proclaimed a recreation ground in 1893. The group walked up the main street in search of a coffee. The cafe was closed but the hotel, which has the longest bar in the Southern Hemisphere, provided suitable coffee which we consumed within the 1940's style décor *(photo 12)*. The local legend has it that the bar taps are never turned off, as there is no time to turn them back on!

We then drove up Miners Road to view the remains of Lake George mine *(photo 13)* and then the gantry crane, weighbridge, railway goods shed and lookout. Gold, lead, silver and vast quantities of copper

11. Foxlow Bridge.

13. Entrance to Lake George mine.

were mined from the mid 1800's to the mid 1900's. The population of the town grew from 50 in 1885 to 5,000 at the peak of the mining. Between 11th January 1939 and 11th March 1962 the Lake George mine produced 4,009,796 tonnes of ore containing 360,104.3 tonnes lead, 154.59 tonnes of silver, 2,850.06 tonnes of gold, 72,615 tonnes of copper, 588,143.6 tonnes of zinc and 501,358.5 tonnes of pyrite (from explanatory notice at the mine site).

We spotted the remains of the Bungendore - Captains Flat Railway line that was closed on 1/9/1968. A year later it was re-opened for the making of Ned Kelly (Mick Jagger) by Ajax Films.

Monday 12th October

The group left at 8:30 again and headed north-west out of Canberra along the Barton highway stopping to pick up Dr. Alex Ritchie, Palaeontologist of the Australian Museum from 1968 until 1995 and then Palaeontologist at the Age of Fishes Museum, from the National Dinosaur Museum at Gold Creek. We turned off the Barton to travel towards Yass and then travelled via some beautiful rural scenery south to Wee Jasper. Everyone was taken with the views of the Devonian period limestone at Taemas Bridge *(photo 14)* so we had an unscheduled stop. This caused us to arrive 10 minutes late for the pre-arranged 10:30am Careys Cave tour but the guide, Geoff, was not surprised *(photos 15 & 16)*. He was use to grey headed nomads enjoying the scenery.

Geoff gave an entertaining cave tour, which was much longer than anticipated. We started outside the cave entrance surrounded by rillenkarren weathering limestone outcrops. This is caused by rain water falling on the upper edge of a rock and then dribbling down the side. As more rain falls upon the rock the drops continue to run down the rock using the same path. Each drop of rain dissolves a little more of the rock. Over a long period of time the drops dissolve a series of grooves down the rock. The cave inside was compact and displayed beautiful sculptured rock chambers, and a wealth of calcite formations including exceptional examples of moonmilk. Careys Cave was discovered in the 1800s, but was not developed for guided tours until 1968. It was formed primarily below the water table (phreatic development), as opposed to a stream-cut cave like Abercrombie Caves. The near flat floor made it easy to traverse. It contained virtually everything that one can see in a cave and all in the one small area. It was one o'clock when we exited. After lunch at the picnic area, Geoff provided a number of fossils to study and Brian gave a talk on the geology of the area.

The predominantly sedimentary rocks at Wee Jasper have been folded significantly. The Wee Jasper Valley is cut into the western arm of a huge synclinal fold; the complex folding of the limestone is clearly visible *(photo 17)* in extensive rock exposures, which are obvious when entering and leaving the valley. Two different types of limestone, the Taemas Limestone, overlying non-carbonate rock units, and Cavan Limestone are found in the Wee Jasper area. Both of these formed about 400-415 million years ago in the Devonian period, when they were laid down in shallow marine waters populated by species of lungfish, predatory fish and an abundance of trilobites (extinct arthropods) and molluscs. Some of the world's most significant and best preserved Devonian fossils have come from the Wee Jasper limestones.

The return trip involved a second stopping at the Taemas Bridge for more photos before heading along the scenic Mountain Creek road. The road traversed parts of the Canberra Rift (mostly Silurian) and the Goodradigbee Rift (mostly Devonian). Associated with the volcanics of the rifts are shallow water sedimentary sequences including the Taemas limestone and Cavan Bluff Limestone.

The route went through Uriarra Volcanics (Laidlaw Volcanic Suite) near Fairlight and Walker Volcanics (Hawkins Volcanic Suite) at the Uriarra Crossing over the Murrumbidgee River. Stops were made to view mud cracks and to take more photos *(photo 18)*.

Back at camp Brian gave brief overview of the geology of the Canberra region. The area lies within the Eastern Lachlan Orogen (Fold Belt) which once lay on the trench/ocean (forearc) side of a volcanic island arc. Most of the rocks in the region are Early to Middle

14. Taemas Bridge.

15. Guide Geoff outside Careys Cave .

16. Group at Carey's Cave Wee Jasper.

18. Uriarra Crossing over the Murrumbidgee River.

Paleozoic (Ordovician to Devonian) 488-359Ma. The region comprises a series of north-south trending rifts and uplifts caused by east-west crustal extension during the Tabberabberan Tectonic Cycle. These begin in the west with the Goodradigbee Rift centred on Wee Jasper, infilled by the Mountain Creek Volcanics and bound by the north-south Tantangara and Cotter Faults. Then came the Cotter Uplift, followed by the Canberra Rift infilled by the Hawkins, Laidlaw and Colinton Volcanics and bound by the Murrumbidgee and Queanbeyan Faults. The Cullarin Uplift bound by the Queanbeyan and Narongo Faults follows this. Finally in the eastern part lies the Captains Flat Rift hosting the Kohinoor Volcanics and associated VMS deposits of the Lake George mine (Finlayson, 2008). Between the Cotter and Murrumbidgee Faults lies the huge granite mass of the Murrumbidgee Batholith (435-425Ma), also intruded during the Tabberabberan.

While the earlier Benambran Tectonic Cycle (490-430Ma) established the foundation of the continental crust around Canberra it was the subsequent Tabberabberan Cycle, which left the most profound legacy for the development of the present landscapes.

The City of Canberra was built within the Canberra Rift, now a low-lying north-south structural feature formed during crustal extension in the Silurian (428-422Ma). Large volumes of volcanic rocks were erupted into a shallow marine environment on the eastern margin of Gondwana.

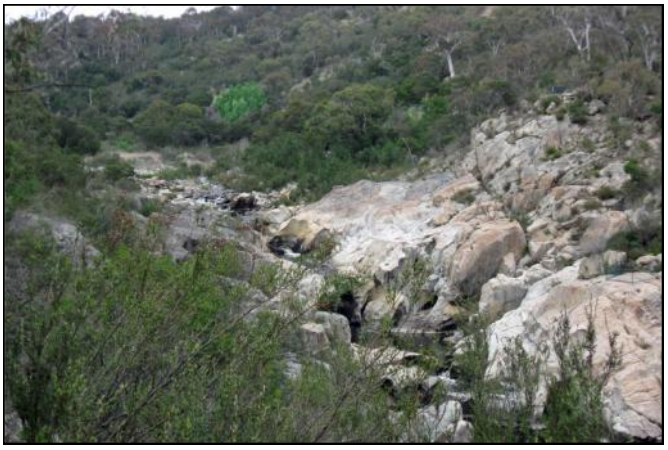
17. Cavan Bluff Limestone near Wee Jasper.

There are no rocks in the Canberra region dated between Middle Devonian (394Ma) and Middle Cenozoic (20Ma) indicating a time gap (hiatus) of 374Ma. This is due to the Middle Carboniferous ice sheets formed when the region lay close to the South Pole and resembled present-day Antarctica. It was also the time of the Hunter-Bowen Orogeny. By 270Ma the ice had begun to melt as Australia drifted north, sea level rose and so did the land surface (due to unloading) in the Eastern Lachlan Orogen to become an elevated highland. This led to rapid erosion resulting in between 2 and 2.4 kilometres of denudation in the Late Permian to Early Triassic. Most of this sediment ended up in the Sydney Basin. There was a further 2 to 2.5 kilometres removed in the Late Cretaceous.

Tuesday 13th October

Another 8:30 start, this time travelling via Queanbeyan to the northern end of Googong Foreshores. The Googong Foreshores is a vast managed public recreation area just 10 kilometres south of Queanbeyan. There are two main areas; the northern end accessed from the Cooma Road via Googong Dam Road and the southern end that is accessed by turning off at Burra Road and then into London Bridge Road. We completed the Black Wallaby Loop walk at the northern end that took us along the downstream end of the Queanbeyan River up to the dam wall through bushland *(photos 19 & 20)*. We had excellent views of the dam and then morning tea in the downstream picnic area carpark.

We then drove the short distance to the dam lookout before driving to the southern end of Googong to the Tin Hut picnic area. Some completed a short loop walk around the Tin Hut dam while others viewed birds from the bird hide. More than 165 bird species have been recorded at Googong. After lunch under apples trees that were in full bloom, we drove to the London Bridge Arch picnic ground. The branch track down to London Bridge saw us crossing Silurian sediments regionally metamorphosed to phyllite with a strong axial



19. Downstream from Googong Dam wall.

21. London Bridge Arch.

plane cleavage. This soon changed to a thick bed of limestone and it came as quite a surprise to walk over to the edge of this outcrop and find that we had in fact been standing on the bridge! This spectacular geomorphological feature spanning Burra Creek comprises a thick bed of Cappanana Limestone deposited in the Tabberabberan Tectonic Cycle (428-425Ma) and lies on the eastern margin of the Canberra Rift. The limestone actually forms an anticline over the creek and this is probably the reason behind the formation of the bridge. Softer metasediments beneath the limestone bed in the core of the anticline were easily eroded out by Burra Creek to form the arch *(photo 21)*. A series of much smaller caves and alcoves led off the main arch. The arch is an important site to the local Ngunnawal people and was first recorded by explorer Mark Currie when directed to it by an aboriginal guide in 1823.

In 1857 John McNamara, an Irishman from County Clare, paid 30 pounds for 30 acres of land in the Burra Valley which he named London Arch. The homestead is a rare example of a vernacular homestead group that contains progressive additions over time. In the 1860s a stone hut with 40 cm thick walls was built from local stone that was transported by horse and dray to the site. A slab hut where the timber slabs were shaped by hand using a broadaxe and adze was also constructed. In the 1890s a large building was constructed using walls made of small slats of timber nailed within timber frames. The frames were filled with mud and then covered with a mixture of mud and horsehair and later white washed with lime. In 1928 the property was sold to the Douglas family who kept it until the Commonwealth resumed most of the property in 1973 to protect the catchment for the dam. The Woolshed and shearer's quarters were built in the 1930's and operated until 1973. Most of the group completed the 3.5 kilometre circuit walk stopping at the limestone arch and then walking to the old homestead *(photo 22)* and returning via farmland to the picnic area.

At 7pm in the camp kitchen we celebrated Elaine's birthday with a pavlova *(photo 23)* and then Dr. Alex Ritchie gave us an informative presentation regarding the research he has undertaken on Ordovician to the Late Devonian fishes, his field trip to the Antarctica in 1970-71, his discovery and excavation of Devonian fish near Canowindra in 1993, and the creation of the Age of Fishes Museum in Canowindra.

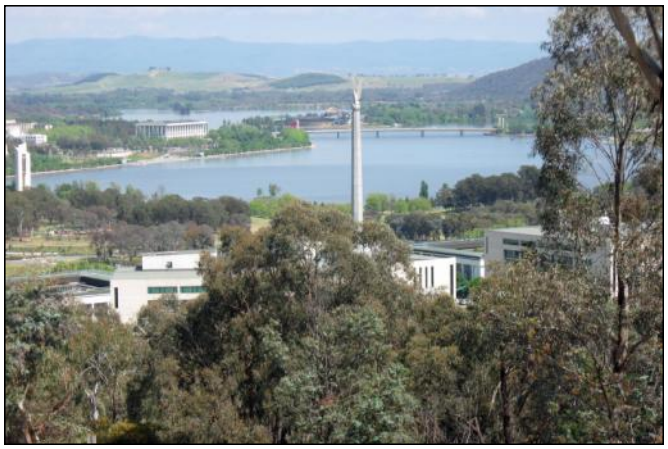
Wednesday 14th October

We had a later start today so that members could have a relaxed breakfast and/or catch up on washing. Our first stop was Mount Ainslie lookout directly behind the Australian War Memorial. With an elevation of 843 metres, this lookout provided great views of the

20. Googong Dam wall from the lookout.

22. London Bridge homestead.

23. Elaine's birthday pavlova.



25. Lake Burley Griffin from Mount Pleasant lookout.

ever expanding but beautiful national capital *(photo 24)*.

We then drove through the military college at Duntroon to Mount Pleasant. Mount Pleasant is grey quartz andesite from the Ainslie Volcanics. The lookout provided views to the northwest over the eroded remnant of the Central Canberra Rift and Black Mountain, with the prominent Deakin Fault at its foot, and beyond to the Brindabella Mountains. The rock here is a dacitic ignimbrite forming part of the Silurian Hawkins Volcanic Suite (428-424Ma), the first of a series of eruptions within the Canberra Rift (Finlayson, 2008). The lookout also provided views to the east and south of Lake Burley Griffin *(photo 25)*, Queanbeyan and Duntroon. We overlooked "Duntroon House" which was built out of stone with wide verandahs by Robert Campbell in 1833. In 1862 Robert's son, George, added a large two-storey extension. In its final form the house contained twenty rooms and is a great example of colonial architecture. It now serves as the officers' mess for the Royal Military College.

Our next stop was to view the rock cutting in State circle *(photo 26)* that has interesting Silurian shale and sandstone. Beautifully exposed in the road cutting here is the unconformity between the underlying highly deformed State Circle Shale deposited during the Benambran Tectonic cycle (490-430Ma) in a shallow marine basin, and the overlying thinly bedded Camp Hill Sandstone member of the Canberra Formation deposited during the later Tabberabberan Tectonic Cycle (430-380Ma). The State Circle Shale is contorted by slumping, with prominent slump rolls visible just above the footpath in the central part of the cutting. This indicates instability during lithification. Both formations are strongly faulted. Specimens of the Early Silurian graptolite *Monograptus* have been found here.

At Kings Park, we had a picnic lunch while listening to a recital at the National Carillon *(photo 27)*. Kings Park is adjacent to Commonwealth Park on the northern foreshores of the lake. It is the access point to the Carillon and Aspen Island. The Carillon was a gift from the British government to Australians to celebrate the 50th Anniversary of the national capital. The Carillon has 53 bronze bells. Recitals are held every Wednesday and Sunday from 12:30pm till 1:20pm.

We arrived at GeoScience Australia in time to stroll around the time walk that has significant samples of rocks from different ages *(photo 28)*. The heat knocked some doing this walk and everyone was glad to go inside the environmentally sound building. We listened to a presentation on the history, purpose and setup of GeoScience Australia. This included an explanation of the sustainable building design including the cooling/heating system, which involves 90 metre deep drillings and water exchange. The curator of the minerals collection discussed the collection and we were able to view many fabulous mineral specimens from

24. Canberra from Mount Ainslie.

26. State Circle rock cutting showing the unconformity.

27. Carillon from Kings Park.

29. River at Boorowa.

around the world. After this we reviewed the education resources and tasted various treats at the cafe before heading back to Eaglehawk.

Thursday 15th October

Our stay at Eaglehawk ended so the group made their own way to Cowra relieved to finally be away from the cold showers, unpleasant smells and noisy buses. Many stopped for morning tea at one of the many cafes in Boorowa and strolled along the attractive Boorowa River *(photo 29)*. I admired the beautiful St Patrick's Catholic Church that was built in 1865.

After settling into Cowra Van Park adjacent the Lachlan River and at the end of the main street, we had lunch and did some grocery shopping. The members of the group that had arrived by 3:30pm walked across the old bridge observing the murals on the pylons of the new bridge on the way to the visitors centre. We watched the hologram which tells the story of the 1944 Japanese POW breakout and aftermath through the eyes of local girl, Clare, acted by Home and Away star, Roslyn Oades. We returned to the park and enjoyed Happy Hour, the temperature being hotter than normal for October at 31^0C.

The park proved to be 100% better than Eaglehawk with hot showers, helpful management, shady sites, no nasty smells and a short walk from the town centre. The women were impressed with the supply of both soap and hand lotion and the many hooks and shelves in the showers.

Friday 16th October

We left at 8:30am and drove through some beautiful farmland along the Darby Falls road to Wyangala Dam. Near Darby's Falls we drove past hill after spectacular hill of granite boulders belonging to the Cowra Granite suite, resulting in several sudden unscheduled stops to satisfy the photographers. Incidentally there is no waterfall at Darby's Falls. Local legend tells of a man called Darby who kept falling off his horse!

The road cutting at Wyangala Dam Lookout exposed examples of the strongly foliated Wyangala Granite, the foliation emphasized by the ferromagnesian minerals hornblende and biotite. There were even stretched mafic xenoliths (enclaves) parallel to the foliation and up to 30cm long!

The dam is the "Jewel in the Crown of the Central West" and is located at the junction of the Lachlan and Abercrombie Rivers. With a catchment area of 8,300 sq. kilometres and a dam capacity of 1,217,600 megalitres, the surface area of the dam is two and a half times the size of Sydney Harbour *(photo 30)*.

After morning tea in one of the many picnic/

28. BIF specimen at GeoScience.

30. Wyangala Dam.

31. Balancing Rock Lookout.

33. Cowra War Museum.

camping areas we walked uphill to complete the Balancing Rock trail that wanders through the 1890's gold fields. We found numerous giant granite boulders, many balancing on other weathered boulders. The Balancing Rock Lookout *(photo 31)* gave superb views over the dam. Various goats adorned granite rocks along the trail. We could not find the path to take us down the hill so navigated our own way down *(photo 32)*.

After lunch we had a short walk around the waters' edge and drove to Thompson's lookout to see the Abercrombie River end of the waters. We then drove through the old gold mining town of Woodstock and stopped at Cowra War Museum, an interactive war, rural and rail museum with over 8000 exhibits including model railways, the Cowra POW Camp exhibition, steam engines and farm machinery *(photo 33)*.

Saturday 17th October

Today most of the group took advantage of the Craft and Farmers Market at Cowra Showground to stock up on fresh produce and homemade treats. We then visited Bellevue (Billy Goat) Hill lookout for views over the district and a close up of the granite boulders that give Cowra its name. Cowra is in Wiradjuri country and the Wiradjuri word for rocks is "Coura". Our next stop was the Japanese and Australian War Cemetery. A cemetery for the Japanese who died from the breakout was established in August 1944. At the end of the war members of the local Returned and Services League (RSL) assumed responsibility for the maintenance of the graves. In 1963 the Japanese government considered the repatriation of the remains of their war dead. However when the Japanese government saw the care by the Cowra RSL of the war graves they submitted a proposal to the Australian government for the establishment of a Japanese War Cemetery. This request was agreed to and the cemetery was opened on the 4th August 1964. All other Japanese who died in Australia during the war, both civilian and military, were exhumed and interned at the cemetery.

32. Navigating down the hill.

This was followed by a short stop at the remains of the POW Camp that was established in 1941 and consisted of four 17-acre compounds with each compound designed to hold 1000 prisoners. The compounds were enclosed within a 12-sided, almost circular perimeter. In August 1944, camps A and C held Italian prisoners; Camp B held 1,104 Japanese prisoners of war and Camp D held a mixture of Korean, Taiwanese prisoners of war, Japanese officers and Italian fascists. On Saturday, 5th August 1944 at 1:50am the largest breakout of prisoners in the world occurred. Of the 1,104 Japanese who occupied Compound B of the camp, 378 escaped through the wire to the outer perimeter and southern gates. The remainder were found within the camp. Over the next nine days 334 escaped prisoners were re-captured. Several committed suicide. The result was that 231 Japanese prisoners and 4 Australian soldiers lost their lives. However, from the tragedy a long lasting friendship between the people of Cowra and the nation of Japan has developed. This was evident in our next stop, the spectacular Japanese Gardens and Cultural Centre. Many spent the morning exploring the five acres of manicured garden, serene

34. Cowra Japanese Gardens.

36. Koorawatha Falls.

lakes and cascading streams which make up the largest Japanese designed garden in the southern hemisphere *(photos 34 & 35)*. The design incorporates six elements; mountains, rocks, mountain waterfalls, mountain lakes, rivers turning into oceans and pine trees. The cultural centre showcased an extensive collection of Japanese art and artefacts.

The most outstanding area in the gardens to the geologically minded was the symbolic mountain lookout set on a hill strewn with large granite boulders. This geomorphology is typical of outcrops of the Silurian Cowra Granodiorite in the region. The Cowra Granodiorite contains garnet and cordierite as accessory minerals. This is unusual but the most striking feature was the enclosed xenoliths of metamorphic rocks (phyllite and schist) and, very surprisingly, large angular blocks of white quartz.

Some of the group enjoyed a lunch of roast pork or fish with baked vegetables at Cowra Hotel for $5 each. After lunch we drove to Koorawatha Falls via Koorawatha Reserve *(photo 36)*. Koorawatha means place of tall pines and these were evident as we drove the four kilometres from Koorawatha to the weir. Koorawatha weir was built to provide a water supply for the steam trains. We traversed the short walking track to the falls and found a spectacular columnar jointing. There was a trickle of water running over it, amazing, as many of the locals have never seen the falls with water flowing. Two main geological time periods are represented at this site. The oldest rocks are volcanics associated with the Hawkins Group, deposited during the mid-Silurian period. These volcanics are dominated by welded rhyodacitic ignimbrites, which formed as a result of explosive volcanism within a terrestrial environment. The rhyodacitic ignimbrite at the falls shows pronounced columnar jointing. Sedimentary rocks associated with the Late Devonian Hervey Group unconformably overlie these strata. The Hervey Group comprises fluvial derived sediments such as conglomerates, sandstones and siltstones, and has undergone low-grade metamorphism. The Illunie Rhyolites are comprised of a mixture of rhyolite, dacite, tuff and agglomerate. After many photo stops on the return journey back to Koorawatha we found the cairn recalling the gun battle between Ben Hall's gang and the local police at the Bang Bang Hotel in 1864 *(photo 37)*. We then returned to Cowra via Wattamondara and stopped at Molongla cemetery to view the many wildflowers.

Sunday 18th October

Today we headed west for 9 kilometres along the Mid-Western Highway and then turned right (north) to drive along Barryrennie Road for 17 kilometres until we reached our destination – the Ironbark walking track in

35. Serenity!

37. Site of Bang Bang Hotel.

Conimbla NP. The track took us along the eastern side of a north-south trending syncline in rocks of the Late Devonian Weddin Formation, a series of cross-bedded fluvial sandstones within the Hervey Group. These sandstones form occasional low rocky ridges. It was an easy loop bushwalk that went along a ridge and up onto a broad flat plateau, with a lookout over Cherry Creek. We strolled through sandstone country containing dry eucalypt forests, ironbark, black cypress pine, scribbly gum, red stringybark and heathlands containing various wildflowers. We spotted black wallabies and red tailed black cockatoos along the track. The park is significant as it is the border of the temperate western slopes and the drier western plains and so supports flora from both regions. Some drove, others walked to the Wallaby picnic area where we ate our lunch. We then drove to Yambira Mountain via Warrumba Road. This is the highest point in the central west. After driving further than intended, we returned to Cowra via Major-West Road and the Mid-Western Highway. We all had a few drinks and snacks around the picnic tables in the caravan park later in the afternoon.

Monday 19th October

An easy day spent on a sheep farm where fish fossils had been found. The entire region is covered by outcrops of the Weddin Formation belonging to the Middle to Late Devonian Hervey Group, which covers an area of 400 square kilometres. The fossil-bearing strata comprise interbedded red and green siltstones, fine sandstones and red mudstones, the latter containing scattered fossil fishplates. A fluvial depositional environment is indicated for the Weddin Formation as a whole, with the fossil horizon deposited in a low energy environment such as river overbank or lakebed.

After morning tea under the shade of large trees in the home paddock we drove to the rear of the farm and went searching for fish fossils *(photo 38)*. One would think that with 24 people searching something would turn up, but nothing! Richard may have found a fish plate and others found signs of bioturbation in the shaley bands. Even around the original discovery site, marked by a steel post, we recognized nothing. But at many famous fossil sites the fossil-bearing layer is often very thin and difficult to find. We had lunch in the paddock and then returned either on foot or by car to the front paddock for an inspection of the shearing shed. We returned to Cowra mid-afternoon and prepared for a pleasant evening out at the refurbished Cowra Services Club.

38. Looking for fish fossils.

39. Stamper at O'Brien's Hill.

Tuesday 20th October

We left at 8am and headed west to the birthplace of Henry Lawson, Grenfell. Our first stop was O'Brien's Hill where gold was first discovered in an outcropping reef of white quartz by shepherd Cornelius O'Brien in 1866. This was prior to the settlement of Grenfell when the area was known as Emu Creek. Cornelius quickly registered a claim at Young and the discovery became known as O'Brien's Reef. By January 1867 around 10,000 people were on the goldfield and Government surveyors were sent to map out a town. It was named Grenfell in 1867 in honour of John Grenfell, a commissioner of crown lands who had been murdered by bushrangers in 1866. The Grenfell Goldfield became the richest in the Colony of NSW, with 12.5 tonnes of gold having been mined between 1866 and 1874. Production had declined by 1870 and following the death of his wife O'Brien left the district in 1875.

Animals played an important role in life on the goldfields. Horses were used for transport and recreation while chickens, cattle and pigs provided food, bullock teams brought in supplies, mining machinery and fresh water. Dogs provided both companions and security. They included British bulldogs and mastiffs were a common sight, chained to stumps alongside miner's tents to deter thieves. Stray dogs roamed the streets living off scraps and were generally ignored by the townsfolk. One of these dogs featured in Henry Lawson's "The Loaded Dog". He was a big black young retriever dog, or rather an overgrown pup, a big, foolish, four-footed mate, who was always slobbering around them and lashing their legs with his heavy tail that swung round like a stock whip. Henry Lawson's birthplace lies just south of O'Brien's Hill.

40. Big Gold Pick and Pan.

42. AGSHV group at Ochre Arch.

The Consol mine on the crest of O'Brien's Hill was one of the state's most significant gold mines. The stamp battery on O'Brien's Hill *(photo 39)* was forged in a foundry at Castlemaine around 1875, but was moved here from Wellington in the 1970's as part of a small-scale mining revival. The steam driven camshaft lifted each of the stampers in an uneven sequence to ensure they did not all drop at the same time (which would have destroyed the structure). Quartz was shovelled into the crushing chambers from the rear. Water fed into this chamber washed out the crushed quartz and directed it over copper plates coated with mercury which would catch the gold. A second set of mercury plates lower down increased the chance of recovering any missed gold. But the system was not efficient and often left enough gold in the tailings to provide a future resource.

Remnant mining machinery was observed, including the stamper, air shafts and poppet head and the interpretive signage explained the gold production process. Next stop was the Big Gold Pick and Pan at the Grenfell Men's Shed near the historic Railway Station *(photo 40)*.

We then drove in a north-west direction to Ochre Arch at Pinnacle. For $25 a head we were given a delicious home cooked morning tea and then taken on an interesting tour around the farm. Our hosts, Phil and Jan, provided a detailed insight into running their sheep and cattle station with limited use of machinery, chemicals and fertilisers. The philosophy involves low stocking rates, natural vegetation and ordered paddock rotation. Phil spoke about his water supply and the use of wind and solar power. We viewed the Ochre Arch that was used extensively by aborigines and listened to info on the history of the area. Ochre Arch is a 1.5m thick bridge of reddish residual rock over a short tunnel high enough to crawl through along the creek bed *(photos 41 & 42)*. Crude bedding in the rock in this area allowed the stream to exploit a plane of weakness and carve out the arch. Examination of the arch-forming rock under a stereomicroscope back home by Brian shows it to comprise unworn granite detritus (quartz, mica and feldspar) cemented by clay. Hence the rock represents residual clay-cemented detrital material weathered from the granite capping the surrounding ridges and so is very recent in origin geologically speaking.

Driving up a ridge, we saw views of the surrounding district and found an outcrop of tourmaline. While consuming our lunch Phil showed us various artefacts.

We then drove to the western end of Weddin NP. The Weddin Mountains appear to have been named after the Wiradjuri word for to stop or to remain. Carved trees, worked stones and other archaeological evidence suggest a long occupation of this area. From the excellent camping area we completed the uphill loop walk to Ben Hall's cave disturbing a large goanna on the

41. Ochre Arch. Host Phil on left.

43. Goanna on the walking track to Ben Hall's Cave.

44. Pig Sty, now rebuilt after fires.

46. Inside the Seaton Homestead.

way *(photo 43)*. This walk provided views of the surrounding countryside but the cave was fenced off so we could not enter it. In 1862, Ben Hall, Frank Gardiner and six other bushrangers carried out what was then the greatest robbery in Australian history when they held up the gold coach outside Eugowra. The gold has never been found and is believed to be somewhere in the Weddin Mountains.

The next stop was the nearby Seaton's Historic Farm, which is now part of the national park. Seaton's Farm is how one man and his wife turned every bit of wire into something useful. Jim Seaton handmade 3 km (1.8 miles) of kangaroo proof fence by hand, with posts of local saplings, which are rot and vermin proof. The property was occupied in the late 1920s and during the Depression, it was set up as a farm. Times and the land were hard and the buildings represent this. The homestead was built of mud walls over wire frames with earth floors. Tea was sprinkled on the floor to settle the dust. The furniture was made from white cypress pine scraps making it terminate-proof. There was no electricity. Kerosene was used for lighting and to power the fridge. The car battery was used for the radio, it was charged on the weekly trip into town for supplies. The sheds have walls made from flattened corrugated iron so that it stretched further. One of the sheds is full of old wire, iron sheets, bottles, and everything you can imagine plus more. All the old machinery is still there,

45. Wall of chook shed.

sitting where it was when the family sold the property to the Government in the 1980s. This is a unique place, showing how the less well-off farmers did it in the early and mid 1900s *(photos 44, 45 & 46)*.

On the drive back to Cowra, we stopped in Grenfell where we enjoyed an ice-cream amongst the many historic buildings in the main street. It was after 6pm when we returned to camp.

Wednesday 21st October

Winston led the trip from Eugowra today. First stop was Escort Rock, the site of Australia's largest robbery. The prominent valley just out of Eugowra has been eroded over a fault above the epicentre, at a depth of only 2 km, of an earthquake swarm. This swarm of earthquakes occurred at Eugowra during August, September and October 1994. 50 tremors occurred between 19th and 21st August and ranged in magnitude up to 4.2 on the Richter scale.

Near the Escort Rock site, stone kerbing of the original road and wheel ruts made by the wagons and coaches is still visible *(photo 47)*. The Gold Escort, loaded with mail bags and four iron boxes containing gold and bank notes to the value of about £14,000 (pounds, worth multi millions in today's money), departed from Forbes about mid-day headed for Bathurst. About 5 km past Eugowra, two bullock teams were drawn up in the roadway leaving only a narrow passage between the bullocks and a huge granite boulder *(photo 48)*. As coach driver Fagan guided the horses through the narrow space, a group of masked men opened fire at the Escort wounding troopers Condell, Moran and one of the horses. Fagan jumped down to steady the terrified horses but they tried to bolt and the coach overturned. The wounded and shaken troopers returned fire but were outnumbered and outgunned. The troopers and Fagan escaped to the home of Mr.. Clements, leaving the bushrangers to plunder the capsized coach. The bushranger gang included Frank Gardiner, John Gilbert, John Bow, John O'Meally, Dan Charters, Ben Hall, Harry Manns and Alexander Fordyce.

47. Stone kerbing on the original road approaching Escort Rock .

49. Mural depicting Gardiner's Gang, Eugowra.

We then returned to Eugowra for morning tea and to view some of the village murals that depict the Forbes Gold Escort Robbery at Eugowra Rocks, the members of Frank Gardiner's Gang, vintage vehicles and the once busy Eugowra Railway Station *(photo 49)*.

The group then visited the Central West Granite Supplies processing plant where approximately 2000 granite slabs were produced for the construction of Parliament House in Canberra. The granite was quarried locally at several quarries to get the different shades of stone required. The Eugowra Granite Suite is comprised of five different granites. The Eugowra Granite is a biotite or biotite hornblende granite whereas the lighter coloured Manildra Granite, the main source, is leucocratic biotite granite. The plant now produces monumental stonework, table and bench tops, feature wall panelling, and other stone products *(photo 50)*. Much of the stone used now is imported from overseas including China.

The group passed an abandoned church built of pisé or rammed earth construction *(photo 51)* on the way to Gooloogong and crossed the Holman Bridge completed in 1904 featuring DeBurgh trusses and concrete piers *(photo 52)*. Twenty bridges of this design were built in NSW.

'Gool-a-gong' station was originally 22,400 acres. Dr William Redfern, the personal physician to Governor Lachlan Macquarie, established it in the 1820s. The town followed in the 1860s but was devastated by a severe flood so was moved higher to the east. Gooloogong Memorial Park details the railway history, the Women's Land Army during WW II, an authenticated pine derived from the Lone Pine at Gallipoli, and a wall containing brass plaques outlining the history of local pioneering families *(photo 53)*.

Opposite the park, the Gooloogong Log Cabin Hall and the old stone St Malachi's Church, built in 1880, are being renovated as a private residence. The current St Malachi's Catholic Church with its steel framed bell tower was opened in 1953, and is located around the corner.

Heading east towards Canowindra the group passed a quarry lying on the N-S trending axis of a syncline in Late Devonian red siltstones. Immediately to the east, resistant underlying sandstones cropped out to form small N-S trending strike ridges *(photo 54)*. Further eastward pits on the weathered surface of an outcrop of red siltstones were caused by differential weathering of minute hollow worm burrows. A few kilometres on another outcrop of Late Devonian sediments showed a

48. Escort Rock. The coach was forced to pass between the rock and a bullock team to the left.

50. Trimming stone slabs at the Central West Granite Supplies.

51. An old pisé constructed church showing the horizontal layers of rammed earth and the whitewashed covering render.

53. The Pioneers wall at the Gooloogong Memorial Park with the Log Cabin Hall in the background.

200mm cross-bedded sandstone unit overlain by an 80mm parallel bedded sandstone unit. The outcrop also revealed faulting and other structural disturbance indicating that although the folding in the area comprises relatively open folds, significant small scale adjustments have occurred throughout *(photo 55)*.

A roadside sign on a low rise traversing an outcrop of Late Devonian quartzite and featuring the Late Devonian fish, *Canowindra grossi*, marks the site of the original find of the now internationally famous Canowindra fish beds *(photo 56)*. Unfortunately, overzealous or ignorant fossil hunters have stripped the surface at site of remaining fossils. There are more fossils at the site but these have been carefully protected and reburied to be recovered, at great expense, in the future. A bulldozer driver who turned over a large slab of rock and noticed some strange markings on its surface found the site in 1956. Later a local apiarist saw it and reported it to the Australian Museum. The slab was taken to the Museum where it has been on display since 1966. In September 1992, Dr Alex Richie, Head Palaeontologist at the Australian Museum, gave a talk to the local Rotary Club about the fossil fish find and aroused local interest. In January 1993, the Cabonne Shire Council provided a 22 tonne excavator and driver to undertake a trial dig. The results were astounding with 70 tonnes of material recovered including some 2 tonne slabs. The new slabs contained more than 3,100 fossil fish specimens. Because of the scale, quality and significance of the discoveries, it was decided to keep all of the new finds in Canowindra to form the 'Age of Fishes Museum'.

After lunch at the Canowindra Pioneers Park the group visited the adjacent 'Age of Fishes Museum'. Here many of the best and most spectacular specimens are on public display *(photos 57, 58 & 59)*.

These are shown in the context of their evolutionary significance with detailed presentations of their geological, temporal and environmental settings through diagrammatic, panoramic and audio-visual presentations. Also included is the 1993 audio-visual presentation on the discovery, subsequent collection and processing of the fossils by mostly volunteers. The museum has a life size model of *Mandageria fairfaxi*, the NSW State fossil emblem, together with a collection of other fossils and minerals from locations around the world.

Located in Canowindra's main street, Gaskill Street, is the 'Royal Hotel' *(photo 60)* on the site of the previous 'Canowindra Inn' owned by Mr.. William

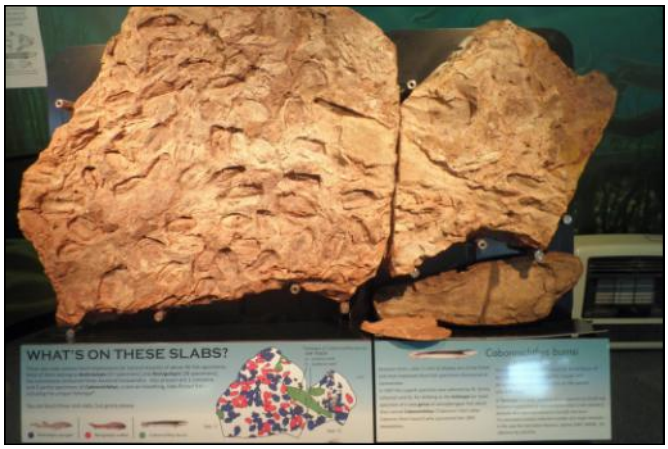
52. The Holman Bridge over the Lachlan River at Gooloogong.

54. Strike ridges of resistant Late Devonian sandstones interbedded with softer siltstones.

55. Late Devonian cross and parallel bedded sandstones.

58. Part of the display of fossil bearing slabs from the original site.

56. Site of the original Canowindra Fossil Fish discovery.



59. Fossil bearing slab with diagram showing the various species present.

57. Quartzite slab from the original site showing the density of fossil fish .

60. The 'Royal Hotel' on the site of the 'Canowindra Inn' from which the Hall Gang took over the town.

Robinson jnr. in which the Hall gang of bushrangers held the town hostage for two days in September 1863.

Earlier that day the gang had raided Mr. William Rothery's, 'Cliefden' station on Limestone Creek about 25 km west of Carcoar. They captured the employees and then surrounded the homestead so that those inside surrendered. They stole three of the best horses and two of the finest saddles and fired on the unarmed victims to discourage any counter retaliation. The door on the barn at 'Cliefden' still bears bullet holes made during this raid and is now on public display in the Bathurst Historical Museum.

From Gaskill Street a lane leads to a pedestrian suspension bridge over the Belubula River where there is a monument on the site of the 'Travellers Rest' hotel. The hotel was owned by Mr. William Robinson snr. *(photo 61).*

Further along Gaskill Street is the Canowindra Motors Holden Museum containing a collection of 50 classic and collectable cars with an emphasis on

61. Artist's impression of the old "Travellers Rest" hotel on the southern side of the Belubula River.

63. Carcoar dam.

Holdens. The Museum's owner and founder, Mr. Charlie McCarron, became a Holden dealer in 1959 and began to search for a 1948 'Model 48/215' or the 'FX' Model, Australia's first own car. In 1970 he found his dream car in Tanunda SA, and drove it back to Canowindra. Among the other vehicles on display is a 1950 Armstrong Sidley, a 1980 Brock Holden VC Commodore, a 1959 XC Holden, a 1968 Holden Monaro GTS and a 1972 Holden LJ Torana GTR-XU1.

A coffee at the Rose Garden Cafe in the main street finished the day.

Thursday 22nd October

We left the wonderful caravan park and fantastic hosts at Cowra and headed to Bathurst. Our first stop was the historic village of Carcoar where the recent TV show on the story of Peter Allen was filmed. We had a pleasant morning tea at the Teapot Cafe in the old Stokes building. Carcoar is the third oldest town west of the Blue Mountains and was the site of Australia's first bank hold up and the haunt of Ben Hall, the bush ranger. The Church of Immaculate Conception, constructed in 1870, has an ingenious cooling system with air passing through wall cavities with vents in the window sills. We then stopped at Carcoar dam *(photo 63)* to read the information about the establishment of the windfarm by Blayney council.

62. The 1948 215/48 (FX) model Holden which Peter Brock drove in the parade lap around Mt Panorama, in 2004.

After setting up camp in Bathurst we ate a late lunch and had a free afternoon. A number of the group called into the visitors centre and walked around the CBD. We had happy hour in the camp kitchen to refine the itinerary for the week. This year, Bathurst is celebrating 200 years since Governor Macquarie, who raised the Union Jack on the banks of the Macquarie River on 7th May 1815 proclaimed it a town. It is Australia's oldest inland settlement.

The City of Bathurst and surrounding low hills of the Bathurst Plains are located on the Bathurst Granite, a huge outcropping complex batholith dominated by Middle to Late Carboniferous granodiorite. The area is completely enclosed by a ring of mostly heavily wooded hills representing a metamorphic aureole in the sedimentary rocks adjacent to the granite contact. The aureole is around 2.5 kilometres wide and comprises contact metamorphosed Early Silurian to Late Devonian sediments and volcanics in which phyllites and quartzites predominate, with some areas of schists and marbles. These rocks are much more resistant to chemical weathering and erosion than the granite and so stand much higher in relief. The aureole contains dozens of small metallic deposits, mainly tungsten-molybdenum -gold, but also copper-lead-silver-zinc (Wisemans Creek, Cow Flat and Mount Apsley mines). Prior to intrusion of the granite the region had been divided into a series of north-south zones defined by faults. These zones include the Hill End Trough and Sofala-Rockley Volcanic Belt. This geology explains why all roads in and out of Bathurst climb steeply.

64. Abercrombie House.

66. Mayfield Gardens. Waterfall in the Water Garden complex.

Friday 23rd October

This was a free day. Most of the group went to the Australian Fossil and Mineral Museum, situated in the heart of the City housed in the 1876 Public School building at 224 Howick Street, next to the Post Office. This collection was the lifetime obsession of Warren Somerville who donated much of his collection to the people of Australia in 2000. The Museum was opened in July 2004. The school underwent major refurbishment before the stunning displays were installed. The display comprises two third minerals and the rest fossils, all of which are museum quality and heritage significance. Warren was encouraged and mentored by the late Albert Chapman, internationally renowned mineral connoisseur, who was personally responsible for encouraging a number of other Australian Collectors.

The entire collection was originally housed in a purpose-built museum in the grounds of the Somerville's Tollbar Orchard on the outskirts of Orange, opened to the public in 1978. Only half this collection was donated to the Museum Trust and of this only a quarter is on current display. The remainder is in storage on site. Founding partners include Bathurst Regional Council, Charles Sturt University, The Australian Museum, NSW Ministry for the Arts, and the Australasian Institute of Mining and Metallurgy.

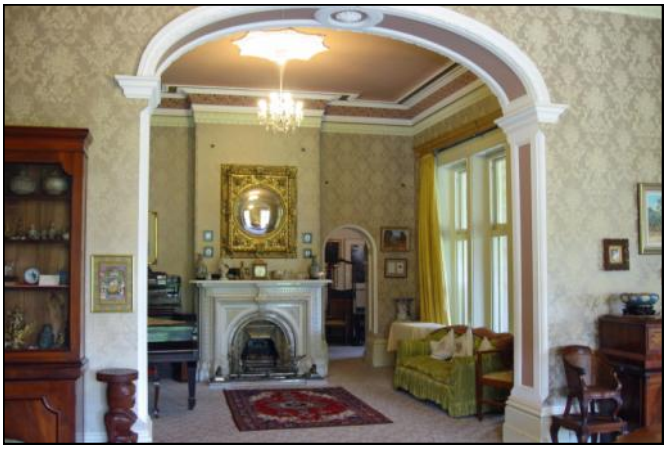
Ian and I visited the Boundary Road Reserve that is now being managed by the local land care group. They are attempting to return it to natural vegetation and are conserving the yellow box trees that are predominant there. We then went to the spectacular Abercrombie House *(photo 64)* that was built in the 1870s from local granite. The rooms were very impressive despite the clutter *(photo 65)*.

We had lunch in town and walked around historic Machattie Park, which was designed in 1890 and built at a cost of £2,000. The fernery was erected in 1890 and the marble statuary was installed in 1901, originally on loan from the National Art Gallery in Sydney. The yellow and orange clivia's in the fern house were worthwhile seeing.

Saturday 24th October

What a superb day! Terry, Laurel, Chris, Maree and I went to Bathurst farmers market at the showground and then drove to Mayfield Gardens near Oberon. The gardens were the best gardens I have ever seen, just amazing! *(photos 66, 67, 68 & 69)* We spent over five hours walking around. We had afternoon tea at Oberon before heading back to the camp.

Winston took 18 members to Hassall Park, O'Connell where there are several granodiorite boulders

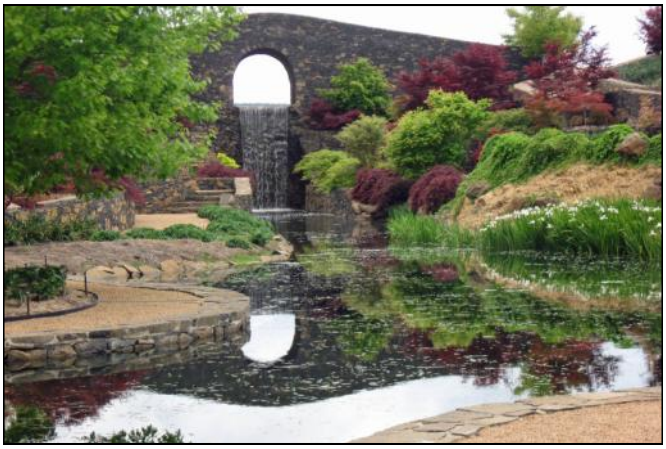


65. Inside Abercrombie House.

67. Mayfield Garden. Water Garden complex.

68. Mayfield Garden. The 'Grotto".

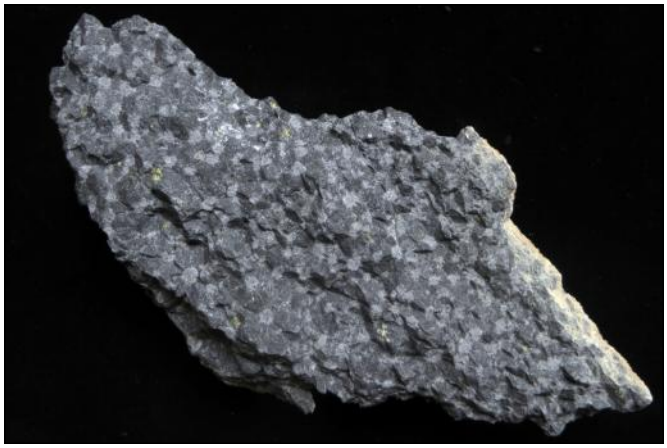
71. Felsic dyke intruding metamorphosed sediments, Bathurst–Oberon Road.



69. Mayfield Garden. The Stone Bridge.

72. Metamorphic cordierite hornfels at contact with felsic dyke.

70. Xenoliths in granodiorite boulder at Hassall Park.



73. Unusual texture in basalt at Oberon Lookout.

containing xenoliths. Xenoliths (stranger rocks) are inclusions which are usually intensely metamorphosed and derived from fragments of country rock torn off by the upwelling of the magma or fragments spalled off from the wall or roof of the magma chamber and then sunk into it *(photo 70)*.

Several kilometres to the east and a few hundred metres beyond the edge of the Bathurst Granite Batholith, a one metre thick felsic dyke intruding the country rock was exposed *(photo 71)*. Here the clay rich country rock at the intrusion margins has been metamorphosed into a hornfels containing aggregates probably of the mineral cordierite (a magnesium silicate). The differential weathering of the cordierite has given the rock a spotty appearance *(photo 72)*.

A few hundred metres eastward a road cutting exposes an outcrop of hornfels. The hornfels was originally most likely a lithic sandstone which has been contact metamorphosed by the heat from the granite batholith. The original grains have been altered and

74. "Devil's Dice', oxidised cubic crystals of pyrite (FeS_2).

76. Crenulation lineation in Silurian argillites at the Hazlegrove quarry.

welded together to make a very hard dark rock. These contact metamorphosed rocks being more resistant to weathering than the granite form a contact metamorphic aureole of more rugged topography around the perimeter of the granite batholith.

The next stop was at the Oberon Rotary Lookout where a residual of a basalt flow overlies a possible deep lead gold deposit. A small amount of reef gold was recovered intermittently between 1875 and 1889 about 600m to the south at the 'Homeward Bound Reef' and alluvial gold has been recorded in gullies immediately north of the lookout. It is possible that gold weathering from the reef was washed into a stream that was covered by the basalt flow forming a deep lead deposit. The erosion of the basalt capping covering the auriferous gravels is now exhuming this deposit. Some unusual textures and weathering features were also observed in the basalt *(photo 73)*.

At the old Oberon Railway Station several dozen metasedimentary boulders have been placed as decoration alongside the Railside Trail. Most of the boulders contain cubic crystals, now oxidised, of pyrite (iron sulphide) often known as 'devil's dice' *(photo 74)* and some contain quartz veins. Also there are a few basalt boulders containing vesicles.

To the north-east of Oberon near Hazlegrove on 'Goldbrook' property are six igneous stocks together with two others, one on Hazlegrove road and the other, the largest and which was visited, on the Hazlegrove-Duckmaloi road. The stocks are circular to ovoid in plan and range from 120 m to 400 m in diameter and, with one exception, are of very similar compositions.

When fresh, the rock is mid grey in colour, fine grained and equigranular. It is composed of indeterminate feldspar with biotite and other indeterminate black minerals and less than 10% quartz. The rock is probably a dolerite. The rocks do not outcrop prominently but can be identified by rounded boulders within a weathered matrix of mostly soil. These stocks lie about 4 km from the Bathurst Granite to the north and 2.5 km from the Duckmaloi Granodiorite stock to the south-east.

At the junction of Hazlegrove Road and the Hazlegrove - Duckmaloi Road, a quarry in finely laminated argillites of the Silurian Kildrummie or Campbells Groups displayed some interesting sedimentary structures. These included bioturbation and crenulation lineation *(photo 76)*. Also the remains of an imported basalt stockpile which contained large olivine aggregations *(photo 77)*.

Returning a kilometre back towards Oberon in a large roadside cutting, steeply dipping sandstones and siltstones of the Silurian Kildrummie and Campbells Groups have been intersected by a series of sub-

75. Group members at the Hazlegrove quarry.

77. Olivine aggregation in the basalt stockpile.

78. Minor fault offsets at cutting on Hazlegrove Road.

79. Intraformational structures within Silurian sedimentary beds at the cutting.

80. Weathered, folded and faulted interbedded sandstones argillites and cherts of the Ordovician Rockley Volcanic at the Langs Road junction.

81. "Essington Park" House.

horizontal minor faults showing small offsets *(photo 78)*. Some intraformational structures within the sedimentary beds are also clearly visible *(photo 79)*. A major north - south trending fault is present a few hundred metres to the east of the outcrop.

The Oberon road passes rocks of the Ordovician Rockley Volcanics and these rocks form the underlying country rock. Lunch stop was at 'The Common' Park, which lies approximately on the junction between the Rockley Volcanics and the Ordovician Triangle Group. After lunch the group headed west along Sewells Creek Road towards Rockley and, after about 6 km, stopped at the Langs Road junction. Here a good exposure of weathered, folded and faulted interbedded sandstones, argillites and cherts of the Ordovician Rockley Volcanics was examined. Slaty cleavage was developed in the argillaceous beds and an incipient cleavage could be seen in some of the less amenable and interbedded cherty beds *(photo 80)*.

The route passed 'Essington Park House', the country residence of Captain Phillip King, son of Governor King, who was granted this estate in 1824. King was a sailor and was seldom on site, so his overseer William Hayes managed his rural affairs. Henry Humphries built the Essington Park House in 1860. The Essington Park House now stands on a 12 acre block and has ivy clad walls *(photo 81)*.

Another kilometre on is the Foleys Creek Road junction named after the Foley family. In 1862 John Foley teamed with Fred Lowry and committed several robberies. On New Year's Day 1863, they held up patrons at the Brisbane Valley races and during the hold -up Lowry shot one of the patrons. Lowry was later captured but escaped from gaol with William Woodward. They met up with John Foley and the trio continued on with their robberies. These included their biggest haul, the robbery of the Mudgee Mail, ten kilometres from Bowenfells, which netted £8000 in banknotes. However the banknotes' serial numbers had been recorded and this proved to be the bushrangers' downfall. Both John's father, Lawrence and Mr.s Foley were found with some of the stolen banknotes.

82. Sewells Creek Road phyllite near the Beaconsfield Road junction.

84. Offsets in a quartz vein inside the Native Dog Creek mine adit.

On the roadside a kilometre before Beaconsfield Road are several large slabs of phyllite. Phyllite is an argillaceous metamorphic rock intermediate between slate and schist. It has well developed cleavage with sericite mica deposited on these planes and responsible for the silky sheen *(photo 82)*.

During dynamic metamorphism, water in the sediments together with water and other minerals produced by the alteration of original argillaceous minerals in the sediment are forced into the cleavage planes and any cracks or fractures, which may be present. Milky vein quartz is a common product and, as phyllites usually weather readily, white quartz fragments are often scattered across the ground surface.

Another kilometre beyond Beaconsfield Road, the road crosses Native Dog Creek that was the scene of an historic riot between the Chinese and European prospectors before the more publicised riot at Lambing Flat. In April 1861 a group of Chinese found gold and by the second week in May there were about 1500 people on the ground. Rivalry and jealousy soon erupted between the reported 1200 Chinese and 65 Europeans. Around the 23rd May a large party of Chinese walked away from an area, which they had been working after not finding any gold. A single European then tried his luck and was successful. The Chinese then rushed the European, took his find, pulled up his pegs and erected their own. The Europeans returned to the area. In the ensuing melee three Europeans were injured. The police arrived the next day and charged two Europeans with being the ringleaders. A month later the gold was dwindling and by July the area was almost deserted. Pits and digging in the alluvial deposits can still be seen. Across the creek is an adit to a copper/gold mine, which extends horizontally for about 15m into the Late Ordovician Rockley Volcanics country rock *(photo 83)*. In the mine quartz veins are offset by movement along the cleavage planes in the host rock *(photo 84)*. Mining here was undertaken in 1904 to 1908. Panning the gravels here will usually turn up a colour of gold, some spinels and rarely a sapphire or garnet in the heavy mineral residue.

83. Inside the mine adit .

The route returned to Beaconsfield Road and headed north through Wisemans Creek, the scene of significant mining activity between 1875 and 1911 and intermittently until 1951. These base metal deposits

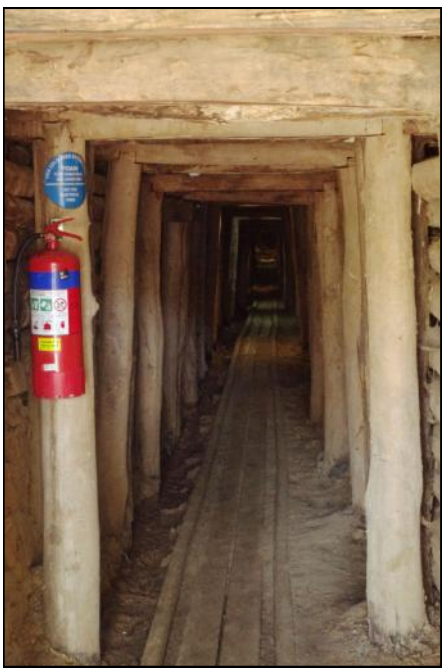
85. Silurian fossiliferous limestone at Limekilns .

86. Breccia of rounded pebbles of stromatoporids, tabulate corals, shale fragments and other reef debris at Limekilns .

were mostly stratiform with some vein-type copper deposits. While the road follows the creek over Ordovician Triangle Group rocks, most of the mines are located on the ridge to the east in Silurian rocks of the Kildrummie Group.

The group then viewed the Silurian coral limestones at Limekilns *(photo 85)* where the limestone cropping contained abundant tabulate corals and stromatoporids. Several large boulders revealed a breccia of rounded pebbles of stromatoporids, tabulate corals, shale fragments and other reef debris *(photo 86)*.

On the return to Bathurst, at the crest of the hill in the contact aureole before descending onto the granite, there was an outstanding view of the entire contact aureole ridge around the perimeter of the Bathurst Granite Batholith. In the road cutting immediately north of the Winburndale Rivulet bridge, a perched stream bed with rounded pebbles was well exposed.



87. Bald Hill mine.

88. Looking down shaft at Bald Hill mine.

Sunday 25th October

We travelled to the old gold mining town of Hill End that is now managed by National Parks and Wildlife Service to protect the buildings and artefacts. After passing Sofala and heading northwest to Hill End, the geology began to get interesting. For a few kilometres west of Sofala the road passes though the Ordovician Sofala Volcanics, the oldest of the rock sequences in the area. The road then crosses into the Late Silurian Bells Creek Volcanics which are separated from the overlying Late Silurian Chesleigh Formation by the Wiagdon Thrust Fault, marked by shearing in the Sofala Volcanics evident in road cuttings.

At Big Wallaby Rocks 7.3 kilometres west of Sofala fine quartz-rich greywackes of the Chesleigh Group are exposed in the high cliff to the left of the road. These beds feature a spectacular series of recumbent folds formed by bed-surface thrust faults.

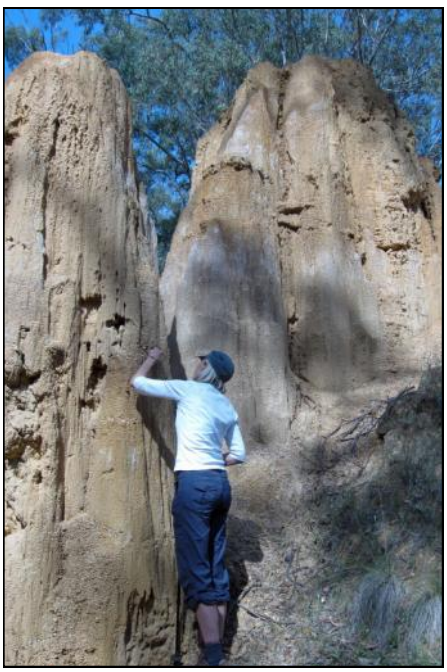
Further on towards Hill End new road cuttings expose spectacular thickly bedded quartzose volcanoclastic sandstones and dacitic to rhyolitic lavas lying on the eastern limb of the north-south trending Hill End Anticline, the major structure in the region. All these beds dip steeply to the east. These beds include the Merrions Tuff that weathers like granite into rounded boulders along the line of outcrop. All these rocks belong to the Early Devonian Crudine Group. Near Hill End rocks of the Chesleigh Group again outcrops along the top of the Hill End Anticline.

Our first stop was the new visitors centre and museum located in the former district hospital for morning tea. We then drove along Beyers Avenue which is lined with trees planted by Louis Beyers who made his fortune from Hawkin's Hill gold for a quick look at some of the many historic photos positioned around the town. The main streets, Clarke St and Tambaroora St, use to be a bustling commercial centre during Hill End's boom years from 1871 to 1874. By the end of 1872 there were 8000 people living in and around the Hill End area. During this period the town had five banks,

two newspapers and 52 hotels. The richness of the earth 50 metres below Hawkin's Hill was unparalleled. Investors in Sydney poured money into Hawkin's Hill mines and the town provided unlimited opportunity for fraud so need for investment regulation hastened the formation of the Sydney stock exchange. We then drove to Bald Hill mine, which was worked unsuccessfully in the 1870s. Its purpose was to intersect and exploit three sub-parallel quartz veins, which had yielded good returns at the King Reef mine a few hundred metres to the west. The original application to mine was refused on the grounds that, because of its basalt cap, Bald Hill was thought to be an extinct volcano and that diamonds were a more likely product. The mine produced neither gold nor diamonds. Worked intermittently from 1872, the mine had a second lease of life at the turn of the Century when, as a form of unemployment relief, the Government paid out of work miners a guaranteed wage to shift tonnes of waste rock.

Our guide, Eddy, explained the history of the mine and showed us the quartz veins that were supposed to be gold bearing. He demonstrated the old mining methods and showed us the tools used. We exited the mine by climbing up 30 metres on 10 ladders to the shaft entrance *(photos 87 & 88)*.

The gold at Hill End occurs in quartz veins in the form of normal and inverted saddle reefs along fold hinges and as large "blows" associated with faults known as "cross courses". The latter, particularly on Hawkin's Hill, were the source of bonanzas such as the Holterman-Beyers nugget (actually a large chunk of reef gold), which was found in the Star of Hope mine on 19th October 1872. It weighed 286 kilograms! The host rocks are interbedded shales and sandstones of the Silurian Chesleigh Formation converted to slate, quartzite and hornfels by regional metamorphism. These rocks form part of a deep marine sequence deposited in the Hill End Trough. Alluvial deposits along the Turon



89. Exploring Golden Gully.

90. One of the many arches in Golden Gully.

and other streams, such as Golden Gully, were the initial major source of gold.

The Hill End-Tambaroora Goldfield was the site of the first reef gold mining in Australia. Alluvial gold was discovered in Golden Gully in 1851 as prospectors moved northeast from Ophir where the first alluvial mining for gold took place a few months earlier. Total recorded production for the area is over 50 tonnes, 12.4 tonnes from Hawkins Hill. More recently, Hill End Gold worked beyond the Amalgamated Tunnel in Nuggety Gully and produced a considerable amount of gold, but went bust and closed in 2010.

After lunch in the park we drove up to the Bald Hill lookout that gave views over the whole town. The group all met up again at 3pm and drove to Golden Gully where we spotted many arches *(photos 89 & 90)*. The miners would dig down to bedrock through the ancient river gravels in search of gold bearing leads. Massive erosion has occurred on this warren of mines. We drove home stopping at Sofala, Australia's oldest surviving gold town, on the way but found the cafe was shut.

Monday 26th October

The convoy drove south west to Abercrombie Caves. After morning tea in the picnic area we purchased tickets to enable us to walk through the great

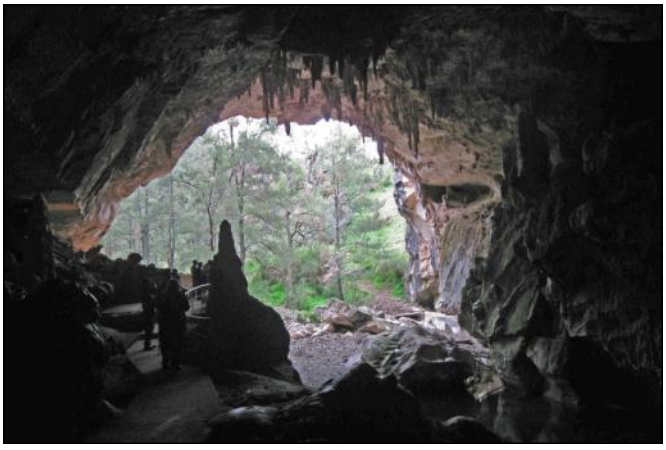
91. Limestone cliff near entrance to main arch.

92. Back entrance (upstream) to main arch.

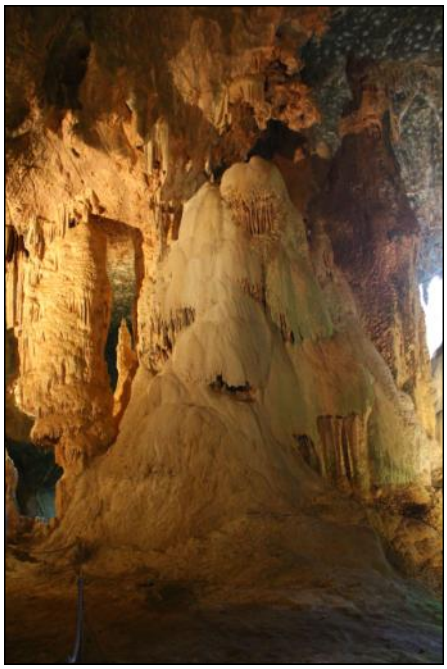
arch, the largest natural bridge of limestone in the Southern hemisphere. We walked up towards the rear of the main arch and diverted from the track to view the stable arch where bushrangers known as the 'ribbon gang', held their horses in the 1830s. While we were walking through the main arch it rained. A feature was the 1880s gold miners dance floor that is still used today for weddings and concerts *(photos 91, 92, 93 & 94)*.

While being entertained by the resident possum, Polly and her baby, we had lunch in the undercover picnic area and then drove instead of doing the planned walk, to the Grove Creek waterfalls *(photo 95)*. It stopped raining so we could walk around the lookout. We spotted both donkey and spider orchids *(Photos 96 & 97)*.

On the return journey to Bathurst we stopped at Trunkey Creek. No coffee, so some enjoyed a beer at the Black Stump Hotel chatting to the locals while others walked around the main street. The town was established after Edward Hargraves announced that there was payable gold to be found at the junction of the Abercrombie River and Grove Creek in September 1851. One story says that the settlement got its name from a prospector who was endowed with a large nose, and the nickname "Trunkey". The creek he was working in became known at "Trunkey's Creek". The town prospered when Joe Arthur made a major gold find on



93. Looking out of the rear entrance to the cave.



94. One of many formations within the main arch.

the hill opposite the existing village in 1868. The whole hillside was mined and the town population expanded to 500. The village was surveyed in the winter of 1869 by Mr. Randolf Macattie, and proclaimed as the village of "Arthur" in February 1873. This remained the official name until 1988 when it was changed to "Trunkey". However, even from the earliest days, residents referred to their home as being at "Trunkey Creek" and this is also the name shown on most modern day maps. So in 2004, after representations from local residents, the village name officially became "Trunkey Creek". At one time the village had a population of around 2,500 but only has about 60 residents now. Photo 98 shows a historic two storey wooden building known as Alma House, which was constructed in 1872 by the Glasheen

95. Grove Creek falls.

96. Donkey Orchid.

97. Spider Orchid.

family. It was previously a branch of the Bank of New South Wales, the Golden Age Hotel, a private school, a dance hall, and last traded as Hunters General Store.

We returned to Bathurst, some went for coffee, others went shopping and others relaxed. Most caught up again with the group for Happy Hour.

Tuesday 27th October

After a cold night we awoke to overcast skies and decided we would brave the weather and try our luck by following the planned itinerary on this bleak day. Our first stop was the flat rock reserve on Mutton Falls Road, 7km east of O'Connell. O'Connell is a historic

98. Alma House at Trunkey Creek.

village which is classified by the National Trust. The township developed in the 1820s on the first road extending west to Bathurst. This reserve was a very pretty place on the Fish River and well worth the stop *(photo 99)*. Next on our agenda was Tarana Railway station which is also listed by the National Trust as the Station Master's residence is incorporated in the station building. To our surprise a train stopped while we were perusing the station but the guard seemed upset that none of us wanted to board the train *(photo 100)*.

We then drove to the recently upgraded, (but still missing facilities) Evans Crown carpark on Honeysuckle Falls Road, 4 kilometres south-east of Tarana for morning tea. Most of the group had found their winter jackets and beanies to wear but the walk up towards the crown of around 500 steps had the blood flowing. From the top we headed towards the crown but could not find a definite track. We tried a track towards the west and it did lead around to the base of the crown. Crown Rock was an initiation and corroboree site for the Wiradjuri people. From its apex George Evans first sighted the Bathurst Plains in 1813. The reserve comprises 425 hectares with spectacular granite formations. The summit at Crown Rock is 1,104 metres above sea level. The granite boulders that litter Evans Crown are known as tors. They begin their life as molten rock, which cools underground. Over a long time movement and faulting cause cracks to form in the rock and water seeps in. The water weathers the sides of the rock taking off the sharper edges and making the blocks rounder *(photo 101)*. The boulders belong to the Tarana Granite, part of the Carboniferous Bathurst Batholith.

We had lunch at the carpark and then drove to Tarana pub for coffee/hot chocolate and use of their toilet facilities. While there, Brian delivered an outline of the history of mining *(photo 102)* at Sunny Corner, our next stop.

Just after driving through Sunny Corner village from the east we took Dark Corner road to the north, which followed the ridgeline on the western side of Daylight Creek. At one point along the road we were able to walk to the east over the crest of the ridge and

99. Flat Rock Reserve, Fish River.

101.Tors, formed from weathered granite at Evans Crown.

gain a panoramic view of the long abandoned Sunny Corner silver mines. Although the side of the ridge around the old mine is largely overgrown with pine trees, we could see the Cornish-style brick chimney built in 1891 and the unique slag block boiler house.

Gold was found at Mitchells Creek (later Sunny Corner) in the 1850's. By 1881 assays had showed the ore at Sunny Corner to be rich in silver. In 1884 The Sunny Corner Silver Mining Company was formed and the first imported American smelter was in blast on 27th August. This was the first time silver had been successfully smelted anywhere in Australia. But by 1903 only small scale operations remained. Most of the buildings and houses were dismantled and moved to the new cement town of Portland. In 1984 the mine area was declared a historic site by the Department of Lands. The ruins were classified by the National Trust in 1985 (Powys, 1989). The mine area has been rehabilitated, but sensitively so that all relics have been preserved.

The ore at Sunny Corner had a similar origin to that at Captains Flat, i.e. VMS deposited by sea floor hydrothermal vents in the Middle Devonian to Early Silurian. The 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.

We all went to the Bathurst Services Club for dinner to celebrate Laurel's 70th birthday and a great safari *(photos 104 & 105)*.

Wednesday 28th October

The itinerary for today was a mystery tour. It was another cold morning but sunny so felt warmer than yesterday. We drove west to Orange and then to the Pinnacle lookout *(photo 106)*. The walk up had numerous steps but the panoramic views over the Towac Valley were worth the climb *(photo 107)*.

Next was morning tea at the Tea House picnic area where the remains of Laurel's birthday marble cake was consumed. We crossed the road to the Tea House for info and toilets. We then drove to the summit of the majestic Mount Canobolas. This is an extinct volcano formed when Australia was sitting over a hotspot in the earth's crust. It is part of the Brigooda-Oberon chain that stretches 800km from southeast Queensland to near Oberon in NSW. Mount Canobolas erupted in several phases between 13 and 11 million years ago, making the mountain a relatively recent geological feature. Earlier eruptions were less violent with free flowing lavas reaching a maximum coverage extent of approximately 800 square kilometres. Later eruptions became more violent, producing increasingly

100. Tarana Railway Station.

102. Brian outlining mining history of Sunny Corner.

103. Former Sunny Corner mine.

105. Laurel with her two birthday cakes.

viscous lavas with less extensive coverage. Additional volcanic features are present within the zone of volcanic influence, including vents, dykes, peaks, domes and plugs. With its rich soil, high altitude and cool climate, the surrounding area is the perfect environment for a range of plants and animals.

A European first climbed the mountain when Major Thomas Mitchell came there in 1835. Numerous towers used for television and radio transmissions across large areas of central New South Wales now dominate the top of the mountain. These transmitters include towers for Air services Australia, Royal Australian Air Force, Prime Television, WIN Television, Australian Broadcasting Corporation and Southern Cross Ten.

After reading the signage about the history of the mountain and current flora and fauna, we decided to do the walk to the summit of Young Man Canobolas. This was perhaps the most strenuous walk of the trip and only seven members completed the downhill track that passes through snowgum grassy woodland and the steep uphill rocky track to the summit. On return to the carpark we drove to the Federal Falls picnic area for a late lunch *(photo 107)*.

The Mount Canobolas area comprises volcanic (trachytes and basalt) and intrusive rocks (porphyry and dolerite) associated with large quantities of agglomerate and tuff formed during explosive eruptions. In the earliest stage there were large outpourings of Mafic (basaltic) lavas, building up a large shield volcano with a mean basalt age of 11.7Ma. Around 11.4Ma came the eruption of a series of felsic (trachytic) domes, with more recent basaltic material extruded to partly mantle the trachyte domes at 11.0Ma. The different lava types were due to fractional crystallisation in a sub-volcanic magma chamber, enabling different magma types to erupt at different times. The activity lasted around 700,000 years so that each rock type was weathered prior to the next eruption phase. The volcanic vents represented by Young Man Canobolas, Old Man Canobolas, The Pinnacle, Mount Towac and Johnsons Pinnacle ceased activity at different times, with Old Man Canobolas the last to cease eruption. At least 50 different eruption centres have been identified in the area (Harrison, 2010).

The geomorphology around Mount Canobolas is far less spectacular than that associated with the Warrumbungle Volcano, which formed between 17 and 13Ma. Being much older, there has been more time for

104. Farewell dinner at Bathurst Services Club.

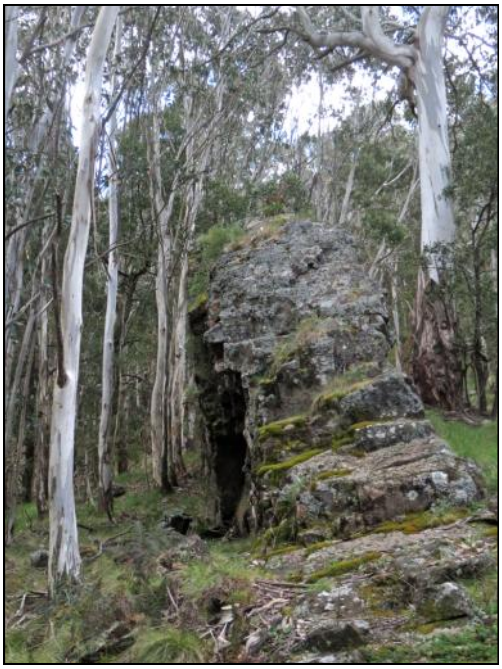
106. Pinnacle Lookout.

107. View towards Orange from Pinnacle Lookout..

weathering and erosion in the Warrumbungles to remove the softer rocks leaving the resistant trachytic rocks to stand proud as plugs, domes and dykes. So give Mount Canobolas time!

The Mount Canobolas Volcano is the most recent in a boomerang-shaped line of volcanoes extending from Brigooda (28Ma) in Queensland, through Inverell (23-20Ma), Nandewar Range (18Ma), Warrumbungle Volcano (17-13Ma) and Dubbo (14Ma) which formed over a stationary hot spot in the Earth's mantle as the Australian continent moved northwards over it. This hot spot now lies under Bass Strait (Australian Geographic – Boomerang Volcanoes: Will Tasmania be next?). There are at least 7 other similar lines of volcanoes in Eastern Australia.

The last stop of the day was at the Wentworth gold mine in Lucknow. The mine headframe and associated corrugated iron buildings have been restored by Orange City Council as a tourist attraction open to the public the first Saturday and Sunday of each month. This would be worth forming part of a future trip to the



108. Dyke near Federal Falls Picnic Area.

Bathurst area, including officially sanctioned access to the Sunny Corner mine site and the old copper mine at Burraga.

We finished the safari with Happy Hour in the caravan park that evening. I would like to thank all participants for their cooperation, support and enthusiasm throughout the three weeks. You made the job leading the group a wonderful experience. I was overwhelmed to receive some wonderful gifts in return for organising the safari. I would like to thank all who helped, in particular, Brian, Joan and Terry who assisted with the planning, Ian with emailing the info, and Winston for leading two days. Both Winston and Brian have contributed to this report and Barry, Ian and Ron have provided some photos.

Report by Sue Rogers, Brian England and Winston Pratt.
Photographs by Sue Rogers, Ian Rogers, Barry Collier, Winston Pratt, Ron Evans, Brian England.

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Social Activities 2015

Several enjoyable social events occurred throughout the year, organized as usual by our excellent Social Committee.

Soup and Slides and the Christmas Party were the main social activities involving all members, held once again in the home of Ian and Sue Rogers.

As well as these two regular activities, members of the Social Committee also hold a craft/sewing day at regular intervals. This activity occurs in participants homes on a roster basis. I believe that most of societies problems are solved during these get-togethers.

As usual, a very big thanks to all involved from all members of the AGSHV.

Publication Acknowledgements.

As in the past, Geo-Log 2015 is a collaborative publication with input from trip leaders who provide a report of the activity they prepare and lead, members who provide photographs for inclusion, President Brian for editing Geo-Log and Life member Ron for compiling the publication.

Lakemac Print, Speers Point produced the printed publication.

If you wish to quickly log onto the Amateur Geological Society of the Hunter Valley website, scan the QR Code below. You may need to install a QR Code reader (free on the web) onto your phone or tablet.

Ron Evans.