'Geo-Log' 2018

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

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President's Introduction.

Hello Members and Friends.

This past year has been a remarkable twelve months for our society. The AGSHV Inc. celebrated its 40th Anniversary, a very significant milestone. From meagre beginnings in 1978, the society has flourished into a very well respected organisation. The knowledge base and talent within our group allows a wide and varied range of activities from the earth sciences, indigenous and European cultural history, as well as flora and fauna.

Congratulations Brian England and Ian Rogers in being awarded well-deserved Life Member status for their outstanding and continuing service to our society over many years.

On behalf of the society, I would like to thank the Anniversary Planning Committee for their outstanding work in organising and delivering the very enjoyable luncheon with 60 members and guests in attendance. It was a memorable day.

In a sense the anniversary celebrations represented the culmination of a very successful year. No one-year is ever the same. During the very hot month of January, we trialled an indoor presentation whereby Robin Offler gave an informative presentation on the newly formed Port Macquarie Geo-Trail, followed up with a very successful field excursion to Port Macquarie in the cooler months. The society also travelled to the South Coast and conducted a safari from the North Coast of NSW to Central Queensland.

We visited the ANSTO nuclear facility at Lucas Heights where we had a special treat. Dr Joseph Bevitt, Scientific Coordinator and head of the Bragg Institute User Office, explained how Neutron tomography produces image slices through objects which can be combined to produce three dimensional images. The 3D image can be linked to a 3D printer to create an exact copy of a fossil inside a rock without cutting open the rock and causing damage. Fascinating!

The social committee also deserves special mention for the wonderful role they play behind the scenes. The catering and organisation in running the Soup & Slide night and the Christmas get-together is always high on our calendars. As ever, a big thank you to Ian and Sue Rogers for the use of their lovely home; we appreciate your generosity.

Finally, we all look forward to receiving the societies Geo-Log in the New Year. Please spare a moment and consider the hours of work Ron, as well as Brian put into the journal. Many hours of critical evaluation right down to the smallest detail has to be correct, and it only gets better each year. Thanks Ron and Brian.

The coming 2019 program is going to be very busy with a variety of activities. So stay fit and healthy. You will need all your energy for 2019 activities. Thank you to those people organising and running them.

With very best of wishes for the coming year. I look forward to seeing you soon.

Chris Morton.

Port Macquarie Geotrail

Presenter: Conjoint Associate Professor Robin Offler.
Date: Thursday 18th January 2018.
Attendance: 41 members.

Introduction.

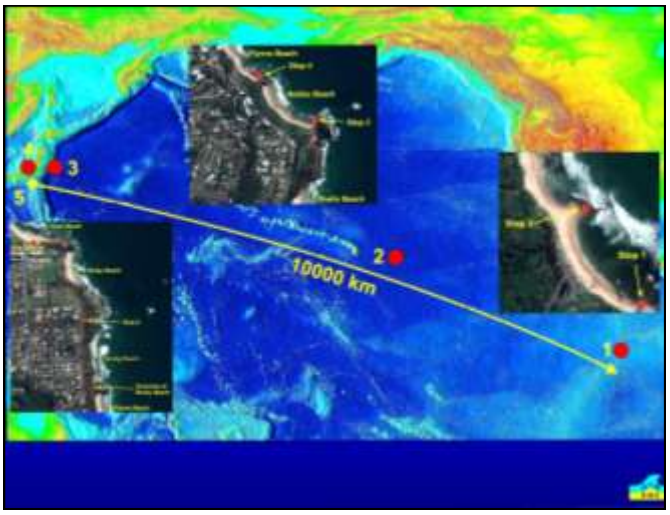
An interesting talk was presented by Conjoint Associate Professor Robin Offler on a new Geotrail that will explain the rock formations on the coastal foreshore of Port Macquarie. This was held at West Wallsend Workers Club.

Firstly, a little information about our speaker: Robin Offler joined the Geology Department staff at the University of Newcastle in 1968. He has very many and varied geological interests, mainly focussed around but not limited to, metamorphic and structural geology. His research interests as listed at the University of Newcastle website are "Low grade metamorphism. Determination of the tectonic setting of ultramafic and mafic igneous rocks in orogenic belts. Determination of tectonothermal history of orogenic belts. Dating of brittle deformation events."

Robin has undertaken extensive fieldwork around the Hunter and New England area. He also has extensively analysed rock samples from these areas by optical and electron microscopy, x-ray fluorescence, x-ray diffraction and mass spectrometry. He has undertaken age dating of many mineral separates from these samples. Robin has an extensive publication record of 72 journal articles and presentations at 41 conferences. He has been retired since 1997 but still does an impressive amount of research work at the University of Newcastle.

Robin informed us that he became involved with this project after Ron Boyd (Conjoint Associate Professor Ron Boyd, University of Newcastle) took an interest in the rocks outcropping along the beaches of Port Macquarie. The Port Macquarie Geotrail Project involves a team of people from Geological Survey of NSW and Port Macquarie-Hastings Council. The project involved compiling in depth information on the geology of the area, interpreting and presenting it in a concise, yet understandable for the general public, manner in the form of signs, short documents and apps. The idea is to allow a person walking along foreshore at Port Macquarie to look at and understand the geological significance of the rocks that they are looking at. This is an important project for the geo-tourism economy.

Slide1: This slide shows the location of the stops and types of rocks visible along the Port Macquarie Coastal geotrail.



Slide 2: This slide shows where these stops would sit in a modern-day setting.

Summary of geology.

The Geotrail talk gave a summary of the geology which I think is best illustrated with the two slides above taken from Robin's talk.

In summary:

Robin's talk looks at the journey of Mid-Ocean Ridge Basalts, their formation and journey across the ocean floor, the deposition of ocean ooze (later cherts), the deposition of turbidites closer to shore, the subduction of the basalts and sediments, the change in the minerals sliding down the subduction zone with increasing pressure and temperatures and lastly the large scale faulting that brought different wedges back to the surface to sit close together.

The Geotrail gives groups like ours a chance to

enjoy the scenery with a deeper understanding of the processes behind the features that we see. This talk will enhance our understanding of the geology at Port when we undertake our excursion to Port Macquarie Excursion in June.

Note.

This particular activity is an experiment in a new format for our AGSHV group. There have been a few people concerned about our activities taking place at this time of year during the summer heat. Coastal activities were one attempt to lessen the problem and still are a good choice. One activity, in the last couple of years to Catherine Hill Bay, took place in temperatures around 40°C and proved particularly uncomfortable with a trip to the pub for a cool drink high on the agenda at it's finish.

This meeting has proved to be particularly popular with a total of 41 people attending. We had members travelling from as far afield as Port Macquarie and Sydney. It seems to have been a good chance for people to come along, who are not normally active members. Many people said they enjoyed the talk along with the social gathering and a meal.

Report by Richard Bale.
Photograph by Ron Evans.

Reference:

OCH D. J., LEITCH E.C., and CAPRARELLI G., *Geological units of the Port Macquarie-Tacking Point tract, north-eastern Port Macquarie Block, Mid North Coast region of New South Wales*. Geological Survey of New South Wales, Quarterly Notes, October 2007, Vol No 126

BOYD, RON and OFFLER, ROBIN. Permission to use slides presented by Robin Offler granted by phone, *Port Macquarie Geotrail Workshop, 18 November 2017* personal communication, 23/3/2018.

Slide 1: This slide shows the location of the stops and types of rocks visible, "Where is the Port Macquarie Coastal Geotrail?", Presentation Slide 4.

Slide 2: This slide shows where these stops would sit in a modern-day setting. Presentation Slide 8.

West Wallsend Workers Club acknowledgement.

On behalf of the AGSHV, I would like to thank David Jackson, Manager of the West Wallsend Workers Club, and all his staff for their support in organising our talk even to the extent of purchasing and installing a new data projector after I had issues with connecting my computer to their old data projector. I would also like to thank the catering staff for providing a great meal.

Geotrail Information.

Port Macquarie-Hastings Council (www.pmhc.nsw.gov.au) has two excellent websites providing information on the Geotrail namely:

- Coastal Walk Geotrail and
- Geology (pdf document)
  (The following two photographs are from the Geology pdf document).

Pillow structures in basalt.
Stop 1. Shelly Beach.

1. Richard introducing Robin Offler to AGHSV members before his lecture.

Blueschist cut by numerous quartz veins.
Stop 5. Rocky Beach.

Astronomy Night

Leader: Paul Wickham.
Date: Saturday 10th February 2018.
Attendance: 8 members.

The first astronomy night I ran for the Hunter Valley Amateur Geological Society was in March 2016 and soon after I was asked to hold the event again the following year. Unfortunately, the combination of repeated foul weather and other commitments hindered our attempts to do some star gazing in 2017. I am happy to report that our second astronomy night on Saturday 10th February went without a hitch. Once again, Col and Marcia Maybury extended their hospitality beyond the call of duty and allowed us to descend on their Kurri property en masse. That dreaded requirement to postpone because of rain and cloud was avoided and our scheduled evening was blessed with clear skies, pleasant temperatures and about fifteen enthusiastic participants.

We began the night by revisiting the stunning Orion Nebula, a giant cloud of gas and dust created by a supernova explosion about 3 million years ago, which is relatively young for celestial objects. This makes it possible that the bright glow of the supernova may have been witnessed by early Homo sapiens. The Orion Nebula, at 1,350 light years distance, is the closest region of massive star formation to Earth.

In 2016 we only had one nebula to observe but this year we were a couple of months earlier and the Tarantula Nebula was also in the sky. This fantastic object is located in the Large Magellanic Cloud, a satellite galaxy of the Milky Way, which means that we were looking out into space at an angle perpendicular to the plane of the Milky Way. In other words, we were no longer looking at things in our own neighbourhood, like the Orion Nebula, but we were looking across 7,000 light years of intergalactic space to view an object outside our own galaxy.

As mentioned, we were fortunate in 2016, to have the most spectacular of all Globular Clusters, Omega Centauri, in the sky, an object so amazing that its 10 million stars are so compact that they all fit within the viewing field of the telescope. This year we had to settle for some of the more pedestrian members of that family, although they were all lovely and quite unusual and we had a swarm of them to chose from. We began with the Beehive Cluster in Cancer, the largest of the nearby bright open clusters with about 1000 stars. It is about 600 million years old and is located 594 light years away. We then looked at a trio of smaller open clusters in the constellation Auriga, which is close to Gemini. We had the Starfish Cluster with about 100 stars, the Pinwheel Cluster with about 60 stars, and M37, the richest of the trio with about 150 stars. Unnamed celestial objects like M37 are referred to by their catalogue number. The two most widely used catalogue references used are the New General Catalogue, which are allocated numbers beginning with NGC and the widely-known Messier Catalogue which all start with M. The Orion Nebula is commonly referred to as M42 and the Crab Nebula is sometimes referred to as M1. We finished off our tour of the open clusters by looking at M35, a large bright cluster of about 120 stars in Gemini.

The crowd were still hankering for more but I had exhausted the list of stimulating objects I had prepared so I scoured the list of February viewing objects and decided to introduce people to Binary Stars. To the naked eye most stars appear as pinpoints of single light in the night sky but the fact is the sky is dominated by multiple star systems, ie. systems of two or more stars orbiting a common centre of gravity. The fact that 85% of stars are multiple star systems suggests the universe has a strong preference for producing them and single stars, like our Sun, are merely deviants. Sirius, the brightest star in the night sky is a double star consisting of Sirius A, a very bright main-sequence star and its much fainter white dwarf companion, Sirus B. We looked at half a dozen double star systems and I had to point out that not everything we looked at was orbiting a common centre of gravity. *Optical double stars* look exactly like gravitationally bound stars but they are actually quite distant from each other and merely appear close because they are almost on the same line of sight.

It was starting to get quite late but someone in the group had heard of "the Jewel Box", a pretty little group of stars close to the Southern Cross. We could successfully locate it with binoculars but after many frustrating attempts I could not locate it in the viewing field of the telescope. While I was struggling to find it I asked Greti to try to find a catalogue number that would allow the telescope's database to slew straight to it. Unfortunately, she couldn't find one so we wrapped up the evening about 11:00pm without getting a nice look at it. When I got home I had a dig around and discovered that the Jewel Box is also known as NGC 4755. Damn! Disappointingly, that wasn't the only thing that got away from us. In the description of the evening I circulated before the event I promised people a look at something called "The Carbon Star", a luminous red giant star with an atmosphere that contains a lot of carbon monoxide in its upper layers, giving it a glorious ruby red appearance. The best carbon star in the southern night sky is in the constellation Lepus, near Orion, but I just could not get a fix on it, try as I might.

Sorry folks! Next time maybe.

Report by Paul Wickham.

Paul with his telescope.

ANSTO Visit

Leader: Chris Morton.
Date: Thursday 22nd March 2018.
Attendance: 26 members.

Today's activity was a departure from our normal field excursions. A bus trip was organised to the Australian Nuclear Science and Technology Organisation (ANSTO) at Lucas Heights, NSW.

A brief history.

ANSTO began in 1949 as an industrial committee composed of scientific and Government representatives.

In 1952, the Committee evolved to become the Atomic Energy Policy Committee and then in 1953, the Australian Atomic Energy Commission (AAEC).

During 1956, the Commission began active promotion of radioisotopes in Australia and in the same year the foundations were laid for Australia's first nuclear reactor, HIFAR (High Flux Australian Reactor).

HIFAR was switched on by Prime Minister Menzies on Australia Day, 1958. The reactor provided all of the radioisotopes manufactured in Australia and was used to study the effects of high intensity atomic radiation on materials. It was also a source of neutrons for studying the structure of materials.

In 1981, parts of the Commission were split off to join the CSIRO. The remainder continued until 1987, when it was replaced by the Australian Nuclear Science and Technology Organisation (ANSTO).

OPAL research reactor.

Australia's Open Pool Australian Lightwater (OPAL) reactor is a state-of-the-art 20 megawatt multi-purpose reactor that uses low enriched uranium (LEU) fuel to achieve a range of nuclear medicine, research, scientific, industrial and production goals *(photo 1)*. Opened in 2007, it replaced the decommissioned High Flux Australian Reactor.

OPAL is one of a small number of reactors with the capacity to produce commercial quantities of radioisotopes. This capacity, combined with the open pool design, the use of LEU fuel and the wide range of applications, places OPAL amongst the best research reactors in the world.

While OPAL is the centrepiece of ANSTO's research facilities, the suite of neutron beam instruments housed next to the reactor building and operated by ANSTO's Centre for Neutron Scattering represent a significant addition to ANSTO's research capabilities.

1. Full scale model of the OPAL Reactor.

The trip.

Meeting at the bus terminal beside Morisset railway station at the unaccommodating time of 7 am for a 7:30 am departure, did not dampen the enthusiasm of our members. Some had to leave home at 5:30 am to arrive at the designated time. The trip to Lucas Heights through peak hour traffic was uneventful thanks to the skill of our driver. Arriving at 10 am allowed plenty of time for morning tea and to complete the rigorous security checks that must be taken before you can enter the Lucas Heights nuclear facility.

After completion of this task, Carol, our vibrant and enthusiastic ANSTO Discovery Guide gave us a safety briefing and went on to explain that because we were a special interest group ANSTO had organised a special treat for us. This meant however, that we would have to race through some of the tour. We were then ushered onto the bus where we drove to the substantial security gate leading to the reactor grounds. This entailed entering Australian Capital Territory (ACT) because the area inside the security fences is designated ACT and is subject to federal law. Such is the security, that at the gate, an Australian Federal Police Officer (AFP) boarded the bus and checked that we were not carrying any electronic recording devices, cameras (even Apple watches were forbidden), weapons or any other illegal objects that could cause harm.

Continuing on, we passed the now disused HIFAR building where guided public tours are conducted on weekends. Arriving at the OPAL complex, we were shown a model display of the reactor building topped with what seemed like a steel gridded cage. The weird structure is called the "Cessna Shredder" and its function is to stop planes crashing into the OPAL reactor building. It can also stop most

other objects reaching the reactor, and if that fails, the walls surrounding the reactor are composed of 2 metres of solid reinforced concrete.

We were then shown models of the reactor rods that are inserted into the OPAL reactor. Only 6.4 kg's of fuel is used by this reactor. Some time was spent here in vigorous discussion about these rods, before moving onto another display of the many high quality medical products that are in great demand and shipped all over the world from ANSTO. Moving on, we stopped at a video screen where we could see the staff working above the reactor pool in real time. We were also fortunate enough to have the gantry move away so we could see down into the reactor pool to where the reactor was operating, surrounded by light water. Light water is purified normal water which is all that is necessary to absorb the radiation from this LEU reactor and to provide radiation shielding, as was demonstrated by the proximity of technicians to the reactor.

The Neutron Beam Instruments.

As we crossed an open corridor, we could see the Cessna Shredder on top of the 2 m thick concrete walls of the reactor building. The corridor lead into the research facility's suite of neutron beam instruments housed next to the reactor building and operated by ANSTO's Centre for Neutron Scattering which is a significant addition to ANSTO's research capabilities *(photo 2)*. World-class research is conducted within this building, where each of the Neutron Beam Instruments is scheduled with projects for many years ahead. Read about these projects by clicking on the Research Hub at:
http://www.ansto.gov.au/ResearchHub/OurResearch/environmentresearch/index.htm

Neutron Beam Instruments have been given names from native animals of Australia. They are listed below along with some of the applications performed by these instruments.

ECHIDNA, WOMBAT, KOALA.

1. Verifying crystal structures against first-principle energy calculations.
2. Deriving energetically reasonable starting models for structure refinement.
3. Choosing between different disordered structures.
4. Investigating the structure of glasses and amorphous systems.
5. Spin-density distributions.
6. Electron density distribution.

TAIPAN (SIKA, PELICAN).

1. Lattice dynamics for temperature factors and inelastic scattering.
2. Molecular dynamics for temperature factors, thermal expansion and inelastic scattering.
3. Band structure and density of states.
4. Elastic, dielectric and piezoelectric constants.

ANTARES and STAR accelerators.

Back on the bus we drove to ANTARES accelerator building where the accelerator is used for Ion Beam Analysis and Accelerator Mass Spectrometry. The latter is used to detect minute quantities of radioisotopes in samples, usually to establish their age. One of the most widely used isotope is carbon-14, a natural radioactive form of carbon. ANTARES has carried out thousands of radiocarbon dating projects on objects up to 50,000 years old.

This section of the tour was somewhat expedited unfortunately, as there was so much here that had applications to climate change and many other fields of interest. However, we were running late, and we needed to return to the Discovery Centre for the extra special treat that ANSTO had prepared for us.

2. 10 MV ANTARES Tandem Accelerator, first commissioned in 1991.

3. Dr Joseph Bevitt giving a lecture on Neutron Tomography.

Special Treat: Show and tell with Dr Joseph Bevitt.

Arriving back at the discovery centre, we were ushered into the lecture room where Dr Joseph Bevitt was waiting to give us a lecture on Neutron Tomography *(photo 3)*.

Dr Bevitt is the Scientific Coordinator and head of the Bragg Institute User Office. In this role, Dr Bevitt has access to the 13 world-class neutron beam instruments at the OPAL nuclear research reactor at ANSTO. He provides scientific and technical advice to researchers during the submission of their proposals to use these facilities and is responsible for the peer-review, approval and scheduling of all proposals. Dr Bevitt also coordinates the Institute's outreach and technical training activities, workshops and conferences.

His expertise as instrument scientist on the DINGO radiography/tomography/imaging station allows Dr Bevitt to collaborate with both Australian and international museums and universities to pioneer the use of neutron micro CT for 3D imaging of objects using neutrons with micrometre resolution. The main areas of use are in palaeontology, archaeology and cultural heritage to digitally excavate and reconstruct fossilised remains; to investigate disease and medical practice in ancient times; and to determine methods of manufacturing ancient cultural artefacts. Dr Bevitt also has expertise in the monitoring of kinetic processes such as gas exchange and gas adsorption in porous materials using both single-crystal and powder diffraction methods.

He has expertise in research administration and research policy and as Executive Officer of the NSW Synchrotron Consortium, he facilitates access to and provides technical and scientific advice to a host of inaugural investors of the Australian Synchrotron infrastructure (13 universities and the NSW Science Agencies).

Neutron tomography produces image slices through objects which can be combined to produce three dimensional images. Its resolution is lower than that of X-ray tomography and this makes it useful for specimens that have low contrast between the matrix and object of interest: as in fossil plants or vertebrate remains with a high carbon content. The 3D image can be linked to a 3D printer to create an exact copy of a fossil inside a rock without cutting open the rock and causing damage.

Dr Bevitt produced a few extremely rare and interesting fossils in matrix from Mongolia, Canada and South Australia which he allowed his audience to look at closely *(photo 4)*. He delivered a PowerPoint presentation explaining how neutron tomography imaging allowed him to 'see' inside a rock containing bones and other fragments such as the animal's last meal. This enabled identification of the fossil and what it had eaten without disturbing or damaging the fragments. One specimen showed the stomach lining of a dinosaur - think dinosaur tripe - that has never been seen before. This has given new insights into how dinosaurs behaved and what they had eaten. The full results are yet to be published, as some fossils still require a lot of computer time to extract all the imaging data.

After the lecture, Dr Bevitt posed for photos with our group *(photo 5)* and then we all adjourned to the cafeteria for lunch. Over lunch it was decided the rushed part of the tour was overwhelmingly compensated for by Dr Bevitt's presentation. In return, Dr Bevitt sent out a request for scientific illustrators. Luckily, this was Anne Llewellyn's chosen field, and as a lecturer at Newcastle University she offered to recruit students. Sometimes stars do align.

Our trusty driver negotiated the return traffic and had us back at Morisset railway station by 4:30 pm.

Thank you to all the members who attended and a very special thanks to ANSTO Discovery Centre for a memorable experience.

Report by Chris Morton.
Edited by Joan Henley.

4. Dr Joseph Bevitt showing fossil specimen to Anne.

5. Dr. Bevitt with members of the AGSHV.

Resources.

ANSTO: http://www.ansto.gov.au

http://www.ansto.gov.au/AboutANSTO/HistoryatANSTO/HIFAR/index.htm

http://www.ansto.gov.au/AboutANSTO/OPAL/index.htm

http://www.ansto.gov.au/ResearchHub/OurInfrastructure/ACNS/Facilities/InstrumentSchedules/index.htm

https://en.wikipedia.org/wiki/Neutron_tomography

(http://www.ansto.gov.au/ResearchHub/OurInfrastructure/ACNS/Facilities/Instruments/index.htm)

(http://www.ansto.gov.au/ResearchHub/OurInfrastructure/ACNS/Facilities/Instruments/Analysisofneutronscattering/index.htm)

(http://www.ansto.gov.au/NuclearFacts/AboutNuclearScience/ReactorsandAccelerators/ParticleAccelerators/index.htm)

(http://www.ansto.gov.au/ResearchHub/OurPeople/StaffProfiles/BEVITT-JOSEPH)

Tathra - South Coast Geology

Leader: Barry Collier.
Date: Sunday 15th to Sunday 22nd April 2018.
Attendance: 20 members.

Background.

The idea behind this excursion was to explore remnants of the short-lived (5-10Ma) volcanic activity forming part o the Devonian (380-360Ma) Eden-Comerong-Yalwal Volcanic Rift exposed along the coastline north of Tathra on the far South Coast of New South Wales. Our initial exploration concentrated on Mimosa Rocks National Park and the northern section of Bournda National Park.

The northern section of Bournda National Park comprises mainly Devonian volcanics, principally rhyolite and rhyolitic ignimbrite, while in Mimosa Rocks National Park the exposed rocks are principally Ordovician sediments with areas of Devonian rhyolitic volcanics in its northern part and some patches of Quaternary sediments. The eleven kilometres of coastline in the northern part of Bournda National Park is steep and rocky with a few small secluded beaches and over seventy coastal gorges. The Ordovician sedimentary rocks along this coastline are mainly turbidites, layered sediments deposited by turbidity currents in a deep oceanic environment at the base of the then continental shelf and adjacent abyssal plain.

These sediments originally built up into a thick mass in the area now known as the Ross Shelf off Antarctica. This sediments mass was carried on the back of its oceanic plate for over 1000 kilometres, eventually colliding with the eastern continental margin of Australia as the oceanic plate subducted around 440Ma. This destructive plate margin lay where western New South Wales and Victoria are now. These Ordovician sediments, now tightly folded, form the basement into which various volcanic episodes intruded and into which all later sediments were deposited following erosion.

The Ordovician rocks are eroded relatively easily and form steep slopes which retain only thin infertile soils. They comprise much of the bedrock in the national parks we visited and are often indicated by a cover of spotted gum forest (*Coymbia maculata*).

The group stayed at the Big 4 Tathra Beach Holiday Park in Andy Poole Drive, owned by the well-known entertainer Franky J. Holden. It was one of the very few parks to largely survive the devastating wildfire which roared down on the town on 18th March.

Monday 16th April.

Our first site of interest was at Picnic Point south of Aragunna in Mimosa Rocks National Park. We headed out north along Bermagui Road through very steep hilly terrain covered with open forests of spotted gum and ironbark, turning off towards the coast along Wapengo Lake road (dirt) which skirted the northern shoreline of Lake Wapengo. This is the only coastal lake in the region open to the sea and hence its shoreline supports extensive mangrove forests.

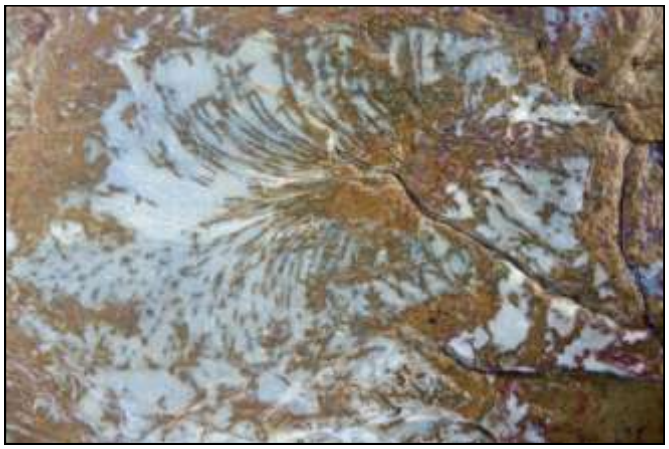
Many of the headlands in this region expose vertically tilted Ordovician basement turbidites which have been folded isoclinally by the immense forces associated with the collision of these beds with the east Australian margin. Some of the vertical sections through these beds close to the shoreline show spectacular chevron folds *(photo 1)*. But overlying the turbidites is a completely different sequence of horizontal bedded Devonian dark grey lake bed mudstones. On the rock platform these younger beds show an amazing variety of tessellation patterns *(photo 2)*, spectacular differentially weathered boxworks *(photo 3)* and Liesegang rings, plus a small area of coral-like patterns *(photo 4)* that defy explanation. These mudstones were laid down on the bed of a large freshwater lake. Some of the earliest fish on earth swam in this lake and occasionally a dead lycopod (club moss) floated in and sank. Grouped together in a more elevated outcrop of this mudstone we found several well-preserved trunks clearly showing the cross-hatched patterning where leaves were once attached *(photo 5)*. These fossils are the remnants of one of the earliest Gondwanan forests. Club mosses are still common today, but as a much smaller ground-hugging moss-like form, unlike the giants of the Devonian Period.

We returned to Bermagui Road and headed north again, turning right into Aragunna Road which led into Mimosa Rocks. We arrived at the Aragunna Beach Picnic Area at 11:55 am and took a break for lunch in the shade of the huge magnificent Bangalay *(Eucalyptus botryoides)* trees.

3. Weathered boxwork in Devonian mudstone at Picnic Point.

1. Chevron fold in Ordovician turbidites at Picnic Point.

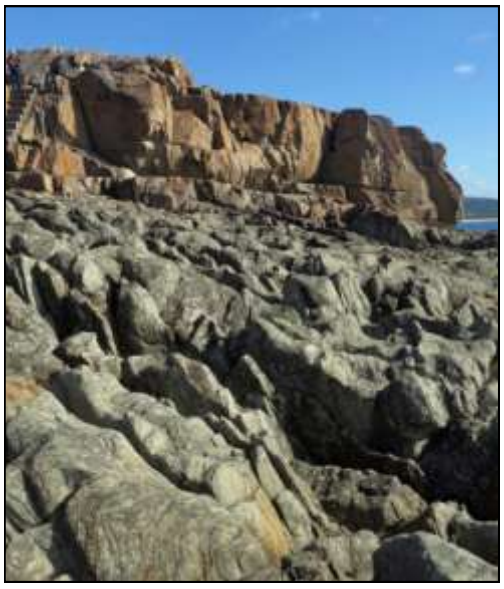
2. Tessellated pavement, Picnic Point.



4. Unexplained structure in Devonian mudstone at Picnic Point.

5. Fossil lycopod in Devonian mudstone Picnic Point.

6. Columnar-jointed rhyolite and a boulder beach south of Mimosa Rocks.



7. Rhyolite outcrop on Tathra Head.

8. Distorted ash flow deposit in rhyolite, Tathra Head.

From the lookout platform near the picnic area the rocks at either end of he beach did not look particularly interesting so we drove further north to the Mimosa Rocks parking area. From here we walked down along the elevated boardwalk to the small low patch of sand which connected the coastline with a small rocky island just offshore. To the north lay a spectacular boulder beach (called Rocky Beach) made up of rounded rhyolite boulders eroded from the low cliff of columnar jointed rhyolite forming the northern. Many of the boulders reflect the columnar nature of the source outcrop and someone (possibly children) had erected several in balancing towers along the beach. The bouldery expanse of Rocky Beach proved treacherous but most of the group reached the northern headland for spectacular views over the rugged offshore mound of dense rhyolite called Bunga Head *(photo 6)*. This also provided an opportunity to examine the structure of the rhyolite in relatively fresh and unweathered outcrop. The rock consists of a very fine (aphanitic) pale groundmass containing closely scattered broken crystals of glassy grey quartz. A crude flow banding was seen in some of the outcrop.

To the south of the coastal rhyolite outcrops the rock platform seaward of the beach exposed a wide expanse of vertically dipping turbidites striking roughly northeast/southwest.

The afternoon excursion finished earlier than expected so the group headed back to the Holiday Park and relaxed over coffee at the nearby fish and chip shop. Only Roz and Shayne decided to drive back to Aragunna and walk down to Aragunna Beach to explore the rock outcrops that had been ignored that morning. What they found led to the next day's program being altered to enable the whole group to witness an extraordinary piece of local geological history.

9. Waiting for lunch, Tathra Wharf.

11. Cave in coffee rock at Aragunna Beach.

Tuesday 17th April.

As a direct result of the disastrous wildfire which destroyed much of Tathra on 18th March we were unable to do the Tathra coastal walk, with virtually the entire boardwalk along the cliff edge destroyed. So, most of the morning was spent exploring the bare rocky expanse of Tathra Head, one of the best coastal outcrops of the Devonian rhyolite/rhyolitic ignimbrite *(photo 7)*. Some of the features found here included distinct flow banding, columnar jointing and contorted ash flow deposits *(photo 8)*. Access to some more distant parts of the outcrop was made possible by using concrete fishermen's paths across the rougher patches.

We found our way back to the historic restored Tathra Wharf along the scant remains of the eastern end of the Snowy Mountains Highway, washed away by floods, the result of ferocious storms in the 1970's. The museum at the Wharf was closed for the day, but coffee in the restaurant was quite acceptable and the range of cakes decadent! We stayed on till 12 pm to enjoy a great lunch *(Photo 9)*.

Hunger pains satisfied, we se off in convoy for a return to Mimosa Rocks National Park to explore the outcrops Roz and Shayne had found yesterday. Literature references and an explanatory sign at the Aragunna Beach Picnic Area referred to the explosive nature of rhyolite emplacement in the area during the Late Devonian. Sure enough we found the evidence in the cliffs at the northern end of Aragunna Beach.

In the Late Devonian the area around Aragunna was covered by a huge deep freshwater lake. Then a large lava dome formed beneath the lake bed. The viscous lava eventually forced its way to the surface, interacting with the lake water to produce sudden bursts of steam which led to catastrophic phreatic fragmentation of both the lava and lake bed sediments. The eruption was so violent because the highly viscous rhyolitic lava had entrapped the generated steam, which could only be released after sufficient pressure had been generated to fracture the rock. As the dome grew large blocks of lava were shed down its sides into the lake. This violet event is now evidenced by the presence of a large variety of volcanic rocks occurring as shattered fragments in a matrix of dark grey to black mudstone representing the lake floor sediments *(photo 10)*.

10. Shattered fragments of volcanic rock within a mudstone matrix.

12. Group at a shanty found at Moon Bay.

If the volcanic chaos created by this eruption was not enough to satisfy our geological curiosity, at the back of the beach and hidden by coastal scrub south of the headland lay a spectacular thick bed of black coffee rock. This is a loosely consolidated indurated quartz sand cemented by organic matter and formed from river sediments during the Pleistocene. It is relatively common in patches along the entire east coast, but this was one of the thickest exposures seen by the Society. Several caves were evident in this relatively soft rock, one extending for over 20 metres into the cliff *(photo 11)*. Herbert was able to crawl through this cave to a natural shaft which provided an escape route to the surface.

We walked south along the beach to the next rocky outcrop, a cemented chaotic jumble of angular rhyolite blocks, again part of the fragmented lava dome. Afternoon coffee was enjoyed at the picnic area before returning to the Holiday Park.

Wednesday 18th April.

Once again, we headed northwards along Bermagui Road, turning onto the track into Wajurda Point and driving right to its end. Here we found plenty of parking and two toilets, but nothing else. Most braved the 250 metre stairway down to Moon Bay Beach, a magnificent stretch of white sand with cliff-bordered rocky headlands at either end. Near the north end of the beach someone had build an elaborate tepee-like shelter of tree branches on the sand so we took advantage of it for a group photo *(photo 12)*.

The south-facing rock wall and adjoining rock platform at the northern headland exposed astonishing examples of Ordovician deep-sea turbidites. Here we could easily see the complete Bouma sequence repeated many times across the rock platform. Each component

13. Ordovician turbidites on rock platform at Moon Bay.

14. En-echelon quartz veins in turbidites at Moon Bay.

layer had been eroded to a markedly different degree to clearly show the gradation in grainsize within each bed, ranging from more resistant coarse sand at the base to very fine laminated silts at the top *(photo 13)*. Each bed represents a single turbidity flow onto the sea floor, the coarse layer depositing almost immediately and the very fine silts settling out from suspended clay-size particles after the initial turbulence had ceased. Then another turbidity current would come down and deposit another Bouma sequence on top, often eroding the layer of laminated silt from the previous bed, and so on.

Also present here were excellent examples of *en-echelon* quartz veins *(photo 14)* formed by torsional stress during later deformation. Again the turbidite beds, once laid horizontal on the sea floor, have been tilted vertically by tight isoclinal folding. The same turbidite sequence was exposed on the southern headland, but in vertical section and not differentially eroded.

Barry explored the top of the southern headland for tracks that might lead to good vantage points and found one indistinct path that led to the top of the cliff, providing magnificent views over the rocky coastline south to Tathra.

After the long plod back up the stairway to the vehicles we paused for coffee before walking out to the lookout platform at the end of Wajurda Head. On the way back Barry and Chris ventured off into the scrub several times looking for good views and eventually found a great vantage point looking over Moon Bay. After hearing Barry's colourful account of the view many people walked back to take photographs of what was really a magnificent view *(photo 15)*.

It was a little early for lunch so it was decided to drive northwards again on Bermagui Road, this time turning into Bithry Inlet, then left into Penders Road through an open forest of spotted gum with an understorey of Burrawangs (*Macrozamia communis*), a plant dating back to the Gondwanan forests. We found the car park almost full, such was the popularity of the sandy river shoreline here and some of our vehicles had to park amongst the coastal banksias in the nearby bush.

15. View over Moon Bay from Wajurda Head Track.

After lunch at the wooden tables between the car park and the beach we walked down across the sand towards the next rocky headland. National Parks had recently acquired the historic Myer Farmhouse south of the car park and several new walking trails had been constructed through the forest. Some of these would be explored later, but the coastal geology would come first.

The rocks exposed around the headland provided a real geological treat! There were fascinating weathering patterns in the Ordovician turbidites, areas of Liesegang rings *(photo 16)* and the best example of a near-isoclinal fold in both longitudinal (on the rock platform) and vertical (in the adjacent cliff) section that any in the group had ever seen *(photo 17)*.

On the southern side of the headland, instead of returning to our vehicles along the coast, we took one of the new tracks back through the hinterland forest, passing some interesting man-made structures on the way.

The day finished earlier than planned so we drove back to Tathra for coffee at the fish and chip shop to end the day.

16. Leisegang rings in turbidites south of Bithry Inlet.

17. Fold in Ordovician turbidites south of Bithry Inlet.

Thursday 19th April.

Our first excursion for the day was down a rough unmarked track leading to White Rock. Here the headland comprised rhyolitic lavas, parts of which had been bleached white, giving the locality its name. Many interesting geological features were seen here but the main attraction, for the photographers at least, was the immense coastal gorge caused by erosion of a wide igneous dyke, parts of which were still present *(photo 18)*. Most people then returned to the top of the headland while a few explored the headland's southern side below the white cliffs. From here the group returned to the vehicles parked in a clearing immediately above an old quarry.

After morning coffee most people walked the few hundred metres along the Kangarutha Track south of the road to view an amazing termite mound over two metres high *(photo 19)*. We then walked 120 metres along the track to the north of the road, before a short scrub

18. The gorge at White Rock.

bash to the head of the gorge. By then it was almost noon, so back to the Holiday Park for lunch.

Lunch over, our group drove down to Kianinny Bay, a surprising little harbour. The first thing we noticed was a fisherman cleaning his catch surrounded by seagulls and in the water two giant black stingrays, possibly the largest in Australia. There are said to be five of these rays resident in the bay and those who stayed near the boat ramp saw all five! People then wandered along the shoreline and walked the first section of the track to Chamberlain Lookout, now closed due to bushfire damage. After a quick survey of the area we drove up Chamberlain Lookout, which offered great views and some interesting rock structures. Then we returned to the Holiday Park.

Friday 20th April.

Barry thought this would be the best day of the entire trip but the best photo opportunities required cloud cover to minimise reflections. We drove to the Turingal Head Picnic Area then walked up to Wallagoot Gap and the start of the Kangarutha Track to Tathra. It is an easy track, mostly through *Melaleuca armilaris* forest. After about a kilometre we came to a clearing on the right which provided access to a spectacular gorge. A few hundred metres further on Barry looked for access to the coastline at the south end of a small bay. He eventually found a suitable route to the south side of the bay at a point overlooking three spectacular gorges on the north side and a large gorge at its head, and another spectacular gorge beside the viewing platform. All that was needed was cloud to take the reflections off the water!

From this viewpoint the track followed close to the edge and there were a few detours to overlook more spectacular coastline before reaching Games Bay, with a nice little beach but none of the spectacular headlands we had seen at all other beaches. It was then back to the picnic area for lunch. After lunch Barry had intended to lead the more physically fit people out to the trio of gorges at the end of Turingal Head, while Elaine was to lead the others down to the entrance to Wallagoot Lake and the base of Turingal Head. The group was then to meet at Wallagoot Gap at 3 pm, when the tide would hopefully be low enough to allow access through the gap. But unfortunately, just after starting the walk, Terry fell and hurt his ankle and had to be helped back to camp, leaving only Chris, Barry and Rod to continue. They were able to walk right around Turingal Head for spectacular views over the gorges, the coastline and into Wallagoot Gap. One of the fascinating features was a wide expanse of smooth rock covering almost a hectare and displaying weird twisted patterns and areas of what appeared to be polished breccia.

Our traditional group dinner was held at the Tathra Bowling Club where the meals were huge and absolutely delicious.

Saturday 21st April.

This was the last day of the Tathra trip so it was decided to have a free morning on which participants could do their own thing. Many left for home, while Barry and Elaine returned to Wallagoot Gap to capture some more of the exceptional coastal scenery.

After lunch, those remaining walked out to Nelson Lagoon. At the end of the Nelson Lagoon Walking Track they followed around the edge of the lagoon before following the track down to Nelson Beach, with great views across to Baronda Head. Along this track they passed an amazing number of female Burrawangs loaded with huge amounts of bright red fruit. The Burrawangs here grow at their southern limit and reach the maximum size for the species. Once on the beach the group walked its full length to Wajurda Point where there were more stunning Ordovician turbidite exposures.

Report by Brian England (Days 1 to 3) and Barry Collier (days 4 to 6).

Photographs by Brian England and Barry Collier.

19. Giant termite mound.

Terrigal to Putty Beach

Leaders: Chris Morton and Winston Pratt.
Date: Saturday 19th May 2018.
Attendance: 13 members.

Introduction.

The purpose of this excursion was to examine the sedimentary rocks and structures around The Terrigal Skillion.

Sediments forming the Skillion were deposited during the middle Triassic Period and make up the Terrigal Formation (formerly the Gosford Formation), the uppermost 212 m of the Narrabeen Group.

The Excursion.

We met at 8:45 am in the car park at the base of the Terrigal Skillion on a sparkling sunny morning with a slight cool southerly breeze that reminded us that winter was on its way.

After introductions and house keeping, we commenced a survey of the barrier-island, shoreline model proposed by Bramberry (1993) for the exposed rock sequence.

Though our society has previously conducted excursions to Terrigal with Rebecca Butterworth in April 2001, and in May 2011 with Chris Herbert (2011), many questions remained.

Discussion and questions on a variety of very complex sedimentary features and structures that outcrop on the southern and northern side of The Skillion had the geologists in the group working hard explaining the subtleties of many features.

Geological Setting.

At the beginning of the Permian Period a massive subsiding trough developed between the Lachlan Fold Belt on the west and the New England Fold Belt on the east. This trough, the Sydney - Gunnedah Basin, extended from Batemans Bay almost to the Queensland border.

Sediments shed from the flanking high mountains of the New England Fold Belt in the east and the still eroding mountains of the Lachlan Fold Belt to the west, together with volcanic lavas and tuffs, were transported into, and deposited throughout the trough by a major river system which ultimately reached the sea to form a large delta.

During the trough's 100Ma existence many factors simultaneously operated to influence the depositional environments. These included: varying rates of subsidence; varying periods of uplift and quiescence of the flanking fold belts; fluctuating sea levels; fluctuating climates and fluctuating tidal variations. At any one time many different depositional environments were present in various locations throughout the trough. At one stage almost the entire trough was covered by the sea.

Large deltas are complex structures, not only influenced by the processes listed above, but also by local influences including whether the delta is dominated by tidal, wave or stream processes.

Each of these varying influences dictate the geomorphic structures building the delta. Through time these factors may change from one to another and the delta may move laterally along the shoreline burying or eroding a previous form, or the delta may prograde seaward when stream dominated or be destroyed or buried when the sea moves over (transgresses) the land.

The Terrigal Formation is dominated by fluvial deposits including channel sands, point bar deposits, overbank deposits, stacked channels, palaeosols, and channel lags. Randomly orientated blocks of undercut overbank sediments are common in the channel sands

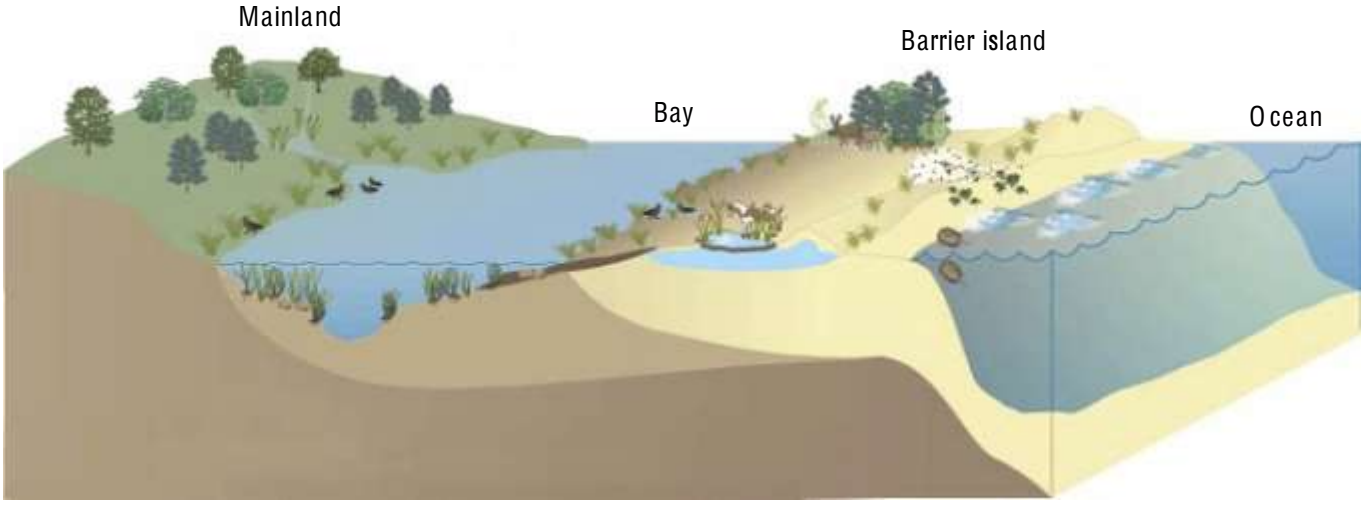


Fig 1. Diagram illustrating the structure of a barrier Island.

with one observed block comprising in excess of 5 m thickness of strata. There are also indications that these fluviatile deposits form part of a delta complex with barrier islands *(Fig 1),* salt marshes, levees, crevasse splays and distributary bays. All of the above deposits indicate a variety of environments at the one place but separated by time.

Terrigal Skillion and Broken Head.

Site A.

To examine the sedimentary structures on the southern side of the Skillion required us negotiating a short steep rough eroded track to the rock platform *(photo 1).* Upon reaching the rock platform the dramatic cliff line displayed rich red iron oxide stained sandstone and a prominent palaeo-riverbed cutting across grey laminated shales associated with a mud flat environment *(photo 2).*

The sediments observed were deposited on a tidal-flat on the landward side of a barrier island. The rear section of this system can be seen at Broken Head, immediately to the north of this location.

Grey and reddish siltstone interbedded with thin trough crossbedded sandstone *(photo 3),* Skolithos ** burrows, sand filled desiccation cracks, a cuticle-coal layer (coalified leaf-litter) and channelised erosional surfaces with ferruginous pebble lags are some of the prominent sedimentary structures that outcrop at this location.

Capturing our attention was a prominent mineralised joint that runs across the platform. This joint was offset with, in some places, the rock being brecciated. Where the joint terminated, both ends had large splayed distorted sections that may be fractured/ crushed horsetail splays *(photo 4).* This may suggest wrenching or faulting of the sandstone platform has occurred at some stage.

We also examined northern face of The Skillion, formed from deposits on the landward side of the proposed barrier-island featuring channelised and interbedded sandstone and grey shale. Within the grey shales some *Dicroidium* fossils were discovered *(photo 5).* The *Dicroidium* flora displays characteristics associated with a warm to hot dry climate.

*(**Skolithos: Straight vertical to slightly inclined cylindrical tube burrows. Walls of burrow are smooth with structureless fill. Can be slightly J-shaped)*

Site B.

To examine the floodplain and channel bar deposits of the lowermost units of the Terrigal Formation, we walked onto the Broken Head rock platform to site B *(photo 6).*

Channelised and interbedded sandstone and grey shale, prominent ferruginous pebble lag deposits can be seen in the cliff above the rock platform *(photo 7).* The ferruginous clay that drapes along crossbeds may define tidal bundles and reverse direction ripples. About halfway around Broken Head the rock platform consists of a noticeable, smoothly-weathered, off-white, very well-sorted, medium grained sandstone. The top surface shows vertical escape burrows, and numerous depressions. Controversially, some workers have interpreted these depressions as reptile/amphibian tracks.

Numerous rip-up clasts along with larger blocks displaying fine laminae are abundant *(photo 8).* One clast in particular had a nice kink fold, suggesting distortion while still in a plastic state. These blocks were probably undercut lakebed deposits that had collapsed into a

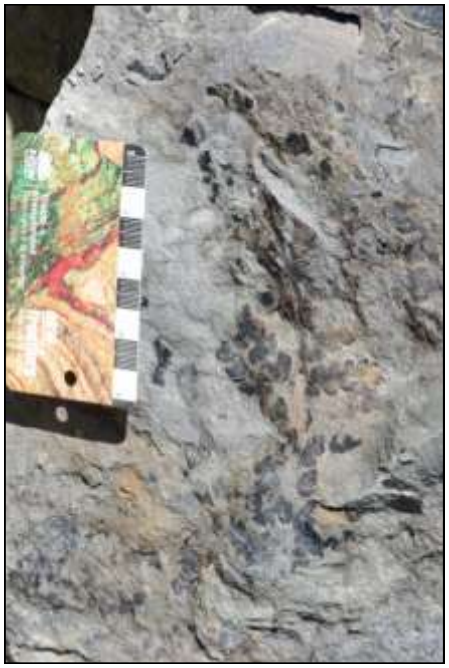
Headland at Terrigal showing the sites examined.

1. Rock platform on the southern side of the Skillion. Trough crossbedding in the sandstone was obvious.

2. Reddish sandstone overlying a channel floor deposit that has eroded grey laminated shales during deposition.

3. Trough crossbedding in sandstone of the Terrigal Formation.

4. Brecciated splayed end of a mineralised (iron oxides) joint.



5. *Dicrodium* fossil. The black leaflets consist of carbonized cuticle.

6. Broken Head rock platform and cliff exposing the lowermost units of the Terrigal Formation.

7. Pebble-lag deposit within cross bedded sandstone.

8. Rip-up clasts of fine laminated rock incorporated into a sandstone layer forming a sedimentary breccia.

9. Sandstone overhang at Broken Head resulting from the more rapid erosion of the underlying rock.

10. Aboriginal axe grinding groves in sandstone on the western side of Broken head rock platform.

flowing river.

Also observed was mineralised jointing with a horsetail splay that had cut through a large 5 m long block displaying fine laminations, indicating movement or wrenching after lithification. Horsetail fractures splay asymmetrically out, often on one side of the main fault in a fan-shaped network. They tend to develop where the slip dies out more gradually towards the fault tip.

A very prominent wave-like structure that runs along the cliff at the back of the rock platform is a result of differential weathering due to the varying competency of the different sedimentary layers *(photo 9)*.

We also discovered aboriginal axe grinding grooves near the boat shed that overlooks Terrigal Haven. These oval-shaped indentations are evidence of the indigenous heritage in this area *(photo 10)*. The axe grinding grooves are in sandstone. Aboriginal people made the grooves when they shaped and sharpened stone axes by grinding them against the sandstone. Flat, low outcrops of fine-grained sandstone were used to give stone axe heads a sharp cutting edge.

Little Beach.

After lunch at Terrigal we drove approximately 13 km south to Little Beach near Macmasters Beach (see map above). From the car park we walked ¾ of a km through tall coastal forest along a steep undulating gravel track to Little Beach. Reaching the beach we explored the rock platform at the southern end where

11. Overlapping channel-fill deposits exposed in the cliffs, Little Beach .

the rocks are also associated with the Terrigal Formation.

The sea cliffs here reveal an excellent section through a vertical stack of overlapping river channel deposits formed as the river meandered back and forth over the delta (*photo 11).*

This is probably the best example of stacked river beds in the Triassic deposits of the Sydney Basin.

The coastline in this area has been interpreted by McDonnell (1974) as deposition in an alluvial in-channel floodplain environment. The in-channel environments recognized include channel floor, channel bar, point bar, and abandoned channel. Floodplain environments are not so strongly differentiated, but include levee, back-swamp, marsh, and crevasse splay.

Fluvial sheet sandstones outcropped in the vertical cliff faces. These strata are interpreted as braided river sandstones on the basis of sedimentary structures, internal erosion and growth surfaces *(photo 11).* These rocks represent more than a single phase of deposition and the internal erosion surfaces indicate truncated streambeds or more significant riverbeds.

Channel stacking may have occurred in two ways: relocation of rivers in the same area over time, or an abrupt change in the course of a stream or anabranch within a braided river within a hierarchy of channels

12. Channel cross-stratification.

13. Tessellated pavement. The raised borders are due to hardening in joints by mineral deposition while the flat surface of the blocks have eroded more rapidly.

(photo 12).

Tessellated pavements *(photo 13)* were also observed on flat sections of the rock platform.

From this point we ventured around to the northern end of Little Beach, carefully negotiating boulders that covered the rock platform. The boulders have either fallen from above, or were washed ashore by rough seas. The sedimentary structures at the northern end of Little Beach become very complex. There are numerous examples of pebble lag deposits and abundant rip-up clasts in a variety of bedding features.

One curious anomaly covering part of the rock platform was a thin deposit/veneer of dark coloured muddy sandstone containing angular fragments of cherts and other rocks plus rounded cigar shaped ironstone concretions. This was interpreted as a possible flood deposit after a levee bank collapse. An unusually thick bed of rip-up clasts (sedimentary breccia) was also seen in the northern part of the rock platform *(photo 14).*

A spectacular sheer cliff face that plunges into deep water allowing the breakers to smash against the rocks face sending the water and spray high into the air prevented any further exploration *(photo 15).* So all that was left was to make our way back to the beach and our vehicles and call an end to the day.

Report by Chris Morton with geology by Winston Pratt.
Photos by Chris Morton (2, 9, 15) and
Ron Evans (1, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14)

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14. Sedimentary breccia layer overlain by sandstone with a honeycomb weathered face.

15. Looking north from Pretty Beach rock platform.

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When the Ocean Floor Came Ashore - Port Macquarie Coastal Geotrail

Leaders: Ron Evans and Chris Morton.
Date: Monday 25th to Wednesday 27th June, 2018.
Attendance: 27 members.

Preamble.

The Port Macquarie trip was mooted after Robin Offler from Newcastle University presented a talk on the new Port Macquarie Coastal Geotrail at West Wallsend Workers Club on 28th January 2018.

Brian England was the obvious choice of leader for an AGSHV trip to explore the geotrail, having explored every part of the Port Macquarie coastline repeatedly since 1966 and led two previous AGSHV trips to the area (England, 2008). He has also carried out research on many of the mineral occurrences.

Brian, Ron and Chris visited the geotrail prior to the excursion to ensure that all the mentioned features could be located easily. Brian had also prepared detailed notes to be handed out to each participant expanding on the information present in the Port Macquarie Coastal Geotrail brochure.

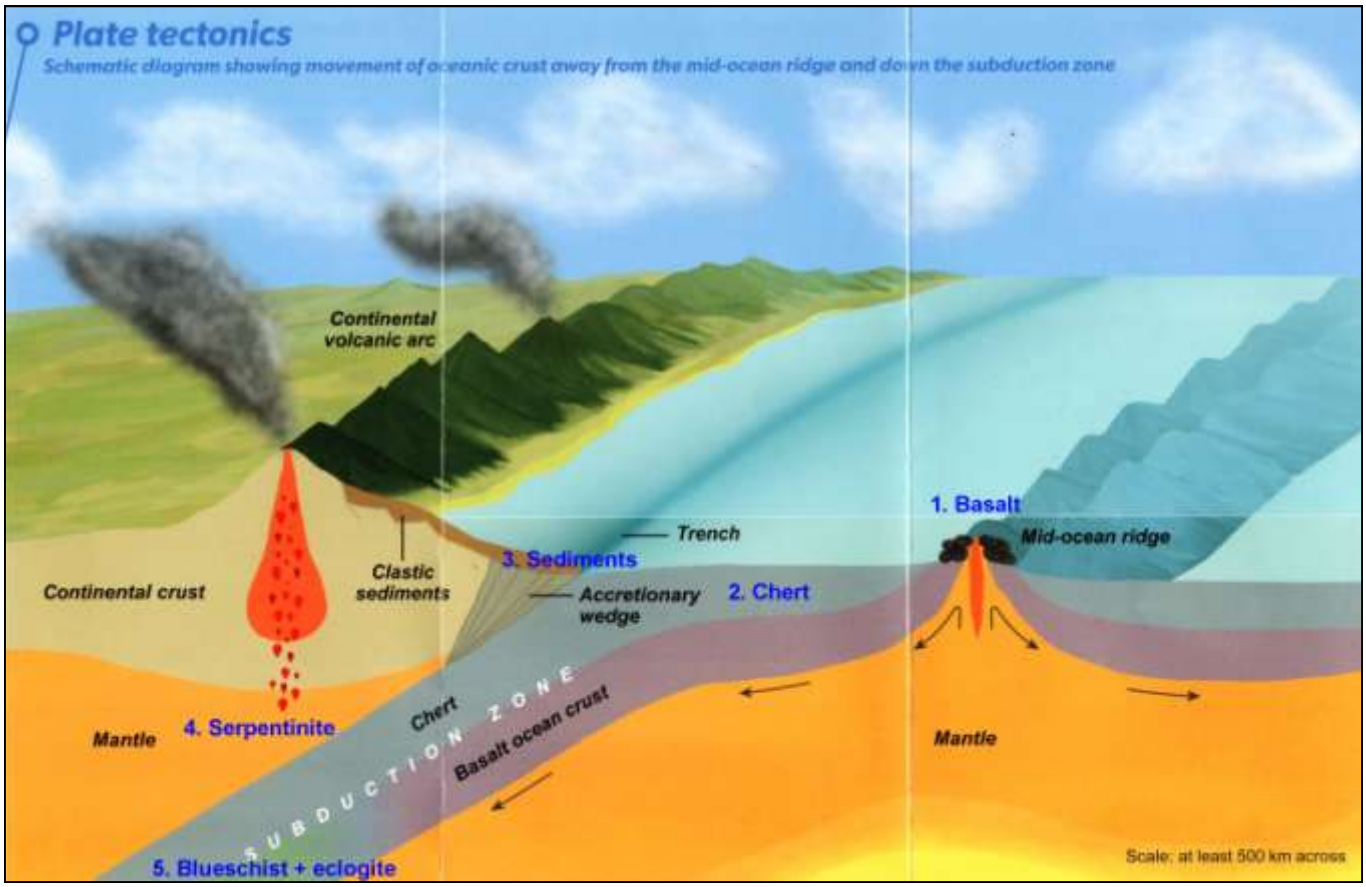
However, Brian was bitterly disappointed to have to pull out the activity due to his mother's sudden illness and even had to abandon plans to show the group his special sites on day 2 of the trip. With Ron also unable to be present on that day this task fell to Chris who handled the day admirably.

Very fortunately Lin Sutherland, who lives in Port Macquarie with his wife Gayle, was able to attend day 2 and fill in additional detail on the sites visited. New member, geologist Bill Darcy from Queensland, was also able to assist. The todorokite (a complex hydrous manganese oxide mineral) locality on the cliffs south of Oxley Beach could not be visited due to wet conditions, but Lin was able to show participants a specimen Brian had given him a few years ago.

Introduction.

Plate tectonics explains how the Earths crust forms and moves.

Earths crust or lithosphere in made up of a number of major and several minor tectonic plates that move relative to each other. Plates may be convergent (as they were along the coast at Port Macquarie), divergent (like they are at mid-ocean ridges and the Great Rift valley in Africa) or transform (they slide past each other as occurs along the San Andreas fault).



The blue labels 1 to 5 indicate the position in which the rocks observed along the coastal geotrail formed.

Along mid-ocean ridges, new rock slowly rises up to the surface as basaltic magma from the mantle. This pushes the oceanic plates adjacent to the ridge apart.

Over time, the newly formed oceanic crust moves further and further away from each side of the ridge until it meets other plates.

In the location of what is now Port Macquarie, the convergence of the ocean plate with the edge of the continental plate along what was then the east coast of Australia occurred.

Port Macquarie Geotrail.

The trail has been cleverly designed to tell the extraordinary story of the destructive plate margin while avoiding the complexities that are unique to Port Macquarie. Here the ophiolite (sea floor) sequence has been dismembered and the components scattered in confusion along the present coastline during a process called obduction in which the ocean floor is pushed up over the land surface instead of subducting.

The geotrail spans the equivalent of up to 6,000 km across the Pacific Ocean of today, in just 4 km from Shelly Beach to Rocky Beach.

Some rocks are made of microscopic marine organisms, others were formed by volcanoes or underwater gravity (turbidity) currents. Some rocks formed at high pressures over 100 km below Earth's surface, and were later brought to the surface by faulting or obduction, as at Port Macquarie.

The plate tectonics diagram (above) illustrates the processes involved and indicates where these rocks formed (blue labels).

The geological map on the next page shows where these rocks outcrop along the coastal strip of Port Macquarie covered by the geotrail.

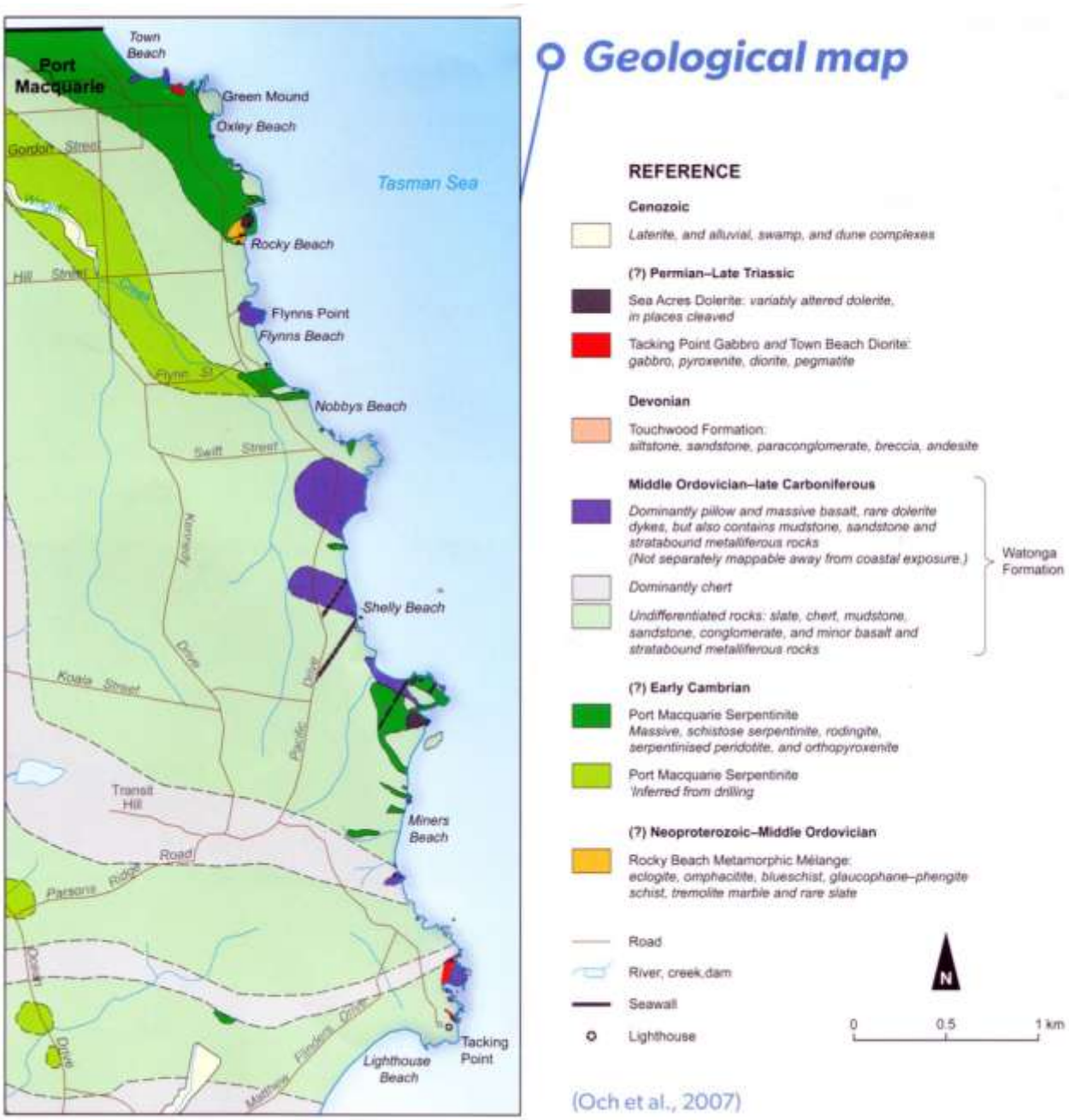
The Port Macquarie Coastal Geotrail followed was as per the map from the brochure shown on page 24.

Monday 25th June.

All participants met in the camp kitchen in Flynns Beach Caravan Park at 5 pm where they were welcomed by President Chris and provided with Port Macquarie Coastal Geotrail brochures and other reference material.

Ron then presented an outline of what we were going to look at the next day along the geotrail and gave an outline of plate tectonic processes that caused the formation of the rocks present along the geotrail.

Those present were asked to car-pool the next day to reduce the number of vehicles present and to make parking easier.



1. Examining and photographing pillow basalts.

2. Pillow basalt (spherical lobes).

Tuesday 26th

Tuesday 26th June.

Participants in the days activity left Flynns Beach Caravan Park at 9 am, driving to and parking at Shelly Beach. There, Ron explained the days program before leading the way south along Shelly Beach.

Stop 1: Volcanoes under the sea

At southern Shelly Beach, rocks formed at the start of their plate tectonic journey across the ocean outcrop. Ocean crust is mostly formed from a dark, fine-grained volcanic rock called basalt. This type of rock forms in mostly underwater (or submarine) volcanoes in places like the mid-ocean ridge. On southern Shelly Beach the basalt flowed out of submarine volcanoes as molten lava that cooled in the shape of pillows. Sometime after the first cooling episode, new molten basalt was injected into the ocean floor crust as long, thin fingers called dykes. In some locations, basalt first cooled slowly deep in the earth forming big shiny feldspar crystals, before later flowing out onto the seafloor and forming the smaller surrounding dark crystals. (Port Macquarie Coastal Geotrail)

We identified and examined pillow basalts *(photos 1 & 2)* and associated dykes *(photo 3),* and further along the beach, porphyritic basalt containing large feldspar crystals *(photo 4).*

Stop 2: Death on the seafloor

In the middle of Shelly Beach, rocks called chert formed part way along their plate tectonic journey. After the ocean crust basalt (Stop 1) was formed, it travelled away from the mid-ocean ridge and began to collect sediment on top. This sediment mainly formed from tiny marine organisms such as radiolarians that lived near the surface of the ocean. After death, their skeletons rained down on the sea floor. They collected in layers above the basalt. These layers formed from variations in the type and amount of marine skeletons and the amount of external sediment added. When thick layers of sediment built up, pressure and chemical changes converted the fossil skeletons into the rock we call chert. As the chert was transported towards the trench, it commonly slumped and slid, forming sinuous folds. Fossils known as conodonts (jaw structures of oceanic eel-like animals) can be used to date the chert, which at Port Macquarie is around 460 million years old. (Port Macquarie Coastal Geotrail)

The cherts in the area were easily identified by their lighter colour, fine grain size, extreme hardness and banded nature. Kinking and folding was present in some rock outcrops examined *(photo 5).*

Due to the low tide, the boundary between underlying basalt and the overlying chert was clearly visible and easily identified due to the underlying basalt being deeply weathered to shades of brown *(photo 6).*

3. Basalt dyke cutting pillow basalt.

4. Porphyritic basalt. Note how the plagioclase crystals are aligned indicating flow movement during solidification.

5. Folded and faulted banded chert.

6. Basalt/chert boundary. The weathered basalt in the foreground has eroded more than the harder chert sitting on top of it.

7. Outcrop of turbidites, Nobby Head easily examined from the rock platform.

Stop 3: Sediments move from land to sea

On the northern side of Nobby Head, you are mid-way along the geotrail. The ocean plate was also mid-way along its tectonic journey, nearing a subduction zone and a chain of volcanoes. Here, sediments were eroded from the volcanoes and deposited nearby in the ocean. The sediments were transported by gravity-driven (or turbidity) currents downslope into a trench, where they accumulated with the marine cherts in deposits called turbidites.

Trenches lie next to chains of volcanoes either in oceanic or continental areas and are the deepest parts of the ocean. After leaving the trench area, the ocean plate and the sediments riding on it descended into the subduction zone, where they experienced increased heat and particularly pressure. There they underwent slumping, sliding, folding and faulting. (Port Macquarie Coastal Geotrail)

Once again, thanks to the low tide, we were able to access the rock platform *(photo 7)* associated with the outcrop of mixed sediments which provided close up views of these rocks.

Very obvious in one outcrop was a mixture of siltstones and mudstones (carried down the trench by turbidity currents) and land-derived sediments *(photo 8)*.

Associated with the turbidites were patches of black manganese oxide deposited as a secondary mineral *(photo 9)* in cracks, typically showing a reniform habit.

A photograph of Nobby Head *(photo 20)* is on page 29.

8. Bands of mudstones (dark) with siltstones (light) mixed with folded cherts (brown) and land derived sediments. The layers were folded during subduction.

9. Deposit of manganese oxide along cracks in rocks at Nobby Head.

Stop 4: Down the subduction zone

The rocks at Flynns Beach descended into the earth down a subduction zone and affected the mantle rocks around them. The original mantle material surrounding the basalt was transformed into a rock called serpentinite, which has a soft greasy feel and is commonly bright green. This colour is due to the original dark mantle minerals transforming into greenish minerals such as lizardite and antigorite as a result of heat and water produced during subduction. Serpentinite was formed at depths of 1-60 km, where pressures are low but temperatures are relatively high (350-600°C). Due to stress in the earth, or shearing, the serpentinite has a strongly aligned texture called cleavage (schistose serpentinite). It also contains unsheared, large dark fragments of the transformed mantle (called phacoids), making it look like green fruit cake on cliff faces. Serpentinite is exposed at the southern headland of Flynns Beach. (Port Macquarie Coastal Geotrail)

Following lunch at Flynns Beach surf pavilion café, we walked south along Flynns Beach to a small headland composed of Port Macquarie Serpentinite *(photo 10)*.

Before examining the serpentinite cliff, we walked up a set of steps leading to the southern side of the headland situated at the northern end of Nobbys Beach. Here we located several small lamprophyre dykes that had intruded the serpentinite *(photo 11)*.

One dyke clearly showed chilled margins and a coarsening of crystals towards the center, the result of slower cooling in the center of the dyke *(photo12)*.

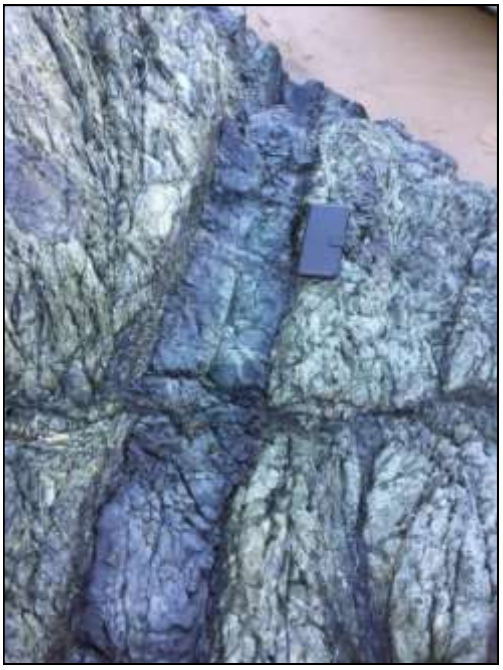
Near one dyke, a patch of black vitreous schistose serpentinite was discovered *(photo 13)*. This was most unusual as none of our group had ever seen such an occurrence before.

Returning over the steps to the northern side of the headland, we spent time looking at and discussing the serpentinite and its associated phacoids. One observed had been displaced by faulting *(photo 14)*.

A small outcrop of talc was discovered *(photo 15)* near the serpentinite outcrop. Talc in hydrated magnesium silicate formed by the metamorphism of magnesium rich minerals (such as serpentine) in the presence of carbon dioxide and water.

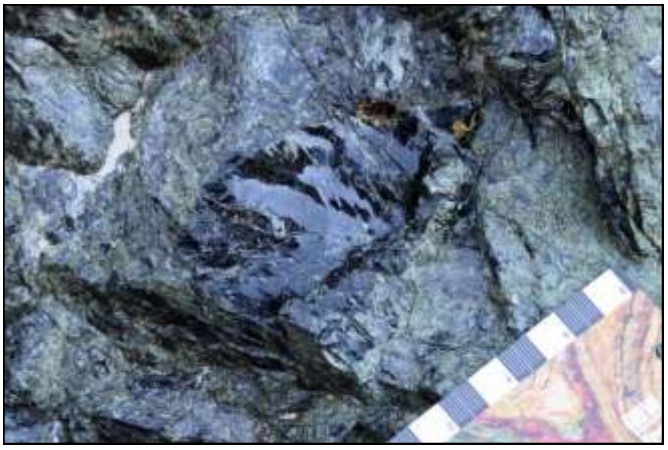
We then walked to a headland at the north end of Flynns Beach where we were able to view an excellent example of pillow basalts *(photo 16)*.

10. Serpentinite outcrop at the southern end of Flynns Beach.



11. Lamprophyre dyke intruding schistose serpentinite.

12. Note the dark chilled margin and coarser greenish minerals in the centre.



13. Black vitreous serpentinite outcropping near a lamprophyre dyke.

16. Outcrop of pillow basalts. Note how the roundish lobes of basalt are stacked on top of each other. Flow markings on outer surfaces are beautifully preserved.

14. Chris pointing out a phacoid of massive serpentinite displaced by faulting.

15. Small outcrop of talc probably formed by the metamorphism of serpentine minerals.

Stop 5: Rare rocks from deep Earth

The rocks at the north end of Rocky Beach represent the end of the plate tectonic journey. Around 460-490 million years ago, after travelling thousands of kilometres across the ocean, these rocks were dragged down (or subducted) as part of a crustal plate to depths around 104 km below the surface, and to temperatures around 570°C. We know subduction happened at Rocky Beach due to the special rocks and minerals found here. They only occur deep in subduction zones and include blueschist and eclogite. They are very rare to find on Earth's surface today.

Blueschist is a deep blue colour and has beautiful minerals such as phengite, which has been folded during the subduction event. Eclogite is an emerald green rock composed of attractive minerals such as omphacite and lawsonite. (Port Macquarie Coastal Geotrail)

These rocks only form at extremely high pressure and must be brought to the surface very quickly to be preserved without alteration. At Port Macquarie the blueschist is made up of the blue sodium rich amphibole glaucophane (identified by XRD). It is amongst the purest occurrences of glaucophane known, although some chlorite is also present in patches (Richard bale).

After leaving the outcrop of pillow basalts, we walked up Tuppenny Road (the road from Pacific Drive to Flynns Beach) to a sharp bend where a lookout is situated.

From the lookout, a steep track follows the ridge down to Rocky Beach *(photo 17)*. After all made it safely down, we walked to the north end of Rocky Beach where we located outcrops of blueschist and associated greenish eclogite *(photo 18)*.

Some of the outcrops of eclogite contained garnets weathered to a brown colour *(photo 19)*.

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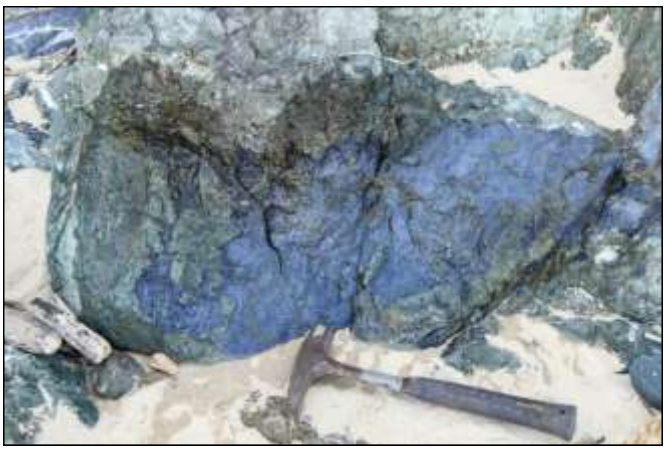
17. Steep narrow track from Tuppenny Road down to Rocky Beach.

20. Nobby Head and Nobby Beach as viewed from the southern end of Flynns Beach.

Wednesday 26th June.



18. A piece of blueschist and greenish eclogite.

Today's exploration was in addition to the Port Macquarie Coastal Geotrail that we followed on Tuesday, none the less it was just as important and spectacular. Our meeting point at Oxley Oval/Sports Ground opposite Oxley Beach on a breezy, overcast morning, with showers threatening was strategically planned. One of our members Lin Sutherland, volcanologist and retired head of the Earth Sciences Department at the Australian Museum, joined us for the day. Before setting off, Lin informed us about a small but rich iron ore operation here. The mine pit operated at what is now the Oxley Sports Ground. The history of the mine is not well documented and is mainly anecdotal. The iron ore deposit was mined at this site between 1903 and 1951. There seems to be no history of rehabilitation of the mine site on what is now a sports ground. The only official record that I could uncover is cited below.

At Port Macquarie on the North Coast of, New South Wales, deposits of magnetite-hematite have been quarried continuously since 1903 for use in gas purification. Before 1903 some ore was mined for its cobalt and manganese content. The iron ores are residual deposits derived from the weathering of underlying serpentine. The thickness of residual material over the serpentine reaches 60 feet and averages about 16 feet. The ore contains 38 to 50 per cent iron, 7 to 17 per cent silica, and 6 to 16 per cent alumina. Reserves have not been determined but they appeared to be sufficient for fifty years at the 1950-51 rate of production, namely 10,000 to 12,000 tons per annum (Barrie, 1961).

19. Eclogite and blueschist. Note the brown patches in the eclogite. They are weathered garnets.

Another interesting fact not mentioned in Lin's address was evidence of gold mining at Port Macquarie. Although this venture never really amounted to much, there was mention in the newspaper of the day, the Town and Country Journal on November 11, 1853. This small article was found in TROVE. I have copied the article verbatim mistakes and all.

Gold at Port Macquarie: FIELD BEING - OPENED UP.

A new gold field is being opened up two miles from Port Macquarie. Gold in the beach sand first drew the attention of prospectors. About 40 miners are how on the ground. Good prospects have been obtained in the alluvial wash drifting down a steep bank on to the beach. The gold is found generally fine ánd up to the size of grains of corn. The red flag has not yet been hoisted, though a good number of claims have been pegged out. Close at hand a large defined lode of cobalt ore has been found. The country is generally serpentine, and other minerals are plentiful, viz., magnetic iron, copper, nickel, manganese, and traces of silver. There is no reason as yet to rush the new field. A reply has been received by the Under-Secretary for Mines from the warden's office, Kempsey, respecting the discovery of alluvial gold in the face of the cliffs two miles south of Port Macquarie. One prospector found gold at the Nobbles, a few feet from . an old- shaft Bunk in search of copper many years ago, whilst another find was made about half a mile away at Shelly Beach. The gold is of a rough scaly description, and not waterworn. The wash is on a level with the seashore, going back inland, and good color is found in every dish. Six claims were pegged out. The warden thinks it premature to state that a payable find will result. Another party working at a sluicing machine on the black sand at Shelly Beach cleaned up in a couple of days, and got a return of over 1oz to the ton.

Lin also spoke of an interesting manganese wad that Brian England had found in this area a few years earlier, and had later gifted a sample to him *(photo 21)*.

This manganese wad is a dull black substance that forms in veins and irregular patches in the weathered serpentinite outcrops along the sea cliffs. It is the residual poorly-crystalline insoluble oxide material left behind during weathering.

XRD analysis shows this wad to comprise major barian todorokite and minor magnetite, with small amounts of hematite formed by magnetite oxidation. Not surprisingly, chemical analysis shows the wad to contain significant amounts of nickel (around 3.5% NiO) and cobalt (around 6% CoO), which are characteristically associated with ultrabasic rocks similar to those from which the serpentinite was derived. These elements occur in todorokite replacing some of the manganese. What is surprising however, is the presence of the complex cerium silicate Cerite-Ce,

21. Manganese wad from the cliffs south of Oxley Beach.

22. Shelter cave, northern Oxley Beach.

which accounts for the presence of up to 4.5% Ce_2O_3 in chemical analyses of the wad. (England, 2008). It was scattered deposits of this wad that supported short-lived cobalt mining in Port Macquarie.

We proceeded across the road onto Green Mound at the northern end of Oxley Beach, where we examined the rocky point consisting of the chert-slate-sandstone and metabasalt assemblage of the Watonga Formation (Buckman et.al., 2014). Here some of our members sought shelter from a passing light shower in a small sea cave *(photo 22)*.

The sedimentary and igneous rocks have experienced low-grade metamorphism and episodic deformation, with the earliest event predating complete sediment consolidation from the middle Ordovician to late Carboniferous (Och et.al, 2007).

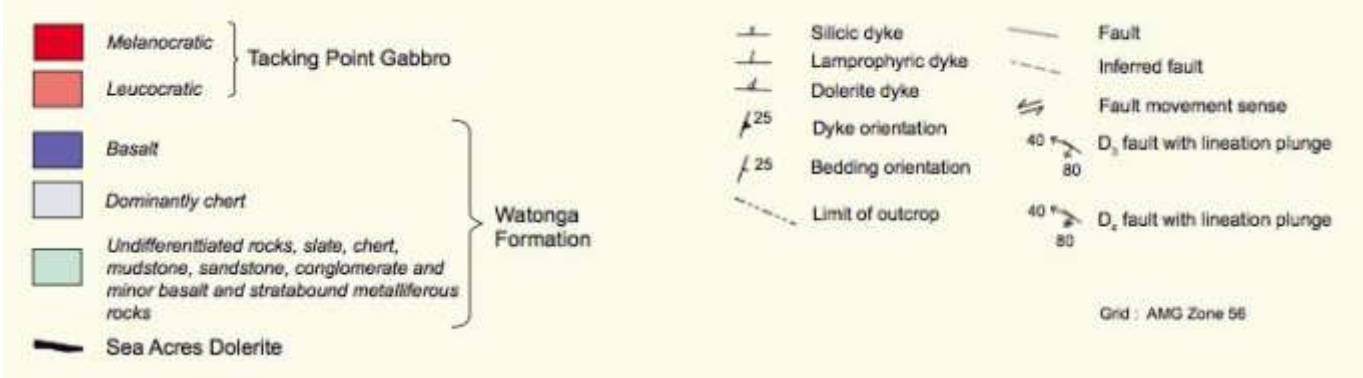
23. Offset injection dyke, northern end of Oxley Beach.

24. Chevron fold within a small dyke within distorted sandstones.

26. Tacking Point and lighthouse.
The outcrop of rock in the foreground is leucocratic Tacking Point Gabbro.

25. Magnesite veins (white) within serpentinite at the southern end of Oxley Beach.

Detailed geological map of the area immediately north of Tacking Point. (Copied from Och, et.al. 2007.



27. Contact between banded cherts and gabbro.

28. Intricately folded banded chert.

29. Tacking Point gabbro melange.

At the eastern end of Town Beach, quartzo-feldspathic volcaniclastic sandstone (Parker, 2010) forms the entire headland and tectonically underlies the Town Beach serpentinite unit (Buckman, Solomon et.al 2013). Here the rocks display chaotic quartz veins, box-work jointing, faulting, folding and various sized igneous dykes. One prominently weathered dyke displayed two periods of deformation by faulting *(photo 23)*, one while the rock was still fluid and one after the rock had cooled and hardened *(photo 24)*.

From here we walked to the southern end of the Oxley Beach, where the geology is very different. This rocky headland is characterised by Port Macquarie Serpentinite, with evidence of hydrothermal fluid activity, adding the complexity of the serpentinite. A section of the cliff face displays a prominent web of magnesite veins *(photo 25)*. The rock platform below the cliff face at one point has fine gossamer veining of a yellowish mineral, showing evidence of migration of hydrothermal fluids through micro fractures within the rock. One section of the rock platform had a definite burgundy tinge indicating higher iron content. Also there are 1 m size chert blocks incorporated within the serpentinite platform and an interesting 20 cm igneous dyke that displays a step and bifurcation intruding the cliff face towards the southern end of the headland. From here we decided to disperse and have our lunch before meeting at Tacking Point at 1pm *(photo 26)*.

The name Tacking Point Gabbro relates to a small surface exposure of a pluton consisting of pyroxene-rich melanocratic gabbro and plagioclase-dominated leucocratic gabbro, gabbroic pegmatite and aplite (microleucogabbro) that were intruded into the Watonga Formation (Ordovician) during the Permian.

This pluton is exposed on the shore platform in the intertidal area 200 m north of Tacking Point, the source of the name. Included in the unit are irregular gabbro dykes. *See (Och et.al., 2007) for more detail.*

This dramatic and complex area is very difficult to define. The pluton preserves intrusive contact with cherty broken residue of the Watonga Formation.

30. Large isoclinal fold within gabbro melange.

31. Basalt dyke intruding gabbro exhibiting a chilled margin.

32. Dyke rock is magnetic (due to magnetite) as shown by a magnet within the film canister.

33. Intrusions within gabbro seemingly injected along fractures.

Xenoliths of the Watonga Formation are present within the pluton. A 100 m roof pendant of basalt is exposed within the pluton, with a large outcrop of Sea Acre Dolerite along with a differentiated basalt dyke that has strong magnetic qualities and a maze of various igneous intrusions.

At the bottom, not far from the stairs you encounter what would have been the magma chamber, a very complex tortured, chaotic and untidy collection of rocks that has endured multiple deformations. The boundary between the gabbro and chert is very distinct with the ribbon chert folded along the contact zone *(photo 27)*. Further inspection of the chert not far from the intrusion of gabbro shows intricate folding of banded chert, which was possibly from seismic activity, or slumping from gravity driven movement, a result of tectonic activity before consolidation *(photo 28)*. There are ample examples of terrestrial sediments identified as slates, mudstones, sandstones etc. in close association with the chert on the southern end of this complex.

The leucocratic gabbro (light in colour) shows numerous injections of melonocratic gabbro (dark gabbro). Other intrusions includes breccia, dykes (some being offset) and xenoliths, a result of different viscosity or density of individual gabbro's, indicating mixing while still in the molten stage. A small section of gabbroic rock displayed a pink hue; this was thought to be plagioclase, which surprised our geologists.

From the pocket size beach a prominent saddle joining onto a circular knoll that represents a 100 m roof pendant of Watonga Formation basalt separates the two exposures and has to be crossed to examine the rest of this extraordinary area. Descending into what was a magma chamber you are confronted with a confused assemblage of rocks *(photo 29)*, which is described in an abridged excerpt below *(from Och et.al., 2007)*.

The Tacking Point Gabbro (Och et al., 2007a) is multi phase intrusion, with medium to coarse-grained hornblende-bearing gabbro, leucogabbro and tonalitic suites. Although predominantly massive, some zones exhibit evidence of layering between leuco- and melano-gabbroic phases as well as signs of magmatic mingling suggesting there were repeated injections of mafic melt into a more felsic, fractionating magma chamber. The Tacking Point Gabbro contains isoclinally folded pendants of Watonga Formation chert and basalt which in some cases have been completely bleached and recrystallised. The intrusive rocks are only weakly deformed. A minimum age of 359 Ma emplacement. Tacking Point gabbros plot well within the typical range of island arc igneous rocks. (Buckman, Solomon et.al 2014).

The Tacking Point Gabbro was tentatively accorded a Permian age (Och, et.al, 2007). However more recent work has U/Pb zircon 390±7 Ma is Middle Devonian (Buckman, Solomon et.al 2014).

A notable large isoclinal fold *(photo 30)* along with a sizeable Sea Acres Dolerite dyke are some of the features that dominate this area, along with a differentiated basalt dyke that displays a distinct chill

margin *(photo 31)* along with strong magnetic quality *(photo 32)* that has been weakly folded . The magnetism is probably due to a high concentration of magnetite. Interestingly the basalt roof pendant did not seem to display the same magnetic qualities as this dyke, which implies alteration, or more likely, a much later intrusion.

Near the northern edge of the pluton there are numerous igneous intrusions. These seem to be intruding along joints and fractures rather than being injected into the gabbro like those on the southern section of the pluton. Remarkably one intrusion resembled the letter A *(photo 31)*.

This brought our excursion to an end, all that was left was to return to the car park and walk to the lookout and marvel at the whales, that were engaging in their annual migration north.

Report Monday and Tuesday by Ron Evans.
Photographs by Ron Evans

Report Wednesday by Chris Morton and Joan Henley.
Photographs by Chris Morton.

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OCH, D.J., LEITCH, E.C. and CAPRARELLI, G. (2007). *Geological units of the Port Macquarie-Tacking Point tract, north-eastern Port Macquarie Block, Mid North Coast region of New South Wales.* Quarterly Notes October 2007 No 126, Geological Survey of New South Wales.

TROVE. https://trove.nla.gov.au/newspaper/article/71191665

Piles Creek Walk

Leader: Barry Collier.
Date: Saturday 22nd September 2018.
Attendance: 15 members.

On 22nd September 2018, I had the pleasure of leading a group of 15 people on one of the most scenic walks on the Central Coast. We met on the old Pacific Highway, 300 m north of the bridge over Mooney Mooney Creek, where there is vehicular access to the Hawkesbury Track.

We then organised a car shuffle and drove everyone in half the cars to Girrakool. From Girakool, there is a 4.5 km loop track along both sides of Piles Creek. As there was very little water flowing over the waterfall and as it was mid September, the peak wildflower season, I decided to go down the eastern side of the creek where there is better habitat for wildflowers and more gullies.

First stop was a lookout overlooking the main waterfall, although most of the fall cannot be seen. We then crossed the creek and got slightly better views of the falls before heading along the track.

Along the track, we soon came into some great wildflower displays, dominated by Toothed Phebalium *(Leionema dentatum)* and two rare, but very beautiful Boronias, *Boronia fraseri (photo 1)* and Native Rose *(Boronia serrulata)*. Below the track, in sheltered areas, were stands of large shrubs covered in bright yellow flowers, *Pulenaea blakelyi*. When the Threatened Species Conservation Act was passed, Native Rose was listed as a threatened species, but the authorities soon realised around 90% of them occur in national parks, so it was removed from the threatened species list.

The track also passed some large overhangs, with great rock formations in them. One had a fascinating excretion of iron carbonate, almost looking like a limestone shawl *(photo 2)*. A little further on we passed three interesting caves, two with spectacular honeycomb weathering *(photo 3)*.

Further on, the track became quite rough as is passed through Rat Gully. There was once a bridge over the gully, but it was washed away by floods and NPWS replaced it with some very irregular steps. Rat Gully contains one of the most beautiful waterfalls on the Central Coast, but there are no tracks to it and on the day there was no water, so we didn't bother about it.

Not far past Rat Gully the track joined the Hawkesbury Track, part of the Great North Walk and we were to follow that track almost to the bridge over Mooney Mooney Creek. We shortly crossed Piles Creek, over the suspension bridge *(photo 4)*, built after the previous bridge was also washed away by floods.

Immediately over the bridge we had morning tea

at the place titled on Google Map as Rest Ground for the Great North Walkers *(photo 5)*.

From there the track followed the edge of the Piles Creek flood plain, with interesting vegetation, dominated in places by Mountain Blue Gum *(Eucalyptus deanei)*, Swamp Oak *(Casuarina glauca)* and Grey Mangrove *(Avicennia marina)*. There were some interesting cliff lines above the track and we saw some clumps of Blunt Greenhood orchids *(Pterostylis curta)*. We also saw some quite pretty little crabs, Haswell's Crabs, along the foreshore.

About 300 m before the bridge over Mooney Mooney Creek, the track joined Mooneey Mooney Creek, which we followed to just before the bridge *(photo 6),* where we walked up to the waiting cars and then drove back to Girrakool.

After lunch, we did the short loop upstream from the picnic area. The trail passed through bushland, almost to the northern boundary of the park, then descended into Leask Creek, below a normally beautiful waterfall *(photos 7 & 8)*, which was just dribbling. There were a number of bright orange excretions of iron oxide, which were quite obvious without the cover of falling water.

The track then followed Leask Creek, almost to Piles Creek, before ascending up to the picnic area, past beautiful displays of Toothed *Phebalium* and *Pultenaea blakelyi*. We detoured over to the lookout opposite the main waterfall in Piles Creek *(photos 9 & 10)*, which still had some water going over it. While at the lookout, someone spotted a hawk flying past and landing on a nearby tree, so lots of photos were taken. It was a Crested Hawk, which lives in rainforests further north, but has only recently been observed near Sydney.

From there it was back to the cars and the end of another enjoyable day.

Report by Barry Collier.
Photographs by Barry Collier and Ron Evans (5 and 6).

2. Iron carbonate in cave ceiling Piles Creek Loop Brisbane Water NP.

3. Cave off Piles Creek Loop Brisbane Water NP showing 'honeycomb weathering'.

1. *Boronia fraseri beside track,* Girrakool Brisbane Water NP.

4. Bridge over Piles Creek.

5. Morning tea near the bridge beside Piles Creek, 'The Rest Ground'.

8. Fall in Leask Creek from below Andamira Lookout. (Not photographed during the walk)

6. Walkway beside Mooney Mooney Creek just east of the Mooney Mooney bridge..

9. Main fall on Piles Creek Girrakool Brisbane Water NP.

7. Fall in Leakes Creek, Girrakool Brisbane Water NP.

10. Main fall Girrakool Brisbane Water NP after rain.

Gresford/Allyn River Trip

Leaders: Janece McDonald & Lawrence Henderson.
Date: Sunday 21st October 2018.
Attendance: 18 members.

The majority of the group met at Bolwarra Lookout, a magnificent viewpoint overlooking the extensive Hunter River floodplain.

The group proceeded to the first stop at Gresford Museum. Here they were joined by local members and greeted by George Sales, President of Gresford Historical Society. Thank you George for opening the Museum and explaining some of the amazing exhibits.

The Gresford district has an extensive and rich history extending back to the first settlements in the 1820s. The museum contains artifacts, documents and photographs chronicling this history. There was much interest in the old schoolroom, images and artefacts re timber getting and the dairy industry and items long since redundant *(photos 1 & 2)*.

Next the group moved onto the Twin rivers café (named for the twin rivers being the Paterson and Allyn rivers) for a 'cuppa' *(photo 3)*.

Moving onward the group drove to Allynbrook, located 12 km north of East Gresford, across the Camyr Allyn Bridge, which spans the Allyn River. We arrived in light drizzle at the beautiful St Mary-on-Allyn Church *(photos 4 & 5)*. Here Ian and Narelle Bird made us very welcome and Ian gave a great history of the church *(photo 6)*. St Mary-on-Allyn Church, a sandstone church was built in 1840 on the banks of the Allyn River at Allynbrook. Located within the churchyard are the tombs of William and Mary Boydell. Mary was the daughter of Bishop Broughton, the first Bishop of Australia. William Boydell was travelling to Australia on the same ship as the Bishop and his family in 1836.

2. Two unlikely lads in the Gresford Museum.

William and Mary began a relationship and Bishop Broughton made it a condition of their marriage for William to build the church on his land grant. William and Mary were married in 1844 and St Mary-on-Allyn church was consecrated by the Bishop in November 1845. The church has an iron gateway with an old gas lamp. There are lancet-arched leadlight windows *(photo 7)* with timber tracery and a lancet-arched doorway topped by a gable with carved timber bargeboards. Caegwrle next door also has lancet arched windows and door. The public school adjacent dates back to 1881.

Narelle and Ian generously allowed us to have our "picnic" lunch in the church Hall due to the inclement weather and we thank them very much for their generosity. After lunch the group headed back towards East Gresford, turning into Lewinsbrook Road and arriving at the now disused-Dungog Council quarry *(photos 8, 9 & 10)*.

The geological setting of Lewinsbrook Quarry is Early Carboniferous Period, approximately 340 million years ago. The lithic fabric of the quarry has been named the Bonnington Siltstone. This formation outcrops in numerous places throughout the southern part of the

1. Richard Bale examining exhibits in the museum.

3. The group waiting patiently for coffees and cake.

4. Rod Fletcher leads the way into St Mary on Allyn Church.

7. Interior showing the beautiful stained glass windows in St Mary on Allyn Church.

5. A view of the cemetery attached to St Mary on Allyn Church.
Photograph by Ron Evans.

8. Lawrie explains the geological setting of the Lewinsbrook Quarry to an enthralled and captive audience.

6. Ian Bird relates the history of this beautiful and historic church. Originally, the church did not have the side naves.

9. The group let loose to explore the Lewinsbrook Quarry.

Tamworth Trough. The trough is bounded on the south western side by the Hunter-Mooki Thrust and the Peel Fault to the north east *(image 1)*. The formation of this Palaeozoic geosyncline is considered to be caused by the Proto-Pacific oceanic plate plunging beneath the continental plate of eastern Australia, resulting in an archipelago of volcanoes similar to what we see in Indonesia today.

The Bonnington Siltstone is an ash-rich offshore siltstone and the lower half of the Flagstaff Formation contains a thick sequence of volcanogenic turbiditic sandstone deposited in a fault controlled trough within a shallow marine shelf. The Bonnington Siltstone supported a single fauna species, brachiopods named *Orthotetes australis (photo 11)*. The siltstone consists of layers of a hard grey matrix containing volcanic ash particles mixed with terrigenous detritus eroded from the adjacent land. These layers were periodically interrupted by volcanic activity from the Gilmore Volcanic Group *(images 2 & 3)* raining excess ash over the marine shelf, smothering the brachiopods.

These appear to be quite numerous in the lower strata of the quarry, directly below each ash fall, but diminish with time. In the upper layers of the quarry, the brachiopods disappear altogether, indicating either a local extinction or a lowering of the sea level.

Report by Janece McDonald.

Reference:

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Image 1. Tamworth Trough.

11. *Orthotetes australis (Brachiopod)*. The literature indicated that this is the only species to be found.

10. Many robust discussions were undertaken.

Another species of Brachiopod found in the quarry.

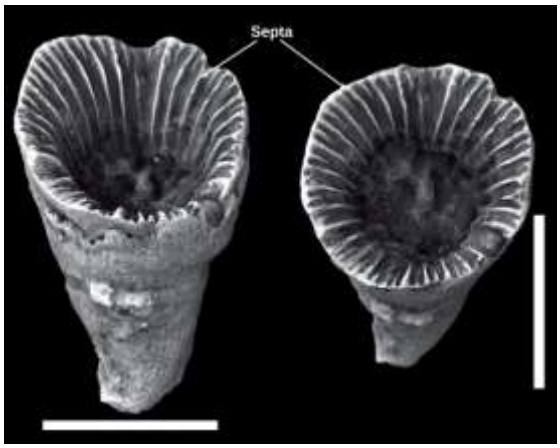
Gilmore Volcanic Group

- Eagleton Volcanics
- Mobray Formation
  - Brechan Sand
  - Brechan Ignimbrite Member
  - Lambs Valley Ignimbrite Member
- Newtown Formation
  - Hudsons Peak Ignimbrite Member, Johns Hill Ignimbrite Member, Martins Creek Ignimbrite Member
  - Vacy Ignimbrite Member

Source: Australian Stratigraphic Units Database, Geoscience Australia, 1988

Images 2 & 3.

Several specimens of solitary rugose corals were found. Also found were fossilised terrigenous vegetation fragments.



Solitary rugose corals.
(https//:samnoblemuseum.ou.edu/common-fossils-of-Oklahoma/invertebrate-fossils/corals)

AGSHV Inc.
40th Anniversary Celebration

Date: Thursday 1st November, 2018.
Attendance: 60 present members, invited past members and invited guests.
Venue: Hexham Bowling Club.

Although the 1st November 2018 did not mark the actual day the AGSHV Inc. was first inaugurated 40 years earlier, it was the most convenient time to celebrate the outstanding achievement of reaching 40 years of operation. Work to form the organisation began in 1977, however it was not until February 1978 that the Society truly started operating.

The celebrations began with M.C. David Atkinson giving an *Acknowledgement to Country* recognising the Aboriginal history and their connection to the land that we travel through. He also informed the members and guests of the afternoon's proceedings and invited everyone to enjoy themselves.

After canapés and drinks, our president Chris Morton was called upon to welcome present and past members, family, friends and special guest Phil Gilmore, Manager of Regional Mapping NSW Geological Survey. Chris thanked the organising committee for their endeavours in organising the afternoon's celebrations. Credit was also given to the past and present members for their commitment over the many years in establishing a vibrant active organisation ensuring continuing success.

Special mention also went to those individuals that over the years, and still do, organise and deliver the varied and exceptionally interesting activities that only seem to get better every year. These excursions are quite extensive. They range from local Hunter Valley trips to those extending well beyond the Hunter Valley, interstate and New Zealand.

Chris then proposed a toast to the society and its members. He then invited Phil Gilmore to the dais to say a few words. Phil thanked the Society and acknowledged the 70 or so members and over 260 field trips that we had undertaken over the years. The Society was also acknowledged by Phil in a later Instagram post on "geologicalsocietyofaustralia" (Geological Society of Australia) which has over 12,200 followers.

With regards to the AGSHV Inc., Phil mentions *"That beyond the cumulative knowledge and passion for geology (plus biota and cultural history) there is the real sense of community and friendship. Geology is unique in the sense of adventure and friendship that our interest in the Earth can bring".*

Phil went onto to say he would support the Society well into the future.

Ron Evans, past Vice President, President, Secretary, Life Member and producer of Geo-Log, then delivered a timeline and historical overview of the AGSHV Inc. from inception to the present day. He concluded by congratulating the society members for their dedication.

After the formalities a scrumptious lunch of fillet steak and potato bake, or chicken pasta was served. During lunch a gallery of photos that Sue Rogers put together were projected onto the large screen. These images prompted much convivial banter and long remembered stories of places, and the many characters that have been associated with the Society over the years.

After lunch, our M.C. David called Chris to the dais to announce two very special awards that had been organised in great secrecy. These awards were conceived by a select few to be a pleasant, but very deserving surprise. It had been decided that Brian England and Ian Rogers should have Life Memberships bestowed upon them for their outstanding service over the years.

Brian and Ian's record speak for themselves

BRIAN: Joined in 1991. 27 years a member.

Showed his mineral collection to AGSHV Members twice and presented a lecture on Hawaiian Volcanoes before joining.

President:	2007 to 2015	9 years
Committee member:	from 2000	18 years
Geological reference:	Since 1991	27 years
T*rip Leader:*	Many many times over the years	
Geo-Log editor:	2013 to 2018	6 years

IAN: Joined in 1994. 24 years a member.

Vice President:	1994 to 1995	2 years
President:	2005 to 2006	2 years
Secretary:	2707 to 2016	10 years
Public Officer:	2011 to 2016	06 years
Webmaster:	2007 to 2018	12 *years* +
Committee member:	On committee many times when requested.	

These awards were a total surprise for both Brian and Ian and to all that are close to them. Congratulations to both Brian and Ian. They each received a stainless steel plaque on a beautiful rosewood base.

After this very emotional moment, David asked for members to stand up and retell some of the more of the funnier moments that had occurred over the years. As some stories were told, others started to remember long forgotten incidents. Some stories revolved around some particular members that had the audience chuckling to themselves, which was all taken in good humour.

The final formality occurred when Past President John Cater (1995 to 2003) was invited to cut the cake. John gave a short speech, then as a gesture of recognition to his lengthy service as President, invited Brian England to come and help him cut the cake. This was very worthy gesture that was the culmination to great day of celebrations and merriment.

BRIEF HISTORY AGSHV Inc.

Outline of Keynote address presented by Life Member Ron Evans at the 40th Anniversary Celebratory Lunch.

During 1976 and 1977, the Open Foundation Program of the Department of Community Programs of the University of Newcastle presented a course on geology. The lecturer was Associate Professor Arthur Ritchie. Near the end of the course, field excursions were conducted and were enjoyed by course participants.

In December 1977, Open Foundation participants met at Fay and Don Oldham's home to discuss the possibility of forming of an Amateur Geological Society for the Hunter valley.
At the meeting, a committee was formed to prepare a constitution.

1978: The steering committee met on January 10th and prepared a constitution as well as suggestions for activities.

The inaugural meeting of the Society was in the form of a field excursion to the Paterson District led by Professor Ritchie on February 11th. The constitution and program suggestions were adopted by those present. This was advertised in the Newcastle Herald (see clip below).

Newcastle Morning Herald: Tuesday, Feb 14, 1978

Amateur geology group formed

A NEW amateur society is to be formed to cater for those who have a genuine interest in any branch of geology.

The society has grown out of geology courses in the open foundation program of the department of community programs of the Newcastle University. Regular meetings with talks, slides, movie films and exhibitions will be held, and some meetings will take the form of excursions led by prominent geologists.

The inaugural meeting will be a field excursion to the Patterson district led by professor A. S. Ritchie. A committee has prepared a constitution to be submitted at the meeting for approval during the field excursion.

The meeting place is the Patterson Showground entrance at 10 am on February 11. It is suggested a packed lunch be brought and the excursion will be limited to the Patterson martins Creek district.

In the event of heavy continuous rain, the field excursion will be cancelled and a short meeting will be held in the coffee lounge at the University Union at 10 am the same day. For details phone Fay Oldham 81-1539 or A. S. Ritchie 52-1483.

First Executive of the AGSHV.

Patron:	Prof Arthur Ritchie
President:	Mrs Leonie Hansen
Secretary:	Mrs Fay Oldham
Treasurer:	Mrs Jocelyn Hardy
Ass. Sec:	Mrs Jan Prasil
Auditor:	Ian Ritchie
Committee:	Mrs Chris Hawkin, Mrs Bronwyn Vickers and Mrs Shirley Ryan.

Fees were $3 per mailing address.

Members in 1978 numbered 32.

The society met monthly, sometimes indoors for slide or film evenings, for workshop sessions and sometimes to listen to a guest speaker. The remaining activities were field trips, either for a day or over a weekend.

1979: Attendance had dropped with only two people attending the AGM which had to be cancelled. In April, the AGM was again held with 10 members present. By this time, Ron Evans had become active in the Society.

1980: Numbers in Society dropped due to members not re-joining and lack of new members. There was a lack of finances due to fees not being paid. Attendance at activities was around 8 - 10 people.

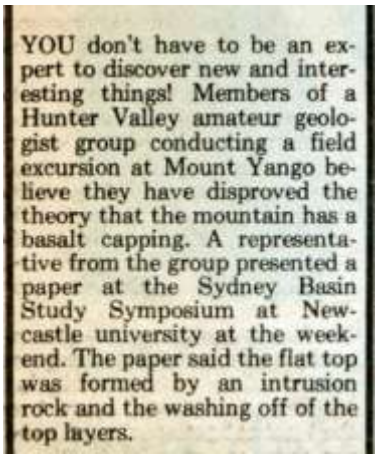
Organisation was ad-hoc with meetings held in the field in the field and poor communication.

At the March AGM attended by 8 members, Ron Evans was elected Vice President.

1981: Ron Evans became President. He formalised club procedure by producing a yearly program, posting monthly notices and conducting formalised meetings such as the AGM.

In **May 1981**, on behalf of the Society, Ron presented a paper at the fifteenth symposium on "Advances in the Study of the Sydney Basin" held at Newcastle University. This resulted from the societies findings on the structure and geology of Mt. Yengo (after three fieldtrips) proposing that the top of Mt Yengo is the remnant of a large sill composed of analcime dolerite (teschenite) and not a basalt cap as previously postulated. This presentation was also reported on by the Newcastle Herald.

To further advertise the AGSHV, Secretary Fay Oldham gave an interview on 2NUR FM regarding the Society.



YOU don't have to be an expert to discover new and interesting things! Members of a Hunter Valley amateur geologist group conducting a field excursion at Mount Yango believe they have disproved the theory that the mountain has a basalt capping. A representative from the group presented a paper at the Sydney Basin Study Symposium at Newcastle university at the weekend. The paper said the flat top was formed by an intrusion rock and the washing off of the top layers.

1983: Following Ron's presentation in 1981 on the structure and geology of Mt Yengo, David Atkinson presented a second paper at a subsequent symposium on the structure and geology of Mt Wareng (Little Yengo) with similar findings to those for the nearby Mt Yengo.

This resulted in new members being attracted to the society and a number of different people became involved in the Executive.

Membership remained around the low to high thirties for the next 15 years with a solid core membership.

By 1991, membership reached 41.

1994: After 14 years, Carol Lawler was the second female to be elected as President.

1995: The first Geological Safari was organised by Brian England. It was a 16-day trip to the Flinders Ranges. Participants flew to Adelaide where a self-drive coach had been hired. President John Cater and Bob Bagnall drove the coach. Brian England was the safari leader. It was a strenuous but wonderful safari.

During 1996 and 1997, no Safaris held. They were replaced by extended weekend trips to venues including Mount Kaputar (twice), Kiama, Stuart Town, Orange and Hat Head National Park.

However, safaris started again in 1998 with a trip to the Grampian Mountains. Safaris have been held every year since.

To date, 25 very successful Geological Safaris have been conducted to venues such as Tibooburra, Kangaroo and Flinders Islands, the Australian Alps and New Zealand.

Membership steadily increased reaching 60 in 2000.

1998: Membership cards were printed and distributed to all members.

2003: The Society reached a milestone having been successfully functioning for 25 years with a membership of 51.

Jan Harrison and a team of helpers organised a 25th Anniversary Dinner for members and invited guests. It was held in the garage at the residence of Ron and Ellen Evans.

Anniversary shirts were made available and purchased by many members.

2004: Jan Harrison became the societies third woman president.

Colour monthly activity notices were produced for members, with the addition of colour photographs of activities.

Following discussion amongst members, Ron Evans produced and printed the first Geo-Log for distribution to members.

Geo-Log 2004 was a 36-page publication. Over the years, Geo-Log grew in size and became an onerous task to print, collate and staple, with the added problem of wear and tear on the personal printer used. So, after the production of the 76 page 2012 Geo-Log, Lakemac Print was chosen to print subsequent Geo-Logs.

2006: The AGSHV Inc. affiliated with the Royal Australian Historical Society. This was a viable solution to the increasing expense of insurance.

2014: Engraved name badges were purchased and distributed to all members as part of their fees, replacing the printed ones.

Present Day:

The Society continues to grow. More members with a geological background have joined, expanding the interest and knowledge base of the Society.

A new executive has brought fresh ideas to the society. Well-planned and led Safaris are attracting a strong core of participants expanding the geological knowledge of all members involved.

Geo-Logs continue to develop providing a valuable resource to members and the public alike through the Societies web site (agshv.com) expertly compiled and maintained by Ian Rogers.

Over the life of the Society, hard working teams of people (usually ladies) have participated in a social committee responsible for organising and running Soup and Slides and the Christmas Party. A huge vote of thanks goes to those people.

To further the social aspect of the Society, several years ago the ladies commenced craft days on a bi -monthly basis. All members were welcome to participate with participants meeting in different members homes on each occasion. During the last two years, some of the men also meet on the craft day and undertake a local walk before joining the ladies for lunch.

Present membership exceeds 70. Its interesting to note that to date, the Society has had in excess of 260 members since inception in 1978.

Over 265 different places have been visited, some more than once.

So, from an slow start with the focus on educational films, lectures and the occasional excursion, the Amateur Geological Society of the Hunter Valley Inc. has developed into a thriving Society with a strong cumulative knowledge base that educates members in earth sciences and their processes, provides for strong social contact and friendship, it gives members the opportunity to travel safely in a group to out of the way places and to venues not available to the public so as to understand and appreciate the extraordinary Australian landscape (geology, landforms, biota and history) and the geological processes that shaped it.

May the AGSHV Inc. thrive for another 40 years!

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

Past and present AGSHV members having a talk before formal proceedings commenced.

Past members Betty and Norm.

President Chris presenting Life Membership to Brian (Left) and Ian.

Past presidents John Cater and Brian England cutting the cake.

Treasures on the Tideline - Beachcombing at Stockton Beach and Fishermans Bay

Leader: Roz Kerr.
Date: Friday 2nd November 2018.
Attendance: 17 members, 1 guest.

Introduction.

A hot day was forecast for our beachcombing excursion. It was already warm when we met at 8:30 am at Stockton Beach, in the picnic shelter between Stockton Surf Life Saving Club and Lexie's Café. I chose the date and time for this activity because a low tide of 0.68 m was predicted at 10:18 am, ideal conditions for a morning of beachcombing.

The purpose of the excursion was to explore the beaches for beautiful shells and remains of other sea creatures washed up onto the sand and left stranded by the falling tide. Participants would learn to identify some of them and find out about their habitat and where they may have originated. Three information sheets I had prepared previously for local government summer coastal activities would be used to help identify the treasures (Kerr, 2006, 2007, 2013).

After beachcombing along the southern part of Stockton Beach from the surf club to the northern breakwall of the Hunter River, we would drive up to Fishermans Bay in the Port Stephens area for beachcombing on a much smaller beach. Would we find the remains of different creatures here?

Stockton Beach.

Stockton Beach is a long, sandy barrier beach extending in a gentle northeast-trending arc from the mouth of the Hunter River in the south to Birubi Point in the northeast. The beach is almost 32 km long, the longest beach in NSW. The sand consists almost entirely of well-rounded quartz grains, with minor amounts of calcareous shell fragments and local concentrations of dark heavy minerals.

As well as the remains of marine organisms, the remains of estuarine creatures and plants from the river are washed up onto south Stockton Beach. Storm waves and the prevailing southeasterly swell regularly batter Stockton Beach, and beach erosion is major issue. *Photo 1* looks south along the beach towards the breakwall. Recent wave erosion of the incipient foredune at the back of the beach can be seen on the right. Close inspection of the erosion escarpment further north towards Lexie's Café revealed thin dark layers of heavy mineral sand – rutile, zircon, ilmenite, monazite within white quartz sand, cut by root traces and vertical and subvertical invertebrate burrows (*photos 2 & 3*). The

1. Looking south along Stockton Beach.

2. Root trace (L) burrows (R) cutting through heavy mineral sand layers.

3. Unbranched invertebrate burrows cutting through layers of heavy mineral sand.

incipient foredune is thinly vegetated with grass and ground cover. The burrows were probably dug by crabs.

We explored between the tide lines for about 40 minutes *(photos 4 & 5)*. Everyone found lots of interesting remains. Shells are the hard outside skeletons of animals without backbones (invertebrates). The most abundant shells are those of molluscs (bivalves and gastropods). Their shells are made of calcium carbonate. Many shells were broken due to recent rough seas.

In terms of the numbers of shells, bivalves are the most common ones washed up onto Stockton Beach. Most live burrowed in the beach sand or on the sandy sea floor. A few live in the Hunter Estuary. They have two-piece shells, joined by a tough ligament on one side. When the creature dies the internal muscles that hold the valves together relax, and the two valves open out. Wave action breaks the ligament so that the valves separate to form two shells.

Bivalves we saw on the beach included: bitter sweet clam *Glycymerididae* family with a zigzag brown pattern *(photo 6)*, brown/white or black/white stripes; native flat oyster *Ostrea angasi (photo 7)*, pipi *Donax deltoides (photo 8)*, cockle *Anadara trapezia (photo 9)*, scallop *Pecten fumata* and fan scallop *Chlamys*, trough shell *Mactra rufescens*, jingle shell *Anomia descripta*, hairy mussel *Mytilus edulus planulatus*.

Several kinds of Gastropods were found. They have one-piece shells, generally coiled into a spiral (sea snails). Most live on sandy beaches or on rocky shorelines. Gastropods seen included: variegated tun *Tonna variegata* fragments, southern mud creeper *Velacumantus australis*, auger shell *Telebra*, tiny banded kelp shells *Bankivia fasciata*, moon or sand snail *Polinices didymus*, cart-rut shell *Dicathais orbita*, heavy turban shell *Turbo torquatus*, tent shell *Australium tentoriforme*, violet snail *Janthina janthina* with small barnacles attached, and elephant snail shell *Scutus antipodes*.

Remains of other creatures found included: pink and purple barnacles, cuttlefish bone, stalked sea tulip *Pyrura gibbosa gibbosa*, Port Jackson shark egg case *(photo 10)*, by-the-wind sailor I, sponge skeletons *Porifer*, and mangrove seeds *(photo 11)*.

A lump of sub-angular gneiss, originating from Rio de Janiero and brought to Newcastle as ballast on sailing ships in the late 1880's, and dumped as amour stone on the Newcastle Harbour Shoreline at Stockton was found. It may have come from a shipwreck on the Oyster Bank, over which Stockton Breakwall now lies. The gneiss could have been rolling around on the sea floor for over 130 years!

On returning to the welcome shade of the picnic shelter, we laid our finds out on the tables and enjoyed a 'Show and Tell' session. Roz helped participants identify their treasures *(photo 12)*.

Erosion at Stockton Beach.

After morning tea in the shelter, we drove up the road to the corner of Mitchell Street and Barrie Crescent

4. Searching for treasures on Stockton Beach.

7. Native flat oyster.

5. Joan, Roz, Maree, Laurel and Barry heading for some shade, Stockton Beach.

8. Pipi.

6. Bittersweet clam.

9. Cockle with borer holes.

10. Port Jackson shark egg case.

11. Mangrove seeds.

12. Show and tell in picnic shelter.

to view the severe wave erosion of Stockton Beach in front of the Stockton Early Learning Centre.

Bathymetry and hydrosurvey information dating back to 1816 for Stockton Beach indicates that there has been a significant loss of sand from the beach. The rate of sand loss appears to have accelerated significantly since the late 1980s. There has been a corresponding deepening of the sea bed profile which has dramatically increased the potential erosion energy of waves impacting on the beach. The rate of erosion from 1990 to 2001 was far greater than previously and is a one-way trend (Jamieson, 2001).

In August and September 2017 beach erosion in front of the child care centre exposed two structures at the site of Stockton Colliery No. 3 Shaft. A metal tube, possibly the lining for a fresh water bore for steam engines on site, and the top of the ventilation shaft, 3m in diameter, were revealed. Stockton Colliery closed in 1908. The top of the shaft was originally 6.7 m above high water mark, in sand dunes about 110 m from the shoreline at the time. The top of the surviving shaft is now at a level of a 0.35 m low tide, showing that a thickness of 6.35 m of sand has been eroded from this site. The shoreline has also retreated more than 100 m since Nobbys and Stockton breakwalls, at the entrance to Newcastle Harbour, were completed over 100 years ago (Rigby 2017).

Ron Boyd, Associate Professor of Geology at the University of Newcastle, and a long-time resident of Stockton, said it has been estimated that up to 70 m of beach has been lost in front of Mitchell Street since 1981, a time span of 37 years. Coastal erosion was caused by climate cycles, but too much sand has been lost from Stockton for the beach to recover. The reservoir of sand that was available to replenish the beach has been washed away. Each time we have a cycle the beach never gets back to the level is was before. The volume of sand lost is just too great. Heavy storms which lash the coast wash tonnes of sand out to sea and further up the coast.

Over the past century Stockton Beach has lost more than 10 million cubic metres of sand and the sea bed has dropped up to 7 m.

Another Stockton resident, Geoff Smith, said waves now smash against the 750 m long rock wall stretching along Mitchell Street, built in 1989 and designed to save the suburb's homes. Year after year the family has watched the beach slowly disappear. It gets worse every year (Page, 2018).

From Stockton we drove onto Fishermans Bay, northeast of Stockton Beach.

Fishermans Bay.

Fishermans Bay is a small, sheltered scenic beach in Tomaree National Park near Anna Bay. It is a sandy pocket beach surrounded by a sloping rocky shoreline of hard rhyolitic ignimbrite (Early Carboniferous volcanics). Lovely rock pools full of marine life occur adjacent to the beach. From a dirt track off Pacific Street a steep boat ramp leads down onto the sand. Although it was quite hot above the beach in the late morning, it was cooler next to the water as we searched the sand for treasures *(photo 13)*.

In contrast to Stockton Beach in terms of numbers of shells and species, bivalves are not very common here. Two notable kinds found were Noah's Ark shell *Arca pistachio* and hairy mussel *Mytilus edulus planulatus*.

13. Searching for treasures at Fishermans Bay.

14. Zebra top shell.

However, lots of kinds of gastropods were observed here. Many of the species that are found here, but are absent at Stockton, live on the adjacent rocky shoreline and in the rock pools.

Gastropods seen included Moon or sand snail *Polinices didymus*, cart rut shell *Dicanthais orbita* and cart rut egg mass, heavy turban shell *Turbo torquatus* and operculum of heavy turban shell, tent shell *Australium tentoriforme*, violet snail *Janthina janthina*, abalone *Haliotis*, imbricate pearl shell *Granata imbricata*, southern bubble shell *Bulla quoyii*, slipper shell *Crepidula*, green warrener *Turbo undulata*, zebra top shell *Austrocochlea porcata (photo 14)*, black nerite *Nerita atramentosa*, striped-mouth conniwink *Bembicium nanum*, small cone shell, variegated limpet *Cellana tramoserica (photo 15)* and small star limpet with eight radiating ribs *Patella chapmani.*

Other remains seen were: pink and purple barnacles, chiton segments, white galeolaria worm tubes, and the blue bottle *Physalia.*

Small particles of coal are always present on this beach. As there are no coal outcrops in the vicinity,

15. Variegated limpet.

some participants suggested that the fine coal was probably washed from the decks of coal ships as they travelled north off the coast. The fine coal had spilled onto the deck as coal was loaded in Newcastle Harbour. After about 40 minutes exploring the beach and adjacent rock pools we retreated to the cool bistro of the Anna Bay Tavern for lunch.

Report by Roz Kerr.
Photography by Shayne Kerr.

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Looking for treasures at Fishermans Bay.
Photograph Ron Evans.

Some of the 'treasures' found at Fishermans Bay.
Photograph Ron Evans.

Social Committee Activities

2018 was another successful year for the social committee with record numbers attending the Soup and Slides in July. This was a long day as it was combined with the AGM.

The Christmas Party also had record attendance with 44 acceptances but only 40 attended as a fierce storm on the night prevented some from venturing out.

Both functions went smoothly and seemed to be enjoyed by all attendees. Many comments circulated on how tasty the food was. However a decision was made at the meeting held at the Christmas Party to no longer hold these functions at the Rogers' residence. A new venue will be designated in 2019, perhaps Hexham Bowling Club where the 40th Anniversary luncheon was held.

Bi-monthly craft days continued and whilst the women were sewing or knitting the men managed to socialise either via a bush walk or a cuppa in a local café and returning in most cases in time for lunch. The friendships that have developed through these days are invaluable to all. It is known that the binding together of people in friendship helps each of us define and realize a meaningful life. I feel that the group that attends these craft days are true friends and will remain so for long time.

Thank you to everyone to who has contributed to the success of the social functions, particularly those involved in preparing the wonderful feasts we have devoured.

Sue Rogers
Convenor.

AGSHV members enjoying a variety of soups at Soup and Slides, organised by the Social Committee.

Geological Tour - Carnarvon Gorge and Beyond
Geological Safari 2018
Sunday 5th to Tuesday 28th August

Leader: Sue Rogers.

Attendance: Up to 20 members.

Day 1: Sunday 5th August. Red Rock.

We began the safari by meeting at 5 pm in the camp kitchen at Red Rock Caravan Park, 34 km north of Coffs Harbour, for a discussion on Red Rock and Solitary Islands geology during our happy hour. Red Rock Headland is reputedly the sight of a massacre of Gumbaynggirr indigenous people in the 19th century which began at Blackadder's Creek when mounted police entered their camp. The police started shooting and then pursued the survivors to the Corindi River where they continued shooting. The headland may have been named Red Rock because the river went red from the blood of the indigenous people or simply because of the prominent unique red rocks here.

The rocks that make up the headland are named the Redbank River Beds. They comprise fine grained sedimentary rocks that were deposited in the ocean below wave base and most current activity. Deposition possibly took place near an underwater volcanic vent. The Redbank River Beds are very strongly deformed. They are folded and faulted into very contorted shapes.

These rocks are an enigma to geologists as they occur only at Red Rock Headland. We do not know if they are older or younger than the rocks that outcrop elsewhere in the Coffs Harbour district. Their age may range from Silurian to Carboniferous, spanning an interval from about 420 million years to 350 million years old. One possible explanation is that the Red Rock Headland is a huge block of rock which was broken from its original site of deposition and deformation, and dropped into deeper water where it was engulfed by younger sediment. Another possibility is that these rocks may represent a small preserved portion of the older rocks which could occur below the surrounding rocks in the district.

1. Joan explaining how beachrock is formed to the group.

North of Red Rock Headland there is an obvious change in the coastline character as it is of low relief and comprises long stretches of sandy beach and coastal dunes in contrast to the numerous headland protrusions found south of Red Rock. This change in geology is due to the area lying outside the New England Fold Belt.

Day 2: Monday 6th August. Red Rock.

We walked from the Caravan Park at 8:30 am to Little Beach and then westward along the creek bank to visit some spectacular large folds, fault planes, and picturesque red jasper that are listed in Bob and Nancy's geotour of the Red Rock headland. Because the tide was out we went to stop 10 first to examine the beachrock.

Beachrock is unique to tropical and sub-tropical marine shorelines and is composed of sand that has been cemented together by various materials including calcium carbonate. The rock forms from the long term, repeated evaporation of sea water from shoreline sand so is found in the intertidal zone on a beach that is protected from strong wave/current action with temperatures warm enough to enable rapid evaporation *(photo 1)*.

Next we viewed the elevated sand dunes which were formed during periods of low sea level when large amounts of sand were blown from exposed sandy sea floors onto elevated parts of the coast. The dunes have now been stabilized by thick vegetation but erode rapidly when the vegetation is removed *(photo 2)*. Our third stop was to view a mass debris flow of pebbly jasper with manganese oxide coatings. The ribbon layered jaspers black surface coatings were of glossy manganese oxides such as pyrolusite, or psilomelane. This outcrop contained slightly rounded jasper pebbles and small boulders of jasper. Near here were piles of smaller jasper pebbles *(photo 3)*. Further out from the shore was a similar outcrop of jasper pebbles but some of these had been fractured into angular fragments forming a breccia. This fragmentation was the result of high pressure fluids, presumably water, moving along fractures in the rock long after the mass debris flow was deposited and deeply buried *(photo 4)*. The next rock we examined was a massive bed of sandstone on the eastern side of little beach which contrasted markedly with the rocks that form the headland.

Some of this grey sandstone had thin irregular layers of red mudstone suggesting the deposition of

2. Sand dunes erode rapidly when the vegetation is removed.

siliceous oozes was temporarily replaced by an influx of coarser sediment from the land *(photo 5)*.

It was then time for morning tea so we all made our way back to our vans to make a cuppa and sat in the camp kitchen to consume it.

Following morning tea, we walked out to the beach and up to the bottom of the cliff face. Here we observed some colourful isoclinally folded cherts and jaspers *(photos 6a & 6b)*. We also observed some micro-faults as well as a large fault with rocks on the ocean-side isoclinally folded *(photo 7)*. We spotted some quartz veins that infilled fractures in the rock near the fault. We then walked up the timber stairs to the headland passing the aboriginal memorial on the way. We looked over a stack which is small vertical chimney-like rock formed when the softer rocks around it were eroded away. The western wall of the stack showed recumbent isoclinal folds that resulted from strong compression within the crust that was not equal in all directions, allowing the compressed contorted rocks to collapse in one direction

3. Jasper pebbles.

4. Mass flow pebbly jasper coated in manganese oxides.

(photo 8). We had wonderful views to the south over the sandy crescent shaped beach and views to the north over the Corindi River entrance *(photo 9)*.

After lunch back in the caravan park the clouds intensified but we only encountered a few spots of rain as we walked around Red Rock Reserve to commence the walk along the boardwalk and through a paperbark forest adjacent to the crystal clear Corindi River *(photo 10)*. The walk offered wonderful scenery and some interesting vegetation *(photo 11)*. We passed Jewfish Point, a significant aboriginal midden site in the Yuraygir National Park and then passed a gnome and fairy garden *(photo 12)*; amazing what you find in national parks! The vegetation changed and eventually we were back on the road leading to the caravan park. Some had hot chips; others had coffee but most enjoyed an ice-cream from the shop on our return. We were entertained by a bush turkey defending its territory from

5. Grey sandstone with thin interlayers of red mudstone.

6a. Colourful cliff face with folds and micro-faults. (Photo Ron Evans)

sea gulls that were being fed in the park. Ian spotted a plover's nest *(photo 13)* in the caravan park on our return. Internationally significant migratory seabirds can be spotted here including waders such as the endangered beach stone-curlew. Today was a great start to the safari and a day free of driving.

Day 3: Tuesday 7th August. Environs south of Red Rock.

We travelled south along the Solitary Islands Way and made our first stop at Arrawarra Headland to view the fish traps on the northern side of the headland *(photo 14)*. The use of these stone fish traps is now restricted to special occasions such as Easter and Christmas, as well as 'once in a blue moon'. According to the Garby Elders, the blue moon occurs when there are two full moons in one month, and when two high tides occur in one night. A range of fish species are targeted such as mullet, luderick, bream, flathead and whiting. Only men use the fish traps. The traps are baited with cunjevoi or fish heads when the first high tide runs out, so all the bait smells go out to the fish enticing them to come in for a feed. Women may wade out to their waists and sing to the dolphins, encouraging these dolphins to bring the fish into the traps. Arrawarra means 'meeting place', and all the tribes would gather here to celebrate and share in the plentiful food of the region.

7. Near vertical fault. Note isoclinally folded rocks on left. (Photo Ron Evans)

We then walked down to view the 'tramway geology' on Ocean View Beach on the southern side *(photo 15)*. The headland is renowned as a place of cultural significance and an important men's rainmaking site. Barry had spotted a colourful sandstone on the edge of the Arrawarra beach so we returned there to inspect it *(photo 16)*. We then drove to Ocean View Headland for a photo stop and views of the Solitary Islands. This was followed by a walk around Mullaway Headland. These headlands were formed from a sequence of marine sediments laid down in the late Carboniferous age (350-280 million years ago). The sediments have subsequently been heated under pressure (metamorphosed) and tilted. This Coffs Harbour Sequence consists of layers of greywacke, siliceous argillite, sandstone, mudstone and a lesser amount of chert. The northern part of this sequence is known as the Coramba Beds which has a greater frequency of sandstone than the neighbouring

6b. Ribbon-like layering of the fine grained cherts. (Photo Ron Evans)

8. Recumbent isoclinal folds on the stack wall. (Photo Ron Evans)

9. Corindi River entrance.

12. Gnome Garden.

10. Walking in the rain.

13. Plover's nest.

11. Interesting bark.

14. Fish traps.

15. Tramway geology.

16. Colourful sandstone.

17. View from Mullaway Headland.

Brooklana Beds. During a time of lower sea levels approximately 15,000-20,000 years ago, when the coastline was further east, the Solitary Islands were low hills on a coastal plain. Over time, erosion and inundation by rising sea levels has differentially removed the softer strata and led to the island formations we see today. These processes are continuing *(photo 17)*.

We drove to Woolgoolga for morning tea at Woolgoolga Lake and a walk to the beach to observe the remains of Buster. The Buster was driven ashore and became a total wreck at the mouth of Woolgoolga Lake on March 8, 1893. The 310 ton vessel, a 39 m barquentine was built in Nova Scotia, Canada in 1884. It arrived at Woolgoolga from Sydney in February 1893 to load timber bound for New Zealand. The crew put down two anchors and ran a cable to a buoy near the former Woolgoolga Jetty. But when a storm from the south-east hit, the vessel's anchor cable snapped and its holding chains failed. No lives were lost when the vessel then broke away from its mooring and eventually beached stern-first 200 m down the beach just south of the Woolgoolga Lake mouth *(photo 18)*. We watched two riders taking their horses for a dip in the lake on our return from the walk to the beach to see Buster.

After a photo stop at Woolgoolga Headland that gave wonderful coastal views that stretch to Yuraygir National Park and the dunes and rolling hills of the Coffs Coast and hinterland, we drove west to Sherwood Nature Reserve and completed the easy 3.6 km walk to Woolgoolga Creek waterfall. The landscape ranges from rugged sandstone escarpments and coastal ridges with dry open forests and heath, to lowland subtropical rainforest gullies *(photo 19)*. We found a lemon tree showing us how careful you need to be when consuming fruit in bushland. The reserve is a birdwatchers delight. We had lunch in the picnic area that is surrounded by towering flooded gums accompanied by an uninvited guest *(photo 20)*.

After lunch we drove to Emerald Beach and completed the Dammerel's history walk and the circuit walk around the Look at Me Now Headland, part of the Moonee Beach Reserve. The reserve contains many significant Aboriginal sites, including middens, axe factories, sacred sites and artefact scatters, which provide evidence of a rich history of the traditional use of the area by the Gumbaynggirr people. The name of the reserve is derived from the Gumbaynggirr name for the area, Munim-Munim. This name means 'rocky' and reflects the original importance of the area for axe making, with rocks collected from the area being used for axe heads. The walk had us following a winding sandy path through littoral rainforest, across boardwalks in the coastal she-oak and Banksia woodland, and then up to the headland. The headland, with great views right out to the Solitary Islands, is covered with lush Themeda grass. Signage along the way provided information about the Dammerel family who took the job as full-time operators of the signal station in 1884.

18. Remains of the Buster.

19. Woolgoolga Creek walk.

20. Our uninvited lunch guest.

The story of the Dammerel family, and their life in an Australian light house, is intriguing and tells of hard work, tragedy and mishap.

From the mid 1800s, the economic development of the North Coast of New South Wales relied on the shipping of timber and other produce to Sydney. Shipwrecks along the coast were common. The number of shipwrecks prompted the development of the 'coastal highway of lights' in the late 1800s. South Solitary Lighthouse is located on an island off the coast of the reserve and was part of this 'highway'. Communication from the mainland to the lighthouse originally relied on semaphore flags erected at a signal station near what is now known as Dammerel's Head, named after George Dammerel who was the first operator of the signal station. The memorial to the Dammerel family and a replica of the signal pole were moved to the headland to make way for the development of Emerald Beach.

Mining took place over parts of the reserve during the 19th and 20th centuries, including gravel extraction from Shelly Beach in 1946 and mineral sand mining for rutile in various locations from the 1950s through to the 1970s. Frederick Fiddaman mined the point now known as Diggers Point for gold in 1882. The locations of old filled-in shafts and mullock heaps can still be seen today. NPWS investigated the value of the area in 1972 and sought its protection as a nature reserve. Gazettal of the original part of the nature reserve occurred in 1976.

The name of Look At Me Now Headland is believed to involve a picnic at Shelly Beach where an Englishman, showing off to the girls of the local Skinner family, took off on horseback with the Skinner boys through some low wetlands and upon his return to the picnic, covered in mud, said 'Look at me now!' In 1963, Look at Me Now Headland *(photo 21)* was purchased from the Skinner family for development as a tourist resort featuring a golf course and tennis courts. However in 1987 Coffs Harbour City Council proposed that an ocean discharge point for treated effluent be located at Look at Me Now Headland. The local community raised strong objections. At the height of the controversy, large sewer pipes were laid over Look at Me Now Headland. A Commission of Inquiry was held under the EPA Act in 1993 to review the proposal, and the natural and cultural values of the headland. While the inquiry found in favour of the outfall in late 1994, the project was stopped due to a change in NSW Government in March 1995. Following lobbying by local conservationists, Diggers Point, Bare Bluff, Dammerel's Head and Look at Me Now Headland were gazetted as additions to the nature reserve in 1995. At this time, Look at Me Now Headland was in a degraded state, primarily as a result of the unrestricted vehicular and pedestrian access across the headland which had caused significant vegetation damage, soil compaction and erosion. There was also considerable disturbance from the heavy machinery used to lay the sewer pipes. Since 2001, NPWS has undertaken rehabilitation of the

21. Look at me Now Headland.

22. Devonian-Carboniferous Neranleigh-Fernvale folded basement rocks.

23. A faulted fold exposed in the road cutting.

24. Examining the sheared serpentinite.

headland, constructed a carpark, restricted vehicular access and controlled pedestrian access by constructing tracks. However, the scars from past activities can still be seen today.

The underlying geology of the area consists of sedimentary rocks which have undergone low grade metamorphism, with isolated igneous intrusions. The majority of the reserve comprises undifferentiated Quaternary sediments, overlying the metasedimentary rocks of the Coramba Beds. Three of the four headlands are exposed protrusions of these rocks comprising mostly siliceous argillite and mudstones which have resisted erosion and share similar geology to the Solitary Islands. The dunal systems adjacent to the beaches of the reserve are known as the Holocene barrier and rise up to 10 m in height. In the 1970s, sand mining took place on many of the beaches along the north coast, including the northern end of Moonee Beach. Soils are generally loose, medium or coarse quartz sands of low nutrient status and high permeability. On the headlands, the soils are shallower and are prone to drying out but often tend to be of higher nutrient levels.

A highlight while walking was watching both whales and dolphins play in the beautiful blue ocean. It was then time for coffee and ice-cream at the Emerald Beach café before driving back to Red Rock. This was a great day for all with lots of variety in scenery and activities.

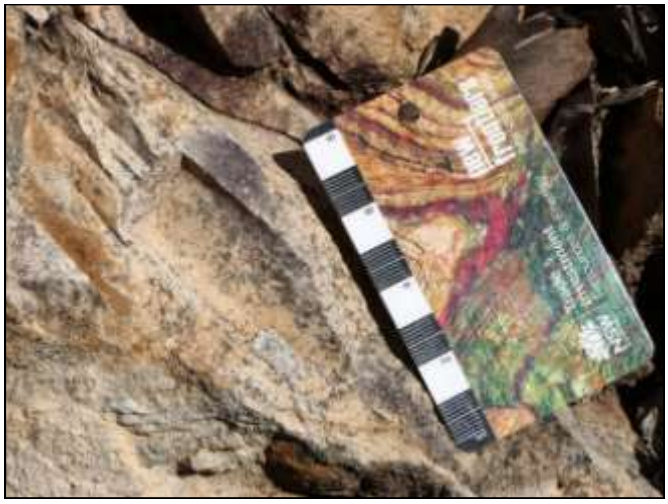
Day 4: Wednesday 8th August. Red Rock to Esk.

Today we drove to the Futures Centre at Fernvale, some via the Pacific Highway and then the Logan Motorway; others decided on the scenic drive through Casino and Kyogle. Bill Darcy and George Winter met us at Fernvale Futures Centre along with Ron Evans, Brian England and Chris Morton who travelled up especially for the Esk part of the safari. After organising everyone into cars only, Bill guided us to Stallman Street to view oceanic cherts and turbiditic sandstones and shales above a subduction zone *(photos 22 & 23)*. We then went to a ridge to view sheared serpentinite *(photo 24)*. After driving on to Esk

25. Intrusive side-wall of the Esk igneous complex.

26. Joan pointing out dendrites exposed on the wall of rhyolite.

27a. Looking for plant fossils in rocks on Outlook Drive. The presence of fossils indicates an ash-fall deposit and not a flow.



27b. Mould of a *Phyllotheca sp.* stem beautifully preserved in the fine-grained tuff. (Photo Ron Evans)

we set up camp and were soon listening to Bill and George again in the huge camp kitchen at the caravan park.

Day 5: Thursday 9th August. Geology around Esk.

Bill and the three authors of the Rocks and Landscapes of the Esk District publication, George Winter, Warwick Willmott and Joe Gough, led us south-east of the township to the base of the Esk Igneous Complex, an oval-shaped (5 km x 6 km) shallow-level rhyolite intrusion. Here, Glen Rock Rhyolite that forms the intrusive side-wall is exposed as a vertical to slightly overhanging cliff *(photo 25)*. Joan pointed out iron/manganese oxide dendrites on the rhyolite *(photo 26)*.

We had an early morning tea stop at Pipeline Park in town before driving halfway up Blanks Mountain and turning left onto Outlook Drive. The rocks in the road cutting at this stop revealed many plant fossils in rhyolitic volcanic ash and which suggested that ash and plant debris had fallen into a lake. *(photos 27a & 27b)*. This outcrop had formerly been considered a rhyolite flow, but the Society visit proved that to be wrong.

We then drove to the top of Mount Banks to view a microdiorite dyke or sill. After lunch at Lakeview Park, falsely named as the vegetation prevented you from viewing the lake, we had a toilet stop back at Pipeline Park in Esk. Some young at heart members tested out the playground equipment with the flying fox the biggest attraction. We then drove 10 km north of town to Calcite Road where we viewed weathered andesite with calcite veins, possibly related to the Brisbane Valley Porphyrites. Our next stop was to a nearby railway cutting where we found leaf and fern fossils in the shale near the intrusive andesite *(photo 28)*.

We returned to town, some stopping at the bakery for coffee, others going for an afternoon walk along the creek. Warwick Willmott later gave a talk on the geology of the regions the rest of our trip covered and many of our group purchased his books. Thanks go to Bill Darcy for taking on the leadership role today and

for organising our guest geologists.

Day 6: Friday 10th August. Esk to Cania Gorge.

We had a 430 km drive through mixed farming country - orange orchards, beef cattle, and irrigated fodder crops to Cania Gorge via Yarraman, Gayndah, and Monto. We managed to see each other along the way and then all caught up in the camp kitchen at 5 pm for a discussion on our three days of exploring Cania Gorge.

Cania Gorge is an ancient place. The gorge was carved out of sandstone by the slow action of water. About 200 million years ago this area was a low plain where major streams deposited sand eroded from distant mountains. The sand settled to form a thick blanket over older rocks, a process that occurred over large areas of Central Queensland. Other sediments were deposited on top of the sand in subsequent lakes and swamps. Over time, the sand and other sediments were compressed into layers of rock, including one known as Precipice Sandstone. Then, about 50 million years ago, crustal movement tilted the layers slightly and caused them to crack and move, creating a fault line.

Run-off from rainwater began to seep southward along the fault-line, eroding the Precipice Sandstone. As time passed, the wide gorge with its 60 m cliffs and the winding bed of Three Moon Creek were formed. Erosion has exposed granite at the bottom of Three Moon Creek. It was formed 240 million years ago from magma which cooled slowly deep beneath the surface of the Earth.

The sandstone outcrops of Cania Gorge are still being changed. Wind and water continue to sculpt the landscape, creating places where plants and animals can live and areas of honeycomb weathering *(photo 29)*. Caves have been created by wind and water. Wind blows fine particles of sand against the cliff face, eroding the rock. Water dislodges the fine clay particles that hold the sand grains together. Eventually, caves are formed. Water finds its way into cracks and crevices in the sandstone, where it erodes the rock and eventually causes large flat-sided blocks to break away from the cliff line along vertical joints.

Day 7: Saturday 11th August. Cania Gorge.

As most had some washing to catch up on we elected to have a later start today. Some walked the kilometre from the camp ground to the picnic area, others drove but we all managed to complete the 3.2 km moderate walk to Dripping Rock and the Overhang. After crossing the Three Moon Creek the track winds through eucalypt woodland and dry rainforest before leading to the moist base of Dripping Rock *(Photo 30)*.

The track continues on to The Overhang, where centuries of weathering and erosion have eroded the base of the sandstone cliff adding striking yellow and red features *(photos 31 & 32)*. We were surprised how

28. Looking for fossils in shale beds along the railway cutting north of Esk.

29. Honeycomb weathering in sandstone.

30. Dripping Rock.

31. Track to The Overhang.

33. The Dragon Cave.

32. Resting at The Overhang.

34. Roof of The Dragon Cave covered by small calcareous stalactites.

many others were on the walking track.

We returned to the picnic ground for lunch. Most then did the 2.6 km moderate walk to Dragon and Bloodwood Caves and the steep walk up 160 steps to the Gorge Lookout. This walk took us through Russell gully then along a steep track to the cliff face, where the left side track branches north to Dragon Cave. Here, the natural black mural of a 'dragon' can be seen highlighted against the white sandstone wall *(photo 33)* while the roof is covered by small calcareous stalactites *(photo 34)*.

The southern branch of the track leads to the beginning of the steps to the steep 200 m track to Gorge Lookout *(photo 35)* where we looked over the road towards the caravan park. We then went to Bloodwood Cave *(photo 36)*, so called because the roots of a bloodwood tree can be seen at the left-hand side of the cave *(photo 37)*.

Day 8: Sunday 12th August. Cania Gorge.

This was scheduled as a free morning to give everyone a choice of activities ranging from sleeping in, going for a drive, doing the walk to the caves for those who missed doing it yesterday or joining me in a longer walk towards Castle Mountain. I had planned to walk from Cania Dam wall but that walk is closed, only a 22 km walk was open which was too far, so we only went half-way. At 2 pm the whole group drove 12 km north to the Shamrock Mine Site which had a number of signs discussing the discovery of gold in the area and life on the goldfields. We saw the remains of an old battery, mine shafts *(photo 38)*, processing sheds and mullock heaps.

We then drove to the lookout over Lake Cania and Castle Mountain and stopped near the Cania Dam wall which is 340 m long and 47 m high *(photo 39)*. The surrounding sandstone cliffs of Castle Rock were impressive *(photo 40)*. We stopped at the picnic area for afternoon tea *(photo 41)*and consumed it while watching Rod swimming in the lake.

Day 9: Monday 13th August. Cania Gorge.

We left the caravan park on foot today at 8:30 am for the 5.6 km circuit walk to Fern Tree Pool and Giant's Chair. The path passed through eucalypt and pine forests, crossed dry Doctors Gully several times and gradually climbed up reaching Fern Tree Pool *(photo 42)* after an hour's walking. We spotted some vertical sections through older boulder-filled stream channels in the bank at one of the crossings *(photo 43)*. We then went up a step section before reaching a fire trail and so

35. The Gorge Lookout.

38. Examining an old mine shaft at the Shamrock Mine site.

36. Participants exploring Bloodwood Cave.
(Photo Joan Henley)

39. Cania Dam wall.

37. Bloodwood root growing down through Bloodwood Cave.

40. Castle Rock. Can you see the elephant head?

had an easy walk along it to the Giant's Chair lookout that was surrounded by sandstone escarpments and grass trees *(photo 44)*. We had morning tea at the picnic table *(photo 45)* next to the lookout while others had a rest *(photo 46)* before venturing down the many steps back to camp to all return by 11:30 am.

We had a rest and lunch at the caravan park. Most were intrigued with the birds that wanted to share our lunch *(photo 47)*. At 2 pm, 11 of the group headed up the Two Storey Cave circuit track, across the road from the picnic area. This was another steep but scenic walk that went around various isolated sandstone monoliths *(photo 48)*. Weathering in the sandstone created many interesting patterns. We spotted some of the underlying granite rock which was highly weathered and breaking up to form sandy soil, many silver elk-horns *(photo 49)* and a bud on a king orchid in the King Orchid Crevice. We inspected the Two Storey Cave

41. Afternoon tea at Cania Dam.

44. Views from Giants Chair Lookout.

42. Fern Tree pool.

45. Morning tea at Giants Chair Lookout.

43. Boulder deposits exposed in an eroded stream bank.

46. The 'old', 'older' and 'oldest' (guess which is which) having a well earned rest.

47. Ian and his birds.

48. Laurel on the track going through a sandstone arch.

49. Silver Elkhorns.

before venturing back to the caravan park.

<u>Day 10</u>: Tuesday 14th August. Cania Gorge to Biloela.

We left our pleasant campsite at Cania Gorge Retreat and were soon on the Burnett Highway heading north to Biloela, a short 95 km drive. At Thangool we turned off the highway and drove 6 km to Mount Scoria, a basalt plug that was the vent of a small volcano formed 20-25 million years ago. It rises 150 m above the cultivated plains, and exhibits 5 - 8 sided columns formed when the lava cooled and contracted *(photo 50)*. Still standing tall after 20 million years, Mount Scoria's exceptional staying power is due to the plug of hard basalt, exposed only after the softer surrounding rock had weathered away. The name 'scoria' is erroneous because most of the rock is not scoria (which is a *highly* vesicular basalt), but vesicular basalt. Little scoria is found which suggests Mount Scoria formed from slow lava extrusion and not a fiery explosive eruption.

After setting up camp at Heritage Park, the current home to the brightly painted 'silo' *(photo 51)* that was built to showcase Australia's rich primary industries at Brisbane's World Expo held in 1988, we drove to the shopping centre to have lunch and then returned to camp to explore the remarkable collection of photographs, artefacts and farming equipment Heritage Park houses. Inside, a circular display showcases snapshots of the past - canvas tents of the roustabout, a blacksmith shop, farmer's fields and plough, dairy, and typical back yard with mum hanging out the washing. Setting the scene, giant murals are a backdrop to each of the exhibits, creating a complete picture of the times. Outside, the first Presbyterian Church (circa 1930's) and old Railway Station (1920's) have more history on show and a unique display of vintage machinery is scattered throughout the grounds *(photos 52, 53 & 54)*.

At 3 pm we had a meeting in the café and a cake to celebrate Diane's 75th birthday.

<u>Day 11</u>: Wednesday 15th August. Biloela & Marble Waterhole.

We commenced today by reading the signage at the colourful Spirit of the Land Mural *(photo 55)* which coats the cylindrical exterior of one Biloela's water reservoirs. The large scale artwork seamlessly pieces together the stories of the surrounding country, from its pre-historic beginnings to early 20th Century times. Told through the eyes of two women from vastly different cultural perspectives, the mural marks the deep connection we each share with land and how it shapes our cultures and customs and brings meaning to our lives

We walked back to the highway to look at the exterior of the timber slab Greycliffe homestead that housed the Nott family for over 100 years from the 1860s *(photo 56)*. It now houses Biloela's historical museum.

50. A jumble of basalt columns near the summit of Mount Scoria.

53. Creamers and Separators.

51. Display Silo at Biloela.

54. Ian next to an ore stamper.

52. Model A Ford displayed inside the silo.

55. Spirit of the Land mural painted on one of Biloela's water reservoirs.

We then drove past the Callide Power Station to various scenic lookouts where we had views over the dam, power station *(photo 57)* and coal mine. Callide mine is an open cut mining operation providing low sulphur, sub-bituminous thermal coal primarily for Queensland's domestic power generation. The mine uses both dragline, truck and shovel methods of overburden removal. Coal reserves at Callide mine are estimated at approximately 225 million tons. Annual production is 10 million tons of saleable coal. The coal fields cover an area of 176 km^2 and contain seams up to 26 m thick. After a short stop to view the spillway it was then time for morning tea at the picnic area at Callide dam *(photo 58)* where some younger members needed close supervision.

Callide dam was constructed in 1965 to supply water for the power station. The dam holds 136,300 mega litres, has an average depth of 10.5 m and a surface area of 1,240 hectares at full capacity.

We then drove along the Valentine Plains Road and through various cattle properties to the western entrance of Kroombit Tops National Park and the Razorback track. The Razorback track takes visitors through rugged terrain in panoramic scenery atop twisting ridges and into the core of the park. The route is a dry-weather high clearance four wheel drive only track. It includes numerous creek crossings, steep ascents and descents and narrow sections.

At the time of deposition of the Marble Waterhole beds some 380 to 390 million years ago, Queensland's coastline was further west and flanked by chains of volcanoes along the continental edge. The lavas that erupted from these strato-volcanoes to form the Marble Waterhole beds were high in silica making them viscous and causing explosive eruptions. The Marble Waterhole beds are composed of sandstones that contain fragments of lava, feldspar crystals and quartz produced by these explosions. Marine life flourished around the volcanoes and as these animals died their skeletons built up to form the large outcrops of limestone that occur in the park. The most common organisms preserved in the limestones are stromatoporoids, corals, crinoids and brachiopods. Towards the end of the Devonian period, about 360 to 375 million years ago, movements of the continent caused the Marble Waterhole beds and chains of volcanic islands to collide with the Australian continent thus putting the coastline in roughly its present position. Several million years later, volcanic activity resumed resulting in the deposition of the Lochenbar Formation, named after the nearby homestead. These rocks were tilted about 40° towards the south by tectonic processes. In places, about 250 million years ago, the sequence was penetrated by dioritic magmas (known as black granite) along cracks and fissures to form dykes. Diorite is a hard, mottled grey-black igneous rock that is resistant to weathering. It contains plagioclase feldspar, hornblende, pyroxene and colourless quartz.

We had lunch at what we thought was the Marble

56. Historic Greycliffe Homestead.

57. Callide Power Station.

58. Glenda supervising the two youngest members.
(Photo Richard Bale)

Waterhole and found a wide variety of coral fossils in the limestone outcrops. A little further along the track we found what we realised was the real Marble Waterhole *(photo 59)* with excellent outcrops of fossiliferous limestone spectacularly intruded by diorite dykes *(photo 60)* . The fossils were very well preserved and only partially recrystallised when the original limestone reefs were slightly metamorphosed by the heat from the diorite to form marble in places *(photo 61)*.

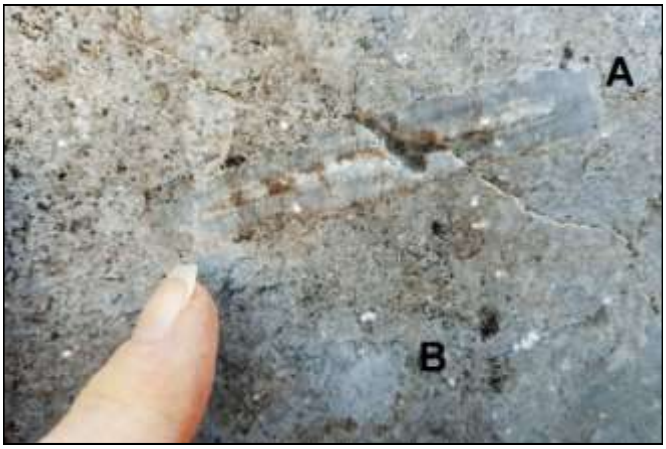
We decided that due to the challenging nature of

59. Marble Waterhole.

62. Blackwater Coal Centre is 10 years old.

60. Limestone intruded by diorite dykes.

63. Japanese Garden at Blackwater.



61. Fossiliferous limestone.
A. possibly a crinoid stem, and **B**. rugose coral
(Photo Joan Henley)

64. Petrified wood at Emerald Town Hall.

the road it was time to return to Biloela, stopping briefly at Kroombit dam. Most of the group had a late but lavish afternoon tea at the Biloela bakery.

Day 12: Thursday 16th August. Biloela to Emerald.

We drove just over 300 km to Emerald, stopping in Blackwater at the Coal museum for lunch en-route *(photo 62)*. We inspected the dry climate Japanese Garden that had 91 trees, 374 shrubs, various perennials and ground covers as well as 3 stone bridges, 8 stone lanterns and a wooden house with a copper roof *(photo 63)*. After we arrived Ian and I walked around the shopping area of Emerald and examined the huge pieces of petrified wood outside the Emerald Town Hall *(photo 64)*. This fossilised wood is estimated to be 250 million years old and was dug up in 1979 when a new railway bridge was being built across the Mackenzie River. Discovered in the year of Emerald's centenary it was presented to the town by BHP who were operating the Gregory Mine to the north of the town at the time. We then went to the huge Visitor's Centre complex but didn't have time to explore all of it before returning for happy hour with the group at 5 pm in the Camp Kitchen.

Three major tectonic units are exposed in the Emerald area:

a. The southern part of the Anakie Inlier, consisting of the Anakie Metamorphics and intrusions of granite, all probably older than Devonian.
b. The eastern part of the Drummond Basin, consisting of 4,877 m of rhyolite and trachyte, tuff, quartz sandstone, shale, and greywacke of Middle Devonian to Lower Carboniferous age.
c. The western part of the Bowen Basin, consisting of 92 m of Permian freshwater pebbly quartz sandstone at the western margin of the basin, and farther east about 2440 m of marine pebbly quartz sandstone and quartz greywacke, overlain by an unknown thickness of coal measures.

The Permian rocks unconformably overlie the Devonian-Carboniferous rocks, and the Permian and Devonian-Carboniferous rocks unconformably overlie the Anakie Inlier. Granite intrudes the eastern margin of the Drummond Basin. Intrusions of spinel-bearing basalt in the Anakie Inlier and in the eastern margin of the Drummond Basin probably occupy the original vents from which the Paleogene basalt flows that cover a fifth of the entire Emerald Sheet area originated.

Sapphires were first recorded in alluvial wash in the Anakie region in 1870. The area subsequently became the largest sapphire-producing region in the world. Some diamonds and semi-precious gems such as topaz are also found. Sapphires and rubies are gem varieties of corundum, a mineral inferior in hardness only to diamond, hence its use as an abrasive. The sapphires originated from plugs of the Mount Hoy Basalt, which explosively brought material from deep within the earth's mantle. There are many of these plugs, which have intruded granites and metamorphics of the Anakie Inlier. The southernmost granites are exposed along the highway.

<u>Day 13</u>: Friday 17th August. Emerald, Sapphire & Rubyvale.

We left at 8:30 am again and drove west for around 40 km to stop at Anakie Railway station to view the bottle tree that soldiers carved their initials on before boarding to go to the battlefields of WW1, over 100 years ago. The engravings have grown with the bottle tree *(photo 65)*. We then stopped at Sapphire to see the windmill.

At Rubyvale we enjoyed morning tea in the gardens at Strudel Hut before visiting various gem shops. We had a very informative underground tour of Heritage Mine that was once one of the largest sapphire mines in the southern hemisphere *(photo 66)*. The tour was followed by lunch at The New Royal Hotel at Rubyvale, which was voted best bush pub for the second year running at the 2015 Queensland Hotel Awards and was constructed of billy boulders and sawn timber.

We then drove along Goanna Flats Road and up the 4WD track to Policeman's Knob, which is the oldest known basalt plug in the area at 56 million years old. From the top *(photo 67)* we could view more of the volcanic plugs that form a circular area some 50 km across. Some of the plugs form sharp hills and mountains while others are just low rises. We spotted numerous Herbert rock wallabies while enjoying the views.

We then drove to the Sapphire Wetlands which was established in 2012 *(photos 68 & 69)*. Most completed the circuit trail stopping at the bird hide, boardwalk and aboriginal scar tree. Signs along the way enlightened us to the various flora and fauna found in the area.

We arrived back in Emerald at 5 pm after a wonderful day but didn't manage to find any sapphires in Policeman's Creek like 12 year old Roy Spencer did in 1935. His palm-sized stone weighed 1,156 carats and spent 9 years being used as a doorstop in the family home because his father said it was a worthless rock. However Roy later found out it had some value and sold it to a Los Angeles jeweller for £18,000 ($31,938) in 1948. The jeweller split it and sold it for over £1,000,000 ($1,774,334) with most of it becoming the Black Star of Queensland that was eventually recognized for what it was, the largest star sapphire ever discovered. It is now believed to be worth over a hundred million dollars.

Evidence points to sapphire and zircon-bearing felsic parental rock crystallising around the crust-mantle boundary before being brought to the surface by pyroclastic eruptions. The main bulk of the sapphire was transported during the pyroclastic phase of eruptions between late Palaeocene to early Oligocene time. It is not known if sapphire accompanied the younger

eruptions (Early Miocene) that delivered high-uranium zircon as no primary deposits have been found containing both the brownish-red to red zircons and sapphires. Alumina in the form of corundum is the second hardest natural mineral known to man. It is formed by both volcanic processes deep in the earth and high pressure and temperature, conditions of metamorphic processes. The purest and most translucent forms of corundum are created by recrystallization of rocks of igneous origin during metamorphism. It is a process that takes millions of years and only a few places in the world have rock outcrops where these rare crystals are exposed by weathering.

Impurity elements that are adsorbed into the aluminium oxide as it crystallises give its fabulous colours. The distinctive colours of many gemstones are caused by the presence of transition metals as impurities in the crystal lattice. Corundum comes in many different colours, all of which are highly prized if they are free of inclusions and translucent or transparent. Beautiful blue sapphire is formed when trace amounts of titanium and iron become adsorbed into the aluminium oxide crystal lattice during its formation.

The early shaft mining of sapphire at the Divide and Bedford's Hill may have worked primary volcanic deposits. Such pyroclastic deposits were being worked for sapphire during the early to middle 1970's in gravel beds on the surface and at depths of 15 to 20 m on Bedford's Hill, at the Divide and adjacent to Sheep Station Creek at Reward. At Bedford's Hill, pyroclastics 1 to 4 m thick overlie granite and are overlain themselves by fluviatile sediments derived partially from the pyroclastics, but mainly from the Retreat Granite and the Anakie Metamorphics. Gravelly lenses up to 1.5 m thick containing sapphire are dispersed throughout the fluviatile sediments. The sapphire and zircon bearing pyroclastics on Bedford's Hill contain both air fall and surge deposits preserved in depressions in the granitic terrain.

70. Emerald Botanic Gardens.

71. Van Gogh Sunflower painting.

<u>Day 14</u>: Saturday 18th August. Emerald free day.

Today was time to catch up on the washing and shop for our week at Carnarvon Gorge. Ian and I spent the morning walking through the extensive 30 year old botanical gardens that located on the banks of the Nogoa River and cover an area of 42 hectares (*photo 70)* . The gardens are home to 12 different themed plant communities, most representing plant species that are native to the region, as well as many birds. They also include a huge rainforest which would be a great place to be in the heat of summer, plenty of playground equipment, a 5 km running track, bike paths, a rose garden and plenty of picnic tables.

Emerald has plenty of shopping centres and a huge number of sporting facilities and events. After lunch we visited the Visitor Centre complex which includes the Emerald Pioneer Cottage which was built

72. The Emerald Dragon.

65. Anakie bottle tree.

68. Entrance to Sapphire Wetlands.

69. Boardwalk over Sapphire wetlands now drylands.

66. Underground at Heritage mine

67. Admiring the view from the top of Policemans Knob.

as a shop on Clermont Street around 1880; the town's lockup (built in 1910 and still operating in 1970); the ordinary timber St Marks Presbyterian Church (built in 1884), and a Communications Museum. The Visitor Information Centre is the first 'straw-bale' building in Queensland. Once famous as a major sunflower producer, Emerald is now home to the world's biggest Van Gogh 'Sunflower' painting. The superstructure is 25 m high with approximately 13.6 tons of steel involved in its construction *(photo 71)*. There is a short walk capturing various art works including a piece made from scrap metal named the Emerald Dragon *(photo 72)*.

I inspected the heritage-listed railway station that boasts an elaborate entry with wrought iron lacework and pillared portico. In 1899 Emerald's first Railway Station was built, but unfortunately burned down within a year. In 1900 a new Railway Station was built of timber, with iron roof and wrought iron trimmings *(photo 73)*. Going on the number of cattle carriages at the station, cattle must be transported by rail rather than road here.

73. Emerald railway Station.

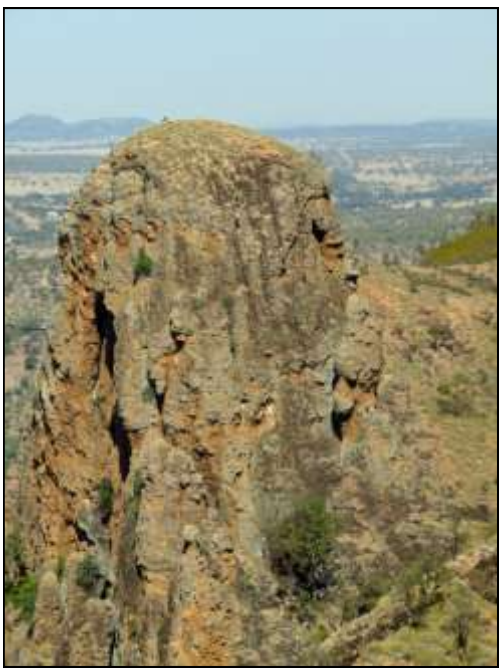
Day 15: Sunday 19th August. Emerald to Carnarvon Gorge via Springsure.

We left Emerald around 8:30am for our drive south on the Gregory Highway to Springsure. We stopped at the rest area just north of the town to capture views of Virgin Rock named because of the weathered likeness of the Virgin Mary holding her child in a cavity on it *(photo 74)*. We then drove into town and disconnected the van before driving with Elaine and Barry and Rod and Dianne 4km south-west of Springsure on Tambo Road. We turned right into Dendle Drive to reach Minerva Hills National Park. Our first stop was Springsure Lookout for views over the town. Next was Fred's Gorge lookout where we enjoyed views down the gorge and morning tea in the new picnic shelter. Then to Eclipse Gap lookout at the end of Dendle Drive for views over pastures and Dillies Knob, a remnant basalt plug from the fiery volcanic past *(photo 75)*. Lastly we stopped at Skyline Lookout and walked 800 metres through interesting vegetation to two viewing platforms offering scenic vistas south over Virgin Rock and Springsure.

74. Virgin rock at Mount Zamia.

We then re-hitched the van and had lunch in Springsure before driving 70 km east to Rolleston where we filled up with fuel before driving a further 61 km south to the Carnarvon turnoff on the Carnarvon Highway and then 45 km west to Takarakka Bush Resort. After setting up camp we met up with the others and then listened to the "On the deck" talk on the various walks at Carnarvon Gorge and the facilities at Takarakka.

National Parks and Wildlife have described the Carnarvon Gorge National Park area as a 'tangle of peaks, gorges, and sandstone cliffs. It is one of the wildest regions of the central western section of Queensland'. In 1932 the bulk of the park (65,000 acres



75. Dillies Knob, a remnant basalt plug.

Was proclaimed with another 1,489 acres (600 hectares) - about 26,300 hectares) was proclaimed with another 1,480 acres (600 hectares) added in 1954. Since then, the park has been further extended to cover 223,000 hectares.

The centrepiece of the park is Carnarvon Gorge itself. Running for over 30 km, it varies in width from 40 to 400 m. The gorge has vast stands of spotted gum, cabbage palm and cycads as well as ferns, elkhorns, and lichens near the waterfalls. The caves and cliff walls were a popular place for Aboriginal art and contain some of the finest examples of hands, axes, emu tracks and boomerangs to be seen anywhere in Australia. Using the technique of blowing pigment over a stencil the Aborigines painted on the walls in red ochre and white, black and yellow pigments.

Precipice Sandstone is the major cliff forming rock in the gorge. It sits on top of the tilted Bowen Basin sequence which includes the Rewan Group, Clematis Sandstone Group and the Moolayember Formation consisting of siltstone, sandstone and mudstone. The Precipice Sandstone is the oldest bed in the Surat Basin and was laid down between 198 and 205 million years ago. The deposition environment was likely to have been freshwater rivers carrying mainly quartz sediments. The youngest rocks in the area are the basalts of the Buckland Volcanic Province, which were extruded between 35 and 27 million years ago. Water and wind have eroded this area into a network of sandy plains, valleys, and gorges separated by basalt-capped tablelands and ranges.

Day 16: Monday 20th August. Carnarvon Gorge.

At 8:30 am we drove 5 km to the new Visitors Centre at Carnarvon Gorge and after crossing the creek

76. The first creek crossing.

77. Climbing steps to the Amphitheatre.

78. The narrow entry into the Amphitheatre.

(photo 76), walked through pretty vegetation that included various species of flowering wattle, spotted gums, cabbage palms and cycads. We went as far as the Amphitheatre (about 4.5 km), and everyone climbed the ladder to this serene spot *(photo 77)* accessed through an extremely narrow crack *(photo 78*) in the sandstone wall. Hidden inside the sandstone walls is a 60 m deep chamber, gouged from the rock by running water. We had morning tea just outside the chamber and then headed back, diverting to the amazing Moss Garden where water soaks constantly through the sandstone walls, and when it reaches the purple shale layer of the

Moolayember Formation of the Bowen Basin, oozes out to support a lush carpet of mosses, ferns, liverworts, lichens and elkhorns. Beneath tree ferns straining for sunlight, a small waterfall tumbles over a rock ledge into an icy pool making a lush scene. After making the return trek back to the Visitor's Centre we had an inspection of it but were disappointed to see that it is not staffed, and there was only limited information on the park on display. We returned to camp for a late lunch and restful afternoon.

Day 17: Tuesday 21st August. Carnarvon Gorge.

At 8:30 am we again drove to the Visitors Centre parking area and our group split into two. Eight climbed the 595 steps up to Boolimba Bluff to be rewarded with spectacular views over the gorge. The 6.4 km walk passed through a diversity of habitats before reaching the top that towers 200 m above Carnarvon Creek *(photo 79)*. This is the only formed lookout track from the gorge. One the way up we saw a kaolinite lens which is where the proportion of kaolinite to quartz is higher and so the sandstone weathers quickly. From the top you can see the white Precipice Sandstone *(photo 80)* that lies on the older inclined strata of the Bowen Basin.

Four others opted for a leisurely stroll along the shady banks of Carnarvon Creek from the Visitor's Centre to the rock pool and were kept entertained by the platypus they spotted along the way.

We all had lunch back at camp and then ventured down to the Wildness Centre to view their informative display about the walks, flora, fauna and geology of the gorge. There was a great selection of rocks and fossils that you could view with the supplied hand lens as well interesting exhibits and a video on the gorge. We then had afternoon tea at the café before returning to camp.

Day 18: Wednesday 22nd August. Carnarvon Gorge.

The group split into two today. Four in the first group walked all the way to Cathedral Cave and Boowinda Gorge and then visited the Aboriginal Art Gallery and Ward's Canyon on the return journey. This 20 km walk involved 20 creek crossings on the way up and of course 20 on the return trip. Thirteen of the

79. Carnarvon Creek with a cliff of Precipice Sandstone in the distance.

81. Cathedral Cave.

80. Cliffs of white Precipice Sandstone overlain by a weathered slope of Evergreen Formation rocks which are capped by basalt that flowed from the Buckland Volcano.

82. Examples of Aboriginal art to be seen in Cathedral Cave.

group opted to only visit to the Art Gallery and Ward's Canyon which was around 11 km, so an excellent physical effort was made by all to see some remarkable scenery. The main track beyond the Art Gallery turnoff is not maintained to the same degree and the creek crossings were not as distinctive so we were glad that it had not rained recently.

Eventually we arrived at Cathedral Cave which is a massive, wind-eroded overhang that has sheltered Aboriginals for over four thousand years *(photo 81)*. A panorama of rock art reflects the rich cultural life of those who gathered here *(photo 82)*. As the overhang provides more shelter than the art gallery site, it is thought that this was the camp site and the art gallery was used for ceremonial purposes. It is disappointing to read when the Gorge was being used as a cattle lease, Cathedral Cave was where cattle were corralled while the Gorge was being mustered and hence cattle have damaged some of the rock art.

The rock-hop into the sculpted Boowinda side-gorge was well worth it. Boowinda means 'thunder' and the smoothly eroded gorge walls give evidence of past flooding *(photo 83)*. The sandstone has been carved into amazing shapes by extreme water flows that have occurred in the past. We then commenced the long return journey stopping at a wonderful pool surrounded by colourful cliffs for lunch *(photo 84)*.

Finally we could take the track to view the two thousand plus engravings, ochre stencils and freehand paintings which adorn the 62 m long sandstone walls of the Art Gallery. This has to be one of the best examples of stencil art in Australia. The leaf shaped hunting boomerangs were not returning boomerangs, as the blade was flat and lacked the twist of the returning boomerangs. The 'V' shaped boomerangs could be thrown sidearm, skimming just above the ground and would easily break an opponent's leg. They were used for bringing down kangaroos *(photo 85)*.

83. Exploring Boowinda Gorge.

84. Lunch stop beside colourful cliffs composed of Precipice Sandstone.

85. Some of the art to be seen in the Art Gallery.

We then walked up the steps alongside Aljon Falls into Ward's Canyon, the home to the world's largest fern, the King Fern (*Angiopteris evecta)*. These impressive green 'dinosaurs' have strong links with the ancient Gondwanan flora. This canyon is the only place in central Queensland where these ancient plants survive *(photo 86)*. The permanent water is essential for the King Fern's survival. The fronds of this fern have no woody tissue - water is their only means of support. Water fills the fronds, exerting pressure outwards and keeping them rigid - like water in a fire hose. This canyon was once the seasonal home of the Ward brothers, possum hunters of the early 1900s.

There are grinding grooves here, evidence of a much older occupation by Aborigines. King Ferns share Ward's Canyon with tree ferns. Tree ferns have a tall trunk with an umbrella-like canopy but the King ferns have a short, thick base from which the fronds arch

86. Wards Canyon, home of the King Fern.

87. A shy echidna seen beside the track.

88. Walking track beside Carnarvon Creek leading from the Visitors Centre to the rock pool.

outwards. On the return trek Richard spotted a shy echidna digging into the dirt along the track *(photo 87).*

Day 19: Thursday 23rd August. Carnarvon Gorge.

This was a scheduled free day but the majority of the group decided to do the lovely 3 km flat walk from the Visitors Centre alongside Carnarvon Creek to the rock pool, the only swimming hole in the gorge area. We saw a few platypuses just after commencing the walk, an echidna and a number of different birds. The vegetation kept changing *(photo 88)* as did the size of the creek.

Most spent the afternoon watching platypus in the creek near our campsite and trying to capture photos or videos of them. Barry got some superb photos and Glenda has a wonderful video to show everyone. We completed the evening by having a roast dinner, pork and lamb with a variety of vegetables plus apple crumble and custard for dessert, cooked for us at a cost of $25 per person.

Day 20: Friday 24th August. Carnarvon Gorge.

We left camp at 8:30 am for a moderate walk along Mickey Creek and Warrumbah Creek side gorges *(photo 89).* When the formed track ended some went on a rock-hopping adventure into narrow side gorges to experience the wonder of being surrounded by interesting sandstone. Some then climbed up the cliff and found a split in the sandstone wall. We then had a late morning tea at the picnic area at the rock pool *(photo 90).*

Next on the agenda was the easy 500 m walk to Baloon Cave located within a gap in Clematis Ridge. *(photo 91).* The cave has been formed by roof collapse of a coarse-grained sandstone above thin beds of fine-grained sandstone and purple siltstone *(photo 92).*

Clematis Ridge is formed from tilted sandstones (about 40° to the west) of the Clematis Group (mid-Triassic, 240 - 235 million years ago) which is believed to be the lowest intake bed for the Great Artesian Basin. This short walk among the fan palms and cycads led to a small sandstone overhang featuring a fine example of stencilled Aboriginal rock art *(photo 93).* Little is known about the spiritual significance of the motifs present, but the site is thought to have been a meeting place. Archaeological excavations revealed occupational evidence dating back 500 years, making it the youngest of the dated sites in the Gorge.

We returned to the Takarakka for lunch and it was only Barry, Elaine and I that ventured out in the afternoon to do the creek loop walk near the Wilderness Centre. Again we captured lovely views of the creek and the neighbouring vegetation *(photo 94).*

Day 21: Saturday 25th August. Carnarvon Gorge to Roma.

Despite threatening clouds and a forecast of rain we packed up camp in the dry and headed east to the

89. Warrumbah Creek Gorge.

92. Roof of Baloon Cave formed by roof collapse of sandstone above finer sediments.

90. The Rock Pool, a very pretty morning tea stop.

93. Aboriginal art on the roof of Baloon Cave.

91. Rest and information platform next to Baloon Cave.

94. Carnarvon Creek from the creek loop track.

Carnarvon Highway and then south to Injune, passing a number of herds of cattle along the unfenced paddocks and a busy farmer ploughing his ground. We had just a few spits of rain when we alighted from the car to walk to the café to have morning tea with most of the rest of our group, but not enough to wet the pavement. We then visited Henrick's Park named after the family who donated the land and saw many of the statues of Injune that tell the stories of local characters *(photo 95)*.

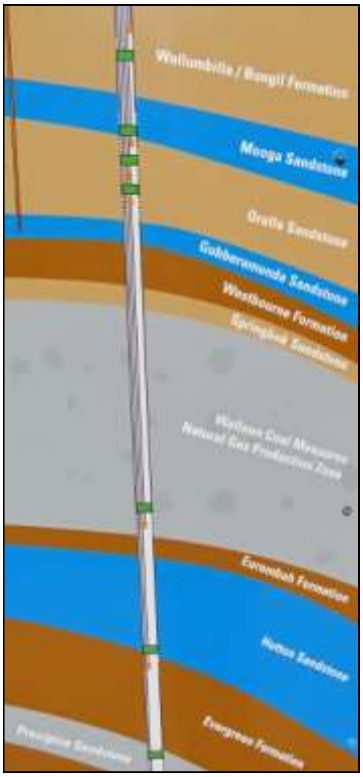
Then we headed further south to Roma, a much larger town with a population of over 8,000. We set up camp under threatening skies but then the sun came out so most of the ladies caught up on their washing. After lunch we drove around the town and stocked up on bread and milk from Woolworths. The Queensland government has banned the use of single use plastic bags at all stores so every shop now charges if you don't supply your own bag. The clouds returned and by 5 pm, our scheduled time for a meeting in the open camp kitchen it had begun to rain, so we moved the meeting into our van. Thus we had a cosy time as we discussed the activities for the next few days. It rained quite heavily and the rain lasted most of the night. We were glad we travelled from Carnarvon Gorge when it was dry and managed to do all of the wonderful walks in there over dry tracks and safe creek crossings. Also this was the first caravan park where we had a slab so it was not muddy like most of the parks are after rain.

Since the discovery of gas in 1900 when drilling for water at Roma, 40 wells have been drilled in the area. A few of these wells encountered some gas and showings of oil. Most of the wells were drilled in areas where the outcropping Cretaceous and Jurassic strata show no evidence of structure except for a slight southward tilt toward the centre of the Great Artesian Basin. Consequently, most of the drilling was a hit-or-miss affair. About all that was known about the subsurface geology was that basement rocks in the vicinity of Roma underlay the surface at depths of 610 to 1,250 m, and that oil and gas showings were found slightly above the basement rocks in non-marine formations thought to be Jurassic in age.

In 1933 Oil Search Ltd. of Sydney initiated a program of geological work and exploratory drilling in the region. During 1934 and 1935, a large area was mapped north of Roma, and two or three promising structures were outlined. During 1934 - 1939 Oil Search Ltd. drilled three deep tests in the area, two of which were located on pronounced anticlines located 97 - 137 km north of Roma, the other being a test of a minor structure a few km east of Roma. Gas was struck in two of the wells, but only slight showings of oil were encountered. The main facts established by the geological investigations and exploratory drilling are as follows:

1. Well defined anticlinal folds are present in outcropping Permian strata 129 - 193 km north of Roma. Although a slight unconformity exists between the Permian and Triassic, and a marked unconformity occurs at the base of the Upper Triassic, the folds in the Permian can be traced southwest in the mild folds of the Triassic, but disappear in the gently southerly tilt of the Jurassic strata.
2. The combined thickness of the Jurassic and Triassic is only 1,067 - 1,676 m, and not 3,658 m as formerly estimated. The Permian strata at their outcrop are only 1,555 - 2134 m thick, or about half as thick as previously reported.
3. The principal oil and gas showings at Roma were found in sandstones and grits of Triassic, not Jurassic age.

95. Ian reading about one of the local Injune characters .



The diagram shows the rock strata present in the Roma district.

4. None of the forty wells drilled in the region, except Oil Search's Hutton and Arcadia tests, were located on an appreciable fold. All earlier wells, except the one at Wallumbilla, were situated on a south-easterly trending basement ridge, the crest of which is transgressed by Triassic strata.
5. The gas encountered in the Triassic near Roma and in the Permian at Arcadia probably originates from Permian carbonaceous strata. The oil encountered at Roma may have had its source in the few hundred feet of marine strata that occur in the middle and lower Bowen series of Permian age. All other strata below the thin mantle of Cretaceous in the vicinity of Roma are non-marine in origin.

96. Examining displays at the Big Rig, Roma.

Day 22: Sunday 26th August. Roma.

When we woke the rain appeared to be clearing so we decided to venture up to the Big Rig at 9 am. This is a $7 million living memorial to the pioneers of Australia's oil and gas exploration industry. We spent over an hour looking at the eleven display stations containing audio and display panels *(photo 96)*, the various drilling rigs and mining equipment that explain the history of gas and oil extraction in the Roma area. We also walked through the Journey through Time tunnel that depicted the formation of gas and oil and showed how it is created. The display also showed how exploration of oil and gas has changed in the last 100 years.

We then went on the Roma Express, a miniature train that took us on a scenic journey along Bungil creek and across the "Bailey Bridge" a pre-fabricated truss bridge invented in England during WW2 and considered to be one of the great engineering feats of the war years. This type of bridge was designed to carry great loads yet was simple to fabricate and assemble its modular components, and could be erected with a minimum of assistance from heavy equipment. The train ride *(photo 97)* was followed by morning tea in the Big Rig cafe.

97. The 'big kids' enjoying a ride on the Roma Express.

A part of the Big Rig Complex is the Lenroy slab hut that was built in 1893 from adze-cut cypress pine, a termite resistant timber, to house a family of 11. The original roof was box tree bark tied down to round rafters with greenhide strips but this was replaced in 1894 with galvanised iron, some of which still remains today. The original floor was compressed earth, amended to timber when sawn timber was available *(photos 98 & 99)*.

98. Leroy Slab Hut, a part of the Big Rig complex.

We returned to the caravan park to then drive 17 km out of town to the Moorlands Bush Garden nursery as they were hosting a special market day. It was a very pleasant location to enjoy our lunch and stroll around the beautiful plants and fascinating corrugated iron animals *(photos 100 & 101)*.

We then drove to Mount Abundance homestead *(photo 102)* for a two hour tour by a passionate Helen *(photo 103)* who is gradually restoring this 1860's building to its former glory. Helen outlined some of the history of Roma from when on the 7th May 1846 Major Mitchell reached Mount Abundance and named it so because he was impressed by the richness of the region. In his book Tropical Australia (1848) he recalled his first impression of the area - *'I ascended an elevated north-eastern extremity of Mount Abundance, and from it beheld the finest country I had ever seen in a primeval state - a region, spotted with wood, stretching as far as human vision or even the telescope could reach.'*

In 1848 Allan Macpherson reached the region and claimed about 400,000 acres (162,000 hectares) of

99. Interior of Leroy Slab Hut.

100. Metal figurines in the Roma Bush Gardens.

land which he called Mt Abundance Station. Here Macpherson built a simple wooden hut. On 4th April 1848, he was visited by Ludwig Leichhardt who was attempting to cross Australia from east to west. Leichhardt wrote his last letter in Macpherson's hut.

The first sign of a township occurred in 1861 when a couple of crude public houses were built near the Mount Abundance homestead. The owner at the time, Stephen Spencer, objected to this change in land use but finally agreed with a Government surveyor that a town could be laid out at a place known as Reid's Crossing. The town was gazetted in 1862 and it had three hotels before any homes were built. The new town, or rather the three pubs, was named Roma after Lady Roma Bowen, the wife of the Queensland Governor of the time. Before her marriage she had been known as Countess Diamantina Georgina Roma. Roma has the distinction of being the first town gazetted in the new colony of Queensland. It grew quite quickly once the area had been surveyed and by 1863 it had its own court of petty sessions, police station, doctor, chemist, and postmaster. It was proclaimed a municipality in 1867. The railway reached the town in 1880 and the census a year later revealed that the town had grown to have a population of 1,838.

We completed the day by attending the 7 pm session of the spectacular Big Rig Night show - a 30 minute show which uses current technology and multimedia to tell the story of early life in the oil and gas industry.

102. Mount Abundance Homestead.

101. " Please please, feed me!".

103. Host Helen, explaining features of the main bedroom.

Day 23: Monday 27th August. Roma.

This was our last day together and was another interesting day filled with a variety of activities. First was a guided tour of St Paul's Anglican Church *(photos 104 & 105)* which has 50 stunning stained glass and lead light windows *(photo 106)* dating back to 1876 as the windows from the poriginal church were put into this church which was built by locals using hand-made concrete bricks in 1913 *(photo 107)*. The arched cypress pine timber roof was beautiful as were the silky oak pews. The font was made of sandstone from Rutherford quarry. At the rear of the church an organ with 567 working pipes that was purchased in 1927, was housed.

We then read some of the inscriptions that make up Heroes Avenue, a memorial avenue of 138 bottle trees that extends from the Railway Station to the Cenotaph in Bungil Street. Each tree is dedicated to a local soldier who fell in World War 1 and the plaque at the base of each tree bears the name and details of the soldier to whom that tree is dedicated *(photo 108)*.

We then listened to the story of Roma depicted on the 3d heritage 18 m² clay mural *(photo 109)* which comprises one hundred and seventy-five individual tiles at the Cultural Centre. We viewed the polished rock collection adjacent to the mural and then headed to a family owned bakery for morning tea. To walk this off we went to the art gallery and saw more examples of polished rocks.

We then drove to Whip Street to complete the Hospital Hill Heritage walk that follows a trail of 12 informative plaques that describe the history of oil and gas exploration in Roma and the discovery of natural gas *(photo 110)*.

After lunch at the skate park opposite Roma Hospital we visited the Roma Bush Gardens, a 14 hectare recreational reserve which includes two interlinked dams *(photo 111)*. It has been designed to recreate, in discrete zones, various native habitats that occur within the region. The development of the Gardens has been a community undertaking, led by a volunteer group formed in 1998. A few then went to Mandandanji Park to explore Roma's indigenous culture

104. St Paul's Anglican Church, Roma.

105. St Paul's Anglican Church interior. Note the magnificent organ.

106. One of many magnificent stained glass windows in St Paul's Anglican Church.

107. Machine that made bricks in 1913 to rebuild St Paul's Anglican Church.

108. One of the many bottle trees in Heroes Avenue.

109. 18m^2 Heritage Mural.

110. Remains of Lander No 4. well completed in September 1929 with no show of oil or gas.

111. Roma Bush gardens.

112. Meals at the White Bull Tavern, Roma.

in the huge display cabinet on the eastern entrance to the town.

As it was our last night on this safari we had to have a meal out together at the White Bull Tavern *(photo 112)* which was named after the famous 'white bull' that featured in Harry Redford's trial in Roma where he was found not guilty of cattle rustling as the jury were impressed by his skills at being able to drove cattle from near Longreach across the desert into South Australia.

<u>Day 24</u>: Tuesday 28th August. Depart for home.

At 8:30 am we were the last from our group to leave the caravan park in Roma as the others were all planning lengthy drives. We headed south to Surat and then east to Glen Morgan where 7 km out of town Myall Park Botanic Gardens is situated on over 132 hectares. The gardens aim at conserving rare, endangered and vulnerable species from arid, semi-arid and dry tropical regions. Although it was before 11 am, we decided to stay the night as the main walking path around the garden is 4 km and then there are multiple paths off this into various plantings. A level powered site for 2 nights is $20 and this includes the garden entry fee of $5 per adult. We were the only ones there so had exclusive use of the amenities block - 4 toilets and 1

113. Art work produced by young volunteers in Myall Park Botanic Gardens.

114. Grevillea Merinda Gordon.

shower. Needless to say, completed the circuit walk as well as many of the extra paths and found some interesting treasures.

The gardens were established by Dave and Dorothy Gordon in the 1940's. They travelled extensively in the 1950's and 60's to add to their plant collection. Dave knew that grevilleas hybridised readily and he called three successful ones after each of his three daughters - Robyn Gordon, Sarah Gordon and Merinda Gordon *(photo 114)*. He gave these to the nursery trade and these became popular around Australia as well as overseas. Dorothy was a talented artist and we viewed many of her 48 watercolour wildflower paintings in the art gallery on site as well as some of the photo albums depicting the history of the garden. The gardens are now owned by a not for profit company and restoration is carried out as funds permit.

Report by Sue Rogers.
Photographs by Sue Rogers, Joan Henley (36a, 60), Richard Bale (57a) and Ron Evans (6a, 6b, 7, 8)

Edited by Joan Henley, Brian England and Ron Evans.

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