'Geo-Log'

2010

Journal of the Amateur Geological Society of the Hunter Valley

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

Contents:

President's Introduction.

Hello members and friends,

Yet another successful year packed with interest has gone by so quickly. Our outings have continued to attract much interest and after 30 years we still manage to run new activities, while sometimes retreading old ground for the benefit of new members.

Outings continue to provide a mix of experiences due to the varied expertise among our membership, most of who have now retired from full-time employment. Our Society is perhaps unique in that every member contributes regardless of their level of knowledge and it is this group effort and resulting camaraderie that makes our Society so enjoyable and successful. The extended Broken Hill trip was a resounding success and repaid the efforts of the organisers many times over. It was a trip that should have been run by our Society years ago, but the logistics and expertise involved with such a large and geologically complex area always seemed just too daunting. It was only with the help of staff of the DPI (Maitland Office), the people of the pastoral stations (especially Kym and John Cramp of Mount Gipps), and some of the locals (especially Trevor Dart of the Broken Hill Mineral Club) that this trip could even get off the ground. To all these people a heartfelt thanks for a wonderful outback experience.

Very special thanks go to the Social Committee for their often unrecognised organisational expertise at events held throughout the year, especially the soup and slides night and the annual Christmas party. Thanks also to Vic and Leonie Mills who made their home available for the Christmas Meeting. Once again it proved an exceptional venue, with everyone enjoying themselves. Ellen and Ron Evans must also be thanked for providing the venue for Ron's superb lecture on how the Earth works and the introductory lecture on Broken Hill geology.

Finally, thanks to the leaders who gave up their time in organising and conducting the field trips and who contributed to this journal, and especially to our Life Member Ron Evans for his sterling efforts in putting together yet another superb edition that we can all be proud of.

Very best regards,

Brian.

Putty Beach

Saturday 23rd January 2010

Leader: Barry Collier and Brian England.

Attendance: Approximately 22 members.

This was an afternoon excursion to take advantage of the tides and also provide the best possible lighting for photography of the rock outcrops. We knew it was going to be warm with a late change and chance of storms but long before Ian, Sue and I reached Killcare the temperature had risen far beyond the predicted 28°C. It had reached stifling 43°C by the time we met up with the rest of the group at 3:00pm in the parking bay at the end of the road off Putty Beach Drive just inside Boudi National Park.

Many changes had been made within the National Park since my last visit a few years ago, when the area was regarded as being unsafe to leave any vehicle unattended. New toilet blocks and picnic tables had been added and the area had been tidied up significantly. We found all the camp sites fully occupied and parking was not easy to find, despite the $7 per car entry fee.

Undeterred by the high temperature and almost unbearable humidity we plodded out onto the hot loose sand of Putty Beach and up the stairway onto the headland at its north end, then followed the boardwalk along the cliff top to the stairs down onto Bullimah Beach.

The cliffs at the north end of Bullimah Beach comprise sandstones and shales belonging to the upper part of the Middle Triassic Terrigal Formation at the top of the Narrabeen Group of sediments which

Ron Evans

Headland behind Bullimah Beach showing a large scour and fill structure and cross bedding

Ron Evans

Large scour and fill structure

lie immediately below the Hawkesbury Sandstone. A number of spectacular sedimentary structures could be examined here. The shales represent low energy overbank deposition of fine sediments on tidal flats associated with an extensive river delta environment. The shales are cut in several places by scour and fill structures, formed where an active meandering stream has cut into the tidal flat and deposited layers of cross-bedded sand in its wake. In time these old stream beds were covered by more shales as the depositional environments meandered back and forth across the delta.

Thin beds of coarse conglomerate are common within and at the base of some of the sandstone beds and represent lag deposits formed as increased water flow in the stream bed carried away the finer sand and silt. However some conglomerate bands occur in the shale and are laterally restricted, often comprising just a few large pebbles. These pebbles could not have been dropped from ice rafts as occurred in the Permian since the climate in the Triassic was not periglacial. But eventually an example was found which also contained imbricated flat shale fragments. This suggests that water from a sudden sharp downpour may have washed pebbles from a nearby exposed lag gravel down across the edge of a shallow depression in the mud flat and out into shallow water, scouring channels and depositing narrow tongues of intermixed coarse gravel and polygonal silt fragments ripped from the dried up rim of the depression.

The thinly bedded shales below the stream bed sandstones commonly show fragmented herringbone cross-stratification formed by currents flowing in alternately opposite directions, a feature typical of a mud flat environment.

By around 5pm the wind had picked up dramatically, blowing the sand up from the beach into

Ron Evans

Lag deposit of imbricated shale fragments in shale

Ron Evans

Pebble lens in sandstone - note indurated joints

our eyes and hair. For once I had remembered to bring my Society name badge. However it vanished from my shirt in an instant along with the field notes I had stuffed into my pocket and hats had to be rammed on tightly to avoid them being entrained and transported up to Newcastle or beyond. Time to retreat! Up on the boardwalk we were protected for a while from the wind's fury, but out on the headland it returned with a vengeance, blowing waves of sand up from Putty Beach and making conditions very uncomfortable. Only the foolhardy continued on around the edge of the cliff line to examine the spectacular tessellated pavements and associated Leisegang banding in the sandstone, but photography was now out of the question.

The Leisegang banding here is some of the finest in the World and extends over the entire outcrop, both vertically and horizontally, presenting unique photo opportunities. The intersecting joint sets making up the pavements formed as the beds of sandstone (which are tough and hence incompetent) were subjected initially to slight regional warping and then unloading as the weight of the overlying material was removed by erosion. Groundwater containing iron in solution leached from the overlying rocks then migrated into the joints and from there soaked into the porous sandstone, leaving behind an iron stained layer as the rocks dried out. This was a seasonal event, resulting over time in a succession of concentric stains. Leisegang banding can only form in sandstones with an open pore network and this explains the relative rarity of this phenomenon.

Looking south towards Lion Island from the headland we could see a wall of what appeared to be rain approaching and obliterating everything behind it from view. Time to retreat more hastily! At least the temperature had dropped to a more comfortable level but the wind persisted, threatening at times to lift us off our feet as we battled back across the sand to the cars. It had been planned to have a picnic dinner before returning home but that was now off the program, except for a few hardy souls who set up their food on a nearby picnic table. They soon regretted their decision. What we had seen approaching from the top of the headland turned out to be dust. Then as Ian, Sue and I drove out towards Killcare a sudden torrential rain squall hit the area, turning the dust into mud.

Report by Brian England.

Ron Evans

Colourful Liesegang Rings in sandstone

Ron Evans

Leached sandstones on top of the headland

Ron Evans

Laterite layer on headland above Putty Beach

Ron Evans

Magnificent Tessellated Pavement

Ron Evans

Leached sandstone on top of headland - the leached iron minerals are being deposited in sandstones beneath forming Leisegang Rings

Redhead Point

Saturday 27th February 2010

Leaders: Ron Evans and Brian England.

Attendance: 18 members.

Participants met in the carpark next to Dudley Beach at 10:00 am. After morning tea, I outlined the purpose of the walk which was threefold:

1) Structure of Dudley beach and the part waves play in its formation.
2) Structure of the cliffed coast at Redhead Point and formation of its wave-cut platform.
3) Common plant fossils found in rocks at Redhead Point.

Field notes were distributed and I spent time going through the notes and answering questions. Specimens of fossils that could be found were shown before we all moved off for the walk to Redhead Point.

During the walk, I brought the group together and pointed out beach structures and again outlined the role waves played in its formation.

We then walked over to a low cliff where the Victoria Tunnel coal seam was exposed at beach level. Brian outlined the formation of coal and the environment thought to exist during the Permian age. Coal samples were handed around and the difference between the very bright black bands (vitrain) and the dull friable bands (fusain) explained.

As we approached Redhead Point, a very good example of imbricated boulders was observed. At Redhead Point some 7m above sea level, the Victoria Tunnel seam (approx 6.5 m thick) can be seen. It is underlain by the Shepherds Hill Formation (floodplain deposits). The platform at this location consists of a layer of ash deposits called the Nobbys Tuff member. Petrified tree stumps (Dadoxylon) were found in it.

Above the Victoria Tunnel seam the blocky outcrop of the Kotara Formation was observed. It consists of pebbly sandstones deposited in a floodplain environment. Intra-formational slumping and cross-bedding were common features.

At the base of the cliff in the scree slope, slabs of shale and fine sandstone associated with the coal seam have collected. Within these rocks, fossils of Glossopteris and Phyllotheca were plentiful. We spent half an hour looking for and collecting fossil specimens.

As we returned the cars by walking across the platform, we encountered a fine grained Dolerite Dyke approximately 1m wide cutting across the platform. Once back at the cars, we conveyed to The Royal Crown Hotel in Dudley for lunch.

Report by Ron Evans.

Ron Evans

Base of the Victoria Tunnel Seam

Ron Evans

Brian describing the structure of coal

Ron Evans

Redhead Point. Kotara Formation (top), Victoria Tunnel seam, Shepherds Hill Formation and platform (Nobbys Tuff member)

Ron Evans

Imbricated boulders just south of Redhead Point

Ron Evans

Phyllotheca stems in shale

Field Notes.

Beaches:

- A beach is defined as *wave washed sediment along a coast, extending throughout the surf zone.*
- The beach zone is one of active sediment movement, both *erosion* and *deposition*, mainly from the effects of waves breaking along the shore.
- Sediment forming beaches is derived from erosion of nearby cliffs and sediment contributed by rivers.
- A beach has recognisable parts:

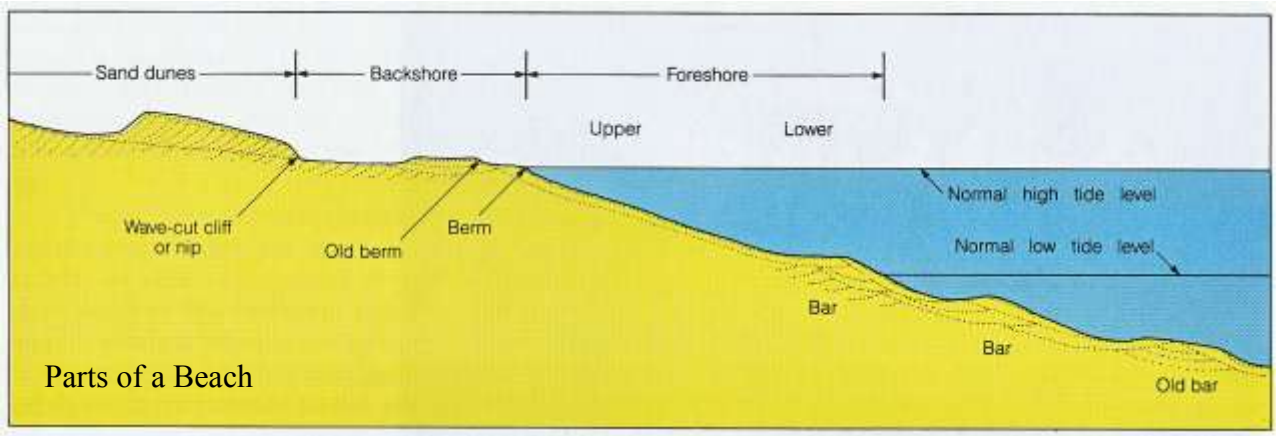
1. **Foreshore**: A zone extending from low tide level to the average height of high tide.
2. **Berm**: A landward sloping bench (usually nearly horizontal) formed by wave deposition of sediments.
3. **Backshore**: A zone extending inland from a berm to the farthest point reached by waves.

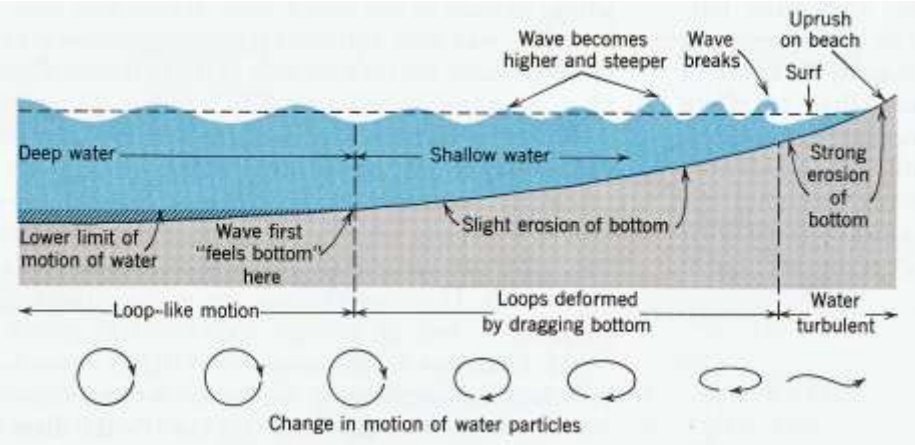
Waves:

- Ocean waves are generated by winds that blow across the surface.
- Particles in the water oscillate with a loop-like motion as a wave moves forward.
- Particle motion is negligible at a depth equal to half the wavelength.
- Below this depth, any sediment carried will be deposited. In this way, sediment deposition forms continental shelves.
- When waves approach the shore, friction causes the velocity of waves to decrease causing an increase in the height of the wave which eventually breaks releasing its stored energy.

Longshore Drift:

- Most waves reach the shore at a slight angle. This results in a longshore current within the surf zone that flows parallel to the shore.
- The direction of longshore drift may change seasonally as the direction of prevailing wind change.
- Longshore drift results in beaches and offshore sediment slowly moving along the coast. Arcuate cusps along a beach indicate relatively rapid longshore drift.





The diagram shows how waves change form as they travel from deep water to shallow water to shore

Cliffed Coasts:

- Seen in profile, the usual elements of a cliffed coast are a wave-cut cliff and wave-cut platform (or bench).

- A **wave-cut cliff** is formed by the action of surf.

a) The cliff is undercut most actively at the base of the cliff (most energy released from waves).
b) As the cliff is undercut, it collapses with the resulting debris providing rock particles to be reworked by the surf.
c) An undercut cliff that has not collapsed may have a well devleloped notch at its base.
d) Sea caves, sea arches and stacks are also associated with cliffed coasts.

- A **wave-cut platform** is a bench cut across bedrock by the surf.

a) The bench or platform slopes gently seaward and is extended progressively seaward as the cliff retreats.
b) Most platforms are covered with sediment that is in transit from shore to deeper water. The most abundant and largest fragments occur close to the base of the cliff.
c) Platforms exposed all the time, or at low tide indicate that relative movement of the sea and land has taken place. e.g. A drop in sea level and/ or a rise of the land.

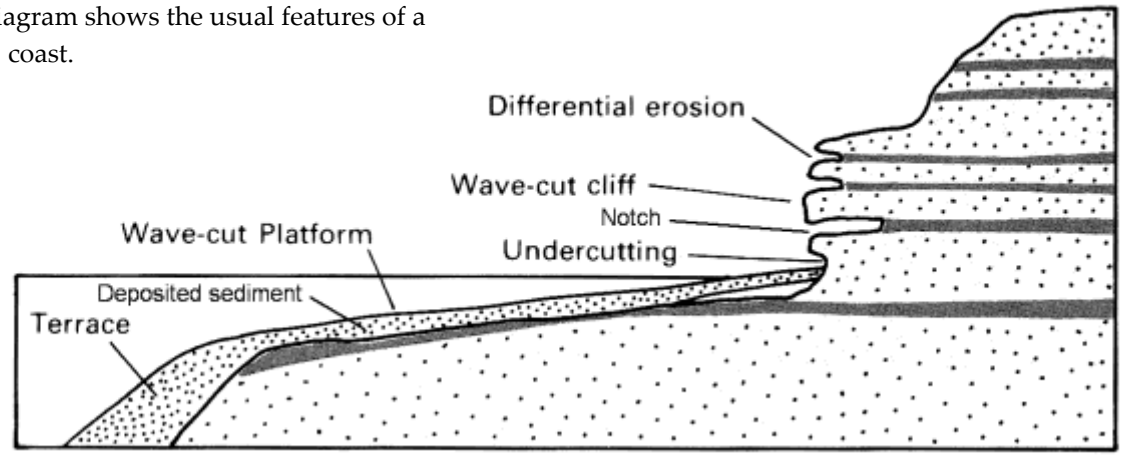
Fossils:

- The climate during the Permian when the coal measures were formed was very cold and wet with widespread coal swamps.
- Fossil tree trunks make up the greater part of plant remains and the coal itself is made up largely of twigs and stems.
- The trees are the Gymnosperm (cone-bearing plants) Dadoxylon.
- In shales associated with the coal seams, leaves of the seed fern Glossopteris are abundant. The leaves are almost never found attached to stems which suggests that they were probably deciduous.
- Associated with the glossopteris is a group of rush -like or bamboo-like plants which apparently lived in swamps. Many forms were branching with the branches produced in whorls around the stem.
- Whorls of small leaves grew on the branches arising from nodes along the stem. Some leaves were spiky while others umbrella shaped.
- Phyllotheca belongs to this group of Sphenopsids. Stems of Phyllotheca are most commonly found.

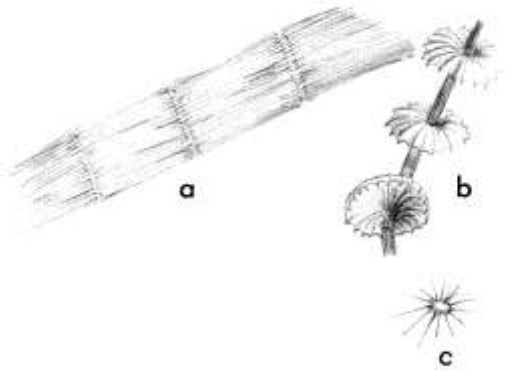
Information Sources.

NASHAR, B. (1964). *The Geology of the Hunter Valley*. The Jacaranda Press.
SKINNER, BJ; PORTER,SC (1987). Physical Geology. *John Wiley and Sons.*
BAMBERRY,WJ (19930. Coastal Exposures of the Northeastern Sydney Basin. *Fifth International Conference on Fluvial Sedimentology.*

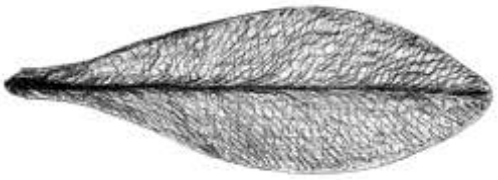
The diagram shows the usual features of a cliffed coast.



Plant Fossils Observed:



a) Phyllotheca stem
b) Umbrella-shaped whorls of Phyllotheca leaves growing at nodes
c) Circlet of spiky Phyllotheca leaves



Glossopteris

Swansea Heads Petrified Forest

Saturday 20th March 2010

Leaders: Chris Morton and Ron Evans.

Attendance: 24 members, 3 visitors.

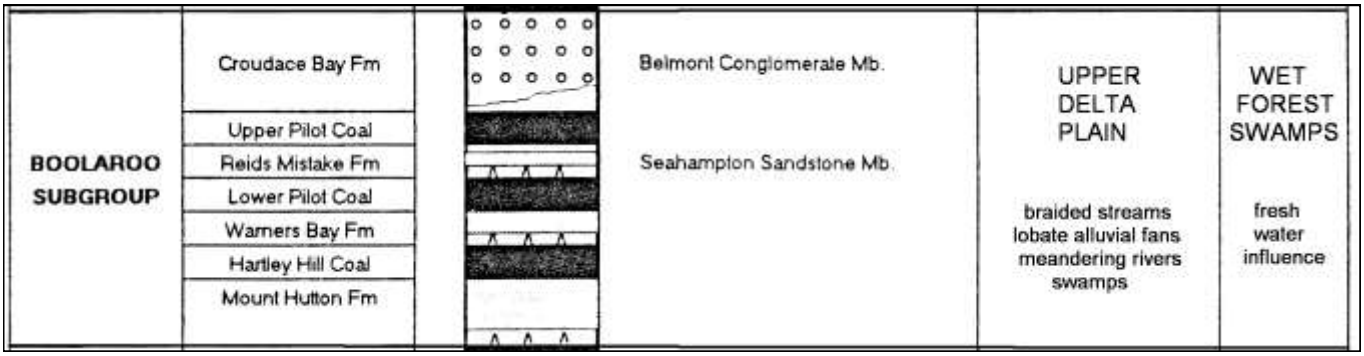
Swansea Heads is an interesting location with a varied history from locations where the Awabakal aboriginal people foraged along the foreshore for food to present occupation. There has been a number of important archaeological digs in the area that has given significant insight to the way the aboriginal people lived. Captain Reid gave his name to the area in the year 1800, when he was sent from Sydney to fetch coal for the colony from the newly discovered coal deposits at Coal River. However poor old Captain Reid's navigation was slightly out and he mistakenly thought the entrance to Lake Macquarie was the entrance to Newcastle Harbour, hence the name Reid's Mistake. However our interests on the day were in a much older event, the 250 million year old fossil forest that was buried by ash from a volcanic eruption that occurred some 20 km to the east off the present coast line.

On a beautiful autumn afternoon we met for afternoon tea at Reid's Park. With pleasantries and financial business out of the way, we made our way down to the rock platform to find the fossil forest which consists of many ancient Glossopteris tree stumps preserved in tuff. The tide was extremely low, seas were calm and so conditions could not be more ideal for exploring the rock platform.

Reid's Mistake Formation represents the stratigraphic interval that separates the Lower and Upper Pilot Coal seams within the Boolaroo Sub-Group of the Newcastle Coal Measures.

The stratigraphic succession consists of the Lower Pilot Seam in the rock platform, Reid's Mistake Formation in the cliff fronting the coast and the Upper Pilot Seam in the upper part of the cliff. Further south along the cliff, massive conglomerates with sandstone layers belonging to the Belmont Conglomerate Member appear. (See stratigraphy next page).

Many coalified and silicified tree trunks protrude from the top of the Lower Pilot Coal into the overlying tuffaceous rocks and have been preserved in growth positions. The preservation of the fossil



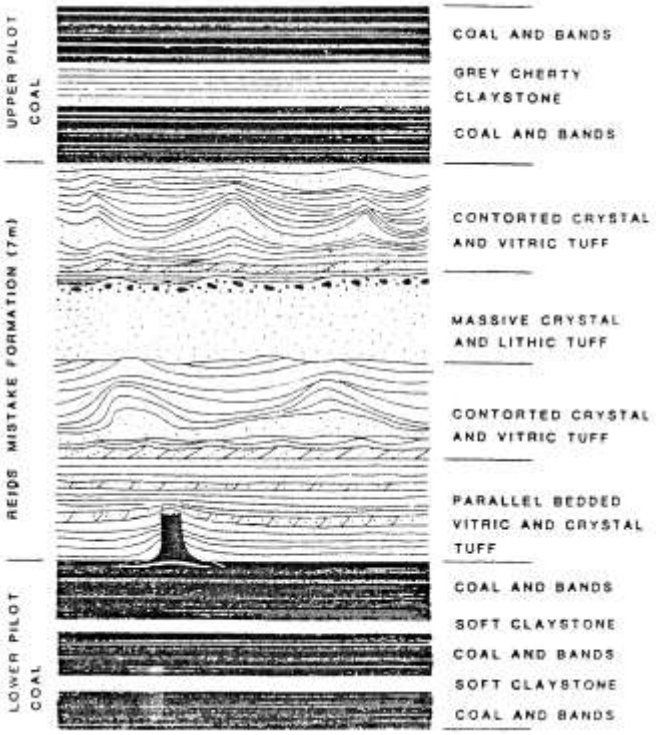
trees was recorded by David (1907) who suggested, *"The oldest forest growth, which went to form the lowest seam, was killed off suddenly by being buried under dense showers of fine volcanic ash".*

Diessel (1984a, 1992) recorded the azimuths of trees felled by base surge deposition of the overlying pyroclastic rocks. He reported that most of the downed trees point towards 260° indicating surges from an easterly source. Diessel (1984a) also noted that some fallen logs remained partly attached to stumps in growth position. Charred wood and stripped bark occur on the outer surfaces of stumps.

The Reid's Mistake Formation consists of vitric to crystal tuffs in thin, blocky beds. The bedforms preserved in this sequence include parallel lamination, ripple bedding, megaripples and massive beds. A section of the sequence is shown in the diagram opposite after Diessel (1984a).

Ron showed us a graph he had drawn from a previous investigation made from 60 compass readings of the alignment of fossilised branches randomly chosen. The graph showed that most of the logs pointed in an east-west direction.

When tree stumps in situ were examined more closely, it was observed that most leaned towards the west. This indicated that the ancient eruption occurred off the coast towards the east.



Generalised structure of the Reids Mistake Formation at Swansea Heads (not to scale; from Diessel, 1984a)

Ron Evans

Petrified stump of Dadoxylon and branch (perhaps attached) preserved in tuff

Ron Evans

Chris giving the group an explanation on the formation of the coal, rocks and fossils

Ron explained that it was probable that an explosive eruption similar the 1980 Mt. St. Helens eruption may have occurred. The blast of hot pyroclastic material would have snapped off the trees tilting the stumps towards the west and aligning the trunks east west. Ash would then have settled out covering the tree stumps and branches ultimately forming tuff.

One fine fossil stump growing in the lower coal seam with its root system still quite visible indicated that the trees were the source of the coal deposits. There were many leaf fossils found in fine laminated (indicates ash-fall) grey tuff that was scattered about the rock platform.

Moving on, we meandered south to the cove where there are many cobbles lying on the beach which I am sure the Awabakal people would have utilised for many for their tools and weapons. Then onto the point where we inspected an ironstone formation exposed because all the sand covering the rock platform had been removed by large waves.

There was an interesting sight in the form of what was called Mushroom Rock, a large boulder had been dislodged from the escarpment and settled on the rock platform. After many years of erosion around the base of the boulder, it was left sitting on a pedestal looking like a large mushroom. There are many other conglomerate boulders strewn around this area that have rolled down from the escarpment. They contain interesting formations such as honey-comb weathering, cut and fill structures and graded bedding as well as fossil tree remains. A very interesting place.

On our return Ron had each of us stand on a fossil stump and wave our arms about like trees to give us some perspective of the density of the Glossopteris forest that once stood there. A very enjoyable afternoon was had by all, a small band of people stayed on and enjoyed tea with the sun setting … letting the world drift by.

Report by Chris Morton and Ron Evans.

Ron Evans

Coalified and silicified Dadoxylon tree stump growing in the Lower Pilot Seam

Ron Evans

"Mushroom Rock"

Ron Evans

Playing "trees". Each person is standing on the stump of a petrified tree

Box Head Walk

Saturday 17th April 2010

Leader: Barry Collier.

Members and interested visitors met at the picnic area at Mt Bouddi, in Bouddi NP.

Shortly after 10 am, most walked out along the Bouddi Ridge to the Coastal Walk, and then down to the saddle behind the headland at the eastern end of Maitland Bay.

Shortly before the Coastal Walk was reached, the track passed through the interface between Hawkesbury Sandstones and the underlying Terrigal Formation, with some interesting rock faces and a considerable number of Rock Lilies which would provide a marvellous display in spring when flowering.

At the saddle we had some great views along this spectacular section of coastline and out to the Maitland Bombora, where in 1896, the SS Maitland was wrecked in a similar storm to that experienced in 2007.

After lunch we drove to the parking area above Tallow Beach and set out on the beautiful walk to Box Head, past, among other things, some spectacular Sydney Red Gums.

At Box Head, after admiring the view, most climbed down a fisherman's track to the rock platform which had a display of Liesegang rings as good as those at Putty Beach, making them among the best in the world. As a bonus there were dozens of small concretions, some previously recorded as petrified tree roots.

We then returned to the cars and at Wagstaffe, undertook the obligatory coffee break before heading home.

Report by Barry Collier.

Barry Collier

Liesegang Rings on the rock platform, Box Head

Barry Collier

Honeycomb weathering in sandstones

Barry Collier

Tessellated Pavement in sandstone showing circular concretionary structure

Sandbar Weekend

Saturday 8th to Sunday 9th May 2010

Leaders: Terry Kingdon and Barry Collier.

Attendance: 21 members, 5 visitors.

Saturday 15th May: Seal Rocks

We all met at Sandbar Caravan Park, and discussed the agenda for the day. The weather was going to dictate what we could and could not do as it was very windy and there were very large seas running. The large seas were going to make things very difficult to get down to the headlands which I had planed to visit; we said that we would make that decision when we got to Seal Rocks.

The group left to go to Seal Rocks at 9.00am. It took about 30 minutes to get to the car park at the entrance to the Lighthouse walk, a pleasant 2 km walk except for the last 100 meters (very steep) up to the top of the hill where the Lighthouse is. Every one walked at their own pace so we all made it to the lighthouse. From the top of the hill you could see up the and down the coast. What struck us when we looked out to sea was the large swell running right along the coast which meant there was no beach left; it had been washed away. I was there only a couple of weeks prior and there was a lovely large stretch of sandy beach to walk on and a easy walk around to the rocks.

While we looking out to sea, we saw what looked like a sailing boat in trouble. It seemed to be heading towards the bay at Seal Rocks for some shelter from the large swell that was running; we think it made it in. There is a large cave that the water runs through at the bottom of the hill. Several of our members ventured down to take pictures, but not me. We returned to the cars and had morning tea.

Ron Evans

Sugarloaf Point Lighthouse

Ron Evans

View south from Sugarloaf Point Lighthouse

We had a meeting to discuss what we could do for the rest of the day - what I had planned we could not do. It was decided to go to Wallingat National Park for lunch at Whoota Whoota Lookout with a wonderful view over Wallis Lake. What a lovely spot, out of the wind, sunny with a great view up the coast to Foster and beyond. We spend some time relaxing and eating lunch.

After lunch we went down into the National Park and went for a walk from Sugar Creek through the cabbage palms and flooded gum forest. I for one enjoyed the walk, as did everyone else. Every one had worked up a thirst after the walk, so we all headed for a coffee shop. The coffee shop is situated over the water so it was very breezy; everyone enjoyed their coffee and cake.

I had booked a large table for 21 at Pacific Palms Bowling Club for tea that night for 6.30 pm. We all had an enjoyable meal that night, even though

Ron Evans

Lunch stop - Whoota Whoota Lookout with Wallis Lake in the distance

Terry Kingdon

Start of the 1.7 km Sugar Creek Walking track

Terry Kingdon

"Map of Australia" cave, Hallidays Point

some had to wait a very long time to get their meal meaning that most had finished their meal before theirs had arrived.

Sunday 16th May: Hallidays Point (21 members)

We met at the caravan park at 8.45am and left shortly after for Hallidays Point which is about a 50 minute drive north of the caravan park. On arrival at Hallidays Point, we went for a walk out to the headland on a loop walking track. Just under the headland we were standing on is a large sea cave. We intended to walk around the coastline to have a look at the cave later in the day, weather permitting. Morning tea in the car park followed the walk.

After morning tea we headed down the coast about 1 km to a car park near the beach. Some of the members decided not to walk along the coast and stayed on the beach to enjoy the scenery while the others went for a walk along the coast. We found a cave that, if you looked out through the cave to sea and used your imagination, could be a map of Australia. There was very little sand on the beach, which made walking very difficult. We eventually made it to the large cave under the headland. We could not get close to it because of the big seas and the fact that all the sand had been washed away. A couple of the members got a little wet trying to take photos the cave because some of the waves washing up on to the rocks we were standing on were very large. After returning from the walk we had lunch at Seal Rocks on a small strip on grass in the shade. It was a nice spot for lunch except for leeches. I got two off me.

After lunch we walked along the beach to a cliff face that I through may be interesting. Along the beach there were local fishermen fishing off the beach for Mullet using large nets. The nets were towed out to sea, around the fish, and then brought to shore, where they were towed up the beach by 4 wheel drive vehicles. The nets had very long tails on them; these tails were filled with fish, tonnes and tonnes of fish.

The cliff face was made up of sedimentary layers, to me were interesting. We would have loved to have gone further along the rock shelf, but could not because of the big seas; maybe another time. On our return to the car park, it was time to say good bye to everyone and head home wards.

The weekend was not as I had planned, not a lot of geology, but I believe everyone had a good time. The coast line in this area is really worth having a look at, if you have not been there.

Report by Terry Kingdon.

Ron Evans

Lookout at Hallidays Point

Ron Evans

Site of sea caves at Hallidays Point

Terry Kingdon

Hauling in fish on Seal Rocks Beach

Ron Evans

Intrepid explorers, Hallidays Point

Fort Scratchley Tour

Saturday 29th May 2010

Leader: John Cater.

Attendance: 17 members.

Participants met leader John at the entrance to Fort Scratchley on a cool dampish morning at 10:00 am. After paying our entry fee, John took us into the fort where he presented a very interesting talk on the history of Fort Scratchley. This was illustrated by a model of the fort and photographs of Sir Peter Henry Scratchley (1835 - 1885) after whom the fort is named.

On completion of the introductory talk, John led the group through the underground part of the fort explaining the purpose of each section. Of particular interest was the site of the 8" 'disappearing guns'. These used a pneumatic system to raise the gun when it was to be fired. Recoil on firing caused the gun to sink down into the fort for reloading.

Upon leaving the underground section of the fort, we went up on its top where a restored gun in its Barbette is located. This gun is fired on ceremonial occasions. A wonderful view of the city and Nobbys is obtained from the gun emplacement.

After the informative and interesting tour was completed, the group proceeded to Newcastle Yacht Club for lunch.

Report by Ron Evans.

Ron Evans

AGSHV members meeting at Fort Scratchley

Ron Evans

Entrance to the underground part of Fort Scratchley

Ron Evans

Explanation of the 'disappearing guns'

Ron Evans

Restored cannon

Ron Evans

Nobbys Beach and Headland

Woy Woy Peninsular

Saturday 17th July 2010

Leader: Winston Pratt.

Attendance: 15 members, 1 visitor.

Saturday 17th July 2010 was a bright sunny but brisk morning when 15 members and one visitor met at the Kariong (Aboriginal – 'meeting place') Hall for the Woy Woy Peninsular excursion.

The first stop was at Staples Lookout on the Woy Woy Road where a good panorama of the Woy Woy Peninsular, Brisbane Water and surrounding countryside could be seen.

The lookout was named after Mr C.J. Staples an early developer of the Woy Woy Peninsular, owner of the Gosford Times newspaper, first President of the Woy Woy Shire Council and who later became the Gosford District Coroner. He also upgraded the Kariong to Woy Woy Road and so brought the first car to the Peninsular.

From the lookout the course of a NW – SE trending lineament which has a significant influence on the geomorphology of the Brisbane Water could be seen . Also seen was Point Frederick jutting out into Brisbane Water and where, at its end in the Pioneers Cemetery, is the grave of T. A. Scott who grew the first sugar cane in Australia at where is now named after him, Tascott.

Also prominent was Blackwall Mountain, named after the shipbuilding area on the Thames River England, across the water from which lies Davistown where the Davis family of ship builders developed one of the major industries of the area in its early days.

Winston Pratt

Staples Lookout looking east over Woy Woy

Also visible was the Woy Woy wharf to which the 'Krait' often visited. The 'Krait' was once a Japanese fishing boat named the 'Kofuku Maru' operating out of Singapore. The vessel came into the hands of the Australian military and was renamed the 'Krait' after a small venomous Indian snake. The boat was taken to Broken Bay and Brisbane Water where secret training of a specialist force ('Z Force') took place. Fourteen soldiers and sailors took part in 'Operation Jaywick' in which the 'Krait' sailed from Exmouth in WA on 2 September 1943 to within 20 miles of Japanese held Singapore. Here she dropped three canoe teams who penetrated Singapore harbour at night and with magnetic explosive limpets mines destroyed or damaged almost 40,000 tons of Japanese shipping. The 'Krait' returned safely to Exmouth on 19 October 1943. After the war, in 1964, the 'Krait' was returned to Australia, handed over to the Governor, dedicated as a Floating War Memorial and then presented to the Volunteer Coastal Patrol for use in trust for training and rescue work (much in Brisbane Water and Broken Bay). The 'Krait' is now in the care of the Australian Maritime Museum at Darling Harbour in Sydney.

A few hundred metres further on from Staples Lookout was a track leading to one of the many aboriginal Guringai People's engraving sites which make this region perhaps the most prolific area for engraving sites on the eastern Australian coast. The engravings are at the end of a rocky ridge and from here several geological and geomorphological features could be seen, including hanging swamps (swamps developed on gently sloping hillsides rather than in topographic depressions), primary and secondary structures in the Hawkesbury Sandstone, the location of the Woy Woy diatremes, now the Woy Woy Waste Disposal Area with its methane drainage and power generator, Mount Wondabyne, the Woy Woy Peninsular sandplain and dune complex, and a nearby probable NW- SE trending basaltic dyke marked by a gully with a more lush vegetation than other gullies.

The descent onto the sandplain crossed the base of the Hawkesbury Sandstone and road cuttings exposed the sandstones and siltstones of the underlying Terrigal Formation. This area was ravished by major bushfire in 2006 in which several homes and property, including 7 cars belonging to volunteers from the Rural Bush Fire Brigade parked at the Fire Shed and burnt while the volunteers were evacuating nearby residents.

Once on the sandplain two areas of remnant sandplain forest were visited. The forest in this area is unique in that the rough barked apple dominates over the smooth barked apple (also called the coastal redgum and prolific on dune complex between North Entrance and Norah Head). Barry also showed the difference between these Angopheras with their leaves alternating on either side of the stem and the Eucalypts with their leaves paired opposite each other on either side of the stem.

Opposite the second site on the corner of Veron Road and Hillview Street, the SW – NE trending Everglades Lagoon could be clearly seen. This lagoon developed in a swale between the parallel dunes. It originally extended for about three times its present length but has since been filled with landfill and then developed as a series of playing fields, the largest being Rogers Park.

Rogers park was named after Chief Petty Officer Jonathan Rogers, GC, DSM (1920 -1964, a local Naval officer who was one of 82 men who lost their lives in the fatal collision between the aircraft carrier HMAS Melbourne and the destroyer HMAS Voyager at sea on the night of 10 February 1964. Rogers was born in the UK and joined the Royal Navy when he was 18. He was awarded the DSM while serving as coxswain of Motor Torpedo Boat 698 in actions on the nights of 23 March and 23 May 1944. He came to Australia and was promoted to Chief Petty Officer in the Royal Australian Navy in 1956.

Winston Pratt

Aboriginal engravings

Winston Pratt

Barry showing leaf structures at the sandplain forest

On the night of the disaster Rogers was one of more than 50 men trapped in darkness in the sinking forward section of the Voyager. He took control to calm the situation and, being a large man, realised that he could not escape through a small escape opening. "He was more intent on getting the younger chaps out first" said a survivor. As the forward section of the ship sank ten minutes after the collision Rogers was heard leading his doomed men in a prayer and a hymn.

Rogers was later awarded the George Cross, the highest award for bravery then available in peacetime "for organising the escape of as many as possible and encouraging.....those few who could not escape....to meet death alongside himself with dignity and honour". His George Cross Medal is now in a stand-alone cabinet centre left in the Hall of Valour with the Victoria Cross Medals in the Australian War Museum, Canberra.

On route to the Rip Bridge the original topography of the dune complex was clearly visible along of the unsurfaced laneways between the streets. Several ridges and swales were visible along several of the laneways and when traced from one laneway to the next the SW – NE trend of the dunes is apparent.

The next stop was at a monument at the south eastern end of the Rip Bridge where Captain Arthur Phillip RN camped with his party on the night of Monday 3 March 1788, just 5 weeks after the raising of the British flag at Sydney Cove. Phillip and his party were unable to make headway against the outgoing tide through the Rip but were able to do so the next morning and so entered the Brisbane Water. On a second journey in June 1789 he further explored Brisbane Water, probably as far as Gosford, and not finding suitable farming land, he then returned to Ettalong and then went on to discover the Hawkesbury River as far as Dangar Island.

Winston Pratt

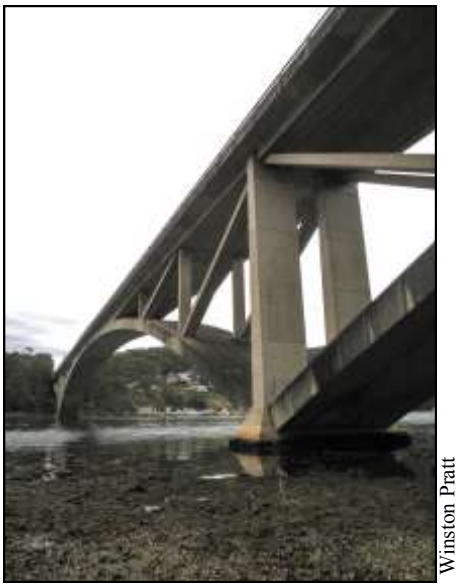
Captain Arthur Phillip RN Memorial

Next was a walk across the Rip Bridge an arch-shaped pre-stressed concrete cantilever truss bridge, which at the time of its opening in 1974 was the longest bridge of this type in the southern hemisphere. The 183m long main span was erected by progressively linking together pre-cast concrete segments with light- weight aggregate concrete drop in-spans.

In a cutting at the northern end of the Rip Bridge fluviatile sediments of the Terrigal Formation were exposed. Also exposed was 400 mm wide weathered basaltic dyke striking about 320 degrees (consistent with the structural trend of other dykes and lineaments in the area). Closer examination revealed that while sandstones predominated on the southern wall of the dyke, the northern side was dominated by mudstones indicating that there had been at least several metres of vertical displacement and that the dyke had been emplaced in a fault.

Returning to the sandplain, a stop was made near the western end of Blackwall Mountain where an abandoned quarry had exposed the fluviatile sediments at the top of the Terrigal Formation. The base of the Hawkesbury Sandstone was at the top of the exposure with outcrop just visible beyond the top of the highwall.

Several hundred metres to the west, the laterite surfacing of a WWII airstrip was still visible in a small carpark at a playground, although recent regravelling of this carpark had almost covered the exposure. This airstrip, and its associated infrastructure of accommodation, sheds and plane storage bays, was constructed to service a planned squadron of Grumman Avenger torpedo bombers. While some of the current roads, streets and houses were present at the time, most of the area was forest and scrub with the aircraft to be stored in camouflage in bays along some of the side-streets. Many of the holiday homes were to be used to accommodation the associated staff. Although the airstrip and facilities were constructed, they remained unused by the military, except as an emergency landing strip. After the war the airstrip was used by some private aircraft owners but after some accidents and the increased development of housing in the area, its use was abandoned and it was buried under residential development.



Winston Pratt

The Rip Bridge

Winston Pratt

Outcrop and dyke at northern end of the Rip Bridge. Note the sandstones on the right and mudstones on the left

Also visible from this location, and several others during the excursion, was one of the bore stations of the Woy Woy Borefield. The area has been subject to severe water restrictions over the past decade or so and to augment the water supply, the groundwater resource of the Woy Woy sandplain was developed. Thirteen bores were developed and connected by 7.5 km of pipeline to provide up to 5 million litres of drinking water per day. The water is piped to a central treatment plant and, after treatment, fed into the town water supply as required. The borefield is computer controlled and each borehole is monitored for downdraw so that pumping can be switched to various boreholes as required so that the pumping does not imping on neighbouring spearpoints or stress the surrounding vegetation.

After lunch at the 'Everglades Country Club', the group travelled towards Patonga to visit a good exposure of polygonal cracking in the Hawkesbury Sandstone. The cause of this unusual style of cracking is uncertain as it is on a much larger scale than similar cracking in mudstones. It does appear to occur only in specific horizons within and only in the Hawkesbury Sandstone, and only in massively bedded and structureless beds with a very uniform grain size. An Aboriginal engraving of a man figure was also visible at this site.

The excursion then travelled through the 'Waratah Patch', an area of a weathered shale lens of the Hawkesbury Sandstone where waratahs are prolific but, unfortunately were not yet in bloom. After leaving the cars in the Warrah Trig carpark and on the walk to the Warrah Lookout over Broken Bay and the Hawkesbury River, Barry pointed out an endangered plant species *'Callistemon linearifolius'* growing on the side of the track. At the lookout the drowned river valley terrain of the Hawkesbury River could be viewed. The Barrenjoey Head tombola (tied island) could also be clearly seen. At the time of Captain Arthur Phillip, high tide washed across the spit but with a causeway constructed to service the then island during and after the building of the lighthouse the sand was then stabilised and built up by the ocean waves.

To end the day we visited a larger area of spectacular polygonal cracking which, in the low angle afternoon sunlight, was particularly good for photographs.

Report by Winston Pratt.

Winston Pratt

Aboriginal engraving of a man figure near the Waratah Patch

Winston Pratt

'*Callistemon linearifolius'*, an endangered plant species near the Warrah Trig

Winston Pratt

View from Warrah Lookout with the drowned Hawkesbury River valley terrain and the Barrenjoey Head

Winston Pratt

Polygonal cracking in the Hawkesbury Sandstone near the Waratah Patch

Winston Pratt

Polygonal cracking in Hawkesbury Sandstone

"How the Earth Works"

Saturday 21st August 2010

Presenter: Ron Evans.

Attendance: 23 members, 1 visitor.

I used a Power Point presentation during my lecture to gave an insight into Earths Structure, Plate Tectonics, Volcanoes and Earthquakes. The following notes summarise information I presented during the lecture.

EARTHS STRUCTURE.

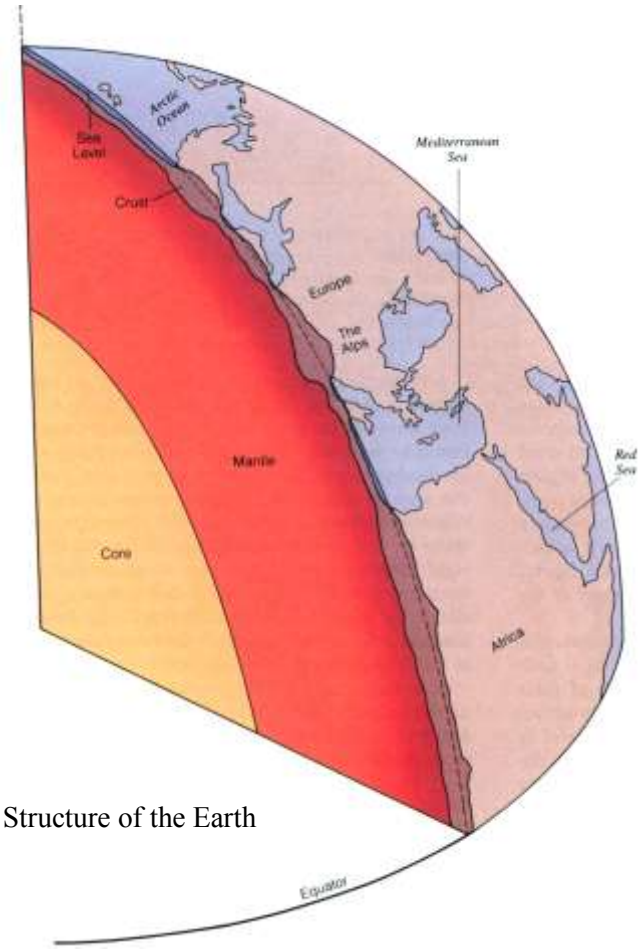
Shape of Earth:

An oblate spheroid or geoid 7,927 miles or 12,757 km in diameter. Earth rotates on its axis daily at 1600 km/hr. This spinning causes the earth to bulge out more at the equator by 21 km compared to the poles. Surface topography varies by about 20 km from deepest ocean trenches to tallest mountain.

Structure of Earth:

Earth is composed of 3 different compositional layers, *CRUST*, *MANTLE* and *CORE*.

a) *Crust*: a thin layer of rigid rocky matter less dense than the mantle rocks below. [0 to 70 km below surface]
b) *Mantle*: a thick layer of dense rocky matter less dense than the core. The *Upper Mantle* starts 5 to 70 km below surface with temperature up to 1000 degrees C. The *Lower Mantle* begins 2,990 km below surface with temperatures of 1,000 to 3,500 degrees C. The Mantle itself is divided into three layers; the *Lithosphere* (the outer 100 km of solid earth), the *Asthenosphere* (starts at depths below 100 km and is a region of the mantle where rocks become plastic and are easily deformed) and the *Mesosphere* (region between the base of the asthenosphere and the core-mantle boundary with rocks gradually become harder and less plastic with increasing depth).
c) *Core*: a spherical mass largely of metallic iron, with admixtures of Ni, S, Si and other elements. It has two layers, the Outer Liquid Core starting 5,150 km below surface with temperatures of 3,500 to 4,000 degrees C. The Inner Solid Mantle commences 6,370 km below surface with temperatures of 4,000 to 4,700 degrees C.



Structure of the Earth

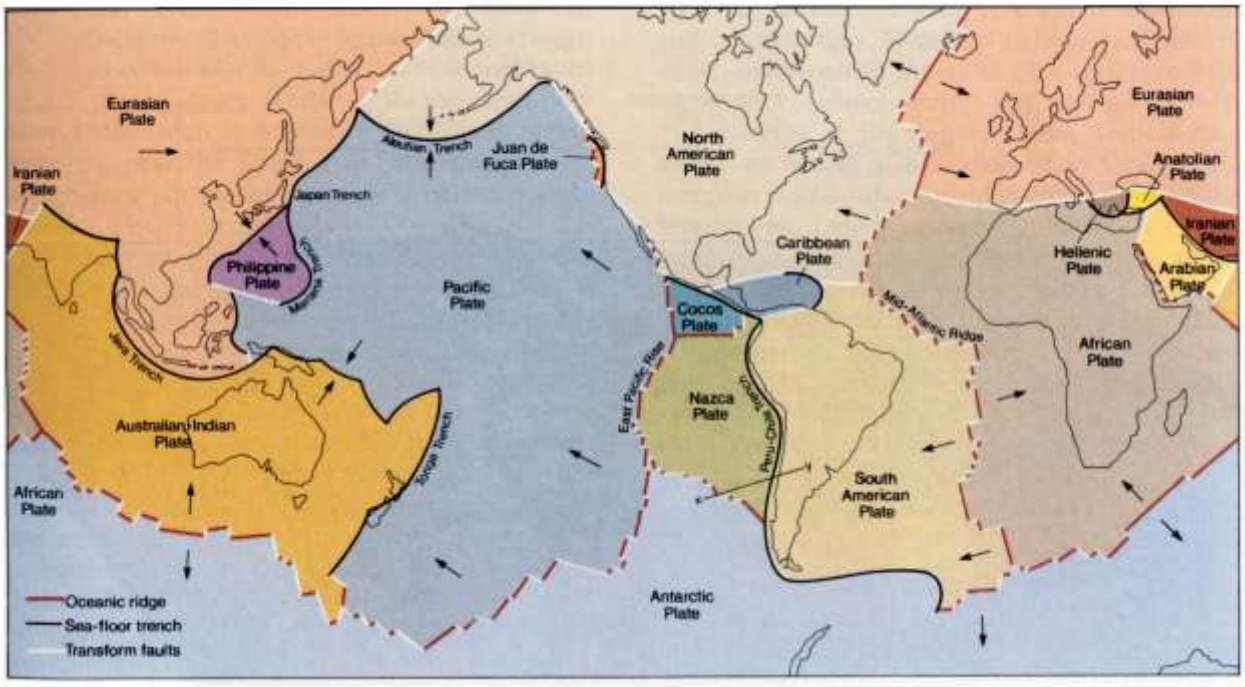
PLATE TECTONICS.

Tectonics: is the study of the movements and deformation of the crust on a large scale, while *Plate Tectonics* is a special branch of tectonics that deals with the processes by which the lithosphere is moved laterally over the asthenosphere.

Plate tectonics is a relatively new science and has revolutionised earth sciences. The semi-rigid lithosphere not only moves, but does so in a series of plate-like pieces.

It is the *movement* of *plates* that causes ocean basins and continents to be where they are and to have the shape they have.

The *lithosphere* is presently broken into 6 large major and several smaller plates that move at speeds ranging from 1 to 12 cm per year average.



Major Tectonic Plates and their boundaries

Plate Movement:

One theory is that convection cells within the mantle move the plates. The relatively cool lithospheric plates are underlain by hot mantle rock plastic enough to flow. Hot mantle rock rises to the surface to form crustal ridges before moving away from the ridge. As it moves, it drags the overlying plate along with it.

Other scientists discount the convection cell theory and instead argue that gravity pushes the actively growing plate away from the high, thermally buoyant ridges. Furthermore, once an oceanic plate enters a subduction zone, gravity acts to pull the cool, relatively dense plate down into the mantle.

As a *plate moves*, everything on the plate, including the capping crust, moves too. e.g. If part of the plate is continental crust and part oceanic crust, then both the continent and ocean floor will move with the same speed and in the same direction as the plate.

To visualise how plates move, think of a conveyor belt. In a conveyor, the belt continually appears from below, moves along the length of the conveyor, then turns down and passes from site as it completes its circuit.

As plates move, relative movement occurs along plate boundaries. These can be:

a) *Divergent movement:* causes plates to move apart. e.g. Along the Mid-Atlantic Ridge.

b) *Convergent movement*: causes plates to collide. e.g. Pacific plate and the Australian-Indian plate.

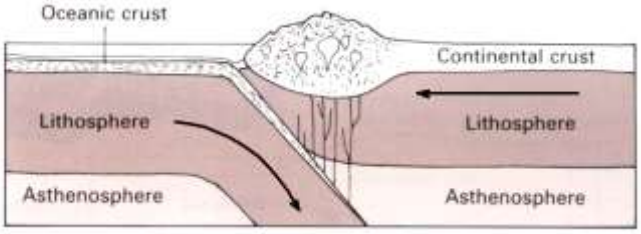
c) *Transform movement*: causes plates to slide past each other. e.g. Along the San-Andreas fault in California.

For divergent movement to occur, new plate material must be created. As a consequence of new plate material being formed, oceanic plate material is destroyed where plates converge.

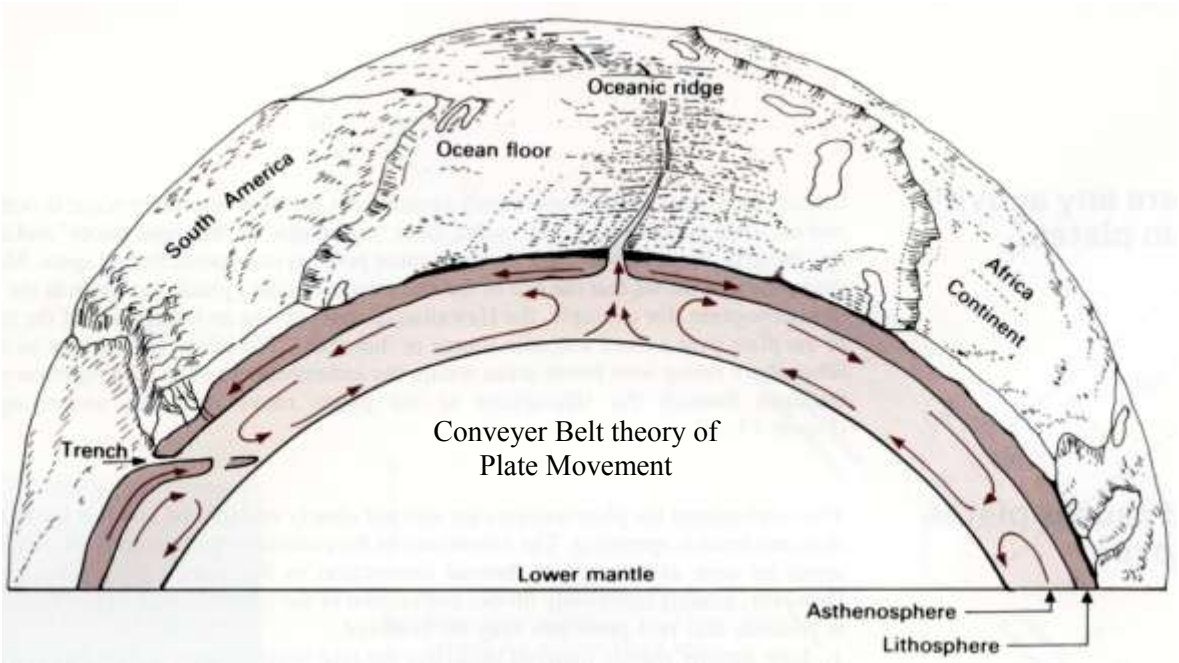
This engulfing occurs along subduction zones.

Subduction occurs along all *convergent plate boundaries*:

a) Ocean - ocean plates.
b) Continental - continental plates.
c) Ocean - continental plates, as illustrated below.



When the oceanic crust converges with the continental crust, subduction occurs with the oceanic crust sinking into the Asthenosphere.



Conveyer Belt theory of Plate Movement

Volcanoes and Earthquakes:

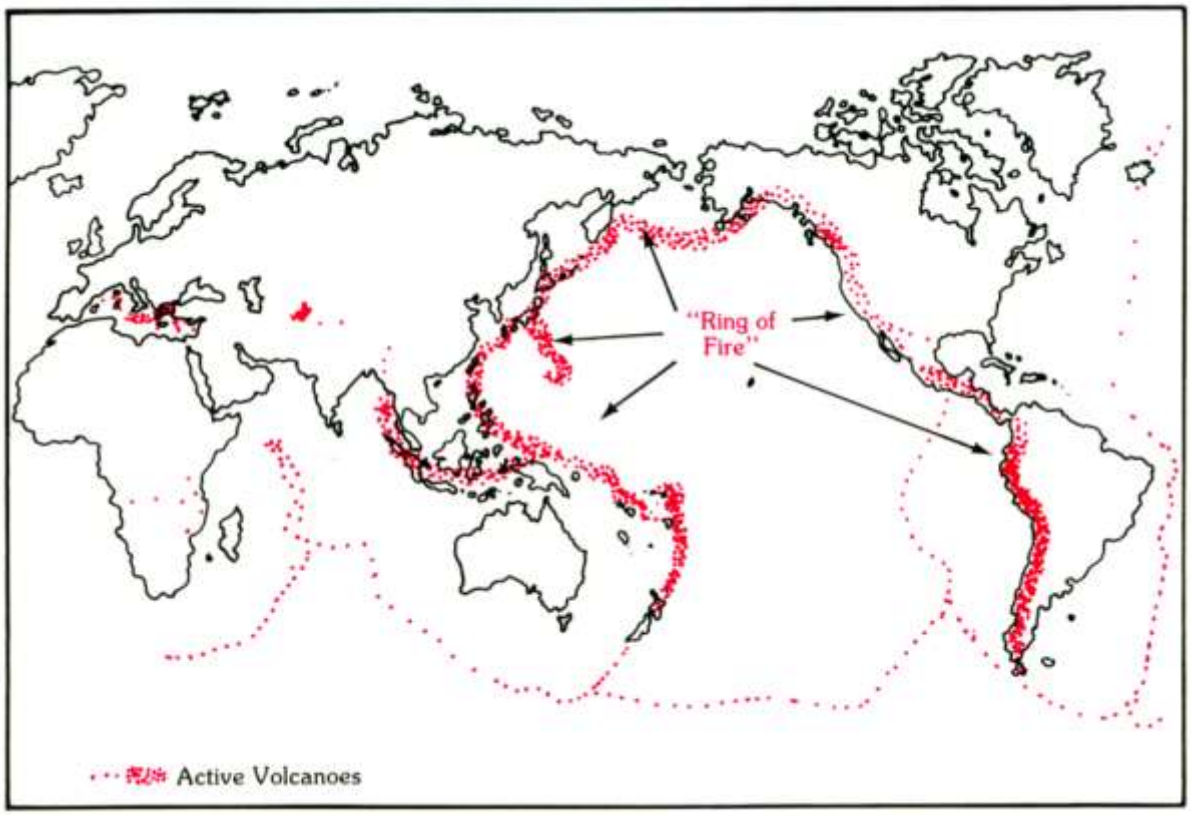
The distribution of volcanoes and earthquakes is clearly related to Earths tectonic plates, particularly their boundaries.

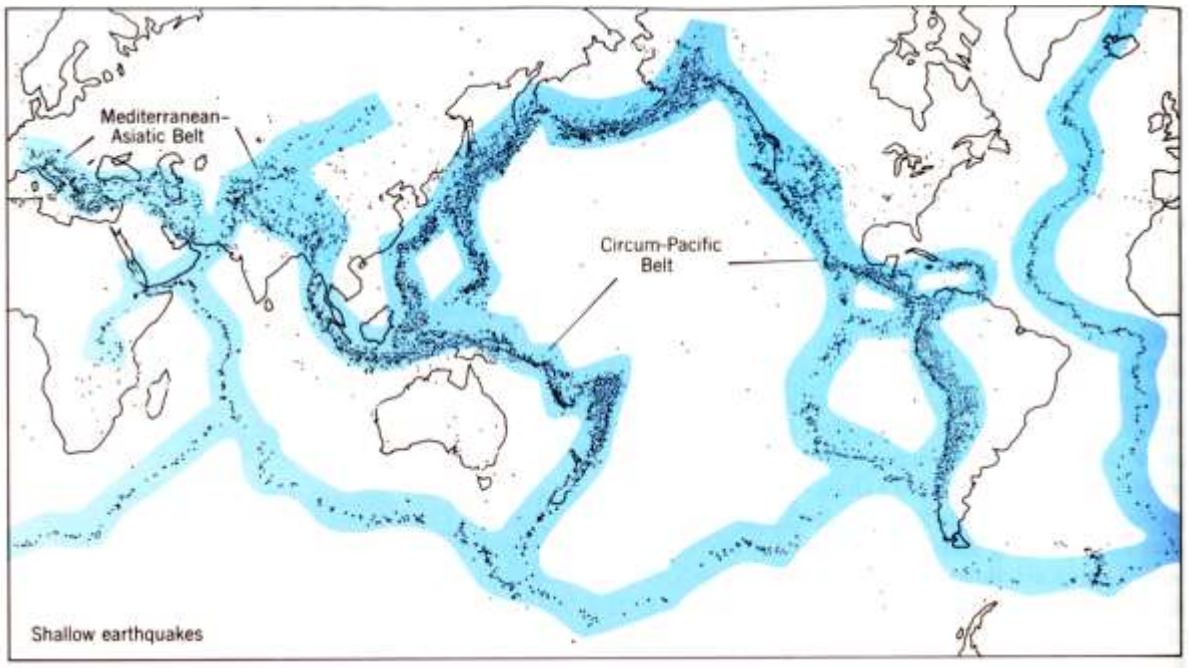
This relationship between volcanoes and earthquakes is clearly seen when they are compared to a map of plate boundaries. Compare the diagrams below showing the location of active volcanoes and earthquake belts to the plate boundaries shown on page 21.

Volcanoes:

A volcanic eruption occurs when molten rock (lava) rock fragments (pyroclastic material) and gases are released on to Earth's surface. The eruption can occur on land or under the sea and can be quiet, explosive or a combination of both.

About 80% of above sea level volcanoes occurs at convergent plate boundaries and 5% at divergent boundaries. Mantle *hot spots* account for the rest found away from plate boundaries.





The **source** of **volcanism** can be explained by examining what occurs at convergent and divergent plate boundaries.

Earthquakes:

Seismic belts are subjected to frequent earthquake shocks.

The most obvious is the *Circum-Pacific belt* where about 80% of all recorded earthquakes occur.

The *Mediterranean-Asiatic belt* accounts for about 15% of all earthquakes.

Lesser belts follow mid-ocean ridges.

The *epicentre* of an earthquake is the part of the crust immediately above the place where the earthquake occurs, called its *focus*.

The depth of earthquake foci also tell a story. Most are no deeper than 100 km. Most earthquakes occur in brittle rocks and the brittle lithosphere is only 100 km thick.

However, deep earthquakes do occur at depths greater than 100 km.

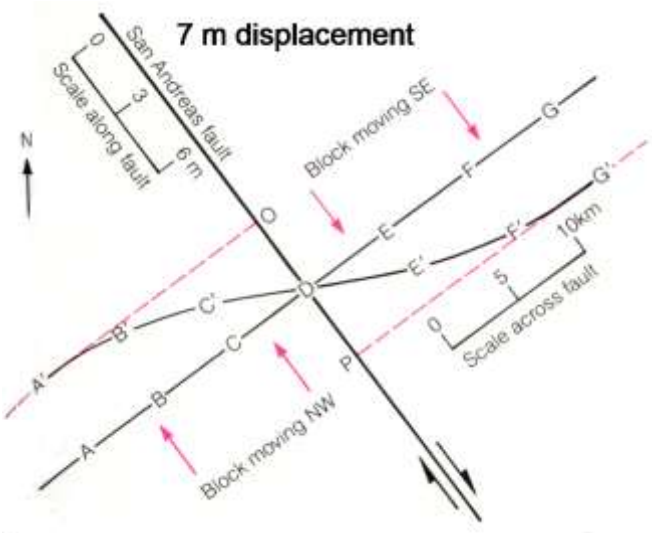
These are closely related to seafloor trenches where the lithosphere sinks down into the mantle. These earthquakes can occur down to a depth of 670 km and follows a well defined zone called the *Benioff Zone*. (See diagram below)

Cause of Earthquakes:

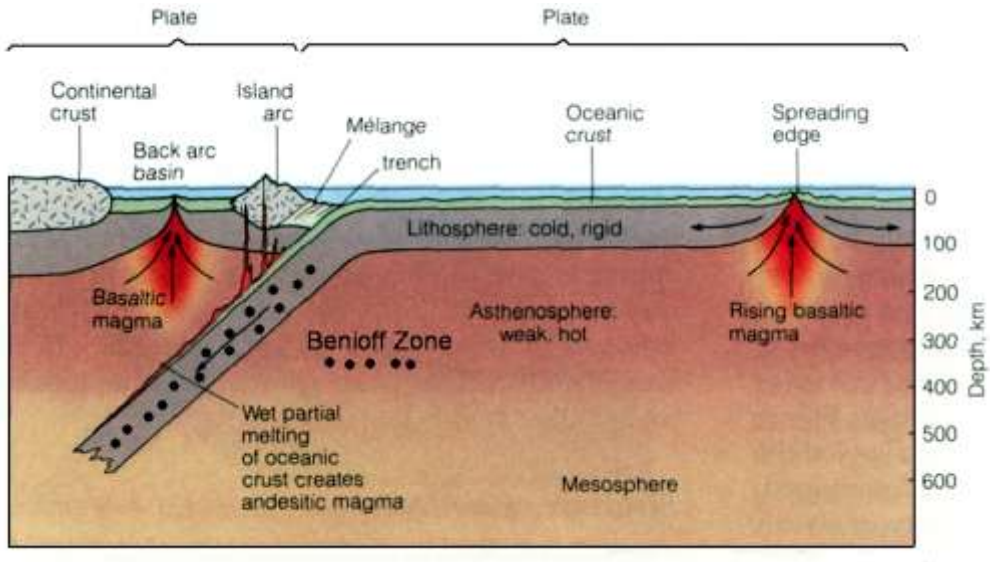
Movements in Earth's crust cause rocks to become *stressed*. (stress - magnitude and direction of a deforming force). This leads to *stain* in the rocks (*changes* in *length*, *shape* and *volume*).

Abrupt movement along *faults* is responsible for most *earthquakes*.

The *elastic rebound theory* is often used to describe how earthquakes occur. For example, movement of plates in opposite directions along the San Andreas Fault in California causes rocks to bend storing potential energy. When the limit of friction along the fault is exceeded, the strained rocks suddenly move into a new position releasing the stored energy as earthquake waves. (see diagram next page)



Elastic Rebound Theory used to explain the cause of Earthquakes



When magma reaches the surface, a volcanic eruption occurs, either quiet, explosive or a combination of both.

When sudden slippage occurs the energy released radiates outwards from the *focus* as earthquake waves. The place above the focus where released energy is most intense is called the *epicentre* of the earthquake.

Types of Earthquake Waves:

There are three types, P, S and L waves.

P or Primary Waves: compression waves (change volume and density as they travel), fastest (6 km/s typical velocity in upper crust) and pass through whole of earth.

S or Secondary Waves: transverse or shear waves (change shape as they travel), slower than P waves (3.5 km/s typical velocity in upper crust) and do not travel through liquids or gases as they do not change their shape (thus not through liquid outer core.)

L or Long or Surface Waves: complex waves caused by free oscillation of Earth. ie. the energy released makes the Earth ring like a bell. This is the source of L waves which are the slowest moving waves. They only travel through the crust and cause most damage in an earthquake.

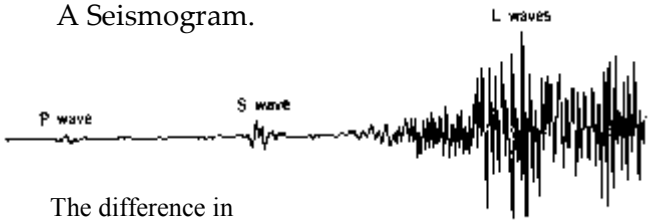
Recording Earthquake Waves:

Recorded on instruments called *seismographs* which have two parts; a *detection device* called a *seismometer* and a *recording* device.

The *recording* made is called a *seismogram*.

Seismograms can be used to indicate the epicentre of an earthquake by triangulation, direction of motions of a fault by studying the features of P and S waves as they arrive at several different seismographs and the magnitude of the earthquake.

A Seismogram.



The difference in arrival times is used to determine distance to epicentre

Amplitude of waves indicates the magnitude (amount of energy) of an earthquake

Sandy Hollow, Merriwa, Bylong
Friday 29th to Sunday 31st October 2010

Leader: Winston Pratt.

Attendance: 8 members, 2 visitors.

Six members and two guests set out from Sandy Hollow on the Friday 29th October leg of this trip. Taking the Golden Highway towards Merriwa up the Halls Creek Valley and paralleling the disused Sandy Hollow to Merriwa Railway. The first stop was at Battery Hill where polygonal basalt columns project almost horizontally from the hillside (Photo 1). Cooling basalt shrinks and forms polygonal columns normal to the shortest dimensions of the flow, usually top to bottom so that the columns are vertical in horizontal flows. In this case however the basalt is in a vertical pipe configuration in which the shortest dimension is horizontally across the pipe, hence the near horizontal attitude.

To this point the route having commenced near the base of the Triassic Narrabeen Group with its predominating conglomerate was ascending the sequence and the conglomerate was now subordinate to sandstone. The Triassic is then overlain by the Jurassic mudstone dominated Purlewaugh Formation which is recessive and outcrops are rare. The overlying Jurassic Pilliga Sandstone, however is more resistant and cropped out in road cuttings before being overlain by Tertiary basalts of the Liverpool Range volcanic province. These basalts were exposed in road cuttings at the top of the ridge east of Merriwa. From here looking back to the east, Mt Dangar dominated the plateau skyline and demonstrating its use as a directional landmark for early explorers. Mt Dangar is a basalt residual dated at about 206 Ma (Late Triassic to Early

Ron Evans

1. Low angle basalt columns at Battery Hill

Jurassic). To the north the Tertiary basaltic peaks of the Liverpool Ranges were clearly visible.

A few kilometres northward from Merriwa we stopped at the entrance to Terragong Station overlooking Coulsons Creek where, at the headwaters near Governors Rock (of the Jimmy and Joey Governor Manhunt), Harry Redford, the 'Captain Starlight' of Ralph Boldrewood's "Robbery Under Arms' novel, threw the remains of the Cabby hack with the markings of the prized racehorse the 'Duke of Athol' and stolen from 'Myrtle Grove' (adjoining Widden Stud) in a successful insurance scam.

In March 1840, hooded bushrangers held up the Terragong homestead and, in the ensuing robbery and struggle, one of the bushrangers fatally shot a farmhand and one of the bushrangers was also wounded. With all of the bushrangers escaping and unidentified, the ensuing police investigation was stalled until police at Cassillis reported a wounded (not gunshot) shepherd with information on the Terragong murder. Thence followed an amazing and complicated story of how the shepherd was wounded in one of four attempts on his life, how another murdered body was found and how eventually the murderer was found and he and his accomplices brought before the court and eventually the hangman.

Returning to Merriwa we had lunch by the Merriwa River where the Pilliga Sandstone crops out under the Golden Highway bridge. We then travelled westward before turning south along Ringwood Road noting the terraces formed by the various basalt flows. In a causeway in the basalt there was a good exposure of amygdaloidal basalt where gas bubbles in the basalt have been elonglated into 'almond' shapes then filled with secondary minerals, usually calcite and often with micro crystal form (Photo 2).

A few kilometres further on a creek had eroded through the basalt to expose the underlying Pilliga Sandstone in another causeway. The quartzose lithology and several sedimentary structures including cross bedding, lag gravels and some mysteries were observed (Photo 3). Also, thanks to Chris Morton's keen and experienced eye, several aboriginal axe and spear sharpening groves were also found (Photo 4). Further southward the road descended from the Tertiary basalt through outcrops of Pilliga Sandstone and then to a quarry in the Purlewaugh Formation. At the quarry reddish-purple mudstone dominated with some minor sandstone. The mudstone was similar to the reddish-purple mudstone of the Lorne Basin or the Sydney Basin but is of a different age (Photo 5). The reddish-purple colour is thought to result from the weathering of the underlying Jurassic Garrawilla Volcanics (mostly basalts) and transport of the iron rich clays southwards. The Garrawilla Volcanics do not crop out south of the Liverpool Ranges (with the possible exception of Mt Dangar) but are widespread in the Gunnedah Basin north of the Liverpool Ranges.

At this point we turned back to the Golden Highway and then a few kilometres to the Bow River where in the process of widening a road cutting west of the bridge, some skeletal remains of a Diprotodon were uncovered. The site was professionally excavated at the time and no further remains were found. On examination of the site it would appear that the remains were in a thin (c. 200mm) bed of river gravel perched on the sloping hillside and later covered by basalt float and debris (Photo 6) at the exact location of the road widening, making it a very chancey find.

Afternoon Tea was taken in a cafe in Merriwa after the planned visit to the Historical Museum and the Tourist Information Hut was cancelled as the closing times had been changed to 2pm in the 3 weeks after the final reconnaissance for the trip. On the wall of the cafe was a large photo of the Longworth's Railway in the Lorne Basin and which we visited the reconstructed section in a previous excursion.

Before heading back to Sandy Hollow we vis-


Winston Pratt

2. Amygdaloidal basalt, Ringwood Road


Winston Pratt

3. Lag gravels in Pilliga Sandstone Ringwood Road

Winston Pratt

4. Aboriginal axe and spear sharpening groves in Pilliga Sandstone

Winston Pratt

6. High level stream gravels in which skeletal remains of a Diprotodon were found

ited the Merriwa Cemetery and saw the graves of the O'Brien family (Photo 7). The wife, her 18 mth son and her full term unborn child were murdered at their farm at Poggy Station on Ringwood Road by Jimmy and Joey Governor. Poggy Station would be included in the Saturday excursion.

On Saturday before turning south-west onto the Bylong Valley Way, a look to the north-east up the Muswellbrook Road saw the conglomerate ridge beyond which lay Wybong (originally Wee Bung) Creek. Martin Cash, the only major Australian bushranger to die a free man and of old age after serving his sentences in full including periods at Port Arthur and Norfolk Island, was assigned, in 1828, as a convict shepherd on one of the George Bowman estates which included pastures along Wybong Creek. Martin Cash is buried in Cornellian Bay Cemetery, near Hobart. Fred Ward 'Thunderbolt', together with the lad Thomas Mason, held up the Muswellbrook to Merriwa Mail Coach at the Wybong Creek crossing on 6 August 1868.

The route to Lees Pinch and Poggy Station through Bylong crosses the Permian-Triassic boundary between the Narrabeen Group and the Wallerawang Subgroup of the Illawarra Coal Measures in several places. The cutting immediately before the Yarraman Road TO exposes Permian tuffs while the house immediately ahead is sited on a knoll capped with Triassic conglomerate. The conglomerates form the spectacular cliffs on the southern side of the Goulburn River valley in which in a few places, near Phipps Cutting and Kerrabee, alluvial terraces can be seen. Approaching the Widden Brook TO, reddish-purple mudstones of the Narrabeen Group are exposed and overlain by conglomerate and sandstone. These mudstones are developed close to the base of the Narrabeen Group. They are not present in the Triassic sequence north of the Liverpool Ranges in the Gunnedah Basin or even in the vicinity of Sandy Hollow.

At the Widden Brook TO the exploits of Elizabeth Jessie Hickman, the 'Lady Bushranger', were briefly mentioned as she would have passed this point many times whilst travelling between her mountain hideaway and the Hunter Valley and moving stolen cattle. Also mentioned were the exploits of Harry

Winston Pratt

5. Reddish-purple mudstones of the Jurassic Purlewaugh Formation at quarry Ringwood Road

Winston Pratt

7. The grave of the O'Brien family at Merriwa Cemetery

Redford, the 'Captain Starlight' of 'Robbery Under Arms'. The theft of Tom Tindall's prized stallion, the 'Duke of Athol' ('Marquis de Lorne' in the novel) was carried out with the assistance of Ben Marsdon (Marston in the novel) and his sons and graffiti left by them remained until very recently in the 'Livery Stable' cave between here and Nullo Mountain on the Yodellers Track in the Wollemi National Park above 'Myrtle Grove'. 'Myrtle Grove' was originally purchased by John Thomas ('Tom') Tindall's (Windhall in the novel) father, a ticket-of-leave man who developed the property into a top horse stud. The property has been owned by the Tindall family until about three years ago when Bill Tindall retired to Muswellbrook.

Climbing the eastern side of Coxs Gap faulting has disturbed the Permian sediments which are overlain by Triassic conglomerates and reddish-purple mudstones at the top of the climb. These faults were noted on the western side on the return journey.

The Bylong Valley Way crosses Murrambo Creek and westwards traverses a large lopolith of presumed Jurassic age and composed of a light coloured fine grained igneous rock composed almost entirely of feldspar. Recent drilling has revealed the lopolith configuration of the igneous body. It is sub-circular in plan and in side section has a slightly domed roof and a basin shaped floor (a laccolith has the reversed side section). The body has been intruded into sediments of the upper part of the Permian sequence. The more fertile soil developed over this body was clearly noticeable by the cleared land and good pasture. The western boundary of the body was passed when the Permian sediments, including coaly beds, were exposed in the road cuttings to be then overlain by Triassic conglomerate as the road ascended the Murrambo Gap. On the descent of the other side, two small dykes were seen intruding the sediments and the Katoomba seam, the uppermost seam of the Illawarra Coal Measures in the Western Coalfield, was exposed in the road cutting. Further down the hill a basalt plug had intruded a dolerite sill and samples of both dolerite and basalt were found at this location on the return journey.

The route left Bylong and took the Wollar Road before turning north up Ringwood Road to Poggy Station about 6 km south of the Purlewaugh F'm quarry visited on Friday. The turnaround on the road overlooked the homestead where the Governor Brothers had murdered Mrs O'Brien and her young son, and severely wounded Mrs Bennett the midwife staying with the O'Briens for the impending birth of Mrs O'Brien's baby. From this point the fertile soil (the reason for the siting of the farm here) indicated that this area was an outlier of basalt from the Liverpool Plains Tertiary lava field. Heading south again Morning Tea was had at Lees Pinch Lookout (Photo 8) from where the pastures of Poggy Station, the rugged Goulburn River gorge country towards Wollar from where the Governor Brothers had come and then retreated, the Bylong gorges and Nullo Mountain area to which the Governors had originally intended to reach where they would disappear into the wilderness and live as traditional aborigines, could all be seen.

On the descent into the Goulburn River Valley the road cuttings revealed good exposures of the Narrabeen Group and the change from sandstone domination to conglomerate domination going down the sequence was clearly evident. Near the base of the unit a thin (c. 400 mm) band of reddish-purple mudstone was poorly exposed. Immediately beneath the Triassic conglomerate a poorly developed Katoomba seam was exposed together with plant bearing mudstones and some thinly bedded sandstones. Minor folding and faulting was also evident in these sediments.

The Goulburn River was crossed at O'Briens (of Poggy Station) Crossing and between here and

Winston Pratt

8. Morning Tea at Lees Pinch Lookout

Winston Pratt

9. Scoracious margin from dyke on Bylong-Wollar Road

Winston Pratt

10. Dyke intruding Permian sediments on Bylong Wollar Road

Winston Pratt

11. Finding Vertebraria specimens. Siliceous sediment horizon visible top left

Bylong a vertical dyke in Permian sediments was well exposed in a road cutting. The weathered basaltic dyke rock had a scoracious margin with some vesicles being filled with secondary minerals (Photo 9). A similar but wider dyke striking almost at right angles to the other was discovered about 50 m away at the top of the cliffs overlooking the river (Photo 10).

Before the lunch stop at Bylong the route took a short deviation to view 'Tarwin Park'. This property was once owned by Peter Andrews who developed a controversial farm management method which he called 'Natural Sequence Farming'. A TV documentary featuring Peter's history and his methods was shown on ABC TV.

On the return journey a stop was made on the western ascent of Coxs Gap to examine a 300 mm thick band of laminated silicious sediment with well developed intraformational slump structures. This distinct marker horizon is thought to have been a lacustrine deposit disturbed by possible earthquakes. The underlying sediments contained good specimens of the Permian plant *Vertebraria* (Photo 11). Ascending the western side of Coxs Gap were a series of faults all with a south side up displacement (Photo 12).

Between the Widden Brook TO and Baerami, at 'Fairview', 'Thunderbolts Gully' could be seen entering the Goulburn River. It was here that Thunderbolt's wife Mary Ann was dying and Thunderbolt went to the Bradford's house to seek help. Mrs Bradford took a cart and brought Mary Ann back to the house. Thunderbolt asked her to call a Minister and the police which she did. Thunderbold, being a fugiative, departed and Mary Ann died the next morning. Mr Kirk, the Baerami storekeeper, made a coffin from tea chests and Mary Ann was buried at the junction of Dingo Creek and the Goulburn River, about 200 m from the Bradford home. The burial site was washed away in the 1955 flood which cut away about 30 m of the river bank. The remains of the Bradford home were seen 50 m from the road (Photo 13). The remains of Kirk's Store at Baerami were also seen from the road. A visit to the St Mathews church graveyard (Photo 14) enabled the group to see the graves of Mr and Mrs Bradford and next to them the graves of Mr and Mrs Kirk. Also seen in the graveyard was the grave of George and Margaret Harris and their 4 children. In this tragic incident all 6 people died on the same day in 1944 as a result of a murder-suicide in which the father killed his wife and four children before hanging himself.

On Sunday the group visited the Baerami oil shale mines after observing the ruins of the Sandy Hollow treatment works behind the Caravan Park. Driving up the Baerami Creek valley the route passed the magnificent old 'Baerami' homestead and the new Baerami horse stud building. Further on there was a cattle stud, an olive grove, a fodder farm with lucerne and other pastures, a previous deer farm (now a horse stud), a dairy farm, a equestrian lodge, a pecan nut grove and several mixed farms.

Little now remains of the Baerami oil shale mines. The first ruin evident is that of the Managers residence, and then some of the crushing plant where

few specimens of oil shale (torbanite) were found and Brian's keen eye discovered some of the residual shale after it had been treated in a retort. The adits are located in the valley walls for a few kilometres up the valley but for safety have been bricked up. These were not located but an interesting exposure in a creek bank revealed a coal seam with some torbanite bands, faulting and high level boulders and gravels perched on the hillside (Photo 15). A welcome morning tea was then enjoyed back at the crusher (Photo 16).

Report by Winston Pratt.

Winston Pratt

14. St. Mathews Church graveyard, Kirks on left and Bradfords on right. Mt Dangar dominates top

Winston Pratt

12. Normal fault south (left) side up in basal Narrabeen Group conglomerate, Coxs Gap west side

Winston Pratt

15. Creek bank exposure at Baerami oil shale mines. Coal seam bottom left, fault zone centre, perched river boulders top right

Winston Pratt

13. Two upright posts and a sandstone doorstep are all that remains of the Bradford's house

Winston Pratt

16. Morning Tea next to the crushing plant at the Baerami Creek oil shale mines

Bateau Bay Walk
Saturday 20th November 2010

Leader: Barry Collier and Brian England.

Attendance: 18 members.

On 20th November, 18 members turned up for a picnic lunch in a very pleasant picnic area in Wyrrabalong NP, at Bateau Bay. An interesting feature is that this is the only beach on the Central Coast with Blackbutts immediately behind it. There are two reasons: a) it is above the beach and on Pleistocene sand rather than on the hind dunes at the rear of most beaches, and b) It has been impacted in the past by a large Swamp Mahogany wetland.

After lunch we moved down to the rock platform on the southern side of the bay, passing exposures of coffee rock, exposed by the construction of a beach access ramp. On the platform we saw chocolate shales and the way their presence has shaped the headland. Further on we found a huge concrete structure built to prevent the road above, and possibly some houses, ending up on the rock platform.

We then came to the only mangrove forest on the ocean front in subtropical Australia. This has been able to occur as a result of the shape of the rock platform, its height with regard to tide levels and the continuing flow of fresh water seeping out of the hillside. In recent years, some River Mangroves have joined the existing Grey Mangroves. River Mangroves generally like less salinity and they have occurred on the uphill side of the forest, where there is more freshwater from the hillside and less salt water.

Around the corner, we found a bay with a pebble beach consisting of pebbles totally different to any of the rocks on the central coast. There are a number of ideas about where they have come from, but every time an idea is suggested, there are many more reasons as to why that could not be the case. Fascinating!

From there we made our way back around the seaward edge of the rock platform, past some fascinating weathering patterns and concretions.

Report by Barry Collier.

Ron Evans

Bateau Bay rock platform and mangrove forest

Ron Evans

Soft chocolate shales weathering rapidly

Ron Evans

Mangrove forest, mainly Grey Mangroves

Ron Evans

Pebble beach of mainly Ignimbritic rocks

Social Activities 2010

The social committee organises the two main social activities of the year – the Soup and Slides Night and the Christmas Dinner. To organise these we need to have a planning meeting and these have become social activities all members are welcome to join.

Our planning meeting for Soup and Slides was on 9th June. We met for a walk from Warners Bay to the new boardwalk and return followed by lunch at the Hotel in Warners Bay. It was a very pleasant half day and several members and one dog attended – the dog went home before lunch.

Soup and Slides:

This was held in the hall attached to Elaine and Barry's complex. Although we pay for the venue it is much more comfortable than in a garage as it is mid winter and the hall has air conditioning. Twenty six members and three visitors enjoyed an excellent variety of soups and slides – really slides and digital photos. Some people missed out on showing the photos they brought. Please keep them on your thumb drive to show at a later function. Unfortunately the photography competition had little support this year. It was disappointing only a few members brought prints of photos taken at outings since last soup and slides. We are seriously considering not having the photography competition next year, so if you'd like to see it continue please let your feelings be known.

The planning meeting for the Christmas Dinner was on 13th November. We met near Valentine Bowling Club. We found a table under a lovely shade tree (probably a fig) to have our meeting. After some discussion we came up with some new ideas for the menu. An amble along the waterfront worked up an appetite for lunch at the Bowling Club. The weather was perfect and several members and two dogs enjoyed the outing.

Christmas Dinner:

This was again was held at our home. It was a beautiful evening and most people enjoyed being outdoors. A trumpeter heralded the first course, excellent hot finger food made by Sue Rogers, a little different to last year's - still very tasty - they disappeared fast.

Sue preparing hot finger food

The trumpeter heralded again when main course was ready. The table was laden with a great variety of food and people helped themselves and found a seat at a table, again most people chose the deck. As there was so much food we gave ourselves a break before dessert. The break was perfectly filled with photos – some slides and some digital. Most of the photos were taken on the recent trip to Broken Hill, the wild flowers were very beautiful as were the rock formations etc.

This was followed with more eating then opening the Christmas gifts (many delighted smiles).

Thirty one members and friends attended and one dog but she was kept downstairs. All feedback on the food was very positive, the additional items of smoked salmon, Waldorf salad (Jenny Green) and plum pudding (Lynne Hain) with custard were given the thumbs up.

Thank you to all members of the Social Committee – Janet Cater, Elaine Collier, Ellen Evans, Jan Harrison, Heather King, Laurel Kingdon, Leonie Mills, Ethel Raine and Sue Rogers. Each one contributed ideas, prepared food, cleaned up and did everything necessary to make things run smoothly.

Leonie Mills
On behalf of the committee, December 2010.

AGSHV members socialising on the deck and nibbling on hot finger food before dinner

"Crab"

Sculptures by the Sea:

On the 3rd November eight members travelled by train and bus (a three hour trip from Newcastle) to view the Sculptures by the Sea exhibition.

The spectacular Bondi to Tamarama coastal walk had been transformed into a giant sculpture park of over 100 sculptures by artists from Australia and across the world. We were impressed not only by the sculptures but also by the geological structures and Aboriginal Carvings along the coastal walk.

Photographs of some of the sculptures observed are shown opposite.

Ian Rogers.
Trip Leader.

"Paint"

"Life"

"Q"

Broken Hill - Geological Safari 2010

Sunday 19th September to Wednesday 6th October 2010

Leader: Brian England

Attendance: 16

Geological Background.

Rocks in the Broken Hill area of the Barrier Ranges provide over 2 billion years of Earth history, a time span covering almost half the age of the Earth itself.

Continental crust existed around Broken Hill 2300 million years ago and the area was quite stable geologically till 1700 million years ago. The crust then began to break apart due to stretching, the land sank in a fault-bound graben (rift valley) and volcanoes were initiated along the floor of the rift, and layers of ash, basaltic lava, debris flows and fluvial sediments began to fill this depression. At times the rift was filled by lake water which left behind evaporite (salt) deposits when the waters dried up, and the sea may also have occupied the region at one stage. This lake (and sea) water percolated down fractures in the rocks towards the source of the volcanism was heated and rose again to the floor of the rift as hydrothermal vents which formed layers of iron-rich precipitates, which are now the banded iron formations (BIF) exposed at places like The Pinnacles.

A second episode of rifting, more catastrophic than the first, lowered the floor of the rift well below sea level and it was filled by sea water. Large volumes of basalt erupted onto the sea floor through submarine volcanoes. Due to the massive amounts of heat generated across the whole area, huge systems of circulating water developed which dissolved metals from the sediments on the rift floor, penetrated along vertical fracture systems above the magma chambers, and then rose to the floor of the rift where it reacted instantaneously with the cooler alkaline sea water to precipitate huge amounts of metal sulphides. This process was similar to that currently occurring in deep ocean water in places like the East Pacific Rise – the now famous "black smokers". This was the juvenile Broken Hill orebody. These sulphide layers were quickly covered over by a thick pile of sediments (the Willyama Supergroup) and so were protected from oxidation and re-dissolution. Slowly there was a transition to shallow water sediments as the rift was filled.

Around 1650 million years ago, soon after the rift was filled with sediments, the area subsided and was intensely folded under high temperature and pressure in a number of stages. The minerals in the original sediments (clays, quartz, iron oxides, etc.) reacted to form new minerals (garnet, sillimanite, staurolite, and kyanite) which were in equilibrium with the new conditions. Temperatures were so high that areas of quartz/feldspar melted and were forced along fractures where they cooled and solidified as coarse-grained pegmatites. Again the area was subjected to high pressure and temperature as molten rock (the Mundi Mundi granite) moved through the sequence. New metamorphic minerals were again formed and the sequence was re-folded, this time into a broad regional nappe. It is this folding which produced the geology we see today.

During this last episode of folding, large amounts of water trapped in the rift sediments was released and rose up along fractures which became major shear zones. Over time these shears were often re-activated and the rocks adjacent to them altered by hydration (retrograde metamorphism). This folding resulted in a massive Himalayan-type mountain belt which existed for 600 million years before it was planed off by ice 1000 million years ago during the Sturtian Glaciation.

Following this glacial episode, glacial sands, muds, clays and limestones of the Adelaidean Supergroup were intermittently deposited over the next 400 million years on top of the Willyama Supergroup basement. The environment was partly shallow marine continental shelf and the limy rocks contain some of the earliest Metazoans (the Ediacaran Fauna).

Around 500 million years ago the Adelaidean sediments were folded and heated by regional metamorphism, forming the spectacular folds now exposed by erosion in the Flinders Ranges to the west. During this folding the shear zones were re-activated, some rocks melted and then re-froze to form the abun-

dant pegmatites in the Thackaringa area west of Broken Hill. This event also resulted in the formation of the Thackaringa-type silver-lead deposits, comprising narrow quartz-siderite-galena veins with little or no sphalerite which cut across the layering of the enclosing rocks. These deposits were formed within major shear zones by remobilization of metals from the main Broken Hill orebody and are restricted to the western and northern parts of the Broken Hill Block.

Then 500-300 million years ago shallow marine sediments were laid down over the Adelaidean and Willyama rocks.

Between 300 and 280 million years ago the area was again scoured by glaciers and a large volume of rock was removed to expose the Willyama and Adelaidean rocks on the land surface.

Around 65 million years ago the Barrier Ranges were uplifted along shear zones (eg the Mundi Mundi fault) during the opening of the Tasman Sea. Since then there has been a great diversity of climate changes and the ranges were eroded to expose the top of the Broken Hill orebody. Part of this period was characterized by tropical conditions (forming laterite deposits), cool temperate conditions (during which macro fauna flourished and lakes were abundant), while other periods were hot and arid (producing dunes of red sand, calcrete, etc.).

Exposure of the orebody to air and water as the overlying sediments were removed by erosion produced large amounts of sulphuric acid formed by the decomposition of the sulphide ore minerals. Metals were dissolved and entered streams and groundwater, and new minerals (the oxidised ores) were formed in the orebody cap. Around 30% of the orebody was removed in solution at this time – one of the greatest periods of natural pollution Australia has ever seen!

The continually changing climate over the past 65 million years coupled with the periodic uplift of the Barrier Ranges complicated the formation of new minerals by weathering of the orebody. Minerals which formed in equilibrium with the previous conditions became unstable with each climate change and new minerals were repeatedly formed. Hence the astonishing display of well-crystallised secondary lead, zinc, copper and silver minerals!

Reference: PLIMER, I.R. (1994). Minerals and rocks of the Broken Hill, White Cliffs and Tibooburra districts. Peacock Publications.

Safari Details.

Sunday 19th September

All participants had arrived at Mount Gipps Station, 42 kilometres north of Broken Hill, by early evening and spent the remainder of the day moving into the shearers' quarters and overseer's cottage or setting up their vans.

Monday 20th September

I travelled into town early to visit the Tourist Information Centre to see what they had to offer, which turned out to be very little apart from bookings for several tour companies operating in the area. Certainly they knew little of the local geological attractions, which seemed strange for an area that offers so much in the way of geological tourism!

At 10:30am the group met at the Broken Hill GeoCentre in the old bond store on the corner of Crystal and Bromide Streets. Here we watched a short film on the geological history of the Broken Hill Orebody and then spent an hour wandering at leisure through the mineral and metallurgical exhibits. There were some good specimens on display, particularly native coppers, but most were mediocre and showed significant damage. Huge cases displayed tiny specimens of some of the Hill's rare minerals (including mawbyite and plimerite) and one held a 42Kg plate of pure native silver from the oxidised zone of the orebody. Then of course there was the famous silver tree. But many of the cases were poorly lit and the majority of specimens had no labels! In fact there appears to have been no follow-up maintenance since the centre was set up. Of greatest concern was the display on the crystal systems and crystal morphology – all of it was incorrect!! Very poor indeed for a tourist attraction that boasts its educational value; although in fact very few museums get this right.

Ron Evans

Our accommodation, Mt. Gipps Station

The visit to the GeoCentre was followed by coffee at the Information Centre, which gradually turned into lunch. David thought the coffee was a bit like the stuff he washed the dishes in that morning, but the food was good.

After lunch some people went shopping for enough food to sustain their existence out at Mount Gipps for the next few days while the remainder went down to Eyre Street in South Broken Hill to visit Photographic Recollections adjacent to the old power station. This privately owned gallery houses an extraordinary collection of high quality black and white photographs which give a comprehensive overview of the mining and cultural history of Broken Hill. The $5 entry fee was money well spent.

On an earlier trip Ron had come across a spectacular walking trail north of the city off the Silver City Highway, so we decided to spend the afternoon there. Earlier in the day Ron and Ellen had gone out to check the two kilometres of access track and after filling in a few gutters had deemed it safe to drive along. We found the road in well signposted as the "Sundown Trail" and drove up to the parking bay at the foot of an isolated range of low rocky hills, stopping several times to photograph extensive showings of bright red Sturt's desert pea and wild hops.

From the parking bay, which had been surfaced with pisolitic calcrete (a marble-like form of concretionary calcium carbonate common in arid soils), we found an indistinct track leading up a steep rocky gully to the summit of the ridge and down again towards a broad flat and largely barren valley floor. The views were spectacular and even the rocks were interesting, comprising strongly foliated Willyama Supergroup sediments cut by numerous quartz veins and quartz/orthoclase/muscovite pegmatites, some of them showing graphic intergrowth of the component minerals (orthoclase/quartz and muscovite/quartz) indicating crystallisation from a melt formed by partial melting of the host rock during metamorphism. Most of the veins were rimmed by muscovite, suggesting late stage hydrothermal activity occurred after their emplacement.

The trail wound down onto the valley floor, where there were more displays of desert pea, then turned back up the ridge to the summit where there was a distant view of Broken Hill to the south. From there the track vanished amongst the rocky outcrops, although we did see occasional guide pegs, and we found our own way down the side of the ridge back to the cars. The hills by now had begun to colour up in the late afternoon sun, providing a spectacular end to a superb 3km walk which had taken just 2 hours to complete. Apparently the track had been abandoned by Broken Hill City Council several years ago and the Tourist Information Centre now denies any knowledge of it. Strange indeed, as we found it one of the best short walks we'd done in terms of scenery, geology and botany. We found ourselves back art Mount Gipps by around 6pm.

Tuesday 21st September

An early morning lecture was held in the meeting room of the shearers' quarters to give a brief overview of Broken Hill geology and provide the framework on which the rest of the tour was to be based.

Today we would compete as much as possible of the Broken Hill City geotour using notes gleaned from Ian Plimer's book (Minerals and rocks of the Broken Hill district) and information provided by the Department of Primary Industries Maitland Office.

Leaving for the City at 9:15 am, our first point of interest was White Rocks Reserve at the northern end of Schlapp Street. Here we found weathered sillimanite-rich metasediments which were originally dirty sands and muds deposited in the rift valley 1700myr ago. Water expelled during metamorphism

Ron Evans

Sturts Desert Pea, Sundown Trail

Ron Evans

Start of the Sundown Trail walk

Ron Evans

Rocky Hill Pegmatite - wild hops in foreground

Ron Evans

Miners Memorial on the Line of Lode mullock heap

dissolved quartz in areas under pressure and re-precipitated it in zones of lower confining pressure, ie opening cracks. The quartz is white due to the presence of very small carbon dioxide bubbles. There is also an unusual gneiss breccia on the town side of the hill between the ice cream cart and the Cable Hotel sign, but it was also deeply weathered.

White Rocks also has some historical significance. On 1st January 1915, the only deaths on Australian Soil during World War 1 took place at Silverton when a trainload of Oddfellows on their way to a picnic were fired upon by two Turkish sympathizers. Three People died and six were wounded. The two gunmen were of Indian/Afghan origin, one a Broken Hill butcher and the other an ice cream vendor. Both were killed by Police at White Rocks, where a railway truck marks the scene of the shooting.

On the southern side of Jones Street at the intersection of Jones and Cummins Streets we explored the very large pegmatite outcrop which gives Rocky Hill its name. Formed 1650 myr ago as a result of escape of fluid-rich molten rock into cracks it is composed mainly of orthoclase and quartz, some of the outcrop showing a striking graphic intergrowth between these two minerals. The original host rock is thought to have been a volcanic ash.

As a break from geology we then drove down to the Visitors Information Centre for morning tea and afterwards walked across to the Kintore Reserve just across Blende Street. Located on the route of the old Silverton Tramway and opposite the Sulphide Street Railway Station, this park is dominated by the old wooden headframe of the Kintore shaft, relocated from the line of lode in 1984 to allow development of the Kintore open cut. Also found here scattered around a small native garden were several large blocks of quartz/orthoclase/muscovite pegmatite showing superb structures and two works of art by Pro Hart, one a huge metal ant and the other the artist's impression of a group of white cerussite (lead carbonate) crystals from the oxidised zone. Several of the gneiss blocks forming the base of the sculptures were found to contain well-preserved fluvial cross-bedding, an undeniable indication of the sedimentary origin of this locally important rock type.

Joe Keenan Lookout, on the southern side of a prominent hill near Marks Street, was deemed the ideal place for a picnic lunch and also gave us a great view of the City as well as the line of lode, now covered by a continuous flat-topped pile of broken rock hauled from new declines sunk to exploit the remnants of the orebody. Interpretive signs here gave an outline of the history and geology, although some need updating to accommodate the recent changes in mine ownership. Just south of the lookout, along a rough tack leading down the hill to Mica Street, we had a chance to examine more metamorphosed sedimentary rocks, this time with original bedding well-preserved. Again these were dirty sands and muds laid down rapidly in the rift valley 1700myr ago but the original minerals have been converted to garnet, sillimanite, quartz, feldspar and biotite. Also present are pegmatite veins formed 1650 myr ago.

At the block 10 Lookout on the site of the old Block 10 mill, we found more interpretive signs showing the structure of the Broken Hill orebody but still identifying the two southern mines as Zinc Corporation and NBHC. The lookout also provided a good view of the Pinnacles to the west. These prominent sharp peaks are capped by banded iron formation (BIF), a mixture of quartz and magnetite deposited as chemical sediment from submarine hydrothermal vents on the floor of the Early Proterozoic rift. Rock outcrops adjacent to the lookout comprise mainly the Rasp Ridge Gneiss (originally a volcanic ash), but with the area immediately around the lookout roped off none of these outcrops were accessible.

After being off limits since it closed in 1972, the old Junction mine's surface works were opened to public access in 1994 and provide a rare and important insight into a traditional self-contained 19th/20th century mining operation. This was to be our last stop for the day and proved the most fascinating. Not only are there the magnificent timber headframe over Browne's shaft plus the mill foundations, winder house (complete with winder) and manager's cottage (now a private residence), but this site also encompasses the best accessible remnant of the Broken Hill lode outcrop. Looking much as it did when Charles Rasp first climbed to the top of the broken ridge in 1883, it is easy to see why he thought this outcrop was a huge deposit of tin. The rock is heavy and black, consisting mainly of the lead manganese oxide coronadite, and remains totally devoid of vegetation. A cutting on the western side of the outcrop below a set of huge steel water tanks exposes an excellent cross section of the leached gossan capping the oxidised section of the sulphide orebody (narrow here because it was stretched and thinned in the British Shear Zone), with the weathered metasediments on either side including both gneiss and garnet sandstone. Mine dumps on the northern side of the outcrop provided good fresh specimens of a variety of gneissic rocks, including some rich in fibrous sillimanite. To the north and visible through the boundary fence were the open cut and headframes of the old North mine (now Perilya northern leases). We dragged ourselves away from this fabulous site and headed back to Mount Gipps Station around 5:15pm to find that Geoff's car had a flat tyre and that the spare wheel did not fit!

Wednesday 22nd September

Dean, Anne, Roz and I left Mount Gipps at 8:30 am headed in to Beaurepairs to drop of Geoff's tyre for repair. Ron and the others turned up soon afterwards with Geoff's spare wheel, which had to be swapped for one that fitted his car. The Riddiford Arboretum was on the opposite side of the road so we thought it worth a look. While an interesting concept and potentially a major tourist attraction we found this garden in desperate need of maintenance, with many of the native plants un-named and some even approaching death. Then it was back to the Browne shaft for more photographs in better light and to search for better specimens of sillimanite gneiss on the dumps.

Satisfied with our finds, we departed the Browne shaft for Silverton and arrived in that tiny historic mining village 25 kilometres to the northwest of Broken Hill at around 11 am. Many of the town's remaining buildings have been converted into art galleries and other tourist traps. But filmmakers regard the location, with its colonial buildings haphazardly placed along its network of wide unpaved streets, the ideal image of an Australian outback town and over 140 films have been set here, including Mad Max II. One of the characters of Silverton, Andy Jenkins, has set up a coin carvery business in an old tin shed where he uses jewelers' saws to cut out the background of Australian coins then gold plates them to make unique pieces of jewellery. A conversation was struck up when I noticed polished nuggets of pure silver scattered throughout his display cases. These had been self collected from various places in the Barrier Ranges near Mount Robe while out prospecting during time out from his normal job as sampler for the North mine. He was thrown out of work when the mine was closed and taken over by Perilya a few years ago. Discussion then turned to the old Umberumberka mine on the outskirts of town and we were assured that while it was on private property, it remained accessible by driving out through the town dump or following the Silverton Tramway embankment for a few kilometres. "So, you're interested in old mines – do you know about the Australian Broken Hill Consols mine?" Well, I certainly knew of it, arguably Australia's most famous silver mine, but had no idea where it was. "OK. I'll show you next Friday" Andy

Ron Evans

Miners Memorial, Broken Hill

Ron Evans

Remnants of Browne's Shaft

Ron Evans

Underground tour party, Daydream Mine

Ron Evans

Smelter ruin next to Daydream Mine

replied. We couldn't believe our luck!

We dragged ourselves away from Andy's workshop at 11:45 am and headed back towards Broken Hill and then north to the Daydream mine on a good well-used dirt road. The mine area appeared abruptly as a confusion of mine dumps and low ramshackle corrugated iron buildings at the end of the road, just beyond the ruins of the Daydream smelter. I had booked our group in for a surface and mine tour at 1pm so while we waited there was time for a picnic lunch around the table outside the mine office and shop. No-one opted for the coffee and scones offered by the indoor café.

Only 11 of the group joined the mine tour, the remainder choosing to relax in the shade of the shop awning. Our guide first took us on a walking tour of the surface workings, the powder magazine (the coolest place to be on a hot day, but no smoking allowed), one of the many mia-mias (small stone huts) where miners and their families lived, and the headframe erected over the main shaft by Robert Pittaway, the last person to work the Daydream mine. Then, at a small corrugated iron shed, we donned hard hats and miners' lamps in readiness for the underground part of the tour.

Entering the main underlay shaft via a flight of concrete steps which soon gave way to a steep uneven floor, we followed our young guide down through an intricate maze of narrow rough-hewn tunnels, often ducking suddenly to avoid the uneven roof. There was no single defined orebody, the tunnels simply following Thackaringa-type galena-rich siderite veins branching randomly throughout the host rock. Here and there we noticed patches of small siderite crystals and down in the depths of the mine we were shown a recently-exposed vein of bright coarse cubical galena, the other half of which is displayed in the mine shop. We were taken along the drive which intersected the bottom of the main shaft and shown the pile of tyres Robert Pittaway used to break the fall of mine timbers and other items he lowered down the shaft when he worked the mine. Much of the mine remains untimbered, but where timbers had been erected, some showed dramatic signs of "talking", ie splintering under pressure from the overlying rock. In many areas we could clearly see how piles of waste rock had been neatly stacked as backfill to shore up the roof. Near the site of a major roof fall our guide showed us the hammer and tap method of drilling blast holes before we reluctantly returned to the heat on the surface, thus ending a most fascinating underground tour.

The Day Dream mine has had a long and somewhat colourful history since its discovery by Joe Meech in December 1881 and has been the subject of

Silverton

Ron Evans

bitter disputes between friends as well as the trials of intermittent operation and various ownerships up to 1895. It was not until 1964 that the mine was re-opened by Robert Pittaway who, with his family, constructed all the buildings on the lease and eventually opened the mine for tourism on 12th March 1983.

We left the Day Dream lease at around 2:30 pm, pausing briefly to photograph the few remaining stone foundations of the old township, named Wilson in honor of the then manager of the mine. Up to 500 people lived here, occupying tents, stone-walled miamias, and dugouts where there was barely room for two people to lay side by side. A little further on the old Day Dream smelter and adjacent Hen and Chickens mine came into view, requiring a further stop for photographs. Then it was back to Silverton and west along the sealed road to the Mundi Mundi Lookout for superb views out over the Mundi Mundi Fault and across the Mundi Mundi Plain, but the good examples of amphibolite I had found here 30 years ago had vanished. All we found were scattered outcrops of fine-grained Mundi Mundi granite, so while some continued down to the Mundi Mundi Plain, the remainder of the group headed back to Silverton to find the Umberumberka silver mine, one of the largest and most productive in the Silverton Field.

Taking the well-defined track (complete with give way sign) to the west at the bend in the road just north of town, we drove up through the rehabilitated town dump from where we could see the mine's steel headframe at the head of a narrow valley. Then it was simply a matter of following the Silverton Tramway towards the mine. But what had been a reasonably good track along the old tramway was abruptly blocked by a deep washout, so we walked the remaining kilometre to the mine, passing through a substantial wire gate at the lease boundary to which a metal sign emblazoned with "Trespassers Severely Dealt With" had been attached. Certainly the gate had been severely dealt with, having been rammed aside by something rather large and heavy! It and the sign probably dated back to renewed operations in the 1970's but we knew after talking to Andy Jenkins in Silverton that the lease was no longer current.

The name Umberumberka means native rat hole in the local Aboriginal dialect and was discovered in 1881 by John Stokie who had moved up from Thackaringa to prospect the area. The mine opened in 1882 and led directly to the development of Silverton with its population of 250. A concentrating plant, leaching plant and roasting furnaces to treat the Thackaringa-type sulphide ore were operating prior to 1892, but the mine closed later that year after producing 20,000 tonnes of ore. By then mining had reached a depth of 130 metres with ore produced from a number of lodes on 7 levels.

We spent an hour or so photographing and exploring the mine area, which lay immediately south of the Silverton Tramway. The old rusted steel headframe made an ideal photographic subject, particularly with scattered brick foundations of the old treatment plant in the foreground and the heavily-leached mine dumps behind. Very little of interest was found on the dumps apart from a few scattered lumps of coarsely crystalline brown siderite and one highly disputed sample of galena in rhodonite which must have come from the Broken Hill orebody as this mineral is not associated with Thackaringa-type deposits.

Back in Broken Hill some of the group returned to the Browne shaft, but it seemed the sun never shines on the outcrop exposed in the cut and we had to be satisfied with photographs taken in the shade of the huge headframe. After shopping for provisions we were back at Mount Gipps just on dusk.

Thursday 23rd September

So far we had adhered little to the set program and today proved no different as we took advantage

Ron Evans

Curious Emus beside road to Mutawintji NP

Ron Evans

Aboriginal Art Gallery Homestead Gorge walk

Ron Evans

Aboriginal hand stencils, Homestead Gorge walk

Ron Evans

Dam used to store water for the old Mootwingee Homestead

of weather conditions and local knowledge to fit things in as best we could. We set off at 8:00 am in four vehicles and headed up the Silver City Highway to Mutawintji.

North of the Corona Road junction at Yanko Glen the Silver City Highway traverses the gently undulating surface underlain by a north-south trending belt of Adelaidean rocks lying between the 1700 myr old Broken Hill and Euriowie Blocks. From the air this region shows spectacular folds similar to those we are familiar with in similar rocks in the Flinders Ranges to the west. Characteristic of this region are expanses of bare reddish ground covered in a thin lag layer of white quartz pebbles eroded from the many quartz veins which filled cracks developed in the Adelaidean sediments during the 500 my deformation event. The highway then crosses the low hills of the Euriowie Block before heading west across the outwash plains to Mutawintji.

After turning onto the White Cliffs road we bade farewell to the tar, but the road was good apart from patches which had been and certainly would be very boggy after rain. It was interesting to observe the ever increasing width of the road around these bog holes, perhaps a modern analogy of evolution in action! We passed two groups of male emus with chicks, but saw no kangaroos. The countryside was green after the rains, with wide expanses of grass interrupted by patches of bright blue salvation Jane. It took around 1.5 hours to reach the National Park, the last 10 kilometres restricted to 40 km/h. Here we pulled into the visitor centre where we found brochures, a pay phone and a single swallow in a nest at the top of the stone dividing wall, and then continued on to the Homestead Creek day use centre. Here there were three wooden tables and bench seats, a good spot for morning tea before we began our walk.

Barry had decided days ago that we would attempt the Homestead Gorge walk so we headed off along the paved Thaakalatjika pathway through thick undergrowth towards Wright's Cave to view some ancient Aboriginal art, then up Homestead Gorge and into an astonishing region of magical rock formations.

The track would take us across beds of early to middle Devonian (390-385myr) quartz and pebbly sandstones which dip steeply to the west on the flank of a large northwest-southeast trending anticlinal fold. These rocks increase in age eastward towards the Mount Wright Fault, a major fracture which has undergone movement several times. The rocks were deposited as part of a thick blanket of sands and gravels laid down by a large braided river system flowing east into the Darling Basin, which then covered much of western New South Wales and northwestern Victoria. Sedimentary features typical of fluvial systems, such as cross bedding and pebble lag deposits, are common throughout these rocks and trace fossils (such as worm burrows) indicate conditions fluctuated between marine and estuarine.

The well-marked track followed the sandy bed of Homestead Creek past several waterholes and across flat rock outcrops, with the scenery becoming more spectacular with every bend in the creek. At one sandy creek crossing Dean and I noticed a distinctive brown crust partly covering the rippled sand and immediately guessed it may be a thin layer of iron hydroxide (goethite) precipitated from the stream water, analogous to the formation (over time) of some of the goethitic iron ores of the Hamersley Province in Western Australia.

As the track climbed out of the creek and up over the head of the gorge past a small waterfall, the views over the surrounding countryside were astounding. Large expanses of bare rock dotted with grotesquely-shaped pinnacles and patches of armor-

like plating unfolded in every direction.

We continued up the ridge and along the Rockholes loop track which, being the highest point, provided even better views into the depths of the surrounding canyons, before returning down the slope to retrace our path back along Homestead Creek to our vehicles.

Back at the cars we had lunch at the picnic tables while dozens of loud corellas in the nearby trees apparently objected to this small human invasion.

Following lunch, it was still early afternoon so a collective decision was made to walk into the old Mutawintji Gorge, southeast of the visitor centre. However at the wide sandy creek just on the north side of the parking bay we came on a seemingly impassible situation. Two 2WD vehicles had become hopelessly bogged side by side in the middle of the crossing!! Coming out of the gorge one driver had stopped his car in the middle of the crossing to photograph the river gums, and of course the car had only sunk deeper into the soft sand when the driver tried to continue. The other driver had foolishly tried to go around the first vehicle but had hit a patch of even softer sand, and so was also firmly embedded. The situation was eventually saved by the owner of a 4WD who hooked each car in turn to an elastic tow rope and pulled them out without further incident. But this had cost us an hour and we were fast running out of time to complete the Old Mutawintji Gorge walk and return before dark.

But the holdup had a positive side. Wandering up the creek to fill in time we found superb examples of modern-day point bars, ripple marking and pebble lag deposits identical to those we had seen that morning preserved in the Devonian sediments on the Homestead Creek walk. This made it very easy for the non-geologists in the group to understand the processes which formed the rocks of the Mutawintji area.

From the parking bay it seemed to take forever to reach the start of the gorge, even at a steady pace. The track wound across the floor and lower rocky slopes of a broad valley before swinging around to the east and following the creek bed between increasingly precipitous walls of red sandstone. In places rapid growth of vegetation following recent rains made the path difficult to follow and towards the end we lost it several times, being forced down onto the sandy creek bed to continue. Had we not done Homestead Creek earlier in the day, this walk would have been classed as well worthwhile, but in fact it paled into insignificance in the light of what we had already seen. Only at the head of the gorge where the creek was reduced to a series of low waterfalls was there any scenery worth photographing. Disappointed, we spent little time here and left to return to the cars at 3:30pm. We were back on the road by 4:30pm and reached Mount Gipps at 6:00pm.

Friday 24th September

One of the main reasons for holding the excursion this time of year was to coincide with the Broken Hill Mineral Show held in the main hall at the Broken Hill Racecourse. It opened to the public around lunch time and I had promised to help two friends from Canberra set up and man their stand for the day. A small regional show, it is typical of the many similar moots held throughout Australia at various times of the year. Most Society members turned up at the show during the afternoon, and some even bought a few specimens! Those that came gained some insight into the mineral collecting hobby and current market trends in Australia.

Dean and I had arranged to Meet Andy Jenkins at the Browne shaft at 5:30pm. He was waiting there for us in his van and led us a short distance south along the Menindee Road where we turned right onto Holten Drive. After a few hundred metres we took a

Ron Evans

Rockholes Loop Walk

Ron Evans

Climbing back down to Homestead Creek

Ron Evans

Mutawintji Gorge walk

Ron Evans

Darling peas near Mutawintji Gorge walk

track to the left over a small white bridge and past the grain silos towards the blue metal quarry, pulling up after another 200 metres. The area had become overgrown and all we could see were scattered piles of broken rock and a few rusty steel relics protruding above the scrub. But then Andy began to point out the lumps of coarsely crystalline brown siderite and piles of calcite cleavage rhombs that had once formed part of the dumps of the famous Australian Broken Hill Consols mine.

Located only 600 metres east of the Broken Hill orebody, the ABH Consols lode was unique in terms of its mineralogy and extraordinarily high silver content, having produced 26 tonnes of silver between 1890 and 1903, including 10 tonnes of the rare silver-antimony alloy dyscrasite. The siderite-rich ore vein reached 3 metres in width, filled a fracture in amphibolite host rock, and bore no resemblance to any other silver deposit in the Barrier Ranges. The silver minerals are thought to have remobilized from the Broken Hill orebody during the final stage of retrogressive metamorphism.

We spent an hour or so searching the dumps for any remaining silver minerals, but were unsuccessful. Andy has plans to dewater the old underlay shaft, if he can find it, and possibly open it as a tourist mine similar to the Day Dream. We thought that idea to be a bit far fetched, but wished him the best of good fortune in this venture. The only sign of any building we could find was the corner of an old stone foundation, perhaps the floor of the mill building, jutting from under the nearby railway embankment. But only access to old photographs, taken when the mine was operating, would reveal the actual mine layout and the location of its infrastructure. We departed a little disappointed, but certainly pleased to have been shown the location of this historic mine.

Saturday 25th September

Today we ran to program, driving out into the Thackaringa Hills on the Adelaide Road for a day exploring the minerals and rocks of the Pinnacles-Thackaringa Shear Zone, formed during the region's last period of folding and metamorphism 500myr ago. This is an area I once knew well but that was over 30 years ago and I wondered if indeed I'd be able to find those locations again. I had obtained permission to enter Thackaringa Station from the owner David Lord yesterday and we were able to explore any part of this huge property without restriction. We had all day, but it was a huge area with few recognizable landmarks. The only stipulation was that we should not drive on the old vehicle tracks which once provided access to many of the sites, as David was trying to return the property to its original natural state.

We pulled to the side of the highway a few hundred metres short of the road up to the repeater station on top of the ridge. To my calculations if we headed off south at right angles to the road we should come after 800 metres to the old sillimanite quarry. Once found, this would provide the only landmark by which to find the important outcrops. Climbing through the fence proved difficult for some but then the group filed like a group of cows up to the top of the ridge and down the other side to a small dry creek bed. That ridge itself provided a few geological surprises, including crenulated schists and some good examples of zoned quartz-orthoclase pegmatite veins, some of them well folded.

A few hundred metres across the creek we began to find well-formed trapezohedral garnet crystals scattered over the ground and then, looking to the west around the side of the ridge from which they had weathered we saw a keyhole cut in the top of the next hill which I immediately recognized as the old sillimanite quarry. I had found good specimens here on

previous trips but since then 30 years of fossicking had removed just about everything. There were a few weathered lumps of tough fibrous sillimanite, formed when the enclosing rocks were subjected to high temperatures and pressures, but none of the good biotite schist specimens I had been hoping for. A few metres to the north of the quarry I quickly relocated the staurolite almandine schist outcrops, but again there was virtually nothing left after repeated visits by university students. However, there was enough visible to show the occurrence of these accessory minerals in the biotite-muscovite schist.

We returned across the hills to the highway, passing over large outcrops of amphibolite some of which were garnet-bearing. After re-negotiating the fence, which proved problematical for some, we drove the few kilometres west along the highway to the picnic area adjacent to the Thackaringa mines where there were tables. Here we had lunch, our sandwiches intermittently seasoned by dust entrained by the hot blustery northerly winds. The day had turned out quite warm and we were exhausted from tramping across the hills, so it was good to pause for a break. We were surprised at how dry the hills were, given the amount of recent rain.

The dumps of the long-deserted Thackaringa mines were clearly visible on the side of the ridge about 700 metres to the south of the highway. The station boundary fence had long since fallen down, but several fairly recent notices warned of the dangers of the mine area. But we had permission to be here and so walked across the remains of the fence and down along the sandy bed of the main creek draining the area, which led up towards the mines. The ground was covered here with a thick layer of soil, but rocks washed down the creek from the mine ridge soon began to give some idea of the area geology. Most common were large lumps of limonite (iron oxide) formed by the oxidation of the siderite gangue in the Thackaringa lodes. Many showed zoning, with the original siderite rimmed by a crust of white quartz crystals which grew on the vein walls. A variety of schistose rocks were also seen

The ridge on which the mines are found originally lay at the junction of the bush tracks linking South Australia with Milparinka and the river ports of Menindee and Wilcannia. Silver was first discovered here by Nickel and McLean in 1875 while well sinking on Thackaringa Station. This was followed by the opening of the Pioneer mine by Paddy Green (a Menindee storekeeper) in 1876. This was the first mine in the Barrier Ranges and the mines supported a small town between 1889 and 1903. The Pioneer produced 18,500 tonnes of ore and reached a depth of 150 metres. The next largest mine, the Gypsy Girl, produced 9450 tonnes of ore between 1884 and 1892 from a 70 metre shaft. There were many other mines and total production was 30,000 tonnes of hand-picked ore.

Thackaringa-type ores occur only in the Willyama Supergroup and are restricted to the northern part of the Broken Hill Block. They occur in lower metamorphic grade rocks than the Broken Hill orebody. These deposits formed 500 myr ago as fluids moved up shear zones dissolving lead and zinc from the Broken Hill type deposits and re-depositing them as sulphides in the shear zones where the fluids intersected graphite-rich rocks. Although both lead and zinc were re-mobilized, the zinc entered the structure of the metamorphic minerals like staurolite where it substituted for iron and magnesium. Some staurolites contain up to 7% zinc and micas up to 1%. Galena was the main ore mineral (silver-rich) while sphalerite was absent or rare.

The Thackaringa deposits occur in narrow steep quartz-siderite veins which cut across the layering of the enclosing rocks. The veins do not contain blue quartz, lead-bearing orthoclase, gahnite or the manganese minerals typical of the Broken Hill type deposits. As a result of 65 my of weathering these deposits were

Ron Evans

Setting off to old Thackaringa Mine site

Ron Evans

Onion weed plentiful around the Thackaringa Mine

Ron Evans

Abandoned Galena (rich in silver) mines on Thackaringa Station

Ron Evans

Happy Hour back at MT. Gipps Station after the days outing

enriched above the water table and some extremely rich ores were mined from them. But the mines were short-lived.

We scratched around for a while at the dumps of the Pioneer and Gypsy Girl mines, where there were signs of recent drilling activity, but found very little apart from abundant siderite and quartz. Most of the siderite had oxidised on the surface to dark brownish red hematite and lumps had to be broken to show the true pale brown colour.

Pausing at the old boiler and brick foundations at the Gypsy Girl mine to take photographs we then proceeded up to the summit of the ridge and followed a vehicle track south to a group of small mine dumps scattered over the hillsides in an area I had never previously visited. Here we found a number of unfenced shafts, some of them quite deep judging from the size of the dumps surrounding them. But there was little in the way of interesting or collectable material, until we inadvertently came across an old ore dump! Dark rocks in this small isolated pile seemed unusually heavy, but so was siderite, and it wasn't until I had broken one open that we found we had hit the jackpot! Many of the rocks contained cores of bright silvery galena and our backpacks soon increased astronomically in weight as we collected together the best of what we had discovered.

Ron Evans

AGSHV members, Thackaringa Mine site

Weighed down with our finds we returned along the same track to the Gypsy Girl and back down the hill towards the cars. But then, as if we didn't have enough weight to carry, Ron found several very large boulders of almost fresh coarsely crystalline siderite embedded in the track. Of course one of these, the largest weighing some 15 kilograms, just had to be carried down the hill to be broken up at our leisure.

Back at the cars we paused for afternoon coffee before driving back towards Broken Hill and taking the sealed track up to the repeater station. We found both gates closed but not locked and so were able to drive right to the base of the tower. Ian Plimer had made reference in his book to a large outcrop of tourmaline-rich pegmatite as well as tourmaline schists near the base of the tower. The pegmatite was easy to find, forming an obvious bold outcrop to the east of the road, but the schist took a little more effort. The outcrop could not be located but a small pile of this rock, sprinkled with small lustrous black prismatic tourmaline crystals, was eventually found at the base of the pegmatite outcrop on top of the ridge and had obviously been dug from the foundation of the adjacent instrument enclosure. I then scrambled westwards down the line of ridge from the tower to see if there was anything else of interest, but returned after about 700 metres with nothing to report apart from spectacular views.

Satisfied with our finds, we returned to the highway and were back at Mount Gipps at 5pm. Amazingly, I had found everything I needed to find to show the group and even located a number of new sites of either geological or mineralogical interest.

Sunday 26th September

Today was a free day with no set program, allowing everyone to do their own thing and not be forced into long treks across the countryside. But for some the urge to explore was irresistible. Barry and I set off before breakfast to climb up the highest pinnacle west of the Corona Road just south of the Mount Gipps gate. Distances are so deceptive here and it was a little further than we thought to the base of the hill, but the climb provided fantastic views over the countryside in all directions. Even the rocks were interesting, with bold ridges of schist weathered into the most fantastic shapes. The ridge is composed of very hard and resistant Lady Don Quartzite, the oldest of the Late Proterozoic Adelaidean rocks. Just to the west lies the unconformity which separates these rocks from the underlying Early Proterozoic Willyama Supergroup.

After breakfast back at camp I drove into the city to return briefly to the mineral show before revisiting White Rocks and a few other places for photographs. I then ventured out along the rough dirt track on the Perilya Northern Leases past the Potosi open pit behind Round Hill and on past the steel headframe of the deserted New Silver Peak mine to explore the possibility of dragging the group in their later if it proved worthwhile, which it did. There were several old mines out there plus a diamond drill in operation.

Several of the group met up for lunch at the up market Café El Fresco around 1pm and then drove back out to the Northern Leases to explore the dumps of some of the small deserted mines along the line of lode. Here the dumps of the Consolidated Broken Hill mine provided interesting specimens of sulphide ore, schist and a few boulders of microcline quartz pegmatite.

Late in the afternoon Dean drove myself, Roz and Anne up the track along Dead Finish Creek just south of Mount Gipps to Freyer's mine perched high on the ridge overlooking the low rounded ridges and wide valleys forming the eastern edge of the Main Barrier Range to the south. Here old windlasses lay partly collapsed over two shafts, one of which still had a ladder leading down into its black depths. Nearby was an underlay shaft leading off a small open pit in which tourmaline and muscovite-rich rocks were exposed. Zones in the surrounding rocks were also found to be rich in small tourmaline crystals. Freyer's mine worked one of many similar small pegmatites containing both wolframite and scheelite confined to a narrow north-south trending zone of quartz-feldspar-biotite-garnet gneiss within the Broken Hill Group lying along the eastern limb of The Paps Syncline.

Ron Evans

Harry Hores' "Red Hut" next to his scheelite mine

From Freyers mine a new track had been cut by the owners of Mount Gipps Station up the side of the ridge to a lookout point which provided spectacular views in every direction over the bare hilly terrain of the Main Barrier Range. Here the skeletons of dead trees and scattered spiky schist outcrops provided the perfect foreground for capturing the late afternoon light on the surrounding landscape in whatever format the photographers in the group desired.

On the way back down the hill we pulled in to the "red hut", a simple but once comfortable corrugated iron residence built by Harry Hores adjacent to his scheelite mine, sunk on another of the pegmatites in that same band of gneiss. His stone chimney was a work of art and cooking was done on a Metter's fuel stove placed outside and some distance from the hut, presumably in case his dinner caught fire! There was even a somewhat dilapidated Hills hoist where he had hung his clothes to dry. But it was his water supply that really caught our attention. Along the northern side of the hut and fed by pipes from the iron roof stood a series of rusted 44 gallon steel drums, each placed slightly lower on the ground and taking the overflow from the one before. The hut has lain unused for many years but is kept maintained by Kym and John Cramp of Mount Gipps for its historical value. Harry's mine shafts had been filled with discarded white goods and other trash and none of the accessible dump material held anything of interest.

We returned to Mount Gipps around 5pm and held happy hour on the porch of the shearers' quarters while watching the sun set over the hills.

Monday 27th September

Today we had been given the chance to join members of the Broken Hill Mineral Club on their excursion to the Radium Hill uranium mine. We met at 8:30am at the "white elephant" on the Adelaide Road 2 km west of the city. This 40m high steel structure is a replica of the headframe of the South mine Number 7 shaft built at the bequest of William Peter Perrin Seward, a local who believed there should be something on the outskirts of the city to remind visitors of the rich mining heritage of the area. In its current setting it appears somewhat out of place, but further developments are planned.

At 9am 14 vehicles loaded with eager fossickers headed out across the Mundi Mundi Plain. The countryside appeared surprisingly dry, although patches of Sturt's desert pea along the tops of road cuttings suggested there had been recent rain. Ninety kilometres west of Broken Hill we turned south into Tikalina Station and drove 6 kilometres to the station homestead along a well-formed dirt track, arriving there at 9:45am. Here we paused to inspect a historical museum set up by the station owners in the miniscule rooms of a small tin hut to display relics and photographs from the Radium Hill mine. Scattered around the homestead were many other items of historical interest, including old drays and an antique road grader that surely must have been one of the first used in Australia.

Another 15 kilometres on a somewhat rougher dirt track took us through dry hilly country down onto Maldorky Station. For the most part the track closely followed the deserted embankment of the South Australian Government railway, constructed in 1954 to service the mine. At the turnoff to the old village we picked up a town map and continued on to the mine, now visible as a group of huge grey concrete structures in an otherwise flat and featureless landscape. Sadly, in an act of thoughtless destruction of the State's mining heritage, the headframes and other infrastructure had been torn down when the mines closed, but the ore bin and water tanks had proved indestructible. We pulled in at the end of the track amongst the only trees on the site and headed for the mine dumps, a sprawling collection of low rock piles enclosed by flimsy wire fences that presented little in the way of a deterrent. Even the occasional sign "Danger, Low Level Radioactivity!" did nothing to discourage any of the group in their search for the infamous davidite, the main uranium ore mineral. But we were limited to three hours fossicking, this apparently providing us with the maximum allowable safe level of exposure!

The mine dumps proved a treasure trove of unusual and spectacular rock types which included coarse amphibolites, biotite and muscovite schists, as well as a variety of very strange metamorphic rocks and the occasional specimen of granitic uranium ore containing patches of resinous black davidite. There were no birds here and the only sounds to echo over the site were those of steel hammers hitting hard rock and the occasional loud beeping as someone's Geiger counter went berserk over a rich patch of davidite.

Located 110 kilometres southwest of Broken Hill, the orebody was first pegged in March 1906 as Smith's carnotite mine, named after the discoverer Arthur J. Smith who worked the mine for the next two years. In 1906 Sir Douglas Mawson recognized the black resinous main ore mineral as a new Rare earth-Uranium-Iron-Titanium oxide hydroxide species which he named davidite after Sir Edgeworth David. In 1908 the original claim lapsed and was taken up by the Radium Hill Company which produced 350 mg of radium and 150Kg of uranium. Mining ended in 1914 at the outbreak of World War I. Radium and Rare Earth Treatment Company NL recommenced mining in 1923 and this continued till 1931.

The final phase of mining began in 1944 when

Ron Evans

Radium Hill Heritage Museum Tikalina Station

Ron Evans

Fossicking for radioactive Davidite, Radium Hill

the then Government Geologist Reg Sprigg made a detailed geological survey which led in 1946 to the Department of Mines commencing preliminary exploration. By 1950 50 men were camped on the site. In March 1952 an agreement was signed by Commonwealth and State Governments, and the Combined Development Agency of the United States and United Kingdom which guaranteed purchase of uranium output for defense purposes. The mine was officially opened on November 10th 1954 by Governor General Sir William Slim. The main shaft was sunk to 420 metres to access a series of sub-parallel lodes up to 5m in width dipping at between 30 and 70 degrees within retrograde schist zones in areas of strong shearing in meta-sediments of the Archaean Willyama Province. The ore comprised segregations of davidite associated with hematite and illmenite, along with reddish quartz and coarse bronze-coloured biotite. The davidite at Radium Hill has been dated at 1730myr.

The davidite was pre-concentrated by heavy media separation using a 2.85SG ferrosilicon suspension and then after grinding in ball mills a final concentrate was produced by froth flotation. A total of 150000 tons of concentrate was railed to Port Pirie where 860 tons of yellow cake worth 15 million pounds was produced from it. This was a fair return on the 6.76 million pounds spent on developing the mine. The mine was closed on December 21st 1961, the infrastructure and town then dismantled and taken away.

While the Mineral Club moved on to the next locality our group, at Trevor's suggestion, drove to the village for a picnic lunch adjacent to the cemetery. Here we were surprised to find the area neatly maintained by the Radium Hill Historical Association Inc. They had also placed signs at many important building sites in the village. It seems specialist groups as well as tourists use this area on a regular basis and a Rotary Kids Camp was setting up in the centre of town as we drove out.

Finding the Mineral Club at the next locality, an outcrop of kyanite-rich gneiss, proved a challenge and some of our group missed it altogether. But those that persisted eventually found the key landmark, a capped drill pipe to the left of the road, and followed the very faint track around the edge of a small ravine and up to the base of a tree-covered ridge where Mineral Club members had parked. We could see activity at the top of a small gully and so headed for it, passing over outcrops of crenulated schists with patches of small pyrite crystals replaced by limonite ("devil's dice"), some of which had weathered out and were lying loose on the ground. There were grasshopper nymphs here too, by the thousands, and every footstep disturbed dense clouds of these voracious insects.

At the top of the ridge were outcrops of gneiss containing scattered pale blue crystals of kyanite to several centimeters in length, but it took some searching and good luck to find the rare patches of coarse bladed aggregates. Some of these reached a diameter of 50cm or more and a few contained scattered crystals of blue corundum to 1cm across. From the top of the ridge the remnant concrete structures of the Radium Hill mine could be seen off in the distance to the south.

Everyone left the site at 3:30pm. We stopped at the Tikalina to report the grasshoppers, but the house was unlocked and deserted! We arrived back in Broken Hill at 4:30pm and drove on to Mount Gipps.

Tuesday 28th September

At 9:30am the group departed for the Torrowangee limestone quarries, beside the Corona Station road 23 kilometres to the north. In 1890 a railway was built from Broken Hill to these quarries to transport limestone used as flux in the Broken Hill smelters between May 1891 and April 1898. The rails were later ripped up to provide fencing around the regeneration area encircling Broken Hill. The remains

Ron Evans

Ruin of Catholic Church

Ron Evans

Lunch Radium Hill Pioneers Cemetery

Ron Evans

Torrowangee Limestone Quarry - red wild hops

Ron Evans

Dam wall built by early miners

of the railway were followed most of the way to the quarry, which was eventually visible some distance ahead as a huge gash in the side of a hill to the west of the road. We parked alongside the high embankment leading to the loading bay across the road, now reduced to an extensive jumble of concrete foundations partially hidden by peppercorn trees.

The limestone and associated rocks exposed in the Torrowangee quarries form part of the Late Proterozoic Adelaide Supergroup, deposited as a sequence of shallow marine muds, silts, sands and limy sediments, with glacial sediments and drop pebble conglomerates forming the hills to the west. Limestone of this age is quite rare, most having been converted to dolomite through partial replacement of the calcium by magnesium introduced from groundwater. The limestone here is dark in colour due to the presence of organic matter derived from the breakdown of biological remains nearly 1000myr ago. Part of the massive heavily-jointed limestone bed has been tectonically fractured to form breccias while other areas towards the top of the sequence contain abundant angular drop stones. But the rare impressions of soft-bodies animals supposed to occur here eluded us. The limestone is interbedded with black pyritic shales and is overlain by thinly bedded shale which pinches out at the northern end of the quarry. The whole sequence was gently folded 500myr ago and subjected to low grade metamorphism which resulted in the numerous white quartz veins seen in the quarry walls. Part of the quarry floor had been taken over by peppercorn trees.

After inspecting a number of prominent quartz outcrops across the creek from the loading area we returned towards Mount Gipps, turning to the west just past the first grid and taking the track along the fence line towards the Allandale mine. The track wound through the hills and down across a wide valley green with new vegetation after recent rains. After taking the right fork at a junction the track wound up a narrow creek bed with several sandy crossings and a few rough stony sections until we eventually reached an old stone dam, once the water supply for the Allandale mine. Then just around the next corner we came to another vehicle and were surprised to find Kym there with some visitors looking for garnets in the creek bed. We also parked here and set out on foot to explore the local geology.

Mica schists in the creek bed showed vertical cleavage and were partially covered with white calcrete, a form of secondary limestone formed by weathering of calcium-rich rocks in arid areas. The ridge to the south of the creek was found to host a number of quartz-orthoclase pegmatite lenses with patches rich in black tourmaline crystals to several centimetres in length, often as graphic intergrowths with the other minerals, and many good specimens were collected here. From the top of the ridge we could see the extensive dumps of the Allandale mine at the head of a small gully off to the northwest and so headed for them.

The dumps were white and powdery and smelt strongly of decomposing sulphides but there was very little unoxidised ore in evidence and certainly nothing on the dumps worth picking up. There were several unfenced shafts, the North Underlay shaft providing a dramatic view down into the depths of the mine. The timber-collared number 2 shaft still contained a ladderway in reasonable condition but without maps of the workings it would prove too risky to explore. Spectacular pegmatite outcrops dotted the mine area. The mine initially operated between 1884 and 1922 to produce around 4000 tonnes of Pb/Ag ore from a Broken Hill type deposit associated with quartz-gahnite lodes within Potosi Gneiss. It was then worked intermittently, with 16000 tonnes of ore picked from the dumps in 1947 and then a further 2200 tonnes of ore mined underground between 1983 and 1990. There

Ron Evans

Allandale (lead/silver) mine site

Ron Evans

Brian next to "Baboon Rock"

were scattered remains of old stone huts in the vicinity but few remnants of mine infrastructure, apart from an old rusting boiler. To the southeast of the workings a small stone village had once housed the miners.

We returned to the Corona road by the same route, choosing not to do the round trip, and stopped just west of the road to explore and photograph a spectacular white quartz blow outcropping along the ridge to the north. This was to prove the most spectacular and photogenic of the many quartz outcrops seen in the Barrier Range.

We were back at Mount Gipps for lunch around 2pm and then headed back to the track up Dead Finish Creek to re-explore the tungsten mines. At Freyer's mine Dean found the main adit down the steep hillside below the shafts and ran back to the car for a torch. We followed him into the darkness, our path lit by only a single weak beam of light, but the roof was solid and we could feel air moving out towards the entrance so it was deemed safe to continue. However, we had ventured only a few metres before tripping over what appeared to be loose piles of canvas-like rubbish on the floor. To our astonishment these turned out to be the mummified corpses of at least a dozen kangaroos, who had chosen the cool dry dark adit to settle down and die of old age! It was only 30 metres or so to the stoped area on the lower of the two mine levels from which around 4.5 tonnes of tungsten concentrates had been removed. But without good light we could see no remaining mineralisation.

Ron Evans

Massive quartzite ridge and pegmatite outcrop

We drove up to the lookout again before returning to Harry Hores Scheelite mine to more fully explore the Red Hut. It remained just as Harry had left it, fully furnished although very dusty after the storms of last year. It obviously had not been used for a very long time! A tiny kitchen led off the entrance lobby where there were two very old kerosene fridges side by side. The other doorway off the lobby led into the only other room, a combined dining and lounge area with carpet on the floor, an old couch against one wall and a big open stone fireplace. The room was lit by daylight from a single window. Ideally sited, the hut provided great views across the countryside towards Mount Gipps Homestead to the north. Alongside the workings near the hut we found a large outcrop of tourmaline quartz rock, but it was too badly weathered to provide good specimens.

Taking the track to the west opposite the second Mount Gipps entry gate we continued a few kilometres till it intersected a wide sandy creek dotted with magnificent river gums just to the east of a small rocky gorge. Here, to the left of the parking area, we found the infamous "Baboon". Used on all Mount Gipps brochures, this 2 metre high outcrop consists of a vertical sheet of Broken Hill Group meta-sediments bearing an uncanny resemblance to the face of a baboon when viewed from the west. Climbing up the slopes south of the creek we found many more spectacular schist outcrops standing several metres above the ground. With imaginations now running out of control, we headed back to Mount Gipps around 5pm.

Ron Evans

Rhodonite crystals - one of many wonderful mineral specimens in Milton Lavers Mineral Collection

Ron Evans

Living Desert Sculpture Symposium on Mount Sundown - "Facing the Day and the Night"

Wednesday 29th September

Today I had arranged for the group to visit Milton Lavers, internationally-recognized mineral collector, close friend and owner of the most comprehensive collection of Broken Hill minerals ever assembled. We arrived outside his home at 10 am and were ushered around the back to the interconnecting sheds where his collection was housed. Once a nurseryman, Milton's yard showed the signs of a passionate gardener, with many carefully tended native plants and lots of cacti squeezed in wherever possible.

Entering the first shed, crowded with bits of rock only an amateur would have the slightest interest in, gave little hint of the treasure that lay beyond! Entering the first room of the main collection simply takes the breath away! Arranged on floor to ceiling shelves are at least two thousand of the most exquisite specimens, all from the Broken Hill mines. Many of these had been self-collected while a miner at the old Zinc Corporation. Others had been bought from dealers or obtained by exchange. Several have been illustrated in the two minerals of Broken Hill books, now standard references on Broken Hill mineralogy. It was well over an hour before we could drag ourselves away. Such a willing, knowledgeable and amiable host is a rarity in this modern society.

Most of the group visited the Silver City Mint, its art gallery, chocolate shop, and rather dismal display of Broken Hill minerals before moving onto Joe Keenan Lookout for a picnic lunch, where it was unpleasantly windy and cold.

The afternoon was spent at the Living Desert Reserve, nestled amongst the rocky hills of the Barrier Range 9 kilometres north of Broken Hill. Here the arid landscape was explored along an extensive network of sometimes challenging walking tracks which provide superb views over the surrounding country from a number of lookout points. One useful innovation was the provision of fresh drinking water at strategic points along the track and the weather had turned hot enough for us to make effective use of this facility.

Forming part of the Reserve is the 180 hectare Flora and Fauna Sanctuary enclosed within an electric predator-proof fence. Here we were able to see the variety of plants native to the Ranges, many in flower and all of them identified, and one of the reptiles (a rather co-operative frill-neck lizard) which call the region home. Also forming part of the Reserve is the Sculpture Symposium, a group of 12 sandstone artworks completed in 1993 by invited artists from around the world arranged around the summit of the central ridge. This was visited by most of the group late in the day to take advantage of the late afternoon light on the sculptures. The site also provided a great overview of the line of lode and the city of Broken Hill.

Most of the group was back at Mount Gipps by 5:40pm.

Thursday 30th September

We were up just after sunrise at 6am and left for the cairn at the edge of the regeneration area on the Silverton Road where we met up at 9am with Trevor Dart, Vice President of the Broken Hill Mineral Club, who had offered to show us some of the geologically interesting localities in the Barrier Ranges. Several kilometres out of town we turned to the right onto Limestone Station, the homestead lying only 0.5km in from the road. There were literally hundreds of bits of old rusting machinery lying around the house, reflecting the Station owner's interest in historical artifacts. Prominent amongst the relics were an old steel-wheeled road grader and ancient wool press, both

once used on the property. We would find this interest in industrial archaeology reflected in the preservation of every aspect of mining infrastructure at each site we visited.

Continuing through the yard we turned left to follow a track along the sand creek bed out into dry gently rolling hilly country. The track was quite good, although there were many washouts which demanded care.

The first site was the Hidden Treasure Pb/Ag mine, worked on a series of mineralized quartz-gahnite lenses related to Broken Hill type mineralisation. The main shaft had been used as a rubbish dump then backfilled, with only gneiss evident on the remaining dump. However a few metres to the north lay a series of sub-parallel quartz-gahnite lodes which after some work provided good specimens of quartz-gahnite rock typical of the Broken Hill lode horizon. Some of these showed sharply-formed gahnite octahedra and one narrow zone even provided exceptionally well-formed spinel law twins up to 1 cm across. Trevor had brought sieves and working the soil around the outcrops provided the occasional small octahedral crystal of gahnite. These gahnite-quartz horizons are common in the Broken Hill area and some extend for up to 25 kilometres across the countryside.

Two kilometres further up the valley we came to the Centennial mine, another of the small Broken Hill-type deposits in the southwestern Broken Hill block. This mine was worked between 1187 and 1888 and then from 1919 to 1927, producing an unrecorded but small quantity of low grade ore. Worked in four shafts, the deepest at 47 metres, the deposit was known as the "poor man's Broken Hill". The mineralisation here is unusual, occurring in both the quartz-gahnite rock and the enclosing metasediments. Widespread patches of white sulphates attested to the former abundance of sulphide rich rock in the dumps and strangely, this was the only site in the Barrier Range apart from Thackaringa where we found good specimens of galena-rich ore and bands of fine granular sphalerite in quartz-gahnite host rock. The high ridge behind the mine contained spectacular pegmatite outcrops, much of it graphic, as well as proving superb views over the surrounding hills. We had morning tea here before moving on to the Great Western, a little over a kilometre to the southeast.

Another of the small Broken Hill type deposits, the Great Western (or Kaiser) mine was worked in 1887-1888 and then between 1920 and 1927 with recorded production amounting to only 50 tonnes of lead carbonate ore from a quartz-cerussite-gahnite lode on the 15m level. But below the water table the sulphide ore here held too much bismuth to be acceptable at the smelters and some of the decomposing galena ore was mildly radioactive!

A few hundred metres east of the small open cut excavated by Ted Williams of Broken Hill in the 1960's, we found yet another large bold outcrop of coarse graphic quartz-orthoclase pegmatite standing proud of the gneissic country rock. Just to the south of this we found the remains of a small stone hut complete with the remains of a bedstead. At least the old miner here had something soft to sleep on after a hard day's work!

We found nothing collectable amongst the many small mine dumps, after hoping for at least a few micro-crystals of oxidised minerals in the piles of vughy limonite-rich gossan. But scattered around the mine were interesting relics including old mine cages, drill rods, and screens used to sort the ore.

Half a kilometre west of the Great Western, on our way back to Limestone Homestead, we pulled in beside the well-timbered two compartment main shaft of the OK mine. Little was found on the dumps here apart from specimens of gneiss and pegmatite and no production has been recorded from this mine.

Ron Evans

Searching for octahedral Gahnite crystals

Ron Evans

Old Centennial mine, Limestone Station

Ron Evans

Lunch along banks of a small Creek, Limestone Stn.

Ron Evans

The start of Byjerkerno Gorge

Barry lost his Polaroid filter here, which took off down the shaft as he was attempting to change it. We almost had to grab him to stop him falling down the shaft after it!

Lunch was held in the bed of the sandy creek adjacent to the homestead amongst a magnificent patch of river gums before returning to Broken Hill.

Back in town we followed Trevor to his home where we had been invited to view his extensive collection. While there were many outstanding specimens from both Broken Hill and other parts of Australia, the thing that really stood out was how the cases were lit by hidden fluorescent tubes which gave the display very evenly distributed lighting.

After coffee at Charloffe's Café opposite the Post Office, I took the group out to the site of the Australian Broken Hill Consols mine near the grain silos just to the east of South Broken Hill. Here we searched the scattered dumps for siderite amphibolite and anything else we could find, but again there was no sign of the silver minerals for which the mine was internationally famous.

The day ended with dinner at the Legion Club on Crystal Street at 6pm.

Friday 1st October

We left camp at 10am and headed up the Silver City Highway across the wide gently undulating expanse of the Late Proterozoic Adelaidean sedimentary rocks then the hilly terrain of the Adjacent Early Proterozoic Euriowie Block. At the White Cliffs turn the highway turned north-northwest and followed the eastern edge of the Euriowie Block, diverting northwards across the vast outwash plains near the abandoned town of Euriowie at Euriowie Creek. Ahead to the west lay the dramatic bare ridges of the Byjerkerno Range.

The Euriowie and Corona geological maps showed two possible routes off the highway into the Euriowie tin mines. The first of these was a track up the valley of Condah Creek which headed directly north towards the mines. But discussion by phone with the owners of Sturt's Meadows Station the previous day had revealed that a few very rough and bouldery creek crossings might prove too much of a challenge for the Foresters. So we opted to continue up the highway to the boundary fence and grid exactly 50.1 kilometres north of the Corona Station road junction.

At the grid we found the second tack leading off to the west along the fence line and followed this up and over the hill past a small relatively new shearing shed, through two gates, and down a steep and badly washed out hillside onto the dry bed of Eight Mile Creek. Here we faced a rough and boulder-strewn track which led the last 100 metres to a group of eucalypts beside a muddy pool of water at the entrance to the spectacular Byjerkerno Gorge. Here we paused for morning tea.

The track in had passed over Cainozoic sands and soil covering the Adelaidean rocks, but here at the start of the gorge the very resistant Adelaidean Christine Judith Conglomerate had formed a high rocky ridge through which the creek had cut on its way out to the eastern slopes.

Refreshed and rejuvenated, we knew the old tin mines lay only a few kilometres up the gorge and climbed up over the first rocky ridge to a point where access down to the bed of the creek was possible. The gorge was certainly a surprise, with sheer rocky walls and abundant outcrops of coarse pebble conglomerate in which the porosity had been infilled by quartz. This had resulted in a very tough and resistant rock which

Ron Evans

Looking down Byjerkerno Gorge

Ron Evans

Old bakers oven and fireplace

eroded to produce flat or gently rounded surfaces with no protruding pebbles. Following the creek west along its intermittently sandy bed we passed a low silted-up stone weir just as the rocks changed to white silicified beds of Lady Don Quartzite, still within the Adelaidean System.

At the first mine, a tunnel in phyllites in the south bank of the creek indicated we had passed over the unconformity separating the Adelaide and Willyama Supergroups. West of the unconformity the terrain abruptly changed from deep rocky gorge to open hilly country, Eight Mile creek becoming a wide tree-lined bed of dry sand as we entered an area of softer less-resistant Willyama Supergroup schists and phyllites.

Other mines appeared further up the creek, all on the north bank. Most were marked by small dumps of pegmatite mullock and in some the host pegmatite remained exposed in the shaft walls. Then came the big one! The Wheal (Huel) Byjerkerno mine appeared ahead on the lower slopes of the ridge as two large mullock dumps with the concrete foundations of the mill at their base and a small stone weir in the nearby creek bed. While Dean walked further upstream to investigate outcrops of calc-silicate rocks and andalusite schists marked on the map, I explored the Huel Byjerkerno, finding two deep unfenced shafts at the top of the dumps which contained a variety of interesting pegmatites and schists. A few scattered boulders comprised a very unusual quartz/muscovite pegmatite in which coarse muscovite flakes had become preferentially aligned due to directed pressure accompanying the folding that many of the pegmatites had undergone in the last deformation episode.

The Wheal Byjerkerno mine was the most productive on the Euriowie tinfield. It was worked between 1884 and 1911, then 1935 to 1972 for a total production of 41 tonnes of cassiterite (tin oxide).

Following a picnic lunch at the weir we explored the rest of the area, finding an old well-preserved baker's oven and other relics. In open forest high on the ridge south of the creek we found a group of shallow shafts and pits encircled by dumps where samples of cassiterite in pegmatite host rock could be collected. My attention taken by the variety of rock types on the dumps here, I suddenly realized I was on my own and so headed back along the gorge to the cars watched by several inquisitive goats perched high on the rocks.

The group had all returned to the cars by 2:30pm and we had afternoon coffee under the eucalypts before returning to Mount Gipps.

Ron Evans

The Wheal (Huel) Byjerkerno mine site

Ron Evans

Byjerkerno Gorge looking upstream

Saturday 2nd October

Most of the group departed Mount Gipps at 10am and again took the track up Dead Finish Creek, this time in an attempt to find the Adelaidean/ Willyama unconformity which our maps showed was only a short distance up the creek. After repeatedly fighting through dense low scrub and walking several kilometres along the sandy creek bed we gave up after finding only Adelaidean sediments and scattered boulders of pelitic schists.

In Broken Hill we paused for lunch at Charloffe's Café and then parted ways, with only Dean, Roz and myself driving out on the Wilcannia Road to locate the beds of BIF shown on our maps. But we could find no outcrop, not even a hint of this banded granular quartz/magnetite rock. So, following Bill Reid's directions, we continued on to the Hobbs memorial outcrop on Perilya's northern leases, taking the track of to the left just before Willa Willyong Creek 3.4 kilometres past the entrance to the Imperial Lake.

This site, used by geologist Bruce Hobbs to demonstrate high grade metamorphic mineral assemblages, soon appeared as a large rugged outcrop of garnet sillimanite gneiss to the east of the old Round Hill mine. We clambered over this and nearby outcrops for nearly an hour before walking west along the track to the top of the ridge. Here a small cutting had dissected quartz-gahnite rock interpreted as being the northeasterly continuation of the main Broken Hill lode across the de Bavay Shear Zone. It was interesting to be able to climb up onto an un-mined section of this famous lode, although it had been heavily leached and was totally devoid of any lead/zinc mineralisation.

Following the ridge to the south we came to the large dumps and old concrete water tank of the Round Hill mine. There was nothing here but gneiss, so we walked back to the car with the intention of trying to complete the Broken Hill Geotrail.

The signposted amphibolite outcrop in King Street, South Broken Hill, proved a disappointment, with not even a scrap of amphibolite visible. Then, following Bonanza Street to the gates of the Airport, we turned left and followed the dirt road for around 600 metres to a small rise. Here we actually found the scattered outcrops of Alma Gneiss, a coarse quartz-feldspar-biotite gneiss with zones of abundant orthoclase crystals as augen (eyes) or well-formed rectangular crystals to 10x2 cm. There were spectacular pegmatites here as well, but we had seen so many by now that they were hardly given a second glance. Leaving a little disappointed, we stopped briefly at the large black bouldery outcrop west of the grain silos. This also proved to be gneiss, stained on the surface by manganese oxides.

By this time all the coffee shops had closed so we returned to Mount Gipps.

Sunday 3rd October

The day began partly cloudy but the sun eventually emerged to raise the temperature to around 26 degrees. Barry led the majority of the group back to Byjerkerno this time taking the track north up Condah Creek to explore a small side gorge with spectacular Aboriginal rock peckings mentioned by Kym a few days ago. But we were unsure of land ownership there, whether or not it was part of Sturt's Meadows for which we had permission to enter.

The track in proved reasonably good and the petroglyphs proved as spectacular as Kym had described. Nearby and only a short distance south of the Huel Byjerkerno mine the group found a high stone dam with a small tree growing out of a hole it its wall. The dam had been ideally placed along the top of a small waterfall.

Ron Evans

Aboriginal petroglyphs - dam silted up

Ron Evans

Vertical schists (above the dam) cut by creek

In the late afternoon, with increasing cloud coming in from the west, the small contingent that had remained at Mount Gipps to sort and pack rock specimens drove up to Baboon Rock and explored the upper reaches of the creek, passing massive schist outcrops of the Willyama Supergroup and picturesque river gums along the sandy creek bed. Back at the Baboon, more interesting shapes could be seen in the schist outcrops further up the ridge and on close inspection a whole menagerie of animal-like shapes appeared, eventually leading to a group of vertical rocks standing like a ruined castle, its base bedecked in wildflowers!

Monday 4th October

We met at Trevor Dart's place at 9:30am and headed out along the Adelaide road towards Thackaringa once again. As Vice-President of the Broken Hill Mineral Club and an avid collector, Trevor was a mine of information as we drove out, pointing out locality after locality as we passed them by. A return trip to Broken Hill seemed assured!

Just as the highway turned up into the Thackaringa Hills we pulled in at a locked gate on the north side of the road. We had to walk from here, following the track as it wound up into the hills past one of the mines in the Thackaringa Fluorite Belt. Diverting off the track up towards the summit of the first ridge we began looking for the magnetite crystals said to be lying loose on the ground, but we found only a few broken fragments. At the top of the ridge we found a series of shallow pits in solid caliche (secondary limestone) but could find no reason why anyone would expend such effort on this useless white chalky material. Down the other side of the ridge along the bed of a small gully was the line of partly backfilled garnet pits. To the south of these diggings and partly hidden by mallee were another series of shallow pits from which small amounts of magnesite (magnesium carbonate) had been mined.

Ron Evans

Searching for almandine garnet crystals

Over an hour was spent digging down through a powdery mixture of decomposed schist and caliche in the hope of finding a few well-formed almandine garnet crystals. Indeed a few were found to 2cm across as well as groups in the biotite schist host rock, but it was enervating work in the stifling heat of this sheltered and breezeless valley. These diggings continued sporadically down onto the flat at the foot of the gully, where good specimens of biotite and muscovite schists could be collected. Here one small outcrop contained attractive small garnets in schist matrix.

Scattered over the lower slopes of the ridge to the south lay a profusion of rough dark brown staurolite crystals, although very few were of any value as specimens. Further up the ridge towards the old tremolite pit we found their source, a knotted biotite schist crammed with protruding staurolites. But fresh unweathered specimens could not be found.

Most of the group gave up at this point, leaving myself, Jim and Trevor to continue exploring the area. We took a more circuitous route back to the vehicle, following the north side of the first ridge towards the east and over country Trevor had not previously explored. Walking slowly and keeping our eyes to the ground we found nothing apart from a few poor garnets weathered from schists outcropping along the crest of the ridge. From the summit we looked down on the Thackaringa davidite pits opposite the Triple Chance turnoff about 600 metres away to the east and decided to go take a look.

A number of shallow pits here exploited patchy occurrences of davidite in irregular veins and lenses of pegmatite extending over an area 8x2 kilometres. Surprisingly, one good specimen of davidite crystals embedded in pegmatite was found.

Our energy almost totally sapped by the 30 degree heat we barely made it back to the car. But I needed to show Trevor the tourmaline schist at the repeater station. We spent only a few minutes there before returning to Broken Hill in air conditioned comfort, dropping Trevor off at his home then retreating to the El Fresco Café for a most welcome iced coffee!

Before returning to Mount Gipps Jim and I visited Whyte's Underground Mine, constructed in the authentic style of underground Broken Hill mine workings and festooned with mine relics. We were first shown a 16 minute film on the history of Broken

Hill, but it was exceptionally poor quality even though the content was interesting and factual. A back room housed over 100 mineral art pictures, painstakingly made from crushed Broken Hill minerals. The main foyer held glass cases packed with poor quality specimens, all for sale, while another room housed a superb collection of dressed antique dolls. We were back at Mount Gipps by 5pm.

Tuesday 5th October

Today we had arranged for Kym to show us around the Mount Gipps property. Starting out at 9:30 we drove up to the shearing shed where around 200 sheep of all colours and sizes had been penned up ready for sale the next day. Sheep are no longer grazed for wool here and are raised solely for the meat market. This particular variety automatically sheds its wool out in the paddocks, avoiding the need for shearing. As a result the shed lies unused.

At Smith's well we inspected the old stone tank which once watered 26000 sheep. The tank is concrete-lined but had a major leak in once corner. However it remains in use and is fed by an electric pump from the adjacent well.

Out on the Silver City Highway we were shown the wonky support pillar holding up the eastern side of the Salthole Creek road bridge, a sort of leaning tower of Salthole! But of much more interest was the nearby outcrop of varved shales in the creek bed on the eastern side of the bridge. These deposits are probably related to the Sturtian glaciation that leveled the region prior to the deposition of the Adelaidean system. The varves are well-defined and include pebble bands. Cleavage in these beds is at 90 degrees to bedding, showing the outcrop to lie on the apex of a major fold.

Although not on Mount Gipps Station, Kennedy's (Government) Tank, just off the highway, is used as a shared watering place for stock. A nearby pig trap made of wire mesh bent in a cuspate shape and baited with dead kangaroos had caught 4 feral pigs a few weeks ago. Not far away was a set of large earth tanks, once used to trap silt. These had been excavated in the early days using only a horse and scraper, one of which can be seen in the yard of the Cobar Museum.

The station tracks eventually led us to the south bank of Yankowinna Creek. Here we set out on foot along the wide sandy creek bed and through the suspended wire mesh fence that marked the Mount Gipps Station boundary into a rocky gorge cutting through hardened Adelaidean sediments. It had turned out dry and cloudless and the heat had begun to sap our energy as we turned back to the vehicles for lunch under a shady tree in the creek bed. Sturt has camped somewhere along this creek during his explorations.

Returning to the Silver City Highway we then drove up the Corona Road to a few spots Kym wanted us to see. The first lay beside a track leading up the sandy bed of an ephemeral tributary of Salthole Creek immediately south of the ridge of Lady Don Quartzite Barry and I had climbed a few days ago. The area was dotted with mine shafts, one of special interest with the remains of a car engine used as a winder still precariously supported over the shaft timbers. Up the gully towards the ridge we came upon a group of scattered stone huts, one still with its slab and earth roof supported by saplings.

Returning to the Corona road and heading north we turned west again along a track following the fence line at the grid immediately south of the Mount Gipps gate. This headed towards a small rocky gorge invisible from the road. Within a kilometre we entered a wonderland of fabulous rock outcrops, with tall serrated ridges of schistose rocks climbing up the southern bank of the creek. Here also at last we found

Ron Evans

Historic watering tank at Smiths Well

Ron Evans

Ruin of a miners dwelling with roof still intact

the clearly defined unconformity between the Adelaide and Willyama Supergroups, as well as the Broken Hill Group type section.

Just upstream of the gorge huge slabs of schist had broken away from the outcrop to land in a confused pile beside the creek, forming a number of quite large shelters which would have been useful to the Aboriginal inhabitants, if not the local wildlife. A few hundred metres further up the creek as the country opened out again, we came to extensive dry stone ruins nestled into the side of the ridge and a stone-walled flume in the creek, purpose unknown. Nearby a shallow pit dug into a gossanous outcrop had obviously been quickly abandoned when no valuable minerals were found at depth. Maybe the miners here had hoped for another Broken Hill!

Back at the entrance to the gorge we explored the area up the slopes in more detail, finding an old dry stone powder magazine adjacent to the largest of the schist ridges and a few metres to the east in another parallel ridge a large vertical plate of schist with a big hole eroded right through it. Here also Kym pointed out a number of unexplained structures in the rocks high on the outcrop but we had run out of time, with things to do back in town before we left for home tomorrow. Clearly, a return trip to Broken Hill now seemed inevitable! As we drove into Broken Hill late in the afternoon dark clouds were building up in the west. It looked and felt like rain!

Officially this was the last day of the trip. Dean, Geoff and Ann had left a few days ago, while David and Jan would head west to Lake Eyre tomorrow. Only myself, Jim, Helena, Terry and Laurel would move on to White Cliffs to spend a day on the opal fields before heading home. But that's another story.

Ron Evans

Mt. Gipps Station - Barry, Terry, Ros, Ron, Ellen and Elaine next to a weathered schist outcrop

Wednesday 6th October

The morning dawned heavily overcast with only occasional thin slivers of blue sky. It was uncomfortably hot and humid, a sure sign of rain. With Mount Gipps Station located 9 kilometres off the Silver city Highway on a dry weather only dirt road, we had constantly kept an eye on the weather with more than a casual interest. Had it rained we would have gone nowhere!

The people going to White Cliffs had left early via the dirt backtrack, but I had to return to the City to visit the local DPI office. As I drove along William Street the heavy black clouds could hold their moisture no longer and rain began bucketing down, turning the streets of the CBD into rivers of muddy water within minutes. The gods had indeed been kind to us, providing a perfect window in the weather for our entire trip.

Safari Acknowledgements.

The planning and organisation that went into this trip really paid off. It is rare for a tour with such a full and complex program to proceed as this one did, without a hitch thanks to the co-operation of everyone on the trip. Landowners proved quite amenable in allowing access to their properties and in some cases were also extremely helpful in locating areas of interest. In this regard special thanks are due to Kym and John Cramp of Mount Gipps Station. Although not appreciated by some, basing the trip at Mount Gipps provided the least amount of organizational headaches and had also given the group the chance to experience life in the bush on a working sheep station, where not everything is perfect. Thanks are also due to Bill Reid at the DPI Office in Maitland, for providing essential locality information at very short notice. Discussions with Rob Barnes, also at the DPI, were also helpful.

Report by Brian England.

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