'Geo-Log'

2011

Journal of the Amateur Geological Society of the Hunter Valley

'Geo-Log' 2011

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

Contents:

President's Introduction.

Hello members and friends,

Another successful year packed with interest and adventure has passed by so rapidly that for some our feet have scarcely touched the ground. Our web site has continued to attract considerable interest and has resulted in a number of new members joining the group. After more than 30 years our Society still manages to run new activities, although in recent years we have found ourselves journeying far beyond the confines of the Hunter Valley to extend our experiences.

Trips into the field continue to provide a mix of experiences due to the varied expertise among our membership, many of who have now retired from full-time employment. Our Society is perhaps unique in that a background in geology is not a prerequisite to joining and every member contributes regardless of their level of knowledge.

The success of the 2011 program is due in no small degree to several people outside the Society membership who so willingly gave assistance. During the Torrington trip these included of Torrington, Ron Gillet of the Emmaville Mining Museum, and of Emmaville. Bill led a tour of his unique mineral processing plant and Ron gave so freely of his time at the Museum explaining the exhibits. Terry's wit, humour and experiences as a tin miner made our day at The Gulf tin mines so much more enjoyable. Thanks are also due to Mick Sherf and members of the Emmaville Court House Trust. We were very fortunate on the Ulladulla weekend to have the leadership of the very knowledgeable and enthusiastic Phil Smart, instigator of the now well-known Gondwana Coast Fossil Walk around Ulladulla Harbour. Thanks are also due to the staff at the Singleton Mines Rescue Centre for a unique 3D underground experience and to Chris Herbert for leading the Geology of the Sydney Basin (West Gosford) excursion.

Very special thanks go to the Social Committee for their largely unrecognised and rarely acknowledged 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. To our tireless secretary Ian Rogers who ensures our newsletters are delivered on time and to Leonie Mills who keeps the Society's finances in order, a grateful thanks from all of us.

Finally, thanks to the leaders who gave up their time in organising and conducting our activities and who contributed to this journal, and especially to our Life Member Ron Evans for his dedication in putting together yet another great edition of the Society Journal that we can all be proud of.

Very best regards,

Brian.

Catherine Hill Bay Walk
Saturday 22nd January 2011

Leader: Chris Morton.

Attendance: 15 members, 6 visitors.

The group met at the disused coal washery at the end of Montefiore Road Catherine Hill Bay on a warm beautiful summer's afternoon, 27° with a light N-NW breeze.

After an introduction and a general overview of the local history, the formation of the New England Fold Belt and its huge influence on the geology of the Northern Sydney Basin (which was laid down during the late Carboniferous through the Permian to early Triassic) was explained and illustrated with diagrams.

The group then strolled down towards the beach which lies beneath the jetty. Recently, the jetty has become a controversial icon (should it be dismantled or kept as a heritage item?). Pausing at the headland to feast our eyes upon the spectacular coastline to the north, we proceeded down onto the beach. On the cliff face we were able to view and discuss the Great Northern Coal Seam, the underlying Bolton Point Conglomerate and the Teralba Conglomerate which lies above the coal seam. *(Photo 1)*

From there we walked a short distance to a wave cut platform where there are a number of Dolerite Dykes *(Photo 2)* intruded about 90 mya when Australia separated from Antarctica and the spreading of the Tasman Sea. A short walk around the headland found us admiring Desoto Inlet *(Photo 3)* which is most likely the result of erosion along a joint plane. The name Desoto Inlet (legend has it), came from an old Desoto being pushed over the ledge into the water many years ago.

2. Dolerite dyke intruding Bolton Point Conglomerate.

A short climb up onto the headland gave us a chance to admire the coastline stretching off to the south. We worked our way down onto another wave cut platform where there were a number of features to be found and discuss. One interesting feature was a good example of intra-formational slumping, most probably being the result of a riverbank slumping into soft river sediment millions of years ago. There were also some nice examples of cross bedding within the pebbly conglomerate. *(Photo 4)*

Heading further south along Moonie Beach just before Flat Island, we examined a large fossilised tree which has two trunks giving the impression it is the fork of a tree. A lonely Mangrove not far from our fossil tree was observed and we wondered if it will

1. Chris explaining geological features in the cliff.

3. Beautiful Desoto Inlet eroded into the conglomerate cliff.

survive the next big sea. Crossing the sand dune onto Ghosties Beach we found some more fossilised trees.

Looking at the cliff which towers over Ghosties Beach, an excellent view of the stratigraphy can be gained. Munmorah Conglomerate can be seen at the top of the cliff with white sandstone below which is overlying the Vales Point Coal Seam. Underlying the coal seam is the Karignan Conglomerate Member which is lying above the Wallarah Coal Seam that is obscured by lush greenery and sand. *(Photo 5)* At this point the Wallarah Seam is separated by 1 metre of strata from the Northern Coal Seam (Bamberry 1993).

Further down the beach we came to a sea cave eroded through joint planes. *(Photo 6)* We found it very refreshing here as it is 5-7 degrees cooler within the sea cave. There are many concretions in the sandstone cliff along with examples of cross bedding and cut and fill gravely stream beds. A number of fossilised branches that have been rolled down these ancient streams can be found dotted around the cave entrance along with the Wallarah Coal Seam which is at the base of the Karignan Conglomerate Member.

This point was the end of our excursion. So we all took the long walk back to our cars parked at Catherine Hill Bay.

My thanks go to Brian, Ron and Barry whose expertise, knowledge and support were most helpful.

Report by Chris Morton.

Photographs by Ron Evans.

References.

CHRIS HERBERT; ROBIN HELBY. Guide to the Sydney Basin. *Geological Survey of New South Wales, Bulletin 26. Dept Mineral Resources 1980.*

BRANAGAN; PACKHAM. Field Geology of New south Wales. *2000 Mineral Resources NSW.*

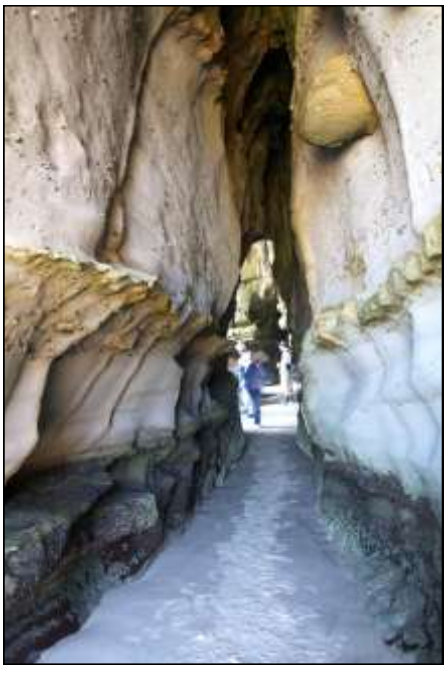
SCHEIBNER, ERWIN; BASDEN, HELENA (editor) 1998. Geology of New South Wales—Synthesis. *Vol 1. Structural Framework. Vol 2. Geological Evolution.*

JOHNSTON, R.W. Intra Plate Volcanism in Eastern Australia and New Zealand. *Cambridge Press.*

JOHNSON, DAVID. The Geology of Australia. *Cambridge Press.*

5. Stratigraphy at Ghosties Beach. From top, Munmorah Conglomerate, white sandstone, Vales Point Coal seam and Karignan Conglomerate member. The Wallarah coal seam is obscured by the green plants.

4. Cross-bedded strata within a conglomerate outcrop.



6. Eroded joint Ghosties Beach.

Singleton Mines Rescue Station
Thursday 17th March 2011

Leader: David Atkinson.

Attendance: 15 members, 3 visitors.

Most of the group met for lunch at the Singleton RSV Club before proceeding to the Mines Rescue Station.

Our visit to the Singleton Mines Rescue Station at 8 Lachlan Ave Singleton Heights *(Photo 1)* gave members an introduction to the mining environment and the safety issues faced by miners.

We were able to see mine and mining simulators used to train miners and safety personnel in the identification and management of underground and open cut mining operations.

The large 3D simulator was breathtaking and represents world leading technology developed jointly with the University of NSW Engineering faculty and the NSW Mines Rescue organisation. We progressed through a long wall mining scenario and found the representation to be realistic and informative. *(Photos 2, 3 and 4)*

The embodied geo-engineering represented in the simulators is part of the reason Australia leads the world in mine safety.

One of our members checked her competence driving a 200 tonne haul truck in the open cut simulator and "killed" us all (steering and braking were options!!) free falling into the pit was not such a good option

1. Mines Rescue Station, Singleton.

2. 3D simulator room with computer controls in centre of the room.

3. Our guide explaining how the 3D simulator works.

4. 3D simulation of an open-cut mine.

Our thanks go to David Connell, Regional Manager Mines Rescue Singleton, and his staff for a very informative and entertaining overview of the role of the mines rescue organisation and the critical role played by the simulators in reducing accidents and recognising danger both underground and in open cut mines.

Report by David Atkinson.

Photographs by Ron Evans.

Muster Point

Saturday 19th March 2011

Leader: Ron Evans.

Attendance: 24 members, 6 visitors.

At 10:00 am on a sunny morning, attendees met our guide Aubrey Brooks near the abandoned BHP Offices. He led on a dirt road through a small patch of bush to the Muster Point, an imposing steel sculpture nestled amongst trees where he outlined its history.

This house-size 70 tonne industrial artwork was constructed as a collaboration by famous Newcastle sculptor Julie Squires and steelworkers in 1999, to mark the closure of the steelworks. Commenced in July 1998, Julie Squires' work was not completed until September 1999. The completed sculpture measures 8 m x 12 m x 8 m high.

The exterior has a stylised representation of the BHP skyline encased with in the design element of a BHP maintenance shop. Inside the structure are items representing people and processes that took place at BHP. Thus, the whole structure, inside and out, has many stories to tell about the history of steelmaking in Newcastle.

Our guide, Aubrey Brooks worked at BHP for 38 years. Both his Grandfather (37 years) and father (42 years) also worked at BHP. This meant that the stories Aubrey told were of a personal nature which imparted drama and realism. Aubrey's respect (and love) for his fellow workers at BHP was a powerful part of the stories he told.

Thanks and gratitude go to Aubrey from all present for giving us such a memorable tour.

Report and photos by Ron Evans.

Aubrey Brooks outlining the history of the Muster Point

Entrance to the Muster Point, Mayfield

Rear entry looking through the Muster Point to the front. Workers silhouettes above the rear entry below are of actual BHP workers

AGSHV participants

Sandbar Weekend

Friday 1st to Sunday 3rd April 2011

Leader: Ron Evans.

Attendance: 13 members.

People attending the weekend activities arrived at Pacific Palms Caravan Park (located next to Elizabeth Beach some 21 km south of Forster) where we stayed. After settling in, we met for a chat and 'happy hour.' Terry, our leader for the weekend outlined proposed activities and suggested we car-pooled for Saturdays activities.

Saturday 1st

Saturday morning was fine and sunny, perfect for our coastal activities. Our first venues were to Treachery and Yagon Heads, south of Seal Rocks reached by means of a rough dirt road.

We parked at Camp Treachery and followed a clearly marked track to the headland. The walk took us past cabin accommodation at Camp Treachery, through a small stand of Littoral rainforest dominated by several large fig trees *(Photo 1)* and into the short coastal heath *(Photo 2)* that covered most of the headland.

Treachery Head is a rocky headland composed of westerly dipping Carboniferous siltstone, mudstone and sandstone. *(Photo 3)* Laminated bedding occurred in many layers, an indication of still conditions during deposition of sediments, the start of the rock forming process. The rocks are well jointed enabling the sea to erode gutters into the rocks leaving finger-like rock projections to jut into the ocean at the end of the headland. Some sandstone strata had weathered into tessellated pavement, the cores of some tessellations showing honeycomb weathering. *(photo 4)*

1. Track to Treachery Head passing a large fig tree.

2. Coastal Heath covering most of Treachery Head.

3. Westerly dipping layers of shale, siltstone and sandstone exposed above a large erosion gutter. Note the laminated bedding in many layers.

4. Tessellated pavement in sandstone.

Returning to the vehicles, we drove south to Yagon Head and parked in the day picnic area. A large goanna was wandering about and it provided an

5. Jim Grey photographing a large goanna while a curious Brush Turkey looks on.

interesting subject for the photographers. *(Photo 5)*

At Yagon head, the beds of rock are more steeply dipping (some 65° to 70°). We examined the south facing wall of the headland before climbing up to the top along an overgrown track. Wonderful views greeted us from the top, including a view down into a small beach that had formed in an eroded gutter. *(Photo 6)* The beach was hidden from view from the main beach.

After lunch, we parked just north of Yagon Head and walked south down to the beach to the northern side of the headland to look for fossils. The edges of south-westerly dipping beds were exposed *(Photo 7)* and we soon found fossil bearing strata. The fossils found consisted of internal and external moulds of Brachiopods, mainly Spirifers and Productids. One outcrop of shale contained well preserved internal moulds of a large Productid, probably a species of *Marginirugus barringtonensis. (Photo 8)*

On the drive back to camp, we detoured into Smiths Lake for a visit to the Frothy Coffee Boatshed where (you guessed it!) we indulged in a mug of frothy coffee and cake *(Photo 9).* After returning to camp, we showered and went to the nearby Pacific Palms Recreation Club for a drink and dinner. Very nice!

7. Fossiliferous bearing strata (steeply dipping) on the northern side of Yagon Head

8. Internal moulds of possibly the Productid Brachiopod *Marginirugus barringtonensis.*

6. Small hidden beach southern side of Yagon Head. Note the steeply dipping strata.

9. Frothy coffee and cake on the verandah of the Frothy Coffee Boatshed, Smiths Lake.

Sunday 2nd

Sunday morning took us north to Cape Hawk where we climbed a well defined path to a lookout tower on the summit. *(Photo 10)* From here, extensive views of the hinterland and Forster/Tuncurry were obtained. Of particular interest was the topography of the lakes system.

10. Cape Hawke Lookout tower.

Four interconnected lakes occupy an ancient river basin bordered on the coast by high sand dunes and in the west much older flatter dunes. These dune systems are described as the outer barrier and inner barrier and were created at separate times. The inner barrier, parallel to the coast, was laid down about 60,000 years ago, before the last glacial period. The outer, higher barrier was formed after the sea stabilised at its present level about 6000 years ago. Some of the highest forest-covered dunes are only 2000 years old. It is a maze of dunes, some of which have moved well inland and covered parts of the inner barrier. Less than 100 years ago, slight changes in stability occurred and a new system of actively migrating sand dunes or 'blow outs' resulted. *(Photo 11)*

The dominant underlying geological structure is a fold in the earth's surface known as the Myall Syncline within which the main rock types were formed in the Carboniferous period, over 275 million years ago. The main rock types are sedimentary (sandstones, siltstones and mudstones) with some volcanic rocks such as rhyolite and basalt under the surface. During times of lower sea level, the bedrock eroded and this created a complex of rocky hills and ridges. When the sea level rose during the Holocene (about 10,000 years ago), some of these rock outcrops became isolated from the mainland, creating a series of offshore islands.

From Cape Hawke we drove south to Sandbar for a quick visit to Danger Point, another rocky headland reached by walking along the top of a concreted sewage outlet pipe. *(Photo 12)* A large dyke *(Photo 13)* juts into the sea on Danger Point headland. Just north of the headland beside a narrow beach, steeply dipping (easterly) strata is exposed. *(Photo 14)*

11. View south from Cape Hawke. Note the long outer barrier dune system with Myall Lake behind it. Rocky headlands and hills surround the lake system to the south.

Of particular interest was several fossils of large worm burrows. *(Photo 15)*

More time could have been spent at Danger Point. However, we had to return to the caravan park, collect the rest of our belongings and leave.

A big thanks goes to trip leader Terry of organizing and guiding a very interesting and informative weekend.

Report by Ron Evans.

Photographs by Ron Evans.

<u>References</u>.

HERBERT,C; HELBY, H (1977). A Guide to the Sydney Basin. *Geological Survey of NSW, Bulletin 26, Department of Mineral Resources 1980.*

OFFICE OF ENVIRONMENT AND HERITAGE, NSW National Parks and Wildlife Service. *Myall Lakes National Park 2011.*

12. Making our way to Danger Point headland.

13. Large dyke, Danger Point.

14. Easterly dipping strata, Danger Point.

15. Large worm burrow fossils in fine sandstone.

Geology of the Sydney Basin (West Gosford)

Saturday 7th May 2011

Leader: Chris Herbert.

Attendance: 12 members, 6 visitors.

Chris Herbert's very generous offer to run an excursion for AGSHV explaining the geology of the Sydney Basin and the Terrigal Formation was gratefully accepted and enjoyed by all who attended.

Chris Herbert's expertise in this field of geology is world renown. Chris is the co-author of "A Guide to the Sydney Basin" and has written countless papers on this subject, and is often referred to by geologists and students alike.

Meeting at the car park above Spoon Bay near Foresters Beach on a beautiful sunny autumn day, with formalities and greetings complete, Chris gave a short introduction on what to expect during the course of the day. We then made our way down to the rock platform at the northern end of Spoon Bay, stopping to examine some rutile that was showing through the sand, the result of transportation from the inland ranges by rivers and then being deposited on our beaches in a process called winnowing. *(Photo 1)* On the platform Chris explained the environmental conditions *(Photo 2)* and the influence of the formation of The New England Fold Belt during the Permian and the Triassic that led to the deposition of the sediments that make up the Sydney Basin and the spectacular coastline. *(Figure 4.2)*

Evidence of activity by burrowing organisms that left fossilised burrows was found on the platform.

2. Chris Herbert describing past depositional environment.

(Photo 3) Chris explained how these animals line the burrows with mucus so as to hold the burrow together, eventually filling with debris after the animal had departed leaving the fossilised burrows. Also pointed out were the red beds that can be found along many parts of the coast. Red Beds that lie above the Permian/Triassic boundary were formed after the great extinction that ended the Permian. A lack of vegetable matter in the sediments that was transported by the rivers coming from the New England Fold Belt allowed the minerals in the sediment to oxidise thus giving them the rusty brown colour that we see in many places along the coast and inland which has become a reliable marker. *(Figure 4.3)*

From Spoon Bay we made our way to Terrigal Haven. The rock platform at the southern end of the Haven lies under a shear cliff face that has many layers of sediment. *(Photos 4 and 5)* Chris explained how these layers had formed, the many transgressions and regressions, pointing to barrier dunes, estuaries and mud flats that make up the stratigraphy. *(Figure 4:7)* A few diagrams were drawn on the rock surfaces to demonstrate the process and how all this occurred, leaving the energy and destructive force of the wind and ocean to cut the cliff faces vertical. Lunch was

1. Recycled Rutile weathered out of the sandstone.

3. Invertebrate trails and worm burrow depressions.

4. Scour and fill in shale near the Skillion with a facies change to sandstone on top.

6. Ferruginous worm burrows, Putty Beach headland.

enjoyed at the base of the Skillion along with stimulating conversation on all things geological.

After lunch Putty Beach was our next destination. From the car park we meandered to the southern end of the beach where we scrambled over some large boulders to find fossilised worm burrows *(Photo 6)* along with fossilised root casts that have been preserved in the layers of sediment. Where the Hawkesbury Sandstone overlies the Narrabeen sediments, an old river channel was pointed formed by a classic scour and fill process. *(Photo 7)* Continuing on around the point we found many more fossilised worm burrows, which somehow led to a discussion regarding the prescience of oil and coal that lie beneath the Sydney Basin. This area gave the photographers in the group a chance to capture images of the spectacular weathered features in the sandstone. *(Fig 4:10)*

Time was getting the better of us; some enjoyed an ice cream purchased at the kiosk on the way back to the vehicles where afternoon tea was enjoyed along with a spirited conversation on climate change.

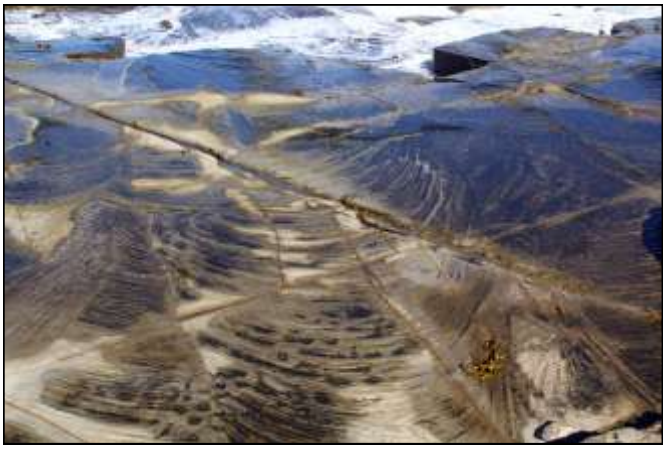
Brian England, on behalf of us all, gave Chris Herbert a huge thankyou for giving up his time and knowledge and presented him with a Geo-Log 2010 as a token of our appreciation.

Report by Chris Morton.

Photographs by Ron Evans.

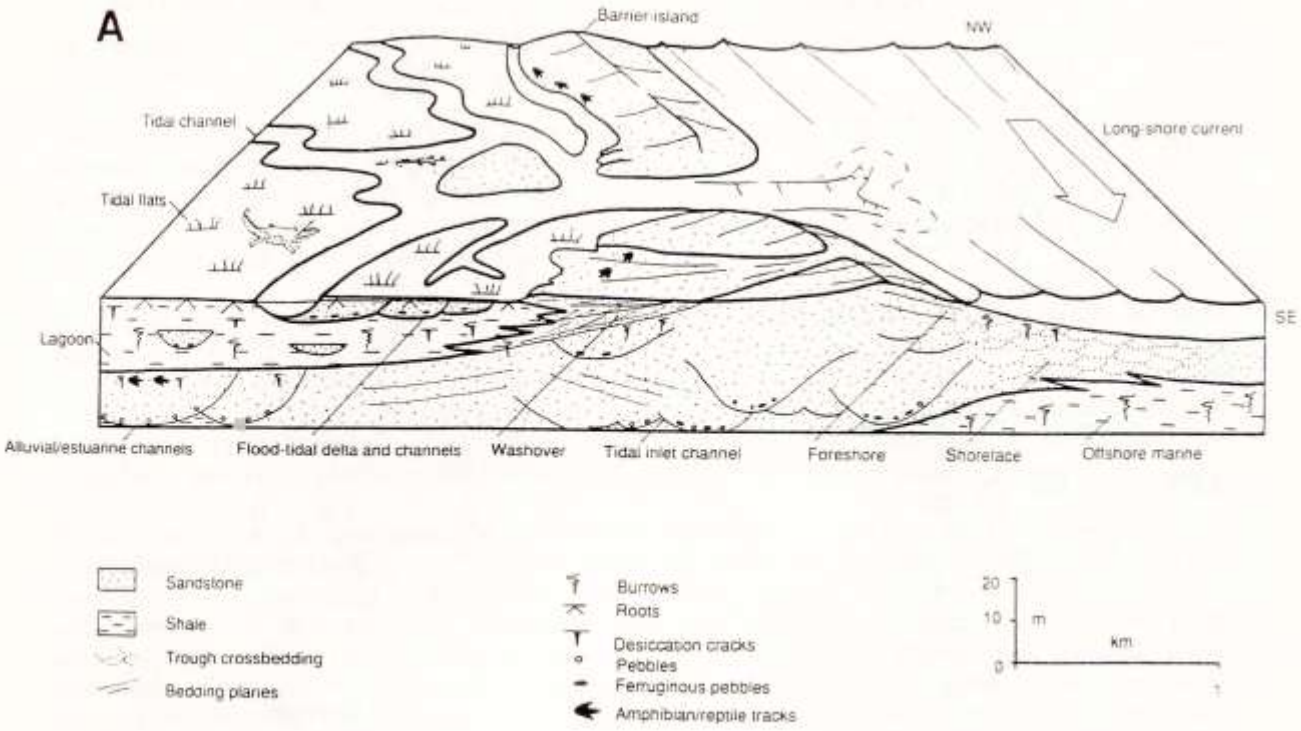
References:

Line drawings copied from "Coastal Exposures of the Northern Sydney Basin" 1993 By Chris Herbert..



5. Trough cross bedding within the Terrigal Formation.

7. Leisegang Rings in sandstone, Putty Beach headland.



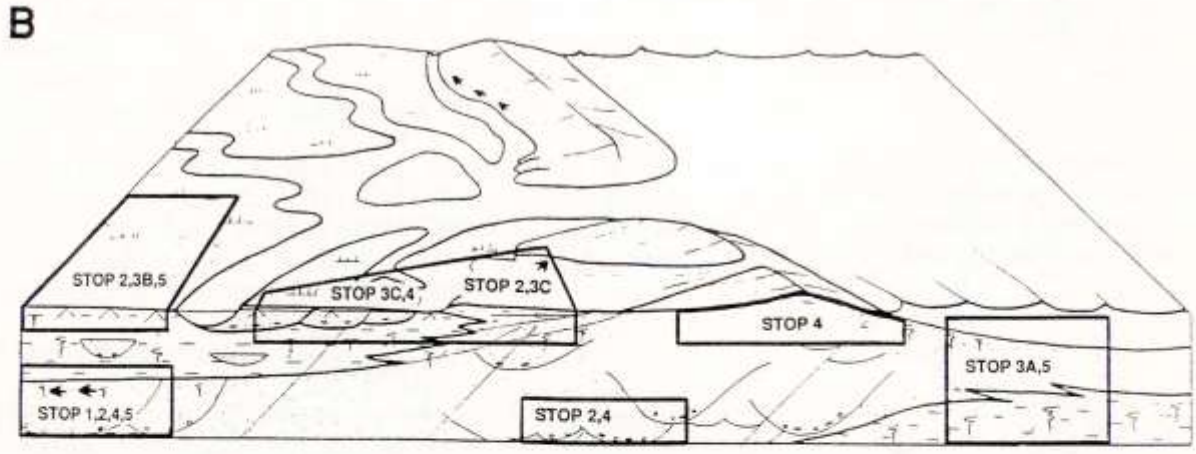


Figure 4.2

A A fluvial/estuarine, paralic back-barrier to barrier-island palaeoenvironmental model is proposed for the Narrabeen Group. The marine shoreline, trending northwest-southeast, was located on the hinge of the more rapidly subsiding part of the Sydney Basin north of Broken Bay. Episodic expansion and contraction of coastal alluvial/estuarine plains and back-barrier lakes, lagoons and marine bays were controlled by changes in relative sea-level. Diagram adapted from Horne and Ferm (1979).

B Sedimentary environments to be seen at each stop are shown in their postulated palaeoenvironmental position in the model proposed in A above.

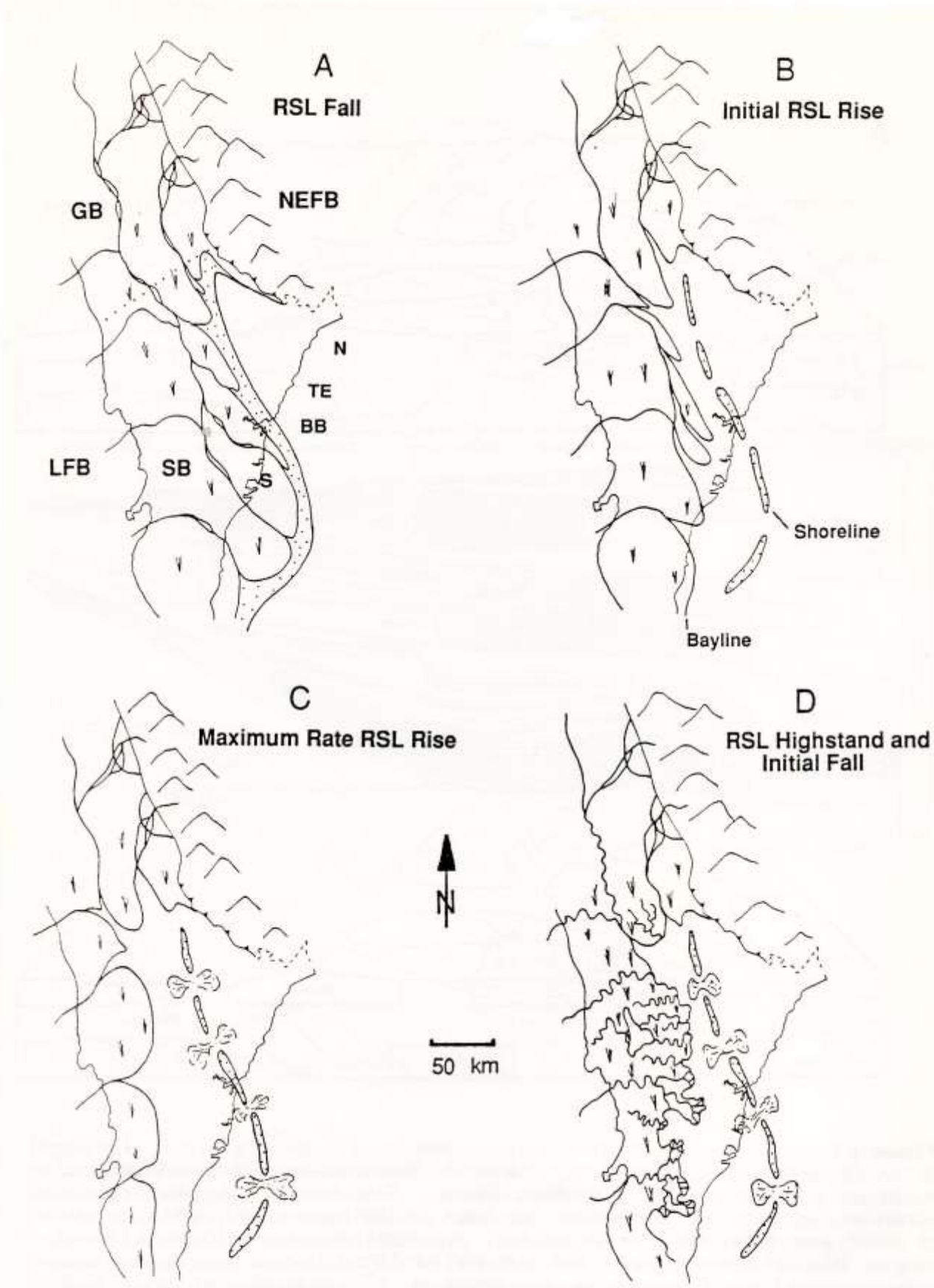


Figure 4.3 Palaeogeographic reconstruction for the Patonga Claystone and the Terrigal Formation during relative sea-level fall **(A)**, initial relative sea-level rise **(B)**, maximum rate of relative sea-level rise **(C)**, and relative sea-level highstand **(D)**. SB - Sydney Basin, GB - Gunnedah Basin, NEFB - New England Fold Belt, LFB - Lachlan Fold Belt, N - Newcastle, TE - Terrigal to The Entrance, BB - Broken Bay, S - Sydney.

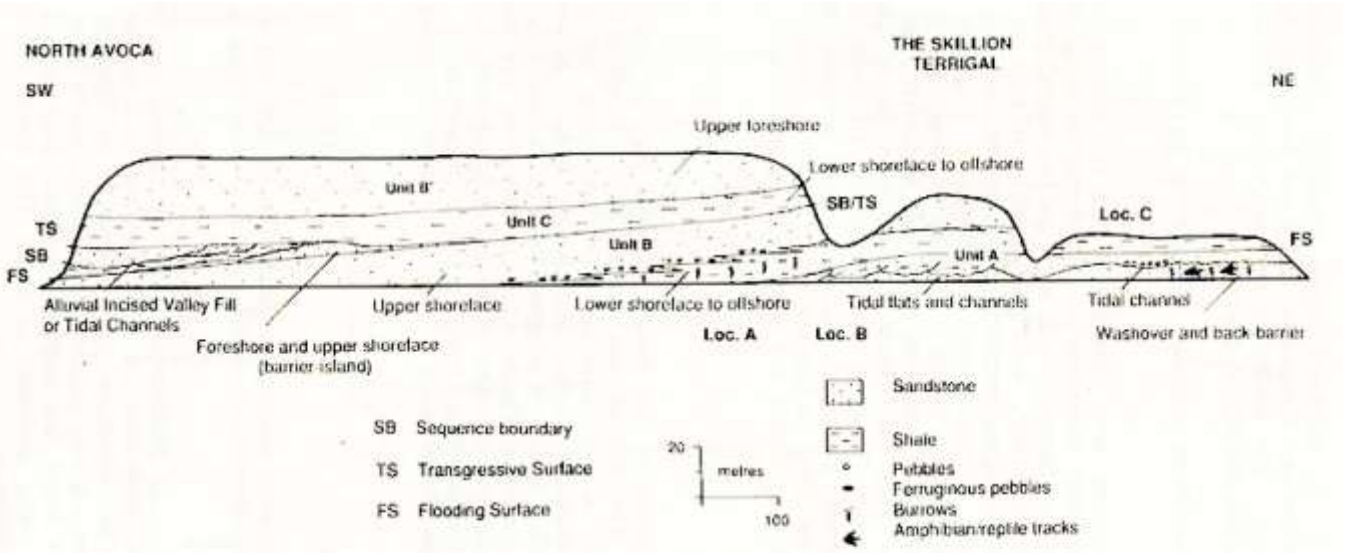


Figure 4.7 Sketch of coastal outcrops from Terrigal to North Avoca.

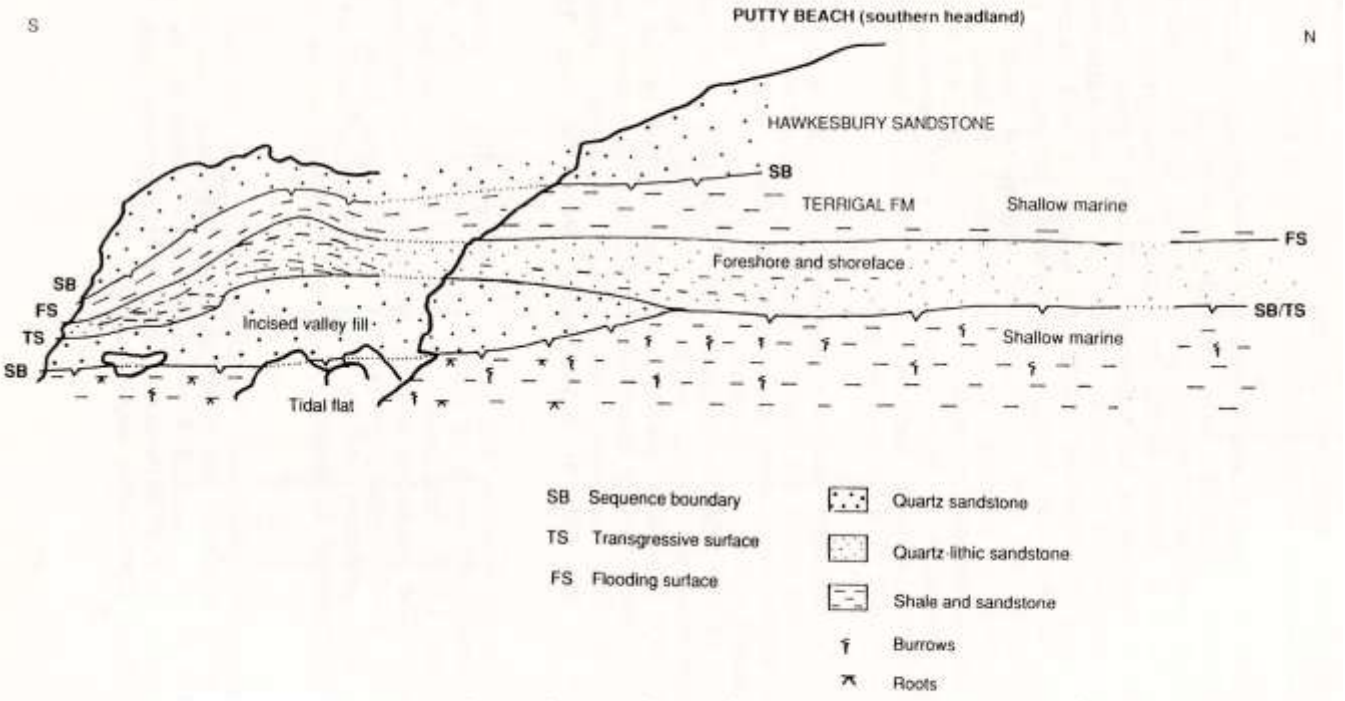


Fig 4:10 Sketch of the southern headland at Putty Beach.

Werri Basin and Beyond

Friday 27th to Sunday 29th May 2011

Leader: Winston Pratt.

Attendance: 18 members, 1 visitors.

The Lower Permian Werrie Basin overlies Upper Carboniferous rocks of the Tamworth Trough component of the New England Orogen. During the Upper Permian the western part of the Tamworth Trough was thrust westwards forming the Mooki Thrust Sheet and bounded on the west by the Mooki Thrust Fault System. *(Figure 1)*

In the area of the Werrie Basin there were two phases of compression, one approximately east – west and the other approximately at right angles, north – south and these resulted in the development of 'dome and basin' or 'egg carton' topography. *(Figure 2)* Although faulting inhibits perfect development, the relatively small size of the Werrie Basin provides an excellent example in which the various dome and basin components can be readily identified from within the basin and viewed overall from a high point on one of the dome structures (the 'Who'd-a-thought it' Lookout). Subsequent erosion has stripped the softer Permian beds of the Werrie Basin from the crests of the domes and exposed the more resistant underlying Carboniferous rocks while the Permian beds (Temi Formation) remain the cover in the basin structures. *(Figure 3)*

To the east beyond the Werrie Basin, the Carboniferous rocks have been thrust against the basin's eastern edge while on the west the sediments have been thrust and folded into an elongate dome or anticline with a steeply dipping leading edge against

1. Doughboy Hollow.

2. Columnar jointed basalt beside railway line.

which the near horizontal beds of the Permian and Triassic Gunnedah Basin have been deposited.

Friday 17th.

The group of 12 members met at Murrurundi and headed out along the New England Highway over the Great Dividing Range at Nowlands Gap. On the descent from Nowlands Gap the flat area of Doughboy Hollow where Inspector Denny Day captured the 'Jewboy' gang of bushrangers and behind Doughboy Hollow *(Photo 1)* the Ardglen Railway Quarry in the Liverpool Range basalts was clearly visible. A little further along a stop was made to view basaltic columnar structures which were curved as the basalt flowed over an embankment in the basement rock. *(Photo 2)*

At Kankool the route crossed the Mooki Thrust Fault onto Carboniferous rocks of the Tamworth Trough followed Chillcots Creek road along which, in 1900, the bushrangers Jimmy and Joey Governor travelled during the manhunt for these fugiatives. The site of Baker's hut *(Photo 3)*, robbed by the Governor brothers and recently demolished, was seen on the way to Henry Hall's (Ben Hall's brother) house which was also robbed by the brothers the next day. They then went up the side road towards Loders Dome (a volcanic plug) and Mr. Hamilton's (Henry Hall's son-in-law) house *(Photo 4)* which they also robbed and stole a 7-shot 32 cal. Winchester rifle which Jimmy still had with him when captured.

The route then continued along Woodton Road back to the New England Highway and on to Wallabadah Homestead and Creek where the next day the Governor brothers were involved in a gunfight with some local people including Henry Hall's son. On the way back to Wallabadah village an outcrop of Caboni-

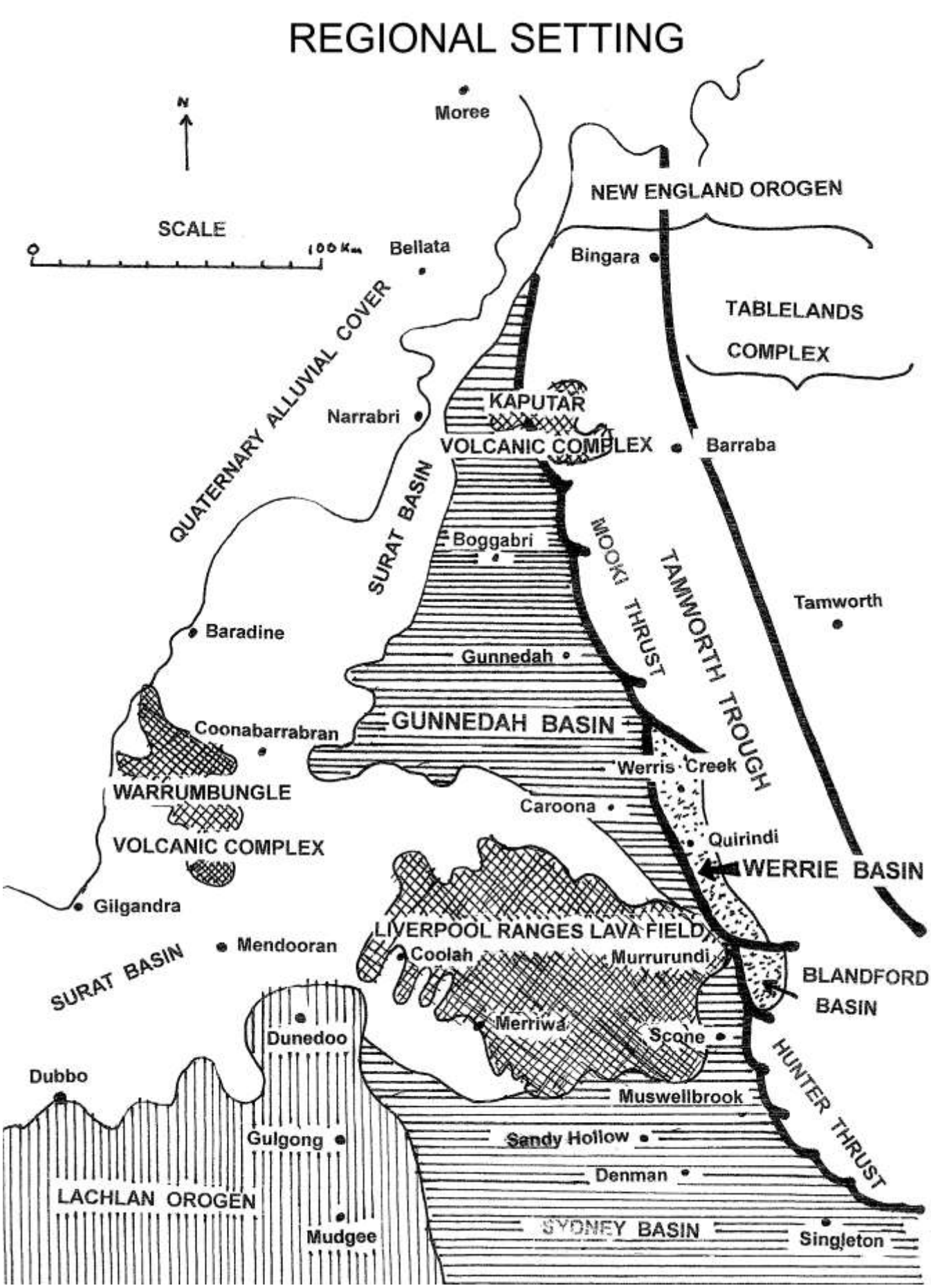
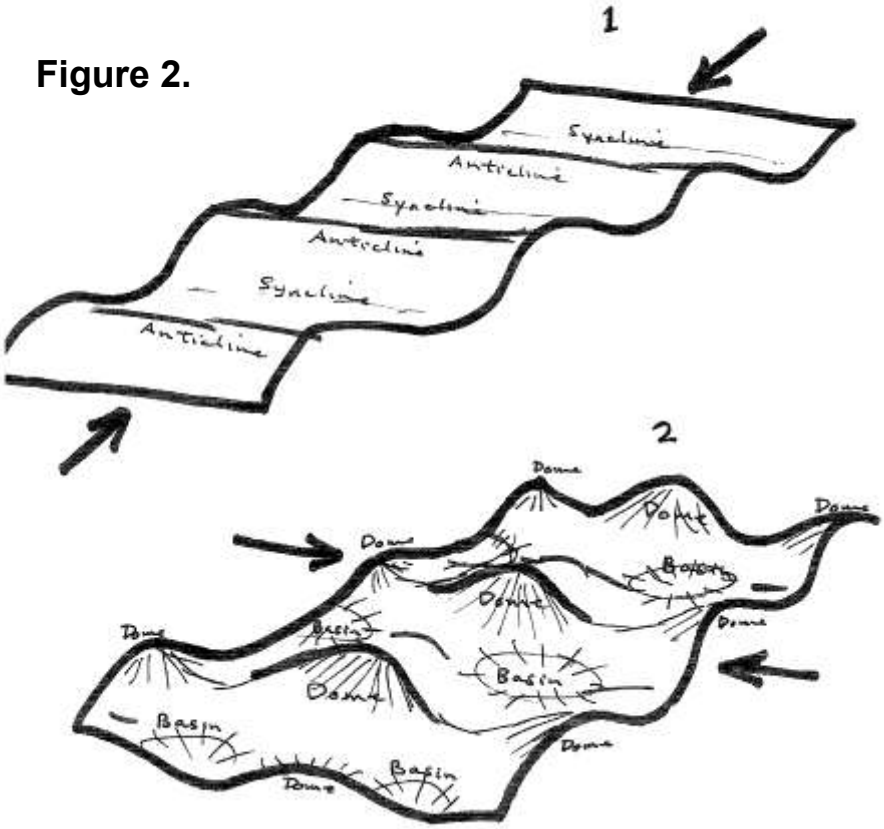

REGIONAL SETTING
N
SCALE
100 Km
Moree
Bellata
Bingara
NEW ENGLAND OROGEN
TABLELANDS
COMPLEX
QUATERNARY ALLUVIAL COVER
Narrabri
KAPUTAR
VOLCANIC COMPLEX
Barraba
SURAT BASIN
Boggabri
MOOKI THRUST
TAMWORTH TROUGH
Tamworth
Baradine
Gunnedah
GUNNEDAH BASIN
Coonabarrabran
Werris Creek
WARRUMBUNGLE
VOLCANIC COMPLEX
Caroona
Quirindi
WERRIE BASIN
Gilgandra
LIVERPOOL RANGES LAVA FIELD
SURAT BASIN
Mendooran
Coolah
Murrurundi
BLANDFORD
BASIN
Merriwa
Scone
Dunedoo
HUNTER THRUST
Dubbo
Muswellbrook
Sandy Hollow
Gulgong
Denman
LACHLAN OROGEN
SYDNEY BASIN
Mudgee
Singleton

Figure 1.

DOME and BASIN ('Egg Carton') STRUCTURE

Figure 2.



iferous andesite which forms a prominent ridge was examined.

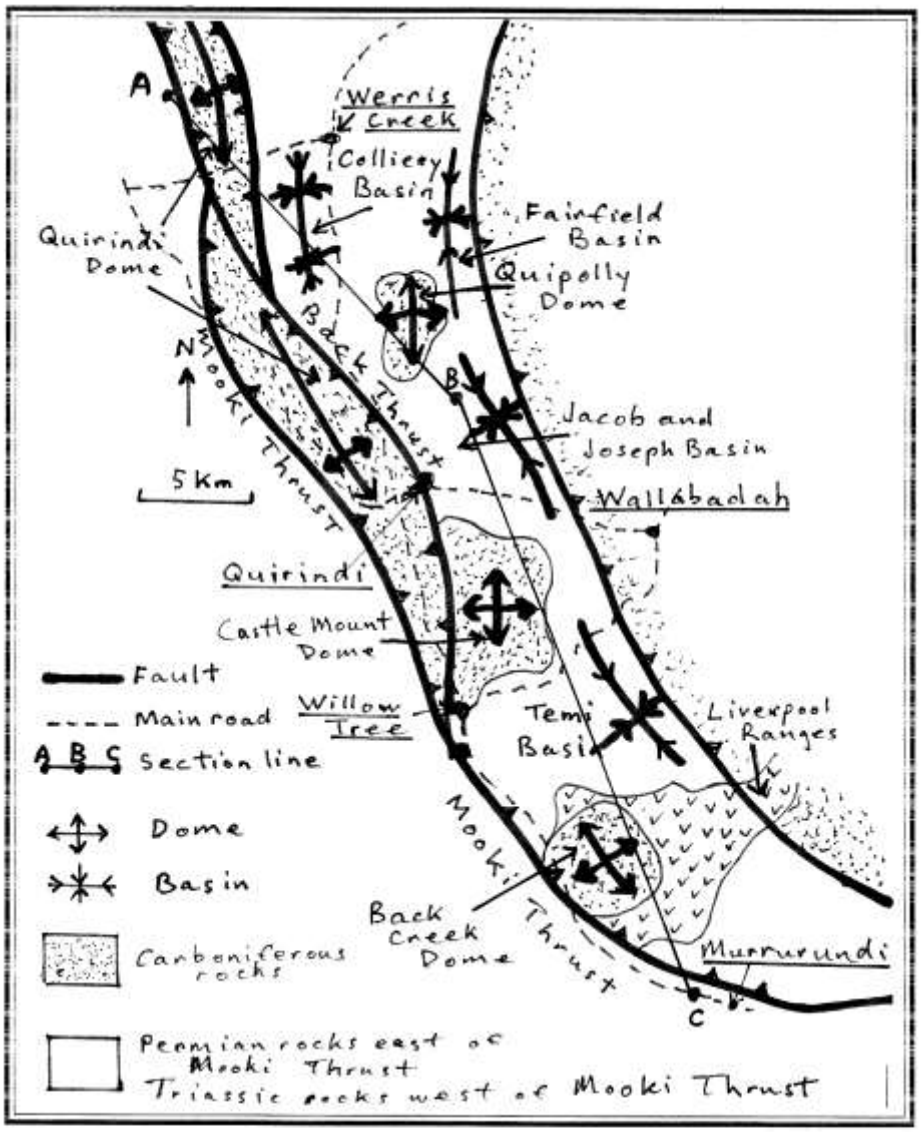
The bushranger 'Thunderbolt' camped for almost a year on Mr Parnell's property at Wallabadah for about five months in 1867. Although his presence appears to have been fairly well known by many of the locals it was not reported to police.

Back at Wallabadah village, afternoon tea was taken at the First Fleet Memorial Gardens *(Photo 5)* before visiting the site of one of Australia's largest remaining undisturbed stands of White Box trees. *(Photo 6)*

A final stop was made on the New England Highway near Willow Tree where roadside cutting in fluviatile sediments of the Early Permian Temi Formation of the Werrie Basin *(Photo 7)* were intruded by a basic dyke containing very large xenoliths of presumed Carboniferous sediments. *(Photo 8)*

3. Baker's Hut before it was demolished.

4. Henry Hall's son-in-law's (Mr. Hamilton) house .



SECTION

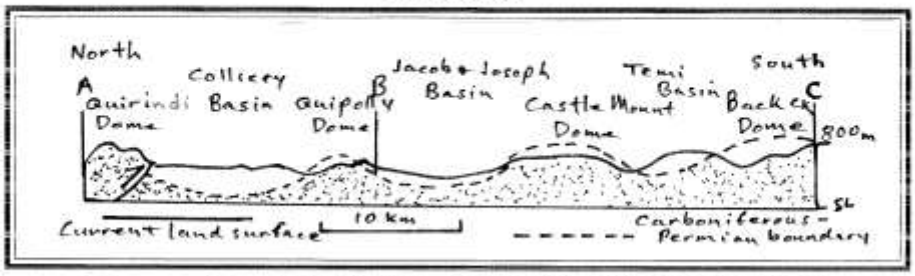


Figure 3. WERRIE BASIN STRUCTURE

Modified from "Gunnedah Coalfield" by W.Pratt, Dep't. Mineral Resources, GS 1998/505

Saturday 28th.

The first stop was at Kankool where Carboniferous sediments sheared and deformed by movement on the Mooki Thrust Fault *(Photo 9)* were examined before observing an outcrop of steeply dipping conglomerate of the Late Permian Borambil Creek Formation of the Werrie Basin *(Photo 10)* near Willow Tree. The Lower Permian coal seams of the Willow Tree Formation are in places covered by recent alluvium. Opposite the Willow Tree school a well was sunk in the alluvium and reached a seemingly thick coal seam but in reality the well had penetrated a near-vertical seam. This was the first discovery of coal at Willow Tree in 1937 and there is still a well, or now at least an electric pump visible at the site.

5. Lunch; First Fleet Memorial Gardens, Wallabadah.

7. Temi Formation.

At the 'Who'd-a-thought-it' Lookout at Quirindi, an excellent view to the west of the Liverpool Ranges and the Liverpool Plains was available, particularly as the weather was perfect. On the east, looking from south to north, the dome and basin topography of the Werrie Basin could be clearly seen. *(Photo 11)* It is rare to be able to see such a well developed example of this topography clearly visible over an area from a readily accessible 'ground' level point location, in this case atop one of the domes.

Continuing through Quirindi town and past Benjamin Cook's Inn (now the Heritage Hotel), held up by the bushranger 'Thunderbolt' on 8 December 1865, the route passed through the Jacob and Joseph Basin and the Fairfield Basin which lies between the Quipolly Dome on the west and the eastern thrust boundary of the Werrie Basin on the east. Skirting the northern side of the Quipolly Dome, a stop was made to examine the Upper Carboniferous sediments of the Currabubula Formation immediately downstream of the Quipolly Dam. These sediments of fluvioglacial origin are brightly coloured, mainly due to the presence of zeolites, and have a variety of sedimentary structures including graded bedding and intraformational slumping. (*Photo 12)* The sediments have also been faulted and intruded by basic igneous rocks, often along fault planes. *(Photo 13)*

The route then headed towards Werris Creek through the Colliery Basin where the Werris Creek coal seams of the Willow Tree Formation occur in the synclinal base of the Colliery Basin on the top of a prominent ridge. *(Photo 14)* The Werris Creek seams (Greta Coal Measures equivalents) were mined from 1925 to supply coal for refuelling locomotives at the Werris Creek Railway complex and for the Tamworth Power Station. With the demise of the steam locomotive and the Tamworth Power Station, together with the increasing difficulties associated with mining steeply dipping and fractured beds in the synclinal axis together with the associated water intake problems, underground mining ceased in 1963. Some years later a small open cut operation was undertaken in the north west of the site but later abandoned. With the increase in coal prices and the availability of machinery capable of mounting a larger scale operation, especially when in conjunction with other similar sites not suitable for a stand-alone operation, a larger scale open cut operation has been developing the southern part of the resource.

6. White Box trees, Wallabadah.

8. Basic dyke (left) intruding the Temi Formation.

9. Folded and sheared sediments due to the Mooki Thrust.

10. Conglomerates of the Borambil Creek Formation.

Near Werris Creek, and near the base of the Permian sequence, the Werrie Basalt interfingers with, and is replaced laterally, by siliceous lavas extruded from a vent area. These siliceous lavas of the Warrigundi Igneous Complex form resistant ridges on either side of the Colliery Basin (a syncline) and, on the east, form the ridge on the east of the town where the Swimming Centre is located. The lower and more gently undulating terrain further eastward is formed from the softer sediments of the underlying Temi Formation, covered in part by Recent alluvium.

These viscous siliceous lavas do not spread far from the vent area whereas the more mobile basaltic lavas flow much further away to form basaltic ring plains. A chain of these Lower Permian siliceous vents with surrounding basaltic ring plains extends from Boggabri through Gunnedah, Piallaway, Werris Creek, Wingen and into the Hunter Valley.

Lunch was taken at Werris Creek and, unfortunately, a planned visit to the Werris Creek Railway Museum had to be cancelled as the museum was closed for some unknown reason as prior enquiries indicated that it would be open on the day.

Leaving Werris Creek and heading westwards, the route crossed the leading edge of the Mooki Thrust Sheet where steeply dipping Carboniferous lavas and conglomerates, the latter with some large grooves of unresolved origin were intruded by a basaltic dyke. These rocks were well exposed in a railway cutting although recent stabilisation by shotcreting has now masked part of the exposure. *(Photo 15)* The route now crossed the rich alluvial soils of the Liverpool Plains where a previously undulating terrain has been buried by the alluvium so that now only the crests of the ridges rise above the plains. In the vicinity of the route these ridge tops are mostly sandstones and conglomerates of the Permian Black Jack Group or the Triassic Digby Formation. In the Doona State Forest near Caroona, aboriginal sharpening grooves were located on an outcrop of the Digby Formation. *(Photo 16)* Here the basal conglomerate of the formation is only several metres thick and grades upwards into sandstone. At Caroona the lithology of the basal conglomerate was examined in an abandoned quarry. The frequent red jasper pebbles, sourced from the New England Highlands and typical of the Triassic conglomerates of the Digby Formation in the Gunnedah Basin and The Narrabeen Group in the Sydney Basin were clearly visible.

11. Basin and dome structures of the Werri Basin east of Quirindi.

12. Fluvioglacial sediments exposed downstream from Quipolly Dam.

13. Three dykes intruding fault planes, Quipolly Dam.

15. The Gap railway cutting.

The route now headed south heading up dip on the regional stratigraphy, passing from the Digby Formation through the siltstones of the overlying Triassic Napperby Formation and the basalts of the Jurassic Garrawilla Volcanics. These latter formations are readily weathered and rarely crop out but form a gentle slope well suited to cropping and pasture. Overlying the Garrawilla Volcanics is the Jurassic Pilliga Sandstone, a fluviatile quartzose sandstone which crops out to form the resistant capping of the Mooki Hills between Caroona and Pine Ridge. At the final stop for the day at Pine Ridge weathered Garrawilla basalt overlain by Pilliga Sandstone was well exposed in a small quarry. *(Photo 17)* A weathered soil horizon could be seen at the top of the basalt immediately beneath the Pilliga Sandstone. Agate nodules, formed by the deposition of silica rich solutions percolating into vugs in the basalt, were being released by the weathering of the basalt and several nice specimens were found.

Sunday 29th.

Oil Shale (Torbanite) was first reported in the Temi area by the Rev. W B Clarke in 1861 and material exhibited at the 1862 London International Exhibition. The Temi deposit was mined intermittently from the 1870's to the 1910's. The shale was brought by flying fox into Murrurundi where it was processed in an unusual vertical cylindrical brick retort *(Photo 18)* which was visited on the first stop of the day. The route then visited the still standing shop of Mrs Eliza Hall (Ben Hall's) mother. In the shop front is a display of artefacts and photos of the Hall family. Mrs Hall and several of her children moved back to Murrurundi from their stay in the Forbes district and were highly respected members of the Murrurundi community. Mrs Hall's grave in the Catholic Church graveyard *(Photo 19)* was then visited.

The route then followed the Mooki Thrust Fault which, east of Murrurundi, is heading west to east and now has a transcurrent configuration, offsetting the Werrie Basin on the north by several kilometres to its southern extension, the Sandy Creek Syncline. The Mooki Thrust here comprises several sub-parallel faults as it dies out and one of these faults was examined in a large cutting on the Timor Road. Being close to Timor the opportunity to examine an impressive set of extensional faults in Carboniferous rocks of the Tamworth Trough in a quarry north of Timor was taken and certainly warranted the visit. *(Photo 20)*

14. Werris Creek coal mine in the Colliery basin.

16. Aboriginal sharpening groves in sandstone.

17. Pilliga sandstone overlying Garawilla Volcanics.

18. Vertical brick retort, Murrurundi.

Returning back towards Murrurundi, the route took a short diversion to a point in the Sandy Creek Syncline where the close-out structure of the southern extension of the Werrie Basin could be clearly seen. On reaching the New England Highway steeply dipping Permian conglomeratic beds were exposed in a road cutting. These beds were disturbed by faulting associated with the northern end of the north trending Hunter Thrust Fault as it meets the Mooki Thrust at right angles while a kilometre or so to the east the beds regain very shallow dips.

The next stop was at the monument marking the place where a young drover, Peter Clarke, and his party were held up by the bushranger Wilson. *(Photo 21)* During the armed hold-up Peter grappled with Wilson who fired off two shots both hitting Peter and mortally wounding him. However, in spite of his wounds, Peter managed to hold onto Wilson long enough for another of the party to overpower Wilson and tie him up. Peter however succumbed to his wounds and died a few minutes later. Wilson was taken to Murrurundi Police station and after a trial was convicted and hung. A public collection was held for Clarke and a magnificent monument erected at his gravesite in Muswellbrook Cemetery. As there were still monies left over, the remainder was used to erect the monument on the Warlands Range at the place where Peter met his untimely death.

19. Elizabeth Hall's grave.

The next stop was made at 'Bickham' Station to view a small basaltic plug in which columnar structures have broken away and partly buried the plug in its own debris. *(Photo 22)* In the road cutting immediately north of the 'Burning Mountain' car park at Wingen, both selenite, (clear transparent gypsum, hydrated calcium sulphate) and magnesite (magnesium carbonate) nodules were seen *(Photo 23)* to be forming in the weathered outcrop of the Permian Branxton Formation. While this was the final formal stop for the day, an optional stop at Scone was suggested for those interested. At the intersection of the New England Highway and the Gundy Road is a small park in which there is a memorial to John Graham *(Photo 24)*, a young employee of Dangar's Store, who was fatally shot by John Shea, a member of the notorious 'Jewboy

20. Series of faults due to the Mooki Thrust within Carboniferous rocks beside the Timor road.

Gang' which was captured by Inspector Denny Day at Doughboy Hollow, Ardglen. The 'Jewboy Gang' had held up Chiver's St. Aubins Inn, the long low white building on the western side of the Highway opposite the park. *(Photo 25)* As some of the gang were approaching Dangar's store on the corner on the southern side of Gundy Road opposite the park, John Graham saw them approaching and ran to get help but Shea saw him and galloped after him. Shea fired at Graham and fatally wounded him. After capture at Doughboy Hollow, Shea was tried and convicted of wilful murder while Marshall, Everett, Davis ('Teddy the Jewboy'), Chitty and Glandville were tried and convicted of aiding and abetting the murder. On Tuesday morning, March 16, 1841, these six men were hanged in the last mass execution at the Old Sydney Gaol, near Harrington Street, Sydney. The execution was held in the Gaol yard and was witnessed by a large crowd, over a thousand people were in the area and many of those unable to gain admittance to the yard gathered on high nearby vantage points from where a view into the Gaol yard could be gained.

Report by Winston Pratt.

Photographs 1, 3, 7, 14, 15, 17, 24, 25 by Winston Pratt.
Remainder of photographs by Ron Evans.

23. Magnesite nodule.

21. Peter Clarke's Monument.

24. Memorial to John Graham.

22. Columnar jointed basaltic plug , Bickham Station.

25. St. Aubins Inn.

Bow Wow Gorge Walk
Saturday 7th May 2011

Leader: Chris Morton.

Attendance: 19 members, 6 visitors.

On a beautiful sunny but fresh winter's morning and a light frost covering the ground, members and guests met at property on Road, Mount Vincent. After greetings we all meandered down to Colin's house to sign Colin's visitor's book. *(Photo 1)*

Colin explained the significance of his property and that he has entered into an agreement with N.P.W.S. and various conservation groups to use his property as a conservation area and a wildlife corridor.

A short presentation on the geology of the area was given by Chris Morton based on the following notes written by Brian England:

`````````````````````````````````````````

*"Bow Wow Gorge is composed of Muree Sandstone, a formation named by the Rev. W.B. Clarke in 1878 after the Muree quarries at Raymond Terrace. This sanstone contains a rich marine fauna and the sands, which formed it, were derived from a northerly source area (mainly the New England Fold Belt), probably as a result of a brief marine regression that interrupted the long transgression that deposited the Mid-Permian Maitland Group of which it forms part. Some early workers (McKellar, Rattigan and McKenzie) regard the Muree Sandstone as a member of the Branxton Formation, which it overlies. The type section lies in the Bow Wow Gorge where it is 82 metres thick and forms the cliff lines. It is usually much thinner, but where it lies adjacent to the Hunter Thrust its thickness increases markedly, indicating sediment deposition continued while the thrust was active. This sandstone bed is easily recognizable in bold outcrop and subsurface over much of the northern part of the Sydney Basin and is continuous with the Nowra Sandstone in the southern Sydney Basin. Overlying the Muree Sandstone is the Mulbring Siltstone, which is typically devoid of fossils (but contains glendonites). Very occasionally, in places where the Mulbring Siltstone has been removed by erosion during a hiatus in sediment deposition, the Muree Sandstone is uncomformably overlain by the Triassic Narrabeen Group.*

*Unlike many other localities in both the Branxton and Muree Formations, where the original shell of the fossils has been leached away by groundwater leaving loose internal casts, the fauna exposed in the sandstone along the bed of Bow Wow Creek and in The Galleries have retained their original calcium carbonate shells. While excellent fossils are found in the creek bed, the best are to be found at the galleries where the fossils stand proud of the cliff face due to their greater resistance to weathering than the enclosing sandstone. Here, and in the creek bed, two distinct horizons are evident. The upper horizon contains the thick-shelled brachiopods Ingelarella, Sulciplica, Echinalosa and various spirifids in a coarse sandstone which represents a relatively high energy sub-littoral or sandy shelf environment, while beneath this lies a zone of finer sand containing abundant thin-shelled productid brachiopods such as Terrakea which was laid down in quieter waters, probably a coastal mudflat. In both beds the fossils remain articulate, suggesting live burial during episodes of rapid sediment deposition.*

*An added feature at The Galleries is pronounced undercutting (by several metres) along the base of the cliff accompanied by the formation of groups of calcite stalactites and columns in the resultant caves. This undercutting occurs on several levels and may be a remnant erosional feature from higher stream levels in the past or more probably the result of fretting and wind erosion of poorly cemented layers. The calcite forming these speleothems was leached from the sandstone (and the contained fossils) by groundwater to be re-deposited wherever this water reached the sandstone surface along cracks or other imperfections in the rock matrix.*

*Both the Muree and Branxton Formations are exposed on the land surface due to the formation and subsequent erosion of a dome-like structure called the Lochinvar Anticline, which was one of several similar fold structures in the Hunter Dome Belt actively forming on the southern side of the Hunter Thrust fault during the Middle to Late Permian. This folding and faulting occurred as Early Permian subduction to the northeast ceased due to the collision of a microcontinent-like mass with the New England Fold Belt."*

*…… Brian M. England.*

Principal Reference:

HERBERT, C. AND HELBY, R. (Editors). 1980. A guide to the Sydney Basin. *Geological Survey of New South Wales, Bulletin 26. Department of Mineral Resources.*

`````````````````````````````````````````

The Walk

A request from
that no trophies or fossil samples are to be taken from their property as it is considered to be a living museum and that they would like the area to remain as close as possible to natural as can be.

Leaving the residence we descended into Wallace Creek where many marine fossils are imbedded in the sandstone rock platform that forms the creek bed. Crossing the creek we entered Bow Wow Creek Gorge and its beautiful Gallery Rainforest. *(Photo 2)* We made our way up the creek gorge alternating from rainforest to rocky creek bed; it was very slow going especially given the size of the group and the terrain. However this gave those in the group a chance to pursue their passion in photography.

There were many places of interest from logging history, old disused saw pits, snig trails and of course geology. There were many eroded creek banks to study, which gave us the opportunity to find fossils *(Photos 3 and 4)* and drop stones that had dropped from melting icebergs that were floating by. It was explained that when the sediment was laid some 250Ma, Australia was a part of Gondwana Land that was positioned down near the South Pole and the nights would have been 3 months long and very cold, a very different environment compared to now. *(Photo 5)*

Eventually we came to a water hole with a waterfall plunging into it. Many photos were taken. Then after a steep climb up the side of the waterfall, we came to another waterfall. This site was of great interest to us, in that, although it too was also plunging into a waterhole not to dissimilar to the previous site. The difference being in this waterfall the water had been splashing onto the rocks below and there had been a build up of travertine creating a Limestone or Travertine Flow. *(Photo 6)* Directly adjacent to this feature was a impressive fault line in the wall of the waterfall; our guide and owner of the property was very curious about this feature and questioned Brian England at length, trying to understand the processes at work after much debate and another short steep climb up the side of the waterfall we came to a sandstone creek bed with many Pot-holes (Gnamma or Kettle-holes) and fossils shells, a lovely place to have lunch *(Photo 7)* although it was not that cold the sun filtering through the trees was well sought after.

2. Colin (R) describing features of the Gallery Rainforest.

After lunch we moved out of Bow Wow Creek and over the hill which brought a complete change of the environment from rainforest to dry sclerophyll forest. Some tiny orchids *(Photo 8)* were found which gave Barry Collier an opportunity to take pictures and explain to those interested about them. Moving to the top of the hill we turned to a south westerly direction bringing us to a precipice overlooking Bow Wow Creek Gorge *(Photo 9)*, a very impressive sight. From here we made our way along the escarpment stopping all the while to take in the scenery and listen to Colin's oratory.

1. Participants being welcomed by Colin .

3. Internal mould (fossil) of a large bivalve.

4. Fossil shell of a large scallop.

Very soon we came upon the entry to the Gallery. *(Photo 10)* This proved a bit challenging to some who had lost some of their agility, but many hands overcame any difficulty. Although there are many wonderful features on this walk, The Gallery has to be the best; it is outstanding. It consists of a solid sandstone wall about 80metres high and over a 120 metres long containing some of the best marine fossils if not the world certainly in Australia; *(Photo 11)* it is literally packed with them. Brian was ecstatic to find some rare Crinoids; some time was spent in discussion. Time was running out and we had to move along as we had taken much longer than anticipated to complete the walk.

Colin after taking two of our number down to their car, (as they had to leave) returned to lead us off the mountain. Back at Colin's house most of the group stayed and enjoyed afternoon tea and discussion on the day's events. This also gave us the opportunity to give Colin a big thankyou for opening up his property and for his generosity in giving up his day to lead us around his extraordinary property. All agreed that a wonderful day was had by all.

Report by Chris Morton.

Photographs by Ron Evans.

5. Colin pointing out features in Bow Wow Creek.

6. Waterfall with a travertine deposit at its base.

7. Lunch above the waterfall.

8. Pixie Orchid.

9. View south over Bow Wow Gorge to the Wattagans.

10. "The Gallery" - examining exposed fossils.

11. Exposed fossil of a 'Spirifer' Brachiopod.

Geology of the Gunnedah Basin and Mount Kaputar

Friday 16th to Sunday 18th September 2011

Leader: Winston Pratt.

Attendance: 19 members, 4 visitors.

Friday 16th.

On Friday 17th September, 19 members and guests met at Gunnedah and proceeded to the Porcupine Lookout which overlooks Gunnedah town and beyond to the Tertiary Nandewar Volcanic Complex (which includes Mt. Kaputar) to the north and the Liverpool Plains to Breeza and beyond in the south. To the east the Mooki Thrust Fault system is marked by ridges, including the Gunnan and Tulcumba Ridges and the Quirindi Dome, which form the western boundary of the Tamworth Trough component of the New England Orogen. To the south the Watermark Anticline, a structure in the Permian strata was visible as were outcrops of the basal units of the Permian sequence in the Gunnedah Basin, the felsic Boggabri Volcanics. The Boggabri Volcanics cluster around volcanic centres while the coeval Werrie Basalts form ring plains further away from the volcanic centres. On the north-western horizon the low Willialla Hills composed of Jurassic Pilliga Sandstone, mark the western edge of outcrop of the Gunnedah Basin and the commencement of the overlying Surat Basin. The extensive unconsolidated alluvial sediments of the Liverpool Plains dominated the view to the south, east and north.

With this regional overview setting the scene, the excursion planned to visit outcrops of all of the main stratigraphic and volcanic units.

The first stop was a readily accessible exposure of the felsic Boggabri Volcanics in the town precincts and then on to Mr Ian Maire's 'Toomevara' property where not only he greeted us but one of Gunnedah's famous koalas was also waiting at the gate. *(Photo 1)*

On the property an abandoned quarry in Digby Formation, the basal unit of the Triassic strata, exposed the Bomera Conglomerate Member overlain by the Ulinda Sandstone Member. In this excellent exposure of the conglomerate, the red jasper pebbles so typical of the New England derived Triassic conglom-

1. Koala at 'Toomevara' entrance gate

erates of the Gunnedah, Sydney and Lorne Basins, were abundant and quartz pebbles more typical of the Lachlan Fold Belt derived sediments were uncommon. *(Photo 2)* The pebble size gave an indication of the energy of the stream which transported this sediment load and it was explained that sedimentation commenced in the northern part of the Sydney – Gunnedah Basin much later than when sedimentation commenced in the Sydney basin.

Next stop was an exposure in a road cutting of the laminated siltstones of the Triassic Napperby Formation which overlies the Digby Formation. The silty nature of this unit makes outcrops rare although the unit is readily recognisable in drill core. To the south the unit becomes even finer while to the north it becomes more coarse as was evident in the Mt Kaputar area. Another roadside exposure of the Ulinda Sandstone with ripple marks was visited before crossing the gently undulating subcrops of the Napperby For-

2. Boomera Conglomerate member of Triassic Digby Formation at 'Toomevara'

3. Columnar blocks of Trachyte at Goolhi Mountain.

mation and the basaltic Garrawilla Volcanics and onto the alluvial floodplain of Coxs Creek.

After lunch stop at Mullalley, the route headed south through a cutting in the basalts of the Garrawilla Volcanics to a safer stop below where a dolerite outcrop was examined. Further south at the southern side of Mt Mullaley, the stone commemorating the journey of John Oxley, the discoverer of the Liverpool Plains was visited. Mt Mullaley is an excellent example of a lava dome.

Lava domes form from viscous felsic lava which, being relatively low temperature when compared with basaltic lavas, cool rapidly to form a solid skin. This skin then fractures as the lava continues to be extruded and the fragments fall down the slopes of the dome. This process continues while the lava continues to be extruded, often almost burying the dome in its own debris which is removed by erosion. There are many lava domes and plugs in the Bulga Complex from south-west to north-west of Mullaley and these domes were extruded towards the later part of the Garrawilla Volcanic event.

A few kilometres north-west of Mullaley is Mt Goolhi, a felsic plug where a remnant flow on the flanks of the cone has well developed columnar structure with columns almost a metre in diameter. *(Photo 3)* Many of the domes and plugs of the Bulga Complex could be seen from this location. *(Photo 4)* This location also lay on the route taken by the fugatives, Jimmy and Joey Governor, as they headed towards Narrabri in 1900.

Heading east along the Oxley Highway from Mullaley to Gunnedah, the next stop was at an outlier of the Pilliga Sandstone underlain by the Purlewaugh Formation. The latter formation weathers rapidly and the exposure in the road cutting was barely discerna-

4. Lava domes and plugs of the Bulga Complex, Mullaley.

ble. After crossing the 150 degree east Meridian, on which Eastern Standard Time is set *(Photo 5)*, a stop near the 'Waharoonga' property indicated that the Jurassic Garrawilla basalts were extruded over an undulating surface with knolls of Triassic Napperby Formation standing above the surrounding lava flows. On the southern side of the highway the break of slope on Haystack Mountain indicated the boundary between a sill of teschenite (analcime dolerite) of the Jurassic Glenrowan Intrusives overlying Garrawilla basalts. *(Photo 6)* The sill was originally intruded between the Garrawilla flows but the overlying lavas have been eroded leaving the dolerite at the top of the mountain. Further eastwards another outcrop of the Glenrowan Intrusives, the Ivanhoe sill was examined. This sill is one of many in the 'Gunnedah Complex' between Haystack Mountain and Gunnedah.

Travelling eastwards back to Gunnedah and down dip through the stratigraphic sequence, the route passed over the outcrop sparse Triassic Napperby Formation, outcrops of the Ulinda Sandstone and the Bomera Conglomerate Members of the Digby Formation before passing over the Permian Black Jack Group and passed a now abandoned and overgrown quarry exposing the Melvilles Coal Seam. Next the route crossed the marine Millie Group passing a very weathered and rare exposure of the Watermark Formation before an outcrop of the Porcupine Formation on the approaches to Gunnedah. Coming into Gunnedah the terrestrial Bellata Group, comprising the Maules Creek Formation and the Leard Formation, was crossed, with the Gunnedah Brickworks thought to originally exploit the clays of the Leard Formation. Then onto outcrop of the basal basin units, the Boggabri Volcanics where the route started and finally a brief visit south east of the town to an outcrop of the other basal unit, the Werrie Basalt.

Saturday 17th.

On Saturday the group relocated to Narrabri, heading north along the Kamilaroi Highway. At the Emerald Hills intersection a stop was made to view the area where Sara Carrigan, an Olympic Gold Medallist in the Women's Cycling Road Race at the 2004 Athens Olympics, grew up and started her impressive cycling career. A little further along the Highway on the eastern side of the road was the 'Rampadells' property between the road and the Namoi River,

5. 150° East Meridian with Haystack Mountain behind.

6. Haystack Mountain.

while across the river to the Blue Vale Road was the 'Kurrumbede' property. These properties belonged to the Mackellar family and their daughter, Dorothea Mackellar was the author of the now famous poem 'My Country' written at age 19 whilst in London. Dorothea often stayed at these properties and also at the other property owned by the family, 'Toryburn' at Patterson. The poem incorporates images of both areas.

Also here is the Gulligal Lagoon adjacent to the now gone village of Gulligal where Pat Kelly and Jemmy the Whisperer, accomplices of the bushranger Fred Ward (alias 'Captain Thunderbolt'), held up Mr Panton's house and Mr Johnston's Store on 13 January 1866. They had separated from Thunderbolt after the gunfight with the police during their hold-up of the Carroll Inn, 20 km east of Gunnedah on the floodplain before the Oxley Highway crosses the Mooki Thrust Fault system.

Continuing to Boggabri where sandstones and conglomerates of the Maules Creek Formation are exposed in the cutting at the railway bridge, the group then went on to the Boggabri Cotton Gin. Although the cotton is harvested in May and in mid July there was a considerable number of cotton modules awaiting processing. Eight weeks later, at the time of our visit, all of the cotton had been processed. Nevertheless the extent of the enormous holding yard which is full after harvesting could be clearly seen.

7. Terry and Laurel beside the George 'Barber' Clarke Monument.

8. Tree with bark scar near Barbers Lagoon.

Returning to Boggabri the travelling a few kilometres along the Manilla Road the group visited the monument to George 'Barber' Clarke, a runaway convict ('bolter') who lived with and as the local Kamilaroi aborigines in the 1820's. *(Photo 7)* His stories of the Kindur, a great inland river, were partly responsible for surveyor and explorer, Thomas Mitchell's great voyages of discovery into the Lachlan, Murrumbidgee, Murray and Darling River systems in the 1930's. Clarke was eventually captured and transported to Norfolk Island and he was later hung in Tasmania for further offences in 1935. Near the monument were several trees with scars in the bark possibly indicating that the bark has been removed by aborigines for the construction of shields and coolamons. *(Photo 8)*

Near the Manilla Road and Kamilaroi Highway intersection, the group examined the outcrop of Boggabri Volcanics which at this location contain agates and chalcedony and also a perlite dyke from which samples were obtained.

Continuing along the Kamilaroi Highway, a stop was made at the massive outcrop of Boggabri Volcanics known as 'Gins Leap', the story of which can be read from the descriptive sign board. A little further northward a stop was made to examine a dyke of pitchstone with well developed horizontal columnar structure. *(Photo 9)* From this location it is one kilometre to the other side of the Namoi River floodplain and the entire catchment of the Namoi River and its tributaries, including the Peel and Mooki Rivers

9. Horizontal columns in a vertical Pitchstone dyke.

11. Pilliga Sandstone overlying weathered Garawilla Basalt.

and Coxs Creek must pass through this 1 Km wide gap. The Boggabri Thrust Fault also passes through this gap and it is thought that movement on this fault caused damming of the river and the subsequent siltation of the entrapped waters to form the vast alluvial Liverpool Plains.

At Baan Baa a brief stop was made at the Baan Baa Cricket Club grounds to admire the grandstand, an example of bush ingenuity at its best. *(Photo 10)* Passing through Turrawan it was noted that Thunderbolt's accomplices, Pat Kelly and Jemmy held up James Ward's Turrawan Hotel on 13 January 1866 before going to Gulligal the next day. Also the Governor Brothers were observed passing by the railway in 1900 on their way to Narrabri.

On Saturday afternoon the group went to Sawn Rocks on the Bingara Road. On the way a caliche deposit in a road cutting was observed. Caliche is formed by precipitation from evaporating groundwater of calcium carbonate, derived from the weathering of calcium rich feldspars in the Garrawilla basalts, in the subsoil. An exposure of the Pilliga Sandstone overlying the Garrawilla Volcanics was visited at a road cutting further along the road. *(Photo 11)*

Sawn Rocks is a spectacular outcrop of columnar structure in a trachyte flow in the Nandewar Volcanic Complex. A famous tourist site, the outcrop is best photographed in the late afternoon sun which brings out the orange colours. Our arrival in the late afternoon on a beautiful sunny day did not disappoint. *(Photo 12)*

Sunday 18th.

Beelera Mt. Lookout, about 3km from Narrabri, was the first stop. The Lookout is on the top of an elongate ridge of Tertiary latite, a dark fine grained extrusive rock in which quartz is absent and plagioclase feldspar equals or exceeds orthoclase. The plagioclase often is present in the form of well developed phenocrysts. The outcrop appears to be the remnants of a flow which came down a valley on the flanks of the Nandewar Complex, solidified and was left as a ridge after the softer surrounding country rock was eroded. A well developed vertical columnar structure was apparent in the outcrop. *(Photo 13)*

The next stop was in a creek bed at the end of and below the Beelera ridge. In the creek bed and

10. Mobile Grandstand, Baan Baa Cricket Club.

12. Sawn rocks, columnar jointing in trachyte.

13. Columnar jointing in a Latite flow, Beelera Lookout.

15. Triassic Napperby Formation channel sands cutting into siltstones on the Mount Kaputar road.

banks sandstones with conglomerate lenses were overlain by light coloured siltstones. The conglomerates contained abundant red jasper pebbles suggestive of the Triassic Digby Formation but appeared to be at a similar level to the nearby outcrop of the Jurassic Pilliga Sandstone and the underlying Garrawilla Volcanics. As with other similar configurations in the area, these sediments are thought to be reworked Triassic sediments deposited in the flanking valleys of the volcanic complex and subsequently buried by the lavas to form deep leads. Another example of this configuration was viewed from the roadside at the next stop. In the deep lead gravels, rich in reworked Digby Formation conglomerate pebbles, diamonds were found and mined at the beginning of last century.

At the base of Mt Kaputar, after a morning tea break, most of the group took a walk up Lawlers Creek where Permian sediments included a coal seam which has been intruded, in two phases, by a nephlinite sill containing, in the upper phase, high pressure magacrysts of kaersutite and ultramafic inclusions. *(Photo 14)* The base of the upper phase had a distinctive scalloped base and the lower phase was composed of weathered material containing abundant magnesite nodules. The dipping beds were abruptly truncated by a weathered zone which may possibly be the remnants of a diatreme as it appeared to have some inwards dipping strata.

On the lower part of the climb up Mt Kaputar, an excellent example of a stream channel, now filled with medium to coarse grained sandstone, cut into laminated siltstones and fine grained sandstones of the Triassic Napperby Formation was exposed in a large road cutting. *(Photo 15)*

Further up the climb good views of Mt Coryah were gained. Mt. Coryah is a massive dyke with chilled margins and columnar jointing normal to the dyke walls. *(Photo 16)* The dyke is part of a ring dyke complex bounding the Yullunduninda crater component of the complex.

At the summit on a clear day, the Warrumbungle Mountains 160 km away can be seen on the horizon as can Mt Mullaley, 100 km away. However, on the day of our visit, smoke haze had restricted the visibility to less than 50 km. The haze did produce some

14. Nephinelite sill with high pressure megacrysts intruding dipping Permian coal seam, Lawlers Creek.

16. Mount Coryah, a massive ring-dyke in the Nandewar Volcanic Complex as viewed from the Mount Kaputar road.

17. View west from the Governor walking track car park.

18. The five mobile dishes of the Australia radio telescope. The sixth fixed dish is situated 5km away.

better definition of the various hills and valleys comprising the volcanic complex. *(Photo 17)*

The day ended with the opportunity for members to follow their own particular interests be they photography, biology, bushwalking, sightseeing from the various lookouts, geology or simply relaxing in this beautiful area. Another option was to visit the

Australia Radio Telescope about 30 km west of Narrabri. *(Photo 18)*

Report by Winston Pratt.

Photographs 1, 3, 5, 6, 8, 10, 11, 12, 13, 14, 15, 17 by Ron Evans.
Photographs 2, 7, 9, 16, 18 by Winston Pratt.

Ulladulla Geology and Fossils

Friday 25th to Sunday 27th November 2011

Leader: Phil Smart, Brian England.

Attendance: 13 members.

We were extremely fortunate in being able to arrange for Phil Smart to show us around the geology of Ulladulla this weekend. Phil is a retired geologist ex BMR and former head of Resource Sciences at Canberra Institute of Technology.

Early in 2010 Phil pulled together the Gondwana Coast Fossil Walk, based on the fossil-rich Wandrawandian Siltstone exposed on the extensive rock platforms around Ulladulla Harbour. His enthusiasm and knowledge of the area is simply stunning. Ian and I had attended a talk Phil gave to the Geological Society of Australia in June 2010 and decided there and then the walk was something the Amateur Geological Society of the Hunter Valley just had to experience.

Friday 25th November

The trip to Ulladulla for most was rather wet, an unwelcome sign of what the weekend might hold in store weather-wise. Most members had arrived and set up camp at the Ulladulla Headland Tourist Park by 2:30pm. By then the rain had cleared temporarily, but the sky remained heavily overcast and somewhat threatening. Since the caravan park backed directly onto the beach and the tide was in our favour we took a walk south along the coastline towards Warden Head, a stretch of small sandy beaches and wide rock platforms backed by cliffs of thinly bedded shales and occasional sandstone beds all forming part of the Middle Permian Wandrawandian Siltstone *(Photo 1).* It should be noted here that the name "Ulladulla Mudstone" formerly used for the richly fossiliferous silty beds outcropping on the headlands at Ulladulla corresponds to the basal part of the Wandrawandian Siltstone and the name "Ulladulla Mudstone" has now been rejected (Herbert and Helby, 1980).

2. Worm burrows (bioturbation) in siltstone.

The walk revealed a stunning variety of geological features associated with periglacial shallow marine sedimentary environments. Trace fossils were in abundance, including horizons of sand-filled worm burrows and layers showing very pronounced bioturbation *(Photo 2),* culprit unknown. Particularly noticeable were richly fossiliferous shales and mudstones containing *Ingelarella*, spiriferid and productid (mainly the species *Terrakea*) brachiopods *(Photo 3)*, both as internal casts and external moulds with many of the shells still articulate. Towards Warden Head a field of perfectly spherical concretions 15-20cm in diameter lay scattered in abundance across the rock platform like the site of some ancient civil war.

Dropstones were scattered throughout the sequence, with both angular and well-rounded shapes

1. Wandrawandian Siltstone, Warden Head.

3. Ingarella shell, Productid spines and a Rugose Coral.

4. Dismembered plates of a Crinoids' Calyx.

6. Fault plane with calcium carbonate deposits below.

represented. The angular blocks were torn from bedrock beneath valley glaciers as they ground their way towards the ancient coastline, while the rounded ones were dropped by streams feeding onto the surface of the glaciers from perched valleys. There were no imbricated groups of dropstones here to suggest plucking of material from pebble beaches by freezing seawater, as can be seen further south at Wasp Head.

The source of these dropstones was mountainous ridges 100 kilometres to the south west and west on the old Gondwana land surface where the valley glaciers were active. They comprise tightly folded metamorphosed Ordovician sediments plus slate, phyllite, schist, quartzite, chert, granite and rhyolite together with pieces of white quartz which formed veins in the Ordovician rocks as they were folded and metamorphosed at the end of the Ordovician.

Another part of the rock platform displayed a long horizontal partially dismembered crinoid stem section replaced by white calcium carbonate (calcite). Below this lay two obvious glendonite crystal groups, replacements of calcite (or occasionally siderite) after ikaite ($CaCO_3.6H_2O$) which, being unstable above 5°C, is another indication of the periglacial environment

5. Convoluted siltstone beds of the Seismite horizon.

which prevailed in the 273 to 269Ma period of Wandrawandian deposition. The eroded surface of a nearby boulder showed a spectacular dismembered crinoids' calyx (cup) *(Photo 4)*, the beautifully patterned individual pentagonal plates still intact and scattered over the surface of the rock.

The main objective of the afternoon walk was to reach the northern side of Warden Head where spectacular "seismite" is exposed in the cliff (*Photo 5)*. Here thinly bedded shales display extraordinary intraformational slump structures formed as a three-metre thick layer of water-rich sediments, then lying near the edge of the continental slope, slid downhill between more competent upper and lower layers, churning over and over as it went. For this to occur required a significant seismic event and experiments have shown that an earthquake of at least magnitude 6 would have been required, probably emanating from the Pacific plate boundary around 150 kilometres to the northeast at around 270Ma.

Several faults were also evident along this section of coast, all low-angle and with similar orientation. Distortion of the rock layers on either side of the fault planes clearly showed the direction of movement and one fault in particular is acting as an aquifer, with colourful deposits of iron-stained calcium carbonate depositing down the cliff face as underground water seeps from it *(Photo 6)*. Of special interest adjacent to the most southern of these faults is a distorted sand wedge (or clastic dyke), a feature typical of periglacial environments. Probably formed initially by ice wedging and then filled by sand carried in by streams as the ice melted, the wedge was compressed as it and the enclosing shales were loaded by the deposition of overlying sediments *(Photo 7)*. While the shales compressed easily under this vertically-directed pressure, the sand wedge remained incompressible and reacted to the this pressure in the only way it could, by crum-

7. Distorted sand wedge below fault.

8. Phil Smart describing local geology.

pling as the thickness of the shale around it decreased. Experiments and calculations have suggested that the sediment thickness needed to create this degree of compression distortion was at least 900 metres (Conybeare and Crook, 1968). This reference offers an alternate explanation involving tension cracking of the wet sediment pile associated with faulting or slumping. During our walk back to the caravan park several more of these structures were seen, all lying directly beneath the same thin sandstone bed. In plan they may form polygons, a feature often seen in periglacial areas and caused by alternate freezing and thawing.

Such was the abundance of fascinating rocks and structures along this part of the coastline that daylight was fading rapidly by the time we had returned to the caravan park. Later that night the rains returned, with a vengeance!

Saturday 26th November

We awoke early to the incessant drum of heavy rain and outside it looked even worse than it sounded. My remark in jest on the way down yesterday about spending the weekend in Bunnings Warehouse may indeed come to fruition! Anyway a trip to a Bunnings store is as good as a holiday! But the forecast had predicted a clearing of the rain by mid-day.

After breakfast Phil arrived on site with a car loaded with the most recently available maps and kept us entertained in the shelter shed for a few hours with an overview of the local geology *(Photo 8)*. Sadly, the Department of Primary Industries had not updated many of the local area maps since 1966, despite some of the information shown on them being very much out of date. Some of the group then managed to find the local 'McCafe' and spent a few hours over coffee, before realising there was in fact a Bunnings store not too far away! They did rather well from the Society that morning! By12pm there was indeed a large patch of blue sky moving in from the west so Phil was contacted and met us at the caravan park at 1pm for a compressed version of the regional geological tour he had planned.

The afternoon tour took us up through the geological succession from the Middle Devonian (380Ma) and folded Ordovician (450Ma) sediments through the various Permian deposition episodes (300-268Ma) to the Triassic Milton Monzonite (245Ma) intrusion and finally the Paleogene (formerly Tertiary) basalt and dolerite dykes and sills (30-31Ma).

Our first stop was north along the Princes Highway at Conjola Creek, where Middle Devonian pink granite outcrops on the west side of the road just prior to a low cutting. This granite outcrop, along with several others, formed off-shore islands (similar to present-day Montague Island) back in the Middle Permian and were shedding sandy sediment into the surrounding sea as it was transgressing the landscape around 275Ma to deposit the Snapper Point Formation. Although the outcrop was quite poor here, examination of the Snapper Point Formation in the road cutting revealed that the grains in the sandstone had mineralogy identical to the underlying granite, indicating that it was indeed the sediment source.

9. Milton Monzonite showing contact between intrusions.

10. Iron stained mixed fossil moulds.

This relationship between the overlying sediment and granite basement represents a very distinct hiatus known as a non-conformity. Even here there was abundant evidence of dropstones in the sediments.

Driving back down the Highway to Milton and turning west onto Woodstock Road we continued out for approximately 5 kilometres to a large recently abandoned quarry in an exfoliating dome-like sill of Milton Monzonite. Here the horizontal contact between two distinctly different (light and dark) phases of the intrusion is clearly evident *(Photo 9)*. The sill was formed when a feeder dyke of moderately viscous magma was prevented from reaching the surface by a massive bed of sandstone within the Snapper Point Formation. The magma was able to lift the sandstone bed and spread laterally along the bedding plane beneath it, gradually thinning away from the feeder dyke as the pressure driving the magma decreased. It was easier for the magma to move horizontally than to break through this overlying sandstone. This quarry was closed due to complaints from new residents setting up small farming properties in the area. But the quarry was there first!!

Moving down to the northern end of Mollymook Beach via Beach Road we were able to examine a 10metre thick dolerite/basalt sill intruded along the bedding planes in massive sandstone of the Snapper Point Formation. The high temperature of the basalt magma (1000-1100^{o}C) thermally metamorphosed a narrow zone in the sandstone on either side of the sill to form an aureole of the much less friable metamorphic rock quartzite. The sill is evidenced here only by a wide zone of black boulders along the beach face, wide here because, along with the sandstone, it dips to the east at a low angle so that its surface exposure is much greater than its actual width. Also present here are small apophyses (wedge-like offshoots) of coarser dolerite within the adjacent quartzite.

We were then taken to the northern side of Ulladulla Harbour for Phil's famous and highly successful Gondwana Coast Fossil Walk.

In the Early Permian (295-269Ma) this part of the southeastern Australian coastline actually formed the coast of the supercontinent Gondwana, which at that time was positioned in the high latitudes with ice sheets and glaciers covering much of the landmass, and a very cold sea. As sea level rose and began to advance over the coastal hinterland, sediments rich in the remains of shallow marine organisms were deposited on the ocean floor to form an 800 metre thickness of sediments now known as the Shoalhaven Group. Around 60Ma the sandstone escarpment west of Ulladulla and the Southern Highlands plateau was uplifted due to rebounding of the continental edge following the opening of the Tasman Sea and splitting off of New Zealand which began around 80Ma. During the Pleistocene, when sea level was much lower due to freezing of the Polar ice caps, erosion carved massive valleys into the uplifted rocks, cutting down as much as 140 metres below present sea level to form deep valleys extending much further to the east than the present coastline. The sea invaded these features after the end of the last glacial phase around 20,000 years ago.

The rocks exposed around the Harbour form part of the Middle Permian Wandrawandian Siltstone, composed of sands and silts deposited on the continental shelf in a shallow sea below wave base. This is one of the major units within the Shoalhaven Group and is exposed in coastal cliffs from Dolphin Point south of Ulladulla to Black Head at Geroa in the north, a distance of 80 kilometres.

Scattered across the rock platform over a relatively short distance are a number of features typical of the Wandrawandian Siltstone. Most obvious were

11. Rounded dropstone with shale layers slumping over it.

12. Tessellated pavement, Ulladulla Harbour foreshore.

the occasional thin horizons of exquisitely preserved remains of bottom-dwelling marine invertebrates *(Photo 10)*. Some of these eked out a living by burrowing through the sea floor muds in the search for food. These included the bivalve mollusks and brachiopods, the latter comprising mainly spiriferid and productid species which occurred in single-species concentrations suggesting they were colonial in habit. Others, including the bryozoans and crinoids, attached themselves to the surface of the mud and filtered microorganisms floating in the seawater. In some horizons the calcium carbonate (calcite) exoskeleton of the organisms had been leached out by groundwater to leave cavities, while in others the original shell material remains or has been replaced by dark brown iron oxides/carbonates, making these replacements casts much more resistant to marine erosion so that they stand out in sharp relief on the rock platform. The spiriferid brachiopods were most evident amongst the replacement casts.

Towards the northern end of the fossil walk a field of cannon ball siderite concretions lie scattered over the rock platform. At this locality the concretions have an internal concentric layered structure and so formed at the water/sediment interface by the attraction of colloidal-size particles to some form of nucleus, which may be a pebble or fossil. Here however the principal type of nucleus was clusters of glendonite crystals, since leached out by groundwater to leave stellate cavities visible in those broken open by wave erosion.

Dropstones *(Photo 11)* are also common here, some in small groups, other alone and as large as over a metre in diameter. Well-rounded, sub-angular and angular blocks occur reflecting a variety of sources. But all were carried to their present location by ice rafting.

At the northern end of the walk, where the rock platform is being broken up into large angular blocks by wave action, seismites similar to but less spectacular than those seen at Warden Head are exposed in the cliffs.

On the southern side of the Harbour at the end of the beach we paused briefly to examine the spectacular tessellated pavement *(Photo 12)* extending over a wide area of the rock platform. Joint blocks had been quarried from this outcrop to form a large coastal swimming pool, the extracted blocks being used to construct the walls of the nearby ocean baths. Here the fracturing comprises two major joint sets at 060^{o} and 330^{o} which, according to Phil resulted from the stress field set up when New Zealand began to break away from Australia to form the Tasman Sea, developing over the 20 million years after the initial rifting began at 100Ma, but prior to the actual separation of the two continents between 80Ma and 60Ma.

A dinner was held at the Ulladulla Bowling Club on the Saturday evening, where Phil and his wife Faye were guests of the Society.

Sunday 27th November

After assembling at the caravan park at 8:30am Phil led us down the Princes Highway south of Ulladulla to the foreshore at Dolphin Point Reserve. This was found at the end of Dolphin Point Road, which left the Highway just south of the Burril Inlet Bridge. The rocks here lie within the lower part of the Middle Permian Wandrawandian Siltstone. To the south of Dolphin Point sandstones and conglomerates of the underlying Snapper Point Formation are exposed.

On the rock platform and only exposed at low tide are two basaltic Paleogene (30-31Ma) dykes which have penetrated the Wandrawandian Siltstone along vertical sub-parallel joints with an east-west

13. A large vertical basaltic dyke, Dolphin Point.

15. Exposed corallum of a Zaphrentis fossil in siltstone.

orientation. The dykes were submerged when we visited but weathered basalt boulders thrown up on the beach by storms show pronounced lineation of plagioclase crystals (phenocrysts), aligned in the flow direction of the basaltic magma.

There were good marine invertebrate fossils here too, mainly the brachiopods *Ingelarella*, *Spirifer* and the productid *Terrakea*, the latter clearly showing the long spines used to anchor the shell in the seafloor muds. Some of the sandy beds exposed along the base of the cliff show extensive bioturbation by mud-filtering organisms such as marine worms. These beds contain no marine invertebrates as these animals could not live in the agitated murky waters caused by the burrowers. Dropstones are also common here.

A little further south around the headland in Dolphin Reserve we followed Phil down a track onto the coastal rocks to observe another vertical Paleogene basalt dyke, this one having dragged adjacent layers of flat-lying Wandrawandian Siltstone upwards to an almost vertical position during intrusion *(Photo 13)*. The rock in this dyke is much coarser-grained than in the dykes seen previously and is probably more correctly called dolerite. Heat transfer from the 1100˚C basaltic magma cooked the sediments for approximately one metre on either side to produce a hornfelsic metamorphic aureole. The edges of the dyke show a prominent chilled margin of very fine-grained almost glassy rock between 0.5-1cm thick caused by rapid (almost instantaneous) cooling. This "tachylite" margin weathers and erodes very rapidly leaving a prominent channel along either side of the dyke. The dolerite itself is very high in magnetite [Fe_3O_4] as shown by the attraction of anything magnetic to the rock surface. Traces of magnetite can also be found in the overlying regolith (weathered zone + soil).

The third stop for the morning was a little further south again at Barnunj Recreation Area where, down along the foreshore *(Photo 14)*, blocks of Wandrawandian Siltstone thrown up by the sea are said to contain the best-preserved fossil casts and moulds of Middle Permian fauna found along this section of coastline.

Our last stop on this trip was at the end of a long rough and often deeply-potholed dirt track through the scrub which eventually led to the beach just south of Lagoon Head at a place known locally as Point Northeast. The rock platforms around the base

14. Looking for fossils near Barnunj Recreation Area.

16. Glendonite crystals in Wandrawandian Siltstone.

of Lagoon Head display exquisitely-preserved horn corals of the species *Zaphrentis (Photo 15)*, their intricate structure preserved by white calcium carbonate standing out in sharp contrast against the dark grey siltstone. These animals were able to survive in small numbers in the cold waters on the muddy bottom of the Permian off-shore shelf but became extinct along with 95% of all marine fauna at the end of the Permian.

Retracing our path back south along the beach, it was along the base of the next cliff line where our group found the best fossils. These included an exquisite internal *Ingelarella* cast still attached to the siltstone host rock, several crinoid calyx plates and thick beds of productid shells. Several horizons in the cliff and on nearby rock platforms displayed sharp but very brittle examples of pineapple glendonite crystal groups *(Photo 16)*. One of these horizons occurred within a thick bed composed almost entirely of productid shells. There were also horizons within the sandstones showing spectacular scallopy bioturbation by large unknown organisms, probably bivalve mollusks. Superb examples of honeycomb weathering were also seen here in boulders of fine sandstone fallen from the cliff.

Towards mid day heavy clouds had begun to build up and there were threatening rain squalls out to sea. So at 12:30pm we set off for the return journey home, leaving Phil to recover and reflect on his first encounter with the Amateur Geological Society of the Hunter Valley!

Report by Brian England using information provided by Phil Smart.

Photographs by Ron Evans.

References and Further Reading:

CONYBEARE, C.E.B. and CROOK, K.A.W. (1968). Manual of Sedimentary Structures. Commonwealth of Australia. *Department of National Development. Bureau of Mineral Resources, Geology and Geophysics, Bulletin 102.*

HERBERT, C. and HELBY, R. (1980). A guide to the Sydney Basin. *Geological Survey of New South Wales, Department of Mineral Resources. Bulletin 26.*

Social Activities 2011

Once again, the Social Committee organized the two main social activities for the year, Soup and Slides and the Christmas Dinner.

Social Committee members held two planning meetings (a walk followed by lunch) to organize these events.

Soup and Slides was attended by 19 members, somewhat fewer numbers than normal, but a great evening as usual.

The **Christmas Dinner** was again held in the home of Vic and Leonie Mills with Committee members preparing an array of tasty food. Several members showed digital photos on a large TV between the main course and sweets.

A very enjoyable social activity held throughout the year were **'Craft Days'** hosted by different members in their homes. The ladies who participated were able to share skills and solve the problems of the world.

Secretary Ian once again acted a leader for members interested to travel by train and bus to **Sculpture by the Sea** held as usual along the Bondi to Tamarama coastal walk.

On behalf of all members, a big thanks to members of the Social Committee and members who made their home available for social activities.

Report and photograph by Ron Evans.

Large crowds enjoying the sculptures displayed along the Bondi to Tamarama coastal walk.

Geology and Landforms of the Mole Tableland Geological Safari 2011

Sunday 16th September to Friday 26th September 2011

Trip Leaders: Brian England and David Atkinson

Participants: 13

The 2010 annual excursion examined the ancient geology and mineral deposits of the Broken Hill region. This year would see the group explore the much more recent geology and landforms of the Mole Tableland and surrounding area on a trip that would take us into unsurpassed granite scenery, trackless bushland and fascinating geology, plus an overview of the tin and tungsten deposits that in the early part of the 19th Century made this region a major World producer of these metals.

The trip was based in the old tin mining village of Emmaville, with Ian and me enjoying the country hospitality offered by John and Marie at the Club (Bottom) Hotel while the others erected their own accommodation at the Caravan Park.

A brief history of Emmaville

In March 1872 Thomas Carlean found stream tin (cassiterite) at the source of Vegetable Creek at the head of a shallow valley 1.6 kilometres east of the present site of Emmaville and 48 kilometres north-northeast of the first tin discovery in the state at Elsmore. By the end of 1873, 2383 tonnes of cassiterite had been won, starting a tin rush to the region and a wave of speculative insanity which landed many in the asylum, led more than a few to suicide, and resulted in hundreds facing the insolvency courts. Only the opening of the deep leads buried under the basalt brought renewed life and prosperity and a thriving township developed with a population of up to 4000. In 1875 Cobb & Co were running three coach services a week from Glen Innes via Tent Hill. In 1881 the first medical benefits fund in Australia (the Vegetable Creek Medical Fund) was established and it was also here that the St. John's Ambulance organisation began.

Originally called Vegetable Creek because of the large number of Chinese market gardeners along the course of the creek, the name of the settlement was changed under considerable protest to Emmaville on 24th April 1882 to honor Lady Augustus Loftus, wife of the then Governor of New South Wales, whose Christian name was Emma.

Background Geology.

Early Triassic Mole Granite dominates the Mole Tableland, an area of 3000 square kilometres of rugged granite country standing 200 metres above the surrounding countryside. This is a sill-like mass of biotite granite between one and two kilometres thick dated at 246Ma. The town of Torrington lies in the southeast corner of the outcrop.

The Mole Granite is the most significant mineralized body of rock in the New England region, accounting for over 1300 individual mineral deposits, including most of the 600 lode tin veins exploited in the past as well as occurrences of gold, arsenic, base metals, topaz and emeralds. The strong fracturing developed in the roof of the granite body as it cooled provided access for meteoric fluids at 300°C that set up a near-surface geothermal system that operated for around 4Ma. These fluids formed large quartz veins in which were precipitated cassiterite and wolframite around 242Ma. The metal phase of the mineralisation came from late-stage magma-derived fluids mixing with the cooler meteoric waters.

Essential to the formation and accessibility of many of the Tableland's mineral-rich reefs is the presence towards its centre of the Torrington Roof Pendant, an oval inlier of Early Permian mudstones and conglomerates perched within a hollow in the granite surface. These have been altered to hornfelsic rocks by the heat of the adjacent granite. The relation of individual deposits to these metamorphic rocks and the enclosing Mole Granite will be discussed under the various localities visited during the excursion.

Surrounding the Mole Granite are extensive outcrops of other igneous bodies including the Dundee Mass of ignimbritic rhyodacite to the south, the

Early Triassic Bolivia Range Leucoadamellite to the south east, and extensive outcrops of undifferentiated Late Permian granites to the east. Large exposures of Emmaville Volcanics occur to the south, east and northeast.

Sedimentary rock outcrops are restricted to areas of Early Permian sediments to the west of Emmaville-Tent Hill, Carboniferous sediments to the Northwest and a folded series of Early Permian sandstones, conglomerates and siltstones to the northeast.

Particularly in the area south and west of Emmaville, Tertiary basalt flows dated at 30Ma fill old river valleys and have formed the famous deep lead tin deposits of the region. These together with the Holocene (present day) fluvial deposits have produced over 78,000 tonnes of cassiterite since 1872, including 6500 tonnes From the Vegetable Creek Deep Lead which extends for over 9 kilometres westward from Emmaville. This lead has been worked intermittently since 1874 and most recently in the 1970's. Most of the tin was recovered by sluicing and remnants of this activity still exist in the form of large water-filled open pits to the east of Emmaville and for several kilometers along the Rose Valley Road to the west, where thousands of tonnes of the Tertiary basalt once capping the deep lead alluvials has been piled into vast heaps.

A significant part (around 30000 hectares) of the Mole Tableland is now contained within the Torrington State Conservation Area, set aside as an important uncleared east-west wildlife corridor linking the wet northern forests of the New England Tableland with the drier woodlands of the North West Slopes. There are over 750 plant species, including 45 which are nationally endangered. Both the geology and weather conditions in this region have allowed unique plant and animal communities to develop. There are several types of heath around its swamps and rock outcrops that are found no-where else on the Planet.

Saturday 15th October

By fortunate coincidence the start of our trip coincided with the Inverell Gem and Lapidary Club's 50th Anniversary show and in the hope of being able to join at least a few of the potentially interesting field trips on their agenda, David, Ian and I went across to Inverell on the Saturday to see what could be arranged. Sadly the storms we had passed through at Guyra on the way north yesterday had closed most of the secondary roads, preventing access to most of the properties opened to fossicking especially for this event. The only option of any interest to us was a bus trip to a crinoid fossil locality near Gravesend on Friday 21st, so we booked the group in.

The gem and mineral show itself was pitifully disappointing, with nothing of interest to any of the group. I can always go to a mineral show anywhere on the planet and immediately know several people, but here I recognized no-one! So after a satisfying lunch at the Imperial Hotel we returned to Emmaville to await the arrival of the rest of the group, pausing along the way to briefly examine an ignimbrite within the Emmaville Volcanics exposed in a road cut 17 kilometres south of Emmaville.

Sunday 16th October

Jenny from the Emmaville Caravan Park had invited our group last night to use the shelter shed at the old Court House for our meetings so we assembled there at 8:30 am for a brief introduction to the regional geology. Then it was off to the Emmaville Lookout 1.5 kilometres east of town on the crest of a prominent ridge. Unremarkable for its views despite the only partly cloudy skies, the summit provided exceptional outcrops of a tough coarse agglomerate member of the Emmaville Volcanics. These rocks form part of the several hundred metre thick Wandsworth Volcanic Group, part of a Late Permian to Early Triassic episode of igneous activity which includes marine ash flow ignimbrites occurring as flat to gently-dipping sheets with dips rarely exceeding 30 degrees, probably representing original depositional dips arranged radially around caldera structures. The ignimbrites resulted from massive subaerial phreatomagmatic eruptions and deposited around major eruption centres related to subduction along the eastern continental margin. These rocks are resistant to erosion and form a prominent narrow line of ridges running northeast from south of Emmaville to the southern edge of the Mole Granite south of Torrington. The Mole Granite intrudes them. On the eastern side of this outcrop lies a series of slightly younger porphrytic volcanics, ignimbrites and andesites of the Tent Hill Volcanics.

After breaking up the requisite number of boulders to provide everyone with good specimens, we had a quick morning tea break before moving on to the Emmaville Mining Museum opposite the Tattersall's Hotel in Moore Street and right next door to the Police Station. Here we spent the rest of the morning in the very willing and knowledgeable hands of Ron

Jillet, one of several volunteers who man the exhibits. The Museum *(Photo 1)* opened on 26th June 1999 and is operated by a committee of townspeople and volunteers with the assistance of the Glen Innes Severn Council. It is housed in the old John Foley Ltd. store and came about when local identities Mr. and Mrs. Curnow donated their extensive collection to the Emmaville community. This is easily one of the finest regional museums in Australia, housing several notable rock and mineral collections including those of the Curnows, Ron Jillett, Gilby, Ellis, Maskey, Schumacher and Alan Tretheway. There is an emphasis on local material but the collections include specimens from all over Australia as well as overseas. A Broken Hill section includes one of the finest spessartine garnet groups known *(Photo 2)* as well as an extremely fine crystallised sphalerite from the North mine. There is also an extensive range of fossils.

The building also houses a collection of over 300 historical photographs depicting the mines, miners and communities dating back to the boom years. Out the back we found replicas of a blacksmith's shop, miner's hut and general store with other rooms housing a large antique bottle collection and other relics. There are plans afoot to extend the main building into the vacant lot between the Museum and the Police Station, a spot once occupied by another of Foley's stores. This will allow material in storage to be placed on public display.

After lunch back at camp we decided at 1:30pm to head for Torrington to see what the recent rain had done to the bush roads. Just north of Tent Hill we pulled in to the side of the Torrington road to overlook the remains of the Glen Tin Smelting Company works. The following quote from Geoffrey Blainey's historical account of Australian mining, "The rush that never ended", outlines the significance of this site as part of Australia's mining and smelting history.

"John Moffat, a tall Scott with chiseled face and short sight, was in his early thirties when he joined the tin rushes. He had been a shepherd near Roma and a grocer near Brisbane, and when Stanthorpe became a rich tin town he set up a general store under the name of Love & Moffat and also bought tin concentrate for a Brisbane smelting works. Sensing at smelting works on the Border tin fields would make profits he joined with John Reid in building a tin smelter at Tent Hill in 1874, and spent heavily on reverberatory furnaces, portable engine, brickworks, stables, carpenters and blacksmiths shops, and workmen's cottages. With a rare eye for neatness he painted every building white and, being a puritan, he refused to allow a hotel in his smelting town. He was a model employer, honest with his smeltermen and the miners who sold him tin. But his furnaces had metallurgical problems and the falling price of tin increased his monetary troubles and Moffat and Reid's tin smelters had to borrow from Love & Moffat's general stores. In 1879 the stores slide into debt and creditors forced them to liquidate. Moffat went to Tent Hill and gave all his energy to the smelting."

Moffat went on to build smelters at Irvinebank in Queensland and spent much of his profits developing new mines. He became the magnate of Queensland's tin fields and the most generous financier of new mining ventures, including oil, the silver-lead mines of Chillagoe and copper at Cloncurry. His kindness to his employees was legendary.

To quote again from Geoffrey Blainey: "Moffat's working life spanned and sponsored the spread of copper and tin mining in eastern Australia. When he reached Australia in the early 1860s South Australia was the only centre of copper mining and there was no centre of tin mining. When he died in 1918 Queensland, New South Wales, Tasmania and South Australia had each produced close to 30 million

1. Emmaville Mining Museum.

2. One of many mineral specimens in the museum.

3. Abandoned boiler near the Eclipse Lode.

4. Foundations for machinery, Curnows Tin Mine.

Pounds worth of the Cornish metals- copper and tin- and in that achievement no man played a greater part than Moffat."

Only the old dam, long since breeched, and part of the waste dumps on the other side of the creek could be seen through the trees, but little else remains of this once important local industry. The hill slopes from here to and beyond the Ottery mine showed very obvious signs of extensive sluicing for tin.

Up on the Mole Tableland we found the sandy bush tracks had dried out remarkably quickly and so we proceeded down Dutchman Road to the locked gate without incident. Bill , one of the well-known brothers who have been long-time tin and wolframite miners in the Torrington area, had given the group permission to explore the Dutchman/ Harts and Curnows mines over which they still hold leases. Bill was trucking granite from the waste dumps to his mill for crushing as a source of gravel for the local roads.

From the gate it was roughly a kilometre walk through bushland still showing the devastation wrought by the 2009 wildfires that had been started by lightning strikes during a dry electrical storm. Even the granite outcrops had been scorched, their lichen coatings completely carbonized. There was little sign of regrowth, leaving the area as a blackened wasteland.

The track took us directly to a clearing adjacent to the partly collapsed 125m deep Harts shaft, its three chambered and well timbered opening choked with vegetation and enclosed by only a very ancient and flimsy wire fence. Nearby an iron mesh had been thrown over the Howes shaft, also on Harts Lode. Down the hill from these shafts a series of partially excavated mine dumps contained abundant coarse granite, along with chloritic lode rock and a few scattered quartz crystals. Surprisingly, good samples of wolframite in granite were found as well as a superb specimen of chloritoid rosettes to a few millimeters perched on quartz crystals in a vugh in a quartz vein traversing the chloritic rocks.

At the Dutchman and Harts mines two lodes were worked between 1875 and 1886, 1912 and 1946 and lastly between 1951 and 1953 to produce over 1473 tonnes of cassiterite concentrate. The lodes are 120 metres apart and developed on parallel alteration zones in the Mole Granite. Chloritoid (mica group) was the main gangue mineral which, together, with minor quartz, hosted cassiterite and wolframite along with small amounts of fluorite, calcite and galena. Overall grades were high at 3.3% tin oxide. From Harts we followed the track along the ridge top, reaching the dumps of the Dutchman shaft after just a few hundred metres.

As we approached a large echidna burrowed its way out of sight amongst the scrub. Neither the Dutchman shaft or the many nearby pits and shafts on the Eclipse lode just to the east provided anything of interest so we followed the road on over the top of the ridge and down into the next gully, on the way passing the abandoned boiler *(Photo 3)* which once fed steam to the engines associated with Porters shaft towards the south end of the Dutchman lode. A track off to the right near the base of the hill led to further deep and dangerously collapsed shafts sunk on the Dutchman lode.

The track swung to the left as it plunged further into the burnt out wasteland along the bed of the deep gully. The blackened bush appeared threatening and there seemed little incentive to continue. Anyway, the track seemed to be heading in the wrong direction to join up with the one from Curnows mine, which was

our goal for the afternoon. As well, the balancing rocks that are supposed to occur here were nowhere to be seen! Retracing our route back up the ridge to the locked gate, we drove back to Nomad's Picnic area for afternoon coffee, then down to the Curnows Road turnoff that took us to another locked gate just short of the Curnows tin mine. A short walk over waterlogged ground brought us to the extensive granite dumps and concrete foundations *(Photo 4)* of what was at the time the deepest tin mine known, with the main shaft extending to 305 metres and workings on 9 levels. It was also the largest individual tin producer in the region, providing a total of 1330 tonnes of concentrate between 1881-1887 and 1926-1950. The cassiterite occurred in a quartz/chlorite vein from 0.9 to 1.2 m wide filling a fracture zone in the Mole Granite. The magnificent timber headframe had long ago collapsed and only the extensive foundations of the mill and a pair of rusting boilers attested to the size and importance of this operation. Further up the track and hidden in thick scrub adjacent to the dumps the old winding drum and engine of the main shaft could be examined by anyone willing to risk the wrath of the snakes that surely called the area home. As with Dutchman/Harts, the mine dumps provided interesting examples of chloritic lode rock and coarse porphrytic examples of the Mole Granite, but there was nothing left of the massive smoke quartz / black tourmaline crystal bonanza found here around 30 years ago.

We returned to our respective camps in Emmaville, arriving at around 6:30pm.

Monday 17th October

Last night I'd arranged with friend and local tin miner Terry *(Photo 6)* to show the group around The Gulf tin mining area, a 40 minute drive at the end of The Gulf Road north of Emmaville. We departed Terry's place at 9:15am with a cool wind blowing and cloud coming in from the west. The gravel road north was dry but there was a lot of water in the table drains and all creeks had fresh flows.

5. Square chimney and boiler, Kathida Mine.

6. Terry in front of boiler.

The Gulf area comprises an unknown but quite large number of small quartz/chlorite vein-type deposits within the Mole granite close to its south-western margin. Many of these veins contained incredibly rich bungs of pure cassiterite, some producing over 40 tonnes from a single pocket. Others like Garth's and the recently re-worked Kathida produced some of the finest crystallised cassiterite specimens ever found on the Planet.

At the now vanished township of The Gulf, we followed Terry down to the Kathida mine adjacent to the most fascinating and best preserved assemblage of relic mine machinery on the Tableland, including a tall beautifully preserved square brick chimney. *(Photo 5)* Partly obscured by trees, scrub and an ancient pile of mine refuse, lay a steam-operated compressor made by Taylor Horsfield of Bendigo, a Tangyre Birmingham 15" stroke 10" bore 120 rev/min steam engine, and various other bits and pieces anchored to concrete plinths, all driven by steam raised in a huge elevated boiler under which lay a set of inclined condensing tubes. Steel framework around the boiler, which probably once supported a protective building, was stamped "Lanarkshire Steel Co. Ltd."

We followed Terry down the hill past the recently rehabilitated Kathida mine, until just a few months ago still being worked by Terry and his brother Don for both tin and specimens. Parking on the

downhill side of a series of water-filled open pits, we then set out on foot, following Terry through mainly trackless boulder-strewn scrub down towards a deep gully and eventually the adit of the Balmain tunnel just above creek level.

Down in the bush a surprise was in store. Beside a little used track stood a lonely headstone with the incised inscription "Samuel Rumsby Died 10-3-1906 MINER." *(Photo 7)* Rumsby is well-known amongst collectors as the operator of Rumsby's mine, its mullock dumps a source of great quartz and green fluorite specimens. When operating, it also provided a small fortune in tin for itinerant prospector Rumsby himself. He'd also found himself a girlfriend in the good times, but the tin ran out, and so did his girlfriend - with his fortune! I guess you'd have to call her a "tin-digger". Rumsby was so distraught that he loaded his shotgun, normally used for hunting rabbits, and blew his head clean off! Other miners in the area heard the shot and discovered his mutilated body. While waiting for Police to arrive from Emmaville the miners guarded the body in shifts. The first pair decided to play a macabre joke on their relief. They attached fishing line to the shoulders of the body, slung the lines up over the rafters of the building, and hid. Hours later, just as the relief crew walked in the door of the hut the first two miners yanked on the lines so that the headless body suddenly sat upright as if to greet them. The newcomers immediately turned tail and were not seen again for days! Terry was full of good stories. That was just one of them. Down at the bottom of a lightly timbered gully we came to the Balmain tunnel *(Photo 8)*, with the

7. Samuel Rumsbys' headstone.

8. Entrance to the Balmain tunnel.

twisted remains of a steel railway track curving from its portal back down the creek across the top of a small mullock dump considerably washed out by the creek. A short cutting led through solid granite into the portal. The tunnel was high enough to walk in but was blocked for the first 10 metres or so by a pool of uninviting soupy water.

A few old wooden planks and carefully placed rocks got us past this initial obstacle but the rest of the tunnel was squishy underfoot, with water still dripping from the roof after the recent heavy rains. Towards the end of the tunnel, about 100 metres in from the portal, we encountered dozens of bats, driven into a flying frenzy by our sudden presence. *(Photo 9)*

Contractors dug the Balmain more as an exploratory mining exercise than to exploit any ore that might have been present. The workings followed a 20cm thick vein of crystallised smokey quartz into the hillside, the vein pocketing occasionally and especially near the end of the tunnel to provide quartz-lined vughs up to a metre in length packed with metal sulphides. The walls around these pockets were stained a powdery blue with copper sulphates, a post-mine result of sulphide weathering. Of course representative samples had to be removed for later study and we had

9. One of many bats within the Balmain tunnel.

the tools for the job this time. I had been here before with Terry, but had walked in without a pick! But extracting what was needed involved working overhand high in the wall of the tunnel and we were constantly showered with fine stinking debris laced with copper sulphate and arsenic in the form of the lethal oxide weathered from an adjacent pod of pure arsenopyrite. Despite safety glasses and helmet I became covered in this muck and despite repeated showers back at camp, for the next few days smelled like I'd almost drowned in a vat of sheep-dip. But specimens were successfully removed and later proved to comprise the uncommon supergene copper sulphides covellite and chalcocite.

Back at the portal we found Stan had tripped over the danger keep out sign lying at the side of the cutting. After regrouping, Terry led us directly up the hill to the collapsed main shaft over the Balmain. Here, trying to get a view down into its depths, Ron lost the hard hat I'd lent him but thankfully did not follow it! From the Balmain main shaft we were led around and up the side of the ridge through trackless bouldery scrub, carefully dodging the scattered untidy mounds of pebbles and sticks built and savagely guarded by monstrous bullants and always on the lookout for snakes, particularly the death adders prevalent in this area. Our bush trek took us up past the White elephant mine, where only quartz crystals rewarded the miners for their efforts and on to the Blue mine where fragments of green fluorine could be picked up. A 1.5 metre goanna, perfectly camouflaged against the black trunk of a large ironbark tree only became visible when it moved and back near the Kathida two small water dragons scuttled across our path.

Back at the Kathida mine we paused for a picnic lunch in the shade of the old chimney *(Photo 10)* before driving back down The Gulf Road to the edge of the State Conservation Area where a track off to the east led into Gaden's mine *(Photo 11)*. After giving us a most interesting and rewarding morning Terry left us here at around 2pm.

11. Waiting for water to drain from Gaden's Mine.

Those with high clearance 4WDs drove the 1.5 kilometres into the mine while the others walked. Terry and others had considerably improved the track in preparation for the recent Emmaville Gemfest. Since my last visit in June, deep gutters had been filled and trees near the track cleared, so there would have been no problem getting any of our vehicles in.

Located 15 kilometres west of Torrington and first worked by Gaden and party in 1877 and again by G. Sherpardly in 1968, this mine exploited a quartz-chlorite-tourmaline-wolframite-scheelite-copper sulphide vein in the Mole granite. It is one of the most mineralogically complex deposits on the Mole Tableland.

The dumps at the foot of the ridge had never revealed anything of interest on previous visits although fossickers in their search for quartz crystals dig over the area repeatedly. Our target here was the adit, the portal of which was located at the end of a long cutting that followed the outcropping vein into the

10. Lunch beside chimney stack, Kathida Mine.

12. Brian trying to collect ore specimen, Gaden's mine.

hillside. At the portal we found a lake, with a curtain of water dripping from above the entrance. But by digging a drainage ditch back down the cutting the lake was drained and within an hour entry was gained. Once inside we found the floor of the tunnel dry underfoot. Although extending 125 metres into the hillside, our goal was the sulphide-rich bung in the ceiling about two thirds of the way in, from which I had unsuccessfully tried to obtain specimens on previous visits. The bung was high in the roof but a short sturdy ladder made by my friend Ray Jones in Rutherford and hidden at the back of the mine made access much easier. But although Chris and I rained repeated blows on the patch of yellow chalcopyrite only small pieces came free and we had to eventually admit defeat. *(Photo 12)* As with the Balmain, this tunnel was inhabited by dozens of bats.

Clambering up through the granite boulders and dense stands of trigger plants to the top of the ridge we came to the main shaft with its wooden tripod headframe above the end of the adit. Searching the small dumps here revealed good specimens of coarse platy chloritoid, fibrous tourmaline and occasional fluorite. A few metres to the west lay a deep water-filled pit with drives running off it just above the water level.

Back in the adit and exploring right to the end I tried my long wave ultra violet torch in the hope of locating something with a fluorescent response, but apart from a small patch of fluorite there was nothing.

We walked back out to The Gulf Road around 5pm, had afternoon coffee at the roadside, and were back in Emmaville by 6pm.

Tuesday 18th October

Today had been set aside in the program as a free day in Glen Innes to shop and explore some of the local attractions, including second-hand bookshops, the Tourist Information Centre, and the exceptional Land of the Beardies History House Museum and Research Centre housed in the former Glen Innes District Hospital at the corner of West Avenue and Ferguson Street. Other attractions included the National Parks Headquarters (although Torrington is covered by the Tenterfied office), the Super Strawberry where delectable strawberry concoctions could be savored, and the hectares of landscaped gardens at the Cool Climate Garden Centre.

Opened on Australia Day in 1970, The History House Museum deserves special mention as one of Australia's best folk and history museums. The first section of the old hospital, the Sharman Wing, was built in 1877 with various other bits added until the hospital closed in 1956. The property now belongs to the Department of Lands which formed the "Land of the Beardies Reserve" with the Glen Innes and District Historical Society as perpetual trustees. The range and quantity of displayed material is breathtaking, with over 35 rooms housing an astonishing range of artifacts, all beautifully presented. The collections came almost exclusively from the town and district. There are even several mineral and rock displays, although poorly labeled.

The group re-formed at the Tourist Information Centre at 1:30pm and set off in convoy up the New England Highway towards Deepwater. Exactly 15 kilometres to the north, the Highway ascends a long hill with a northbound overtaking lane and 4 kilometres beyond this a quarry on the right was the signal to turn in off the Highway. We parked in the quarry and walked up the track behind it as it veered to the right, hoping to find the group of small pits and shafts on a molybdenite show I had explored many years ago!

This is the northern end of the Glen Eden Mineralized Zone, a vey significant exploration target with a potential resource of 30 million tonnes of ore containing molybdenite, cassiterite, wolframite and bismuth. This zone encompasses an area 1800m x 1500m of zoned hydrothermal alteration and mineralisation developed within rhyolitic volcanic rocks of the Emmaville Volcanics (Wandsworth Volcanic Group). Up to 4 shafts were sunk on large mineralized quartz veins in a central greisen-altered breccia lying within an outer zone of similarly mineralised non-brecciated greisen. The breccia body is pipe-like and extends beyond 400m in depth (Henley, et.al.,2001, page 119).

It had been over 20 years since I visited this site and in the intervening years the hillsides had been crossed by numerous tracks, long since abandoned and now difficult to trace through the grassy forest understorey. These tracks had provided access to diamond drill sites, the holes now marked by lengths of white polyethylene pipe protruding from the ground. After following several false leads for over an hour and finding only a few scattered tunnels and pits, our target was eventually found by following the track heading directly south from the quarry and very close to the Highway. Sadly the main pit had been filled

13. Molybdenite containing quartz veins.

15. Ruin of arsenic Calciner, Ottery Mine.

with rubbish but there was enough dump material down the side of the hill to provide specimens of molybdenite, and at least one of the large mineralised quartz veins *(Photo 13)* which characterize the deposit was still visible. A quick check of rocks back in the quarry revealed examples of crystal tuff and ignimbrite similar to the material seen in the Emmaville Volcanics south of Emmaville a few days ago.

After coffee in the quarry we continued along the Highway to Deepwater, there turning west onto the Tent Hill Road. Then at Tent Hill we took the Torrington Road to the north. A few kilometres along this road just south of the grid we veered left into the parking area adjacent to the Ottery arsenic mine.

The Ottery mine was worked to a depth of 74 metres on three levels. There were 5 lodes, all hosted by monzogranite with local intrusions of leucocratic granite, all part of the Early Triassic Mole Granite. Mineralisation is hosted by quartz veins up to a metre wide or as haloes of disseminated sulphides in the wallrock.

These very historic ruins had fallen into a sad dilapidated state since my first visits in 1967, when the mill structures, condensers *(Photo 14)* and old stamp battery were still standing in remarkably good condition. Now everything was collapsing, falling apart as a result of what can only be described as criminal neglect! All the arsenic-covered areas had been fenced off several years ago by the New South Wales Department of Mineral Resources as part of a program of rehabilitation which saw reconstruction of the mine dumps, the building of pathways for tourists, and the erection of a display of photographs and fact sheets on the mine and its history. Part of this project was the construction of a steel viewing platform over the stoped out section of No.1 lode on the steep hillside just west of the watercourse, enabling visitors to peer down into the depths of the mine. But even this was now fenced off, although we did manage to gain access and clear this rather expensive and now abandoned structure of its covering of blackberry vines.

The Ottery was the second largest of over 200 arsenic deposits on the Mole Tableland, but was first worked for tin between 1889 and 1905, with a total production of 2737 tonnes of concentrate. Coopers, who were well known producers of sheep and cattle dips, then worked it between 1923 and 1940 for arsenic. White arsenic (the oxide) was the principal ingre-

14. Brick arsenic (pink deposits) condensers, Ottery Mine.

16. Remains of the Refinery, Ottery Mine.

dient in their dips. The arsenic was also used in weed control, particularly for prickly pear. The treatment plant was constructed using 450,000 bricks made from local clay at the nearby brick kilns of the Glen Smelting Company.

The coarser arsenic ore (the iron arsenic sulphide arsenopyrite) was placed in kilns and the finer ore in a rotary furnace *(Photo 15)* for calination, producing an arsenic oxide vapour which was directed through a series of brick flues before entering a long set of condensation chambers constructed up the side of the hill. In these chambers spiky crystals of arsenic oxide precipitated out and after cooling for several days were raked out with long scrapers to the door of each chamber where the workers would collect it. The men here took all precautions to avoid the irritating crystals of arsenic oxide, by rubbing soap into their skin, wearing silk bloomers under their clothes, and/or applying a red paint. The collected arsenic was transferred to the refinery *(Photo 16)* where further heating varorised the arsenic oxide, leaving behind the iron oxide impurities which had turned the initial product an undesirable pink. After condensation the product was placed in wooden barrels made on site at the cooperage and then transferred by horse-drawn wagons to the rail at Deepwater.

Around 1928 a tin treatment plant was added. The Great Depression stopped operation at the Ottery in 1930 for two years. It was then worked on a small scale, closing down again in 1936. It was subsequently bought from Cooper & Nephews by the Burma Malaya Tin Mining Company, but although the main shaft was sunk a further 30 metres, no more arsenic was produced and Burma Malaya pulled down the mine buildings and moved everything transportable to other projects. The final phase of mining took place in 1963-1976, mainly for tin (Lobsey, 1972).

Wednesday 19th October

The group departed camp at 8:00am with Ron Evans leading and headed west towards Ashford. Efforts to gain access or even view the Ashford Power Station located on a small outlier of Permian coal measures north of the town failed, so we turned back south and took the unsealed Coal Mine Road on towards Kwaimbal National Park, a new park on the junction of the Macintyre and Severn Rivers. This is a region of spectacular river canyons, huge granite boulders and a rolling landscape of rugged hills forested with ironbark and Cyprus pine woodlands, with patches of dry rainforest (a survivor form wetter times) clinging to sheltered rocky sites.

At Lemon Tree Flat we had morning coffee in the most picturesque camping/picnic area imaginable, *(Photo 17)* an extensive grassed area dotted with large river red gums set aside the fast flowing Severn River. The park is a haven for bushwalkers and we began by taking the Junction Track to the northwest along the western bank of the Severn River *(Photo 18)*. Recent floods had left huge mounds of broken trees and shrubs along the track but we soon left the river and climbed to the summit of the adjacent ridge through open forest dotted with the occasional round granite boulder and at least one balancing rock *(Photo 20)*. Viewpoints along the track provided glimpses of the wild waters of the Severn Canyon several hundred metres below *(Photo 19)*. Short of time, we diverted off this track after 3.5 kilometres to view the Dungeon, the deepest and most spectacular section of the canyon with its sheer granite walls and churning water *(Photo 21)*. A fenced lookout on the edge of the cliffs and unfenced outcrops beyond gave spectacular views into this abyss.

Retracing our path back to Lemon Tree Flat we had lunch on the grass under the river red gums be-

17. Morning tea, Lemon Tree Flat, Kwaimbal NP.

18. Severn River downstream from Lemon Tree Flat.

19. Severn River looking down on rapids and canyon.

21. Upstream view of 'The Dungeon.'

fore driving on to Macintyre Falls at the end of the Macintyre Falls Road. Here we began with an overview of the falls from the lookout and then took the beach walk, a series of steep steps down to the jumbled mass of huge granite boulders chocking the river below the falls. Another steep set of stairs carved into the cliff face leading down from the northern end of the car park took us to the edge of the wide plunge pool at the base of the falls, a very spectacular point from which to photograph the falls *(Photo 22)* and surrounding water-sculptured granite. Wild goats watched our every move from their vantage points along the other side of the canyon.

The geology here was spectacular as well. The steps to the plunge pool climbed down what appeared to be a series of schleiren, lenses of late-crystallising magma filling horizontal shrinkage fissures adjacent to the upper chilled margin of the granite pluton. Residual hydrothermal fluids concentrated within these zones had deposited spectacular radiating masses of columnar black tourmaline to 20cm across *(Photo 23)*. Further downstream, what appeared to be an intruded black diorite could be seen just above water level, accompanied by stoped blocks of lighter-coloured granite.

Finding it difficult to tear ourselves away from such interesting surroundings, we drove on down Limestone Road to the Ashford Limestone Caves *(Photo 24)*, located in an outlier of the Kwaimbal National Park. Here we explored Ashford Main Cave, a complex 578 metre long joint-controlled phreatic passage developed in a low relief outcrop of Lower Carboniferous poorly fossiliferous limestone *(Photo 25)*. While extensively damaged by bat guano mining in the 1960's it was interesting nonetheless, with the main chamber an incredible 55m long and 8m high. Speleothems were few and predominantly recent in origin, but still actively growing! The area was also quarried for limestone in the 1850's with the limestone calcined on site to produce lime, which wagons unloading supplies at Inverell would backload to Armidale for use in the building industry.

20. Balancing rock beside track.

22. McIntyre Falls and plunge pool.

23. Columnar crystals of Tourmaline.

24. Entrance to the Ashford Main Cave, Kwaimbal NP.

25. Water-worn passage in main cave. Note how limestone is deposited over a poorly sorted sedimentary layer.

Here was another chance to use the ultraviolet torch, with very surprising effect. The limestone itself proved inert but the few recent speleothems (stalactites and shawls) glowed bright pink to deep red, many of them showing a ghostly bright yellow phosphorescence when the torch was turned off. The effect in the total darkness of the cave was startling!

We returned to Emmaville via Limestone Road and Ashford and arrived back at camp at 5:30pm in time for happy hour before dinner.

Thursday 20th October

The group met up at the Caravan Park at 8:15am ready to depart for Torrington, but we were delayed an hour when Stan discovered a flat tyre on his 4WD, the result of a 5 x 1 cm rock spike picked up on the road back from Kwaimbal yesterday.

Although pastoralists had settled the Torrington area in the 1840's, the Mole Tableland only became well-known after the discovery of tin in the 1870's. This drew hundreds of prospectors and miners, many coming from Cornwall and Devon. The main settlement was eventually named Torrington after a town in Devonshire, England. Mining activity peaked in 1920 when the settlement was serving around 600 miners. The Torrington had 5 general stores, a butcher, baker, Court House, Police Station, Post Office, two churches and a hall. Mining declined slowly after 1946 when the government reduced its wartime subsidy on the tin price. The only remaining Hotel closed several years ago and is now a private residence and even the Caravan Park has closed, leaving only a scattering of houses and rough dilapidated miners' shacks.

At Torrington we turned north onto the Silent Grove Road, almost immediately driving into the roadside ditch at the sight of a mind-boggling example of a Health and Safety nightmare! A local resident, intent on ridding himself of a large tree that was threatening his garage, had rigged up two long ladders, one tied to the other by duct tape and anchored to the tree just below the first branch by the same material!! Several lengths of rope hung noose-like from the branches, presumably rigged to catch them as they were sawn off the trunk - or was he setting himself up for a hanging!! But a few days later both the ladders and the tree had gone, with no sign of a body.

Continuing up the eastern boundary of the Torrington State Conservation Area, with areas of open farmland to the east, we turned left at Tungsten 6.2 kilometres to the north of Torrington onto the Duck Creek Fire Trail. While only a narrow sandy track it was in excellent condition and after travelling a further 1.5 kilometres we took the left fork and headed west towards the Pacific Copper Plant. Two black snakes were tempting fate by trying to cross the road as we drove by. Towards Pacific Copper the road be-

came quite rough, with patches that would certainly be impassable after rain. Turning to the left onto a side track a further 2.6 kilometres on we arrived without incident at the deserted plant of Pacific Copper Ltd. *(Photo 26)*, where we set up beside the track for morning coffee.

In 1974 the CSIRO and New South Wales Department of Mineral Resources recognized the potential for an economic resource in the over 66 large silexite (greisen) bodies identified and mapped in and around the Torrington Roof Pendant. These contain a total reserve in excess of 6 million tonnes, containing 1.2 million tonnes of topaz, the world's largest deposit. The topaz was seen as a source of fluorine and mullite (aluminium silicate) for refractories, ceramics and glass manufacture, and aluminium smelting. A pilot plant was set up in western Sydney in the 1970's, but the initial production of 4 tonnes of high purity mullite was unsaleable despite a large local market due to competition from other mullite sources. The plant constructed at Bismuth in the 1970's treated the mined silexite only for the wolframite, bismuth and gold it contained, but this operation soon proved unprofitable. As far as it is known no full scale production plant to produce topaz or mullite was ever constructed.

The silexite was mined from several large open pits in the Torrington Roof Pendant, including Fielders Hill North and Burnt Hut, both of which we would visit later in the trip.

The primary crusher, which once stood beneath the huge ore loading ramp in front of the plant building had been moved elsewhere. But most of the remainder of the plant was still on site, including a bank of gravity separation jigs on the upper deck *(Photo 27)* feeding into two shaker tables now in a bad state of decay, small flotation cells, magnetic separator and an inclined cylindrical calcining kiln used for drying the wolframite concentrate. A corrugated iron roof protected the area above the kiln, but the rest of the plant was open to the weather. Behind the plant lay a vast tailings dump of quartz/topaz sand, indicating that a huge tonnage of silexite had been processed prior to the plant's closure.

26. Deserted Pacific Copper Plant.

27. Examining gravity separation jigs.

We spent an hour or so exploring the plant and plotting out in our minds the process flow sheet. One of the gravity jigs was accessible via a steel mesh stairway and on the top screen we found small rounded pebbles of metallic iron to around one centimetre. At last here were the "micrometeorites" I had heard so much about many years ago! This brought back memories of a failed local venture in the 1980's. A prospector had discovered these iron pebbles in the regolith (surface weathered zone) throughout the Mole Tableland and on advice that they were small particles of extra-terrestrial iron spent many months dragging a magnet through the bush to collected several 44 gallon drums of the material. He had buyers lined up overseas to purchase the pebbles at something like $3/gram.

However, before any deal went through investigations by myself and staff at the West Australian Museum discovered that the pebbles were in fact blast furnace iron broken from discarded slag! A little literary digging (before the advent of on-line search capabilities) revealed the whole truth. The New South Wales Department of Agriculture, as an experiment back in the 1960's had crop dusted the Torrington pine forests with crushed blast furnace slag to gauge its effect as a nutrient. No word of success or failure, but the little pebbles fooled a lot of people for a long time!

On the western side of the tailings dumps we found a series of shallow water-filled open pits and in the side of the most southerly of these were exposed

28. Silexite vein within hornfels.

30. Partly filled-in open cut, Bismuth mine.

veins of silexite and pegmatite cutting across hornfelsic rocks *(Photo 28)*. The pegmatite was particularly interesting, with prismatic crystals of K-feldspar to six centimetres projecting from ore wall into the fine-grained material which composed the remainder of the metre-wide vein. A loose block of this pegmatite nearby provided fresh specimens without damaging the outcrop.

Back at the vehicles we dumped our rocks and walked over past the ruins of the office building, its filing cabinets and desks strewn about as if in an act of aggression by some disgruntled employee when the plant closed! Beyond we found the remains of an old slab hut, complete with a now largely rotted front porch made of saplings and covered by a tin roof. Inside the timber floor had gone, once raised above the earth by a network of felled timbers to keep out vermin. The walls between each of several rooms had once comprised hessian over which had been glued multiple layers of old newspapers dating back to 1925, but these also had just about gone. Behind the house stood two galvanized iron sheds and the rusting ruins of a car *(Photo 29)*. An occasional rose bush gone wild marked former house gardens. Across the adjacent clearing stood an array of mineral processing machinery including trommels and gravity jigs. An old shed nearby held piles of destroyed electrical switchgear and a large heap of crushed silexite samples.

29. Ruins near the Pacific Copper Plant.

The house had belonged to the Turner family comprising Louisa and Alfred plus their 4 children, who ran a farm here in the 1920's. Their only daughter Millie (Amelia) was the last resident of Bismuth and lived here till a few years before her death in 1975 aged 88. Fortunately the wildfires of 2009, which devastated over 25,000 hectares of the surrounding bushland, had spared these historic relics.

After lunch we drove on to the Bismuth mine, arguably the most famous mine on the Mole Tableland and only 0.5 kilometres away to the north adjacent to the track to Fielders Hill. We arrived at what I knew to be the spot but the mine was nowhere to be seen! The wildfires had removed the deep fuel from the ground and most of the forest understorey. Within weeks the wattle scrub had taken over and was now so dense that nothing could be seen north of the track! But battling through this scrub I soon located the main open cut *(Photo 30)* and then everything else then fell into place. Sadly the old core shed and winding frame adjacent to the open cut had gone, victims of the wildfires.

This is an historical and unique mine site, a draw card to geologists Worldwide. The mineral association here is found nowhere else in the World.

This epi-Permian pegmatite complex comprises an elongated silexite dyke associated with a series of pegmatites of varying composition. The main pegmatite consists of lithium-bearing biotite, orthoclase feldspar, beryl and quartz and shows concentric zoning passing into a biotite-beryl association containing a variety of cobalt, nickel and iron arsenides, of which safflorite (cobalt arsenide) is the most abundant. The

pegmatite was emplaced at shallow depth as shown by the presence of brecciation and stockwork veins. Intrusion of the silexite preceded the pegmatite with material for both derived from the Mole Granite. The pegmatite lies near the southern boundary of the Torrington Roof Pendant.

The silexite-granite contact is exposed in the open cut above one of the two inclined shafts leading from its north-western side. Over 30 years ago I had found a vein of green fluorite at the bottom of this shaft, but had no desire to go back down. A wide bulldozed costean south of the open cut had once provided small clear beryl crystals in a kaolinised pegmatite vein but no trace of this could be found. The silexite body appears to have intruded along a vertical fault, with fine-grained leucocratic granite exposed at the surface on the north side but only at a depth of 100 metres or so on the southern side. The surface rocks present were hornfelsic Permian sediments. The dyke had been offset at 4 points along its length by faulting.

Mine dumps adjacent to the main open cut contained mainly silexite and only hints of the fine biotite rocks and the small open pit to the north which once provided beryl crystals in pegmatite now lay waterfilled. The main shaft, sunk to the south of the costean, was initially unlocatable. In past years it was the dumps around this shaft that had provided the best specimens. But, back towards the Fielders Hill track at a small patch of cleared brush and disturbed ground lay a large pile of rocks recently pushed up by dozer. A little investigation showed that this was in fact the site of the main shaft, the rocks piled over it by National Parks in the hope that the heap would collapse down into the shaft, filling it and thus removing a safety hazard. But the rock pile and disturbed ground around it proved a treasure trove, providing large lumps of coarse biotite pegmatite which were broken up to reveal coarse crystallised wolframite, abundant

31. Fielders Hill North Pit, now water filled.

32. Silexite veins intruding hornfels.

arsenides and patches of fine beryl crystals. Everything black and coarse-grained was quickly loaded into vehicles! Also found were good fresh samples of the host rocks, including fine leucogranite and hornfels showing direct relationships to the mineralised veins. This was a unique opportunity to collect specimens, the likes of which had not been seen since the deposit was worked.

From the Bismuth mine we drove around 1.5 kilometres to the end of the now very rough and stony track where back in 1982 Pacific Copper Ltd. had excavated the enormous Fielders Hill North pit *(Photo 31)* to extract over 72000 tonnes of ore averaging 0.2% tungsten oxide to feed their plant at Bismuth. This open pit is typical of the mined-out silexite bodies. It was pipe-like with sills near the surface. Mining at nearby Fielders Hill South began in 1899 and between 1905 and 1920, 7500 tonnes of ore was mined containing 441 tonnes of tungsten as wolframite, mainly from shallow rich veins. This ore was processed at the old plant near Bismuth Dam.

After viewing the open cut and finding only silexite amongst the rubble on its floor we turned to the large rock dump on the western side of the track. Here we found fresh large blocks of dark grey hornfels intruded by veins of light-coloured silexite and pegmatite *(Photo 32)*, with many blocks showing evidence of stoping of the wallrocks by these intrusions. But the main attractions here proved to be the magnificent bearded orchids *(Photo 33)* growing around the edge of the dump, which the delighted photographers immediately pounced on. A couple of dried

33. Bearded Orchid, Fielders Hill.

34. Perfect reflections!

35. Sunset as seen from Emmaville Caravan Park.

snake skins amongst the rocks attested to the possible presence of some dangerous local inhabitants! Despite what our mud maps said, the view from these rock dumps to the west revealed only low densely timbered hillsides and was not spectacular.

After coffee an attempt was made to locate the continuation of the track to the Carpet Snake Creek Fire Trail a few kilometres to the north, but without success. So we backtracked to the Bismuth mine and on to the haul road from the Burnt Hut mine, which, for a change of scenery, we followed across to the Duck Creek Fire Trail. On the way we came upon several large roadside pools of strangely black water. The fires back in 2009 had been followed a few weeks later by torrential rains that washed out large areas of burnt forest and sent millions of litres of black soot-laden water into local streams and hollows. These pools are remnants of this event. There was not the slightest breeze and in the black sooty water the reflections of the enclosing forest *(Photo 34)* were unbelievable!

Continuing on directly across the Duck Creek Fire Trail we came on the track down into the massive open pit of the Burnt Hut mine, another of the silexite deposits exploited by Pacific Copper. After a brief investigation and finding little of interest we returned to camp, arriving around 5:15pm. The interesting day was completed with a wonderful sunset *(Photo 35)*.

Friday 21st October

Today had been set aside for our joint tour of fossil sites west of Warialda with the Inverell Gem and Lapidary Club. We had to be up by 5:30 am and leave Emmaville by 7:30am to arrive in time to catch the tour bus at the Inverell Showground. Everyone made their own way and all arrived ahead of time.

At the Showground dozens of vehicles had already lined up for a day's sapphire fossicking on Reddestone Creek. But only 11 turned up for the fossil tour, 9 of which were Society members! We left at 8:30am in a 45-seater bus and headed west along the Gwydir Highway through Warialda and on to Gravesend. The country was much dryer out here, with rolling brown hills on either side of the road. There was not even a shop in Gravesend, but it did have a Post Office and Pub!

West of Gravesend the bus turned south on Gravesend Road, then left into Wilson's Road and on to Myall Vale Station, owned by the sole occupier Hugh Kean. On his quad bike Hugh led the bus south through grassy paddocks to the base of a rocky sandstone ridge where our driver Ross parked the bus near a large native pomegranate tree. Here we had coffee before heading off on foot for a long walk around the side of the ridge.

The main geological feature here was immediately apparent, huge blocks of beautifully cross-

36. Coarse crinoidal limestone.

38. Strangler fig growing over a granite boulder.

bedded sandstone scattered over the hillside, some standing more than 10 metres tall. These are probably Triassic in age, were obviously deltaic in origin, and rest uncomformably on the underlying rocks that in most places were covered by regolith. No outcrops of these rocks became visible until we had climbed further up the ridge. Once there, vertically tilted interbedded shallow marine limestones, shales and mudstone of Devonian age (400Ma) became apparent in the network of drainage gutters which had cut down through the soil. The limestone beds were no more than 30cm thick and contained only broken transverse and longitudinal sections of crinoid stems, rare brachiopods, and none of the calyxes we had been led to believe were present in abundance. *(Photo 36)* In reality this was just a normal crinoidal limestone, although Hugh produced from a pocket some very nice rugose corals he had found here.

Despite the lack of good fossils and the tight restrictions on collecting anyway, the walk amongst the huge granite monoliths and open white Cyprus pine forest was interesting and provided great photo opportunities. Many of the large rocks had overhangs sheltering ancient Aboriginal art. *(Photo 37)* Large strangler figs had taken hold on and around some of the rocks *(Photo 38)* due to the proximity of water, with the occasional bonsied example trying to gain a root hold in cracks. One boulder had a natural well of fresh water *(Photo 39)* while others hosted surprisingly extensive cave networks. Near the top of the ridge a large black snake slithered around the edger of a rock, took one look at Dawn, and retreated – good move, wise snake!

During his wanderings Hugh had also picked up well-made stone axes and core stones and early on we were shown a flat horizontal rock face sheltered by a strangler fig where numerous grinding grooves had been carved. The absence of any nearby permanent water supply suggested the existence of a wetter environment when the grooves were made.

Our trek took us around the back and up the spine of the ridge. Near the summit was an area of limestone float where good examples containing crinoid stems could be picked up. The fossils only appear on weathered surfaces of the rock. As we plodded down the ridge back to the bus a large goanna slowly made its way up the trunk of a nearby ironbark tree.

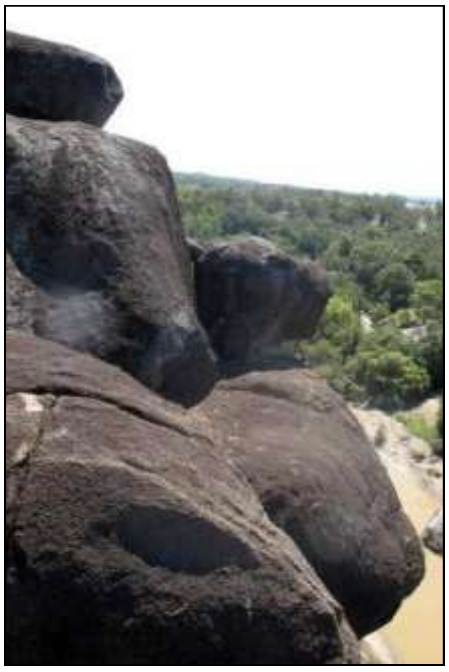
37. Ancient aboriginal art on a rock overhang.

39. Chris examining a natural well within a boulder.

The bus departed the fossil site at 1:20pm and then pulled into the Apex Park at Warialda for lunch. Heading east again on the Gwydir Highway the bus turned to the north just out of town to the Cranky Rock Reserve, a local council tourist project. Here was a large well-appointed picnic area and kiosk. Below the picnic area a suspension bridge over a small ravine led into one of the western-most granite outcrops in the New England Region.

The track wound through typical granite boulder scenery to a lookout over a short but surprisingly spectacular granite canyon. On the way to the lookout the track skirted a gargantuan egg-shaped balancing boulder, probably the largest any of us had ever seen. *(Photo 40)* Other much smaller balancing boulders could be seen across the river. Other tracks led to the bottom of the canyon but with only a half hour available there was just no time to explore this fascinating area to our satisfaction.

Back in Inverell we returned to our own vehicles and headed for the local McCafe for coffee before driving on to Glen Innes to shop for supplies, then back to Emmaville where Ian and I were joined by Stan and Dawn for a delicious baked dinner with cheesecake dessert at the Club Hotel. It had been a hot and exhausting day, especially in the non-air conditioned bus, with the temperature reaching 28°C accompanied by high humidity.



40. Cranky Rock, Warialda.

Saturday 22nd October

Today was much cooler and the humidity more bearable with only scattered cloud drifting across the sky. The group departed in convoy and headed up to Torrington, where we took the Silent Grove road north along the eastern edge of the State Conservation Area. The further north we travelled, the more spectacular the granite scenery became with walls of granite boulders along both sides of the road, in some areas showing closely spaced vertical joints which had split massive boulders into huge parallel slabs like some ancient stone monument. We made few stops on this trip, although in July I'd been shown a number of fascinating sites up here by a friend in Canberra who had pioneered Silent Grove Farm and managed the McGillivray's tin mine, one of the region's largest.

As we came down off the granite of the Mole Tableland into Silent Grove Farm and the folded Early Permian sandstones, siltstones and conglomerates of the Bondonga Beds, the country flattened out. The last sign of metalliferous mining we would see was the site of McGillivray's tin mine adjacent to the western side of the road immediate north of Silent Grove Homestead. Now only the remains of the concentrate drying shed and a huge shed built by the subsequent owner of the property to house military machinery was visible from the road. We had access to these tin workings, but no time to explore today.

Only one geology-related stop was made along the road. Uncomformably overlying the Permian sediments where the road crossed the summit of a narrow northwest-southeast trending ridge 12.4 kilometres northeast of Silent Grove is a small outlier of Late Permian Gibraltar Ignimbrite *(Photo 41)*, a light coloured rhyolitic rock composed of fragmented glassy crystals of quartz and twinned K-feldspar in an almost white aphanitic matrix. This rock overlies warped poorly

41. The 'Camels Hump', an outlier of Gibraltar Ignimbrite.

sorted beds of Early Permian conglomerate with tuffaceous layers, as could be seen in the northern side of the road cutting. On our previous visit back in June, David and I had climbed the hill here, coming across several snake skins amongst the rocks. So climbing the hill on this trip was strongly discouraged. But we had previously left sufficient fresh material at its base to show the group the nature of this spectacular rock.

Further north there were spectacular views over the Mole Valley to the south, making this one of the most scenic roads in northern New South Wales, and several brief stops were made for photographs. Eventually we reached the Bruxner Highway and arrived in Tenterfield at 12pm as planned.

Coming onto town from the hills to the south, due to a diversion off the Bruxner Highway forced by a bridge closure, gave us an overall view of this cultural epicenter. With a population of 3500 it is one of the country's most significant historic settlements. It was here, at the Tenterfield School of Arts on 24th October 1889, that Sir Henry Parkes presented his vision for a united Australia in his famous Federation speech, which led to the Federation of Australian colonies in 1901.

Here we paused for a delicious lunch and great coffee at the Willow Tree Café in the main street, before undertaking a brief tour of the back streets in search of the famous cork tree. Located on the north side of Wood Street between Molsworth and Martin Streets north of the Highway, this is the largest cork tree in Australia. It was brought out from England by Edward Parker and planted in 1861. It is truly massive!

At 1:30pm we met up at the roadside rest area on the New England Highway south of Tenterfield, and then headed on south to the property of Wayne Halliday, located east of the Highway just south of Bluff Rock. On his quad bike Wayne led us down through his paddocks to the trestle bridge that carried the now abandoned Sydney-Wallangarra rail line over the Bluff River. *(Photo 42)*

42. Trestle rail bridge crossing the Bluff River.

Here we spent the major part of the afternoon relaxing beside the magnificent sandy bed of the Bluff River in the shadow of one of the engineering marvels of railway construction. Sadly, with the line now abandoned, the bridge is rapidly deteriorating, but its solid timber construction will see it standing many years into the future. Forming the bridge abutments were large blocks of two very familiar rocks, Bombo Basalt from the South Coast near Kiama, and Martin's Creek Andesite from the Hunter Valley. The latter was the most abundant material and was probably used for ballast along the track. Also scattered around were numerous lumps of coal, a legacy from the days of steam. Branches of the huge she oaks lining the river banks were festooned with spectacular lichens. This was perhaps the first chance we'd had to relax on this excursion and we took our time over coffee before departing rather reluctantly, returning to the Highway and heading south to Deepwater.

Back in July I had visited Leslie Ball at her shop "Mr. Tumbles" when her husband Doug's mineral collection had been put up for sale. I had never seen such a menagerie of tools, specimens and craft supplies so we included a stop here on our afternoon program. Everyone was enthralled and left after an hour or so with armfuls of stuff!

Although Club Hotel Publican John had forewarned Ian and me, it came as a shock to arrive back at the Hotel and find the yard full of dancing bikers from the Ulysses Motorcycle Club. But their presence at the Pub tonight meant that we could join in the special baked dinner arranged for them! The bikers were no problem to us and a boon for the Pub. When the Hotel music machine broke down they rode one of the bikes into the bar and danced to the music of its state of the art CD player till 1am. They did not disturb us. We heard nothing!

Sunday 23rd October

The bikers were still in bed snoring loudly When Ian and I left the Hotel to join the others for a 9am departure for Torrington. It was to be a great day up on the Mole Tableland with a maximum of 21°C, cool breeze and only scattered cloud - ideal for bushwalking!

43. Native Iris or 'Blue Flag'.

45. 'Mystery Face' rock, a spectacular example of differential weathering on a granite boulder.

44. *Boronia granitica.*

46. 'Brain Rock' formed by exfoliation on a balancing boulder.

In Torrington we again drove north on the Silent Grove road, turning west onto Butler Road 2.5 kilometres north of the old mining town and on to the parking bay at Mystery Face walking trail.

Right away we encountered local wildlife. A large huntsman had become trapped behind the Perspex of the National Parks display board! The gravel path from the parking bay meandered through open bushland showing no sign of the recent fires but obviously burnt by previous wildfires. It passed by numerous piles of granite boulders and several really spectacular outcrops. Wildflowers were in abundance, most spectacular of which were the scattered bunches of the native iris "blue flags" *(Photo 43)* along with *Boronia granitica (Photo 44)*, *Phebalium grandulosum* anfields of white flowering *Okaria gravis* between the granite boulders.

We took the trail direct to Westminster Rocks, a stunning pile of huge granite boulders riddled with surprisingly large and extensive caverns formed by weathering and erosion along joint sets. Higher points on the outcrop provided spectacular views over the nearby granite hills. One huge rock face on the western side appeared to display extensive and very old Aboriginal peckings visible only in oblique light.

A short spur off the 2.6 kilometre loop trail led southwards to Mystery Face, another pile of large granite rocks spectacularly arranged. Here we found the intriguing Mystery Face itself *(Photo 45)*, a 2 metre high rock projecting from the regolith with the ap-

pearance of a face on both sides. Little imagination was needed! Just as spectacular is the nearby "Brain Rock" *(Photo 46)*, a large granite boulder crazed by weathering, perched on a tall plinth of weathered granite. From here Chris and I decided to try to reach the next granite hill a kilometre or so to the south as it looked even more spectacular, smaller but more exposed. But dense bush, then a deep canyon blocked our way.

The return walk to the main loop track took us up over eroded granite rock platforms where small plants struggled to survive in rocky hollows where moisture collected after rain. Many of these plants can only survive on the rocks since anywhere else they cannot endure the repeated fires that occur in this region.

After lunch at the picnic tables beside the parking bay some of the group returned to Westminster Rocks to take advantage of the afternoon light on what was a perfect day for photography. The rest drove to Nomad Picnic Area and walked to Thunderbolt's Lookout. Some then drove back to Torrington and on to Deepwater to revisit Leslie Ball at her shop. It was well worth a second visit and again we came away loaded with stuff. Most of the group arrived back in Emmaville by 4pm.

Monday 24th October

This would be the second free day of the trip, available to shop, clean-up, explore, or re-visit areas of particular personal interest.

Ian and I returned to Torrington to revisit the Bismuth mine and further explore the geological and mineralogical diversity revealed in the old dump material pushed over the main shaft. This search proved very rewarding, with large blocks of coarse biotite/K-feldspar pegmatite unearthed, little weathered after being protected from the elements by overlying dump material for decades. Amongst the finds were large books of biotite mica in white quartz, coarse biotite pegmatite with embedded crystals of wolframite to 2cm enclosed in K-feldspar and most surprisingly large blocks of black biotite rich in silvery veins of cobalt nickel iron arsenides. Realising the potential for some interesting associations and in the interests of preserving some quite rare material, every large block of black rock was loaded into the car.

We then drove south past the abandoned Pacific Copper plant and down the hill for 100 metres or so, turning right at the intersection and in less than 100 metres coming to a large sandy clearing on the northern side of Bismuth Dam. I had always wondered where it was! The gravelly soil here was littered with small fragments of topaz, recognized by reflection of sunlight from its flat cleavage faces. This large earth wall dam, built over 100 years ago by horse and dray, is rimmed by reed beds and is drained by spillways dug through tough resistant hornfels on either side of the wall. During the massive rains that followed the fires of 2009, the wall had been overtopped and major damage done to the earth fill. This was made evident by significant seepage from the base of the wall. It is possible to drive across the dam wall but we opted to walk. Peering down the 10 or so metres into the bush at its base there were obvious signs of diggings where fossickers had been searching for topaz.

At the southern end of the wall the track veered off into the bush but after about 50 metres we ventured off through the bush to the east. Just off the track we came to some minor concrete foundations and old stone flumes, part of a very early treatment plant built close to the dam to treat tungsten ore from nearby mines. Further down the hill towards Highland Home Creek were more recent and larger foundations, below which were the remains of a concrete buddle and then vast sandy tailings dumps. But the most fascinating find here were the ruins of a very crudely made drying oven adjacent to the buddle.

Covered by fallen dead saplings and rampant weeds, we had to partly clear the immediate area before the overall construction became clear, in the process disturbing some rather angry, colourful and rather large spiders! Discussion a few days later with local miner and identity Bill Sherratt revealed that his father built this structure sometime prior to 1950! The oven walls comprised rough blocks of hornfels with round one metre high chimneys at the southern end made of half bricks crudely cemented, capped in one case by a section of a sluicing monitor and the other by a rusty tin can!

Ian and I returned to the Nomad Picnic Area for lunch and were soon joined by Ron and Ellen, who then left for Mystery Face. David, our joint tour leader, arrived as arranged at 2:10pm and kindly waited while Ian and I trekked the 2 kilometre track up to Thunderbolt's Lookout.

Located at the summit of yet another huge pile of granite boulders, and accessed by an extensive intra

-boulder cave system then a 5 metre securely anchored steel ladder, the lookout provide magnificent 360 degree views over the surrounding countryside.

We then called on Bill in Torrington to arrange a group tour of his mill, the last one operating on the Mole Tableland. He was only too pleased to accommodate us. Returning to Dutchman Road we left my Forester at the locked gate and David drove us down to the gate on Curnows Road south of Torrington. A few days ago we had attempted to find the connecting track between Dutchman/Harts and Curnows mines, but had been unsuccessful. But now, within a few hundred metres of Curnows mine we re-entered bushland devastated by the 2009 fires and realized we had reached our previous turn-back point! Unknowingly, we had turned back within a few hundred metres of our goal! We continued northwards past Dutchman/Harts workings, coming to a large concrete bunker with steel doors still attached nestled against large granite boulders and close to the older workings of the Jones, Rundles and Valinose shafts along the ridge top beside the Dutchman Road. Presumably this was an explosives store. We were back in Emmaville by 5:30pm.

Tuesday 25th October

Although fine, there was a thick smoke haze building up from early morning, not the best conditions for landscape photography! As the weather forecast had promised no rain it was decided to attempt a cross-country bush bash. We left in 4WD convoy at 9:15am and headed north up The Gulf Road, turning east onto the Carpet Snake Fire Trail just north of the ford over Paradise Creek. This strictly 4WD trail was instrumental in fighting the 2009 wildfires and runs northwards for several kilometres before turning east along the valley of Carpet Snake Creek to join the Duck Creek Fire Tail north of Carpet Snake Mountain north of Torrington.

Just a kilometre from The Gulf Road the track climbed steeply up a bouldery granite ridge and, although recently refurbished as an essential fire trail, deep transverse gutters placed at intervals to slow erosion gave some vehicles a few clearance problems. Half way up the ridge we pulled into a large flat clearing on the right, site of the Specimen Hill mines. Located 17.5 kilometres west of Torrington, this deposit was discovered in 1909 and was last worked in 1950 for tin. It is now popular with fossickers for quartz crystals. The mines worked several lodes over a large area of the Mole Granite outcrop, mainly by shafts sunk on chlorite-rich lodes that contained most of the tin. There are also largely barren quartz and quartz/chlorite veins that often contain crystal-lined vughs.

After morning coffee we pushed on, coming out onto relatively flat open ground a few kilometres further to the north. This part of the Mole Tableland is almost devoid of mines but the wild scenery, spectacular show of wildflowers and variations in the vegetation made for an interesting drive. As the track came into the valley of Carpet Snake Creek the typical piles of granite tors re-appeared and quite surprisingly scattered amongst them and seeming to prefer the gravelly granite soil in crevices between them were abundant grass trees.

Much of the forest along the valley floor had been burnt, but was now showing strong signs of recovery. Small swampy areas still waterlogged after the rains of 2010 hosted stands of bushy pale yellow flowering C*allistemon* amongst tall green grass and the native iris *Patersonia* added splashes of bright blue to the grey granite outcrops. Sections of track were still boggy from seepage after the 2010 rains.

As the trail climbed the last few kilometres to the Duck Creek Trail junction it became very steep and stony, but still easily negotiable. Around 15 kilometres from Specimen Hill we reached the Duck Creek Trail and turned south towards Torrington. It was several kilometres before we came across any tangible evidence of mining. Twelve kilometres north of Torrington Tony and Dorothy Powell from Howard in Queensland had pulled in at an extensive patch of shafts and pits on the east side of the road. We were able to tell them that this was Elliott's 2 lode and that their efforts in searching the dumps would be fruitless, as David and I had explored this area back in June. What was notable here however were the obvious remains of a Chilean mill *(Photo 47)* for grinding

47. Chilean mill remnant - used to grind wolframite ore.

48. emerald mine.

49. Bismuth Dam provided water for mining activities.

the ore to release the wolframite it contained. This deposit is yet another hosted by the Early Triassic Mole Granite and was in the form of a joint-controlled pegmatite vein. T. Elliott worked it between 1911 and 1918 and notable amongst the production was a 250Kg slug of pure wolframite!

The Powells were new to the Mole Tableland so we offered to show them the Bismuth mine, which they would have had no chance of finding otherwise. On the way we paused briefly at emerald mine. *(Photo 48)* While I led them to the Bismuth mine, the others went on to Bismuth Dam *(Photo 49)* where we were to meet for lunch. *(Photo 50)* The return to the Bismuth mine resulted in my finding an 8 kilogram slug of biotite riddled with arsenides, which on breaking up back home revealed the best examples of this association I'd ever seen.

When I arrived at the Dam everyone was on hands and knees looking for topaz! It seemed by the scattering of small pits they were not the first. After lunch we walked across the dam wall and down through the old wolframite treatment plan sites Ian and I had discovered a few days ago. In the rocky bed of Highland Home Creek below the mill tailings we tried unsuccessfully to sieve the bottom gravels for topaz, and yet this was billed as one of the good spots! Disillusioned, we headed back to Emmaville at around 3pm.

The Emmaville Court House Trust had offered to put on a dinner for us at $10/head in the old Court House *(Photo 51)* and a small donation of $5 each on top seemed in order. Terry were invited guests in appreciation of Terry's involvement in the success of the trip. Organised by Mick Sherf (David's brother in law) and Rod and Anne from the Manse, a long wooden table draped with checkered

50. Lunch beside Bisthmus Dam.

cloth had been set up down the centre of the court room in readiness for a feast of lamb and beef stews *(Photo 52)*, followed by the best bread and butter pudding ever, made by Allen and Shirley Taylor of Ben's Falls Retreat. Any profit from the dinner would go towards restoration of the building to its former state, a task which was already well underway with the inner walls stripped of their timber lining to reveal the extraordinary damage done by those voracious little insects called termites.

While we enjoyed the delicious food and lively conversation, outside in the fading light the next generation of these destructive pests had taken to the wing by the thousands around a large pine tree, much to the obvious delight of a lone Indian Myna bird flitting around grabbing what it could.

When the Court House came into disuse all the fittings were auctioned off. Now many of those residents who had taken advantage of the auction are donating the items back so the building can be fully restored to its former use, albeit only to run mock proceedings for visiting groups and school children.

51. Disused Emmaville Courthouse .

53. Mill complex, Torrington.

At 9pm distant thunder announced the approach of a storm from the west and soon it was raining heavily, but hopefully not up on the Mole Tableland! The dinner broke up around 9:30pm as the rain outside eased off.

Wednesday 26th October

Some of the group, particularly those staying at the bottom Pub, had discovered that the paper shop made reasonable sandwiches, so with lunch in hand we set off up to Torrington again at 9:05am. At Torrington we continued out along the Deepwater road to mill *(Photo 53)*, where we found Bill and David already waiting. Bill spent several hours very proudly showing the group around the mill, a clever and often outright ingenious concoction of bits and pieces garnered from around the Tableland. Back at his house and yard in Street is an education in mining hardware! The mill had been tidied up since David and I had visited in June and the breech in the tailings dam repaired. The skills in ore treatment have been made use of by many people, who often send them seconds or difficult mine products to treat. The design allowed every possible product type to be accommodated, from tin and tungsten concentrate to road gravel.

Ore from the stockpiles at the top of the ridge is pushed into a huge ore bin supported by a style of enormous creosoted logs and covered by a grizzly, rails spaced at regular intervals to prevent rock larger than the primary crusher could handle from entering the bin. These are broken up by sledge. A conveyor from the base of the ore bin feeds the ore at a controlled rate to the top of a 14tph jaw crusher driven by a 4 cylinder Perkins truck engine. An exhaust fan at the western side of the crusher extracts dusts and directs it well away from the site. From this primary crusher the ore can follow one of three streams. Granite crushed for road metal is reduced to 3 inches top size and stockpiled near the crusher to be trucked out as demand requires. Crushed rock (again mostly granite) can also be transferred by conveyor fitted with a tramp iron magnet to a Jacques gyratory cone crusher with the product moving on to a trommel for screening to a size distribution suitable for concrete aggregate. Oversize is returned to the cone crusher. The central flow line handles crushed tin and tungsten ore (3 inches top size) which is simply stockpiled, then

52. Waiting for stew to be served, Emmaville Courthouse.

54. Rebuilt curvilinear shaker table.

transferred by front end loader to another bin which feeds into a five-head stamper fitted with an automatic feeding wheel to ensure the stamper is never overloaded. The flywheel on the stamp battery is made of wood, the only material that can withstand the constant thumping of the steel stamps.

Fines from the stamps are funneled into a classifier that separates fines from oversize material that is returned to the stamps. The fines go over curvilinear shaker tables *(Photo 54)* that separate the liberated economic minerals from the worthless gangue (mainly quartz) according to their density. The tables are fitted with splitting boards at the discharge side that can be moved to optimize the purity of the mineral products. Seconds from the tables are returned to table feed to be reprocessed. The quartz sand is dumped, topaz sand is stockpiled, and the coarse cassiterite or wolframite is dried and bagged for sale. The finer impure products from the tables are sent down a sloping bank of blanket troughs where the heavier minerals are trapped in the weave. The product is then washed from the blankets and directed into separate tin and tungsten sumps. This material is then purified in a buddle located off site. With the skill of a specialist, Bill demonstrated with a round nose shovel how the very fine mineral slimes are recovered from the sump material. *(Photo 55)* Before bagging the fine products are dried in a drying shed over a wood fire. The whole process operates largely on gravity feed and hence its location down the side of the ridge.

After a truly fascinating tour Bill eventually left in his old Bedford truck, leaving us to enjoy morning coffee in the shadow of the mill. Before leaving we looked over the tungsten ore stockpile trucked in from the James Hill workings where we found coarse black wolframite scattered through vein quartz traversing hornfels host rock. Breaking up a few boulders not only saved Bill the expense of primary crushing, but also enabled demonstration of the physical nature of wolframite and its associations in the ore.

55. Bill showing how mineral slimes are recovered.

56. Fossicking (no luck!) on the Severn River

The high granite ridge backing the mill site is one of the most impressive in the district, its enormous granite boulders broken into vertical slabs by jointing.

On our way back to Emmaville we pulled in to the site of the Wallaroo tin mine 2.5 kilometres south of Torrington, located at the very southern edge of the Mole Tableland at the start of the bitumen down the big hill. The aim was to see what National Parks had stirred up during rehabilitation of the site since David and I had last visited in June.

Discovered in 1882, The Wallaroo mine worked yet another vein deposit in the Mole Granite and produced 1422 tonnes of cassiterite concentrate from two near vertical tabular quartz/chlorite lodes up to 2 metres thick worked to a depth of 94.5 metres until the mine finally closed in 1944.

The entire area of mullock heaps had been raked up and pushed into untidy heaps over the old shafts, which were now identified by numbered steel pipes. Aesthetically the site was now an unsightly mess with its historical integrity destroyed. But the operation had exposed an abundance of fresh material not seen since the mines operated. A high mound of granite rubble had been placed across the entrance track to keep people out.

Most of the dumps consisted almost entirely of coarse Mole Granite with occasional boulders of chloritic quartz porphyry. An initial surprise was the presence of chalky blue staining on some of the rocks that immediately suggested the presence of copper as the carbonate azurite. But then we realized the colouration was only present on exposed surfaces – it was

paint from a spray can! But the dumps did reveal some real mineralogical surprises, including a few good cassiterite samples, several nice quartz crystals, and a chlorite-rich rock containing abundant vughs lined with dark green rosettes of chlorite. There were also examples of sphalerite and galena in the chlorite rock and some interesting rock types. So even more rock was piled into our sagging vehicles.

After lunch back at camp in Emmaville we set off at 1:30pm for a sapphire fossicking afternoon. Mick Sherf had kindly given the group access to the Severn River south of Emmaville that formed the southern boundary of his property. Just before the bridge we turned right through an open gate and followed the rather indistinct track through tall grass peppered with yellow buttercups to the river's edge.

The water was deep after the recent storms but we found a few spots where gravel was exposed amongst the ignimbritic rocks and dug deep holes into it in an attempt to find bedrock where heavy minerals like sapphire would surely be concentrated. But after a few hours of digging and sieving *(Photo 56)*, our dreams of making a quick fortune faded, as not a sign of sapphire or any of the associated materials appeared in the wash.

Typically the sapphire wash occurs in narrow lenticular bodies along present streams and as large areas of alluvial flats marking the position of older stream beds. The sapphire is concentrated in irregular pockets with the base of the wash giving the highest yields. Associated with the sapphire are pleonaste (spinel), basalt pebbles, ironstone, quartz, fragments of porphyry, granite, metasediments, zircon, ilmenite and tourmaline.

The sapphire has been found almost exclusively in streams draining basalt country suggesting that the basalts are the source but not the origin. These basalts were erupted between 20 and 50 Ma, and even as late as 6 to 7Ma.

In utter disappointment and with darkening skies heralding approaching storms we returned to the Caravan Park to drown our sorrows outside David and Jan's van. By 4pm it had become very cold and by 5pm it was raining steadily.

Thursday 27th November

The last day of the trip started out partly cloudy, with cloud increasing throughout the day and leading to light rain in the afternoon. Time we left!

Moving off at 8:30am again towards Torrington, we paused for some time at the old Wallaroo tin mine site again in the hope of making more discoveries on the redistributed mine dumps. Our search revealed only a few small examples of green fluorite and a few nice examples of microleucogranite veining in the Mole Granite.

After morning coffee at the Nomad Picnic Area, where the digital photographers were mesmerized by tiny lichens on the trees and tiny colourful fungi on posts, *(Photos 57, 58, 59)* we continued on through Torrington and up the Silent Grove road, taking a rough track to the right just prior to the last big granite outcrop south of the Blatherarm Picnic Area turn. He we searched the hillside for the quartz crystals Ron Jillet at the Emmaville Mining Museum said would occur here. The track curved up onto the crest of the ridge past quite a number of abandoned shallow pits, shafts, and deep trenches, generally known as the quartz deposit. All had been sunk on coxcomb quartz veins, often showing signs of central crystal-lined vughs. But it soon became obvious that much time and energy would be needed to find anything good, although a few small groups of crystals were found. Some wolframite was also found scattered through the exposed quartz veins.

On the other side of the Silent Grove road in an area known as Ford's Hill we found a line of deep shafts but there was no indication on the dumps around them of just what was mined there

We had lunch under darkening skies at the Blatherarm Camping Area where there were picnic tables and toilets. Sadly the extensive forest understory of bushy bottlebrush was no longer in flower, their once brilliant fiery red and orange cones now dead and drab. David and I had seen them at their best last June. But scattered Hakea and Grevillea were in flower and kept the photographers busy.

The Blather Creek here was a wide anastomosing expanse of deep sandy channels amongst the dense scrub and while there were scattered fossickers' heaps of sieved gravel our experience at Highland Home Creek suggested that we would have similar luck here! Besides, the gravels here had been turned

57. Small patch of lichens' growing on a wattle tree.

58. Photographing tiny orange fungi, Nomad picnic area.

59. Tiny orange fungi, the largest about 4 mm in diameter.

60. Spectacular Ugly Corner Falls.

over many times in the last 130 years according to a nearby National Parks sign.

Back out on Silent Grove road we pulled into the parking bay for Ugly Corner Falls. None of us knew what to expect and it had begun to drizzle rain. There was no vehicle access to the falls and it would be a 1.4 kilometre walk in down a very steep track, which would turn out to be even steeper on the walk back out!

The first kilometre or so followed a well-formed although often boggy vehicle track down the southern edge of a deep gully past thick unburnt vegetation scattered with wildflowers. One shallow trackside shaft was the only visible sign of mining activity here.

The road then gave way to a walking track carved into the wall of the gully, which eventually wound its way amongst the granite outcrops along the west side of the Oakey Creek Gorge. Within a few

hundred metres we had to cross Oakey Creek as it ran over a wide granite shelf and could already hear the falls, its volume swollen by recent rains. The track then climbed up the east wall to a large flat granite outcrop that gave an excellent vantage point over the falls. *(Photo 60)*

Here we were left in awe by the view. Water cascading over such a spectacular drop into a narrow cleft in the granite wall just didn't seem to fit into the normal rounded boulder scenery typical of the Mole Tableland. Brief appearances of the sun delighted photographers.

The walk out was long and arduous but the effort had been worthwhile. Some of the group dallied a while around the base of the falls photographing wildflowers but by 4pm we were all back at base camp in Emmaville. It was now quite cold but at least the cloud that had dogged us all day was finally clearing. Most of the group would be homeward bound tomorrow.

Report by Brian England with additions and corrections by David Atkinson.

Photographs 34, 35, 36, 37, 38, 39 and 40 by David Atkinson.
Photographs 54 and 55 by Ellen Evans.
Remainder of photographs by Ron Evans.

Publication Acknowledgements.

Geo-Log 2011 was compiled & produced by Life Member Ron Evans.

Special thanks to trip leaders for organising and leading activities, then preparing and submitting reports for inclusion in Geo-Log 2011.

Many of the reports are lengthy and detailed providing an excellent reference for the future. Without their valuable contribution, it would be impossible to produce the publication.

Geo-Log 2011 is larger than normal because four weekend activities were organised in addition to our usual geological Safari. Hence, longer reports and more photographs included.

Thanks you also to trip participants who made photographs available for inclusion in the publication. Their contribution is acknowledged.