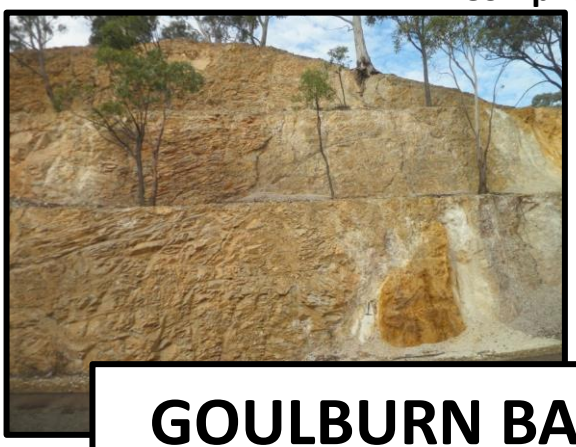
AMATEUR GEOLOGICAL SOCIETY of the HUNTER VALLEY

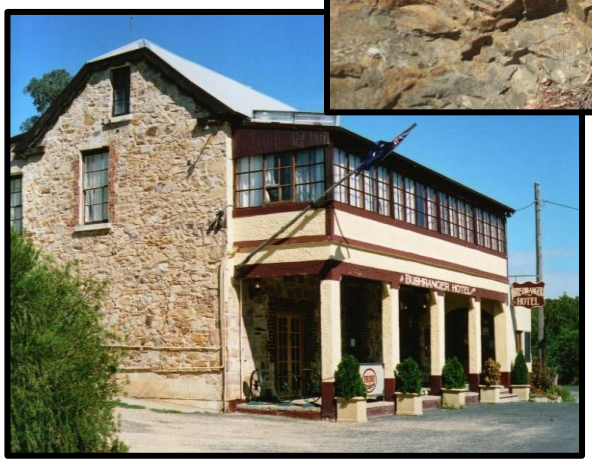
Compiled by Winston Pratt



GOULBURN BASED EXCURSION

2020

GEOLOGICAL BACKGROUND



BUNGONIA – GOULBURN – GUNNING EXCURSION

GEOLOGICAL BACKGROUND

The area covered by this excursion is very varied, both geologically and through time. The major geological structures trend north – south and the following brief outline, somewhat oversimplified, will traverse the area on an east – west section approximately 100 km from Shoalhaven River east of Bungonia, through Goulburn, Gunning, Dalton and almost to Yass. The major structural units encountered by this traverse commences in the Bungonia Shelf, then crosses the Goulburn Basin and the Southern Hill End Trough, followed by the Frogmore Fault Zone before ending in the Yass Shelf. The traverse covers a duration of c.125 Ma and includes three major orogenic events such that the area and period is one of the most tectonically active 125 Ma in the state's geological history. This dynamic period is then followed by a 320 Ma period of quiescence in which deep weathering and erosion produced peneplanation of the area and also provided a significant supply of sediment to the bordering Sydney Permian and Triassic Basin.

The opening of the Tasman Sea finalized about 60 Ma caused a general small uplift of the area now forming the Great Dividing Range. The Crookwell Basalt was extruded over a period from 51 Ma to 36 Ma (Eocene) followed by the extrusion of the Wheeo Basalt during the period 21 Ma to 15 Ma.

The excursion will however visit areas both north and south of this traverse, from north of Binda for 85 km south to Gearys Gap on Lake George. This geological background is summarised largely from the Goulburn 1:250 000 Geology Sheet and Explanatory Notes (Thomas & Pogson, 2012), being the most recent, comprehensive and detailed publication available. The reader is directed to this publication for further detail.

The concept of geological time is often difficult to comprehend and, as this discussion involves an approximate time line, the following examples may be helpful in appreciating the magnitude of the time spans involved.

If Mt Kosciuszko, Australia's highest mountain at 2,228 m, was eroded at a rate of just 2mm (the thickness of a wooden tooth pick) per year, it would be at sea level in 1.2 Ma. A lateral movement on a fault line of a rate of 10 mm per year would produce a lateral displacement of 10 km in 1 Ma.

Another concept involved in this discussion is that of an orogenic period. An orogenic period involves folding, faulting, thrusting, rifting, deformation, intrusion of plutons and accompanying volcanics, and upheaval of the Earth's crust on an almost incomprehensible scale over a period of several millions of years. Each orogenic event imprints its effects on preceding events by further folding previous folds, often in a different direction, folding and/or reactivating pre-existing faults and plutons. The event involves the uplift of areas to form mountains and, particularly in pre-Middle Devonian times (c.390 Ma) when there was no vegetation cover, accompanying very high rates of erosion. The causes of orogenic periods are beyond the scope of this discussion.

The excursion area covers a small part of the Lachlan Orogen, a large structural unit encompassing most of central New South Wales. This unit comprises rocks in age from the Cambrian (c.500 Ma) to the Carboniferous (c.325 Ma) and was accreted onto the eastern side of older units some of which, including the Lachlan Orogen, later became the Australian continent. The Lachlan Orogen contains three major orogenic events, the Benambran, the Tabberabberan and the Kanimblan Orogenies.

These east-west compressive orogenies were indispersed on a cyclical basis with intervening periods of extension during which sedimentary basins formed and filled, and plutons were often emplaced. (**Appendix 1**) A pluton is body of magma which has solidified with a granular texture deep within the crust. A cluster of plutons in close proximity or with differing mineralogies and intruded approximately contemporaneously is called a batholith.

The **Benambran Orogeny** comprises probably two deformational phases in the Lachlan Orogen that were responsible for regional unconformities in the Ordovician and Earliest Silurian (pre c.430 Ma) rocks in this region. These rocks, mostly of the Middle Ordovician (c.>450 Ma) Adaminaby Group and the overlying Late Ordovician (c.450 - 445 Ma) Warbisco Shale and Bumballa Formation, are composed mostly of quartzose

turbidites and black shale sequences together with minor arc-related volcanics and volcaniclastics all of which have been tightly folded, thrust imbricated and generally have a strongly developed cleavage. During the first phase, faulting and folding produced local areas of deposition surrounding eroding areas of uplift, while some granites were possibly intruded into some of the folded and faulted areas during the second phase.

The Tabberabberan Cycle followed the Benambran Orogeny when, in the Early Silurian, extension was renewed and further granitic plutons, including the Oolong and Gunning Granites, were emplaced (c.427 Ma) in an area considered as a probable back-arc setting behind a new west-dipping subduction zone located to the east. Extensional basins developed on a substrate of crust deformed by the Benambran Orogeny at the end of the previous cycle.

In this new tectonic arrangement, sedimentation and subaerial volcanism in shallow marine and shelf environments was active on the Yass Shelf to the west and on the Bungonia Shelf to the east during the mid to Late Silurian (c.425 - 420 Ma). Also in the east local deeper water basins filled with quartzose turbiditic sequences and black shale, some with large blocks of limestone. As the Tabberabberan Cycle proceeded in the Late Silurian (c.420 – 415 Ma) the central part of the area became site of a rapidly subsiding deep water basin, the southern Hill End Trough and filled with quartzose turbiditic sequences, grey to black shales and mass-flow volcaniclastics. Simultaneously a second rift basin, the Goulburn Basin, developed to the south-east and filled with volcano-sedimentary sequences. The wide zone of subsidence encompassed by these two rift basins was bounded in the west by the Yass Shelf and in the east by the Bungonia Shelf. **(Figure 1)**

Table 1 briefly summarises the deposition of sedimentary groups and plutonic suites in relationship to the alternating extensive and compressive stress regiemes. **Table 2** presents a simplified stratigraphy showing sedimentary units, while **Table 3** shows plutonic units also to be encountered during the excursion. **Table 4** presents an igneous rock classification based on mineral composition involving quartz, orthoclase and plagioclase generally identifiable with a hand lens.

While the Goulburn Basin is partly adjacent to and contemporaneous with the Hill End South Trough, its internal stratigraphic relationships reflect a different depositional and volcanic history.

As the Yass Shelf, the subject of past AGSHV excursions, will not be included in this excursion, it will not be detailed further. The Bungonia Shelf is included and the following detail is presented.

The Bungonia Shelf is bounded on the west by a normal fault precursor to the Yarralaw Fault. The underlying Ordovician Adaminaby Formation is overlain unconformably by the Cardinal View Formation (c.420 Ma) of the Bungonia Group.

The eastern part of this group includes the basal Cardinal View Formation in which several limestone beds were deposited in a carbonate shelf system, probably in a range of environments including tidal flats, reefs and marine barriers. However to the south-west the Cardinal View Formation is predominantly siltstones with lesser sandstones, conglomerates and reworked carbonate detritus. These rocks were probably deposited in a marine slope system.

In the Bungonia area only the limestones are well exposed. The basal Cardinal View Formation includes the Lookdown Limestone Member. Further to the north the Cardinal View Formation is overlain by the Frome Hill Formation, but this unit is not present in the Bungonia area, possibly due to faulting, and the Cardinal View Formation is overlain by the Tangerang Formation of the Bindook Group. The Tangerang Formation exhibits an upwards transition from shallow to moderately deep marine redeposited volcaniclastic rocks, quartzose sedimentary rocks and minor limestones passing up into a subaerial sequence of ignimbrites and lava flows.

The Bindook Group in the Bungonia area is predominantly composed of the Tangerang Formation and the overlying extensive Barrallier and Joaramin Ignimbrites.

In the earliest Devonian (c.415 Ma) the Goulburn Basin shallowed markedly, accompanied by bimodal volcanism, and uplift and then erosion of the basin sequence followed. Then widespread largely terrestrial sedimentation and volcanism commenced (c.413 Ma) followed by the emplacement of plutons of the Marulan

Supersuite, the Arthursleigh Suite, namely in the Bungonia area, the Lumley Granite, the Springponds Tonalite, and the Marulan Granite. In the Breadalbane to pejararea the Wologorong Granite of the Parkesbourne Suite (c.410 – 400 Ma) intruded at the interface of the Hill End Trough and the Goulburn Basin.

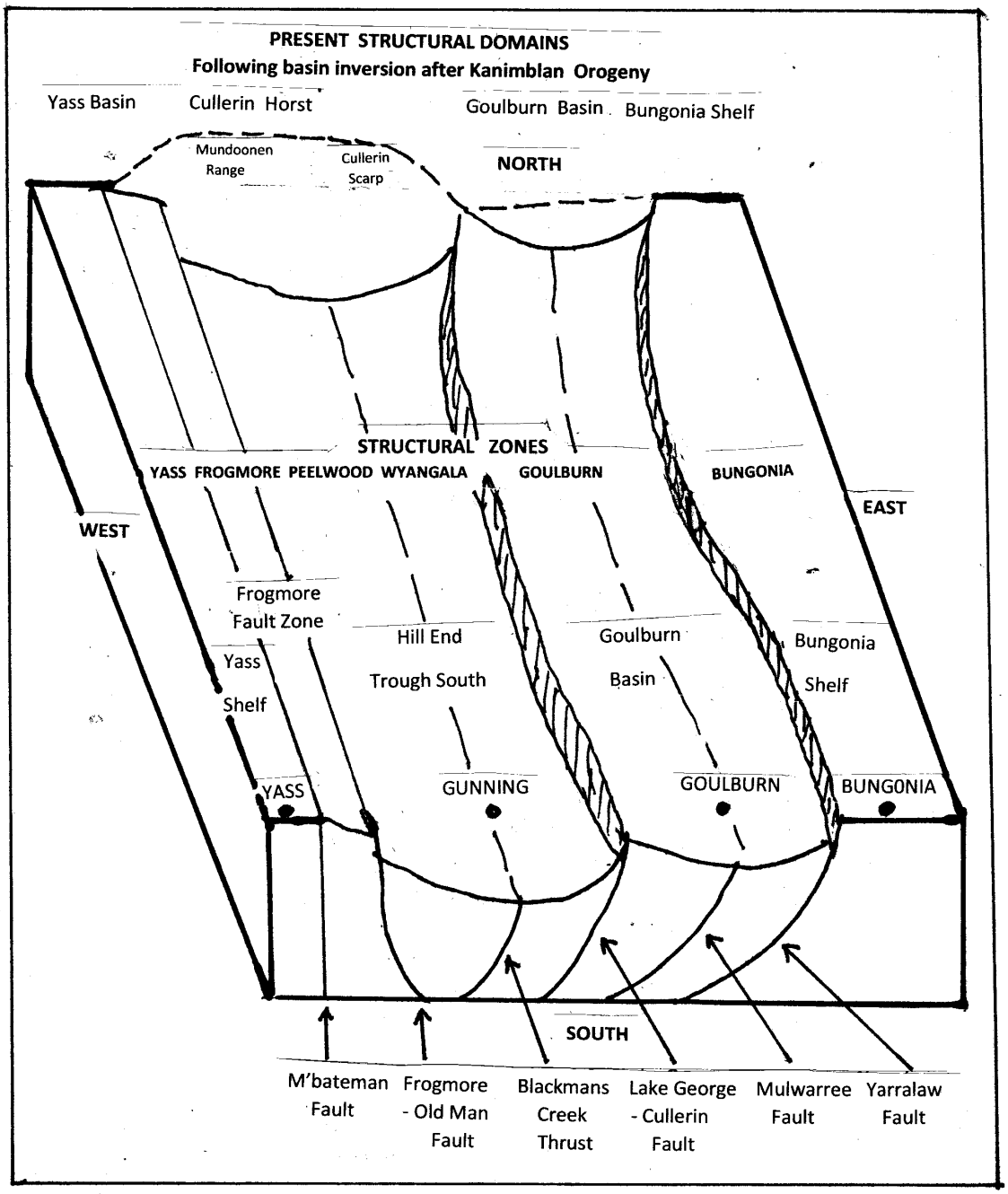


Figure 1. Simplified block diagram showing major structural components of the excursion area. The southern end depicts the structures immediately following the Tabberabberan Orogeny while the dashed line at the northern end depicts the current topographical configuration.

The end of the Early Devonian volcanism and associated plutonism was followed by a period of tectonic stability and gentle subsidence in which mostly shallow marine clastic sediments and limestones were deposited (c.400 – 390 Ma).

The Tabberabberan Orogeny concluded the Tabberabberan Cycle by imposing a strongly compressional regime over the region during the Middle Devonian (c.390 Ma). This deformation produced regional folding, cleavage formation, thrust faulting, shear zones often within or at the margins of granite plutons, and regional metamorphism. The resulting folding, faulting, uplift and erosion from this deformation have produced a markedly angular unconformity between the subsequent Late Devonian sequences and all earlier Palaeozoic successions.

On a regional scale, the Tabberabberan Orogeny resulted in the inversion of the Silurian-Devonian rift basins by which lateral compression squeezes the basin infill upwards to form an uplifted area.

The southern part of the Hill End Trough the strain was strongly partitioned into the Frogmore Structural Zone along the western margin and the Peelwood Structural Zone along the eastern margin where deformation and metamorphism were strongest and east-verging thrust imbrication, including the Binda Thrust, the Copperhannia Fault and the Lake George Fault, was developed.

The Goulburn Basin was also subject to high strain with the Silurian-Devonian basin fill, including the Bindook Group, being deformed into large-scale folds while major west-dipping thrusts, including the Mulwaree Fault, Towrang Fault and the Yarralaw Fault, also developed. Other major faults and shear zones in the Goulburn Structural Zone were also possibly active during this deformation. However the Bungonia Shelf to the east only experienced low strain, with deformation confined to a few broad, open folds in the Bindook Group and with little cleavage development.

The Kanimblan Cycle commenced in the Middle Devonian (c.385 Ma) with the formation of several, long, narrow meridional rifts in response to renewed extension. In the eastern Lachlan Orogen these rifts are characterized by felsic to bimodal volcanic units. The final phase of the Kanimblan Cycle commenced in the Late Devonian (c.380 Ma) and involved a short marine transgression followed by the deposition of more widespread fluvial red-bed sequences that overlie the volcanic rift volcanics. In the excursion area, only the marine to fluviatile sequences of the Lambie Group, are present. As these rocks are commonly bounded by younger faults, the full extent of their distribution is uncertain but these depositional basins were more extensive prior to Kanimblan folding.

The Lambie Group contains a basal marine sequence of sandstone, conglomerate and siltstone overlain by a thick fluvial sequence dominated by lithic-quartz sandstone, conglomerate and extensive reddish purple siltstone.

The Kanimblan Orogeny (c.350-325 Ma) was the last regional deformation to affect the Lachlan Orogen. The older Silurian-Early Devonian sequences and Ordovician basement were also affected by the steeply dipping faults and no major thrust imbrication of Late Devonian sequences occurred. The orogeny produced transpressional re-activation of pre-existing major faults with, folding and faulting of Late Devonian cover rocks and tightening of some existing fold structures in the unconformably underlying Ordovician-Early Devonian rocks. Faults active in the Tabberabberan Orogeny and which were reactivated in the Kanimblan Orogeny include the Frogmore, Lake George, Copperhania, Mulwaree, and Yarralaw Faults.

The east-west compressive forces caused the fill of the north-south trending Hill End Trough South to be squeezed upwards resulting in basin inversion. The Goulburn Basin was also likewise inverted but to a lesser extent.

As the cycle progressed and the compressive forces relaxed, granitic plutons were emplaced including, in this area, the Middle Carboniferous (c.326 Ma) Lockyersleigh Granite. At the end of the Carboniferous and commencement of the Permian periods (c.300 Ma) relaxation had become extension thus promoting the development of the Sydney Basin.

The accompanying Excursion Day Notes are relatively detailed for those readers who are interested in a more in depth view, while those who may find the detail confusing, because it is a large and complex area, the basic framework should, hopefully, be apparent. The main sedimentary units are the Ordovician Adaminaby Group, the Siluro-Devonian Mount Fairy Group, and the Devonian Bindook Group. The formation components of

these Groups are named as they are repeatedly encountered throughout the area and demonstrate the significant degree of folding.

TABLE 1

Table briefly summarising the deposition of sedimentary groups and intrusion of plutonic suites visited in this excursion in relationship to the alternating extensive and compressive stress regimes through geological time.

GEOLOGICAL PERIOD	SEDIMENT GROUPS & PLUTONIC SUITES	STRESS REGIME
Early CARBONIFEROUS	Lockyersley **Suite**	extension
	KANIMBLAN OROGENY	compression
Late DEVONIAN	Lambie Group	extension
	TABBERABBERAN	
Middle DEVONIAN	**OROGENY**	compression
Early DEVONIAN	Bindook Group	extension
	Arthursleigh **Suite**	extension
	Crooked Corner **Suite**	
SILURIAN	Campbells Group	extension
	Mt Fairy Group	extension
	Parkesbourne **Suite**	extension
	Tumboramboro **Suite**	extension
	Gunning **Suite**	extension
	BENABRAN OROGENY Ph 2	compression
Late ORDOVICIAN	**BENABRAN OROGENY Ph 1**	compresssion
	Bendoc & Magules Groups	extension
Middle ORDOVICIAN	Adaminaby Group	extension

TABLE 2

SIMPLIFIED STRATIGRAPHY SHOWING SEDIMENTARY UNITS TO BE ENCOUNTERED DURING THE EXCURSION
together with approximate ages of these units

SEDIMENTARY UNITS

PERIOD	EPOCH	STAGE	Age Ma	GROUP	FORMATION	MEMBER
CARBONIFEROUS			300			
KANIMBLAN OROGENY			361			
DEVONIAN	Late	Famennian	376	Lambie Group	***West*** ***East***	
					Tarlo F'm	
					Cockbundoon S'ndst'n	
		Frasnian	384		Strathaird F'm	
TABBERABBERAN OROGENY	Middle	Eifelian	392			
	Early	Emsian	409			
		Pragian	412	Bindook Group	Barrallier Ignimbrite	
					Joarramin Ignimbrite	
					Tangerang F'm	Carne Dacite
		Lochkovian	418			
	Pridoli		420	Campbells Group — Mt Fairy Group - Bungonia Group	Boxers Ck F'm Frome Hill F'm	
					Covan Creek F'm	
SILURIAN	Ludlow		427		Cuddyong F'm Cardinal View F'm	Lookdown L'stone
					Argyle F'm	
	Wenlock		433		DeDrack F'm	Joppa Siltstone
BENAMBRAN OROGENY Ph 2	Llandovery		444	Duro	***West*** ***East***	
					Hawkins Vol'cs Jerrarra F'm	
BENAMBRAN OROGENY Ph 1	Late		450	Margules Group / Bendoc Group	***West*** ***East***	
					Mundoonen S'ndst'n Poidevins S'ndst'n	
					Bumballa F'm	
ORDOVICIAN					Warbisco Shale	
	Middle		472	Adaminaby Group	***West*** ***East***	
					Abercrombie Formation	

TABLE 3

SIMPLIFIED STRATIGRAPHY SHOWING PLUTONIC UNITS TO BE ENCOUNTERED DURING THE EXCURSION together with approximate ages of these units

PERIOD	EPOCH	STAGE	Age Ma	PLUTONIC UNITS SUITE		
CARBONIFEROUS			300	Lockyersleigh		Lockyersleigh Granite
KANIMBLAN OROGENY			c.326			
			361			
		Famennian	376	A Arthursleigh P Parkesbourn T Tumborambo U Turrallo	A	Marulan Granite
	Late				A	Glenrock Granodiorite
DEVONIAN		Frasnian	384		A	Lumley Granite
TABBERABBERAN	Middle	Eifelian	392		A	Springponds Tonalite
	Early	Emsian	409		P	Wologorong Granite
		Pragian	412		T	Tumboramboro Granite
		Lochkovian	418		U	Forest Lodge Tonalite
	Pridoli		420	Gunning		Gunning Granite
	Ludlow		427			
SILURIAN	Wenlock		433			Oolong
BENAMBRAN	Llandovery		444			
BENAMBRAN OROGENY Ph 1	Late		450			
ORDOVICIAN	Middle		472			

TABLE 4 IGNEOUS ROCK CLASSIFICATION

Texture	Light coloured rocks						Medium coloured		Dark coloured			
Phanerites (equigranular - grains > 1mm)	No Qz, O>P(Na) + Nephaline / Nephaline Syenite	No Qz, O>=P(Na)	Qz, O>P(Na)	Qz, O<=P(Na)	5-20%Qz, O<=P(Na)	>5% Qz, O<=P(Na)	Qz, P(Ca)	10%-5% Qz, P(Ca)	>5% Qz or Ol,P(Ca) Fe-Mg dominant	Ol + Pyrox or H'bl	Olivine	O + P(Ca), Ca Pyrox, F'thoid or Analcime
		Syenite	Granite	Granodiorite	Adamellite	Monzonite	Tonalite	Fe-Mg subordinate Diorite	Gabbro	Peridotite	Dunite	Essexite
Microphanerites (equigranular - grains < 1mm)	Micronephaline syenite	Microsyenite	Microgranite Aplite	Microgranodiorite	Microadamellite	Micromonzonite	Microtonalite	Microdiorite	Dolerite		Picrite	Teschenite
Aphanites & Aphanite porphyries	Phonolite	Trachyte	Rhyolite	Toscanite	Quartz Latite	Latite	Dacite	Andesite	Basalt			
			Feldsite & Feldsophyre				Feldsite & Feldsophyre					
Glasses	Vitrophyre (containing phenocrysts) Obsidian & Pitchstone (without phenocrysts)						Vitrophyre (containing phenocrysts) Obsidian & Pitchstone (without phenocrysts)		Basalt Glass (Tachylyte)			

Qz = quartz O=orthoclase (K) P = plagioclase P(Na) = sodic P(Ca) = calcic Ol = olivine Pyrox = pyroxene H'bl = hornblende

PLAGIOCLASE FELDSPAR COMPOSITIONS

Na	Albite	Oligoclase	Andesine	Labradorite	Bytownite	Anorthosite	Ca
	100% - 90%	90% - 70%	70% - 50%	50% - 30%	30% - 10%	10% - 0%	

MAJOR SOURCES OF INFORMATION

The major sources of information used in the compilation of these notes are as follows and the reader is directed to these sources for further detail.

Goulburn 1:250 000 Geological Sheet SI/55-12, 2nd edition. Explanatory Notes. 2012. Thomas O.D. & Pogson D.J. (compilers). *Geological Survey of New South Wales, Maitland,* NSW. Also component 1:100 000 Geological Sheets.

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Site 39 – Lake George/Weereewa. By Geological Society of Australia, ACT Division. 2013.

Lake George Revisited, Parts 1 & 2. by M. Macphail et al. 2015 & 2016. *Australian Journal of Earth Science* **62** (7) & **63** (4).

Quartz-dominated Cenozoic Gravels in South-eastern Australia. by B. Pillans et al. 2017. *Australian Journal of Earth Science* 64 (8).

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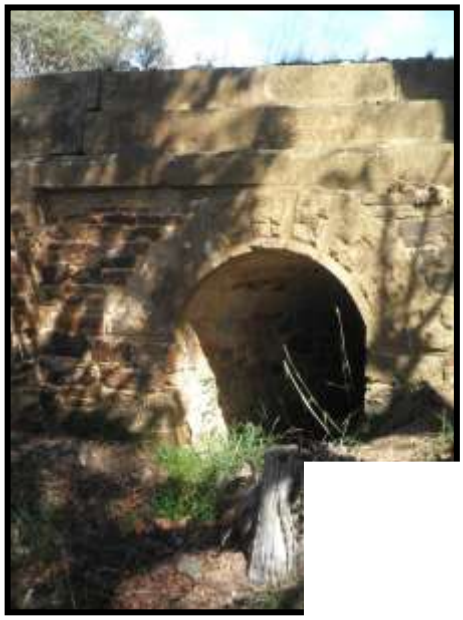
GOULBURN BASED EXCURSION



DAY 1

Goulburn to Marulan

DAY 1 - GOULBURN EXCURSION – To Marulan

This day's excursion will cross some of the many formations from Middle Ordovician to Late Devonian in age and exposures of two of the plutons of the Marulan Batholith will be visited. Generally only Formations observed will be named. The historic village of Marulan, its position on the 150^0 Meridian and as a centre of production of limestone and hard rock aggregate, will be discussed. The site of a hold-up by bushrangers and relics of the convict constructed Great South Road will also be visited.

Location 1. Driveby – Mulwaree Fault

This major N-S trending fault lies approximately up the centre of the Goulburn Basin. It is a complex fault with splits and re-entries. Just south of Chatsbury the fault is joined by another major fault from the west, the Yarra Fault which, north of the Hume Highway, separates Ordovician rocks on the west from Silurian rocks on the east.

Location 2. Driveby – Governors Hill

On the southern side of the Old Hume Highway weathered strata of the Late Devonian Lambie Group are exposed and show a multiple-fault contact between the Cockbundoon Formation and the underlying Strathaird Formation.

Location 3. Driveby - Quialigo Volcanics

On the crest of this hill igneous rocks of the Early Devonian Bindook Suite are exposed. These rocks are coeval with the Bindook Group of the Bungonia Shelf but have been deposited in the Goulburn Trough. The rocks contain non-welded ignimbrites of rhyolitic to andesitic composition with some thin basalts and volcaniclastic sandstones.

Location 4. Driveby - Turallo Suite 'tonalite'

On the crest of this hill igneous rocks of the Early Devonian Turallo Suite are exposed. The rocks are intermediate between a granite and a gabbro and are similar to the Forest Lodge 'Tonalite' which will be examined on another day.

Location 5. Driveby - Boxers Creek Formation

Immediately after crossing Boxers Creek bridge, on the southern side of the Highway, the latest Late Silurian – earliest Early Devonian Boxers Creek Formation of the Mt Fairy Group (MFG) is exposed in the road cutting. The Formation crops out poorly and consists of interbedded brown to cream lithic-quartz, very fine to very coarse sandstone and laminated, cream to grey siltstone and shale.

Location 6. Driveby – Covan Creek Formation

After leaving the Boxers Creek Formation the M1 traverses the latest Late Silurian – earliest Early Devonian Covan Creek Formation and then the Late Silurian Kerraway Siltstone both of the Mt Fairy Group (detailed on Day 2) (MFG) .

Location 7. STOP – The Towrang Stockade

From 1833 to 1843 the Towrang Stockade was the Chief Penal Camp in the southern district of the colony of New South Wales. Up to 250 male convicts engaged in the construction of the Great South Road were housed here. The convicts slept 10 men to a 12 metre square cell on bare boards with one blanket per man.

Culvert on Great South Road near Towrang Stockade

Entrance to Towrang Stockade Powder Magazine

Outcrop of Kerraway Siltstone rocks adjacent to Powder Magazine

The only remaining structure is the Powder Magazine, excavated into the creek bank, and in which the upper part of the entrance was restored in 1975, while the lower part is in original condition. Three nearby graves are associated with the Stockade and are designated: Private John Moxley, died 16.11.1838, aged 38 yrs; Elizabeth Whiticker, died 9.6.1841, aged 33 yrs; and Mary Brown, died 25.6.1847, aged 4 yrs.

These works on the Great South Road were constructed between 1838 and 1843. The complex comprises seven culverts, a stockade and a powder magazine.

The Stockade no longer remains, only its location which is fenced. The Powder Magazine was carved into the rock of the river bank and partially restored in 1975. A good outcrop of the rock is adjacent to the magazine entrance. The rock unit here is the Late Silurian Kerraway Siltstone of the Mt Fairy Grp.

Location 8. Driveby – The Towrang Fault

This major N-S trending fault separates the Late Silurian Kerraway Siltstone on the west from the Ordovician Abercrombie Formation on the east. Northwards this fault is covered by younger Devonian rocks of the Lambie Group.

Location 9. Driveby – Warbisco Shale

The Hume Highway (M1) now passes over the Warbisco Shale, a Late Ordovician unit very near the top of the Ordovician sequence and then the Middle Ordovician Abercrombie Formation, both subject to the massive folding and faulting of the Benambran Orogeny.

Location 10. STOP – Chowne VC, Rest Area (T)

This location is located near the axis of the regional Towrang Anticline. The Rest Area commemorates the VC winner Lt. Albert Chowne KIA in New Guinea in 1945. His wife, now Daphne Dunne, was noticed in the crowd watching Prince Harry, Duke of Sussex, in his 2015 visit to Sydney. Prince Harry noticed that the lady in a wheel chair was wearing a Victoria Cross with other medals and immediately stopped to talk with her and heard her story. He met her again in 2017 during his Invictus Games visit and again in 2018 when he was accompanied by his wife Megan, Duchess of Sussex. Daphne passed away in April 2019, aged 99 years.

As entry to the working quarries in the vicinity of Marulan was not possible, it would be appropriate to detail their operation at this point.

Lynwood Quarry

This quarry, operated by Holcim Australia, commenced operations in 2015 as a hard rock quarry extracting material from the Earliest Devonian Joaramin Ignimbrite of the Bindook Group. This operation was to coincide with the closing of the company's closure of its now exhausted Penrith quarries. The quarry is located adjacent to the Sydney – Melbourne rail line so that most of the product can be transported by rail. However as production developed, it was found that the recovery was not up to expectations and in 2017 a second quarry was commenced a kilometre or so to the west to extract material from the Carboniferous Lockersleigh Granite of the Oberon Supersuite. The original pit has been backfilled and the company has developed another quarry in the Joarramin Ignimbrite on Brayton Road.

The outcrop area of the Lockyersleigh Granite is roughly circular, covers an area of about 44 km^2 and is significantly flatter than the surrounding Ordovician and Silurian rocks. The Lockyersleigh Granite is a medium to coarse-grained porphyritic granite comprising two phases, a central pinkish porphyritic granitic phase and a marginal, generally grey, equigranular and more granodioritic phase.

A table outlining the main mineral compositions of the common igneous rocks is shown in **Table 4 of the Geological Background Notes.**

The majority of products produced are used for construction projects, primarily in concrete and roadway construction. These products include:

*Aggregates for use in concrete, bituminous surfacing, asphalt, landscape works, drainage works, road construction and gravel surfacing

*Railway ballast

*Rock for gabion baskets and wire mattresses used in stabilization and drainage works

*Rock for coastal protection works

*Manufactured sand for use in concrete, as fill and in landscaping

*Road base for use in road construction, as fill and in landscaping

*Oversize rock for landscaping, decorative and stabilization works

Gunlake Quarry

This quarry, operated by Gunlake Quarries of the Gunlake Group, commenced operations in the early 2000's extracting hardrock from the Joaramin Ignimbrite at the Gunlake Quarry in Brayton Road, Marulan.

The quarry caters mainly for the concrete and asphalt batch plants in Sydney and produces a variety of sized aggregates and manufactured sands. Road bases and crusher dusts are also produced together with rail ballast, gabion and large rock.

Location 11. STOP – Kerraway Siltstone Formation & Plumb's Inn, Narambulla Creek

At this point gently folded fine sandy strata of the Late Silurian Kerrawary Siltstone Formation (MFG) are exposed in the low road cutting bordering the median strip. The Kerraway Siltstone contains

Gently folded strata of the Silurian Covan Creek Formation

occasional fine-to medium grained sandstones. Both siltstones and sandstones are grey when fresh and weather to yellowish-grey or off white. The Formation crops out poorly and is characterized by areas of low relief. The depositional environment of the sandy beds is thought to represent distal turbidity flows or slumped sediments into an outer shelf or basinal environment.

Plumb's Inn – now called 'Wandi'

On the opposite side of the Hume Highway (The Great South Road in the 1860's) is the property 'Wandi', formerly 'Plumb's Inn' where on 19 December 1864, there was an incident involving the Hall Gang **(Detail is presented in Appendix 1).**

The building is an excellent example of a former Colonial Georgian coaching inn, and although partially inhabited, it is in poor condition. The main building is of stone construction with stone corner quoins and the wall blocks laid in ashlar style. The building is on the NSW Heritage Sites List.

Location 12. Driveby – Covan Creek Formation

Immediately east after 'Wandi' the Highway again traverses the latest Late Silurian – earliest Early Devonian Covan Creek Formation which is exposed in the road cuttings. The Covan Creek Formation underlies the Boxers Creek Formation and forms prominent wooded ridges with linear rubbly outcrops of quartzite from thickly bedded sandstone intervals, while fine grained rocks are usually poorly exposed.

Location 13. Driveby - Yarralaw Fault

The Yarralaw Fault defines the eastern boundary of the Goulburn Basin and its Ordovician and Silurian rocks from the Devonian rocks of the Bungonia Shelf immediately further east.

Location 14. Driveby – Joaramin Ignimbrite

The probable earliest Early Devonian Joaramin Ignimbrite of the Bindook Group crops out very poorly along this section of the Hume Highway. The rock is predominantly a distinctive rhyolitic, densely welded ignimbrite with prominent quartz and pink feldspar phenocrysts set in a pale grey to brown matrix. The unit is a hard rock source for the Holcim's and Gunlake's Quarries south-west and north-west of Marulan respectively.

Location 15. STOP – Marulan Village (T)

Marulan village is the only village, town or city in the world that lies exactly on the 150^0 S meridian. In 2002 a monument was erected beside the Hume Highway.

RIGHT *The 150^0 Meridian Monument*

The clock tower limestone block

The Australian Eastern Standard Time Zone is based on this meridian. This meridian also intersects the Oxley Highway about half way between Gunnedah and the village of Mullaley. This point on the Oxley Highway was visited on a previous AGSHV excursion.

The town clock rises above a 30 tonne block of limestone donated by Blue Circle Southern Cement Ltd from the South Marulan Quarry. It is the largest piece of limestone ever transported by road in the Southern Hemisphere. In 1818 Hamilton Hume and James Mehan reached the 'Goulburn Plain' and the following year Governor Lachlan Macquarie ordered the construction of the Great South Road from Picton to the Goulburn plains. The southern part of Macquarie's road ran approximately along the current minor roads from Sutton Forest through Canyonleigh, Brayton, Carrick and Towrang where it joined the current route to Goulburn. Another road ran from near Sutton Forest to Bungonia via Wingello, Tallong and South Marulan. In the early 1800's Bungonia was expected to become a major centre, but it subsequently proved unsuitable for intensive agriculture.

In the 1830's Thomas Mitchell rerouted the Great South Road to bring these two roads together at South Marulan and make a junction with one road to Goulburn and the other to Bungonia. However when the Main Southern Railway reached Marulan in 1868, the town migrated 3 km from South (Old) Marulan to the present location near the railway station. The cemetery is still located at South Marulan. The village has many historical buildings located along a short section of the main street which was the route of the Hume Highway until it was relocated to accommodate the Trucking Station in the 1970's.

Location 16. STOP – Greenhills Road, Glenrock Granodiorite

Glenrock Granodiorite

The town of Marulan is located on subcrop of the Glenrock Granodiorite, however outcrop is not apparent and isolated exposures are rare. At the Booral Glenrock Quarry on the South Marulan Road the granodiorite is quarried for a range of hardrock products including aggregate.

The Glenrock Granodiorite is a pink to grey, moderately coarse-grained biotite hornblende granodiorite with abundant fine-grained igneous enclaves and country rock xenoliths locally. It is one of the Marulan Batholith plutons.

Location 17. STOP - South Marulan Road, Marulan Granite

Marulan Granite

The mid to late Early Devonian Marulan Granite is one of the 13 granitic plutons, four of which will be encountered in this excursion, comprising the mid (to late) Early Devonian Arthursleigh Suite of the Marulan Batholith which extends from Bullio, on the Mittagong – Taralga Road, in the north to Windellama in the south and is comprised of more than 20 plutons.

The Marulan Granite contains pinkish/grey coarsely equigranular and strongly porphyritic granite phases. The unit forms a subdued landscape with some boulder outcrops and small tors.

Location 18. STOP. - Jerrara Road – Barrallier Ignimbrite

Barrallier Ignimbrite

The mid Early Devonian Barrallier Ignimbrite is a distinctive dark bluish-grey crystal-rich welded dacitic ignimbrite which is usually massive, composed of multiple flow units and is remarkably uniform over its large extent. The macro- and microscopic features of the unit are consistent with it being a high-temperature, high grade ignimbrite. The presence of densely welded ignimbrite favours a subaerial environment. The lack of unconformities or hiatuses and the unit's uniformity suggests rapid and continuous emplacement of the constituent flow units.

Location 19. STOP – Derrick VC Rest Area – Great South Road (T)

The Great South Road was the name of the original road from Sydney to Goulburn. It was rerouted several times and in this section, built in 1839, there still remains a bridge, probably designed by David Lennox, and six stone culverts. Late Late Silurian—earliest Devonian rocks of the Covan Creek Formation are exposed below the bridge.

Bridge and Covan Creek Formation rocks exposed below

Culvert 1

Culvert 2

Late Late Silurian—earliest Devonian Covan Creek outcrop at the entrance/exit to the French VC Rest Area

APPENDIX 1

The Hall gang held up the Yass mail coach on 11 November 1864 near Lodge's Inn east of Cullerin on the Bredalbane Plains after a series of robberies and holdups over the preceding few days in the Goulburn area.

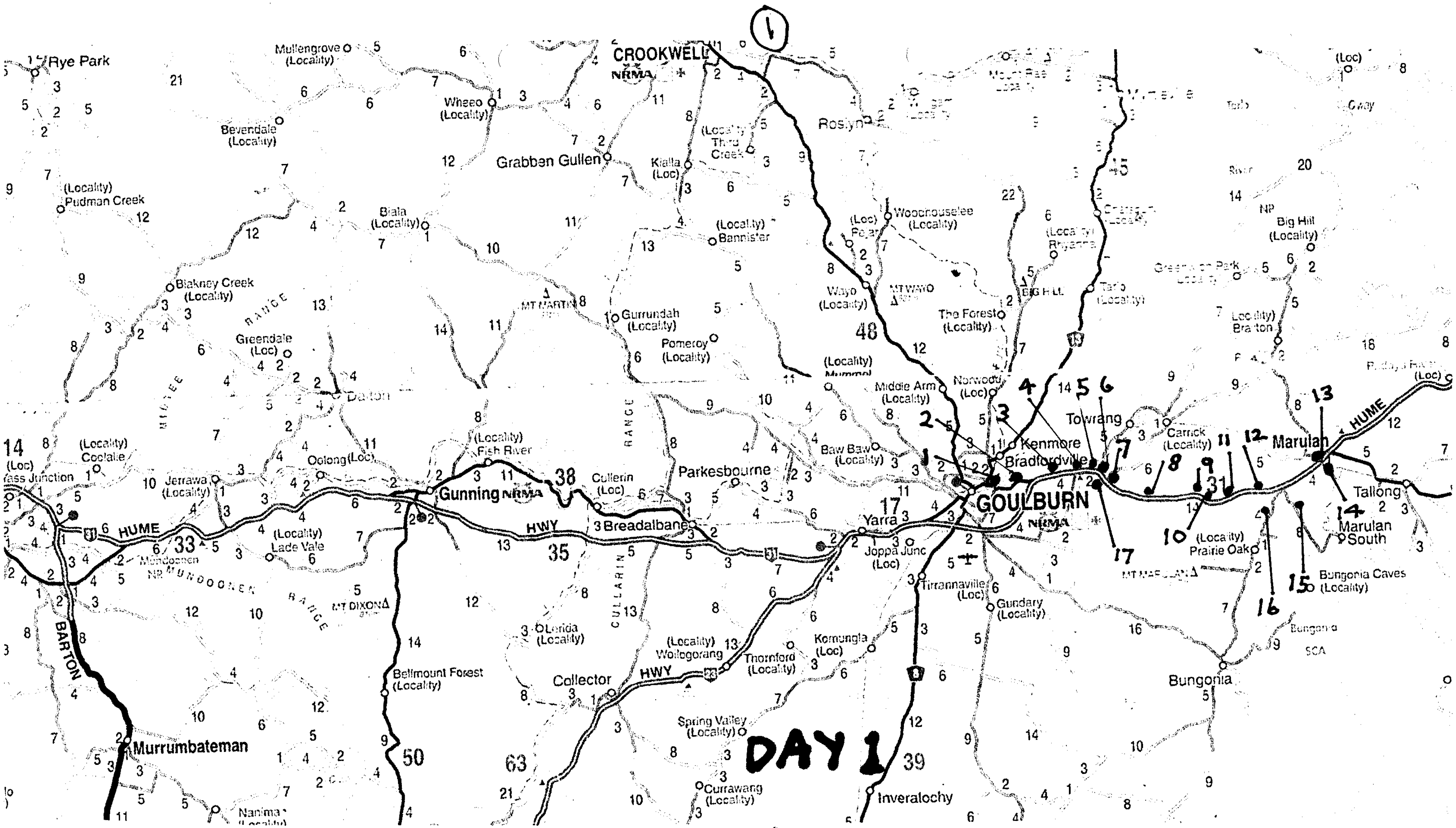
On 19 December 1864 Hall and his gang set up at 8 am near Narambulla Creek on the Great South Road (now Hume Highway) near Plumb's Inn to hold up the Goulburn coach. They held up all passers by and by the time the coach arrived they had 35 captives and a dray. After searching the coach they released all captives about 2 pm. The gang then remained to hold up the passenger coach from Berrima. However the Hon. William Maclean, Member of Parliament for Murrumbidgee, arrived at Plumb's Inn in his buggy and the bushrangers fired at him from across the road. On the Inn's verandah were guests celebrating the wedding of Maclean's daughter and these were rushed inside while Maclean fired his rifle at the bushrangers who promptly fled.

EXCURSION LOCATION DIRECTIONS

DAY 1 - Goulburn to Marulan and return via South Marulan

		pp	cum		
	START			Travel north along Grafton St from Tourist Info to 100m from Lights at Sydney Rd	**Toilets**
Stop		0	0	Turn right into assembly area. It is the 2nd park almost at lights.	
1	**Sydney Road**			Return to Grafton Rd then turn right onto Sydney Rd	
Loc	Mulwarree Fault	0.6	0.6	Sydney Road crosses the Mulwarree Fault at bottom of the hill.	
2	**Sydney Road**			Continue on Sydney Rd and view outcrop in cutting on RHS of road almost at crest.	
Loc	Governors Hill	2.8	3.4	then continue on to the M31 onramp.	
3	**M31**			M31 is passing over this Formation.	
Loc	Quialogo Volcanics	2.4	5.8		
4	**M31**			Continuing on the M31, the Turallo 'tonalite' is exposed in the cutting on the crest	
Loc	Turallo Suite 'Tonalite'	1.6	7.4	of the hill.	
5	**M31**			Continuing on the M31, the Boxer Creek Formation is exposed on the right side	
Loc	Boxers Ck F'm	0.7	8.1	of the M31 at the Boxers Creek Road **Turn Off (TO).**	
6	**M31**			Continuing on the M31, the H'way is passing over this Formation.	
Loc	Covan Creek Formation	0.4	8.5		
7	**M31 & Towrang Rd**			A 8.9 km Turn left into Towrang Rd. Go 220m and do U turn before bridge & return to M31	
Stop	Towrang Stockade	1.2	9.3	(Hume H'way). Parking on left immediately before M 31. Walk 200m alongside M31 and	
				passing old culvert on left, to gate on left, enter & go northwards 150m to sign at stockade	
				site, the continue for 150m to powder mag. in embankment. Return to car.	
8	**M31**			Continuing on the M31, the H'way crosses the M31 100m east of Carrick Rd **TO**	
Loc	Towrang Fault	0.9	10.2		
9	**M31**			Continuing on the M31, in the area from where the median strip in the M31 widens	
Loc	Warbisco Shale	2.0	12.2	for the next 1.6 Km (to the right hand curve), the M31 passes over the Wabisco Shale	
10	**M31**			This area is underlain by the Ordovician Abercrombie Formation.	**Toilets**
Stop	Chowne VC Rest Area	3.1	15.3		
11	**M31**			250 m past Narrambulla Creek bridge there is a lay bye area on the left side of M31	

	Kerrawang Siltstone			for parking. Plumb's Inn is opposite behind the trees. Sediments may be alluvial or	
Loc	Plumb's Inn	2.3	17.6	residual Kerraway Siltstone or Covan Ck F'm. Their sub-horizontal attitude is confusing.	
12	**M31**			M31 is now passing onto the Late Silurian Covan Creek Formation which continues	
Loc	Covan Creek Formation	0.5	18.1	to the Yarralaw Fault.	
13	**M31**			The Yarralaw Fault forms the boundary between the Goulburn Basin and the	
Loc	Yarralaw Fault	1.8	19.9	Bungonia Shelf. Bush on Sth side of M31 changes to open paddocks.	
14	**M31**			From here to the South Marulan overpass the M31 traverses the Lower Devonian	
Loc	Joarramin Ignimbrite	2.0	21.9	Joarramin Ignimbrite. Outcrops are sparse.	
15	**M31 & George St**			Take the 2nd entry to Marulan on left. Turn right 100m at R'bt. 150₀ Monument is	**Toilets**
Stop	Marulan Village	7.6	27.5	in park on right. Continue into village. Take left split for parking at park & toilets	
16	**George St, M31. &**			Continue north to R'bt, turn right & go under M31 to Sth bound M31 onramp. Then	
Stop	**Greenhills Road**	3.2	30.7	1.5 Km turn left into BP. Immediately turn left again onto dirt track to Greenhills Rd	
	Glenrock Granodioite			Go 1.0km to do Uturn in space and return 200m to just past gate on left. O/c on right	
17	**Greenhills Rd, M31 &**			Continue back to BP. Go around back of BP to rejoin Sth b'nd M31.Take Bungonia	
Stop	**Marulan South Rd**	4.4	35.1	Off ramp at Sth Marulan. At R'bt turn left into Sth Marulan Rd. Go 1.4 km & slow	
	Marulan Granite			down as lay by on left of road on left curve is difficult to see until you are there.	
18	**Marulan South Rd &**			With great care to avoid quarry trucks in both directions, turn back to South Marulan	
Stop	**Jerrara Rd**	4.0	39.1	and turn left into Jerrara Rd to Bungonia. From R'bt go 2.6 km to lay by on left.	
	Barralier Ignimbrite			Boulders of Barralier Ignimbrite on embankment opposite.	
19	**M31 & Derrick VC RA**			With care turn back to South Marulan R'bt. Turn left onto M31 and heading towards	**Toilets**
Stop	Rest Area			Goulburn go approx. 15 km to Derrick VC Rest Area. Drive 425 m to parking then	
		15.0	54.1	walk 100m Sth beyond toilets to bridge on Old Sydney Rd. Then turn back and	
				follow Old Sydney Rd for approx 300 m to the old culverts. Return to vehicles.	
				Before exiting the Rest Area and about 30 m from M31 there is an outcrop of	
				Covan Creek F'm on left.	
20	**M31**	9	63.1	Aprox. 9 km back to Start. Hope that you enjoyed the day.	**Toilets**
Stop	Return to Goulburn				



DAY 1
CROOKWELL
GOULBURN
Marulan
Tallong
Marulan South
Bungonia Caves (Locality)
Bungonia
Prairie Oak (Locality)
Carrick (Locality)
Towrang
Kenmore
Bradfordville
Norwood (Loc)
Middle Arm (Locality)
Baw Baw (Locality)
Parkesbourne
Yarra
Joppa Junc (Loc)
Tirrannaville (Loc)
Gundary (Locality)
Kemungla (Loc)
Thornford (Locality)
Wollogorang (Locality)
Spring Valley (Locality)
Currawang (Locality)
Inveralochy
Collector
Lerida (Locality)
Breadalbane
Cullerin (Loc)
Gunning
Fish River (Locality)
Bellmount Forest (Locality)
Oolong (Loc)
Jerrawa (Locality)
Coolalie (Locality)
Lade Vale (Locality)
Murrumbateman
Dalton
Greendale (Loc)
Blakney Creek (Locality)
Pudman Creek (Locality)
Rye Park
Bevendale (Locality)
Mullengrove (Locality)
Wheeo (Locality)
Grabben Gullen
Kialla (Loc)
Biala (Locality)
Gurrundah (Locality)
Pomeroy (Locality)
Bannister (Locality)
Thirit Creek (Locality)
Roslyn
Woodhouselee (Locality)
Wayo (Locality)
The Forest (Locality)
Rhyanna (Locality)
Taro (Locality)
Big Hill (Locality)
Brayton (Locality)
HUME HWY
BARTON
HWY
MT MARTIN
MT DIXON
CULLARIN RANGE
MUNDOONEN RANGE
NRMA
1
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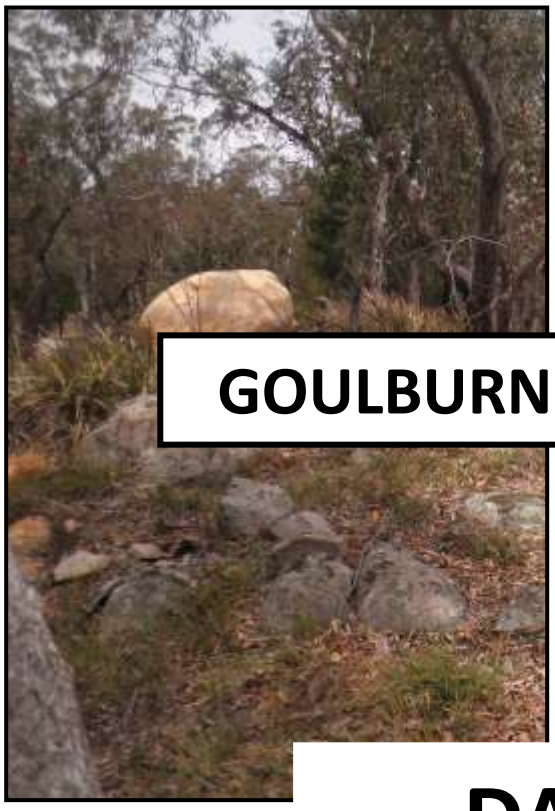
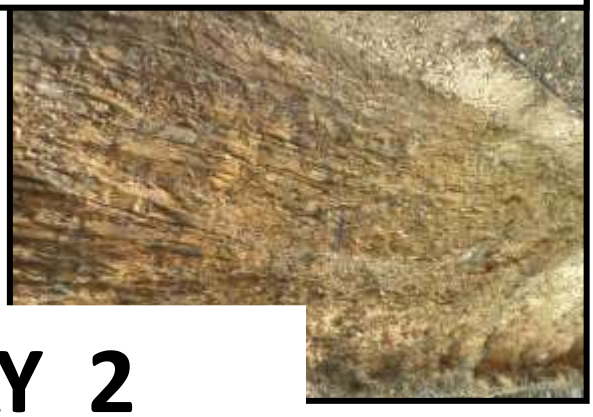
AMATEUR GEOLOGICAL SOCIETY of the HUNTER VALLEY



GOULBURN BASED EXCURSION



DAY 2

Goulburn to Bungonia

DAY 2 – GOULBURN EXCURSION - To Bungonia

This day's excursion is the first part of an east to west transect of this part of the eastern sector of the Lachlan Fold Belt from the Shoalhaven River to Goulburn. While the preferred direction is from east to west, safe parking at many of the locations is on the northern side of the road so the excursion will head east from Goulburn to the Bungonia Gorge. However having seen several of the locations first, the return trip along the same route will give the sequence greater clarity.

Location 1. DRIVEBY – Mundy Street-Braidwood Road - Mulwarree Fault

As noted on the Day 1 excursion, this major N-S trending fault lies approximately up the centre of the Goulburn Basin. It is a complex fault with splits and re-entries. Just south of Chatsbury the fault is joined by another major fault from the west, the Yarra Fault which, north of the Hume Highway, separates Ordovician rocks on the west from Silurian rocks on the east.

Location 2. STOP— Brisbane Grove Road— Boxers Creek Formation

Boxers Creek Formation,

Brisbane Grove Road

The latest Late Silurian – earliest Early Devonian (c. 414 Ma) Boxers Creek Formation consists of interbedded brown to cream, usually thinly bedded lithic quartz sandstone and laminated grey to cream siltstone and shale. Some sandstone units suggest deposition from turbidity currents. The Formation is underlain by the Covan Creek formation and overlain locally by the Gundary Volcanics. The typically well-bedded nature of the Formation in outcrop is a distinctive feature. At this locality weathering has produced significant clay minerals to give the rocks a smooth silky feel. There are indications that the beds are overturned.

Location 3. DRIVEBY – On Mountain Ash Road to Kooringaroo Road – Quialiago Volcanics.

This section passes over Early Devonian rocks of the Quialiago Volcanics of the Bindook Group. The Quialiago Volcanics crop out poorly and are composed of several diverse lithological members ranging from basalt to rhyolite and from sandstones to ignimbrites. It is this diversity which differentiates this formation from other formations of the Bindook Group. The age of this Formation is very Early Devonian (c. 410 - 407 Ma). The presence of this formation in the Goulburn Basin indicates that the sub-aerial Bindook Group volcanism was not restricted only to the Bungonia Shelf.

Location 4. DRIVEBY – Kooringaroo Road to Towrang Fault – 941 Mtn Ash Rd—Covan Creek Formation

This section passes over Late Silurian to Earliest Devonian rocks of the Covan Creek Formation of the Mt Fairy Group and the Formation is confined to the Goulburn Basin, that is confined between the Lake George Fault in the west and the Yarralaw Fault in the east.

The Formation comprises thin to very thick-bedded lithic quartz to quartzose sandstone with interbedded, laminated pale-grey to buff siltstone and mudstone. The formation forms prominent wooded ridges and typical exposures are linear, rubbly outcrops of quartzite while fine-grained lithologies are usually very poorly exposed.

Location 5. DRIVEBY – 1000 Mountain Ash Road – Towrang Fault

The north-south trending Towrang Fault separates the Early Devonian Covan Creek Formation on the west from the Middle Ordovician Abercrombie Group on the east.

Location 6. DRIVEBY - 1053 Mountain Ash Road – Abercrombie Formation

The Middle Ordovician Abercrombie Formation is a very widespread Formation and at this location comprises steeply dipping beds and laminae of honey-coloured, brown to grey terrigenous sedimentary rocks including fine grained sandstone, siltstone and mudstone.

Location 7. STOP - 'Ashgrove' - Mountain Ash Road – Abercrombie Formation

The Abercrombie Formation is defined to include the entire quartzose turbidite and chert sequence of the Adaminaby Group, with mappable chert horizons included as members within the formation.

The outcrop of the formation is usually low, blocky or rubbly and heavily weathered. The lithology comprises a thick sequence of buff, grey to brown, fawn to cream, fine- to very coarse grained, thinly- to thickly-bedded quartz sandstone with interbedded laminated siltstone and mudstone while chert bands are restricted to discrete intervals.

The sequence of bedforms developed through sandstone, siltstone and mudstone cycles is indicative of deposition from turbidity currents. Shallow water sedimentary structures are absent and the deposition is considered to have mainly occurred on submarine fans or in the outer fan in a basin plain setting. Periodic hiatus in terriginous sedimentation allowed pelagic chert to accumulate.

LEFT. *Good exposure of Abercrombie Formation with some minor deformation*

Location 8. STOP - '1480' -Mountain Ash Road – Abercrombie Formation

The Abercrombie Formation has already been encountered earlier at the previous Location 7. At this site the crest of a small anticlinal fold shows the cleavage planes in the more ductile phyllites being refracted at an angle more towards a right angle through the more brittle metasandstones

RIGHT *Crest of small anticline Abercrombie Formation showing refracted cleavage*

Location 9. – DRIVEBY – Springponds Creek, 1850 Mountain Ash Road – Yarralaw Fault.

The Yarralaw Fault defines the western boundary of the Bungonia Shelf and the eastern boundary of the Goulburn Basin. At this point the fault underlies the course of Springponds Creek and separates the Early Devonian Covan Creek Formation on the west from the Late Devonian rocks of the Strathaird Formation on the east. The boundary between the Ordovician Abercrombie Formation and the Early Devonian Covan Creek Formation lies about 2 km to the west.

Location 10. STOP - 1921 Mountain Ash Road – Strathaird Formation

Parasitic folds in the western limb near the crest of an anticline

The Late Devonian Strathaird Formation of the Lambie Group consists of medium-bedded sandstone, calcareous in parts, with interbedded cobble to boulder conglomerate and laminated mudstone. Much of the formation, especially the mudstone, is reddish purple.

The Formation, which underlies the resistant scarp-forming Cookbundoon Formation, usually forms a very steep scree slope with more scree than outcrop. This outcrop is generally only the conglomeratic beds.

The depositional environment is not clear although the conglomerate beds, particularly the basal units, may represent channel fills, while the mudstone and sandstone association may represent a probable coastal alluvial plain with some marine fossiliferous sands representing a transgressive, shallow near-shore environment.

At this location the finer silt and mudstones have been folded into small tight folds called parasitic folds. These folds form on the fold limbs close to the fold crest and on the inner part of the fold where the compression, particularly on more ductile clay rich finer beds are enclosed above and below by more competent strata. To shorten, the ductile strata crumples and forms folds which do not extend into the enclosing strata.

Location 11. STOP – Jarrara Road - Lumley Granite

Lumley Granite, Jerrarra Road

The Lumley Granite of the Arthursleigh Suite is another pluton of the Marulan Batholith and crops out along the Jarrara Road just before and at the Jarrara Rd – Mountain Ash Rd. The unit and forms a low relief landscape in which outcrop occurs as small tors and low boulders but much of the exposure is covered by alluvium. The rock is a pinkish-grey medium to coarse grained phaneritic rock with approximately equal proportions of orthoclase and plagioclase feldspars. There is more than 20% quartz and biotite mica and hornblende.

Location 12. – STOP – Bungonia Village – Lookout Road - Springponds Tonalite

Boulder of Springponds Tonalite, Lookdown Road

The Springponds Tonalite of the Arthursleigh Suite is also another pluton of the Marulan Batholith and is exposed along Lookdown Road in the Bungonia Village.

The Springponds Tonalite comprises the former plutons, 'Wylora Quartz Gabbro' and the 'Springponds Granodiorite'. However due to their similarities in compositional range and in their textures, they have now been combined into a single unit, the Springponds Tonalite. The pluton is mostly poorly exposed in the mainly cleared, gently undulating terrain.

The Springponds Tonalite is a greenish-grey, medium-grained equigranular to weakly porphyritic tonalite and quartz diorite. It is distinguished from other Marulan Supersuite plutons in the Bungonia area by its more mafic composition.

LEFT *Outcrop of Springponds Tonalite, Lookdown Road*

Location 13. DRIVEBY – Lookdown Road – Barralier Ignimbrite

After passing over the Springponds Tonalite, Lookdown Road swings northward and traverses the Barralier Ignimbrite of the Bindook Group. The Barallier Ignimbrite overlies the Joaramin Ignimbrite and forms prominent jointed and blocky to pavement outcrop and which occurs mainly in timbered undulating country. As seen at **Location 16** on Excursion Day 1, the Barallier Ignimbrite is a dark bluish grey, crystal-rich, welded dacitic ignimbrite which is remarkably uniform in its composition over its large extent.

Location 14. STOP – Tantangarang Formation

Weathered Tangerang Formation, Lookdown Road

As the road turns east it traverses the Tangerang Formation. This Early Devonian Formation of the Bindook Group is a complex formation with many members with a variety of lithologies. The Formation is composed of dacitic and rhyolitic rock interpreted as pyroclastics, lavas and shallow intrusions, together with tuffaceous sandstone and siltstone, quartzose sandstone and subordinate conglomerate and limestone.

The topography is predominantly semi-cleared and gently undulating with best exposures confined to incised creeks and rivers, while elsewhere the unit is exposed as rubbly and pavement outcrops. Weathering can be quite deep as seen in the road cutting here.

Due to its many and varied members, the Tangerang Formation broadly represents a transition from basal moderately deep marine environments through shallow marine shelf and deltaic environments into a subaerial environment dominated by extensive pyroclastic deposits, locally reworked in rivers and lakes.

Location 15. STOP – Lookdown Road - Cardinal View Formation

Limestone outcrops in Cardinal View Formation, Lookdown Road. Tangerang Formation at treeline

After crossing Bungonia Creek the road again turns northward and traverses the Cardinal View Formation. The Late Silurian Cardinal View Formation of the Bungonia Group consists of sandstone, siltstone and mudstone with a high proportion of limestone (the Lookdown Limestone Member). Where limestone is a larger component of the unit, the limestone forms linear, low, tor-like outcrops but the siliciclastic beds crop out poorly.

Location 16. STOP – Entrance to Bungonia National Park – Cardinal View Formation

In the Cardinal View Formation the coarser siliclastic beds are pale grey, medium grained, and generally massive, quartz-rich sandstone with poor to good sorting. The finer beds are pale greenish-grey, commonly graded, and include probable volcanic mudstone of silicic provenance.

RIGHT *Fault in Cardinal View Formation before the entrance to Bungonia National Park*

Location 17. STOP – Lookdown Lookout - Lookdown Limestone Member.

Bungonia Creek Gorge entering the Shoalhaven Gorge. Looking east from Lookdown Lookout

At this lookout the Shoalhaven River can be seen to the east in its deeply incised valley. This valley is incised into very tightly folded Middle Ordovician Rocks of the Abercrombie Group. At the top of the eastern valley wall the Ordovician rocks are unconformably overlain by Permian sediments of the Sydney Basin. The Bungonia Creek Gorge extend westwards from its entry with the Shoalhaven towards the lookout and is incised through the Abercrombie Group until it reaches the North-south trending Lookdown Limestone where it enters the 'Slot' which is about 300 m deep but, at the creek bed, is only about 10 - 15 m in width.

The Lookdown Limestone Member forms scattered clumps of boulders and low aligned outcrops in a gently undulating terrain. The Member is a fossiliferous biostromal limestone whose structure, composition and distribution suggest that reefs and shell banks flanked the much deeper intervening basin (the Goulburn Basin) in which much of the siliclastic sediments of the Mount Fairy Group were deposited.

Location 18. STOP – Adams Lookout – Bungonia 'Slot'

Looking eastwards from this lookout the transverse incision of the Bungonia Creek through the Lookdown Limestone and known as the 'Slot' can be best seen. Looking northwards the pit of the South Marulan Limestone quarry can also be clearly seen. The elongate quarry extends along the strike of the Lookdown Limestone until it is intruded by the Glenrock Granodiorite which has caused some contact metamorphism with the limestone. The Glenrock Granodiorite has now been quarried at the Peppercorn quarry over the past few years for hard rock products. Stop 18 is a different view from this location.

RIGHT *The 'Slot', Bungonia Creek Gorge from Adams Lookout*

Location 18. STOP – Adams Lookout - South Marulan Quarries

South Marulan Limestone Quarry, from Adams Lookout

Quarrying at this site commenced in 1871 and has operated continuously since. The quarry is the largest limestone quarry in Australia and today production is up to 3 million tonnes p.a. Most of the production goes by rail to the New Berrima Cement Works which produces 60% of all cement consumed in NSW and the ACT. A branch rail line has been constructed to connect the site with the Sydney – Melbourne rail line enabling most of the product to be transported by rail.

Cement is manufactured by crushing and then heating the limestone ($CaCO_3$) to produce lime (CaO) and drive off the carbon dioxide (CO_2). The lime is then slaked by adding water. $CaO + H_2O \rightarrow Ca(OH)_2$ and when the excess water is completely evaporated, the carbonation commences. $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$. This reaction takes time and requires this non-hydraulic cement to be exposed to the air to absorb carbon dioxide and so cannot be used under water.

In hydraulic cement, silicates are mixed with the crushed limestone and these silicates promote the hardening of the cement by hydration when water is added. Often other materials are added to give the cement specific properties such as rate of setting or setting strength.

The limestone is also used to make lime based products for industrial use (e.g. flux for BlueScope Steel's Port Kembla mills) and lime based agricultural products.

By the 1970's there were two major adjoining quarries, independently owned and operated. In 1974 these amalgamated and became Blue Circle Southern Cement Ltd. The site is often referred to as 'Blue Circle', the site's former owner and, although Boral purchased the site in 1987, the 'Blue Circle' name remained until 2010. The quarry operates 24/7 and employs over 100 people.

The Lookdown Limestone Member being quarried is within the Cardinal View Formation which unconformably overlies the Ordovician Abercrombie Formation. The eastern side of the deposit has the highest grade and in the northern part of the quarry the limestone has been extensively recrystalised by the intrusion of the Glenrock Granodiorite, a pluton of the Marulan Batholith.

Location 19. STOP – Mountain Ash Road – Disused quarry in Abercrombie Formation.

While this quarry in the Abercrombie Formation is inaccessible, parking is available on the western side in a road turn off. Samples of the rock type can be examined here. Graptolite fossils have been found here.

LEFT *Disused quarry in Abercrombie Formation on the Mountain Ash Road*

Location 20. STOP – Goulburn Rocky Hill War Memorial Tower – Cookbundoon Formation (T)

Outcrop of Cookbundoon Formation at Goulburn Rocky Hill War Memorial Tower

In the parking area for the Goulburn Rocky Hill War Memorial is a well exposed outcrop of the Late Devonian Cookbundoon Formation of the Lambie Group. This Formation is the most resistant of unit of the Lambie Group and forms the very prominent Cookbundoon Range. Natural outcrops are restricted to the thickly bedded coarse-grained sandstone while exposures of the finer lithologies such as the laminate sandstone and reddish mudstone are restricted to excavations.

The Formation mostly comprises white to off-white, medium to coarse-grained quartzose and lithic-quartzose sandstone with occasional pebble to cobble conglomerate horizons and very rare minor red mudstone.

The Cookbundoon Formation generally indicates a fluviatile environment, although brachiopod fragments in the lower part of the Formation, near the gradational boundary with the Strathaird Formation, suggests possible deltaic conditions or periodic transgression-regression.

On the descent into Goulburn, the road enters the Strathaird Formation near the first houses. The road then crosses the Mulwaree Fault as it enters the railway underpass.

NOTES

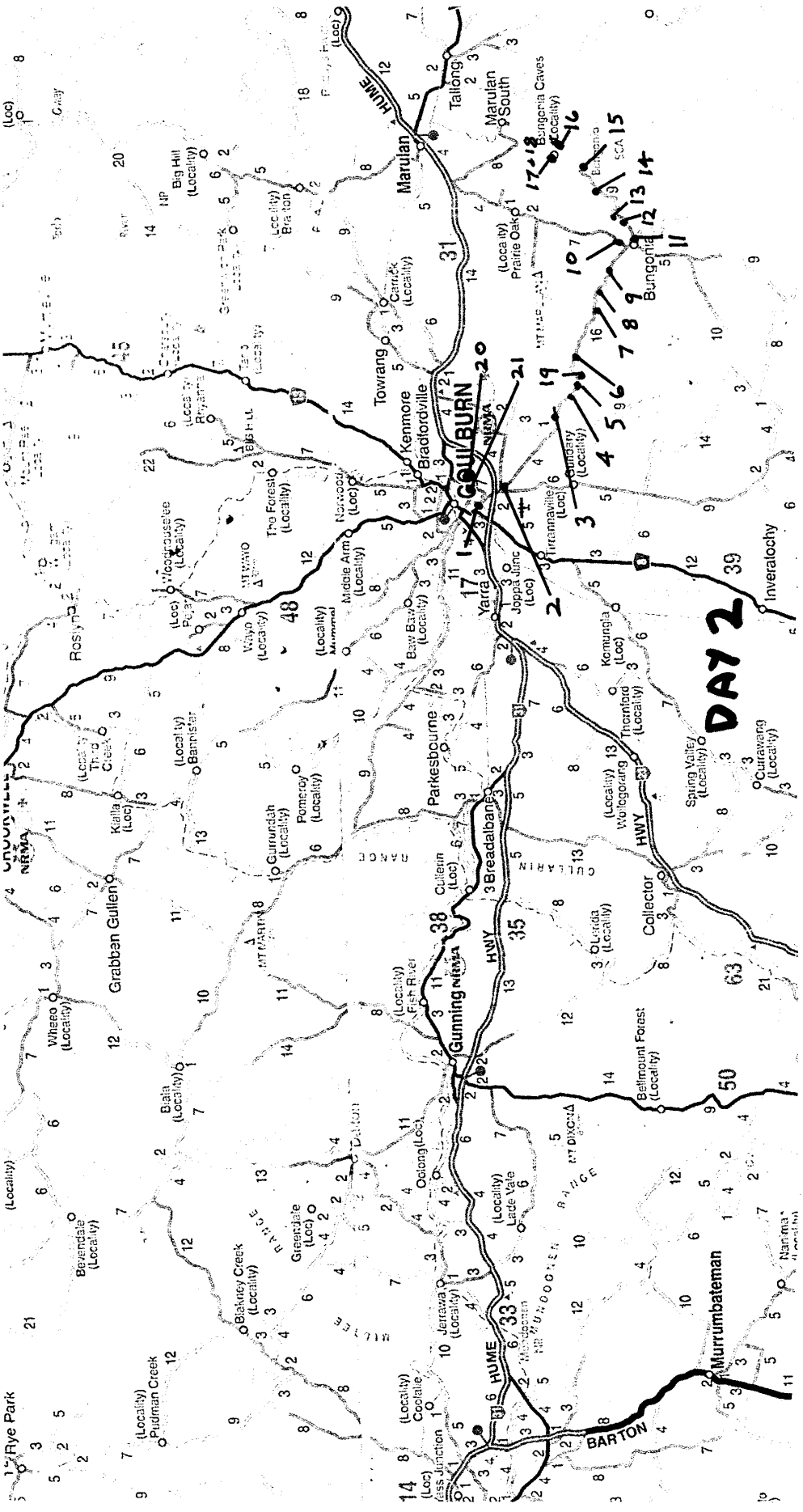
EXCURSION LOCATION DIRECTIONS

DAY 2 - Goulburn to Bungonia National Park and return

		pt to pt	**reset**	cum		
	START	0		0	Start from **Goulburn Tourist Information Centre Car Park,** Sloan Street,	**Toilets**
Stop					opposite SE end of Belmore Park and is 100m NE of Goulburn Railway Station	
1	Mulwarree				Exit car park and turn left into Sloan St. Continue on for 1.0 Km and turn left at Mundy St	
Loc	Fault	1.3		1.3	and into Braidwood Rd and over the Rly bridge. Fault is at the Bungonia **Turn Off (TO)**	
2	Boxers Creek				**Continue on Braidwood Road to M31 underpass**, then go 1.1 Km then turnn left into	
Stop	Formation	3.7		5.0	Brisbane Grove Road. Go 1.1m Km further and stop on left at near end of cutting.	
					Overturned beds can be identified on opposite side of cutting about 15 m from end.	
					WATCH FOR TRAFFIC IN BOTH DIRECTIONS	
					Now continue 1.8 Km to Windellama Rd and turn left for 600 m to Mtn Ash Rd & Turn	
		2.4	**0.0**	7.4	right and **STOP. Reset your Odometer. Property numbers are in Km +10s m from here.**	
3	Mtn Ash Rd to				Mtn Ash Rd is passing over Quialiago Volcanics. Outcrops are sparse.	
Loc	Kooringaroo Rd	6.3	**6.3**	13.7		
4	Kooringaroo Rd				Mtn Ash Rd is passing over the Late Silurian - Early Devonian Covan Ck Formation	
Loc	- 941 Mtn Ash Rd	3.1	**9.41**	16.8	which is confined to the Goulburn Basin.	
5	1000 Mtn Ash Rd		**10.00**		The North - South Towrang Fault separates the Covan Ck F'm on the west from the	
Loc	Towrang Fault	0.6		17.4	Middle Ordovician Abercrombie Formation on the east.	
6	1053 Mtn Ash Rd		**10.50**		Middle Ordovician Abercrombie Formation on the east.	
Loc		0.5		17.9		
7	Ashgrove'		**11.00**	18.4	Middle Ordovician Abercrombie Formation on the east. **WATCH FOR TRAFFIC, BOTH WAYS**	
Stop	Mtn Ash Rd	0.5			Park on left towards to of rise beyond 'Asgrove' entry. Outcrop opposite	
8	1480 Mtn Ash Rd		**14.80**	22.6	Middle Ordovician Abercrombie Formation on the east.	
Stop		4.8			Park on left. Outcrop opposite. **WATCH FOR TRAFFIC IN BOTH DIRECTIONS**	
9	S'ponds Ck, 1850 Mtn		**18.50**	26.3	The Yarralaw Fault defines the eastern boundary of the Goulburn Basin and separates	
Loc	Ash Rd, Yarralaw Fault	3.7			the Covan Ck F'm on the west from the Late Devonian Strathaird F'm on the east	
10	1921 Mtn Ash Rd		**19.21**	27.0	Stop left at the entrance to property 1927. outcrop of Late Devonian Strathaird F'm is	
Stop	Strathaird Formation	0.7			opposite. **WATCH FOR TRAFFIC IN BOTH DIRECTIONS**	

11	Lumley Granite		**27.7**		Continue on Mtn Ash Rd for 7.2 Km then turn left for 300 m into Jerrara Rd and stop on	
Stop	Jerrarra Road	7.5		34.5	left. Lumley Granite is back on left embankment and crops out on right back to the TO.	
					WATCH FOR TRAFFIC IN BOTH DIRECTIONS	
12	Bungonia -Lookdown Rd		**29.3**		Continue on for 250 m to do safe U turn the turn left at Mtn Ash Rd to Bungonia.	
Stop	Springponds Tonalite	1.6		36.1	Take 2nd Rd left (Howick St) and stop left after first intersection. O/crop is under tree	
13	Lookdown Rd		**0.0**		**RESET ODO TO '0'.** Continue on L'down Rd. After 500 m the Rd passes onto Barralier	
Loc	Barralier Ignimbrite	1.1		37.2	Ignimbrite for next 1.1 Km then onto Tangerang Formation.	
14	Lookdown Rd		**2.4**		Stop left before cutting and walk along road to view outcrop.	
Stop	Tangarang Formation	1.3		38.5	**WATCH FOR TRAFFIC IN BOTH DIRECTIONS**	
15	Lookdown Rd		**6.9**		Continue on L'down Rd for 4.2 Km to end of pine trees on both sides of Rd then stop	
Stop	Cardinal View Formation	4.5		43.0	left after 300 m and view to left. **WATCH FOR TRAFFIC IN BOTH DIRECTIONS**	
16	Lookdown Rd				Continue on L'down Rd for 1.0 Km and stop left and view outcrop opposite.	
Stop	Cardinal View Formation	1.0	**7.9**	44.0	Stop is a few hundred metres before National Park gate. **WATCH FOR TRAFFIC**	
17	Bungonia National Park				Continue on into Park, visiting Office as appropriate then proceeding past Adams L'out TO at 700 m	
Stop	Bungonia Lookdown	2.2	**10.1**	46.2	and on a further 1.0 Km to David Reid Picnic area then 150 m to Bungonia Lookdown car park.	**Toilets**
18	Bungonia National Park			48.4	Leaving Bungonia Lookdown go back to Adams Lookout TO and Turn right and then 1.0 Km to car park	**Toilets**
Stop	Adams Lookout	2.2	**0.0**		It is about 300 m walk to Adams Lookout. **Return on Lookdown Rd to Stop 12 . RESET ODO TO '0'**	
19	Mtn Ash Rd				Turn right at end of Lookdown Rd and continue on to Mountain Ash Rd for 6.5 Km to	
Stop	Disused Quarry	18.6	**6.5**	67.0	disused and fenced off quarry on left. Turn left immediately after quarry to park in track.	
20	Rocky Hill War Memorial				Continue to end of Mtn Ash Rd and turn right into Windellama Rd. Turn off into Forbes St	
Stop	Cookbundoon Formation	22.6	**29.1**	96.1	immediately before the Mulwarree River Bridge. Continue on Forbes St and turn right at	
					roundabout into Park St. Continue to crest of hill and turn left into Memorial Rd, continue to car park	
					Toilets are down path on right. **Return to Goulburn via Park Rd. At r'bt go straight ahead into town.**	**Toilets**

EXCURSION MAPS



AMATEUR GEOLOGICAL SOCIETY of the HUNTER VALLEY

GOULBURN BASED EXCURSION

DAY 3

Goulburn to Gunning & Yass Valley Way

DAY 3 - GOULBURN EXCURSION – To Dalton & Yass Valley Way

This day's excursion will continue and complete the east – west traverse of this part of the eastern sector of the Lachlan Fold Belt from the Shoalhaven River to the Yass Shelf. Some historic locations and event scenes will also be visited.

Location 1. Driveby – Hume Highway – Road cutting on crest after Run-o-waters Creek

This cutting exposes the Late Silurian to Earliest Devonian sediments of the Covan Creek Formation of the Mount Fairy Group. This Formation was noted in the previous excursions but some of its details will be included again.

The Formation comprises thin to very thick-bedded lithic-quartz to quartzose sandstone with interbedded, laminated pale-grey to siltstone and mudstone. The formation forms prominent wooded ridges and typical exposures are linear, rubbly outcrops of quartzite while fine-grained lithologies are usually very poorly exposed.

At this location the sediments lie near the axial plane of a syncline.

Location 2. Driveby – Hume Highway – Yarra road cutting – Warbiso Shale & Bumballa Formation

In the southern wall of this cutting, the eastern approximately 1/3 comprises light coloured sediments of the Late Silurian Joppa Siltstone Member of the DeDrack Formation of the Mount Fairy Group. These are then terminated by the Yarra Fault, another major north-south trending fault which joins the Mulwaree Fault in the north near Chatsbury. Darker brown Upper Ordovician rocks of the Warbisco Shale of the Bendoc Group abutt the fault on the west before passing for the final 1/3 of the cutting into the lighter coloured rocks of the Bumballa Formation. As the sediments dip to the west and the Warbisco shale overlies the Bumballa Formation in the sedimentary sequence, it would appear that the Ordovician rocks here are overturned.

The Warbisco Shale comprises laminated to medium bedded black silicious shale commonly with a well-developed bedding fissility and a well-developed slatey cleavage. The shale is generally bleached to a pale grey when weathered and tends to form low ridges. Within the black shale there are sporadic intercalations of light grey to cream, flaggy medium-to thick bedded quartzose fine to medium–grained sandstone. The unit was deposited in a deep marine setting where hemipelagic sedimentation involved the accumulation of radiolarian and graptolites.

Location 3. STOP - Old Hume Highway – 'Rosythe' (Lodges Inn)

This beautifully preserved Georgian style rendered stone building, constructed in 1838, is the Lodges Inn which figured in an incident leading to a gunfight at nearby Mutmutbilly involving the Hall Gang. The Inn was originally called the 'Brisbane Arms' then changed to the 'Breadalbane Arms'. With several changes of owners and many hold-ups by bushrangers, the Inn became the 'Coach and Horses Inn' in 1853. The following year Thomas Lodge held the licence until 1858 when he relocated to the property 'Sweetwood Lea' and established an inn, the 'Breadalbane Arms', while the 'Coach and Horses' was renamed to the 'Red House Inn' by the new owner, Webb Garrett. By 1865

'Rosythe', at one time the 'Coach & Horses Inn' owned by Thomas Lodge

Lodges Inn would now be the 'Breadalbane Arms' at Sweetwood Lea. Lodges apparently became a collaborator with the bushrangers, giving them information for a cut of their takings.

Location 4. STOP – Old Hume Highway – Lake George Fault

The low hill to the south-west is the surface expression of the Lake George Fault, the western boundary of the Goulburn Basin and eastern boundary of the Cullerin Horst. The Lake George Fault splits on the Gunning Road on the escarpment at Collector. The western branch continues northwards as the Cullerin Fault while the Lake George Fault swings north-north-east to Breadalbane and then continues northwards to then rejoin the Cullerin Fault a few kilometres south of Crookwell.

The Lake George Fault at Breadalbane

Location 5. STOP – Old Hume Highway - Bredalbane – Ferricrete

This site is located in an area on the half graben on the eastern side of the Cullerin Fault and containing many very shallow lakes and swamps including Lake George, Wologorong Lagoon, Rowes Lagoon, Dry Lagoon and Wet Lagoon, all of which have high evaporation rates. Also this site is close to the Lake George Fault and several subsidiary faults which have iron ore concentrations, some of which were mined for iron ore in the early 1900's. The rounded quartz pebbles deposited as stream or lake shoreline materials have been cemented in an iron oxide cement. This cement has formed from the deposition of iron-rich groundwater percolation and enriching from marked seasonal wet and dry periods, similar to laterite formation, and/or from evaporation of iron rich waters. Silcretes form from a similar process involving silica-rich waters.

Ferricrete, Old Hume Highway,

Breadalbane

Location 6. STOP – Old Hume Highway - Cullerin Fault

The north-south trending Cullerin Fault which has split from the Lake George Fault near Collector has a surface expression as the prominent ridge topped by many wind turbines visible to the south west.

Cullerin Fault viewed to the south-west from the Old Hume Highway

Location 7. – Driveby - Old Hume Highway – Blackmans Creek Thrust

This north-south trending Thrust is the eastern boundary of the Gunning Granite pluton, Gunning Suite of the Wyangala Batholith. The Thrust line lies on the eastern side of the Railway bridge while on the western side of the Railway bridge granite crops out. However further along the road where it turns westwards, a block of metamorphosed Ordovician Abercrombie Formation rocks is exposed.

LEFT *View to south along the Blackmans Creek Thrust from the Railway bridge*

Location 8. STOP – Old Hume Highway - Metamorphosed Ordovician Rocks.

In this disused quarry metamorphosed Abercrombie Formation rocks are exposed. The fine-grained sandy sediments, probably already regionally metamorphosed by the Benambran Orogeny, have been subsequently hornfelsed by the heat of the adjacent intruded granite. In places these rocks may be mildly migmatised where the intense pressure and heat of the depth of burial has begun to partially melt and incorporate the rock into the granitic magma.

RIGHT *Hornfelsed Abercrombie Formation exposed in disused quarry on the Old Hume*

Location 9. STOP - Old Hume Highway - Migmatite

The process of migmatisation seen commencing at Location 8 is more developed at this location. The intense heat and pressure promotes changes in some of the original minerals as they change into more compact minerals to occupy less volume. Partial melting and mixing of the granite and metamorphic rocks is more apparent.

LEFT *Migmatised rock showing partial melting and mixing of granite and the neighbouring metamorphic rocks*

Location 10. STOP – Old Hume Highway - Metamorphosed Ordovician Rocks.

This location, a few hundred metres west of the previous location, exposes finer sediments of the Ordovician Abercrombie Formation which also have been contact metamorphosed by the adjacent intruded granite. These rocks were previously regionally metamorphosed by the Benambran Orogeny.

RIGHT *Metamorphosed finer sediments of the Abercrombie Formation exposed on Old Hume Highway.*

Location 11. STOP. – Old Hume Highway – Hume Expedition Memorial

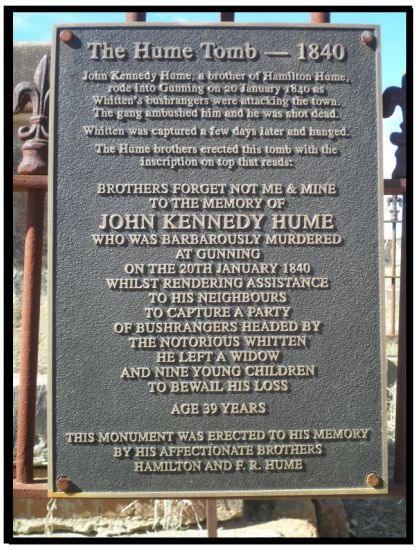
This memorial obelisk marks the centenary of the commencement point of the Hume and Hovell overland expedition to Port Phillip on 17 October 1824.

RIGHT *Memorial obelisk commemorating the centenary of the 1824 Hume and Hovell expedition to Port Phillip*

Location 12. Stop. – Old Hume Highway – Outcrop of Gunning Granite

The Gunning Granite is typically well exposed, cropping out as large boulders and tors in an undulating countryside with low rounded hills. The Gunning Granite comprises medium- to coarse-grained massive to foliated granite, aplitic granite, granodiorite and tonalite. These variants are scattered throughout various areas of the pluton and pods of migmatisation occur abutting the Blackmans Creek Fault as seen at Location 9. At this location fresh specimens of the Gunning Granite can be examined.

Location 13. STOP. – Wombat Street - Gunning General Cemetery



Plaque on the side of the Hume family vault in Gunning General Cemetery

Near the entrance to the Gunning General Cemetery is the Hume family tomb where John Kennedy Hume, the brother of Hamilton Hume, of the Hume & Hovell Port Phillip Expedition, is buried. J.K.Hume was shot dead by the notorious bushranger, Thomas Whitton during a gunfight in the main street of Gunning.

Assigned convicts Thomas Whitton and 'Scotchie' Thompson, absconded from their overseer in Bathurst in 1832 and with two others, Reynolds and Russel, became known as the 'Bathurst Mob'. They travelled down the old 'Mehan Track' near Taralga and over the next eight years committed robberies, arson, intimidation and the murder of an innocent man near Crookwell. They held up the village of Gundaroo and caused considerable anxiety in the district.

The gang had been seen camped near Biala and, on 20 January 1840, a man called Toft rode into Gunning to warn the town that the gang was nearby. A gunfight in the town ensued and J.K. Hume, on his nearby property 'Collingwood', heard the gunfire and, after selecting a group of about seven men, rode into Gunning. The gang had entered Cooper Store. Hume entered the store and when Whitton told him to surrender Hume refused, so Whitton shot him dead.

A posse was organized and two days later the gang was located at Narrawa. In the ensuing gunfight Thompson was shot dead and, being outnumbered, the rest of the gang fled. Two days later the gang was again located and this time Russell was shot dead, Reynolds was captured and Whitton, realising that he was outnumbered, surrendered.

RIGHT *The McDermott Centre (Town Hall) Auburn Street, Goulburn*

Whitton was tried, then hanged on 19 March 1840 and his body buried somewhere in the vicinity of the McDermott Centre (Town Hall) in the main street of Goulburn. Current plans to redevelop the site has raised archaeological interest.

Also in this cemetery are several headstones of the Fisher Family some of which are of an unusual and distinctive laminated siliceous rock type. A possible outcrop of this rock is exposed in the first road cutting on then southern side of the west-bound lane of the M1 after the Gunning on-ramp. The outcrop is a block about half way along and within an outcrop of the Oolong Granite. It is possible that this rock which is possibly the Napperby Chert was cropping out on a nearby property and the owners quarried it to make headstones so that their loved ones would remain with part of the property.

The headstone of Mr Ray Fisher, Gunning General Cemetery

Location 14. STOP. – Yass Street, Gunning (T)

The village of Gunning is located in a valley floored by Ordovician Abercrombie Formation and including a north-south trending fault. East of the valley is the Gunning Granite pluton while on the west is the Oolong Granite pluton, both of the Wyangala Batholith and both within the Wyangala Structural Zone.

Yass Street, the main street, was the site of the Gunning gunfight in 1840 and has several heritage listed buildings including 'Pye Cottage', relocated from Dalton, and 'London House' built in 1881 with its ached coach entry and which operated as a general store and hotel. It now operates as the 'Merino Café'.

Yass Street, Gunning. 'London House' on left

Location 15. STOP – Veterans Road & Peddalls Lane TO. – Oolong Granite

From Gunning enter the westbound M1, after c. 1 km take the Veterans Road TO. left. Stop at the Peddalls Lane TO. To examine fresh exposures of the Oolong Granite.

The Oolong Granite occupies an area of undulating terrain with best exposures in the southern part of its distribution while in the northern part, the unit is more deeply weathered and extensively covered by Quaternary units, including alluvium, along Oolong Creek.

Location 16. STOP – Veterans Road – Oolong seismic centre.

At this location the view to the south has a hill in the centre background and also in the foreground with many Oolong Granite boulders exposed. The dense clump of low trees in the centre are on the Oolong Creek and it is at this spot is the epicentre of six earthquakes Magnitude > 4.0 between 1907 and 1949 while a second site, Gunning east, is a four epicentre cluster. These are shown in Table 1 (modified from McCue et al, 1989).

Oolong Granite outcrop on distant hill and also in foreground.

The Gunning – Dalton area is the most seismically active area in NSW and one of the most in Australia, with epicentres scattered widely throughout the region. Two sites, Oolong and Gunning east, have clusters and these are shown in table1. Both sites are on or close to the medial axis of their respective plutons. The Oolong centre lies on Oolong Creek which has a relatively straight course to the north-north-west which coincides with the axial plane of a syncline in both the

TABLE 1				
Oolong Centre			Gunning East Centre	
Date	Magnitude		Date	Magnitude
20 . 2 . 1907	4+		7 . 9 . 1952	4.7
11 . 1 . 1933	4.8		18 . 11 . 1952	4.4
10 . 11 . 1934	4.8		19 . 11 . 1952	4.9
18 . 11 . 1934	5.6		22 . 11 . 1952	4.6
21 . 11 . 1934	4.8			
10 . 3 . 1949	5.5			

Oolong Granite and the underlying and intruded Abercrombie Formation, as show in the Mineral Distribution Diagram on the Goulburn 1:250 000 Geology S1/55-12 Second Edition Sheet 1. The earthquake- generating movement may have taken place on an axial plane fault in the underlying Abercrombie Formation which also may be the conduit for the granitic magma.

The epicentre of the 4.3 magnitude Oolong earthquake of 9.8.1984 is located 2 km north-west of the Oolong seismic centre.

Location 17. Driveby – Veterans Road, Jerrara Rd TO & M31 – Frogmore Fault

At this location the traverse crosses the north-south trending Frogmore Fault. While enclosed by the Middle Ordovician Abercrombie Formation, the Fault forms the eastern boundary of a complex structural unit, the Frogmore Fault Zone. Rejoining the M1 at the Jerrawa Road junction and continuing westwards for 1.8 km, a further fault introduces the Upper Ordovician Mundoonen Sandstone of the Margules Group and which continues westwards to the Murrumbateman Fault at the base at the Mundoonen Range and which defines the western boundary of the Frogmore Fault Zone and the eastern boundary of the Yass Shelf as indicated by late Early Silurian Hawkins Volcanics.

The Frogmore Fault Zone is bounded on the south-east by the Frogmore Fault which then switches to become the bounding fault on the north-west, replacing the Murrumbateman Fault. On the north-east the Frogmore Fault is replaced by the Old Man Fault. Between the bounding faults is a complex set of oblique faults extending from one boundary to the other, many trending north-east to south-west.

Location 18. STOP – Yass Valley Way Rest Area – Hawkins Volcanics

The M1 crosses the Murrumbateman Fault which is also the western boundary of the Cullerin Horst at the base of the Mundoonen Range. A few hundred metres further on turn left into the Yass Valley Way, then almost immediately turn left again into the Rest Area where the late Early Silurian Hawkins Volcanics of the Yass Shelf are exposed. This location is the western extremity of the Bungonia Gorge to Yass Shelf traverse.

The generally blue-grey to blue-green Hawkins Volcanics mainly comprise uniform medium to coarse-grained dacitic to rhyolitic ignimbrite.

Hawkins Volcanics, Yass Valley Way Rest Area

Location 19. STOP – Old Hume Highway – Mundoonen Sandstone

Returning to Gunning on the M1 turn left at Sheldricks Road the immediately left again for 200 m along the Old Hume Highway where there is a good exposure of the Mundoonen Sandstone.

The Mundoonen Sandstone forms the very prominent Mundoonen Range between Yass and Gunning and for much of its length forms the watershed between the Murrumbidgee and Lachlan catchments. The

Late Ordovician Mundoonen Sandstone, Sheldricks Road

dominant lithology is fine-grained to granule, muddy lithic-quartz to quartzose sandstone, with minor interbedded siltstone. The colour is brown to yellowish brown, although surfaces in cuttings may be oxidised to a deep red. The bedding varies from thin to very thick and from massive to graded, with finer-grained beds showing planar ripple cross-lamination. The presence of thick turbidites, mostly Bouma A to C sequences, indicates deep-water but mostly proximal sedimentation, probably the axial parts of submarine turbidite fans.

Location 20. STOP – Mundoonen Rest Area – Deformed Mundoonen Sandstone (T)

Turning back towards Gunning, but still on the Old Hume Highway, just before the Mundoonen Rest Area is entered is an exposure of Ordovician rocks. On the eastern exit from the Rest Area a cutting in deformed Mundoonen Sandstone is exposed. This cutting exposes one of the many faults (left of photo) occurring adjacent to the Frogmore Fault. The beds to the right of the fault have been considerably deformed.

LEFT *Fault in deformed Mundoonen Sandstone at eastern exit from Rest Area*

Location 21. STOP – Corner Brown St. & Rugby Rd, Dalton – Silcrete outcrop.

Turning left from the M1 into Jerrawa Road, continue on past mostly Oolong Granite to the village of Dalton where, at the corner of Brown St and Rugby Rd an outcrop of silcrete is exposed.

The silcrete has probably formed by the deposition of silica-rich groundwater cementing stream gravels which have underlain a basalt flow, now no longer present. Many parts of the eastern highlands of New South Wales were covered by basalt flows during the Cainozoic Era and silcrete deposits are not uncommon at some of these locations.

Silcrete boulder, Dalton

Silcrete outcrop, Dalton

Location 22. STOP – Gunning Street Park - Fossil Leaves (T)

Returning towards Gunning 150 m past the Gunning Hotel on the left is a park in which a slab of silcrete with well preserved fossil leaves is on display in a small covered enclosure. These specimens were first identified by Von Ettingshausen

RIGHT *Fossil leaves in silcrete,*

in 1888 and aged as Eocene (c. 40 Ma), however recent work suggests that they may be Early Miocene (c. 20 Ma) although plant identification and ages are in need of review.

Location 23. STOP – Dalton Road – Abercrombie Formation & Oolong Granite contact

The Dalton Road crosses across the Oolong Granite then approximately follows the Abercrombie – Oolong Granite contact and at this location the contact is exposed.

LEFT *Contact between Oolong Granite and Abercrombie Formation*

Location 24. Driveby – Gunning East Seismic Centre

On the northern side of the M1, 2 km after the Gunning on-ramp and 500 m from the road, is a farm dam which is the epicentre for the 1952 earthquake cluster, as shown in Table 1.

Location 25. STOP – Wologorong Granite

At this location outcrops of the Early Devonian Wologorong Granite can be seen piercing the usual cover of Cainozoic fluviatile, lacustrine and aeolian deposits associated with the Wologorong Lagoon on the Breadalbane Plain. Outcrop typically occurs as scattered tors and whaleback style exposure on low rises on the generally flat to undulating terrain.

The typical lithology is cream, pale grey and pink, to pale brown where weathered, medium- to coarse-grained, equigranular to sparsley porphyritic granite which is xenolithic in places. The Wologorong Granite is as a whole displays a considerable variation in composition and deformation. Hand specimens will be available at another location on another day.

Tors of Wologorong Granite beside the M1, Breadalbane

Location 26. STOP – French VC Rest Area – Abercrombie Formation (T)

At the exit from the French VC Rest Area are weathered exposures of the Abercrombie Formation and possibly of its Nattery Chert Member. This very widespread Member, near the top of the Abercrombie Formation, contains beds and laminae of honey-coloured, brown to grey chert up to 300 mm in thickness and which weathers to pink and cream. Chert beds are separated by a variable thickness of terrigenous sedimentary rocks ranging from mudstone partings to 2-3 m packets of laminated medium bedded quartzose sandstone, siltstone and mudstone. The chert of the unit has a characteristic rubbly and blocky exposure with abundant bleached float.

The chert bands were probably deposited by the accumulation of biogenic siliceous oozes in the absence of appreciable terrigenous sediment supply in a deep marine setting. The interbedded sandstone, siltstone and mudstone show cross-lamination and graded bedding, reflecting periodic deposition from turbidity currents.

Abercrombie Formation,

French VC Rest Area

RIGHT *Interbedded sandstones and siltstones*

LEFT *Laminated siltstones*

NOTES

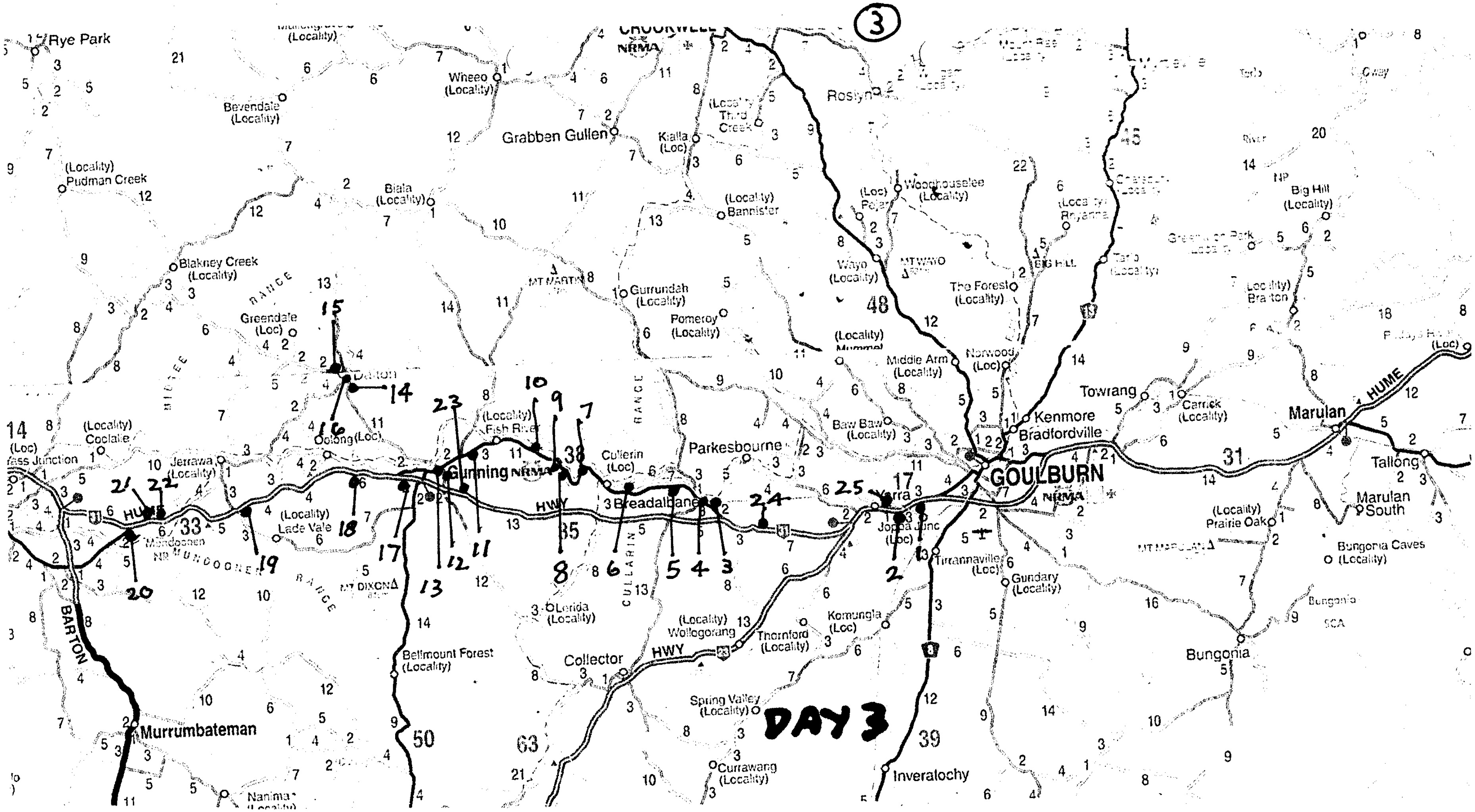
EXCURSION LOCATION DIRECTIONS

DAY 3 - Goulburn to Yass Valley Way via Gunning and return via Dalton and Gunning

		pp	cum		
	START			Start at BIG SHEEP car park. Exit car park turn left, go to r'bt and turn right onto	**Toilets**
Stop	Big Sheep car park	0.0	0.0	M31 and towards Yass. Loc 1 is 2.4 Km from Big Sheep. Then continue on M31	
1	**Crest on M31**			The Late Silurian - Early Devonian Covan Creek Formation is exposed in the	
Loc	Covan Creek F'm	2.4	2.4	cutting at the top of the hill past Run-o-waters Creek	
2	**Yarra Cutting on M31**			In this weathered cutting on the left side, the first formation is the Late Silurian	
Loc	Yarra Fault, Joppa St/S	1.9	4.3	Joppa Siltstone terminated by the Yarra Fault. Then the Late Ordovician Warbisco	
	Warbisco & Bumballa			Shale and then followed by the Ordovician Bumballa Formation.	
3	**Old Hume Highway**			At Federal H'way **Turn Off (TO)**, veer right on M31 then after total 16.2 Km turn Right at	
Stop	**(or Cullerin Road)**	14.9	19.2	TO to Breadalbane on Old Hume H'way. **This Road is called Cullerin Rd on some maps**	
	Rosythe' (Lodges Inn)			Stop 3 is on left at total 19.2 km. **Stop before Inn as it is a private residence.**	
4	**Old Hume Highway**			Go 0.6 Km and stop left to see Lake George Fault as low ridge to SW.	
Stop	Lake George Fault	0.6	19.8		
5	**Old Hume Highway**			Continue on 2.4 Km to when you first see clearly the wind farm ahead. Stop left	
Stop	Ferricrete	2.7	22.5	when road straightens and walk back. Small outcrop in grass. **WATCH FOR TRAFFIC**	
6	**Old Hume Highway**			Fault line is left ahead and is at base of ridge with wind turbines.	
Loc	Cullerin Fault	3.9	26.4		
7	**Old Hume Highway**			The road then goes through a series of bends including a tight sweeping left	
Loc	Blackmans C'k Thrust	2.5	28.9	hander, on exit the short straight stretch before the Rly bridge follows the fault.	
8	**Old Hume Highway**			Continuing on, the road crosses the Rly and follows a long straight before entering	
Stop	Metamorphosed	2.5	31.4	a sweeping right hander. On exit travel about 250 m stop left, quarry opposite is	
	Odovician rocks			hard to see until you are almost opposite. **WATCH FOR TRAFFIC BOTH DIRECTIONS**	
9	**Old Hume Highway**			Continue on for about 200m. Stop left, rock is ontop of left embankment and	
Stop	Migmatite	0.2	31.6	opposite. **WATCH FOR TRAFFIC IN BOTH DIRECTIONS.**	
10	**Old Hume Highway**			Continue on for about 600m. Stop left in lay bye, rock is opposite.	

Stop	Metamorphosed rocks	0.6	32.2	**WATCH FOR TRAFFIC IN BOTH DIRECTIONS.**	
11	**Old Hume Highway**			Continue on for about 5.9 Km. Walmsleys Rd is on left. Stop left past intersection	
Stop	Hume Expedition	5.9	38.1	Monument is on top of embankment opposite at crest of hill. Climb embankment	
	Memorial			where it is less high**. WATCH FOR TRAFFIC IN BOTH DIRECTIONS.**	
12	**Old Hume Highway**			Continue on for about 2.9 Km. Stop left about 250 m before Crookwell TO on right.	
Stop	Gunning Granite	2.9	41.0	Outcrop of Gunning Granite in paddock on left, specimens this side of fence.	
13	**Old Hume Highway**			Continue ahead for about 1.7 Km. Turn first left into Wombat St then 300 m to Cemetery gate.	
Stop	Gunning Cemetery	2.0	43.0	Hume family grave 20 m ahead on right. Fisher family graves about 50 m further on.	
14	**Old Hume Highway**			Return to Old Hume H'way. Turn right and go about 300 m to Toilets/camping g'nd &	**Toilets**
Stop	**now Yass St** Gunning	0.6	43.6	Picnic area on right. Cafes in town about 50m further on. 'Merino Café' worth a try.	**Toilets**
15	**M31 & Veterans Road**			Continue on Yass St (Gunning's main St) for 1.1 Km then turn left onto Gundaroo Rd	
Stop	Oolong Granite	3.7	47.3	At 0.4 Km cross M31 & take Yass onramp to M31. At 2.2Km turn left onto Veterans Rd.	
				At 0.6 Km stop left immediately before Pedells Lane. Oolong Granite exposed here.	
16	**Veterans Road**			Continue on Veterans Rd for 2.0 Km from where a view left to the boulder dotted	
Stop	Oolong seismic centre	2.0	49.3	knoll in the distance crosses a bushy clump in the creek which is the seismic centre.	
17	**Veterans Rd then M31**			Continue on 3.4 Km turn right to Oolong Rd for 0.1 Km then left onto M31. After 7.2 Km	
Loc	Frogmore Fault	7.2	56.5	the M31 crosses the Frogmore Fault 300m before the Jerrara Rd TO on the right.	
18	**M31**			Continue on 8.6 Km where M31 crosses Murrumbateman Fault then after 300 m turn left into	
Stop	**Yass Valley Way Rest Area**			Yass Valley Way, then, after 100m, turn left into Rest Area. Go to end and, a few metres after	
	Hawkins Volcanics	9.0	64.5	turning, a small block of the bluish Hawkins Volcanics is visible beside the road near fence.	
19	**M31, Sheldricks Rd**			Return to M31 and turn right towards Gunning and after 3.7 Km, past top of climb turn	
Stop	**Old Hume Highway**	4.0	68.5	left into Sheldricks Rd, then immediately left again onto Old Hume H'way. After 300m	
	Mundoonen Sndst'n			stop left and walk back along outcrop opposite.	
20	**Old Hume H'way**			Turn around towards Gunning and continue on Old Hume Highway for about 2.4 Km	
Stop	Mundoonen Rest Area	3.2	71.7	where there is outcrop on right (stop to look) then 800 m Rest Area with Toilets and	**Toilets**
	Mundoonen Sndst'n			tables. At the Rest Area exit onto **Old Hume H'way (OHH)** is an outcrop of Mundoonen	
				S/stone. The OHH now becomes the onramp for the M31. Continue on M31.	

21	**M31 & Jerrara Rd**			Continue on M31 for 2.6 Km then turn left into Jerrara Rd. Follow this road to Dalton.	
Stop	**Rugby Rd**	17.9	89.6	At the crossroads at the pub ,far right corner, continue straight adhead on Rugby Rd for	
	Dalton silcrete			300 m and stop left immediately past Brown St on left. Silcrete crop out in paddock	
				left and material for examination is next to road 20m up Brown St.	
22	**Gunning St, Dalton**			Turn around and go back to the Pub and turn left into Gunning St. Go 225m and turn left	
Stop	Fossil leaves	0.6	90.2	into driveway and go 75 m, past cage with leaf fossils to Toilets & tables.	**Toilets**
23	**Dalton Road**			Return to Gunning St and turn left towards Gunning. This street becomes Dalton Rd.	
	Granite contact			After 3.0 Km and towards the bottom of a downhill stop left in a driveway almost	
Stop	with Abercrombie F'm	3.0	93.2	opposite a driveway with blue fencing. The contact is on the left 30m from car.	
24	**Dalton Rd, Gundaroo**			Return to Gunning turn right into Yass St (main street) and then left into Gundaroo Rd	
Loc	**Rd then M31**	13.8	107.0	and then 300m to to take M31 onramp. After 4.2 Km on left about 300m from M31 a	
	Gunning East Seismic			farm dam can be seen. This is the site of the Gunning East Seismic Centre.	
25	**M31**			Continue eastwards on M31 for 23.0 Km (2.8 km after onramp from Breadalbane)	
Stop	Wologorong Granite	23.0	130.0	where there is on the left a long vehicle parking bay. Enter here and stop at outcrop.	
26	**M31 French VC RA**			Continue on M31 for 8.4 Km (1.0 Km after conjunction with the Federal Highway)	
Stop	Abercrombie F'm	8.4	138.4	Stop and examine outcrop on both sides of the exit.	**Toilets**
27	**M31 to Big Sheep**			Leaving the Rest Area turn left onto M31. After 4.3 Km take Goulburn offramp left.	
Stop	Goulburn **FINISH**	5.0	143.4	Return to Start at Big Sheep after a Big Day. Hope that you enjoyed it.	**Toilets**



③
DAY 3
GOULBURN
Marulan
Tallong
Marulan South
Bungonia
Bungonia Caves (Locality)
Towrang
Carrick (Locality)
Kenmore
Bradfordville
Norwood (Loc)
The Forest (Locality)
Middle Arm (Locality)
Woodhouselee (Locality)
Wayo (Locality)
Roslyn
Crookwell
Parkesbourne
Baw Baw (Locality)
Yarra
Joppa Junc (Loc)
Tirrannaville (Loc)
Gundary (Locality)
Prairie Oak (Locality)
Inveralochy
Komungla (Loc)
Thornford (Locality)
Wollogorang (Locality)
Spring Valley (Locality)
Currawang (Locality)
Collector
Breadalbane
Cullerin (Loc)
Lerida (Locality)
Gunning
Fish River (Locality)
Bellmount Forest (Locality)
Oolong (Loc)
Dalton
Greendale (Loc)
Lade Vale (Locality)
Jerrawa (Locality)
Coolalie (Locality)
Blakney Creek (Locality)
Pudman Creek (Locality)
Rye Park
Bevendale (Locality)
Biala (Locality)
Grabben Gullen
Wheeo (Locality)
Kialla (Loc)
Third Creek (Locality)
Bannister (Locality)
Gurrundah (Locality)
Pomeroy (Locality)
Murrumbateman
Nanima (Locality)
HUME HWY
BARTON
HWY
CULLARIN RANGE
MT DIXON
MT MARTIN
MT MUNDOONEN

AMATEUR GEOLOGICAL SOCIETY of the HUNTER VALLEY

GOULBURN BASED EXCURSION

DAY 4

Goulburn to 'Slatevale' & Collector

DAY 4 – GOULBURN – EXCURSION – To Chatsbury (am) & Lake George (pm)

This day's excursion will head north along Middle Arm Road west of and adjacent to the Mulwaree Fault to the historic but now abandoned Chatsbury Slate Quarry where we will be given a conducted tour and talk by the property owner. The group will then return to Goulburn for lunch before heading south-west to Gearys Gap beside Lake George. The route will then return to Goulburn via Collector and Breadalbane.

Location 1. STOP – Middle Arm Road & Rhyanna TO. – Forest Lodge 'Tonalite'

After traversing the complex array of Silurian Fairy Group rocks on the northern surrounds of Goulburn, Middle Arm Road traverses another pluton of the Marulan Batholith, the early Early Devonian Forest Lodge 'Tonalite' which in this area outcrop is poor and comprises sporadic tors and boulders. The rock is technically a Quartz Monzodiorite but, for the sake of simplicity, herein it will be called a 'tonalite' which is compositionally very similar. This pluton is the only one in this area within the eastern part of the Goulburn Basin.

The rock is dark green-grey, medium-grained equigranular to porphyritic in plagioclase feldspar and somewhat variable in texture. The overall fine grain size, porphyritic textures and evidence of originally glassy textures indicate a high level of emplacement and rapid cooling of the pluton.

Outcrops of Forest Lodge 'Tonalite' near Middle Arm Road and Rhyanna Road intersection

Location 2. Driveby – Middle Arm Road - Yarra and Mulwaree Faults

After leaving the Forest Lodge 'Tonalite', the road traverses more of the Silurian Mount Fairy Group sediments passing the operating quarry on the eastern side of the road, then crossing the Yarra Fault which has now turned eastward and about to join the Mulwaree Fault. Beyond the Yarra Fault the road traverses the Ordovician Abercrombie Formation before crossing the Mulwaree Fault just beyond Melamalong Creek and onto the DeDrack Formation of the Mount Fairy Group until arrival at 'Slatevale'.

Folding (left & centre) and faulting (right) in DeDrack Formation of the Late Silurian—Early Devonian Mount Fairy Group in narrow road cutting approx. 1 km north of the Rhyanna Road Turn off

Location 3. STOP - Middle Arm Road - Chatsbury Slate Quarry, 'Slatevale'

The Chatsbury Slate Quarry has extracted material from the Late Silurian Argyle Formation of the Mount Fairy Group. The Argyle Formation typically comprises packets of grey, green, buff or white, medium- to thick-bedded, fine- to medium-grained, quartz and lithic-quartz sandstone, interbedded with packets of greenish-grey and red laminated to thinly bedded, rhythmically interbedded, fine-grained sandstone and siltstone. Iron oxide cements give the sandstone and siltstone red, purple, maroon and green colours.

The Argyle Formation was deposited by turbidity currents in a moderately deep marine environment.

The early Early Devonian Forest Lodge 'Tonalite' then intruded the Argyle Formation increasing its hardness through contact metamorphism. These units were then overlain by Late Devonian Strathaird Formation and Cookbundoon sediments of the Lambie Group. In the Early Carboniferouis, the Kanimblan Orogeny folded all of these units into the Cookbundoon Syncline, in which 'Slatevale' is on the western limb, and imposed a strong axial plane cleavage. This cleavage has been so well developed in the hardened fine sandstones and siltstones of the Argyle Formation at 'Slatevale' that it has produced a high quality slate.

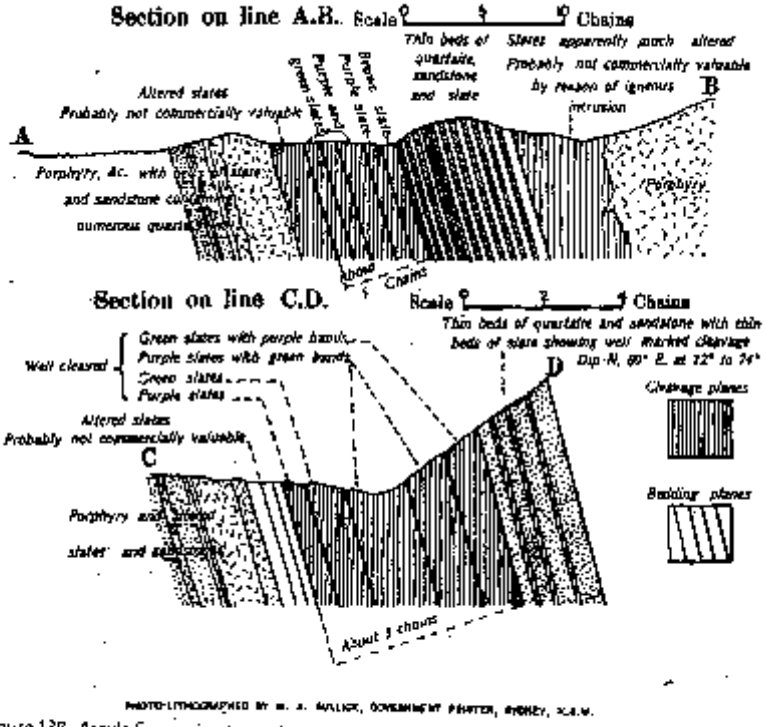


Figure 138. Argyle Formation in section at the Chatsbury slate quarry (GDA GR 752300 6174400); Carne and Andrews (1914).

Two east-west cross sections across the Chatsbury Slate Quarry. Note the almost vertical cleavage parallel to the syncline axial plane and the steep easterly dip of the bedding planes on this western limb of the Cookbundoon Syncline.

(From Goulburn 1:250 000 Geology Sheet S1/55-12, Explanatory Notes, 2012. Geological Survey of New South Wales.)

Chatsbury Slate Quarry.

Flooded main pit. *Spoil and site of machine sheds.* *Façade of Chatsbury slate at motel in Auburn St. Goulburn*

In other areas where the finer sediments have a higher clay content and have been subject to intense regional metamorphism, the clay minerals break down to form a mica, sericite, which forms on the cleavage planes to give this metamorphic rock, phyllite, its characteristic silky sheen. Silica released during the breakdown of the clays is carried away by the concurrent dewatering process generate by the compression and forms vein quartz which, as the softer phyllite weathers away, forms lag deposit on the ground surface. These quartz pebble lag deposits are common in areas dominated by phyllites.

The Chatsbury slate has compact texture, matte to silky sheen lustre good but not perfect cleavage, normal bulk specific gravity, low water absorption, transverse loading strength and resistance to abrasion, frost action and weathering. The colour of the slate is due to chlorite and opaque minerals: 30% chlorite and, <1% opaques in greenish grey slate, and 20-25% chlorite and 10-15% opaques (hematite, pyrite and magnetite) in purplish brown to purplish grey slate.

In the 1890's as the colony of New South Wales increased in population and dwellings became more substantial, slate as a quality roofing material became in high demand. In the 1890's and early 1900's the quarry employed not only local workers but also skilled slate artisans from the slate mining districts of northern Wales.

George Ellis, born at Blaenan, Festiniog, North Wales, arrived in Chatsbury in 1912, aged 24. On 3 August 1915 he enlisted as a private in the 1st Battalion, 18th Reinforcement. Arriving in France, he joined his Battalion in the field on 24 September 1916 and was shot in the right shoulder on 5 November 1916. After hospital in England he rejoined his Battalion on 9 April 1917 and was shot again in the left leg and chest on 5 May 1917. Again after hospital in England, he returned to his Battalion on 1 February 1918 and was shot again in the right leg breaking his femur on 17 April 1918. He died of his wounds the next day. He is buried in the Ebblinghem Military Cemetery, France.

As the quarry was exposed to flooding by the adjacent Tarlo River, a diversion channel was excavated, at great cost, to protect the quarry and the river still remains in this channel.

By the 1930's cheaper alternatives for roofing such as corrugated iron, cement or terracotta tiles meant that slate became less popular and the high cost of labour and transport associated with slate made it unable to compete as a widespread roofing material and the quarry closed.

At the start of World War II the quarry had been abandoned and during the war most of the equipment was salvaged as scrap metal for the war effort. Also as paper was in short supply at this time many children used the old writing slates which were widespread in schools in the late 1890's. They were phased out for hygiene reasons in the early 1900's. Instead of using a damp cloth to erase their work, some children would lick them clean then share with other children.

The quality of the Chatsbury slate is very high and some, from old stockpiles, has been used for decorative stonework such as that on the café on the corner of Auburn and Verner Streets, Goulburn, and the Greek War Memorial, Remembrance Driveway, Canberra.

Location 4. STOP - Tarlo River Crossing

The Tarlo River crossing at 'Slatevale' is across a channel dug to divert the river flow away from the quarry and prevent flooding of the quarry. The excavation was very expensive and was, in part, a contributor to the eventual demise of the company. In the middle of the crossing there is an outcrop of very hard igneous rock, probably associated with the nearby Forest Lodge 'tonalite'. On the eastern bank are bands of heavily crushed and weathered rock which may indicate fault gouge.

Tarlo River crossing, 'Slatevale'

LEFT *outcrop of Forest Lodge 'tonalite' intruding Argyle Formation metasediments*

RIGHT *Argyle Formation metasediments with weathered fault gouge*

Location 5. STOP – Return to Goulburn for Lunch (T)

Location 6. STOP – Federal Highway – Weereewa Lookout, Gearys Gap – Lake George

The Weereewa Lookout is on the southbound lane of the Federal Highway where the Highway leaves the shore of Lake George and ascends through Gearys Gap and to the east overlooks Lake George. 'Weereewa' is the local indigenous word for 'bad water' as the water of Lake George is almost as saline as seawater. Lake George is 25 km long and 10 km wide and when full it is generally has a depth of 1.0 m to 4.5 m. This shallow depth when combined with strong southerly winds makes the waters very choppy and dangerous, so much so that since 1949 13 persons have drowned including, five young cadets from the Royal Military College, Duntroon who, in 1956, drowned in a yachting mishap.

The Lake is a closed drainage basin that collects water but does not permit outflows by streams or rivers. The thickness of sediment exceeds 250 m and the oldest sediments, which lie some distance above the bedrock, were dated at 3 – 5 Ma. It is estimated that the sediments at the basement are 10 - 15 Ma in age. A distance of 250 m in 10 Ma gives a rate of .025 mm per annum. The top 8.6 m of sediment, covering the last 350,000 years are the longest continuous record of fire and vegetation geological history in Australia.

Profiling of the Lake's basement has revealed a branching stream system with the trunk stream exiting west in the vicinity of Gearys Gap. However in the Middle Miocene the Lake George Fault was reactivated and the western side, the Cullerin Horst, uplifted at a rate faster than the stream could cut down thus forming a dam and its associated Lake George.

At the southern end of the Lookout, steeply dipping sandstones and siltstones of the Ordovician Abercrombie Formation are exposed.

Looking south-east towards Boro, beyond low hills in distance right

Looking to the south-east beyond the low range of hills in the distance is the locality of Boro. It is here that the infamous bushranger, Frank Gardiner was born. He took his surname from an elderly blacksmith who was his childhood mentor and who worked on the property where his mother also lived and worked. Frank Gardiner and his off-sider, Ben Hall, had a very profitable butchery business at Lambing Flat (Young) feeding the many hungry miners in the goldfields. Their profits were enhanced as they did not pay market price for some of their cattle, for which they did not pay for at all. Later, in 1864, Gardiner was the mastermind in the Eugowra Rocks Gold hold-up and robbery. (This site was visited in a previous excursion). He was accompanied by Hall, Johnny Gilbert and several others. After the robbery Gardiner fled to Queensland where he was almost caught before fleeing to San Francisco where he bought a pub on the waterfront. This pub was later burnt to the ground by the fires which ensued the 1906 San Francisco Earthquake and destroyed all of the timber waterfront buildings.

Gearys Gap, looking north-east over the dry Lake George

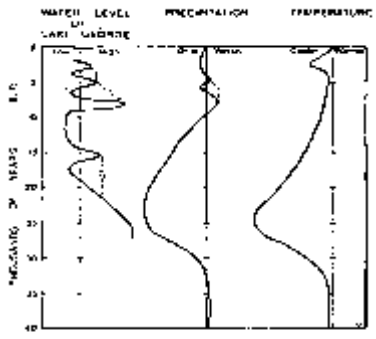
On 26 January 1865, Hall, Gilbert and John Dunn Held up and robbed coaches and travelers at Gearys Gap, and the again at the same place on 4 March. However on 26 January, after the hold-up, the gang moved on to Collector in the afternoon.

Location 7. Driveby—Ancient lake shorelines

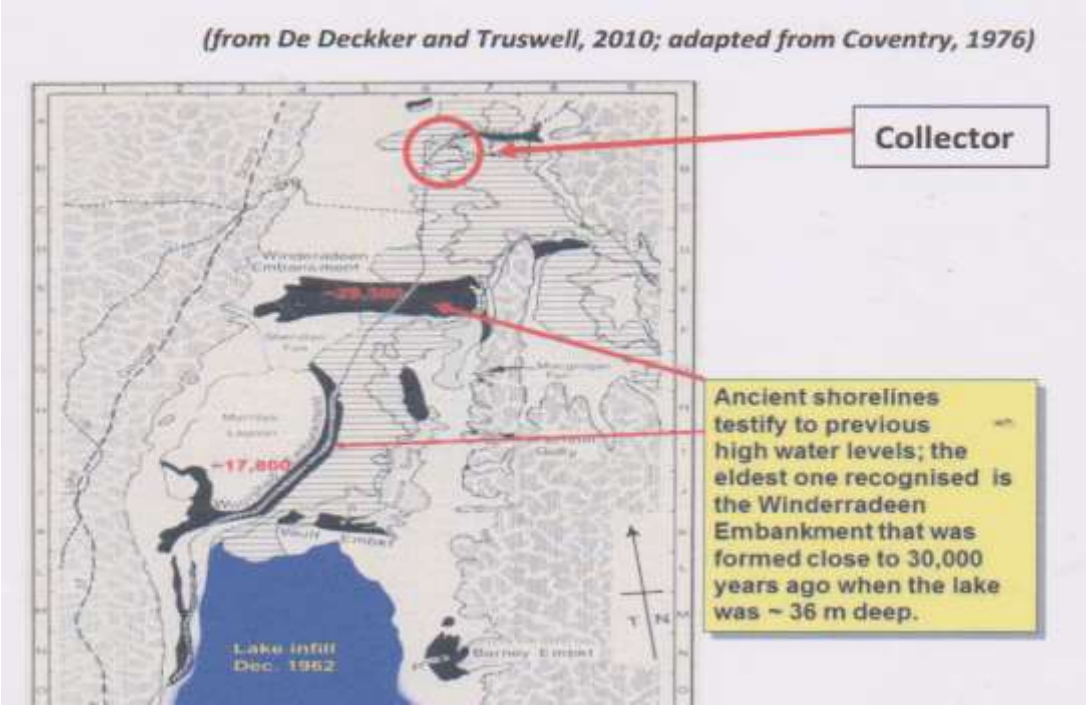
The excursion route now follows the gang's route to Collector. This route traverses evidence of past lake levels. In recent millennia, water levels in Lake George can be gauged from a number of abandoned shorelines (raised beaches) identified on the northern and eastern sides of the lake. Mapping of these raised beaches and dating of charcoal in the embankment (Coventry 1978) indicates that the oldest of these was formed about 29,300 years ago. The oldest embankment, the Winderadeen Embankment, is about 1 km south of the town of Collector. The Federal Highway cuts through it. It is about 2.8 km long and has a width of 300 m to 850 m.

The Winderadeen Embankment is now between 19 m and 43 m above the lake bed. It indicates that water depths at the time of sediment deposition were at about 36-37 m above the present day lake bed. At that depth the water from Lake George would have been flowing out through Gearys Gap into the Yass River catchment. The Woolshed Embankment, dated at 17,800 years old, can be viewed from the dead-end road leading to the Lake George Winery from the Federal Highway. Much of the Federal Highway is built along the top of the Woolshed Embankment.

Woolshed Embankment near the Lake George Winery



Indicator of climate variations over the last 40,00 years (Coventry, 1976).



Location 8. STOP – Const. Samuel Nelson's grave, Catholic Cemetery, Collector (T)

Constable Nelson is buried in the Catholic cemetery, Collector, next to the Police Station and now his sacrifice in the line of duty is acknowledged by a plaque at the Police Memorial near the Carillion on the shores of Lake Burley Griffin, Canberra.

LEFT. *Const. Nelson's grave in the Catholic Cemetery, Collector*

RIGHT. *Const. Nelson's plaque on the Police Memorial Wall, Lake Burley Griffin, Canberra*

Location 9. STOP – the 'Bushranger Hotel' formerly Kimberley's Commercial Hotel, Collector

On the afternoon of 26 January 1865, Hall, Gilbert and Dunn (aged 17) captured seven people, including Henry Nelson the younger son of Const. Samuel Nelson, on the outskirts of town. The gang then took their prisoners into town and, telling young Nelson to mind their horses or they 'would blow his brains out', bailed up Thomas Kimberley's Commercial Hotel (now the 'Bushranger Hotel'). Dunn was left outside to guard the prisoners while Gilbert and Hall ransacked the hotel. Hall came out and gave Dunn a shotgun he'd found inside and then went back inside.

The 'Bushranger Hotel', formerly 'Kimberley's Commercial Hotel'

Const. Nelson's Memorial, Collector

A young girl told Const. Nelson that the gang was at Kimberley's Hotel so Nelson armed himself with a single shot carbine and proceeded towards the hotel. About half way there he was joined by his 18 year old son Frederick. As they approached the hotel, Dunn, who was kneeling down behind a fence, called on them to stop but Const. Nelson kept on advancing and when he was about 20 metres away Dunn fired the shotgun fatally wounding Const. Nelson in the chest. Dunn then fired a revolver and hit the constable in the head and Nelson fell to the ground dead while Dunn fired again at the fleeing Frederick, but missed. Hall and Gilbert ran from the hotel at the sound of the shots then Hall remained with the prisoners while Gilbert and Dunn went to Nelson's body. Gilbert then plundered the constable's corpse by taking the constable's belt for his own use. Hall and Gilbert then took some boots from the hotel before the gang rode off.

Location 10. Driveby - More lakes in the Lake George Half-graben

ABOVE - *Wollogorong Lagoon*

As the excursion route continues to follow that of the Gilbert, Hall & Dunn gang , it passes an area with many lakes and lagoons formed in the Lake George Half-graben. They are all shallow, some are usually dry and others hold water. These lakes include Rowes Lagoon, Murrays Lagoon, Wollogorong Lagoon, Dry Lagoon and Wet Lagoon and several others without formal names.

BELOW - *Dry Lagoon*

BELOW - *Wet Lagoon*

Location 11. STOP. Old South Road – 'Sweetwood Lea'

'Sweetwood Lea', Old South Road,

'Sweetwood Lea' and the relationship of it to Thomas Lodge was mentioned during Day 2 at Bredalbane and now following the murder of Const. Nelson and the flight of the Hall Gang, the story continues.

'Sweetwood Lea' was probably constructed in the late 1820's and called 'Archers Inn', a changing station for Cobb & Co. coaches. By 1865 the Inn had been renamed the 'Brisbane Arms' and then again under Thomas Lodge's ownership to the 'Breadalbane Arms'.

On the morning of 22 February 1865, Mr Augustus Huthwaite, J.P., saw two persons known to be part of the Hall Gang's bush telegraph. After forming a posse of five troopers, Detective Pye and a police informer, they received further information that the Gang was probably at Lodges Inn, the 'Breadalbane Arms'. However on arriving the Gang had been warned and had left. All persons at the Inn were kept there under guard while the posse with an additional trooper and another informer proceeded to the Mutmutbilly home of farmer Thomas Byrne, a suspected harbourer.

There the posse surprised the Gang who were sleeping in the barn. A fierce gunfight ensued in which Trooper Wiles was severely wounded and Hall wounded in the arm. The Gang members escaped, unencumbered by the coats and boots of their would-be captors but Byrne, who was drunk and resisted arrest, was charged with harbouring. At his trial, while the jury found him not guilty, the judge admonished him severely about the company he kept. He is buried in the churchyard at St Brigids, Mutmutbilly.

Location 12. STOP - St Brigids Catholic Church & grave of Thomas Byrne

In the graveyard of this beautiful stone church, constructed in 1874, is the grave of Thomas Byrne who was involved in the gunfight incident at his Mutmutbilly farm as detailed in Location 11.

St Brigids Catholic Church, Mutmutbilly
The shady trees have since been removed

The grave of Thomas Byrne
St Brigids Church graveyard, Mutmutbilly

Location 13. Stop – M1 - Wologorong Granite

Heading east back towards Goulburn at Breadalbane, first on the Old Hume Highway and then on the M1, this location on the Wologorong Granite is close to several granite tors.

The Wologorong Granite is a pluton of the Wologorong Batholith which is comprised of several plutons extending northwards from Collector to near Oberon. In the excursion area the Wologorong Batholith is confined to the western part of the Goulburn Basin.

The Early Devonian Wologorong Granite is mostly covered by Quaternary fluvial, lacustrine and aeolian deposits in this area and outcrop typically occurs as areas of scattered tors and whaleback style exposures on low rises over the generally flat landscape.

The typical lithology is cream, pale grey and pink, to pale brown where weathered, medium- to coarse-grained, equigranular to sparsely porphyritic granite and xenolithic in places.

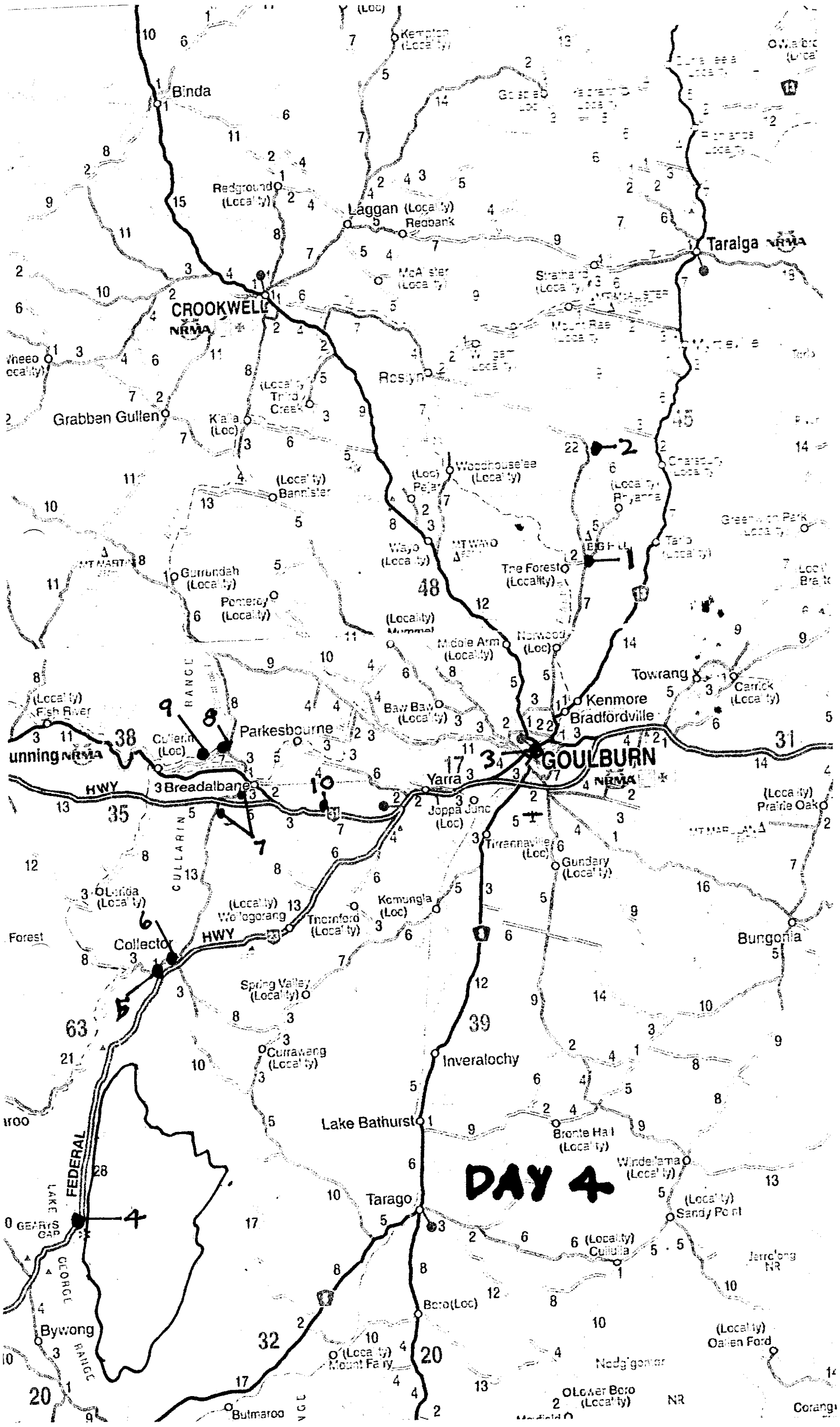
Tors of Wologorong Granite,
Breadalbane Plains

NOTES

DAY 4 - Goulburn to Gearys Gap, Lake George & return via Collector & Breadalbane

		pt to pt	cum		
	START			Start at BIG SHEEP car park. Exit car park turn left, go to r'bt and turn right onto	**Toilets**
Stop	Big Sheep car park	0.0	0.0	M31 and towards Yass. After 8.2 Km keep left and take Federal H'way to Canberra.	
				Due to cancellation of the Excursion due to Covid 19, today's excursion is modified	
	Please NOTE			**to exclude Locations 1 to 5 as the Chatsbury Slate Quarry is on private property.**	
				START at the Big SHEEP Car Park and proceed to Stop 6 following the above directions.	
6	**Federal H'way**			If needs be, there are Toilets at the Rest Area at 48.7 Km. At 52.4 Km turn left into	**Toilets**
Stop	Weereewa L'out,	52.4	52.4	Weereewa Lookout . On exiting the Lookout turn right onto the Federal H'way	
	Gearys Gap, Lake George			heading back towards Goulburn.	
7	**Federal H'way**			Between the northern end of Lake George and the Collector TO, the H'way	
Loc	Ancient lake shorelines			passes along the Woolshed Embankment at 13.5 Km and across the Winderadeen	
		20.7	73.1	Embankment at 19.5 Km. Turn left onto Collector Rd at 20.7 Km	
8	**Collector Rd, Bourke St**			After 1.0 Km on Collector Rd Turn Right into Bourke St. Go 700 m to **Toilets** on right.	**Toilets**
Stop	Const. Nelson's Grave	2.1	75.2	Then back along Bourke St for 350m (just past right bend) Stop. Grave is about half	
				way along the Police Station fence. See photo of grave in notes to find it easily.	
9	**Bourke St, Murray St**			Continue back along Bourke St. Turn right into Collector Rd (now Murray St).	
Stop	Bushranger Hotel'	0.8	76.0	After 150 m turn right into driveway to Hotel. After 260 m Stop. Monument on right.	
10	**Surry St, Breadalbane Rd**			Continue on now Church St for 700m and turn right into Surry St (Breadalbane Rd).	
Loc	Several Lakes			After 6.5 Km on this downhill the Dry Lagoon is ahead. After a further 5.3 Km is the	
				M31 underpass and a further 800m the Wet Lagoon can be seen on the left. A further	
		17.1	93.1	3.8 Km Breadalbane Rd meets the Cullerin Rd (or Old Hume H'way (**OHH**)). Turn left.	
11	**OHH, Old South Rd**			Follow OHH for 830m then turn right into Old South Road over Rly and then 2.8 km to	
Stop	Sweetwood Lea'	3.6	96.7	'Sweetwood Lea' on right. Park before house (Private residence)	
12	**Old South Rd**			Continue on Old South Rd for 600m to St Brigids Church. Look for grave headstone as	
Stop	St Brigids Church	0.8	97.5	shown in photo but all trees have been removed since photo taken. It is near middle.	

13 Stop	**Old South Rd, OHH, M31** Wologorong Granite	9.7	107.2	Turn around and return to Breadalbane. Low rises on either side of road just past	
				'Sweetwood Lea' are ancient lunettes. From Breadalbane continue on OHH to M31.	
				After 2.4 Km on M31 take Truck parking bay on left and go 400m. Granite is on left.	
				This is the same stop as Stop 26 on DAY 3 (see Day 3 Notes). If seen already continue.	
14 Stop	**M31** French VC Rest Area	10.2	117.4	After 10.2 Km turn left into French VC Rest Area for **Toilets. This is the same stop as**	**Toilets**
				Stop 26 on DAY 3 (see Day 3 Notes) If seen already the Toilet stop may help.	
15 Stop	**M31 to Big Sheep** Goulburn **FINISH**	5.0	122.4	Leaving the Rest Area turn left onto M31. After 4.3 Km take Goulburn offramp Left.	
				Return to Big Sheep after another Big Day. Hope that you enjoyed it.	**Toilets**



DAY 4
Binda
Redground (Locality)
Laggan (Locality)
Redbank
Taralga
CROOKWELL
Grabben Gullen
Roslyn
Bannister
Gurrundah (Locality)
Pomeroy (Locality)
Woodhouselee (Locality)
The Forest (Locality)
Middle Arm (Locality)
Norwood (Loc)
Towrang
Kenmore
Bradfordville
Fish River
Parkesbourne
Baw Baw (Locality)
GOULBURN
Yarra
Breadalbane
Joppa Junc (Loc)
Tirrannaville (Loc)
Gundary (Locality)
Prairie Oak
Bungonia
HWY
CULLARIN
Collector
Woologorang (Locality)
Thornford (Locality)
Komungla (Loc)
Spring Valley (Locality)
Currawang (Locality)
Inveralochy
Lake Bathurst
Bronte Hall (Locality)
Windellama (Locality)
Sandy Point
Tarago
Cullulla
Bywong
FEDERAL
LAKE GEORGE
GEORGE RANGE
Boro (Loc)
Mount Fairy
Oallen Ford
Lower Boro (Locality)
Butmaroo
Forest
1
2
3
4
5
6
7
8
9
10

4

AMATEUR GEOLOGICAL SOCIETY of the HUNTER VALLEY

GOULBURN BASED EXCURSION

DAY 5

Goulburn to Laggan,

Binda & Crookwell

DAY 5 - GOULBURN EXCURSION – To Laggan, Crookwell & Binda

This day's excursion will pass historic locations, the Tumboramboro Granite, the Cuddyong Formation, a wind farm and the Pejar Dam.

Location 1. – Driveby - Crookwell Road – Yarra Fault

After leaving Goulburn City, the Crookwell Road crosses a complex array of Silurian rocks before crossing the Yarra Fault at this location. The road then continues across Ordovician rocks mostly of the Abercrombie Formation until the Woodhouselee Road TO where the excursion route also turns off.

Location 2. STOP - Woodhouselee Road TO – Mount Wayo – Wheeo Basalt

LEFT *Mount Wayo*

To the east of the turn off Mount Wayo is clearly visible. The Mount has a capping of Wheeo Basalt which has ages clustering about 15 Ma and 18-21 Ma indicating that the basalt was extruded in several episodes over a period of time. The Basalt is underlain by silicified and unconsolidated sand and gravel of probable Palaeogene age, or on Palaeozoic metasedimentary rocks and intrusions.

Location 3. – Driveby – Woodhouselee Road – Woodhouselee – Pratton's Inn

The Roslyn Road continues on again over Ordovician rocks of the Abercrombie Formation.

Laggan village

Pratton's Public House, Woodhouselee. Now called 'Hillview Park'

During August 1863, at McCrae's 'Sir Colin Campbell Inn' in Laggan, Detectives William Camphin and John Sanderson, disguised as gold diggers, were given banknotes in their change after buying drinks. These banknotes were identified as originating from the Mudgee Mail robbery. The detectives had visited Thomas Vardy's 'Limerick Races Inn' at Cooks Vale Creek where they received information leading them to Laggan. On 29 August, just after daybreak, the two detectives together with Snr-Sgt. James Stephenson and Const. Herbst returned to Vardy's Inn with a search warrant. Fred Lowry and Larry Cummins were hiding in the Inn and in a stand up face to face gunfight between Lowry and Stephenson, at a range of just a few metres, Lowry was shot in the throat and Cummins then surrendered.

Vardy, his step sons Michael and Robert Hogan (one of the Mudgee mail notes was found on Robert), James Williams, Robert Brown and John Watson were arrested on harbouring charges. The

prisoners and their escort were returning to Goulburn and by evening they had reached Woodhouselee station (7 km south of Roslyn) but Lowry was suffering severely and Stephenson decided to stop at Pratton's Public House and to send for reinforcements and for Doctor Waugh to treat Lowry. Lowry asked Camphin to tell his brother-in-law Elliot that **"he died game"** as Lowry always said he would not be taken alive because he thought that he would be hung and he didn't want to die a coward. The other prisoners all knelt down while Camphin read the Catholic litany for departing souls, with Lowry sometimes repeating the responses before he died at 6 am the next morning.

Location 4. – STOP – Woodhouselee Road – Crookwell Basalt

LEFT *Crookwell Basalt on Woodhouselee Road*

Heading towards Roslyn, the Woodhouselee Road traverses the Crookwell Basalt. The Crookwell Basalt comprises several flows and forms a very level surface except where the upper flows have been eroded to form low residual hills. The basalt flows are Eocene in age, varying from 36 Ma to 51 Ma. The Crookwell Basalt is difficult to distinguish from the Wheeo Basalt other than by age, although the Crookwell Basalt tends to occupy a topographical higher and less dissected area than the Wheeo Basalt.

Location 5. Driveby – Merrivale – Dame Mary Gilmore (nee Cameron)

Dame Mary Gilmore was a poet, activist and journalist who, in 1937 was made a Dame of the British Empire in recognition of her contribution to Australian literature.

She was born and raised at Merrivale (or Mary Vale) in 1865 at which time the settlement was known as Cotta Walla. Her father was a property manager and building contractor. At age 9 she was attending Wagga Wagga Public School and also spent a year as a probationary teacher at Yerong Creek Public School before teaching at several different schools in the district. In 1895 she resigned and moved to Paraguay where she married Victorian shearer William Alexander Gilmore and later had their son William Dysart Cameron Gilmore. She returned to Australia in 1902. Dame Mary passed away in 1962.

Location 6. STOP. – Roslyn Road – Tumboramboro Granite

Immediately after turning onto the Roslyn Road the Road traverses the Early Devonian Tumboramboro Granite, the most voluminous pluton of the Tumboramboro Suite, the northern part of the Wologorong Batholith. The pluton is separated from the Wologorong Granite by a thin screen of metasedimentary rocks. The Tumboramboro Granite is pale grey to cream, medium- to coarse-grained, and equigranular to porphyritic. Metasedimentary xenoliths are present in places and the granite varies from relatively unstrained to strongly schistose.

Outcrops of the Tamboramboro Granite

Location 7. STOP – Laggan Village

Laggan began as a private village, never having been gazetted in the Government Gazette as a village. It later was considered to be where a major township would be settled. In its heyday it had a Post Office, Court House, Police Station and Lockup, four stores, National School, three churches, a blacksmiths shop and five hotels. McCrae's Hotel is no longer, and the Laggan Hotel (sited on the present hotel's car park) was burnt

RIGHT *Laggan village, present hotel on right*

down in 1924 and rebuilt on the adjacent block. However Crookwell became the district's main town and Laggan faded to a quiet village.

The role of McCrae's 'Sir Colin Campbell Inn' at Laggan has already been noted at Location 3. After the arrest and trial for harbouring of Thomas Vardy's stepsons, Robert and Michael Hogan, they were acquitted of the charges (probably by a sympathetic local jury). After returning from the Goulburn assizes on 26 September 1863, they, and several of their friends, started boozing up at the Sir Colin Campbell Inn at Laggan. The grog had been flowing very freely for quite a while when, finally, the owner, John McCrae, refused to serve more drink. One of the Hogan's friends, Donald McDonald, abused McCrae who retaliated by striking McDonald over the head with a cutlass. McDonald then had McCrae charged with intent to do grievous bodily harm. At his trial the jury found against McCrae and he was sentenced to 2 years hard labour at Goulburn Gaol. Whilst in gaol, his licence for his inn was cancelled on police application and the house was abandoned. The inn was reopened as the 'Sportsmans Arms' in early December 1864 with John S Paris the new owner.

Location 8. STOP – 'Biligal', Laggan Road – Cuddyong Formation

From Crookwell to Laggan the road traverses the Late Silurian Cuddyong Formation of the Campbells Group. The Cuddyong Formation consists of interbedded quartzose sandstone and siltstone, rhyolitic to dacitic coherent and volcanic rocks, grey to black siltstone, shale and mudstone, and rare limestone. In this area the slopes are more gentle than in other more severely dissected and higher relief areas.

The Cuddyong Formation was deposited in a marine environment below storm wave base and considerable variation in thickness suggests an irregular basin, consistent with a rifted basin.

Minor folding and shearing

Intruded quartz dyke

Refracted cleavage in siltstones

Location 9. STOP – Crookwell town (T)

The north-south trending Lake George Fault passes through the town about a kilometre west of the town centre while about the same distance to the south-west the Copperhania Fault splits to the west from the Lake George Fault. The Copperhania Fault extends north towards Wellington and forms the western boundary of the Hill End Trough.

Crookwell is rural service centre surrounded by a rich agricultural and pastoral district. The district is recognized as one of the State's major producers of seed potatoes, wool, fat lambs, beef cattle, oats, hay, dairy products and cold climate fruits. It is also the home of the Lindner Sock Factory.

Location 10. Driveby – Binda Road

After crossing three major faults on the western outskirts of town, the road traverses the Ordovician Abercrombie Formation before traversing the Binda Granite of the Boggy Plain Supersuite which extends in a meridional belt from north-east Victoria to Dubbo.

The Binda Granite crops out poorly and is predominantly a speckled cream to white, and grey to black or pink, medium- to coarse-grained equigranular to porphyritic, massive to recrystalised and foliated, hornblende-biotite granite and borderline tonalite/granodiorite.

Location 11. STOP – Binda Village. (T)

Binda originally was the main administration centre for the Abercrombie District and had the first Post Office, Police Station, Court House and the first Government School in the Crookwell Shire.

Binda had a colourful history with bushrangers and among the more dramatic was the 1864 Binda Christmas Ball.

Binda village

On 26 December 1864 Hall, Gilbert and Dunn rode into the village of Binda to a Christmas Ball accompanied by local girls Christina McKinnon (25), Margaret Monks (19) and her sister Ellen Monks (17). The three girls went straight to Morris' store where Ellen had worked and lived with them for over a year. A few minutes later the men came in and held up the store. They all then went to the hall where the gang bailed everyone up and told all that they were to stay in the hall and proceedings were to continue. Later in the evening Mr Morris escaped outside and hid, but was seen by the gang who were furious and they then, assisted by Ellen and Christina, went out and burnt Morris' store down. The Gang then left to carry out even more violent crimes (as noted on Day 4). The girls however, were later charged with aiding the offences and, as the jury could only agree on one of the charges, they were released on 100 pound bonds and a caution.

The Monks family itself also has a colourful history, some detail of which will be included as an aside.

On December 28 1863 at about 3 am at Laggan, William Holland, the Tuena mailman, was held up and robbed by a masked bushranger with an unusual tone to his voice and suspicion fell on a James Monks. Monks who had been gaoled previously for horse stealing was caught by Snr Const. William Hughes on January 28 1864 in the bush near Thalaba (18 km N Laggan). He was identified by his voice by William Holland and charged with 'mail robbery under arms'. However, because of lack of visual identification, he was acquitted by the jury.

In the early morning of 31 October 1859, while James Monks was in gaol, his 44 year old mother Ellen battered her second husband Thomas, who was a drunkard and in his sixties, to death with a hammer. He had been abusing her and said that he was going back to the 'Limerick' (Vardy's pub). She then burned the body in the fire and threatened her two of her daughters with the same fate if they told anybody. Ellen had four daughters, Bridget, Mary, Margaret (14) and Ellen (12). Later in the day she took the remains, put them in a bag and then threw them into a nearby waterhole. Two days later she sent one of the girls to the police to say that the father had gone missing. During the ensuing search, Const. Pagett met another of the daughters who told him what had happened. Returning to the home with Const. Poltick, the troopers found human remains in the house and also recovered those in the waterhole. Ellen Monks was arrested and the next day she confessed to the murder. She was tried, convicted and sentenced to death. In spite of a petition signed by about fifty gentlemen from Sydney, nearly all Members of Parliament, Ellen Monks was hanged at 9:04 am on Tuesday May 8 1860 at Darlinghurst.

Location 12. Driveby – Junction Point Road – Binda Thrust between Binda Granite and Cuddyong Formation

For the next several kilometres past Binda on the Junction Point Road, the Binda Thrust Fault separates the Binda Granite on the west from the Cuddyong Formation on the east. The carriageway is over the Fault line and the Granite forms the upthrust ridge immediately west. The Binda Thrust Fault extends northwards from near Cullerin to well beyond the Abercrombie River and runs sub-parallel between the Cullerin and Blackmans Creek Faults. Return to Goulburn via Crookwell.

RIGHT *Binda Thrust escarpment on left of Junction Point Road, north of Binda*

Location 13. STOP – Goulburn Road - Crookwell Wind Farm

Wind turbines, Crookwell Wind Farm

Returning to Crookwell and then continuing on towards Goulburn, the road traverses the Crookwell Basalt before arriving at the Wind Farm on the western side of the road.

The Crookwell Wind Farm, constructed in 1998 following long term wind monitoring, was the first in Australia to supply electricity into the National Grid. At full output the wind farm will be capable of meeting the average electricity demand of 3,500 homes. The farm will save about 8,000 tonnes of carbon dioxide emissions each year that otherwise would be produced by coal-fired power stations. The wind farm is connected via underground 11 kV cables to a substation which steps up the voltage for connection to the local 66 kV transmission grid.

On completion, the 5MV wind farm had 8 turbines of 600 kW capacity. The hub height is 45 m, blade diameter is 44 m, the rotation speed is 28 rpm and the start-up wind speed is 15 km/h, 54 km/h maximum speed and 72 km/h cut-out wind speed. However subsequently there have been several more farms constructed in the area and there are now more than 20 additional windmills in the in the local area and many more visible on the horizon.

Location 14. STOP – Pejar Dam – Wologorong Granite

After the Wind Farm, the Goulburn Road traverses the Wologorong Granite.

The Pejar Dam was constructed in 1979 by the NSW Dep't of Public Works to supply water to Goulburn City. It is a rock and earth filled dam located at the junction of the Wollondilly River and Pejar Creek. When required, water from the Pejar Dam is released from the tower and flows 54 km's down the Wollondilly River, where it is impounded at Rossiville Weir. The rock used in construction and, in places, to stop bank erosion is mostly the Wologorong Granite and fresh specimens can be seen at the parking area.

Pejar Dam, Wologorong Granite in foreground, dam wall on left

Location 15. Driveby - Yarra Fault

After the Pejar Dam the road traverses the Wologorong Granite for a further 4 Km before passing onto the Abercrombie Formation for another 10 km before quickly passing through the Late Ordovician units of the Bumballa Formation, Warbisco Shale and then the Poidevins Sandstone and Dignam Siltstone (these latter two are the approximate eastern equivalents of the Mundoonen Sandstone in the west). The road the crosses the Yarra Fault and onto the Siluro-Devonian Mt. Fairy Group, here the Kingsdale Limestone Member of the DeDrack Formation.

Location 16. STOP— Marble Hill Road—Kingsdale Limestone

The mid-Silurian Kingsdale Limestone forms a subdued topography and has an irregular karst surface covered by terra rossa soils and residual iron deposits. The Member consists of massive and bedded fossiliferous limestone and marble, and laminated to thinly bedded limestone, marl and buff siltstone.

The depositional environment has several components including calm shallow water, some turbulence to concentrate disarticulated brachiopod shells and a shallow marine littoral environment offshore from a beach system.

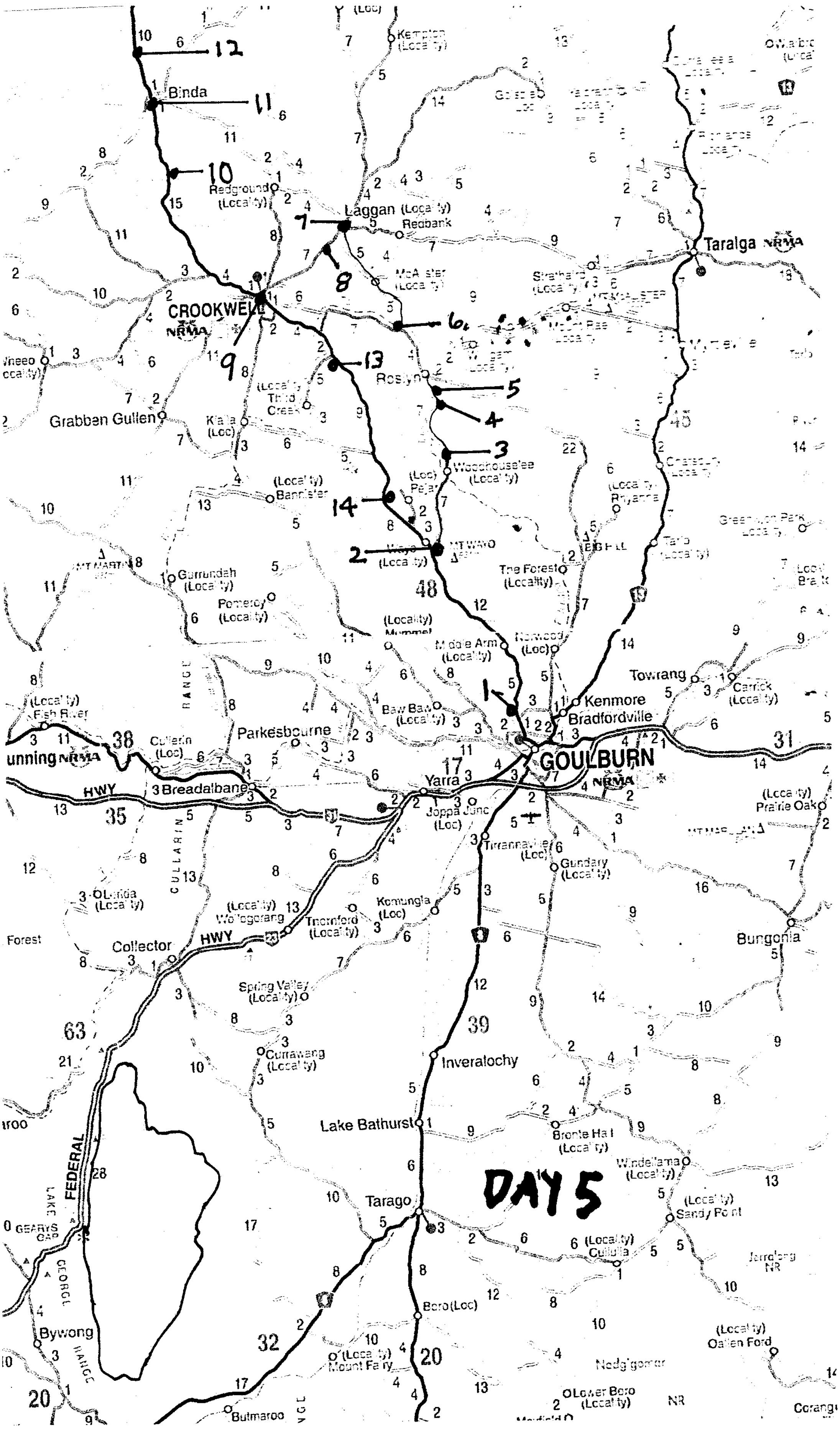
Kingsdale Limestone on Marble Hill Road

EXCURSION LOCATION DIRECTIONS

DAY 5 - Goulburn to Laggan, Crookwell, Binda & return via Crookwell and Pejar Dam

		pt to pt	cum		
	START			Start from **Goulburn Tourist Information Centre Car Park**, Sloan Street,	**Toilets**
Stop		0	0	opposite SE end of Belmore Park and is 100m NE of Goulburn Railway Station	
1	Yarra Fault			On exiting the Info. Centre car park turn right into Slone St . After 700m turn left into	
Loc		9.1	9.1	Goldsmith St at 2nd Rbt . Continue on for 1.4 km until final Rbt and turn right into	
				Fitzroy St (Crookwell Rd). Continue on Crookwell Rd for 7.0 Km where the Rd crosses	
				the Yarra Fault near the bottom of the hill.	
2	Mt. Wayo			Continue on Crookwell Rd for 10.2 Km and turn right into Woodhouselee Rd. Then stop	
Stop		10.2	19.3	on left at lay bye to view Mt Wayo.	
3	Pratton's Inn			Continue on Woodhouselee Rd for 8.0 Km to Woodhouselee village where Pratton's	
Loc		8.0	27.3	Inn is the 4th house on the right, some way past the other dwellings.	
4	Crookwell Basalt			Continue on Woodhouselee Rd for 6.5 Km where the Crookwell Basalt crops out at	
Stop		6.5	33.8	the crest of a hill. Stop on left of road. **WATCH FOR TRAFFIC BOTH DIRECTIONS**	
5	Merrivale			Continue on Woodhouselee Rd for 900m where, on the right, the 'Merrivale'	
Loc		0.9	34.7	Homestead is set back from the road and mostly concealed by a stand of large trees	
				which extend from the house to the entrance gate.	
6	Roslyn Road			Continue on Woodhouselee Road for 4.2 Km and turn left into Roslyn Road. Go 300 m	
Stop	Tumboramboro Granite	4.5	39.2	and **stop left at granite outcrop on left**. **WATCH FOR TRAFFIC BOTH DIRECTIONS .**	
7	Laggan Village			Continue on Roslyn Rd for about 300 m to **do a safe U turn** and go back to	
Stop				Woodhouselee Rd. Then turn left and follow Woodhouselee Rd for 10.0 km to	
		10.5	49.7	Laggan Village. Continue on for 250 m to hall on right and **do safe U turn** back to Hotel	
				car park on left. Stop here to walk around village as desired. Toilets may be available	**Toilets**
				in Hotel.	
8	Biligal'			Continue back for 200m and turn right into Laggan Rd (to Crookwell). Go 800m and	
Stop	Cuddyong Formation	1.0	50.7	Stop left immediately before the entrance to 'Biligal'. View outcrops in gutter from	

				the other side of the entrance for about 150m up the hill.	
9	Crookwell Town			Continue on for 7.0 Km to Crookwell town and turn left into Goulburn Road. After	**Toilets**
Stop		7.3	58.0	150m turn left again for 150m to Public Tolets and park. You may wish to take a break	
				for lunch in the town.	
10	Binda Road			Turn around and go back to Goulburn Rd. Turn right and on for 150m to the Laggan Rd	
Loc		10.0	68.0	intersection. From here continue on the Binda Rd towards Binda 20 Km away.	
11	Binda Village			From Crookwell it is 20.5 Km to the village of Binda. Stop left opposite the General	**Toilets**
Stop		10.5	78.5	Store for Toilets and Park. Facing the Store, the site of Morris' store, burnt by the	
				Hall Gang, is behind the block to the right of the Store.	
12	Binda Thrust			Continue on what is now called Junction Point Rd for 1.6 Km where the Bindi Thrust is	
Loc		5.9	84.4	immediately left and Cuddyong F'm in the flatter country on the right. Then continue	
				on for a further 3.3 Km to the Sylvia Vale Rd TO on the left. Continue straight ahead	
				for 1 Km to a Council stockpile lay bye on the left with farm buildings almost opposite	
				on the right. Turn into the lay bye, and turn around to exit right back to Crookwell	
				making a safe U turn. WATCH FOR TRAFFIC BOTH DIRECTIONS .	
13	Crookwell Wind Farm			After travelling back 26.4 Km to Crookwell, continue on straight through town	
Stop		37.9	122.3	(stop if you need Toilets or food etc) on the Goulburn Rd for 11.5 Km from the Laggan	**Toilets**
				Rd intersection to the Windfarm Lookout car park on the right side of the road. Turn	
				into the car park.	
14	Pejar Dam			On exiting the car park, turn right towards Goulburn, **WATCH FOR TRAFFIC BOTH WAYS**	**Toilets**
Stop	Wologorong Granite	8.5	130.8	and go 8.5 Km and turn off left into the Pejar Dam car park.	
15	Yarra Fault			On exiting the car park, turn left, **WATCH FOR TRAFFIC BOTH WAYS ,** towards Goulburn	
Loc		16.3	147.1	for 16.3 Km where the road crosses the Yarra Fault as the road descends the hill.	
16	Marble Hill Rd			At the base of the hill turn left into Marble Hill Road and goabout 1.8 Km to over crest	
Stop	Kingsdale Limestone	2.4	149.5	to do a safe U turn, **WATCH FOR TRAFFIC BOTH WAYS** , go back about 400m Stop on left	
				Kingsdale Limestone outcrop on left.	
Finish		9	158.5	Go back to Goulburn Road, **WATCH FOR TRAFFIC**, turn left and continue to Goulburn	**Toilets**



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Gunning
Breadalbane
Yarra
Joppa Junc (Loc)
Tirrannaville (Loc)
Gundary (Locality)
Prairie Oak
Bungonia
Collector
Kemungla (Loc)
Spring Valley (Locality)
Currawang (Locality)
Inveralochy
Lake Bathurst
Bronte Hall (Locality)
Windellama (Locality)
Tarago
Sandy Point
Bywong
Boro (Loc)
Mount Fairy
Bulmaroo
Oallen Ford
FEDERAL
HWY
DAY 5

OROGENIC PROCESSES

The following overly simplified diagrams illustrate the major structural processes involved in an orogenic event comprising a compression phase followed by an extension phase.

The diagrams show firstly a vertical section then secondly a vertical section after peneplanation together with a plan view of that section as would be encountered in a surface traverse.

The traverses show the increasing complexity at the surface as the deformation progresses.

The folding and faulting occur simultaneously.

1. HORIZONTAL BEDDED STRATA

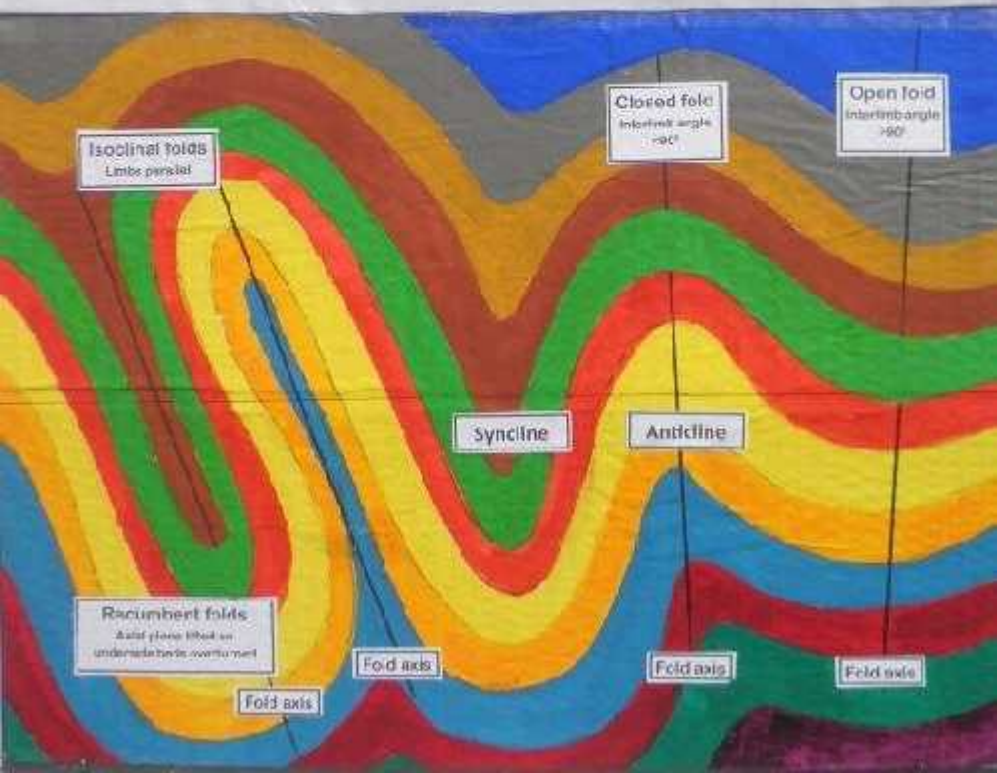
Vertical section

1. HORIZONTAL BEDDED STRATA

Plan view of traverse after peneplanation

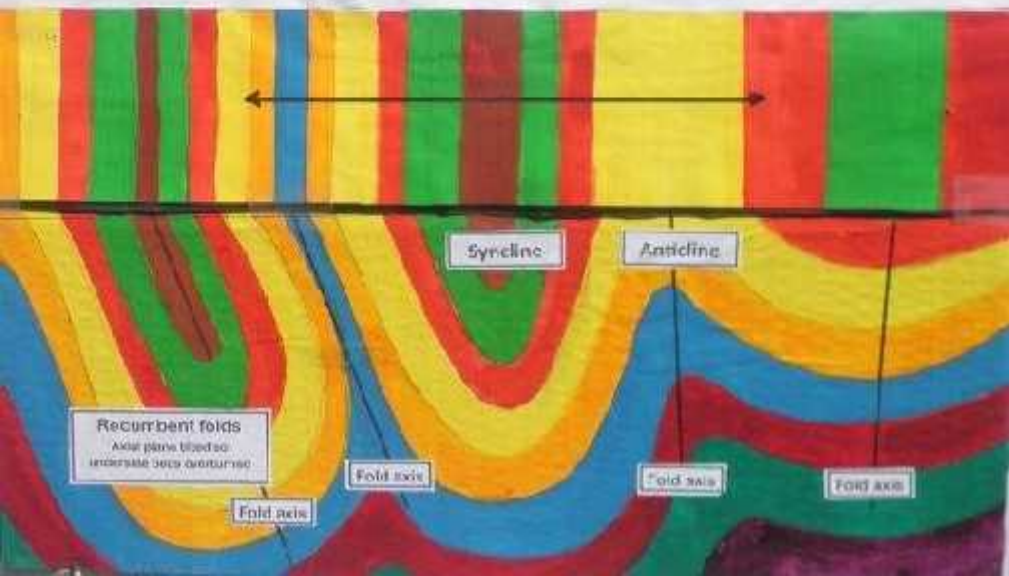
2. COMPRESSION (A) — FOLDING

Vertical section



2 . COMPRESSION (A) — FOLDING

Plan view of traverse after peneplanation

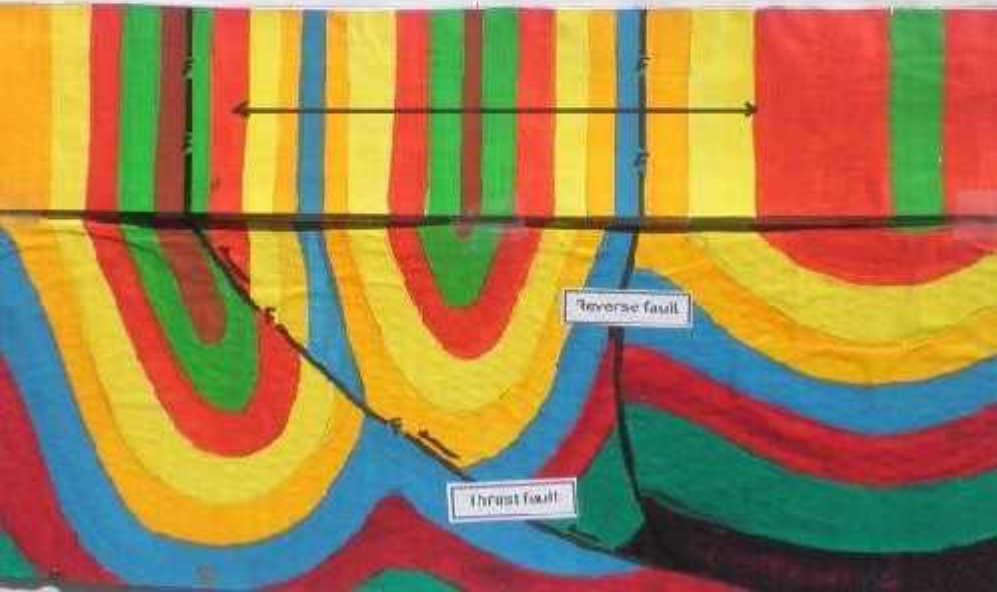


3. COMPRESSION (B) — FAULTING

Vertical section

3. COMPRESSION (B) — FAULTING

Plan view of traverse after peneplanation



4. EXTENSION - FAULTING and INTRUSION

Vertical section

4. EXTENSION — FAULTING and INTRUSION

Plan view of traverse after peneplanation