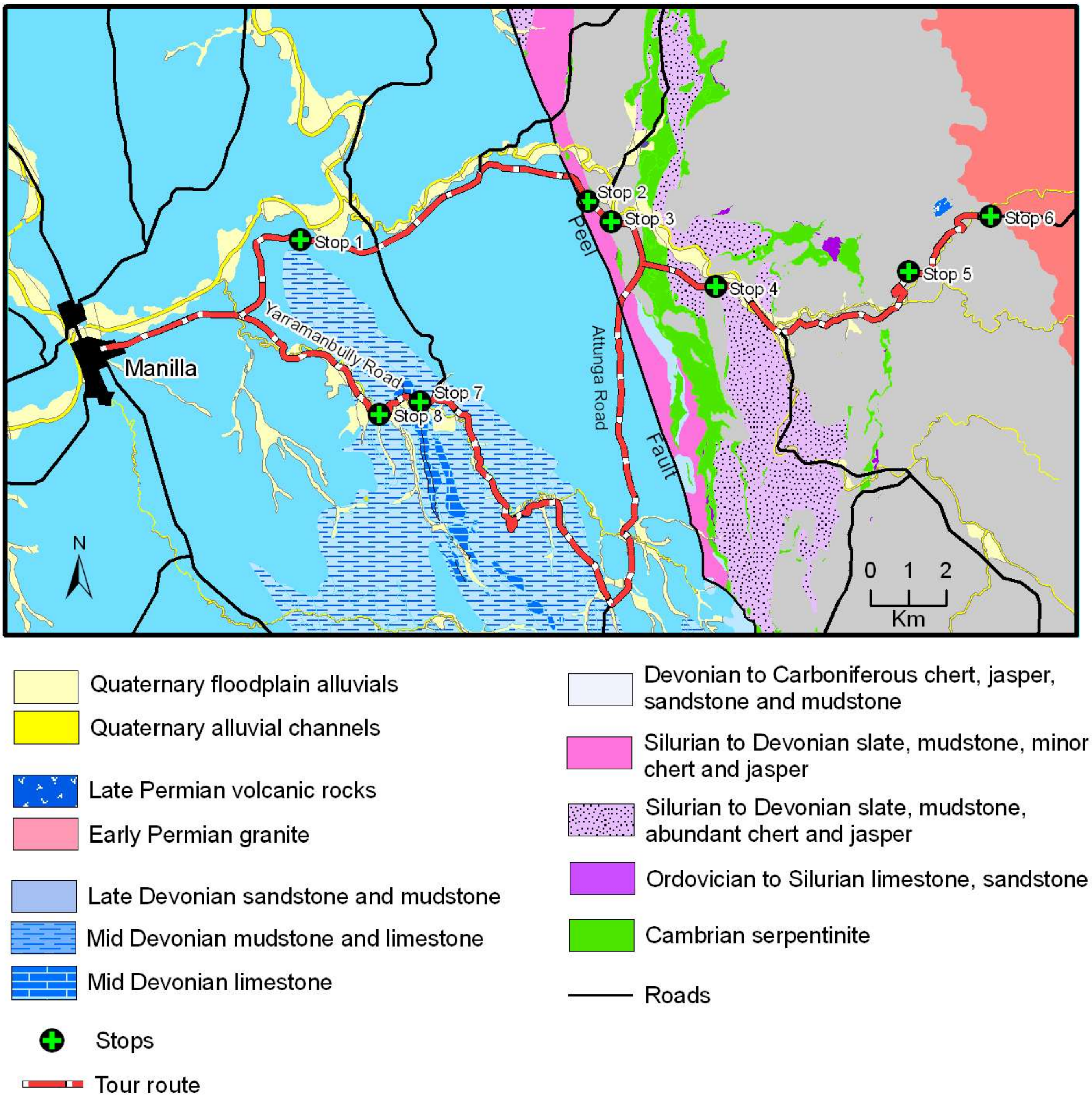
Geological Tour of the Manilla Area

The oldest rocks present in the Manilla area represent what were slices of deep ocean seafloor during the Cambrian period about 580 million years ago. These were mainly igneous[1] in origin and were formed eastward of the young Australian continent. The igneous seafloor rocks were progressively covered with deposits of silt, siliceous (ie. quartz rich) sediment (chert and jasper), and basaltic lavas at great depths below sea level. This process took place until the Early Carboniferous, about 330 million years ago.

Simplified geology of the Manilla geological tour route



[1] Igneous rocks are produced from solidification of molten magma.

GEOLOGICAL HISTORY OF THE MANILLA REGION

PERIOD	YEARS AGO	LIFE FORMS ORIGINATING	GEOLOGICAL EVENTS
QUATERNARY	0 2,000,000	Human Beings	Continuous alluvial deposition
TERTIARY	65,000,000	Grazing and carnivorous mammals	Volcanic activity produced basalts over much of area
CRETACEOUS	145,000,000	Last dinosaurs First flowering plants	Continued deposition on land
JURASSIC	200,000,000	First birds	No rocks preserved from this period in local area
TRIASSIC	251,000,000	First dinosaurs and mammals	Deposition on land and in shallow sea giving rise to Gunnedah coal field
PERMIAN	299,000,000	Mammal-like reptiles, last Trilobites	Deformation, metamorphism, major activity of Peel fault
CARBONIFEROUS	359,000,000	First reptiles; fern forests	Progressive deformation, alteration and upward intrusion of serpentine Glaciation and volcanic activity Progressive shallowing of sea. Volcanic activity in west
DEVONIAN	416,000,000	First amphibians and insects	Deposition of deep sea sediments and basaltic lavas
SILURIAN	443,000,000	Vascular land plants	
ORDOVICIAN	488,000,000	First corals, fish with vertebrae	
CAMBRIAN	542,000,000	Shellfish, Trilobites	Formation of oldest seafloor lavas and intrusions which were subsequently altered to form serpentine.
PRECAMBRIAN	700,000,000 1,500,000,000 3,500,000,000 4,500,000,000	Algae Complex cells Primitive cells Formation of the Earth	No record

Further westward, toward the continent landmass, chains of volcanic islands rose above sea level, depositing vast amounts of lava and ash into the surrounding seas. Limestones were deposited in the relatively shallow waters about these islands. Violent earthquakes periodically broke slabs of limestone and lava free from the shallow water, plummeting them downward amongst deep-water silts and sands. Meanwhile, the ancient ocean floor rocks were being deformed and altered, with rocks of many different ages being stacked as slices amongst one another. Serpentinite (serpentine) was formed from the alteration of igneous sea floor rocks, and began its progressive intrusion upward into shallower rocks.

By the end of the Early Carboniferous, about 325 million years ago, the local seafloor had shallowed, resulting in the appearance of the first land-deposited sediments. A period of glaciation ensued, accompanied by volcanic activity derived from the west.

A major episode of deformation and uplift about 300 million years ago resulted in the formation of new depositional basins, including the coal-bearing Gunnedah basin to the west. The Peel Fault (see geological map) became active and formed a plane along which serpentine was emplaced as thin slivers, and subsequently where gold-bearing fluids were introduced. Deep oceanic sediments from the east were thrust against their shallower counterparts, forming the major geological structural blocks of today: the *Tamworth Belt* west of the Peel Fault, and the *Central Block* to the east. The first of the major granite bodies resulted from melting of the crust as a result of the deformational processes.

Additional granites were emplaced during the Late Permian to Early Triassic (240-255 million years ago). The Manilla area contains no subsequent record of activities until the coming of the Tertiary, when extensive lavas blanketed the region about 20 to 36 million years ago. From the Tertiary to the present, the region has experienced alluvial deposition and occasional activity from the Peel Fault.

THE GEOLOGICAL TOUR

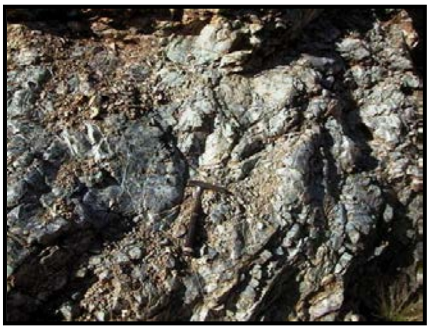
Some aspects of the geological history of the Manilla area can be demonstrated in a scenic drive from Manilla eastward towards Watsons Creek. The tour commences in Late Devonian marine sandstones and mudstones of the *Tamworth Belt* and passes across the Peel Fault into serpentine and deep-water oceanic silts and cherts of the *Central Block.* The tour is completed within the Bundarra Granite, having passed through a zone of rocks showing thermal baking from the granite's emplacement.

Commence in Manilla, taking the road to Bendemeer and Watsons Creek. The road passes through low hills comprising Late Devonian mudstones and sandstones. Thick sandstone beds of the same age, rich in volcanic ash and rock fragments form the dominant rock type in the ridges north and northeast of Manilla.

Stop 1. Late Devonian, steeply dipping, thinly bedded siltstone and mudstone. These rocks occur on the eastern side of a regional-scale fold which was passed through on the road between here and Manilla. On the other side of the fold the rocks dip in the opposite direction. Note the thin, white volcanic ash beds and layers, and minor folding of the beds near the top of the eastern end of the bank. These rocks were deposited well off shore from a volcanic island chain which shed ash and sediment into the surrounding sea.

The hills bordering the road between Stops 1 and 2 are younger, folded sandstones and mudstones.

Stop 2. *Schistose serpentinite* (serpentine) developed just to the east of the Peel Fault. This rock represents highly deformed and altered, ancient seafloor igneous rock. This rock was probably formed about 500 million years ago, and has been progressively intruded into its present location. Further to the north, near Woodsreef and Bingara, rocks such as this are often closely associated with gold reefs.



Stop 3. Road cutting in strongly cleaved metamorphic[2] rocks (*phyllites* and a little *chert*). These ancient rocks were laid down in a deep ocean at some great distance from land. Consider the amazing earth forces that have juxtaposed these rocks against those examined in stop 1. Note the vertical cleavage developed in these rocks, a product of great pressures that have produced major folding.

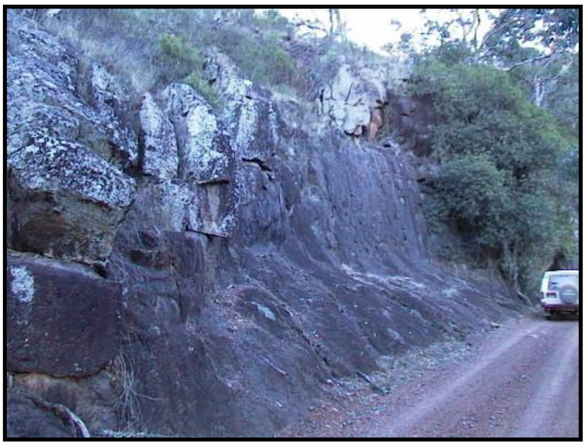
Continuing eastward, the next few cuttings contain more cherts and metamorphosed mudstones and claystones. Note the low outcrops of serpentine in the field on the left just before the road intersection. Take the left turn at the intersection with Attunga Road. We will return here after

[2] Metamorphic rocks have undergone alteration through heat and/or pressure

Stop 6 and proceed along Attunga Road to Stop 7. Note the ridges of serpentine on the right of the road. These are shown on the enclosed geological map.

Stop 4. Deep road cutting showing well bedded cherts and claystones on the western end, red jasper in the centre of the cutting, and metabasalt on the eastern end. The cherts and claystones were slowly deposited far at sea in very deep water. Sea floor volcanic activity introduced basaltic lavas amongst the clays, and produced iron and manganese-rich deposits. Cherts that received a larger iron intake have formed jasper. Black, earthy manganese oxides coat some of the rocks, and in localities close to here, have formed thick deposits which were worked for manufacturing batteries. Some of the nearby manganese deposits are associated with the semi-precious stone *rhodonite*.

The road continues through the same, ancient marine sedimentary and volcanic deposits. At the next intersection, take the left turn and proceed with caution along this narrow road. Caution should be used on this narrow, winding route. The abrupt change from rolling hills to steep topography is due to the baking of the local rocks by the Bundarra Granite. Intense heat has recrystallised and toughened these rocks, often forming new minerals. The metamorphic term for these rocks is *hornfels*. Many interesting road cuttings can be viewed along this road, but care should be taken when selecting a suitable place to stop.



Stop 5. Biotite pegmatite and altered dolerite. This unusual rock is probably an altered variety of one of the many rocks that make up serpentinite. The nearby granite has coarsened the rock, and some interesting specimens of black, platy biotite mica can be found.

The road continues climbing through cherts, jaspers, and hornfelsed mudstones and claystones. Some jaspers are red, and unusual black jasper is also present. This could make attractive polished specimens. Some of the jaspers and cherts are very thick. Metamorphosed basalt occurs in some cuttings.

Stop 6. Fine grained, pale coloured granite. This is the western margin of a major granite body that is more than 40km wide at this point. The granite becomes progressively coarser away from the margin. This is due to more rapid cooling of the outer edges of the granite, whilst the remainder cooled slowly and grew coarser crystals. This change in grainsize is visible over the next 200 metres of road. This granite formed from melting of sedimentary rocks deep within the earth's crust about 300 million years ago.

To travel to Stop 7, negotiate the road back down the hill with caution and return to the Attunga Road intersection. Turn left into Attunga Road and follow this for about 9.6 km until the intersection with Yarramanbully Road is reached. Turn right into Yarramanbully Road. As you travel along Attunga

Road you can see the prominent escarpment of the Peel fault on the eastern side of the road (see geological map). The road is travelling across Late Devonian mudstone and some sandstone, but these don't outcrop very well. The road also crosses the Peel Fault, but there is little evidence of its presence along the roadside.

Yarramanbully Road passes through some very beautiful countryside, with classic Australian scenery, old homesteads, and interesting geological features. After about 9.3 km you will pass Oodnadatta homestead on the southern edge of the road, and a few hundred metres after this are the prominent roadside outcrops of Stop 7.

This is private property. Please respect the site by not straying too far from the road and not littering.

Stop 7. Mid Devonian limestone. These spectacularly textured grey outcrops are fossiliferous limestones. They were laid down in the ocean about 390 million years ago from fragments of calcium carbonate (lime) and the remains of shallow water marine organisms. At this locality the limestones occur within the core of a broad fold (see geological map). The fold can be seen in the limestone on the next hill to the south of the road. The limestone shows beautiful *karst* textures, sharp edged fluting resulting from the corrosion of the limestone by rainwater over many thousands of years. Close examination of the limestone will reveal the abundant fossils which make up a large part of the rock. The fossils include abundant *solitary corals*,

Karst texture on limestone.

Small pothole in limestone.

Fossils in limestone. These include tube-like crinoids, and solitary corals with an internal radial structure.

An artist's impression of long stemmed crinoids filtering food from their ancient ocean. The tough stems are most commonly preserved, whereas the soft, fleshy top of the creature was usually lost.

numerous *crinoid* stems, and minor shelly fragments. Solitary corals, as the name implies, are corals which live in a non-reef environment. Crinoids (an ancient sea lily and a relative of modern star fish and sea urchins) are preserved as tube-like, segmented stems. You will also note small solution potholes, features which could eventually enlarge to form *sink holes* or caves.

To travel to Stop 8, continue along the road for about 1.4 km, stopping on the roadside by a low, steep hill on the north of the road, and a creek with steep banks to the south (see photo below).

Stop 8. Complex soil profile. The creek bank shows layered, orange coloured sand and pebbles overlain by a prominent pale layer, then a thick capping of uniformly grey clay soil. The orange pebbly gravels are typical products of a flowing stream. The pale layer represents a soil horizon developed on the gravels during a lengthy period of exposure, with little or no erosion of that layer by stream activity. The grey upper layer was mud deposited over the sides of a flooding stream, or deposited in a small lake or pond formed by the temporary damming of the stream. There was a cessation in deposition of the original orange gravels because either the original stream abruptly changed course by a significant amount, or because the stream gradient changed (became lower, thereby slowing the rate of water flow and erosion in the headwaters). This resulted in prolonged exposure of the alluvial flats, with little local erosion. At some much later stage the stream may have become dammed by some natural phenomenon such as a rock slide or vegetation accumulation, flooding the area and resulting in the deposition of silt in the small lake. Alternatively, the silt may have been sourced from stripping of soil from adjacent valleys by minor tilting of the land surface, or during a period of anomalous rainfall which resulted in severe flooding. There are many possibilities to explain this feature, which has not been scientifically investigated.

Complex alluvial profile showing coarse sand and gravel, a bleached soil profile, and grey silt

This concludes the formal part of the tour. To return to Manilla, follow the Yarramanbully Road to its intersection with the Manilla Road, and turn left. The remainder of the road is very scenic, and passes some interesting road cuttings in thinly layered Late Devonian mudstones.