Vulkathunha-Gammon Ranges National Park: Oocaboolina Outstation

Oocaboolina Hut (white rectangle, Fig 1) is about 6 km east of Nipapanha on the north side of Gammon Ranges Road, about 200m north of the road. Geologically, it is situated on the southern limb of a large east-west elongated syncline (basin-like structure).

Figure 1

These sedimentary rocks were formed in the early part of the Cambrian Period (530 Ma), when a biological explosion of the first multicellular life occurred after the warming of the earth's climate. The previous 200 million years were Ice Age conditions covering the Earth, referred to as the Cryogenian Period. No vegetation existed on Earth at this time; thus when ice melted, erosion of rocks and sediments by rivers was much more intense and vigorous, enabling large quantities of sediments to be carried into sedimentary basins.

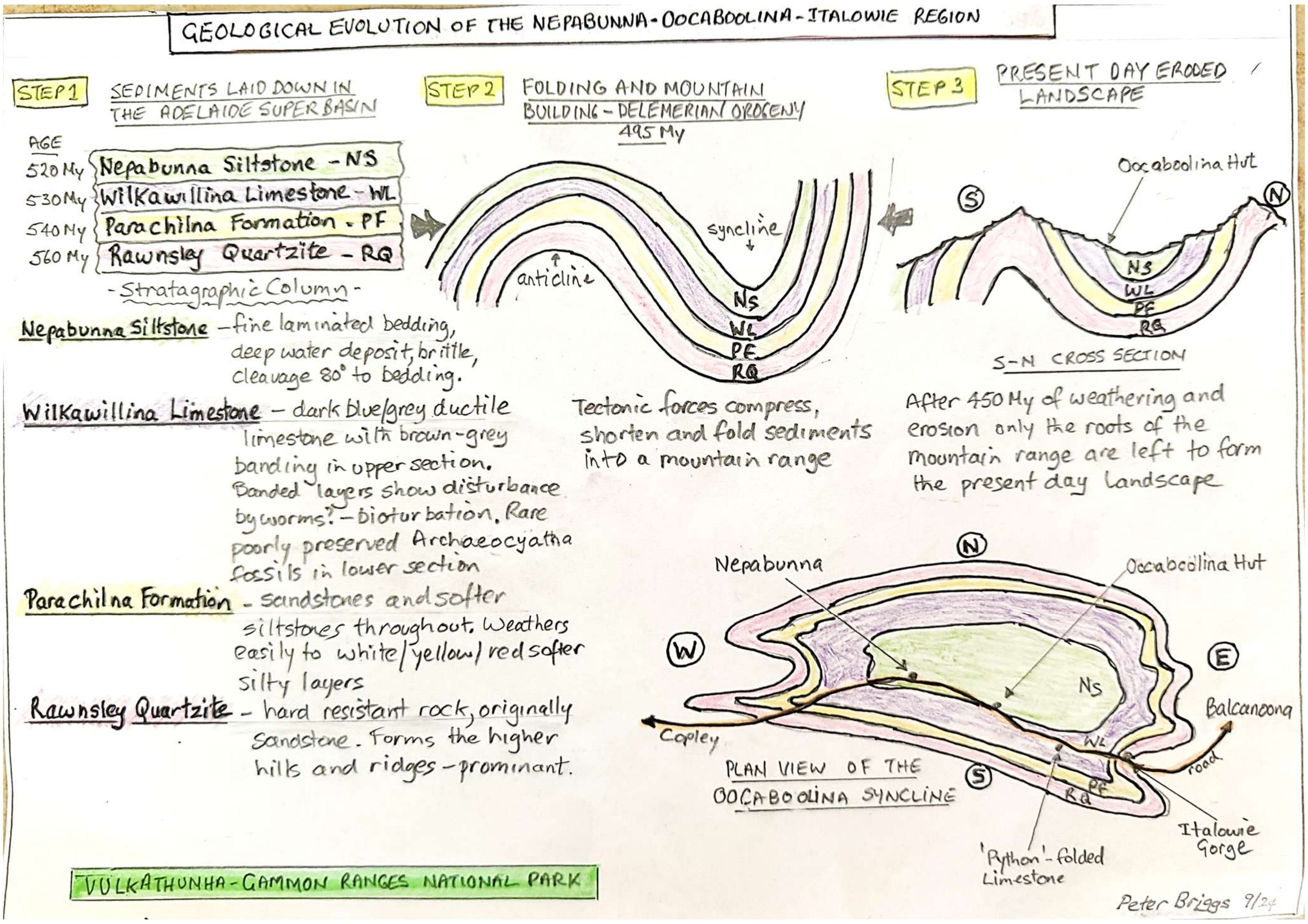

Figure 2

Peter Briggs Sept '24

Figure 3

The hut (Fig 3) is almost in the middle of a large W-E elongated syncline as shown in the diagram above. The hard resistant Rawnsley Quartzite forms an outer surrounding rim of higher hills, and Oocaboolina Hut is situated near the middle of this basin structure. Wilpena Pound is another example of a syncline basin.

The rocks near the Hut are the Nepabunna Siltstone (Fig 4), which outcrops in the small hills immediately adjacent to the Hut. This calcareous siltstone has a fine, laminated (2-4 mm) bedding, dipping to the south, and is heavily fractured with a near vertical cleavage (80 degrees to the sedimentary bedding plane). This gives rise to the sharp, flat scree debris. The fine sediments that formed this siltstone indicate a deeper water environment with some calcium carbonate precipitation.

Figure 4

Figure 5

The left photo (Fig 4) shows the fine bedding, while the right photo (Fig. 5) shows the dominant cleavage, which produces sharp fractures on the exposed surfaces.

This cleavage is the result of a later secondary folding event in the syncline. Brittle siltstones tend not to absorb the tectonic stresses and tensions produced by tectonic pressure and hence fracture to form this near-vertical cleavage. The same tectonic pressures have a different effect on the limestone, which is more ductile and tends to fold. This secondary folding would have occurred soon after the major folding event (Delamerian Orogeny) while the beds were still buried and subject to some heat and pressure.

From the satellite image (Fig. 1) and the sketch (Fig. 2), you can see that the geology in this area forms a syncline, an elongated basin shape, trending east-west. The stratigraphy (age of the rocks) becomes older as one moves outwards from the center to the rim formed by the older Rawnsley Quartzite. The road near the hut follows the boundary between the Nepabunna Siltstone and the Wilkawillina Limestone. The contact is not visible but probably hidden under the creek bed.

On the south side of the road, the stratigraphy trends older into the older Wilkawillina Limestone with low rounded hills rising to the south. This limestone deposit is banded in the lower sections. The bands alternate between dark grey to buff/brown and are about 20-30 mm thick (Fig 6 & 7). This periodic change in colour is probably due to a seasonal effect at the time of deposition. The grey bands accumulate more calcium carbonate, while the brown bands may be dolomitic with inclusion of iron minerals. This seasonal difference may be due to water temperature variations during the year, which influences the precipitation of soluble minerals such as calcium carbonate, calcium magnesium carbonate (dolomite), and dissolved Iron minerals. The colour differentiation in the bands would have developed later when the sediments became compressed and hardened in a process called diagenesis.

Figure 6 & 7

Another distinctive feature of the banded limestone is the disturbance and breaking up of the layers by burrowing animals like worms, which is called bioturbation (Fig 7). Such disturbances show active biological activity in the depositional environment.

The low hills south of the road, across the creek, consist of banded Wilkawillina Limestone, dipping approximately 45 degrees to the north, the same dip orientation as the Nepabunna Siltstone seen on the northern side of the road. Climbing the low hills, the stratigraphy and rocks get older and dip to the north. If one continues for three kilometers in this direction, you would move into the older Parachilna formation (sandstone & siltstones). Further south in the distance you can see a line of higher hills, which is the more resistant and older Rawnsley Quartzite. In other words, you are climbing up the southern side of the syncline, crossing over formations that get older.

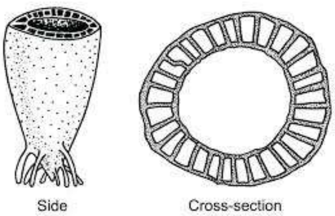

Figure 8

Midway into the Wilkawillina Limestone it is no longer banded but becomes hard and dark grey. At this level some poorly preserved Archaeocyatha fossils (Fig 8) can be found. These were a cone-shaped sponge filter feeder with double walls connected by radiating structures and are common to the Wilkawillina Limestone in other locations (eg Wilkawillina Gorge, Brachina Gorge). When they die, they tumble over into different orientations. These are not as clearly defined due to poor preservation, but enough exist to convince one of their presence. Archaeocyatha means ‘ancient cup shape’.

Archaeocyatha are considered important index fossils in geology because they existed only in the early Cambrian, the beginning of multi-cellar life. They had a worldwide distribution. Then all of a sudden, they became extinct. Hence, Archaeocyatha fossils can confidently be used to date the rocks to the early Cambrian.

Figure 9

Photos (Fig 9) above show that these fossils were fossilized by replacing their original organic sponge material with calcium carbonate and dolomite. Rainwater with dissolved atmospheric carbon dioxide will slowly dissolve the exposed limestone (calcium carbonate), but the dolomite in the fossil is much more resistant. Hence, the Archaeocyatha become prominent when the limestone around them dissolves, leaving the harder brown dolomitic Archaeocyatha in relief. The limestone is scattered with these brown dolomitic Archaeocyatha fragments, standing out in relief due to differential chemical weathering. The active depositional environment here did not favour fossilization, so very few were preserved (maybe 0.1%), and others fragmented to form brown etchings on the blue/grey limestone exposed surface.

Moving east 2 km along the road towards Balcannoona on the south side is a 100m stretch of folded and contorted limestone referred to as the "Python" (Fig 10) by the local Adnyamathanha people. These folds contain tight synclines and anticlines, giving an overall appearance of a sinuous python. Unlike the sandstone and siltstone rocks in

Figure 10

the area, these limestone beds were able to absorb the tectonic pressure by folding. This would have occurred deep underground, where heat and pressure made the limestone beds ductile enough to fold.

Figure 11

At the eastern end of this structure, near the road and a creek crossing, is a domed-shaped anticline with bedding peeling off like an onion skin (Fig 11). On one of these surfaces are two sets of ripple marks (arrows) indicating a shallow water deposit that had currents running in at least two different directions.

Because the limestone behaves in a ductile manner when under tectonic heat and pressure, it folds and buckles in this way, whereas the Nepabunna Siltstone is more brittle and will fracture and crack to form the cleavage pattern seen in the rocks by the Hut.

In conclusion, the Oocaboolina Hut sits almost in the middle of a large basin-shaped syncline and is close to the contact boundary between the Nepabunna Siltstone and Wilkawillina Limestone. Further out to the edge of the syncline and climbing higher is the Parachilna Formation (Sandstones and Siltstones) and the Rawnsley Quartzite, the oldest rocks in this area that form the distant rim of hills around the elongated syncline. Being a quartzite, they can resist weathering and erosion and therefore stand out as a ridge of hills. These two outer rock formations were not visited, but can be seen from the tops of Wilkawillina Limestone Hills.

The geology in this area represents the Early Cambrian Period (530 Ma), when life in the seas was developing, commonly referred to as the beginning of the Cambrian explosion of life forms, represented here by Archaeocyatha fossils and trace fossils of worm burrow disturbances of the banded bedding layers.

This geological report was developed after a visit to the area by Peter Briggs and Henry Pecanek in September 2024. The interpretations are speculative and open to further discussions.

Report written by Peter Briggs 2024.

Friends of the Vulkathunha-Gammon Ranges National Park

References

Satellite photo*: European Space Station,*
https://www.esa.int/ESA_Multimedia/Images/2020/07/Flinders_Ranges_South_Australia

Photos: *Peter Briggs, Henry Pecanek & Graeme Oats*