INTRODUCTION.

The North-Western Coalfield of New South Wales comprises an area extending from the Nandewar Mountains, north-east of Narrabri, to the vicinity of Blandford, a distance of approximately 150 miles.

The geological survey of the coalfield was included in the programme of the New South Wales Geological Survey. Field work commenced in 1945 and has been proceeding continuously during field seasons since that date. A considerable amount of field work still remains to be completed. The work has been concentrated on the study of the Permian rocks, formations of other ages being studied only as far as was necessary to map the boundaries of the Permian system and elucidate the structural geology of the area.

It is proposed to publish the work in a series of papers, based on reports made to the New South Wales Department of Mines, dealing with different sections of the area. Although the bulk of the work carried out so far has been centred on the Gunnedah-Curlewis district, the geology of the Willow Tree district is being published first because it provides the clue to the correlation of the Permian Sequence of the North-Western Coalfield with the type area in the Hunter Valley.

TOPOGRAPHY AND ACCESS.

Willow Tree is 1,390 feet A.S.L. and is situated in the County of Buckland on the New England Highway and the Great Northern Railway Line, being 233 miles by rail from Sydney. The area shown on the Geological Map of the Willow Tree district (Plate VII) extends about 2½ miles in a north-westerly and south-easterly direction and is about one mile wide. Relief is moderate, the highest point surveyed being 570 feet above the level of the railway station or 1,960 feet A.S.L.

The central portion of the area is occupied by the valley of Borambil Creek, which has been eroded on the softer Permian rocks. The south-western edge is occupied by a line of hills composed of Triassic rocks capped in places by Tertiary basalt. Carboniferous rocks occupy a corresponding line of hills to the north-east.

The survey was carried out by means of a telescopic alidade and plane table. Contours at intervals of 50 feet are shown on the Geological Map of the Willow Tree district (Plate VII).
The geological formations comprise the following:

- **Tertiary to Recent Alluvium.**
- **Tertiary Basalt flows and dykes.**
- **Triassic Conglomerates and sandstones.**
- **Permian—**
  - **Borambil Series**
    - **Upper Stage** Soft claystones, sandstones, conglomerates and thin limestone bands.
    - **Lower Stage** Sandstones and conglomerates with Upper Marine fossils.
  - **Willow Series**
    - **Upper Stage** Shales, sandstones, conglomerates and coal seam. *Glossopteris* present.
    - **Werrie Stage** Mainly amygdaloidal basalts.
    - **Lower Stage** Sandstones, shales, tuffs, conglomerates and carbonaceous beds. *Glossopteris* present.
- **Carboniferous—**
  - **Upper Kuttung**
  - **Upper Glacial** Conglomerates, varves, tuffs.

The rocks will now be described in detail, commencing with the oldest.

**Carboniferous.**

The only Carboniferous rocks mapped form a small outcrop in the northeastern section of the area. They comprise the uppermost beds of the Upper Glacial Stage of the Upper Kuttung as described by Carey (1934, 1937) in connection with the geology of the Werrie basin. They consist of fluvio-glacial conglomerates, varves and a thin bed of tuffs which is probably the topmost bed of the Carboniferous system, although it could be the basal bed of the Permian. Micro-sections of the tuffs show excellent examples of shards.

**Permian.**

The discovery of Upper Marine fossils in sandstones outcropping along Borambil Creek has rendered necessary a complete reclassification of the Permian strata of the Willow Tree area. Owing to some uncertainty in the correlation with the Hunter Valley sequence and the unsuitability of the terminology for application to the Willow Tree strata, it is considered advisable to give the series local names, and the classification shown above is suggested. It is proposed to describe the sequence first and leave the discussion of the correlation until later.

**Willow Series.** This series consists of two groups of freshwater sediments separated by a considerable thickness of lava flows. It has been divided into three stages which are shown below, together with their probable thicknesses.

- **Upper Stage** More than 1,050 feet
- **Werrie Stage** Less than 2,400 feet
- **Lower Stage** 300–550 feet
- **Total thickness** 4,000 feet

The Lower Stage consists of sandstones, shales, tuffs, conglomerates and carbonaceous beds. They are continuous with rocks mapped by Carey (1934, 1935) in the Werrie Basin, from which he recorded the presence of the *Gangamopteris-Noeggerathiopsis* flora. He and Baggatt (1932) recorded the occurrence of coal seams in the beds at Currabubula and in the parishes of Quirindi, Coeypolly and Werrie, County of Buckland.
There is no sharp line of demarcation of the top of the Lower Stage, the uppermost strata being interbedded with flows of amygdaloidal basalt belonging to the Werrie Stage. This stage is the southerly continuation of the Werrie basalts mapped by Carey.

The boundary between the Werrie and Upper Stages of the Willow Series is entirely obscured by the alluvium along Borambil Creek. The section of the Upper Stage available for examination comprises about 900 feet of the topmost beds which outcrop along the south-western bank of Borambil Creek. A coal seam of good quality, probably at least 10 feet thick was struck in a well shown on Plate VII. The strata exposed consists of shales, sandstones, grits and conglomerates and contain bands of concretionary ironstone. Impressions of Glossopteris are plentiful.

Borambil Series. This series has been so named because of its occurrence along and to the west of Borambil Creek and has been divided into two stages. The Lower Stage consists of sandstones and conglomerates and shows current bedding in places. On one horizon the following suite of fossils has been found:

- Spirifer sp. indet.
- Spirifer duodecimcostata McCoy.
- Spirifer vespertilio Sowerby.
- "Martiniopsis subradiata" Sowerby (large var.).
- Merismopteria macroptera (Morris).
- Deltoplecten subquinquelineatus Eth. and Dun.
- Pelecypod (internal cast) indet.

The stage appears to be somewhat lenticular, the maximum thickness being 350 feet.

The Upper Stage is at least 2,000 feet thick and is composed of soft claystones, sandstones, conglomerates and thin beds of limestone. The latter are concretionary, at least in part, and may be equivalent to the calcareous concretions found at different horizons in the Mulbring Stage of the Upper Marine (Raggatt, 1929b; Morrison and Raggatt, 1928). The rocks are soft, easily eroded and form poor outcrops. No fossils have been found in this stage and it is impossible to state definitely whether they are of marine or freshwater origin.

There is a small isolated outcrop of soft clayey and carbonaceous beds beneath the Triassic cliffs at the head of the main branch creek north of Oaklyn Homestead. They may be distinct from the Upper Stage of the Borambil Series, but have been included with them for mapping purposes.

Correlation.

Previous workers (Carey, 1934, 1935; Raggatt, 1938a) classified all the sediments overlying the Werrie basalts (Borambil Series and Upper Stage of the Willow Series) as Upper Coal Measures, the basalts themselves as Upper Marine and the underlying freshwater sediments as Lower or Greta Coal Measures, although Carey (1935) discussed the possibility that the last may correspond to an horizon in the Lower Marine Series.

The key to the correlation with the Permian Sequence of the Hunter Valley is provided by the marine fossils discovered in the Lower Stage of the Borambil Series. It is not possible to give an exact correlation of the fossiliferous horizon with the Upper Marine sequence of the type area. The lithology of the rocks would favour correlating them with either the Muree or Branxton Stages. However, Mr. H. O. Fletcher states: "The facies of the marine fossils indicates a geological age fairly high in the Upper Marine Series of the Permian." In the absence of fossil evidence on which to base an opinion, the correlation of the
Upper Stage of the Borambil Series must be doubtful, but it is considered that it is probably equivalent in part to the Mulbring Stage of the Upper Marine, and in part to the Tomago Stage of the Upper Coal Measures.

The outcrop of clayey and carbonaceous rocks referred to above may be an integral part of the Upper Stage of the Borambil Series or may represent part of the Newcastle Stage of the Upper Coal Measures, immediately underlying and conformable with the Triassic rocks.

The Upper Stage of the Willow Series is the equivalent, at least in part, of the Lower or Greta Coal Measures. However, because of the doubt as to the exact position of the fossiliferous horizon in the Upper Marine sequence and the possibility that some of the Glossopteris-bearing sediments may be a freshwater equivalent of portion of the Upper Marine of the Hunter Valley, it is considered preferable to refer to the sediments as the Upper Stage of the Willow Series. In the Cessnock district the Greta Seam forms the topmost bed of the Lower Coal Measures, which range in thickness from 100 to 300 feet (Jones, 1939). The roof of the coal seam at Muswellbrook is 75 feet from the top of the Lower Coal Measures and the total thickness of Greta sediments is 370 feet (Raggatt, 1929a).

At Willow Tree, if we assume that there has been no normal strike faulting or igneous intrusives which are obscured by the alluvium along Borambil Creek, the coal seam is at least 1,050 feet from the top of the Upper Willow Stage and the total thickness of the stage probably greater than this figure. Any thrust faulting present would increase these estimates. The conditions could be explained by considering the top portion of the Upper Willow Stage as being a freshwater equivalent of part of the Upper Marine of the Hunter Valley or by an increase in thickness of the Greta sedimentation. In the latter alternative the Willow Tree coal seam may also be a separate seam developed at a much lower horizon than the Greta Seam.

David (1907) records from the Seven Mile near Raymond Terrace the occurrence of freshwater sediments, which contain abundant tuffaceous bands and a coal seam, and which underlie a thick formation of amygdaloidal basalts. He assigned them to the Lower Marine, and the writer considers that the Permian freshwater sediments and the overlying Werrie Basalts at Willow Tree are approximately on similar horizons. Browne and Dun (1924) also record the presence of a sandstone formation, tuffaceous in appearance, underlying amygdaloidal basalt near Lochinvar. The authors state that “The lower parts contain indeterminate plant stems and it was from the upper portions, which are in places pebbly, that the marine fossils were obtained”. A similar relationship is found in the Loder’s Mount area (to be described in Part II of the Geology of the North-Western Coalfield), where Lower Marine fossils have been found in the topmost beds of the stage. Amygdaloidal basalts which were probably contemporaneous with the above also occur in the Muswellbrook and Wingen-Murrurundi districts. The Lower Marine Basin probably occupied much the same area throughout the whole of the Lower Marine time, but the proportion of the basin which was open to the sea varied considerably. At times considerable areas would appear to have been occupied by freshwater lakes, although some of the plant-bearing horizons, particularly where the plant remains are fragmentary and could have been carried into the sea, may have been laid down under marine conditions. Basalt flows were poured into the basin throughout the whole of the area under consideration and the greater thickness of basalts in the Werrie Basin may be due to the continuation of volcanic activity in that area while sedimentation was proceeding in the Lower Hunter Valley.

WW—December 3, 1947.
Triassic.

Only the basal portion of the Triassic System was examined. It consists of coarse conglomerates which are interbedded with fine conglomerates and sandstones. It is characterised by the presence of abundant jasper pebbles and is similar to the basal portion of the Triassic as exposed throughout the North-Western Coalfield in sections already surveyed in detail.

Tertiary.

Tertiary basalt occurs as a capping to the line of hills along the south-western edge of the area mapped. It overlies the Triassic rocks and in places obscures completely the junction between the Triassic and Permian rocks. It also occurs as isolated outcrops and as dykes in the Permian rocks.

Tertiary to Recent.

The alluvium along Borambil Creek consists of black sticky clay containing gravel beds which yield good supplies of underground water at shallow depths. It has been derived mainly from the weathering of the Werrie and Tertiary basalts of the neighbourhood.

Structural Geology.

The structural geology of the area is extremely interesting. For a full discussion it would be necessary to consider neighbouring areas, and the present discussion will be confined to the area mapped.

A cross-section of the area is shown in Plate VII. The portion beneath the Triassic rocks can be regarded as diagrammatic only.

Broadly speaking, the area surveyed may be regarded as being situated on the south-western limb of an anticline, whose axis trends in a north-westerly direction. The core of the anticline consists of Carboniferous rocks and the flank of Permian sediments. On the eroded edges of the latter the Triassic beds were laid down unconformably.

On the hill in the north-eastern corner of Plate VII the dips in the Carboniferous are low, being about 12°. Proceeding in a south-westerly direction the dips steepen until the Lower Stage of the Willow Series, which dips at about 55°, is reached. The dip continues to steepen until it reaches about 65°, and with few exceptions all outcrops between this point and the Triassic rocks dip at this angle or more steeply. Vertical dips are common and in places the beds are overturned; in one place a dip of 70° in the opposite direction was measured.

It was impossible to measure the dip of the clayey and carbonaceous beds at the head of the main branch creek north of Oaklyn Homestead. It is, therefore, impossible to state whether they dip in conformity with either the Borambil Series or the overlying Triassic rocks.

To what extent the sediments are affected by strike faulting in the section occupied by the Werrie Basalts and the alluvium along Borambil Creek it is impossible to say. It has certainly been affected by oblique faults which trend parallel to thrust faulting further to the north-east and are related to it.

An outcrop of finely bedded shaley sandstones occurs beneath the alluvium in the bed of the main creek north of Oaklyn Homestead and dips to the north-east at 35°. It is bounded on the south-west by a fault and on the north-east by creek alluvium. It probably represents portion of a block which has been caught between two faults, thus accounting for the anomalous dip.

The Triassic rocks have a general dip in a south-westerly direction which averages about 15°. They cross the line of the strike of the Borambil Series in the northern section of the area mapped and the isolated outcrop of Triassic
conglomerate in this section is surrounded on three sides, at least, by vertically
dipping Permian strata. It is considered impossible to explain the relationship
of the Triassic to the Borambil Series without postulating an almost right-angled
unconformity between those formations.

It is considered that the folding of the Permian and Carboniferous at Willow
Tree took place before the close of Upper Coal Measures time because the degree
of unconformity existing between the Permian and the Triassic would require a
period of erosion prior to the deposition of the latter. Also the outcrop of clayey
and carbonaceous beds at the head of the main creek north of Oaklyn Homestead
may be conformable with the Triassic rocks and represent portion of the Newcastle
Stage.

In connection with the determination of the lower limit of the commencement
of the folding, the first manifestation of the late Palaeozoic diastrophism was
recorded by David (1907), who observed the fact that the folding of the Lochinvar
anticline commenced at the end of Muree time. However, at Willow Tree there
is at least 2,000 feet of strata lying apparently conformably above what may be
the equivalent of the Muree.

Raggatt (1938b) considered that Mulbring and Tomago time together
represented a period of quiescence between the commencement of folding in
Muree time and uplift of the surrounding land which he considered took place in
Newcastle time. The writer has observed an interesting structure in a cutting
on the Pelaw Main railway line at the point where it is crossed by the East
Maitland-Mulbring Road. The Tomago Coal Measures west of the tunnel and
in a small section near the base of the cutting east of the tunnel dip at about
35°–40°, while the remainder of the sediments east of the tunnel dip at approxi-
mately 10°. The main portion of the junction between the two groups of sedi-
ments is obscured by the tunnel, but where visible dips at about 10° and is
parallel to the bedding of the overlying sediments. The lowest bed of the more
flatly dipping sediments contains small pebbles near its base and appearances
favour regarding the relationship as an unconformity. If it is due to faulting
it would be in the nature of a low angle overthrust which shows no signs of
dragging the underlying sediments along the thrust plane in the section exposed.
If the section represents a local unconformity situated not far below the accepted
junction between the Tomago and Newcastle stages of the Upper Coal Measures,
it would show that some folding of the Permian took place at that time and
would furnish additional evidence on which to base an estimate of the age of the
commencement of folding at Willow Tree.

It is considered that the folding probably commenced about the beginning
of the Newcastle age. However, all the faulting did not take place in the pre-
Triassic time because the Triassic and Lower Jurassic (Lower Comiala) in the
vicinity of Murrurundi are dragged up against the Carboniferous, along a thrust
fault, until they are dipping nearly vertically.

At Willow Tree there appears to have been minor normal faulting, probably
during Tertiary time, along the margin of the Triassic rocks, which explains the
outercrops of Triassic conglomerate below the general level of the main Triassic
conglomerates further west. On Plate VII the fault has only been shown on the
northern section of the map. It probably continues along Toll Bar Ridge east
of the main mass of Triassic conglomerate and would explain the occurrence of
abundant Triassic conglomerate pebbles on a number of hills below the level of
the main outcrop and separated from it in many instances by a saddle. It was
thought preferable not to show the fault continuing further to the south because
its exact location is somewhat doubtful, and although Triassic conglomerate
pebbles are very abundant on the hills, actual outercrops are wanting in most
instances.
The unconformity between the Triassic and Permian is regarded as being only of local occurrence and marking approximately the position of the Triassic shoreline. It is considered that the dips in the Permian would quickly flatten in a south-westerly direction, the Newcastle stage of the Upper Coal Measures would progressively increase in thickness, and the Triassic and Permian would have their usual conformable relationship.

ACKNOWLEDGEMENTS.

I was assisted on the present survey by Mr. J. C. Lloyd, B.Sc., who was responsible for the instrumental work in connection with the alidade survey, and drafting of the plan to accompany this paper. Many helpful discussions with him on points raised during the progress of the survey are gratefully acknowledged. I am indebted to Mr. H. O. Fletcher, of the Australian Museum, for the determinations of the Upper Marine fossils. I also wish to express my thanks to Mr. J. E. Lancaster, Under Secretary for Mines, and Mr. C. St. J. Mulholland, B.Sc., Government Geologist, for permission to publish this paper.

SUMMARY.

The Permian rocks of the Willow Tree area form the south-western flank of an anticline whose core consists of Carboniferous strata. The Permian probably comprises the equivalents of the Lower Marine sediments (represented by freshwater beds) and lavas, Lower Coal Measures, Upper Marine and Tomago Stage. They were probably folded prior to the deposition of the Newcastle Stage. The Triassic was laid down unconformably on the eroded edges of the Permian strata along the south-western boundary of the area. It is considered that the degree of unconformity would lessen markedly in a south-westerly direction and the relationship between the Triassic and Permian would become conformable.

REFERENCES.

Browne, W. R., and Dun, W. S., 1924. This Journal, 58, 198.

View This Item Online: https://www.biodiversitylibrary.org/item/174128
DOI: https://doi.org/10.5962/p.360484
Permalink: https://www.biodiversitylibrary.org/partpdf/360484

Holding Institution
Smithsonian Libraries

Sponsored by
Biodiversity Heritage Library

Copyright & Reuse
Copyright Status: In Copyright. Digitized with the permission of the rights holder
Rights Holder: Royal Society of New South Wales
License: http://creativecommons.org/licenses/by-nc-sa/3.0/
Rights: https://www.biodiversitylibrary.org/permissions/

This document was created from content at the Biodiversity Heritage Library, the world's largest open access digital library for biodiversity literature and archives. Visit BHL at https://www.biodiversitylibrary.org.

This file was generated 27 June 2023 at 10:03 UTC