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CAMBRIAN SUCCESSION IN QUEENSLAND SOUTH OF THE 22ND PARALLEL

(Preliminary Report - Revised Edition)

by

Dr. A.A. Öpik.

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INTRODUCTION

In 1957, from 4th September until 7th October, I visited the Georgina Geological Party (Party Leader J.N. Casey), which was mapping the Boulia 4-mile Sheet area and extending the mapping to the west into the area of Glenormiston 4-mile Sheet.

The Chief Geologist, Dr. N.H. Fisher, consented to my proposal to use the resources of the Georgina Party,

(1) to visit the Cambrian areas south of the 22nd parallel, on Boulia, Mt.Whelan, and Glenormiston 4-mile Sheets, and

(2) to finish the mapping of the Palaeozoic in the Duchess 4-mile Sheet area.

The leader and members of the party accompanied me by turns on the traverses, taking me to all the desired places, collecting fossils, measuring sections, and pooling all previous experience and observations.

The present summary is based only on observations in the field. Important observations, however, pertaining to the Cambrian succession, to the problem of the "boundary" of the Middle and Upper Cambrian Series, and to intra- and intercontinental correlation, are already apparent and can be presented in this preliminary form. More shall be reported in the course of study of the numerous collections of fossils.

I shall now explain the reasons why the Cambrian deposits of Queensland south of the 22nd parallel should be studied and shall add some comment on the previous geological exploration of the region.

The Cambrian region north of the 22nd parallel has been investigated and mapped and a summary of the results published (Öpik, 1956a; 1956b). This summary also includes material for a small part of the Glenormiston Sheet and reconnaissance observations on the Boulia Sheet area, that is, south of the 22nd parallel. No first-hand observations, however, were available for the greater part of this southern region, except for the material published by Whitehouse (1936, 1940). Of Palaeozoic rocks on the Boulia Sheet area he mentioned only the presence of Lower Ordovician (Ninmaroo) and described Upper Cambrian fossils and their succession on Mt.Whelan Sheet, south of the rivers Pituri and Georgina, in the Georgina Limestone. This succession was in need of revision, as it was published twenty years ago and could not be interpreted in the light of the advanced knowledge of the Cambrian in general and the Australian Cambrian in particular.

I am compiling a correlation chart of the known Cambrian deposits and their faunas of Australia. This cannot be done without a first-hand acquaintance with important published sequences such as the Georgina Limestone and the Pituri Series of Whitehouse.

The Georgina Geological Party has mapped the Boulia 4-mile Sheet area with great accuracy. This, in turn, necessitated improvements to the Palaeozoic belt of the Duchess Sheet that I had mapped previously on reconnaissance. This was done and the geology of the junction of the two Sheets (the 22nd parallel) jointly revised.

As a matter of course, assistance in the field was requested by, and given to, the geologists mapping the Palaeozoic rocks of the Boulia Sheet area. I was especially interested in the Upper Cambrian, which was almost unknown in the Boulia area before the Party started its work.

Finally, I had the pleasure of introducing the geologists of the Georgina Party to the Palaeozoic and "subcambrian" strata of the southern border of Urandangi 4-mile Sheet and of studying jointly the extension of the Palaeozoic strata south of the 22nd parallel in the Glenormiston Sheet area.

The present report serves also as an amplification and correction to my field report of September, 1954: "Present status of the knowledge of the Cambrian Deposits - West Queensland; Results of a Reconnaissance of Cambrian Rocks, Duchess and Boulia 4-mile Sheets". This report was not edited because some additional field observations were necessary, but copies of it were made available to the Georgina Field Party. Parts of the report were also exploited in compiling the articles for the Cambrian Symposium (Öpik, 1956a, 1956b). The present report contains all necessary corrections to the Symposium papers as well.

MOUNT WHELAN 4-MILE SHEET

Introduction

The area was examined by J.N. Casey and the present writer.

Previous work

An approximate geological map of the area has been published by Whitehouse (1940, p.32). The general setting is also seen on Whitehouse's map (1936, p.63). The distribution of Precambrian, Cambrian, Ordovician, Cretaceous, and Tertiary rocks is shown. A pair of south-east trending faults (Toko faults) is postulated.

Comments

The Precambrian has been described as "gneiss" in the eastern part of the area, in two inliers (Sun Hill and Polly's Lookout). The rock is micaceous arkose and conglomerate with quartz pebbles. The deeper levels of the rock, as observed in one locality, show quartz veins surrounded by crumbly arkosic material. It seems reasonable to assume that the arkose rests on crystalline rocks at shallow depth and is derived from such rocks. Upper Cambrian sediments rest unconformably on the arkose. The arkose is unfossiliferous and is "subcambrian" by its position. Its age may be Middle Cambrian or Lower Cambrian. The term "arkose" is used here for brevity. The rocks are conglomerate, arkose, sandstone, and shale.

The Ordovician is outcropping in the south-eastern extension of the Toko (Togo) Ranges. It consists of three rock units: (1) green shale with sandstone and calcareous interbeds (below); (2) brachiopod-bearing limestone; and (3) sandstone, in places a "Pipe-rock" (top). The "Toko faults" postulated by Whitehouse seem to be absent. To the south-west and south the ridges of Ordovician rocks are covered by the sandhills of the Simpson Desert. The Ordovician belt is mildly folded; the rocks dip south-west, or south-south-west, five to ten degrees. Whitehouse applies the name "Toko Series" to these Ordovician rocks. An older name is "Glenormiston Series" ,also by Whitehouse (Whitehouse, 1936, p.68, footnote 11).

Cretaceous rocks have not been observed. Tertiary rocks consist of limestone and chalcedony, and occur in several patches.

The Cambrian sequence is discussed below separately.

Cambrian on Mt.Whelan Sheet. In the literature the Cambrian rocks of the Mt.Whelan 4-mile sheet area are usually referred to as "the Cambrian on Glenormiston Station", or "the Cambrian south of Glenormiston". Two rock divisions have been named by Whitehouse in the area:

1. Pituri Series (or Pituri sandstones, or Pituri sandstones and shales);
2. Georgina Limestones (or Georgina Series, or Georgina Limestone series).

Comment on "Pituri Series". The "Pituri Series" (sandstones, "sandstones and shale") has been described as the upper division. It cannot be identified, however, either geographically or palaeontologically.

Geographically, the Pituri Series was described by Whitehouse as occurring at a "hill immediately west of Tyson's Bore" on Glenormiston Station. West of Tyson's bore lies a grass plain. North-west of the bore is a low limestone hill with some billy on top. The limestone belongs to a very low level of the Georgina limestone, with Glyptagnostus and the "lower O'Hara fauna". About two miles south-west from Tyson's bore is a hill, Mt.Idamea. Here the upper levels of the Georgina limestone are indeed shale, with interbeds of limestone and with limestone nodules. If this is the Pituri shale, the latter is a local member of the Georgina Limestone. The hill itself is capped by a sandstone with a quartz-pebble conglomerate at base. The age of this sandstone is not evident, but it could be anything between Cambrian and Cretaceous. Palaeontologically, limestone layers in the shale contain fossils of the "Eugonocare stage" of Whitehous According to Whitehouse, however, the Pituri Series represents the "Elathriella Stage". The nominate trilobite, "Elathriella" plebia, could not be identified in our collections in the field. Another form "Aspidagnostus" parmatus Whitehouse (= Clavagnostus), described from the "Elathriella" stage, belongs to the lower levels of the "Georgina Limestones". Pseudagnostus nuperus Whitehouse and Idamea superstes Whitehouse, recorded by him from the "Elathriella" Stage, seem to occur in the limestone at the base of Mt.Idamea, and belong to the "Eugonocare Stage". It is, however, possible that the rocks of Mt.Idamea extend farther west, and future study and mapping may provide better evidence for a Pituri rock unit or "stage".

Comment on "Georgina Limestone" The Georgina Limestone consists of well-bedded limestones of several varieties, including bitumous beds, intra-formational breccia, sandy interbeds, etc. The dip (1 - 2 degrees) is to the south-west; the exposed thickness may be several hundreds of feet. The limestone seems to be truncated by early Ordovician rocks that are visibly dolomitic. The break between the systems covers the middle and upper parts of the Upper Cambrian. Middle Cambrian rocks are expected in the north at the base of the Georgina Limestone, but they have not been seen in the field as yet. In the east the base is the above-described arkose sequence of Sun Hill, separated by a major break from the limestone. The age of the Georgina Limestone is roughly the lower third of the Upper Cambrian.

Fossil stages of the Georgina Limestone and the Pituri beds. Whitehouse (1936, 1939) gives the following succession of stages of the Upper Cambrian recognized by him in the Georgina Limestone and the Pituri beds (in descending order):-

Elathriella Stage
Rhodonaspis Stage
Glyptagnostus Stage
Eugonocare Stage

Some reservations as to the meaning of these stages and their order of succession has been already expressed by Opik (1956a, p.21).

Generally speaking these stages cannot be used as units of correlation.

From the statements above it appears that the faunal list of the *Elathriella* stage is based on a blend of fossils collected from the base and the top of the Georgina Limestone. The rock is itself a part of the Georgina Limestone and seems to belong to the "*Eugonocare* Stage".

The examination of the localities referred to the *Rhodonaspis* Stage suggests its near-identity with the *Eugonocare* Stage.

The order of superposition and the character of the fauna reveal that the "*Glyptagnostus* Stage" lies below, and not above the *Eugonocare* Stage. In other words, Whitehouse described the sequence in inverted order.

The lowermost faunas and rocks of the Georgina Limestone occur in the north of the area, in the vicinity of Glenormiston itself and west of it. They contain the "lower O'Hara" fauna (Opik, 1956a, p.22), which in turn grades into the *Glyptagnostus* fauna above. The actual sequence of faunas of the Georgina Limestone can be summarized as follows (in descending order):-

Top — "*Eugonocare* Stage" (including "*Elathriella*" and "*Rhodonaspis* Stages"), with the fossils as listed by Whitehouse. *Iddingsia* is also present. For correlation see - Duchess Sheet, O'Hara Shale, and Pomegranate limestone (below)

Middle part — "*Glyptagnostus* Stage", covering the local range of *Glyptagnostus*, and having in its upper half *Eugonocare* and the forms listed by Whitehouse, and in its lower half several forms of the "lower O'Hara fauna". *Crepicephalus* is also present here.

Lowermost part	"The lowermost O'Hara fauna" without Glyptagnostus, but with Agnostus, and with the "upper Kushan" trilobites "Drepanura, Liostracina, etc.), just as in the lowermost fossiliferous bed of the O'Hara Shale (see Duchess Sheet).

It should be noted that this fauna grades below into the "Mungerebar fauna" of the northern part of Glenormiston Sheet (see below).

Observations on morphology and general geology on Mt.Whelan area.

Within the visited area a variety of surface forms is displayed:- (1) In the west is the hilly plain of arkose rocks, developed as an erosional pediment plain. (2) East of (1) is the area of the Georgina Limestone, a plain and mostly prairie. (3) South of (2) is spread the slightly rolling great gibber plain (hammada) - the fringe of the sandy Simpson Desert. (4) Along the southern border of the gibber plain and partly in that plain lies a belt of mud springs (Carlo, Peanunga), salt and clay pans with occasional date palms; Mt.Whelan itself, with a double summit, is a large spring mound of chalcedony, sinter, and gypsum-bearing mud flows. It is surrounded by an apron of gibber derived from its own chalcedony. Finally, (5) in the south-west the low Toko ridges appear as a contrast against the general plain topography of the area. Bores are shallow, but the water is mostly of poor quality. Deeper bores in Cambrian rocks (Tyson's bore for example, 1,810' deep) yield salt water.

GLENORMISTON 4-MILE SHEET

The traverse in the northern portion of Glenormiston Sheet, in the Mungerebar and Smoky Creek areas, was made in company with M.A. Reynolds and R. Vine.

It was found that the Middle Cambrian Steamboat Sandstone extends from Urandangi Sheet (where it was first described) over a large area of Glenormiston Sheet; the Cambrian limestone of the Smoky Creek area visibly interfingers with the Steamboat Sandstone along a mildly folded belt that trends south-west. Besides interfingering of sandstone and limestone the passage is marked by beds of mixed material: calcareous sandstone and sandy limestone beds are common. The age of those strata is the same - the zone with Leiopyge laevigata, the top of Middle Cambrian.

The highest beds of the sandstone with some cherty limestone interbeds and the highest levels of the limestone of the Smoky Creek area contain a fauna that can be interpreted as the passage between the Middle Cambrian and the Upper Cambrian Series. Leiopyge laevigata disappears, and genera of the subsequent "lower O'Hara fauna" become apparent. The first samples of this fauna were collected and given to me for examination by Dr.Reiner of C.S.I.R.O. in 1955. I refer to it as the "Mungerebar fauna". The position of the Mungerebar fauna in the sequence above beds with Leiopyge laevigata and below the "lower O'Hara fauna" corresponds to the position of the unfossiliferous Selwyn Range Limestone on Duchess 4-mile Sheet.

DUCHESS 4-MILE SHEET

Several traverses were made (together with P. Pritchard) to collect observations on the south-western belt of Palaeozoic rocks on Duchess Sheet. Now it is possible to replace on the existing map (draft) the legent "undifferentiated Cambrian and/or Ordovician" by specific formation names and to refer them to appropriate series. On traverses in the central and eastern part of the area (company, J.N. Casey) the mapping was accomplished in a similar manner. In a joint effort of almost the whole Georgina Geological Party, fossils were collected at my locality D 29 (lower fauna of the Upper Cambrian O'Hara Shale). My previous collection was made on foot in 1954, and the collection as yet available, although containing already about 30 species, was too small. Excellent material was also collected in the Upper Cambrian Pomegranate limestone and at my previous locality D 124. The rock is a limestone, the major part of which outcrops on Boulia Sheet and will be referred to in future as the "Chatsworth Limestone". It rests above the Pomegranate limestone.

The Mt.Birnie Beds (Formation), which I described in 1956 as "subcambrian". and which are outcropping along the western belt of the "Burke River Structures" on Mt.Bruce, Mt.Aplin, and Mt.Birnie, and along the northern big faults, can now be dated as Lower Cambrian. The previously observed "pipes" of Mt.Birnie and the Bronzewing Creek locality proved to represent a Diplocraterion related to the Swedish Diplocraterion lyelli of Lower Cambrian age. With it J.N. Casey found trilobite tracks as well: thus the Palaeozoic age of the sequence could be established.

Moreover, the Mt.Birnie rocks (green shale, ferruginous sandstone, and arkose conglomerate) are separated from the Thorntonia Limestone (above) by an erosional break. The age of the Thorntonia Limestone is lower Middle Cambrian, and consequently the Mt.Birnie Beds are Lower Cambrian. It is the first record of Lower Cambrian in Queensland, and in the whole of northern and eastern Australia. Lower Cambrian was known as yet only from South Australia and central Australia.

A substantial portion of Cambrian rocks of Duchess 4-mile Sheet area was previously designated as "undifferentiated". These rocks occur in the western structural belt of the area, north and south of Monastery Creek and around Mt.Murray and Mt.Bruce. These rocks are now recognized as Middle Cambrian in age and contain Ptychagnostus atavus (below) and punctuosus (above). The sequence consists of siliceous shale and chert with interbeds of smelly limestone (below) and of limestone with shale interbeds (above). The thickness of this sequence may exceed 2,000 feet. It rests with a break partly on Mt.Birnie Beds (Lower Cambrian), partly on Beetle Creek Formation, and partly on Thorntonia Limestone (lower Middle Cambrian), as seen on the surface. In a bore (No.1 bore, heads of Woodya Creek) the Cambrian sequence is about 3,300 feet thick and may consist of Middle Cambrian and Lower Cambrian only.

The Upper Cambrian sequence of the Duchess Sheet is now completely understood. The O'Hara Shale in the north and the Pomegranate limestone in the south are visibly contemporaneous with a contact climbing towards the south: the O'Hara Shale peters out in the same direction on Chatsworth and is gradually replaced by the Pomegranate limestone.

Succession of Upper Cambrian and Middle Cambrian faunas along the Burke River, Duchess 4-mile Sheet, Queensland

<table>
<tr><td>Franconian and younger</td><td colspan="2">Chatsworth limestone</td></tr>
<tr><td rowspan="3">lower Franconian

Dresbachian</td><td>O'Hara succession:</td><td>Pomegranate Creek succession:</td></tr>
<tr><td colspan="2">unfossiliferous upper part of O'Hara Shale</td></tr>
<tr><td>"Lower <u>Eugonocare</u> fauna"
Shale with <u>Glyptagnostus</u>

"Lower O'Hara fauna"</td><td>Pomegranate limestone
<u>Parabolina</u>, <u>Irvingella</u>, <u>Iddingsia</u>, <u>Pterocephalia</u>, <u>Pseudagnostus</u>, <u>Eugonocare</u>, <u>Rhodonaspis</u>, <u>Proceratopyge</u>, etc.,

Intraformational breccia
<u>Glyptagnostus</u> and <u>Olenus</u>
"Lower O'Hara fauna" (base not seen).</td></tr>
<tr><td>"Passage" beds (Mungerebar fauna)</td><td colspan="2">Diastem
Selwyn Range Limestone</td></tr>
<tr><td>Middle Cambrian (top), zone with <u>Leiopyge laevigata</u></td><td colspan="2">Devoncourt Limestone (above) and Roaring Siltstone (below)</td></tr>
<tr><td></td><td colspan="2">Break</td></tr>
<tr><td>Middle Cambrian (middle)</td><td colspan="2">Shale and limestone with <u>Ptychagnostus punctuosus</u> and <u>Pt.atavus</u> (Inca Formation)</td></tr>
<tr><td></td><td colspan="2">Break</td></tr>
<tr><td>Middle Cambrian (lower)</td><td colspan="2">Beetle Creek Formation; Thorntonia Limestone</td></tr>
<tr><td>Precambrian</td><td colspan="2">Break (unconformity)</td></tr>
<tr><td>Lower Cambrian</td><td colspan="2">Mt.Birnie Beds</td></tr>
<tr><td></td><td colspan="2">Basement</td></tr>
</table>

Remarks.

1. The Eugonocare fauna of the O'Hara Shale is older than the upper fauna of the Pomegranate limestone because this part of the shale contains some Dresbachian forms.

2. Irvingella is a new record, and has been found in the correct association.

3. The Selwyn Range Limestone (unfossiliferous) occupies the position of the Mungerebar fauna (see Glenormiston Sheet).

4. The general succession of faunas is the same as in the revised succession of the Georgina limestone (see Mt.Whelan Sheet).

5. The lower portion of the Chatsworth limestone was wrongly interpreted in the Symposium as possibly uppermost Upper Cambrian or even Tremadocian. (Opik, 1956a, p.23, "the southern outcrop of Chatsworth (the unnamed limestone)", etc.). New collections indicate a Franconian age.

6. It was suggested in the Symposium (Opik, 1956a, p.23) that unexplored parts of the Upper Cambrian of the Duchess Sheet (shale and chert above the Pomegranate limestone) might contain the rest of the Upper Cambrian. Trempealeau (uppermost stage of Upper Cambrian) faunas were, however, discovered in the area of Boulia Sheet (q.v.) by the Georgina Geological Party.

7. The references to the American stage names of the Upper Cambrian are employed to facilitate the correlation, and the interpretation of the Upper Cambrian/Middle Cambrian boundary. The new interpretations and correlations by J.L. Wilson and by Dr.Lochman-Balk are not applicable; the scheme outlined in the Australian part of the Symposium is, however, confirmed. The "Mungerebar fauna" occupies the position of the American Bolaspidella fauna.

8. The breaks in the succession are seen along the western hills. Some of them may be missing in the basin along the Burke River.

BOULIA SHEET

1. The Chatsworth limestone is the continuation (upward) of the Upper Cambrian sequence of the Duchess Sheet. Particulars can be worked out only qhen the fossils are examined. Even a single section (south of Chatsworth) is said to be about 600 feet thick, is very fossiliferous, and represents a major development of Upper Cambrian rocks.

2. The Upper Cambrian rocks in the core of the Black Mountain anticline, on Ninmaroo, on Mt.Datson, and in the Dribbling Spring area south of Mt.Datson, represent the upper part of the Upper Cambrian, which passes without visible break into the Ordovician (Ninmaroo).

3. The "Burke River Structures" as previously observed on Duchess Sheet and reconnoitred on the Boulia Sheet should be considered a prominent tectonic belt of post-Ordovician age.

CONCLUSION

In the region covered by Duchess Sheet and Boulia Sheet all three series of the Cambrian System are represented by fossiliferous marine sediments. The breaks: (1) between Lower Cambrian and Middle Cambrian, and (2) within the Middle Cambrian are, however, minor interruptions, because in the north-west (Camooweal area) the Middle Cambrian breaks are absent. It is obvious that a major region of Cambrian rocks is under investigation; it has a universal importance, and should be regarded as "Classical" within Australia.

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