30. COMMENTS ON THE PROTEROZOIC STRATIGRAPHY OF VICTORIA ISLAND AND THE COPPERMINE AREA, NORTHWEST TERRITORIES

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Abstract

The age and correlation of the Precambrian sedimentary rocks in the Wellington and Duke of York inliers is not clear; ages ranging from Archean to Hadrynian have been suggested. A review of the literature and new field data help to clarify the problem. Differing structural trends and lithotypes clearly indicate that the rocks of the two inliers belong to separate successions. The rocks of the Wellington inlier are correlated with member Bp of the Aphebian Burnside River Formation and those of the Duke of York inlier with the upper parts of the Hadrynian Rae Group and the Glenelg Formation. In the Coppermine area, rocks identified as units 24 and 25, originally classified as part of the Rae Group, are Cambrian and are probably equivalents of the Saline River Formation.

Introduction

Victoria Island and the Coppermine area are underlain by extensive Proterozoic sedimentary rocks (Fig. 30.1). On Victoria Island, Proterozoic rocks are exposed in three inliers, the Minto Arch and the Wellington and Duke of York inliers. The regional geology of Victoria Island was described by Thorsteinsson and Tozer (1962) and that of the Coppermine area by Baragar and Donaldson (1973). Christie et al. (1972, p. 77-82) discussed the tectonic and stratigraphic significance of Proterozoic rocks in the two areas and also offered some alternative correlations. A more recent correlation scheme and discussion of the stratigraphy of the two areas were proposed by Young (1977).

This report reviews some aspects of the regional correlations of previous workers and presents data obtained in the summer of 1973.

Acknowledgments

I would like to thank Union Oil and Amoco Canada for permission to publish data collected during the 1973 field season. Also, I extend my thanks to the geologists and assistants from the two companies who helped collect much of the field data. D.G.F. Long and M.P. Cecile offered many valuable suggestions to improve the paper.

Stratigraphy

Wellington Inlier

Thorsteinsson and Tozer (1962) identified three units within the Wellington inlier. Map unit 1, identified only at the head of Hadley Bay, consists of grey and pink quartzites with minor amounts of micaceous quartzite, micaceous hematitic quartzite and greywacke. The beds dip steeply to the northwest, are partly schistose, and are intruded by diabase dykes and quartz veinlets. These observations were verified by the author and others in 1973, although the presence of schistosity was queried. In the same area of Hadley Bay, a granodiorite body (map unit 2) was recognized and tentatively interpreted by Thorsteinsson and Tozer (op. cit.) to intrude map unit 1 strata. The third unit identified by Thorsteinsson and Tozer (op. cit.), occupying the southern part of the Wellington inlier, between Washburn Lake and Wellington Bay (Fig. 30.2), was correlated with the basal clastic rocks of the Glenelg Formation in the Minto Arch.

The discovery of a granite and some suspicions of the correlations in the southern part of the Wellington inlier confirmed the need to re-evaluate some aspects of the work by Thorsteinsson and Tozer (op. cit.).

The rocks at the southern end of the Wellington inlier are mostly bright red to pink quartzitic sandstone and conglomerate. Siltstone and cherty ironstone occur about 10 km south of Washburn Lake, the latter as a 15 m thick bed in association with quartzitic sandstone. The coarse clastic units tend to be thickly bedded and crossbedding is very common. Young (1974, p. 20) interpreted these units as fluvial deposits with an easterly source area. Young (op. cit.) used Thorsteinsson and Tozer's (1962) correlation with the Glenelg Formation but he later revised it (Young and Jefferson, 1975). Silica cement is ubiquitous and most of the rocks are well indurated. The lack of vertically persistent sections prevented reliable thickness measurements but a composite section indicated at least 120 m of exposed strata.

The rocks in the southern part of the inlier contrast markedly with the basal sandstones of the Glenelg Formation of the Minto Arch, which are predominantly grey, with only a slightly pinkish colour, fine grained, quartzitic, and very

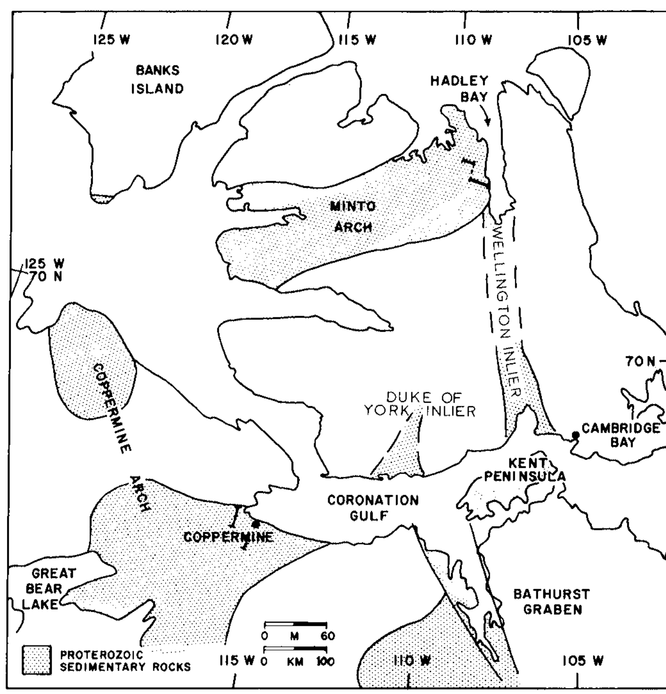

Figure 30.1. *Distribution of Proterozoic sedimentary rocks, Victoria Island and adjacent mainland. Also shown are the approximate positions of the composite sections illustrated in Figure 30.5 (Hadley Bay and Coppermine).*

commonly interbedded with greenish black silty shales. Conglomerates are rare, and the basal part grades upward into a predominantly shale succession (Fig. 30.5). A marine origin is assigned to the basal Glenelg Formation, in contrast to the fluvial origin of sediments from the southern part of the Wellington inlier.

Rocks more similar to those of the Wellington inlier occur to the south, on the Kent Peninsula and in Bathurst Inlet area (Fig. 30.1). On the Kent Peninsula, Fraser (1964) reported the presence of a pink quartzite unit (unit 11 of the Goulburn Group), later named the Burnside River Formation (Tremblay, 1968), which is comparable in lithotypes and structural attitude to rocks from the adjacent Wellington inlier. Young and Jefferson (1975, p. 1735) also noted the similarity. Detailed descriptions of the Burnside River Formation by Campbell and Cecile (1975, 1976, 1979) indicate that rocks of member Bp are correlative with those at the southern end of the Wellington inlier on the basis of lithological descriptions and paleocurrent trends; e.g. both areas contain red or pink quartzitic sandstones and conglomerates derived from an easterly source.

Correlation of the Wellington inlier rocks with those of the Bathurst Inlet and Coppermine areas has been suggested by previous workers (Stockwell et al., in Douglas, 1970, p. 84) but only Young and Jefferson (1975), Long (1978, p. 330), Campbell and Cecile (1979) and I have made specific correlations with the Burnside River Formation. The age of the Burnside River Formation is generally accepted as Aphebian (Tremblay, 1968; Stockwell and Williams, 1964, p. 12; Wright, 1967, p. 46; Stockwell et al., in Douglas, 1970, p. 76; Campbell and Cecile, 1976; Campbell, 1978).

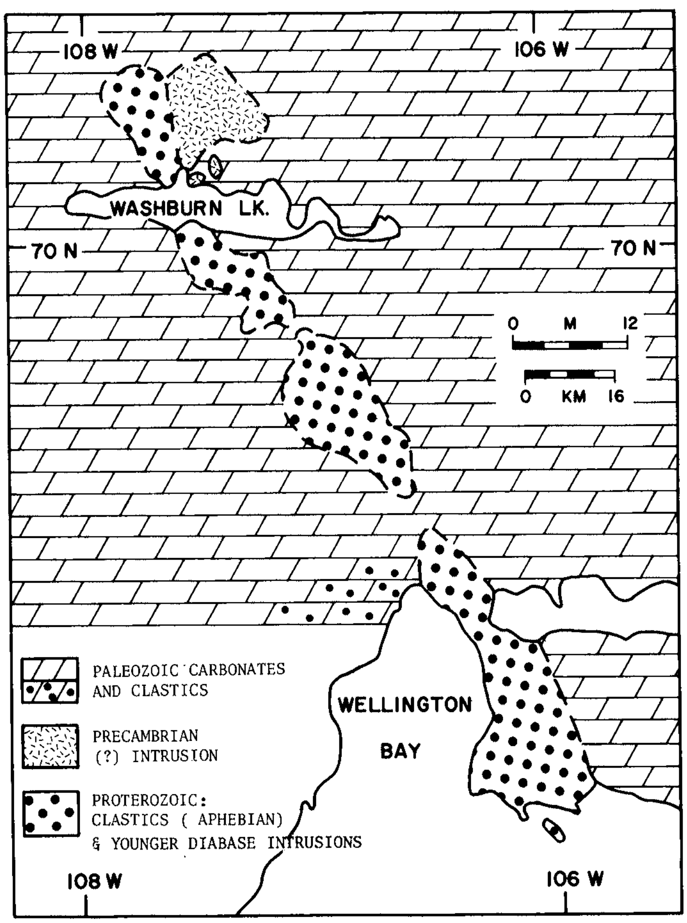

Figure 30.2. Geological sketch map of the southern part of the Wellington inlier, Victoria Island.

In the vicinity of Wellington Bay, Victoria Island (Fig. 30.2), Christie (in Christie et al., 1972, p. 78) recognized gently and steeply dipping strata which led him to suggest that two successions could be present. The steeply dipping strata were interpreted as part of the Hudsonian basement (i.e. Aphebian) and the more gently dipping strata as part of a young succession. Young (1974) noted there was a gradual change in dip between the steeply- and gently-dipping strata and that the two successions were similar. This was confirmed by our 1973 observations and it was also noted that the steeply-dipping strata are adjacent to a large, westward dipping diabase dyke. It is therefore unlikely that two successions are present, as suggested by Christie (op. cit.).

The granitic body exposed north of Washburn Lake (Fig. 30.2) may be intrusive, although contacts were not located. Topographically the granitic body is more prominent than the adjacent Proterozoic clastic rocks and in the approximate position of the contact there is a shallow, north-south linear depression. Paleozoic carbonate rocks were seen to surround knolls and fill in depressions and joints on the igneous rock, confirming previous conclusions that the Wellington inlier is part of an exhumed topographic surface (Thorsteinsson and Tozer, 1962; Christie et al., 1972).

The Washburn Lake igneous body is granodiorite and may belong to the same suite of igneous intrusions as the granodiorite at Hadley Bay and the latter has a K-Ar age of 2405 Ma (Thorsteinsson and Tozer, 1962, p. 25). However, a K-Ar age of 1673 Ma, ±42 Ma (Aphebian) was obtained from muscovite in the Washburn Lake igneous rock (W.A. Gibbons, in Campbell and Cecile, 1979). The Washburn granodiorite may be contemporaneous with the Dismal Lakes granitic intrusions mapped east of Great Bear Lake and dated as Aphebian by Baragar and Donaldson (1973, p. 12, Map 1338A). Due to the uncertain field relationships between the igneous and Proterozoic sedimentary rocks, and the lack of reliability of K-Ar dating, the age of the granodiorites remains debatable.

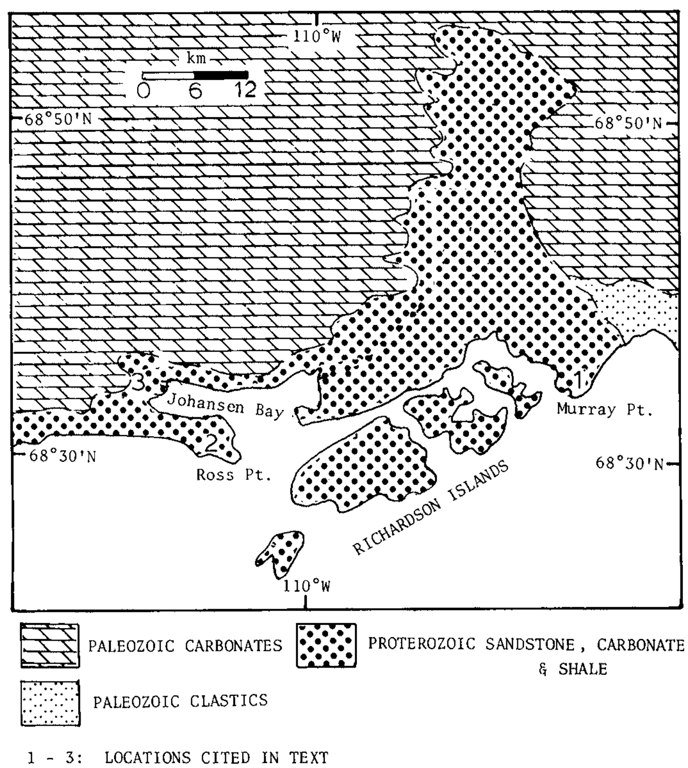

Figure 30.3. Geological sketch map of the Duke of York inlier, Victoria Island.

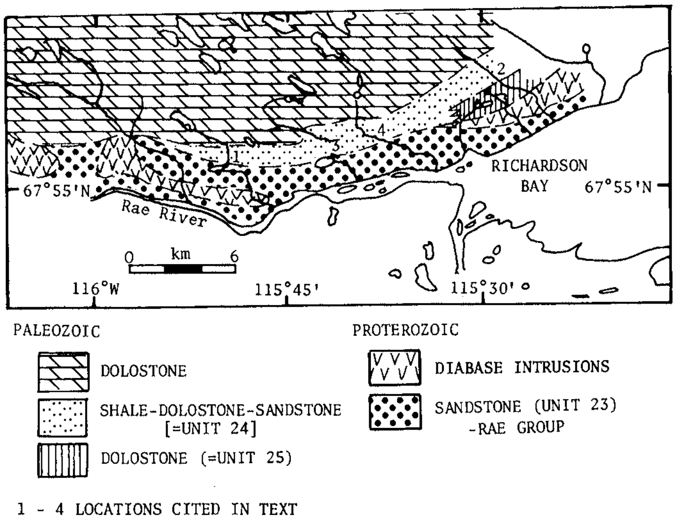

Figure 30.4. *Geological sketch map of the Rae River area, Coppermine.*

The relationship between the sedimentary rocks at Hadley Bay (map unit 1) and those at the southern end of the Wellington inlier is still not clear. The contrast in lithotypes, structural attitudes and apparently higher degree of metamorphism at Hadley Bay could be interpreted to indicate two separate sequences. Christie (in Christie et al., 1972) implied that they were two separate sequences and that the Hadley Bay one was older, an interpretation which fits the available data.

Duke of York Inlier

Thorsteinsson and Tozer (1962) originally correlated the rocks in the Duke of York inlier with the Glenelg Formation. Christie (in Christie et al., 1972, p. 79) considered these rocks to be a landward continuation of the arcuate outcrops of the Duke of York archipelago in the Coronation Gulf. The rocks of the archipelago and Duke of York inlier are predominantly diabase sills but Proterozoic sedimentary rocks are present locally. Baragar and Donaldson (1973) included the island outcrops in the Hadrynian Rae Group.

Scattered outcrop and topographic dominance of the diabase intrusions in the Duke of York inlier made it difficult to compile a continuous section but, from exposures at Murray Point, Ross Point and the western end of Johansen Bay (loc. 1 to 3, respectively, Fig. 30.3), a general succession was compiled. At Murray Point there are about 187 m of interbedded shale, argillaceous limestone, limestone and dolostone with stromatolite horizons. These are overlain by about 119 m of light pink to grey weathering, thickly bedded to massive, fine- and medium-grained quartzose sandstones interbedded with shale. At Ross Point, 110 m of grey weathering, fine- and medium-grained quartzose sandstone containing local occurrences of low angle crossbedding were measured. The Ross Point section probably overlies the Murray Point section. A stromatolitic dolostone of unknown thickness was located at the western end of Johansen Bay and is stratigraphically higher than the Ross Point section. A minimum thickness of 416 m of Proterozoic sedimentary rock is present within the Duke of York inlier but, because the above locations are widely separated, the intervening areas could contain a significant thickness of strata.

The differences in lithotypes and structural trends preclude any correlation between the Duke of York and Wellington inliers. Rocks within the Duke of York inlier dip gently northwestward, whereas those in the southern part of the Wellington inlier dip to the west and southwest. Gravity data across southern Victoria Island (Hornal and Boyd, 1972) show a gravity maximum along the Wellington inlier and an adjacent low to the west. The steep gradient between the two gravity features could indicate a major fault zone, possibly a northerly extension of the eastern fault zone of the Bathurst graben.

The structural continuity between the Duke of York inlier, the outcrops in the Duke of York archipelago and the Hadrynian Rae Group of the Coppermine area suggest a direct correlation. Furthermore, the sandstones of unit 23 in the Rae Group (Baragar and Donaldson, 1973, p. 11, Map 1337A) are comparable to those at Ross Point and Murray Point; both are quartzose, predominantly grey in colour, locally crossbedded and both have thick successions with virtually no shale interbeds. However, there are some differences, notably in thicknesses – approximately 91 m in the Coppermine area as opposed to at least 229 m in the Duke of York inlier. Also the interbedded carbonate and shale sequence at Murray Point is not directly comparable to unit 22, a stromatolitic dolostone, in the Rae Group. Some of these differences could be accounted for by the lack of exposure in the upper and lower contacts of unit 23.

There are also many similarities between the Duke of York inlier rocks and the upper part of the Glenelg Formation in the Minto Arch. The carbonate-shale sequence could be equivalent to the upper part of the Glenelg dolostone unit, the sandstone at Ross and Murray points equivalent to the upper clastics of the Glenelg Formation and the stromatolite bed at Johansen Bay equivalent to a stromatolite bed at the top of the Glenelg Formation (Fig. 30.5). The stromatolite beds at Johansen Bay and in the upper Glenelg Formation show a similar external form, large low amplitude mounds made up of columnar stromatolites (see Young and Long, 1976, Fig. 2 for an illustration of the Glenelg stromatolites).

Coppermine Area

The work of Baragar and Donaldson (1973) is the most comprehensive available geological report for the Coppermine area and was used as a guide during our 1973 field work. Strata of Helikian to Paleozoic age were examined and, for the most part, there was close agreement with Baragar and Donaldson's work. However, units 24 and 25 of the Rae Group, exposed north of Rae River, were found to be incorrectly dated and consequently mismapped. Very small, chitinous, inarticulate brachiopods were found in thin bedded, fine grained sandstones and dolostones in what Baragar and Donaldson had mapped as unit 24 of the Proterozoic Rae Group (loc. 1, Fig. 30.4). The stratigraphic position of unit 24, underlying Paleozoic carbonates and a regional comparison with nearby basal Paleozoic sequences indicated a Cambrian age for unit 24 (Fig. 30.4).

North of Richardson Bay, at locality 2 (Fig. 30.4), a 45.6 m dolostone and dolomitic shale succession, presumably equivalent to Baragar and Donaldson's unit 25, occurs beneath a 62.5 m sequence of red and green gypsiferous shales interbedded with thin beds of sandstone and dolostone. As mapped in the field, the gypsiferous shale sequence appeared to be contiguous with the strata at locality 1 and presumably also equivalent to Baragar and Donaldson's unit 24. However, at locality 2 (Fig. 30.4), unit 25 may be the Cambrian. There is no apparent structural or major sedimentological break between the dolostone and gypsiferous shale successions; both appear to be part of the same overall sedimentary sequence. The dolostone (unit 25) appears to be replaced westward by a shalier and sandier facies when traced to localities 1 and 3 (Fig. 30.4). A prominent orange or brown weathering dolostone bed, up to 6 m thick and containing columnar and laterally linked domal stromatolites, is present at localities 3 and 4 and forms a topographic bench which, when traced to

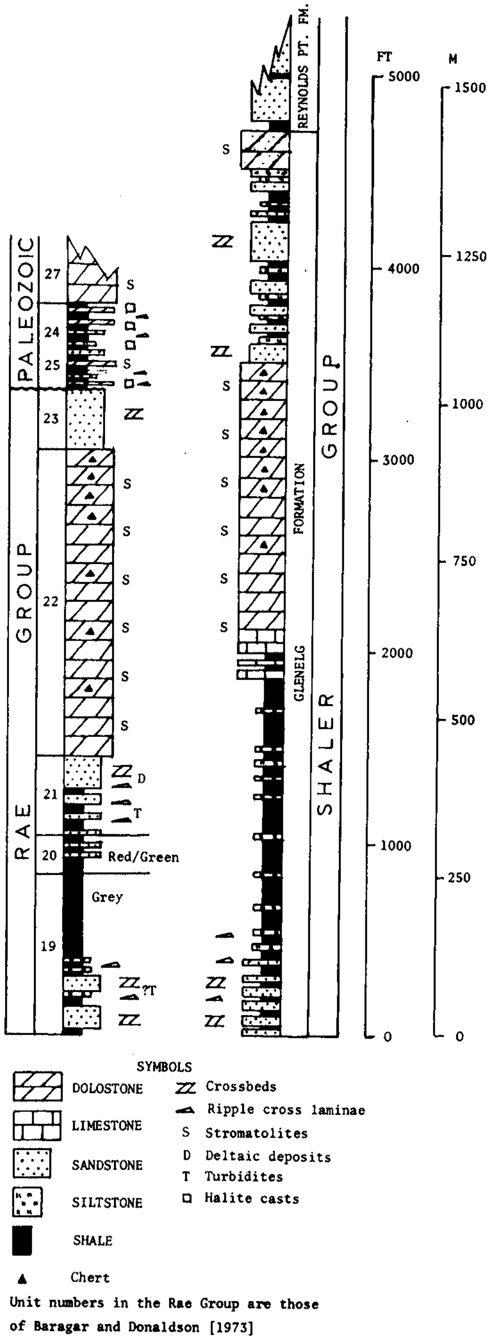

Figure 30.5. *Comparison of the Rae Group and Glenelg Formation successions from the Coppermine and Hadley Bay areas respectively (see Fig. 30.1 for approximate geographic locations).*

locality 2, appears to coincide with the top of the dolostone succession (unit 25). The orange weathering dolostone appears to occur within the Cambrian sequence at locality 3, forms the only exposure at locality 4 and apparently is absent at locality 1.

Baragar and Donaldson (1973) mapped units 24 and 25 as far as 116°40'W, whereas during the 1973 work these units could not be identified west of Longitude 116°W. Paleozoic dolostone of unit 27 was seen to lie close to Proterozoic intrusions at about 116°W, such that units 24 and 25 must thin westward to a zero edge at about 116°W.

The presence of sedimentary features indicative of high evaporation and a shallow water marine environment in units 24 and 25 and their probable Cambrian age indicate a correlation with the evaporite sequence of the Saline River Formation present in the Anderson-Horton Plains area west of the Coppermine Arch. Locality 2 contained the thickest section (107 m) but tentative correlations between the section at localities 1, 2 and 3 suggest that at least 134 m of section are present. However, in no places were the basal and upper parts of the sequence exposed.

Discussion

The correlation of some of the Wellington inlier rocks with the Aphebian Burnside River Formation of the Bathurst Inlet area demonstrates stratigraphic separation between the Wellington inlier rocks and the Hadrynian strata of the Duke of York inlier and Minto Arch. However, the relationship between the strata in the Duke of York inlier and Minto Arch has not been made very clear by previous workers.

Young and Jefferson (1975, Fig. 1), Young and Long (1976, Fig. 1) and Young (1977, Fig. 1) included the Duke of York inlier in the Hadrynian Amundsen Basin and, presumably, intended a correlation with the Rae and Shaler groups. Young and Jefferson (1975, p. 1735) stated that the Duke of York inlier rocks were part of the Shaler Group and also noted the physical continuity of the diabase sills between the Richardson Islands and those in the Rae Group of the Coppermine area. However, very little data were presented to support these conclusions. In the preceding sections it was stated that the Duke of York inlier rocks show many lithological similarities to both the upper part of the Rae Group and the upper Glenelg Formation and this would help further substantiate the correlation of the Rae Group with the Glenelg Formation suggested by Young (1977).

While accepting most of Young's (1977) correlations between the Coppermine area and Minto Arch, I would like to point out some problems. If my proposal is accepted of a Cambrian age for units 24 and 25, previously assigned to the Hadrynian Rae Group (Baragar and Donaldson, 1973), then it precludes their use as distinct Hadrynian marker beds in regional correlations as proposed by Young (1977, Fig. 1, p. 1779) who correlated units 24 and 25 with the basal part of the Reynolds Point Formation of the Shaler Group.

Although the general successions of the Rae Group and Glenelg Formation are generally similar (Fig. 30.5), there are differences in detail. Units 19, 20 and 21 of the Rae Group have no direct equivalents in the basal part of the Glenelg Formation. Each of these Rae Group units is a distinct lithostratigraphic division with sharp, possibly disconformable, boundaries; whereas the basal Glenelg Formation appears to be a continuous succession with gradational lithological changes. However, these differences could be due to local paleogeographic conditions and need not detract from Young's (1977) correlation of the Glenelg Formation with the Rae Group.

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