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STRATIGRAPHIC TERMINOLOGY OF LOW-GRADE METAMORPHOSED ROCKS AT BATHURST HARBOUR, S.W. TASMANIA

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(with one table and two text-figures)

ABSTRACT

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A sequence of low-grade metamorphosed rocks surrounding Bathurst Narrows and Joe Page Bay in southwestern Tasmania crops out between areas of higher-grade metamorphic rocks. The higher-grade rocks have undergone at least two deformation events which did not affect the lower-grade rocks and are inferred to be the older of the two sequences. The lower-grade rocks are divided into five formations with conformable boundaries between them. These formations together form the Clytie Cove Group. A correlate of the Clytie Cove Group occurs ten kilometres to the east of the type section of the Group, which is around Bathurst Narrows and Joe Page Bay. Previously proposed correlations of the Clytie Cove Group with rocks in the Davey River area and on the West Coast Range are invalid, as they were based on an incorrect and incomplete stratigraphic section at Bathurst Narrows.

INTRODUCTION

Detailed geological mapping around Bathurst Harbour and Bathurst Narrows in southwestern Tasmania (fig. 1) has resulted in the need to redefine the stratigraphic units in the area. This paper deals with the redefinition of units in lower-grade metamorphic rocks which are faulted against metaquartzite and phyllite metamorphosed to the garnet grade of the greenschist facies. In this paper, the metaquartzite and phyllite sequences are referred to as "metamorphosed" rocks. Their stratigraphic terminology is not discussed. Previous terminology defined for the lower-grade rock units has been published by Jennings (1960) and Stefanski (1957). The relationship between the units defined by Stefanski was unclear, and type sections were not defined. Hence his terminology is invalid. Jennings established the order in which the rock sequences occurred, but produced an incomplete stratigraphic column. He also did not adequately establish type sections and stratigraphic thicknesses. The correlation of sequences at Bathurst Harbour with sequences at the Crossing River (Bowen and MacLean 1971) was based on the incomplete section of Jennings (1960) at Bathurst Harbour and therefore cannot be considered valid.

DISTRIBUTION OF AND RELATIONSHIP BETWEEN SEQUENCES

A geological map of the area (fig. 1) shows three sequences, referred to as Proterozoic, probably Proterozoic, and Ordovician. The Preterozoic rocks are the southern continuation of the metamorphosed rocks of the Tyennan region elsewhere in Tasmania. They are dominantly quartzite, quartz schist and phyllite. Sedimentary structures have been preserved in places in these rocks, with well-developed cross-bedding, ripple-marks and mudcracks being common at Bramble Cove and to the east of Bathurst Harbour.

The Clytie Cove Group consists of five conformable formations which are delineated over the basin. The dominant rocks types in the sequences are conglomerate, graded poorly-sorted sandstone, and mudstone. The clasts making up the basal conglomerate beds of the Group are metaquartzite, quartz schist and occasional phyllite fragments. These clasts contain at least two tectonic surfaces which bear no geometrical relationship to

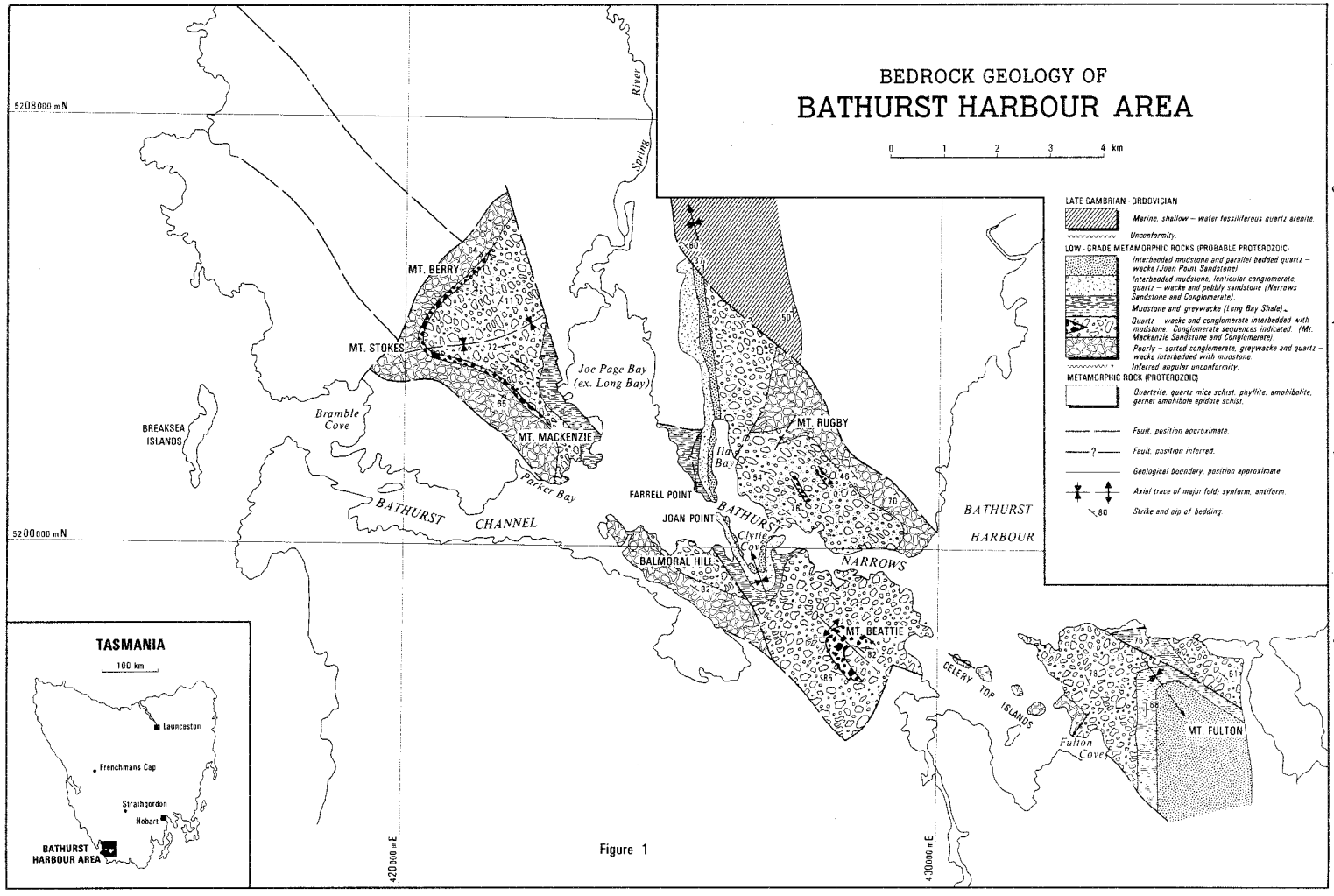
BEDROCK GEOLOGY OF
BATHURST HARBOUR AREA
0 1 2 3 4 km
5208000 mN
5200000 mN
420000 mE
430000 mE
Spring River
MT. BERRY
MT. STOKES
MT. MACKENZIE
MT. RUGBY
MT. BEATTIE
MT. FULTON
BREAKSEA ISLANDS
Bramble Cove
Joe Page Bay (ex. Long Bay)
Parker Bay
BATHURST CHANNEL
FARRELL POINT
JOAN POINT
Ida Bay
Clytie Cove
BALMORAL HILL
BATHURST HARBOUR
NARROWS
CELERY TOP ISLANDS
Fulton Cove
LATE CAMBRIAN - ORDOVICIAN
Marine, shallow – water fossiliferous quartz arenite.
Unconformity.
LOW-GRADE METAMORPHIC ROCKS (PROBABLE PROTEROZOIC)
Interbedded mudstone and parallel bedded quartz – wacke (Joan Point Sandstone).
Interbedded mudstone, lenticular conglomerate, quartz – wacke and pebbly sandstone (Narrows Sandstone and Conglomerate).
Mudstone and greywacke (Long Bay Shale).
Quartz – wacke and conglomerate interbedded with mudstone. Conglomerate sequences indicated. (Mt. Mackenzie Sandstone and Conglomerate)
Poorly – sorted conglomerate, greywacke and quartz – wacke interbedded with mudstone.
Inferred angular unconformity.
METAMORPHIC ROCK (PROTEROZOIC)
Quartzite, quartz mica schist, phyllite, amphibolite, garnet amphibole epidote schist.
Fault, position approximate.
Fault, position inferred.
Geological boundary, position approximate.
Axial trace of major fold; synform, antiform.
Strike and dip of bedding.
TASMANIA
100 km
Launceston
Frenchmans Cap
Strathgordon
Hobart
BATHURST HARBOUR AREA

Figure 1

the cleavages present in the matrix of the conglomerate. The clasts are indistinguishable from rocks cropping out in the surrounding metamorphosed Precambrian sequences.

The Clytie Cove Group is faulted against the metamorphosed rocks (fig. 1). However, clasts with disoriented cleavages and indistinguishable from the surrounding metamorphic rocks occur in the basal conglomerate beds and indicate that an unconformity existed between the two sequences prior to faulting. At least two deformation events affected the basement rocks prior to the deposition of the Clytie Cove Group.

The third distinct sequence lies between Mt Rugby and the Spring River [GR260050]. It is composed of siliceous clastic sedimentary rocks (conglomerate and well-sorted sandstone) and lies uncomformably on the metamorphosed Precambrian sediments. The boundary of these rocks with those of the Clytie Cove Group is a fault, but an age difference between them is inferred because of the differences in structural style and deformation history. Also, the unconformable contact with the metamorphosed rocks trends north-south, while the general fault-bounded trend of the Clytie Cove Group is north-west and the unconformity is truncated. The siliceous clastic rocks are fossiliferous, containing a gastropod with almost flat spiral coil which occurs in lithologically similar rocks containing Ordovician faunas elsewhere in southwestern Tasmania (M. Clarke, *pers. comm.*). These are thus correlated with the upper part of Denison Subgroup sequences elsewhere in Tasmania, which ranges in age from Late Cambrian to Early Ordovician (Corbett 1975).

STRATIGRAPHIC TERMINOLOGY OF THE SEQUENCES

(i) Metamorphosed rocks

No attempt has been made to define individual stratigraphic units in the metamorphic rocks. Taylor (1959) and Stefanski (1957) have defined units in areas surrounding Bathurst Harbour and on the south coast, but these definitions have not been extended or used in this work, as it has not been possible to establish stratigraphic relationships between the different metamorphic rock types.

The metamorphosed rocks of the Tyennan region in Tasmania are considered by all authors to be Precambrian. Recently Raheim and Compston (1977) indicated minimum metamorphic ages for rocks in the Frenchmans Cap area (fig. 1) and the Strathgordon area (fig. 1) ranging from 800 my to 550 my with major metamorphic events at 800 my and between 550 and 630 my. The available evidence suggests a Precambrian age of greater than 800 my for the rocks underlying the Tyennan region.

(ii) The Clytie Cove Group

Stefanski (1957) and Jennings (1960) have given stratigraphic names to the less metamorphosed, sedimentary sequences at Mt Fulton and around Bathurst Narrows. The Davey Group has been a widely used name for some years (David 1932), but it has been used by Carey (1947), Hills and Carey (1949) and David (1932, 1950) for both the metamorphosed and less metamorphosed rocks in the area. It is thus inappropriate for the purposes of current work.

Table 1 shows the names used in this work and their relationship to the names used by Jennings (1960) and Stefanski (1957). The nomenclature proposed in this paper follows the established terminology as closely as possible, but it has been necessary to redefine Jennings' units and rescind those of Stefanski. Stefanski did not rigorously define his units, and did not state their exact geographical locations. The formations he used did not have tops and bottoms and the relationship between them was not established. The author therefore considers them invalid. A new group name is introduced and defined, the Clytie Cove Group.

The Clytie Cove Group consists of five formations, defined below, which were deposited as a conformable sequence of rocks. It is defined as that succession of rocks around Joe Page Bay and Bathurst Narrows which consists of five formations: Mt Rugby Conglomerate at the base, Mt Mackenzie Sandstone and Conglomerate, Long Bay Shale, Narrows Sandstone and Conglomerate, and Joan Point Sandstone at the top. Clytie Cove lies in the central part of the major syncline, on the axial trace of which the highest stratigraphic unit

TABLE 1

PUBLISHED STRATIGRAPHIC NAMES

This work	Jennings, 1960	Stefanski, 1957	Thickness (m)
Joan Point Sandstone	--	--	150
Narrows Sandstone and Conglomerate	--	--	200
Long Bay Shale	Long Bay Shale	Varvoid Bay (?)	300
Mt Mackenzie Sandstone and Conglomerate	Mt Mackenzie	Beattie	600
Mt Rugby Conglomerate	Mt Rugby	Fairy Tale Head (?)	500

occurs [GR266966]. The total thickness of the group is between 1750 m and 1850 m. A generalised stratigraphic column of the group is shown in figure 2, which shows the general fining-upwards nature of the sequence and the stratigraphic location of major conglomerate units.

(a) Mt Rugby Conglomerate - The Mt Rugby Conglomerate is defined as that sequence of conglomerate, sandstone and mudstone east of the fault on the SW margin of the outcrop area below the Mt Mackenzie Sandstone and Conglomerate cropping out in a line from GR225012 to GR228020 across the southern extension of Mt Mackenzie. The formation forms the major topographic highs in the area, such at Mt Mackenzie [GR223020], Mt Stokes [GR200037] and Mt Berry [GR207050]. Mount Rugby [GR269023] and Balmoral Hill [GR244998] are underlain by correlates of this formation. The conglomerate at Mt Rugby is on the opposite limb of the major syncline to the type section. The stratigraphic units are symmetrical about the synclinal hinge trace. The Mt Rugby Conglomerate passes gradationally into the overlying sandstone and conglomerate. The transition zone is narrow. The formation is 500 m thick in the type section but lateral thickness variations are common. The lower boundary is a fault against metamorphosed Precambrian basement rocks (quartzite and conglomerate). It is exposed on the shoreline at GR225012. The lithology of the formation is variable, consisting of massive conglomerate, conglomerate with aligned clasts and well-defined bedding and conglomerate with thin sandstone and mudstone. Jennings (1960) used the name for similar rocks to those included in the present definition but did not give a type section.

(b) Mt Mackenzie Sandstone and Conglomerate - The Mt Mackenzie Sandstone and Conglomerate is defined as that sequence of rocks conformably overlying the Mt Rugby Conglomerate on the eastern flank of Mt Mackenzie, and overlain gradationally by the Long Bay Shale. The formation crops out throughout the valleys to the south and east of Mt Berry and Mt Mackenzie. The type section is at Mt Mackenzie (from co-ordinates 220028 to 225022) where the formation has a minimum thickness of 600 m. The formation fines upwards from a sandstone-conglomerate sequence to a sandstone-siltstone sequence overlain by a succession of interbedded mudstone and medium- to fine-grained sandstone.

Correlates of this formation occur on Mt Beattie [GR282983], Mt Rugby and around the northern and southern foreshores of Bathurst Narrows. Lateral thickness variations are common, and some major conglomerate lenses occur in this formation and its correlates. In the type section the formation contains fine conglomerate with aligned pebbles at the base, with or without graded-bedding and cross-bedding. The fine conglomerate passes upwards into clean, well-sorted sandstone with medium-scale cross-bedding and scour and channel structures. Above this, siltstone and fine-grained sandstone show load casting, small scale cross-bedding of the festoon type, and convolute lamination.

The formation as defined above is equivalent to the Mackenzie Conglomerate of

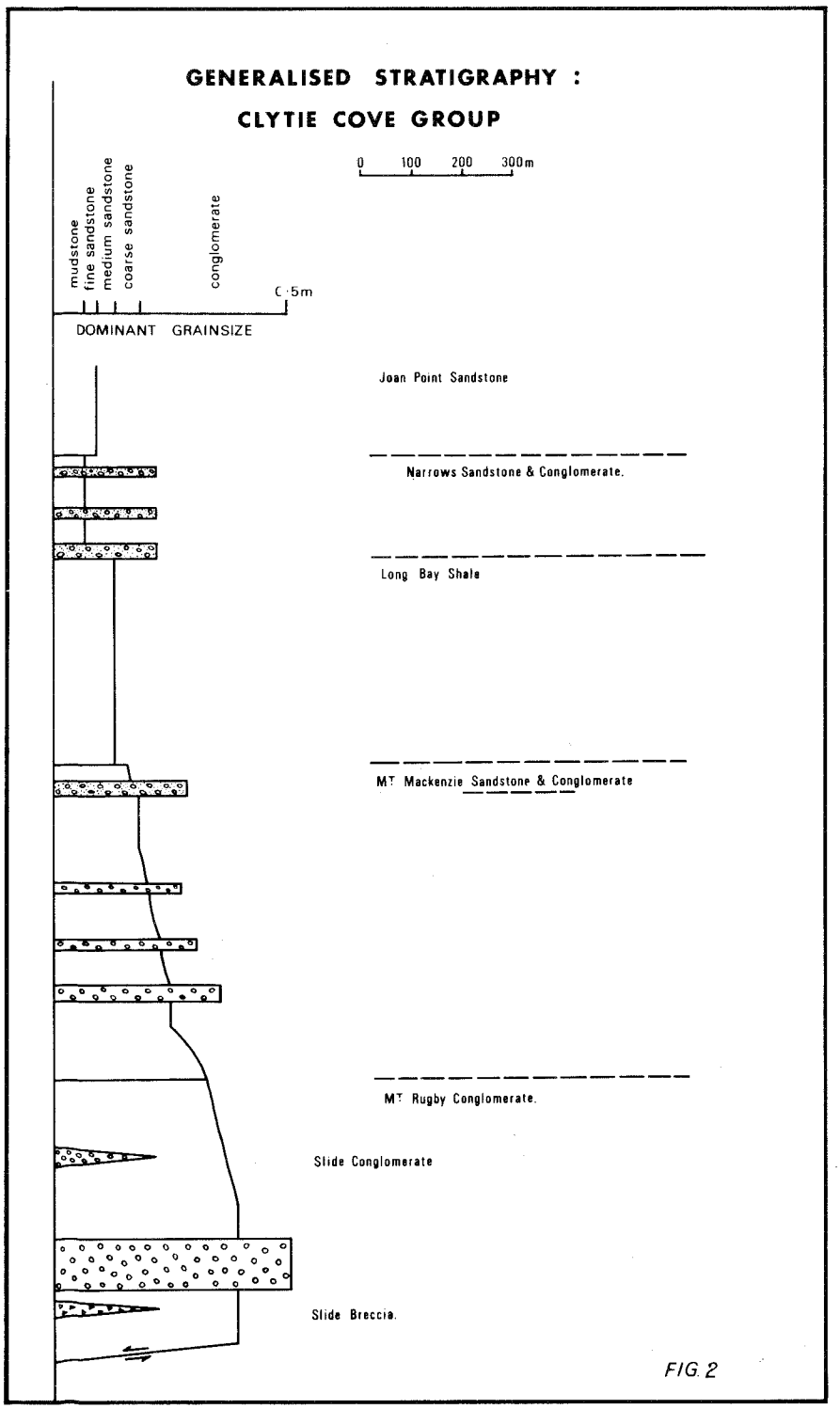
GENERALISED STRATIGRAPHY :
CLYTIE COVE GROUP
0 100 200 300m
mudstone
fine sandstone
medium sandstone
coarse sandstone
conglomerate
0·5m
DOMINANT GRAINSIZE
Joan Point Sandstone
Narrows Sandstone & Conglomerate.
Long Bay Shale
Mt Mackenzie Sandstone & Conglomerate
Mt Rugby Conglomerate.
Slide Conglomerate
Slide Breccia.

FIG. 2

Jennings (1960) for which a type section was not given. The Beattie Formation of Stefanski (1957) is a probable correlate of this and is also without adequate definition or location. Consequently the name Beattie Formation is declared invalid.

(c) Long Bay Shale - The Long Bay Shale is defined as that sequence of interbedded mudstone, siltstone, sandstone and minor conglomerate cropping out along the southeastern shoreline of Bathurst Channel opposite Joe Page Bay between coordinates 257999 and 262998. The sequence grades downwards into a sandstone sequence correlated with the Mt Mackenzie Sandstone and Conglomerate. It is overlain conformably by the Narrows Sandstone and Conglomerate. A possible fault exists in the type section, and the amount of the succession missing is uncertain. In the type section the formation consists of sandstone beds less than 0.5 m thick interbedded with thinner siltstone and mudstone beds. The ratio of sandstone to mudstone and siltstone is overall less than one. The sandstone is graded and laminated, sometimes with a ripple-marked top. Finer-grained beds often show all the Bouma divisions. This formation has a minimum thickness of 300 m in the type area. In Joe Page Bay [GR250020] the thickness reaches 400 m. The Long Bay Shale is correlated with rocks referred to by Jennings (1960) as the Long Bay Shale and his name retained although the type section defined above is not on the shores of Joe Page Bay (ex Long Bay). Jennings (1960) did not define a type section. The Varvoid Bay Group (Stefanski 1957) is also a probable correlate of the Long Bay Shale (Jennings 1960). Rocks north of Mt Fulton [GR350967], at the probable location of Varvoid Bay (an unused name), are of many types and as Stefanski (1957) did not show the group on a map and the geographic location is uncertain, the name should no longer be used.

(d) Narrows Sandstone and Conglomerate - The Narrows Sandstone and Conglomerate is defined as that sequence of rocks cropping out as a topographic high along Farrell Point [GR257008] and Joan Point [GR258006]. The type section is located on the tip of Farrell Point. It consists of coarse- to very coarse-grained conglomerate with moderate to well-rounded clasts, interbedded with finer-grained conglomerate showing cross-bedding and graded bedding. Sandstone and mudstone units also occur, the sandstone showing features typical of the underlying formation. Scours and channels are common at the base of conglomerate beds.

The section is 200 m thick and is underlain conformably by the Long Bay Shale and overlain conformably by Joan Point Sandstone. The contact with the former is sharp but the latter boundary is gradational.

(e) Joan Point Sandstone - The Joan Point Sandstone is that sequence of interbedded sandstone and mudstone cropping out from Joan Point to Clytie Cove [GR265997] and along the western shore of Ila Bay [GR260014]. It conformably overlies the Narrows Sandstone and conglomerate. The top is not exposed. It is at least 150 m thick. The type is defined as the section from Joan Point to Clytie Cove between co-ordinates 260006 and 265997. The section is very nearly parallel to the strike. The Joan Point Sandstone consists of interbedded sandstone and mudstone. The ratio of sandstone to mudstone is high. The sandstone beds are about 0.2 m thick with scoured bases. They begin with a graded division and pass upwards into parallel lamination and then into convolute lamination. Convolute lamination is a characteristic feature of this formation. The sandstone is moderately- to poorly-sorted and the beds are laterally continuous over large distances.

Jennings (1960) apparently included these last two formations in the Long Bay Shale.

(f) Correlates of the Clytie Cove Group at Mt Fulton.- Four units can be recognised on Mt Fulton. The basal unit consists of coarse-grained conglomerate with interbedded sandstone and mudstone and crops out on the western side of Mt Fulton, north of Fulton Cove [GR365928] and on the Celery Top Islands (*e.g.* GR308977). It is about 250 m thick. It is correlated with the upper part of the Mt Rugby Conglomerate. The base of the sequence is faulted out.

The second formation consists of interbedded sandstone and conglomerate which show marked lateral facies changes. The sequence has a minimum thickness of 500 m and is correlated with the Mt Mackenzie Sandstone and Conglomerate.

Conformably overlying this correlate of the Mt Mackenzie Formation is a sequence of medium-grained sandstone with flute marks, graded-bedding, convolute lamination and numerous scours interbedded with mudstone or finely laminated mudstone. It is 190 m thick, and is correlated with the Long Bay Shale.

Five hundred metres of sandstone, conglomerate and mudstone conformably overlie the correlate of the Long Bay Shale. The conglomerate horizons lie high in the sequence. The section above the Long Bay Shale correlate is correlated with the Joan Point Sandstone, even though no conglomerate occurs in that formation. There are no conglomerate horizons low in the section enabling correlation with the Narrows Sandstone and Conglomerate.

In a sequence such as the Clytie Cove Group lateral facies changes are the norm rather than the exception and so a strict lithological correlation between regions is not to be expected. The general features of the columns in both regions are similar and indicate the same depositional system. The total thickness of the column at Mt Fulton 1440 m compared to about 1850 m for the generalised column at Clytie Cove. This difference is partly due to faulting at the base of the Mt Fulton sequence.

CORRELATION OF THE CLYTIE COVE GROUP WITH SEQUENCES IN THE CROSSING RIVER AREA

The Clytie Cove Group consists of three interbedded rock-types: (i) graded bedded sandstone and siltstone; (ii) graded bedded and ungraded conglomerate and pebbly sandstone; and (iii) mudstone. Different parts of the column contain differing proportions of the three types of beds. The sandstone beds show typical features of turbidites such as graded-bedding, sole marks, Bouma sequences (Bouma 1962) and sharp, erosional bases and gradational tops. Consequently it is inferred that deposition of the Clytie Cove Group took place in a basin which was receiving turbidity currents throughout its history. The conglomerate beds are also considered to have been deposited by subaqueous gravity flows (Middleton and Hampton 1973) because they are interbedded with the sandstone beds. The sequence therefore contains a significant proportion of resedimented conglomerate.

Bowen and MacLean (1971) argued that rocks unconformably overlying the metamorphosed Precambrian rocks near the junction of the Crossing and the Davey Rivers are lithologically and structurally equivalent to those at Bathurst Harbour. This is not the case. The rocks described by them are non-marine terrestrial fanglomerate and fluvial conglomerate which were correlated with the Owen Conglomerate (a correlate of part of the Denison Sub-Group of Late Cambrian to Early Ordovician age) (Bowen and Maclean 1971). Williams (1979) has shown that the sequence at Bathurst Harbour is a subaqueous accumulation in relatively deep water.

The sequence of structural events within the Clytie Cove Group is much more complex than that in the sequence at the Davey River (Bowen and MacLean 1971). In the Davey River area structural conformity is inferred between rocks which were correlated with the Caroline Creek Sandstone and the underlying conglomerate sequences.

At Mt Rugby, the fossiliferous sandstone and conglomerate were simply deformed during one fold phase, producing folds on shallowly northnorthwest plunging hinge lines. The conglomerate and sandstone of the Clytie Cove Group were deformed during four deformation events, producing vertically plunging major folds and refolded fold hinge lines. A structural break is inferred between the two sequences.

Consequently the correlation of conglomeratic sequences at the Davey River with the conglomeratic sequence at Bathurst Harbour (the Clytie Cove Group) is not valid.

Low-grade Metamorphosed Rocks, Bathurst Harbour, Tasmania

SUMMARY

The sequence of low-grade metamorphic rocks faulted against higher-grade metamorphosed rocks at Bathurst Harbour in southwestern Tasmania forms the Clytie Cove Group consisting of five formations: the Mt Rugby Conglomerate (base),Mt Mackenzie Conglomerate, Long Bay Shale, Narrows Sandstone and Conglomerate, and Joan Point Sandstone. These are derived from rocks underlying the Tyennan region which consists of the higher-grade metamorphosed rocks. The sequence is overlain with an inferred unconformity by correlates of the Denison Sub-Group (Late Cambrian to Early Ordovician in age). Previous stratigraphic correlations (Bowen and Maclean 1971) are probably incorrect.

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