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UPPERMOST PROTEROZOIC FORMATIONS IN CENTRAL MACKENZIE MOUNTAINS, NORTHWEST TERRITORIES

J.D. Aitken

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Cover

Risky Formation in the type area. The feature-forming Risky dolomites are conformably underlain by dark, recessive mudrocks and sandstones of the Blueflower Formation, and paraconformably overlain by less resistant, Lower Cambrian sandstones (darker) on Risky Peak, in right background. Photo by the author, 1979.

Critical readers

A.F. Embry
H. Gabrielse
D. Morrow
E.W. Bamber

Authors' address

Institute of Sedimentary and
Petroleum Geology
3303-33rd St. N.W.
Calgary, Alberta T2L 2A7

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PREFACE

The Proterozoic succession of most of Mackenzie Mountains was considered, as recently as 1973, to be an unfossiliferous succession ending with the Sheepbed Formation. Only in Sekwi Mountain map area had informal, apparently post-Sheepbed, units been mapped. The discovery in these units of trace and body fossils of Ediacaran type, during the 1979 visit of the Precambrian-Cambrian Boundary Working Group, led to their detailed study in 1981 and 1982.

This Bulletin provides a full description of the character and relationships of Sheepbed and younger formations of the central Mackenzie Mountains, and establishes nomenclature for the post-Sheepbed, Proterozoic formations. Thus, the earliest occurrences of fossils is placed in a clear relationship both to the youngest of the Proterozoic glacigenic deposits and the oldest Cambrian strata of the region. The lithostratigraphic breakdown already has been applied successfully by others to a remarkably fossiliferous, Precambrian-Cambrian transition section in the Wernecke Mountains, and has been proved thus to have wide application.

Elkanah A. Babcock
Assistant Deputy Minister
Geological Survey of Canada

PRÉFACE

On a cru, jusqu'en 1973, que la succession protérozoïque constituant l'ensemble des Monts Mackenzie était non-fossilifère, et qu'elle se terminait avec la Formation de Sheepbed. Exceptionnellement, des unités informelles et postérieures à cette formation avaient été cartographiées dans la région du Mont Sekwi. Ces unités furent l'objet d'études plus détaillées en 1981 et 1982 suite à la découverte de fossiles et d'ichnofossiles édiacariens, effectuée en 1979, lors de la visite du "Groupe d'étude de la limite Précambrien-Cambrien".

Ce bulletin décrit le caractère et les relations stratigraphiques de la Formation de Sheepbed et des formations qui lui succèdent dans la région centrale des Monts Mackenzie. On y propose une nomenclature détaillée pour les formations protérozoïques postérieures à la Formation de Sheepbed. De même, on y établit une relation entre les plus anciens gisements fossilifères, les plus jeunes des formations glaciaires protérozoïques et les plus anciennes strates cambriennes. Le canevas stratigraphique proposé est d'application régionale puisque on l'a déjà utilisé, avec succès, pour décrire une section fossilifère de qualité exceptionnelle chevauchant la limite entre le Précambrien et le Cambrien dans les Monts Wernecke.

Elkanah A. Babcock, sous-ministre adjoint
Commission géologique du Canada

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Abstract

In the Sekwi Brook area of Sekwi Mountain map area, Blusson (1971) mapped the succession beneath the unconformable base of Map unit 12 (Lower Cambrian Backbone Ranges Formation) as Map unit 11 (dolomite and sandstone, of platformal aspect), overlying Map unit 10b (mudrocks, turbiditic sandstones, and deep water carbonates). In this report, Map unit 11 is formally named the Risky Formation and Map unit 10b is divided into three, conformable units: the Blueflower Formation at the top; Gametrail Formation; and Sheepbed Formation (s.s.) at the base. Elsewhere, the Gametrail (carbonate rocks) unconformably underlies the Backbone Ranges Formation, and is in a facies relationship to upper Sheepbed mudrocks.

In the next structural panel to the west, which passes through June Lake, Blusson's Map unit 10b comprises the Risky, Blueflower and Gametrail formations (the last incomplete downward). The Risky is overlain by the Ingta Formation (new), which consists of red and green shales and thin sandstones, with carbonates (informal "Limestone member") at the top. The Ingta has erosional upper and lower contacts. It has been treated elsewhere as a deeper water facies of the Upper member of the Backbone Ranges Formation, but from evidence presented here is more probably a pre-Backbone unit that is truncated eastward at the sub-Backbone (sub-Cambrian?) unconformity.

Trace fossils are abundant in the Blueflower and Ingta formations, but are not known to occur in the Sheepbed of the region studied.

An important implication of the new data is that Precambrian strata in Selwyn Basin southwest of Selwyn Valley may be almost entirely of post-Sheepbed (s.s.) age. Such a conclusion would be significant in the search for more lead-zinc-silver occurrences, such as the Majesty property, hosted in the Sheepbed Formation.

Résumé

Aux environs du ruisseau Sekwi, dans la région cartographique du mont Sekwi, Blusson a cartographié la séquence gisant sous la base discordante de l'unité cartographique 12 (formation de Backbone Ranges du Cambrien inférieur) comme suit: l'unité cartographique 11 (dolomie et grès carbonaté de plate-forme, qui repose sur l'unité cartographique 10b (pélites, grès turbiditiques et roches carbonatées d'eau profonde). Dans le présent rapport, l'unité cartographique 11 porte le nom officiel de formation de Risky, et l'unité cartographique 10b est divisée en trois unités concordantes: la formation de Blueflower au sommet, la formation de Gametrail et la formation de Sheepbed (s.s.) à la base. Ailleurs, la formation de Gametrail (roches carbonatées) repose en discordance sous la formation de Backbone Ranges et est reliée au faciès des pélites de la partie supérieure de la formation de Sheepbed.

Dans le prochain bloc structural à l'ouest, qui traverse le lac June, l'unité cartographique 10b de Blusson se compose des formations de Risky, de Blueflower et de Gametrail, cette dernière étant incomplète vers le bas. La formation de Risky repose sous la nouvelle formation d'Ingta, qui se compose de schistes argileux rouges et verts et de grès minces, avec des roches carbonatées (membre officieux de Limestone) au sommet. Les contacts supérieur et inférieur de la formation d'Ingta sont de nature érosionnelle. D'autres chercheurs considèrent cette formation comme étant un faciès d'eau plus profonde du membre supérieur de la formation de Backbone Ranges, mais selon les renseignements contenus dans ce rapport, il s'agirait plutôt d'une unité déposée avant la formation de Backbone Ranges, et tronquée vers l'est au niveau de la discordance observée sous la formation de Backbone (sous-Cambrien?).

Les ichnofossiles sont abondants dans les formations de Blueflower et d'Ingta, mais on n'en a pas retrouvées dans la formation de Sheepbed dans la région à l'étude.

Les nouvelles données portent à croire que presque toutes les couches précambriennes dans le bassin de Selwyn au sud-ouest de la vallée de Selwyn se seraient accumulées après la formation de Sheepbed (s.s.). Cette conclusion pourrait fortement influencer la recherche de nouvelles venues de plomb, de zinc et d'argent, comme le gisement Majesty, contenues dans la formation de Sheepbed.

INTRODUCTION

The youngest Proterozoic formations (Sheepbed Formation and younger) of the central Mackenzie Mountains are, to date, incompletely described and poorly understood. Fieldwork on these formations in 1977 and 1979, undertaken as a contribution to the work of the Precambrian-Cambrian Boundary Working Group (I.U.G.S. - I.G.C.P.), was subordinated to the author's other projects, but produced several measured sections, revealed important relationships, and located additional, critical exposures for subsequent study. Accordingly, two weeks of the 1981 field season and one week in 1982 were devoted to obtaining further documentation for a complete report. Two composite sections (B and C, Fig. 1), both in Sekwi Mountain map area, were studied (see Map 1333A, in Blusson, 1971). The first section is located in the "Sekwi Brook panel" (B), the most easterly structural panel[1] of post-Sheepbed, Proterozoic strata in the Sekwi Brook area, and is an expansion and extension of Fritz's (1980) Section 37. The second section is located in the "June Lake panel south" (C), 20 km south of June Lake, in the eastern limb of the overturned anticline passing through June Lake. It is a southward offset along strike from Fritz's (1979, 1980) Section 33, and is a repetition and downward extension of Fritz's (1979) Section 35. Although the June Lake south section comprises a number of excellent exposures, structural disturbance and broad covered intervals in its lower part (below the Risky Formation) create serious doubts as to the accuracy of the stratigraphic thicknesses assigned to some units. The lower part of the section was constructed in part from a "range finder and compass" traverse.

The salient points of this report are:

1. The resistant, dolomite-and-sandstone formation, mapped by Blusson (1971) as Map unit 11 east of June Lake (Risky Formation), is in interbedded, gradational contact with the underlying Map unit 10b, and is overlain at an erosional contact by Map unit 12, equivalent to all or part of the Backbone Ranges Formation. The Risky and older formations down to the Sheepbed Formation are interpreted as underlying a regional, sub-Backbone (sub-Cambrian ?) unconformity

2. In the June Lake structural panel, Fritz's (1979) statement, that Map unit 11 (Risky Formation) is present as calcareous sandstone and sandy limestone within rocks mapped by Blusson (1971) as Map unit 10b, is confirmed. The overlying unit (Ingta Formation of this report) separates the Risky from the quartzite-dominated strata of the Backbone Ranges Formation and consists of green and purple-red shales, with thin sandstones, abundant trace fossils and, at the top, carbonate beds. This shale and sandstone unit has generally been interpreted as, or assumed to be, a facies intermediate between the shallow marine quartzites of the Backbone Ranges Formation or its upper member, and basinal, mudrock-dominated equivalents to the west. A possible, alternative interpretation is that the Ingta Formation underlies, and is truncated eastward at, the sub-Backbone unconformity

3. Limestones (not mapped by Blusson) at the base of the June Lake south structural panel correspond to the middle member of carbonate strata in Map unit 10b in the Sekwi Brook panel. These carbonate rocks, herein assigned to the Gametrail Formation, intertongue with the upper part of the Sheepbed Formation, as demonstrated in other areas. Thus, all younger strata exposed in the June Lake panel are post-Sheepbed. To the extent that grey weathering limestones, widely reported at or near the base

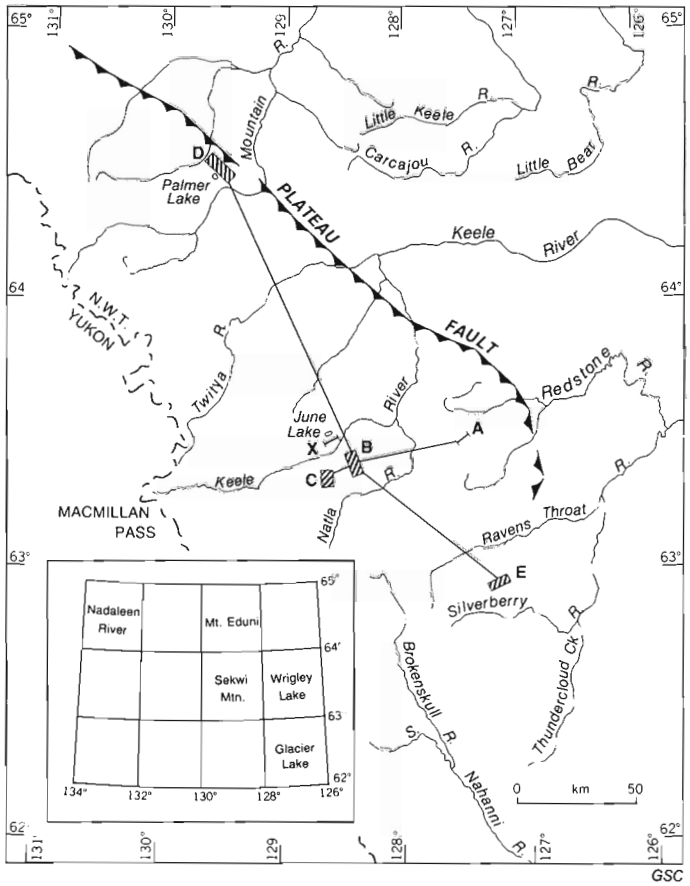


Figure 1. *Index map.*

A. Section 79AC-26, 63°27'34"N; 127°32'22"W.
B. "Sekwi Brook panel", composite of sections 79AC-24, 79AC-28, 81AC-9, 81AC-10. Centre of cluster at 63°24'00"N; 128°24'30"W.
C. "June Lake panel south", composite Section 81AC-15/16. Centre at 63°22'30"N; 128°41'00"W.
D. "Palmer Lake" area, composite of sections 77AC-24a, 77AC-27, 77AC-28, 77AC-33. Centre of cluster at 64°30'20"N; 129°32'00"W.
E. Composite of sections 79AC-16, 79AC-17, 79AC-18. Centre of cluster at 62°56'30"N; 127°14'25"W.
X. Section 33 of Fritz (1979, 1980).

[1] The term "structural panel" and its contraction, "panel", are used here to denote a structurally intact, homoclinal slab or sheet of rocks containing the strata of interest, without regard to the classification of the overall structure (e.g. fold limb or thrust sheet).

of the section in Selwyn Basin[1], are the same unit as that at the base of the June Lake panel (which remains to be demonstrated), all Precambrian strata exposed in Selwyn Basin southwest of the Selwyn Valley may be post-Sheepbed in age.

4. The 'Grit unit' of Selwyn Basin southwest of the Selwyn Valley may be in large part or entirely equivalent to post-Sheepbed formations. The Sheepbed Formation itself displays a southwestward change to a 'grit' facies; therefore, in other areas, the lower part of the 'Grit unit' may include strata of Sheepbed or older age (see Eisbacher, 1981, Figure 14, for evidence of 'Grit unit' equivalent to the Twitya and Keele formations).

Acknowledgments

Thanks are due to the following persons, who contributed to this work: to field assistants Shirley Dawson, Christian Viau, and Rob Booker, and especially Jon Jones and Martin Teitz, who helped with the labour of documenting the observations; to Hans Hofmann and Guy Narbonne, who identified trace fossils; to W.H. Fritz, who co-operated in the study of two of the described sections; to Chris Lord (Department of Indian and Northern Affairs), who provided helicopter transport to the Majesty property; to Elspeth Snow, who prepared figures and assisted with manuscript preparation; and to Ann Seif, who typed the manuscript.

UPPERMOST PROTEROZOIC AND LOWERMOST CAMBRIAN MAP UNITS PRESENTLY DEFINED

Keele Formation/Map unit 8

Geologists active in the region are in general agreement concerning the characteristics and stratigraphic position of the Keele Formation. As the first carbonate bearing formation above the lithologically unique Sayunei and Shezal formations (Eisbacher, 1978, 1981), it serves as a "floor" to the strata dealt with in this report.

At its type section (Gabrielse et al., 1973) and throughout much of the Plateau Thrust plate, the Keele is a platform carbonate/quartz-sandstone complex characterized by grainstones, especially ooid grainstones, and cryptalgal laminites, with a highly variable content of sandstone and minor mudrocks. Eisbacher (1978, 1981) emphasized the cyclicity of the formation.

In northeastern Sekwi Mountain map area, the rocks at the same stratigraphic position as the Keele, mapped by Blusson (1971) as Map unit 8, are mainly carbonate-clast diamictites (tillites), associated with numerous dropstones embedded in laminated mudrocks. The interval containing diamictites is much thinner than, but is in continuity with the Keele as mapped to the east by Gabrielse et al. (1973) in the adjoining Wrigley Lake map area. In southwestern Mount Eduni map area, adjoining the Sekwi Mountain area to the north, similar diamictites are present at the level of the Keele. Eisbacher (1981, p. 29), however, expressed doubt about the glacial origin of these diamictites.

Sheepbed Formation/Map unit 9

The Sheepbed Formation consists of "thin-bedded, locally platy, dark brown and black, noncalcareous shale and siltstone" (Gabrielse et al., 1973). A few thin beds of fine grained sandstone are mentioned in the original description as occurring in Wrigley Lake and Glacier Lake map areas. In central Mount Eduni map area, the formation contains minor amounts of very fine grained sandstone in very thin beds and laminae, but in the southwestern part, beds of gritty sandstone occur (D.G. Cook, pers. comm., 1977). In northeastern Sekwi Mountain map area, a few graded beds (some thick) of quartzose grit appear in the upper part of the formation, as noted by Blusson (1971).

In the key Sekwi Brook area of Sekwi Mountain map area (see below), the Sheepbed consists of dominantly dark mudrocks with abundant, thin, mainly very fine grained sandstones that form distinct Bouma sequences and are interpreted as distal turbidites. Minor units of limestone (ribbon-bedded lime mudstone) are also present. The lowest beds seen are thick, massive, graded beds of sandstone, partly coarse grained, with rusty weathering carbonate cement and many carbonate-quartz veinlets. A single sample (n=20) of foreset dip directions from ripple crosslaminae in Bouma C units, collected by Martin Teitz and Jon Jones, reveals a pronounced northward-directed paleocurrent maximum; this observation is consistent with the southward or southwestward facies change to coarser grained turbidites outlined above.

Neither trace nor body fossils have been found anywhere in the Sheepbed Formation within the region studied, despite careful, repeated searches.

Map units 10a and 10b (Sekwi Mountain map area)

Blusson (1971) subdivided his Map unit 10 on the map, but not in the accompanying text. He made the following points:

a. Map unit 10 "is essentially a shale-siltstone sequence that includes rocks older than Map units 11 and 12 and westward shale-silt equivalents of these two units". [Map unit 12 is now recognized as at least a partial equivalent of the Backbone Ranges Formation (author)].

b. East of June Lake, Map unit 10 includes "a middle cliff-forming member 600 feet thick of medium blue-grey weathering platy to thin-bedded dark limestone, with distinctive rouge weathering parting surfaces".

[1] Examples are: southwest corner of Bonnet Plume Lake map area (106 B); southern part of Nadaleen River map area (106 C); northern part of Niddery Lake map area (105 O), all mapped by Blusson (1974); and northeastern part of Niddery Lake map area, mapped by Cecile (1981).

c. Rocks assigned to Map unit 10 near the west boundary of Sekwi Mountain map area, pale green slate and phyllite, are possibly correlative with the top of the Hadrynian "Grit unit [see Gabrielse et al., 1973; Green, 1972 (author)].

On his map, Blusson (1971) shows the panel of Map unit 10 passing through June Lake, and the Sekwi Brook panel to the east (the easternmost) as Map unit 10b, "dark grey brown and green well banded and laminated platy to thin-bedded siltstone and shale; minor argillaceous sandstone; east of Sekwi Mountain has thick member of medium blue-grey weathering platy dark grey limestone and buff to grey dolomite". All strata of similar stratigraphic position and rock type farther west are assigned to Map unit 10a, "dark grey to brown and minor green silty slate, slate and phyllite commonly banded and laminated grey and greenish grey and deep red-brown weathering; occasional bands of laminated siltstone and thin beds of platy to flaggy brown fine-grained quartzitic sandstone; contains a thick member of orange-weathering dolomitic shale near top of unit where it grades eastward to quartzite of Unit 12".

The present study shows that, in the eastern, or Sekwi Brook, structural panel, Map unit 10b comprises the following: Sheepbed Formation (incomplete); a conformably overlying carbonate formation of regional though discontinuous extent, here named the Gametrail Formation, which elsewhere is seen to intertongue with the upper part of typical Sheepbed clastics; and a conformably overlying formation of turbidites, here named the Blueflower Formation. The Blueflower is in interbedded contact with the overlying Risky Formation (Map unit 11 of Blusson, 1971). In the western, or June Lake panel, Map unit 10b comprises the Gametrail and Blueflower formations, and a calcareous sandstone and sandy limestone unit recognized as the Risky Formation. Overlying, varicoloured shale, thin sandstones, and stromatolitic limestone and dolomite, included by Blusson within the base of Map unit 12, are here named the Ingta Formation.

Map unit 11

Blusson (1971) described Map unit 11 as forming ". . . buff-coloured cliffs, where it underlies a thick quartzite sequence [that is, the Backbone Ranges Formation/Map unit 12 (author)] in a restricted area north and south of the big bend on Natla River. It consists of thick-bedded, buff-weathering dolomite, in part oolitic, which grades upward into dolomite-cemented sandstone". He did not mention or map calcareous sandstones and sandy limestones that occur in the same stratigraphic position in the June Lake structural panel, correctly correlated by Fritz (1980, Fig. 7.3, Section 33) with Map unit 11.

The limited distribution of Map unit 11 bears emphasizing. It is known or interpreted as being present only in the following areas:

a. Near Sekwi Brook and in the June Lake structural panel, Sekwi Mountain map area

b. In the Corn Creek – Goz Creek area of Nadaleen River map area, and extending southward into northeastern Niddery Lake map area, according to the preliminary map of Blusson (1974). (See also Fritz, Narbonne and Gordey, 1983, and discussion by Aitken, 1984, and Narbonne, Hofmann and Aitken, 1985)

c. Possibly, in the cores of Broken Skull and South Nahanni anticlines, Glacier Lake map area, where it was tentatively mapped as the middle member of the Backbone Ranges Formation by Gabrielse et al. (1973), and treated as such by Fritz (1982). This question is discussed further below, under "Backbone Ranges Formation".

In more easterly structural panels, Map unit 11 has been removed by sub-Backbone erosion unless, as maintained by Fritz, Map unit 11 corresponds to the middle member of the Backbone Ranges Formation. This mappable unit merits a formal name; it is here designated the Risky Formation (see below).

"Grit unit"

The following description of the regional "Grit unit" (see Green, 1972) of westernmost and southwestern Flat River map area, from Gabrielse et al. (1973, p. 30, 31), is significant in that it covers virtually all aspects of the total exposed section below the massive quartzites of the Backbone Ranges Formation/Map unit 12 in the Sekwi Brook and June Lake south structural panels (emphasis added by the present author):

> "The 'Grit unit' comprises about equal amounts of argillaceous and quartzose rocks and includes from 5 to 10 per cent limestone and minor phyllite. The main rock types in decreasing order of abundance are: black and dark green shale and slate, quartzite (commonly gritty), calcarenite, feldspar-quartz-pebble conglomerate, sandstone, brightly coloured maroon, green, and buff shale and slate, and limestone. The maroon and green shales are the most conspicuous strata and appear to occur in the upper part of the sequence . . . Carbonate is abundant in the matrix of the gritty rocks . . . The pebble-conglomerates form competent beds, generally from 50 to 100 feet thick [meaning, in units 50 to 100 feet thick; H. Gabrielse, pers. comm., 1981] which break into large blocks. These rocks with interbedded shales occur relatively low in the map-unit. Blocky-weathering limestone, in beds tens of feet thick, occurs at or near the top of the 'Grit unit'. Minor dark grey, fine-grained limestone is present locally in the lower part of the sequence".

Backbone Ranges Formation/Map unit 12

Gabrielse et al. (1973) described at length the type Backbone Ranges Formation and a number of the regional variations of the unit. In summary, the formation is characterized by quartz sandstone and feldspathic sandstone, commonly coarse grained. Sorting is generally good to excellent and crossbedding is widespread. The formation contains minor amounts of quartz-pebble conglomerate and mudrocks. A middle member of distinctively coloured dolomite is widely recognizable.

The best-dated section of strata equivalent to at least part of the Backbone Ranges Formation is Fritz's (1980) Section 33, at June Lake. There, the interval treated by Blusson (1971) and Fritz (*op. cit.*) as Map unit 12 spans not only the quartzite-dominated equivalent of the Backbone Ranges Formation, but, in addition, 250-350 m of underlying,

variegated mudrocks and sandstone beds (Ingta Formation of this report), identified by Fritz et al. (1984) as the lower submember of Map unit 12. Trace fossils and rare body fossils, from the quartzite-dominated part of Map unit 12 that overlies the variegated beds, indicate an Early Cambrian age (Fritz, 1980, p. 44).

The original description of the formation notes the eastward thinning of each member, and an apparent unconformity at the base.

No problems attend recognition and correlation of the Backbone Ranges Formation where, as at the type section, it is tripartite, with quartz-sandstone dominated upper and lower members and a middle, distinctively coloured, mainly dolomite middle member. A major problem arises, however, in the more westerly structural panels, where no obvious tripartite character is demonstrable, and the unit readily recognized as Backbone Ranges equivalent is a single, thick unit of quartz sandstone and minor mudrocks, treated by Blusson (1971) as Map unit 12. Two different correlations of this unit merit consideration.

Fritz (1980, 1982) has accepted the view expressed (with reservations) by Gabrielse et al. (1973) in text and in mapping, that a thick dolomite unit in the core of the Broken Skull and South Nahanni anticlines, underlying a thick, quartz-sandstone dominated unit, is the middle member of the Backbone Ranges Formation. An extension of that view to Sekwi Brook equates Map unit 11 (Risky Formation) with the middle Backbone (although the underlying rocks there are dark mudrocks with subordinate turbiditic sandstone), and Map unit 12 with the upper Backbone. The disagreement hinges critically on whether the dolomite unit at these three localities is, or is not, the middle member of the Backbone Ranges Formation.

The writer has not seen the sections at Broken Skull and South Nahanni anticlines, and no description of the putative middle Backbone dolomites at these localities has been published. The reservations of Gabrielse et al. (1973) suggest that (at least, at South Nahanni anticline) the dolomites that form the base of the exposed section at these localities lack the unmistakable coloration of the typical middle Backbone Ranges Formation. Certainly, Map unit 11 at Sekwi Brook and in June Lake anticline bears little resemblance to the typical middle member of the Backbone Ranges. The basic characteristics of the two units are as follows:

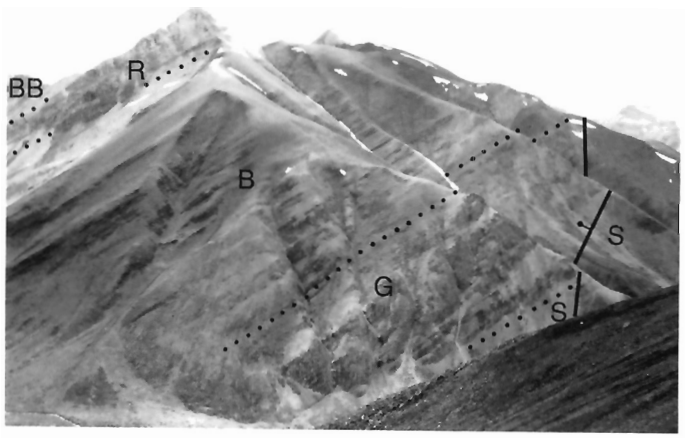
Middle member of Backbone Ranges Formation	Map unit 11 (Risky Formation)
Thin bedding and lamination characteristic (but not exclusive)	Thick and very thick bedding characteristic
Fresh colours pink to brick-red, cream, pale purple	Fresh colours grey, pale brown-grey
Weathered colours of the limestone are similar to fresh; where dolomitized, similar, or grading to orange shades	Weathered colour, mainly pale orange (peach), some grey
Sandstone not recorded, sandy carbonates minor	Very dolomitic sandstone, abundant to dominant. Dolomites mainly sandy
Erosional upper contact reported only at type section and Broken Skull and South Nahanni anticlines	Erosional upper contact at all sections studied
No ooids or oncoids	Ooids and oncoids prominent (Sekwi Brook)
Stromatolites simple and rare	Stromatolites widespread and, in part, complex and large

A corollary of the argument that Map unit 11 (Risky Formation) is not correlative with the middle Backbone, is that, at western localities such as Sekwi Brook and the June Lake structural panel, the middle member of the Backbone Ranges is missing (at least as a carbonate unit). Because knowledge of the internal stratigraphy of the Backbone Ranges Formation is limited, it is not known whether this inferred absence is more probably due to erosion, non-deposition, or facies change.

The arguments presented to date by Fritz in defense of his interpretation are not conclusive, nor are those presented here as an alternative interpretation. Both interpretations should be kept in mind, as alternative working hypotheses, until further information is obtained.

PRECAMBRIAN SECTION AT SEKWI BROOK

In the Sekwi Brook area of Sekwi Mountain map area (B, Fig. 1), Blusson (1971) mapped the basal part of the exposed stratigraphic column, below the thick, quartzose, crossbedded sandstones of the Backbone Ranges Formation (Map unit 12), as Map unit 10b overlain by Map unit 11. This part of the column consists of four formations (Figs. 2, 3): a lower formation of dark mudrocks, sparse turbiditic sandstones, and minor turbiditic limestone, lacking trace fossils (Sheepbed Formation); a formation of ribbon-bedded lime mudstone and derived dolomite (Gametrail Formation); a formation of dark mudrocks with abundant turbiditic sandstones, minor units of turbiditic limestone and abundant trace fossils (Blueflower Formation); and, at the top, a formation of sandy dolomite and very dolomitic sandstone (Risky Formation; Map unit 11).



Sheepbed Formation . . . . . S
Gametrail Formation . . . . . G
Blueflower Formation . . . . . B
Risky Formation . . . . . R
Backbone Ranges Formation . . . . . BB

Figure 2. *Uppermost Proterozoic formations at Sekwi Brook (Fig. 1, B).*

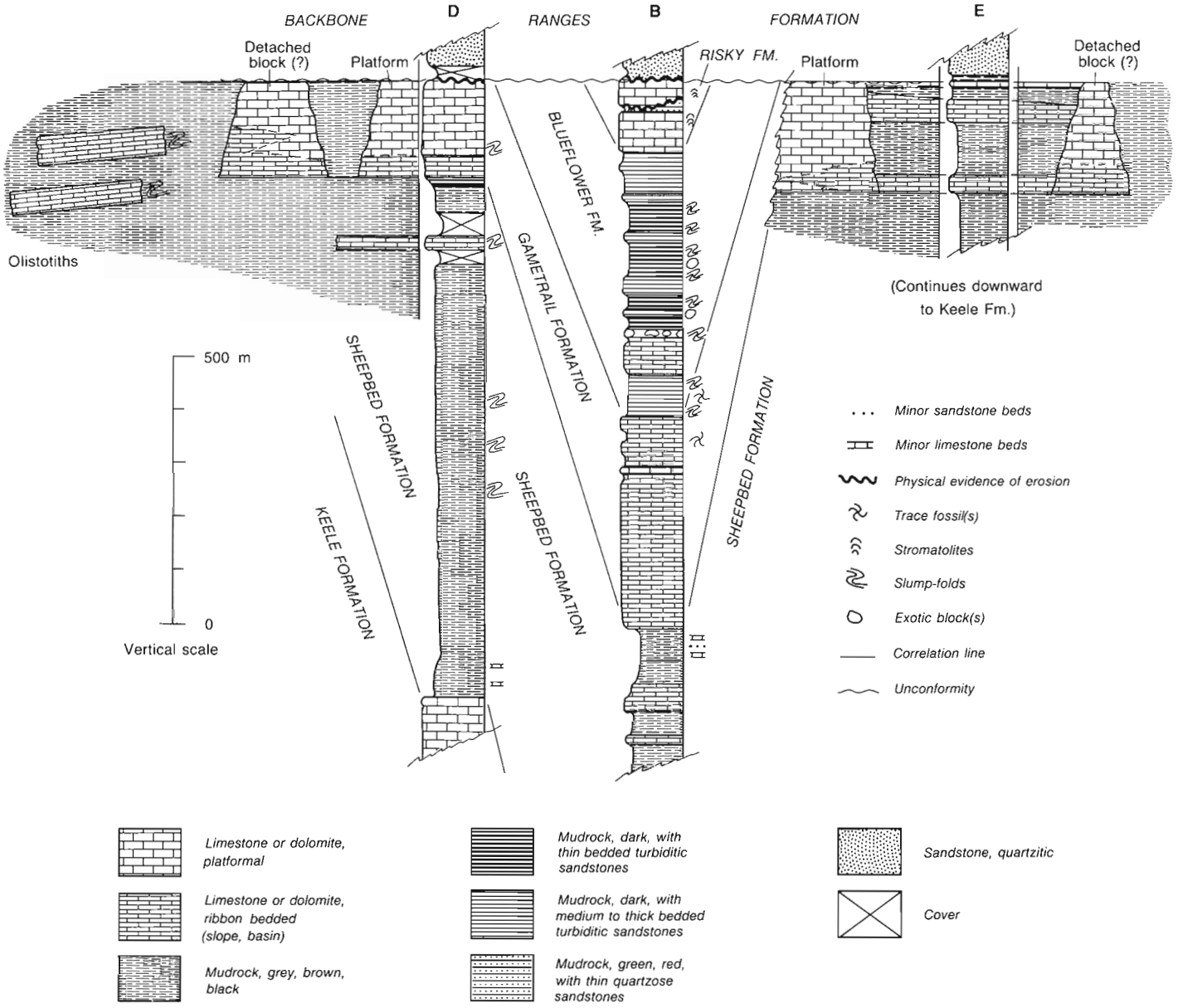


Figure 3. *Stratigraphic section D-B-E (see Fig. 1). Horizontal distances not to scale.*

Sheepbed Formation

This lowest formation, with base concealed and thickness unknown, is a thick unit of turbiditic aspect. In addition to brown and dark grey, partly calcareous mudstone and shale that occur throughout, units of siltstone are prominent, especially in the upper parts of the formation. These siltstones are mainly grey, dolomitic, thin bedded and rusty-orange weathering, with pronounced platy parting. Also present in the upper part are units of dark grey limestone (ribbon-bedded lime mudstone, partly sandy and locally dolomitized). Slump folds are common in these carbonate units, as are slide surfaces truncating bedding, and lenses of limestone-clast, generally matrix-supported breccia, interpreted as debris-flow deposits. Bundles of thin sandstone beds with planar lamination succeeded by unidirectional ripple-drift crosslaminae (Bouma BC units) also occur in the upper half.

In the lower exposures, carbonate beds are fewer; instead, thick, massive, graded beds of fine to coarse grained sandstone, with rusty weathering carbonate cement and abundant carbonate-quartz veinlets, occur in widely spaced bundles. Disturbance of depositional geometry increases downward toward the core of the faulted anticline that brings these rocks to view, with increasing development of an axial-plane, spaced cleavage and the development of lustrous,

micaceous surfaces, as mentioned by Blusson (1971, p. 9). From its relationship to the overlying, unmistakable Gametrail Formation, this lowest unit is the Sheepbed Formation, in a turbiditic facies much coarser grained, on average, and much more proximal in aspect than the facies seen near the trace of the Plateau Fault. As in the Sheepbed at other localities examined for this study, no trace fossils or macrofossils of any kind are present.

Gametrail Formation

Above the lower unit of turbiditic clastics at Sekwi Brook, and in faulted contact with them (except at the north end of the exposed structural panel where the contact is interbedded and gradational; Fig. 8), is a 322 m thick carbonate unit, consisting of ribbon-bedded lime mudstone and, mainly, derived grey dolomite.

This unit, here named the Gametrail Formation (see below), has a regional though discontinuous distribution, and occurs in two lithofacies, a platform facies and an off-platform facies (as at Sekwi Brook). At two localities, one on Silverberry (South Redstone) River, the other near "Palmer Lake" (E and D, Fig. 3), the platform dolomites, partly derived from lime grainstones and algal stromatolites, and the off-platform facies, characterized by ribbon-bedded lime mudstone and derived dolomite, are exposed in lateral continuity with one another, eliminating any doubt as to their equivalence. At both localities, low-angle erosional truncation of the platform facies beneath the Backbone Ranges Formation is demonstrable. In addition, in the "Palmer Lake" area, clastic dykes of coarse quartz sand and pebbles fill karstic solution openings that extend as much as 80 m below the sub-Backbone unconformity.

Eisbacher (1981, Fig. 11) noted, but did not discuss, a carbonate unit at the top of the Sheepbed Formation; Aitken (1982, 1984) referred to it as the "Sheepbed carbonate".

Blueflower Formation

Above the Gametrail Formation and in conformable, interbedded contact with it, is a second formation characterized by turbidites, here named the Blueflower Formation (see below). It is 450 m thick at Section 81AC-9, designated the type section (Fig. 8). The dominant, dark grey shale and mudstone are interrupted by sandstone beds that are mainly thin and fine or very fine grained, with some units of medium and thick, coarse grained beds. Near the base are several units of ribbon-bedded limestone.

The Blueflower Formation of the Sekwi Brook panel differs from the Sheepbed Formation of the same panel in three main ways:

a. The content of platy siltstone, prominent in the upper Sheepbed, is insignificant in the Blueflower

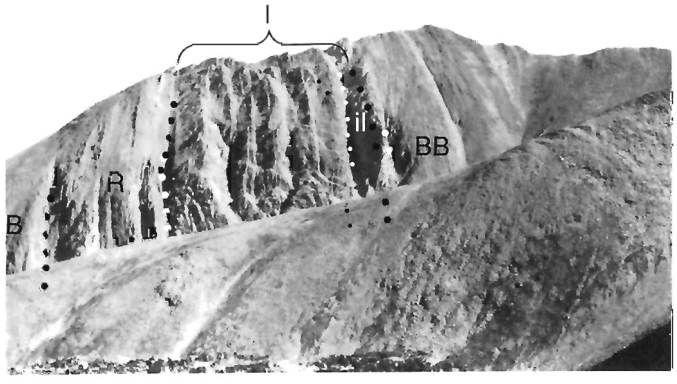
b. The bundles of partly coarse grained, turbiditic sandstone occurring low in the Sheepbed consist mainly of beds that are thicker and coarser than any in the Blueflower

c. The abundant and well preserved trace fossils of the Blueflower (Fig. 6b, c), largely assignable to *Torrowangea*? sp. and *Planolites* sp.

Risky Formation

Succeeding the Blueflower Formation, and in conformable, interbedded contact with it, is the distinctive, 114 to 167 m thick formation of dolomite and sandstone identified by Blusson (1971) as Map unit 11 and here named Risky Formation (see below). This strongly cliff-forming formation has the appearance of a carbonate unit that weathers to a distinctive pale orange, or "peach-coloured", shade. On close examination, the amount of dolomite, including sandy dolomite, is at least equalled by the amount of thick bedded, very dolomitic sandstone.

At Sekwi Brook (Sections 81AC-10, 14), the uppermost beds of the Risky Formation are jumbled and loosened, and the siliceous component, possibly together with younger, introduced material, appears to be concentrated in pockets, as in a regolith. Furthermore, clastic dykes and sills, and pockets of coarse grained quartz sand that apparently postdate their host beds, occur up to 55 m below the contact with the Backbone Ranges Formation/Map unit 12. I interpret this as the same karstic erosion surface as that described herein as occurring at the contact between the Backbone and the Gametrail formations elsewhere. This interpretation differs markedly from that of Fritz (1980, especially Fig. 7.3; and 1982) and Blusson (1971, p. 9). The question is obviously important with regard to correlation of the youngest Precambrian formations of the region.



Blueflower Formation . . . . . B

Risky Formation . . . . . R

Ingta Formation (il-*Limestone member*) . . . I

Backbone Ranges Formation . . . . . BB

Figure 4. *Uppermost Proterozoic formations at "June Lake south" (upper part only), and type section of the Ingta Formation.*

PRECAMBRIAN SECTION, JUNE LAKE PANEL SOUTH

At June Lake south (Sec. C, Fig. 1), the lowest strata exposed in the core of the overturned, faulted anticline are limestones assigned to the Gametrail Formation, with their base hidden. They are overlain by a thick formation of mudrocks with turbiditic sandstone and minor limestone, containing trace fossils, the Blueflower, which is followed in turn by calcareous sandstone and sandy limestone that are thinner, distal equivalents of the Risky Formation.

The Risky is overlain at an abrupt, erosional contact by a unit of green and subordinate purple-red shale with thin beds of quartzose sandstone and abundant trace fossils and, at the top, beds of limestone and dolomite (Fig. 4). These strata are named here the Ingta Formation (see below). The Ingta is overlain at an erosional contact by the quartzite-dominated Backbone Ranges Formation/Map unit 12.

Gametrail Formation

The Gametrail Formation at June Lake south forms a tight, faulted anticline. The carbonate strata are faulted against the Blueflower Formation on the east limb of the major anticline, but are in depositional contact with the overlying turbidites on the west limb.

Ribbon-bedded lime mudstone with thick beds of debris-flow breccia serve to identify the formation, whose exposed thickness is at least 30 m. Medium beds are much more prominent than at Sekwi Brook; many of these bear internal, millimetre thick laminae. Also present are beds of intraclast packstone – wackestone with dolomitized intraclasts.

Blueflower Formation

The Blueflower Formation at June Lake south displays a minor change of facies relative to that at Sekwi Brook: at the former locality, sandstones are fewer and thinner, and thick intervals of mudrocks lacking sandstones more prominent. The thickness is not known. In the west limb of the anticline, two, non-overlapping, incomplete sections were measured, one giving 281 m from the base upward and the other 716 m from the top downward. These sections are separated by several hundred metres of cover, which possibly conceals structural repetitions. The disturbed, eastern limb, measured by "range finder and compass" traverse, has an apparent thickness of 1300 to 1400 m, with major uncertainties.

Trace fossils are not abundant nor very well preserved at June Lake south, because of bedding-plane shear (Fig. 6D; GSC loc. C-94099), nevertheless, most units of suitable rock type yield a few specimens. The trace-fossil suite is the same as at Sekwi Brook.

Risky Formation

In the June Lake structural panel, the strata assigned to the Risky Formation (84-97 m) consist mainly of very calcareous sandstone that is dark grey, fine and very fine grained, in parallel-laminated, medium, thin and very thin beds that weather grey. Numerous matrix-supported, tabular-clast breccias and conglomerates appear to be debris flows, while a blocky breccia virtually identical to one described at Sekwi Brook, and believed to be the same unit, appears to be a slide mass. Limestone in medium and thin beds makes up only 10 to 15 per cent of the formation; it is dark grey, very finely crystalline and massive, with traces of primary grainstone fabric. The top of the map unit contains short columnar stromatolites at some localities.

The Risky Formation is missing by non-deposition in the west limb of June Lake anticline.

Ingta Formation

The Ingta Formation is missing from the Sekwi Brook panel, and has been studied only in the June Lake panel, where it is 256 m thick in the east limb of the anticline and 220 m in the west limb (at the southern section), and consists mainly of interbedded shale and sandstone, with a limestone member at the top. The silty, micaceous shales identify the formation by their colour, dominantly green, with subordinate units that are a distinctive purple-red. Sandstones and minor quartzites are thin, very thin, and medium bedded, with rare thick beds; they are pale brown, green, and pale grey, and almost entirely very fine and fine grained. Trace fossils are abundant and well preserved.

At the top of the formation in the east limb of the anticline is a limestone member 39 m thick, consisting of two units of carbonate rock, separated by 7.5 m of clastic rock. Fritz (1979, Fig. 3) appears to have miscorrelated these units (at the base of his Section 35) with Map unit 11 (Risky Formation) in his Section 33; thus, it is apparently the carbonates from the Ingta, and not the Risky, that yielded the specimen of *Protohertzina* cf. *P. anabarica* reported by Fritz (1980) and Conway Morris and Fritz (1980). In the west limb of the anticline, the limestone member is only 5 m thick.

In the east limb of June Lake anticline, the upper and lower contacts of the Ingta are erosional, as detailed below. In the west limb, no evidence of erosion was observed.

Fritz (1982) interpreted the Ingta Formation ("lower submember of Map unit 12") as a facies of the upper member of the Backbone Ranges Formation, transitional to western, basinal facies equivalents. His interpretation hinges on his correlation of the middle member of the Backbone Ranges with Map unit 11/Risky Formation, and the obvious disappearance westward of the thick orthoquartzites that characterize the Backbone Ranges Formation.

The evidence presented here favours a different interpretation: that the Ingta Formation unconformably underlies Map unit 12 (the Backbone Ranges Formation entire), and is overlapped eastward by the base of the Backbone (Fig. 5). The evidence is as follows:

a. The observed, erosional upper contact of the Ingta

b. The progressive, westward appearance of new units beneath the Backbone Ranges Formation/Map unit 12. This is consistent with observed erosional bevelling of the Gametrail Formation at D and E (Fig. 1) beneath the complete Backbone Ranges Formation (lower, middle and upper members), and with erosional bevelling of both the Risky and Gametrail formations, by a single erosional

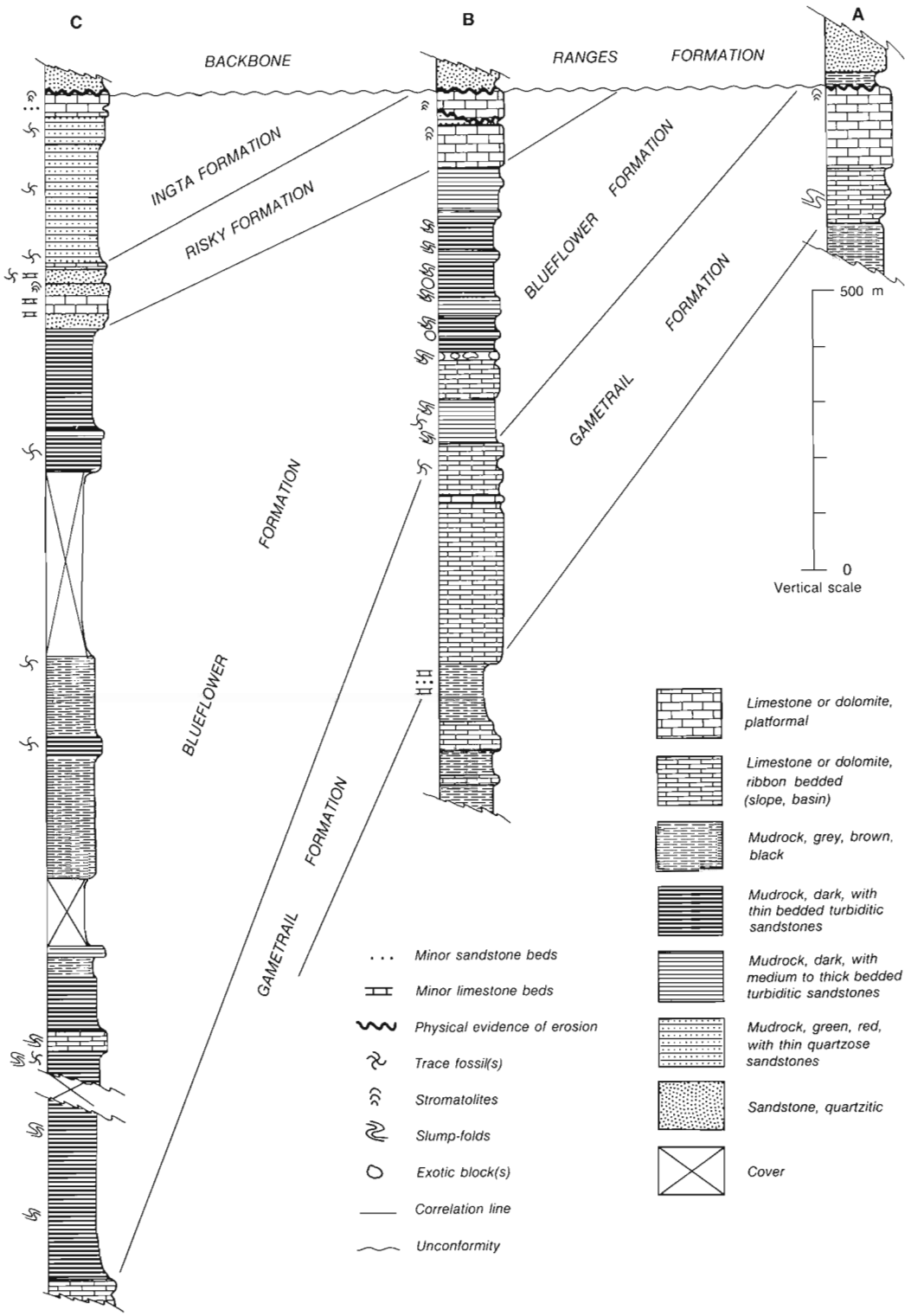


Figure 5. *Stratigraphic section A-B-C (see Fig. 1). Horizontal distances not to scale.*

surface, north of Corn Creek in Nadaleen River map area. In the latter instance, the formation above the erosional surface contains Cambrian trace fossils (*Rusophycus* sp., *Phycodes pedum*) as reported by Fritz et al. (1983), and may be regarded as Vampire Formation (Fritz et al., 1983) or Backbone Ranges Formation, incomplete as a result of strong onlap (Aitken, 1984). The point is that demonstrable bevelling takes place above the Gametrail and the Risky, which are parts of a conformable succession

c. The change in ichnofauna between the Ingta Formation and the lowest trace fossils in Map unit 12. It was precisely this change to an ichnofauna of Cambrian aspect that led the Precambrian – Cambrian Boundary Working Group to suggest placing the boundary "350 to 370 m above the base of Map unit 12" (Fritz, 1980, p. 44), that is, 350 to 370 m above the base of the Ingta Formation, in Fritz's (*ibid.*) Section 33. This study tends to confirm that placement, recognizing the boundary as a formational contact and an unconformity. It may be worth noting that, in the absence of trace fossils diagnostic of age, the size of such common forms as *Planolites* undergoes a marked increase across the sub-Map unit 12 contact (in the case of *Planolites*, from 1 - 2 mm to 4 mm).

STRATIGRAPHY AT THE MAJESTY PROPERTY

Shale-hosted, lead-zinc-silver mineralization has been explored by drilling at the Majesty property on Natla River (lat. 63°16'18"N; long. 128°27'18"W). The writer visited the property briefly in July, 1981, and confirmed that Blusson's (1971) geological map is correct for the vicinity of the claim block in terms of the map units recognized by him.

The stratigraphy below the Backbone Ranges Formation is directly relatable to that at Sekwi Brook, and includes the following formations:

Risky Formation
Blueflower Formation
Gametrail Formation
Sheepbed Formation

Little of the Sheepbed is exposed near the property, because the base of the Gametrail dolomites descends to creek level a few hundred metres upstream from the drill camp.

The mineralization is in the lower of the two shaly (turbiditic) formations at the property (J. Hardy, pers. comm., 1981) and was in part reached by drillholes collared in the Gametrail, therefore, the host formation is the Sheepbed Formation. This observation may be important in directing further exploration for Proterozoic shale-hosted deposits in the region.

DEFINITION OF FORMATIONS

Gametrail Formation

Definition

The name Gametrail Formation is proposed here for a mappable unit of carbonate rocks (mainly dolomite and locally relict limestone), that overlies and intertongues with the mudrocks of the upper part of the Sheepbed Formation (Gabrielse et al., 1973). It is conformably overlain by the Upper Proterozoic (Ediacaran) Blueflower Formation defined herein, or, more widely, unconformably overlain by the Lower Cambrian and (?)Ediacaran Backbone Ranges Formation.

Origin of name

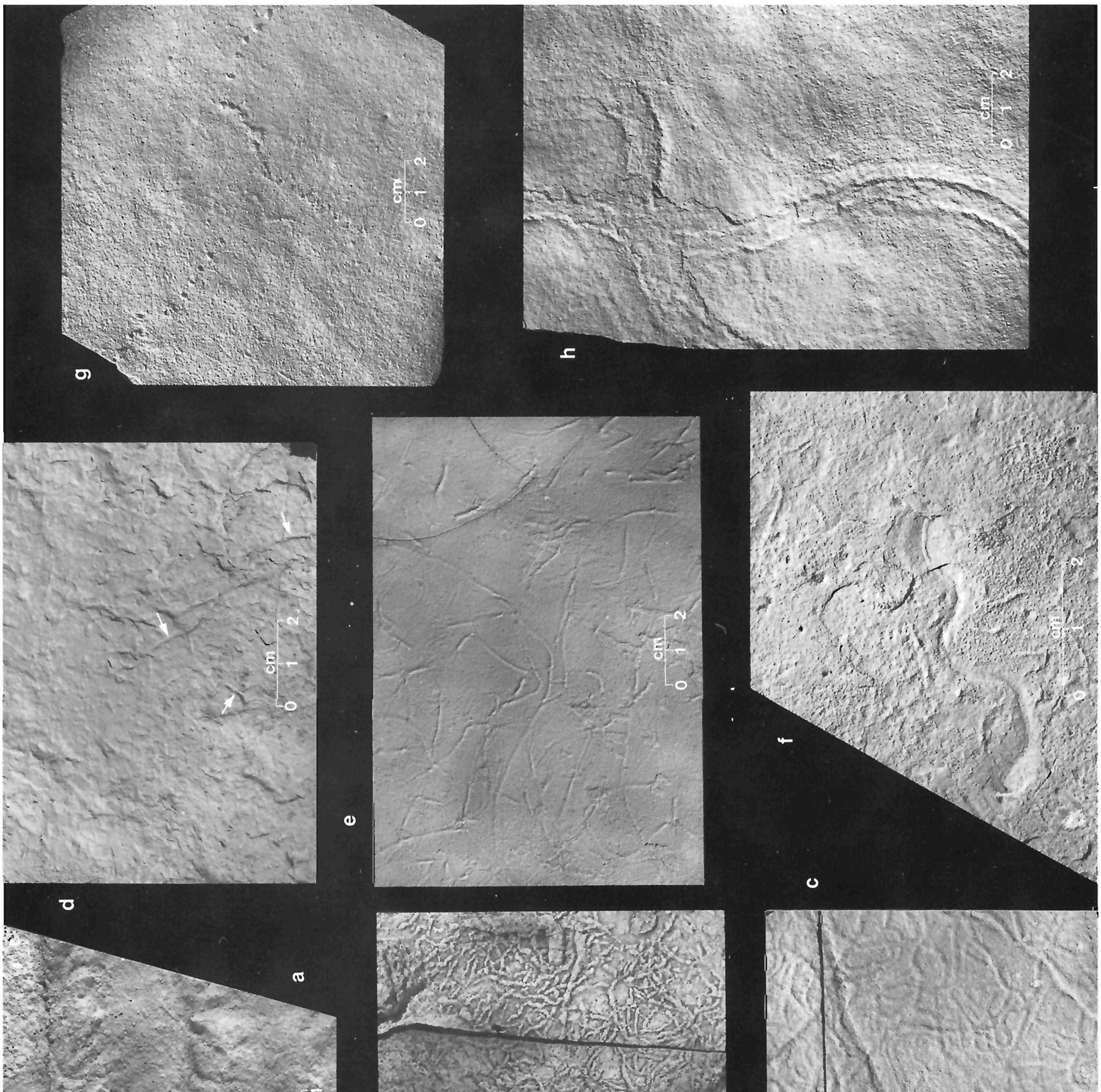
The Formation is named after Gametrail Creek, which drains the core of the mountain block bounded by Natla River, Keele River, and Sekwi Brook, in northeastern Sekwi Mountain map area, Mackenzie Mountains. The creek flows southeast to join Natla River at latitude 63°20'49"N; longitude 128°04'51"W. The name, Gametrail Creek, is new, and appears on the 1985 edition of the 1:250 000 scale topographic map of Sekwi Mountain map area.

Figure 6. *Significant and representative fossils of the Blueflower and Ingta Formations.*

A. ***Pteridinium*** *sp. from near-basal Blueflower Formation, Sekwi Brook panel, GSC loc. C-94062, GSC 68463.*
B. ***Torrowangea*** *sp. from low in the Blueflower Formation, Sekwi Brook panel, GSC loc. C-94061, GSC 68464.*
C. ***Planolites*** *sp. from low in the Blueflower Formation, Sekwi Brook panel, GSC loc. C-94060, GSC 68465.*
D. ***Planolites*** *sp. (arrows) from the Blueflower Formation, June Lake panel south, GSC loc. C-94099, GSC 68466. These fossils are clearly identifiable as metazoan traces, despite smearing by bedding slip.*
E. ***Planolites*** *sp. from the basal 4 m of the Ingta Formation, June Lake panel south (Fig. 1, C), GSC loc. C-94090, GSC 68467.*
F. ***Cochlichnus serpens****, from the Ingta Formation, 157.5 m above the base, June Lake panel south, GSC loc. C-94086, GSC 68470.*
G. ***"Neonereites****-like trails", GSC loc. C-94090, GSC 68468, same locality as E.*
H. ***Scolicia*** *s.l., GSC loc. C-94090, GSC 68469, same locality as E.*

All photographs use a common scale bar graduated in cm and mm (see B, D, G), or parts thereof.

All figured specimens are stored in the National Type Collection of Invertebrate Fossils, Geological Survey of Canada, Ottawa.


a
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Type and reference sections

The type section of the Gametrail Formation (Section 81AC-10, in original field notes) is near the head of the first, major, west-flowing tributary of Sekwi Brook, 5 km above the mouth of the tributary, at latitude 63°25'45"N; longitude 128°26'00"W (Fig. 8). The line of section follows a steep gulley that bisects a prominent mountain spur, and exposure is excellent.

A reference section is also designated here for the Gametrail Formation, to illustrate the platformal facies. This section, field designation Section 77AC-33, has its mid-point at latitude 64°32'00"N; longitude 129°35'00"W, in Mount Eduni map area. It is especially important in that, in the immediate vicinity, the slope facies of the formation can also be studied, including olistoliths one kilometre or more in length, that slid intact into the contemporaneous shale basin.

Description

A majority of the studied sections of the Gametrail Formation, including the type section (see below), are in a grey dolomite facies of deep water, slope origin, characterized by thin, planar bedding. In this facies, nearly all beds thicker than 10 cm bear traces of a relict, matrix-supported, rudaceous texture, and appear to be amalgamated and resedimented beds. Lenticular and "beaded" beds, and slide surfaces that truncate bedding either from above or below are common, penecontemporaneous folds less so. Where undolomitized, the characteristic thin beds are lime mudstones. Supply-grading of quartz sand grains in rare sandy beds, and partial Bouma sequences identify this "ribbon bedded" facies as turbiditic in origin. The thicker, massive beds are generally identifiable as debris-flow breccias. Distinctive white, medium to coarse crystalline dolomite, disposed in parallel sets of short gash veinlets, is highly characteristic of the dolomitized, ribbon-bedded facies. This type of late-developed dolomite is informally referred to as "presquilite" in field descriptions, because of its occurrence, familiar to many, in the Middle Devonian Presqu'île Dolomite of the Pine Point lead-zinc district of Northwest Territories.

A less widely preserved facies (because of northeastward erosional bevelling) is a platformal facies characterized by medium and thick bedded grey dolomite with relict grainstone textures, including oolite, and well to poorly preserved algal stromatolites. At a number of sections studied, the Gametrail Formation consists of a lower member of the ribbon bedded facies overlain by a member of the grainstone – stromatolite facies.

The Gametrail is everywhere a resistant, feature-forming formation.

Boundaries

The Gametrail Formation is in conformable, interbedded contact with dark mudrocks of the underlying Sheepbed Formation. The contact is drawn above the transition interval of interbedded mudrocks and carbonates, and at the base of the thick unit of essentially continuous carbonate rocks. The physical relationships strongly suggest that the contact is intertongued and diachronous.

The upper contact is abrupt, concordant, and apparently conformable. It is drawn where relatively recessive-weathering, dark-coloured mudrocks, or dark, ribbon-bedded lime mudstones, commonly sandy and interbedded with dark shales, overlie resistant, pale weathering dolomite, or, rarely, relatively massive, resistant, lime mudstones. At Section 79AC-24 (Fig. 7), the contact is locally erosional, but because the overlying beds display antidune bedforms indicative of upper-flow-regime current velocities, this erosion was probably submarine and penecontemporaneous with deposition.

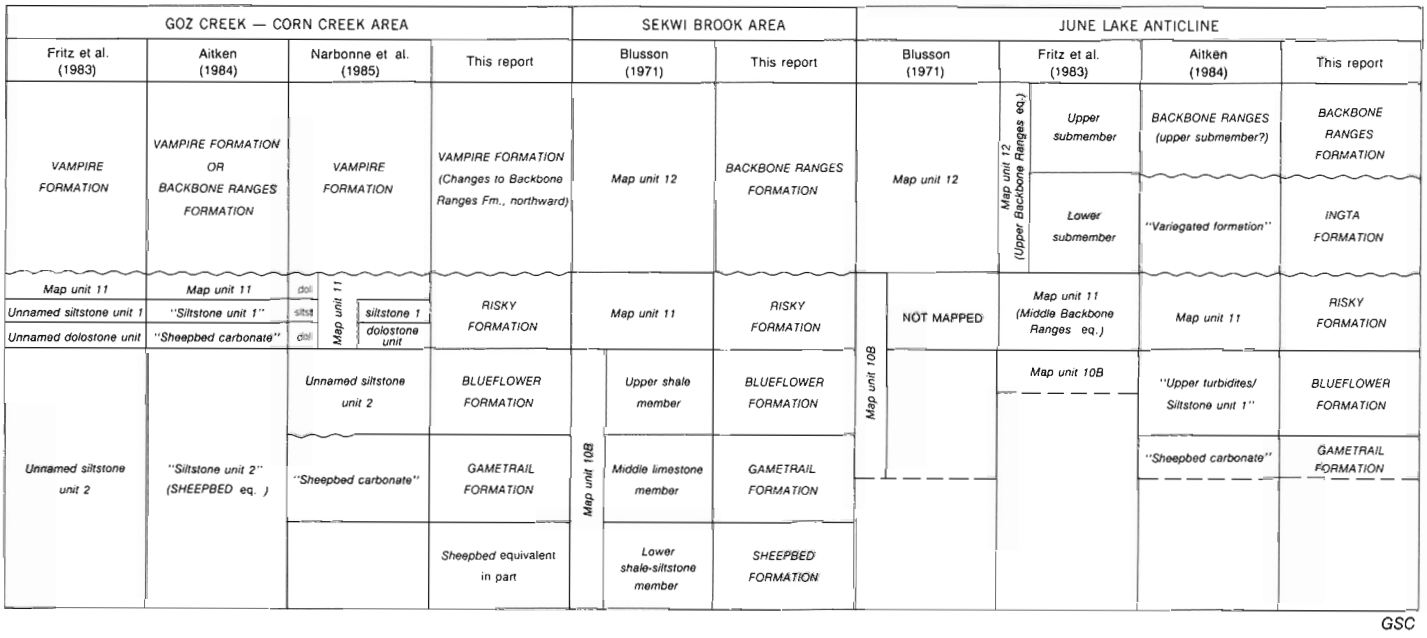


Figure 7. *Comparison between stratigraphic nomenclature of this report and nomenclature published previously. The columns for the Goz Creek - Corn Creek area incorporate interpretations published since completion of this manuscript.*

At several localities, the upper contact of the Gametrail is a regional unconformity beneath the much younger, Lower Cambrian and (?) latest Proterozoic Backbone Ranges Formation.

Historical background

The rocks here assigned to the Gametrail Formation have received little attention in geological maps and literature. Gabrielse et al. (1973), considered the Sheepbed Formation to be ". . . the youngest Proterozoic rocks exposed in Mackenzie Mountains within (their) report area", and made no mention of carbonate strata in their definition of the Sheepbed. Indeed, the Gametrail Formation outcrops only rarely in Wrigley Lake and Glacier Lake map areas, but the writer has studied two sections of the Gametrail in that country (A and E, Fig. 1). Similarly, Eisbacher (1981) considered the Sheepbed to be the "highest Windermere Formation in the region".

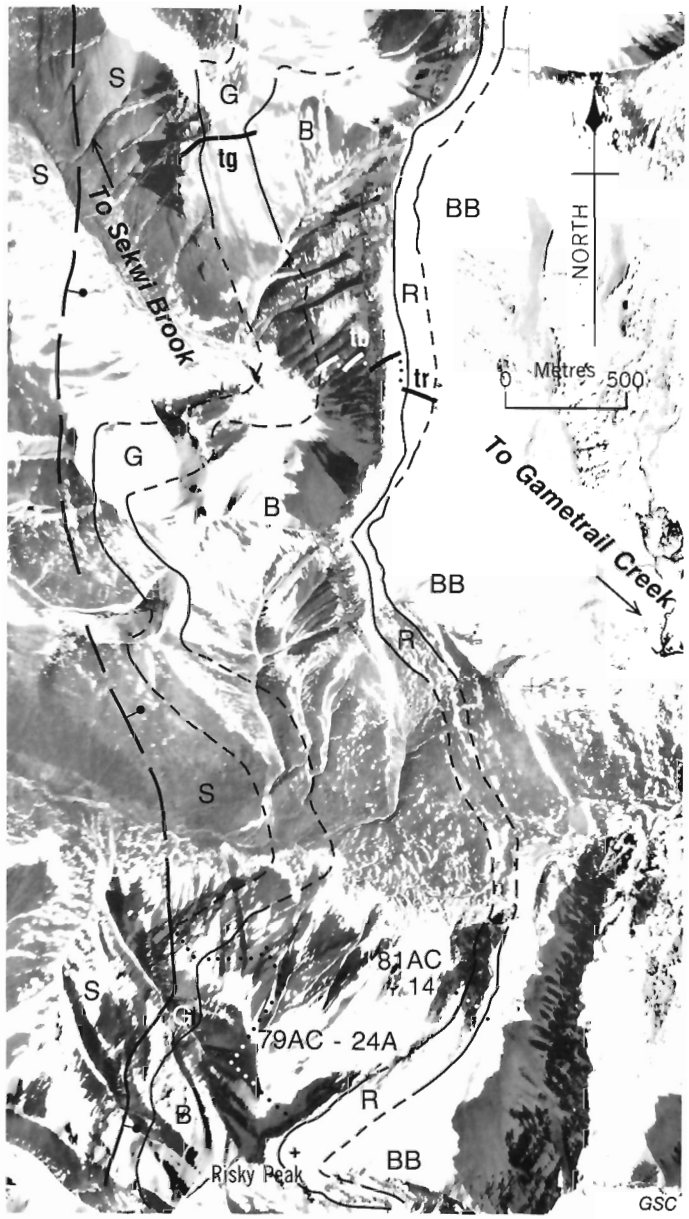
Blusson (1971) recognized the Gametrail Formation as the middle carbonate unit in his Map unit 10b, but did not map it separately (Fig. 7). Eisbacher (1981, Fig. 11) illustrated an occurrence of carbonate rocks above the Sheepbed Formation in Mount Eduni map area, but did not comment on it. Aitken (1984) referred briefly to the Gametrail under the informal designation, "Sheepbed carbonate".

Dimensions

The Gametrail Formation is exposed at scattered localities disposed along an arc extending from northern Glacier Lake map area, through western Wrigley Lake and Mount Eduni map areas, to central Nadaleen River map area. It is 322 m thick at its type section and 214 m thick (preserved thickness) at the reference section of platformal facies, in Mount Eduni map area. In northern Glacier Lake map area (E, Fig. 1), the Gametrail is bounded above by an unconformity beneath the Backbone Ranges Formation, but the thicknesses measured suggest pronounced thickening at the platform edge, from about 107 to about 170 m. In the Corn Creek area of Nadaleen map area, Wernecke Mountains, the Gametrail is 72 m thick at latitude 64°43'49"N, longitude 132°54'12"W, and in a section 12 km to the northwest about 100 m.

Age

The age of the Gametrail Formation is very late Proterozoic. It postdates the uppermost Proterozoic glacial sediments (whether these are taken to be the Shezal Formation or tillites at the level of the Keele Formation, referred to earlier). It is barren of trace or body fossils, and is immediately overlain by turbiditic mudrocks, limestones and sandstones (Blueflower Formation) with abundant, simple trace fossils and sparse elements of an Ediacaran fauna (Hoffman, 1981).



Sheepbed Formation . . . . . S
Gametrail Formation . . . . . G
Blueflower Formation . . . . . B
Risky Formation . . . . . R
Backbone Ranges Formation . . . . . BB
Type section of Gametrail . . . . . tg
Type section of Blueflower . . . . . tb
Type section of Risky . . . . . tr

Figure 8. *Geological map (air photo base) of the type sections of the Gametrail, Blueflower and Risky formations.*

Dotted lines indicate other informative sections studied in the immediate area. National Air Photo. Library, part of air photo A13416-272.

Correlation

Upper Proterozoic carbonate formations of the Cordillera are, as yet, insufficiently well dated to justify correlating the Gametrail Formation beyond the Mackenzie and Wernecke mountains. It is instructive that attempts to correlate the youngest Proterozoic carbonate formations along the length of the Cordillera in Canada and even beyond have overlooked the Gametrail and Risky formations.

Having recognized the Gametrail Formation ("Sheepbed carbonate") in the eastern Wernecke Mountains (localities A and B, Fig. 2, in Aitken, 1984), the author correlated it with the "Unnamed dolostone unit" of Fritz et al. (1983). In June, 1984, Guy Narbonne kindly guided the author over Section 8 of Fritz et al., and it is clear that the Unnamed dolostone unit is <u>not</u> the Gametrail Formation and, accordingly, that the clastic formation underlying it is most unlikely to be the Sheepbed, contrary to the author's earlier conclusion.

Genesis

Interpretation of the genesis of the Gametrail Formation is straightforward. At basinward (southwestern) localities, the abundant evidence of mass-movement on slopes (debris-flow breccias, slide surfaces, penecontemporaneous folds, and the overall resemblance of bedding style to that of other, documented occurrences) and the absence of "shallow water" rocks and structures, clearly point to origin on a submarine slope in "deeper" water. At northeastern sections, the presence of algal stromatolites, thick bedded, crossbedded grainstones, fenestral fabrics, teepee structures and suncracks, points clearly to origin on a very shallow water, partly intertidal, marine carbonate platform.

Progradation of the carbonate platform is demonstrated by those sections at which the ribbon-bedded slope facies is overlain by the platformal facies.

Section 81AC-10

Type Section of the Gametrail Formation
(Mid-point of the section is at lat. 63°25'45"N; long. 128°26'00"W)

Note: The informal rock name "presquilite" is used here to denote a type of dolomite particularly characteristic of the Gametrail Formation, but also widely distributed, both geographically and throughout the geological column. The definitive element in the "presquilite" fabric is short, lenticular gash-veinlets of millimetre to (rarely) centimetre scale, filled with white, crystalline dolomite that is coarser than the matrix dolomite. Characteristically, these gash-veinlets occur in parallel sets, inclined to the plane of bedding; less commonly, the veinlets form sets parallel to bedding. The name is suggested by the well-known Presqu'ile Dolomite (Middle Devonian) of the Pine Point lead-zinc district of Northwest Territories, of which this fabric is particularly characteristic. Each use of the coined term saves a paragraph of repetitive description.

Unit No.	Description	Thickness in metres: Unit	Thickness in metres: Total from base
	Blueflower Formation		
	Recessive weathering and poorly exposed here. Basal beds are platy, shaly lime mudstone with interbeds of dark grey shale. Upward, very thin beds of platy, dolomitic siltstone and sandstone appear, and about 15 m above the base, very thin, normally graded beds of turbiditic sandstone.		
	Gametrail Formation		
20	**Dolomite:** pale grey, fine crystalline, mainly sandy (quartz sand); mainly medium and thick bedded, beds commonly "beaded" or lenticular. The fabric appears to be grainstone, largely destroyed by white, crystalline dolomite (small-scale "presquilite"). Tops of beds commonly bear small mounds; if these are bioherms, all evidence is destroyed. Subordinate, thin sub-units of ribbon-bedded dolomite, as below. The dolomite is greyish pink where maturely weathered. Thickness approximate	16.7	322.2
19	**Covered:** recessive weathering. Thickness approximate	3.0	305.5
18	**Limestone:** ribbon-bedded lime mudstone, flaggy	3.0	302.5
17	**Dolomite:** basal 1.5 m are dolomite, as Unit 12. The rest is a single, massive bed, with erosional and load-casted base, of dolomite, as below. Rare, tabular, "floating" clasts are discernible. This is a dolomitized, debris-flow breccia; in outcrop to the south, it is at least 3 m thick	3.7	299.5
16	**Limestone:** ribbon-bedded lime mudstone, sandy at the top. In the middle, a recessive weathering, covered notch	12.3	295.8
15	**Dolomite:** as Unit 12; strong development of coarse crystalline, white dolomite, "presquilite"	6.2	283.5
14	**Covered:** a recessive weathering notch; float of brown-grey shale and platy siltstone	3.8	277.3
13	**Dolomite:** as below, ribbon-bedded, very thin bedded, flaggy, weathering brownish grey	6.4	273.5
12	**Dolomite:** pale grey, fine crystalline, grey weathering; mainly irregularly medium and thick bedded, partly sandy. Development of white dolomite ("presquilite" on a small scale) has destroyed most of the primary texture, but traces of "floating", sand- and pebble-sized grains are present. A bundle of debris-flow breccias(?)	7.8	267.1
11	**Covered:** recessive weathering, on route of measurement. In outcrops offset to the north, the middle of the unit (2 m) is exposed and consists of thin bedded, flaggy, sandy dolomite beds. These are Bouma B, BC, and ABC sequences, with both size- and supply-grading of quartz sand grains	14.8	259.3
10	**Dolomite:** pale grey, fine crystalline, partly sandy; appears to be mainly dolomitized grainstone; medium bedded, massive, weathering yellowish grey. Rare, floating, flat pebbles. One weathered surface reveals ooid grainstone texture. Upward, ex-grainstone alternates with an increasing proportion of ribbon-bedded dolomite	9.7	244.5
9	At the base, recessive weathering, covered (2 m), with float of shale, as below. Higher, laminated and thin bedded, ribbon-bedded dolomite, flaggy, with minor interbeds and thin sub-units of shale	13.0	234.8
8	Basal unit of a major, recessive weathering member (units 8, 9). Ribbon-bedded lime mudstone, partly lenticular bedded, above 2.5 m of mostly covered, fissile, brown, calcareous shale	7.1	221.8
7	**Dolomite:** as Unit 3. Appears thin to thick bedded, but is mainly ribbon-bedded. Three thick beds, internally massive, may be debris-flow breccias, but texture is destroyed. Locally, at the top, ribbon-bedded limestone is preserved	37.0	214.7
6	Sedimentary **breccia** (debris-flow). Dolomite as below, in a single, massive bed, with abundant, recognizable, angular, matrix-supported dolomite clasts	6.8	177.7
5	A major cliff-former. "Ribbon dolomite", as Unit 3, but here, the appearance is medium bedded and minor thick bedded. Invaded throughout by coarse crystalline white dolomite, in "presquilite" form. Above 52 m from the base, wavy and lenticular bedding is notable, as are orange weathering patches (ferrodolomite?). Above 69 m from the base, much of the "presquilite" lamination is parallel to bedding, rather than inclined. In longer views, a few, widely spaced truncation surfaces (slide surfaces?) are visible	95.6	170.9
4	**Dolomite:** as below, but in very thin beds and laminae; platy to shaly, recessive weathering. In the middle, a bundle of medium beds. Bedding planes and minor shaly dolomite weather dull red	13.3	75.3
3	**Dolomite:** dark grey, weathers dull yellow and grey; fine crystalline, mainly thin bedded, minor very thin bedded; bedding planar. Thicker masses are amalgamated beds with flowage folds (basal 12 m only). Interbeds of dark grey shale occur in minor bundles. From 8 m above base upward, abundant lenses, 1 to 5 cm thick, of black chert. Extensively, but not entirely converted to "presquilite". Bedding: strike 014°, dip 36°east	42.8	62.0

2	Recessive weathering, covered at top. Limestone: dark grey lime mudstone, laminated, very thin and thin bedded, largely argillaceous, shaly	7.2	19.2
1	A resistant unit, basal contact covered. Dolomite: grey, fine crystalline, completely and intensely converted to "presquilite"; thick, medium and minor thin bedded. Scoop-shaped slide surfaces are widespread. Pods of relict limestone (as Unit 2).	12.0	12.0

Sheepbed Formation

Description of the uppermost eight units of the Sheepbed is presented to illustrate the interbedded nature of the Sheepbed – Gametrail contact. The formation is recessive weathering, and forms sombre, talus-littered slopes.

8	**Siltstone:** brown, argillaceous, dolomitic, finely parallel laminated, platy, with partings and interbeds of dark grey shale. Minor rock types occur throughout, as follows: Rare, thin beds of dolomitic sandstone, commonly normally graded Bundles of very thin, planar beds of argillaceous, very fine crystalline dolomite, as below Matrix-supported, debris-flow breccias, with slabby limestone clasts Graded, 15 cm beds of limestone with oncoids and ooids as phenoclasts	49.7	177.0
	Flow-folding is prominent in the basal 18 m, less so above. The uppermost 15 m is richer in mudstone/shale, with muddy debris-flow breccias, and is poorly exposed		
	Unit 8 is poorly exposed at the base, becoming more resistant and well exposed higher		
7	**Mudstone:** as Unit 3	18.0	127.3
6	A confusing, interbedded mixture of: Dolomite: as Unit 5 Mudstone: as Unit 3 Shale: brown, calcareous, flaky, with minor limestone, as Unit 4. Rare, thin, normally graded beds of fine to very fine grained quartz sandstone.	16.5	109.3
	Evidence of slope-failure occurs throughout the unit.		
5	**Dolomite** and **shale** **Dolomite:** dark grey, fine crystalline, weathering pale orange, bedded as the limestone below, but with more medium beds. **Shale:** dark grey (30% below, increasing upward).	25.0	92.8
	All of the slope-failure structures of Unit 4 are repeated; many, metre-scale slide-masses are present. Unit is poorly exposed.		
4	**Limestone:** as Unit 1, but becoming yellow weathering upward. The basal 2 m is a folded and refolded slide-mass. Two massive metre-scale slides or debris-flows with scaly fabric occur higher. Upper part poorly exposed	16.0	67.8
3	**Mudstone:** brown, dolomitic, partly sandy, weathering brown and yellow. Indistinctly thin bedded, scaly; bedding-parallel fracture dominates. Several metre-scale, jumbled, massive slide-masses. Unit is poorly exposed	36.0	51.8
2	**Dolomite:** dark grey, fine and very fine crystalline, thin and medium bedded, yellow weathering. Bedding is planar. "Scour-and-fill" surfaces on a scale larger than bedding are probably slide surfaces. Several medium beds with scaly fracture and matrix-supported rudite fabrics are undoubtedly debris-flows. Some dolomite beds are very sandy (quartz sand)	4.5	15.8
1	**Limestone:** dark grey lime mudstone, weathering grey, yellow-grey; thin and very thin, minor medium bedded. Planar and very lenticular bedded; the lenses tend to display confused bedding and are probably slide masses. Very minor partings of grey shale, and a trace of intraclast packstone.	11.3	11.3
	Bedding attitude of Unit 1: strike 176°, dip 41° east.		
	Downward, exposure is sparse.		

Section 77 AC-33

Reference Section for the Gametrail Formation
(Mid-point of the section is at lat. 64°32'00"N; long. 129°35'00"W)

This section is chosen as a reference section because it illustrates the platformal (platform-edge) facies of the Gametrail, which is in a slope facies at the type section. Directly across the valley to the southwest, the Gametrail Formation occurs only as olistoliths of ribbon-bedded dolomite (slope facies) measuring hundreds of metres in length and tens of metres in thickness, embedded in dark grey Sheepbed mudrocks.

Backbone Ranges Formation
(basal beds only)

Only the basal beds of the Backbone Ranges are preserved here in structural continuity with the Gametrail. Immediately upslope, a normal fault, northeast-side-up, repeats the Gametrail Formation and, in sequence, the Backbone Ranges. All three members of the latter formation, lower, middle and upper (Gabrielse et al., 1973) are present in the immediate vicinity, in their characteristic manifestations.

1	**Sandstone:** at the base, pale grey, fine grained, poorly sorted, silica-cemented, medium bedded; grades upward to quartz-pebble conglomerate (mode 4 mm), with ferroan calcite cement	12.0	12.0
	Basal contact is erosional. Clastic dykes filled with quartz-pebble conglomerate are up to 20 cm wide, and extend at least 12 m downward from the contact.		

Gametrail Formation

The Gametrail Formation is resistant, forming grey and yellow-grey weathering cliffs.

In views from a few hundred metres distance, much of the formation (at least the grainstone units, No.'s 4 to 9) is seen to be composed of metre-scale, foreset beds, inclined at more than 20° to the paleo-horizontal. The inclined bedding is not apparent to an observer standing on the outcrop. The foreset beds reveal a depositional paleo-relief of over 100 m at the advancing edge of a prograding, carbonate platform.

13	**Breccia:** mass of angular fragments of dolomite as Unit 12. Debris flow or solution-breccia	6.0	214.0
12	**Dolomite:** very fine crystalline, in alternating pale grey and dark grey, thin beds, locally pinkish grey. Indistinct, wavy laminae, confirmed as cryptalgal in upper fault block. Small slump-folds throughout. Quartz- and dolomite-filled vugs widespread	25.0	208.0
11	**Dolomite:** pale to dark grey, very fine crystalline, well laminated. Laminae are generally disturbed (slumped) and partly brecciated. 12 m above the base, an apparent pocket (pull-apart?) filled with kinked but non-brecciated, finely laminated dolomite, with a few angular clasts. One 25 cm bed is sandy (quartz sand)	16.8	183.0
10	**Breccia:** angular clasts of dolomite as below (slump-breccia?)	2.2	166.2
9	**Dolomite:** as below, but mainly medium bedded, with minor thin and (upward) thick beds. Local good preservation of oolitic fabric	26.5	164.0
8	**Dolomite:** as below, less affected by dolomite veins and vugs, but tabular, dolomite-filled vugs are aligned with bedding. Locally, white chert and silicified dolomite preserve an intraclast/superficial oolite grainstone texture. 17 m above the base, an apparent slip-surface truncates (from below) 30 cm of laminated dolomite	39.5	137.5
7	**Dolomite:** grey, fine and medium crystalline, laminated (cryptalgal??), deformed and brecciated; weathers as surrounding grainstone	3.0	98.0
6	**Dolomite:** as Unit 4; a relict, ooid grainstone texture is very locally discernible. Vugs and gash-veinlets filled with very coarse crystalline dolomite are common. Pyrite occurs locally	48.0	95.0
5	**Dolomite:** as Unit 3; intensely deformed, base irregular	2.5	47.0
4	**Dolomite:** brownish grey, medium crystalline, with traces of a relict grainstone texture; nonbedded (resedimented?), weathers pale brownish grey, blocky, massive, locally dusky red. Base of unit is load-casted and locally injected into underlying breccia, and locally truncates underlying lamination	7.0	44.5
3	**Dolomite:** as below, but almost entirely crumpled into box and chevron folds. Folding locally passes to brecciation	10.5	37.5

2	**Dolomite:** as below, but locally silty and dusky red. Suncracks and small, blister-shaped algal stromatolites are present. Partings between cryptalgal laminae are grey-green, argillaceous. Slump-folding of 50 cm thick bundles of laminae is general. Upward, minor, thin, flat-pebble breccias and questionable teepee structures are present. One scour-and-fill is 4 cm deep	15.0	27.0
1	**Dolomite:** pale grey, brownish grey, fine crystalline, reddened near fractures; weathers dull orange, locally dusky red; entirely cryptalgal laminite, with mudcracks throughout. Laminae are locally crumpled and truncated, as if by sliding, with some brecciation. Deformation increases upward.	12.0	12.0

Unit 1 overlies a covered interval whose top appears to correspond closely to the top of the Sheepbed Formation (dark grey shale at outcrops in the vicinity).

Blueflower Formation

Definition

The name Blueflower Formation is proposed here for a mappable unit of recessive weathering, marine strata, consisting mainly of dark-coloured mudrocks with a subordinate content of limestones and sandstones of turbiditic aspect, and mass-flow deposits such as pebbly mudstones. It overlies the Upper Proterozoic Gametrail Formation with apparent conformity, and is conformably and gradationally overlain by the Upper Proterozoic Risky Formation.

Origin of name

The formation is named after Blueflower Mountain, a prominent peak in the area, elevation 7541 feet, latitude 63°20'04"N; longitude 128°19'16"W, overlooking Natla River to the south. The name is new, and appears on the 1985 edition of the 1:250 000 scale topographic map of Sekwi Mountain map area.

Type section

The type section of the Blueflower (Section 81AC-9 in field notes) is continuous with that of the overlying Risky Formation, and is one kilometre south-southeast of the type section of the Gametrail Formation (Fig. 8), at latitude 63°25'25"N; longitude 128°25'00"W (mid-point of section). The gully chosen for the line of the lower part of the section is the most southerly in the cirque providing exposure of the top of the Gametrail Formation and hence, the base of the Blueflower. In the upward course of measurement of the section, the line was twice offset southward on distinctive units, to reach more continuous exposures in adjacent gulleys.

Most of the paleontological material from the Blueflower Formation was collected at Section 79AC-24, 2.5 km south of the type section (Fig. 8). This section provides broader outcrops and more bedding-plane exposures favourable for the search for fossils, but, especially in its upper half, broad, covered intervals and structural uncertainties impair its suitability as type section.

Description

The Blueflower Formation is a recessive weathering unit consisting mainly of fissile shale and lesser, nonfissile mudstone that are dark grey to black, partly silty, partly pyritic, and partly calcareous. The mudrocks weather grey to black and brown. The subordinate rock types, quartzose sandstone, limestone, and mass-transport deposits, give the formation its distinctive character.

Sandstones in the lower three quarters of the formation largely display the characteristics of partial or complete Bouma sequences, and hence are interpreted as turbidites. The dominant sandstone beds are thin and very thin beds and laminae that interrupt the prevailing mudrocks. These are fine and very fine grained, are not usually detectably graded, and commonly are Bouma BC units. Their bases commonly bear flute- and groove-casts, and the thicker beds, load casts. These beds have commonly undergone post-depositional flowage that produced extremely attenuated (fluidized) folds; in extreme examples, they are rolled into pseudonodules. Medium beds and the uncommon thick beds of sandstone are generally coarser grained and commonly graded (Bouma A units); for instance, coarse grained at the base to fine grained at the top. The graded or ungraded, basal, A division is commonly succeeded by a plane-parallel laminated B division, and, more rarely, by a finer grained, C division with waning-current ripple marks. These beds commonly have erosional bases with sparse flute-and groove-casts, and prominent load casts. Several coarsening-upward, thickening-upward cycles are apparent at the type section.

In the upper quarter, although a few sandstone beds with turbidite characteristics persist, the sandstones, here much more prominent, even dominant, are mainly medium to thick beds of fine grained sandstone with dolomite cement. They characteristically display plane-parallel lamination or low-angle crosslamination, and sole markings are rare.

Limestone, other than as clasts in mass-flow deposits, is confined to the lower third of the formation. In the Skewi Brook area, these limestones are entirely thin bedded, rarely medium bedded lime mudstones, largely planar bedded, but partly lenticular bedded. Where a small content of quartz sand is present, it is usually supply-graded (content diminishing upward within each bed). These limestone beds are interbedded with dark-coloured shale and minor, usually thin, beds of turbiditic sandstone. A very few, thick, massive beds of grey, orange weathering, sandy dolomite occur near the top of the formation; these forecast the transition to the overlying Risky Formation, and might be viewed as tongues of the Risky.

Mass-transport deposits include deformed slide-masses of mudrocks, with or without sandstone; bouldery debris-flow deposits; and exotic boulders. The exotic boulders, and clasts in the debris-flow paraconglomerates, are entirely of carbonate rocks of shallow water aspect, including algal stromatolites, grainstones, and cryptalgal laminites; these clasts occur only in the lower three quarters of the type section.

Boundaries

The basal contact of the Blueflower is abrupt, concordant, and apparently conformable. Locally observed erosion is considered to be the product of high-velocity turbidity currents, as noted at sub-turbidite contacts within

the Blueflower. No karst features nor evidence of weathering have been observed.

The upper contact is interbedded and conformable. It is drawn where thick, massive beds of sandstone and/or dolomite assume clear dominance over mudrocks.

Historical background

Like the Gametrail Formation, the Blueflower has received little attention. It is the upper part of Blusson's (1971) Map unit 10b (Fig. 7), and was referred to informally as "Upper turbidites" in Aitken (1984). A clastic formation, homotaxial with the Blueflower but lacking turbiditic characteristics, that occurs in the Corn Creek area of the eastern Wernecke Mountains, was briefly described and figured by Aitken (1984, Fig. 2, locality B); its correlation therein with Siltstone unit 1 of Fritz et al. (1983) is now known to be erroneous (Narbonne et al., 1985).

Dimensions

The Blueflower Formation has been studied in its typical aspect only in the Sekwi Brook and June Lake anticline areas of Sekwi Mountain map area; homotaxial strata in central Nadaleen River map area, Wernecke Mountains, are of different facies.

The formation is 450 m thick at the type section in the Sekwi Brook area. A measurement of 520 m at Section 79AC-24 nearby (Fig. 8) is suspect, because of large covered intervals and possible structural complications. In southern June Lake anticline, it is at least 1000 m thick, but it has not been possible to measure a complete, unfaulted section. The homotaxial clastic strata in central Nadaleen River map area, of shallow water facies, are 190 m thick where studied.

Age

The Blueflower Formation carries an Ediacaran fauna, and is latest Proterozoic. Hofmann (1981) reports the body-fossils *Inkrylovia* sp. (a pteridiniid), and *Sekwia excentrica* (a medusoid), and the trace fossils *Gordia* sp., *Torrowangea* sp., and several problematica. A specimen of *Pteridinium* sp. (GSC 68463; identification by M. Fedonkin) was found in the basal unit of the formation. All of these fossils were collected from Section 79AC-24 (Fig. 7).

Correlation

Correlation of the Blueflower Formation beyond Mackenzie Mountains and Selwyn Basin is not attempted.

As discussed earlier, Fritz (1982) correlated Map unit 11 (here Risky Formation) with the middle member of the Backbone Ranges Formation. If that view is correct, the Blueflower Formation must be a basinal facies equivalent to the lower member of the Backbone Ranges. Reasons are given on an earlier page for doubting Fritz's correlation, but the case remains unresolved.

Because of its position below redbeds near the Precambrian-Cambrian boundary, its turbiditic character, and a small content of quartz granules in some beds, the Blueflower is very probably a correlative of part of the 'Grit unit' of Selwyn Basin (Gabrielse et al., 1973). It appears to be a distal facies of the 'Grit unit', and as such, has important paleogeographic implications.

Genesis

The Blueflower Formation in the Sekwi Brook area is mainly an assemblage of deep water mudrocks punctuated by sandstones and limestones of turbidity current origin, and by mass-transport deposits. Exotic boulders and thick, coarse debris-flows are unlikely to have been deposited any great distance in front of the toe-of-slope. Accordingly, the thin bedded turbidites interleaved with the mass-transport deposits are considered to be of upper fan origin, despite the lack of known channels.

The upper half of the formation is a shallowing-upward sequence, recording the progradational deposition that provided a shallow platform on which the succeeding Risky Formation could be laid down.

In the June Lake structural panel, sandstone and limestone beds are in general fewer and thinner, and debris-flow deposits less common. These facts suggest an environment more distal than at Sekwi Brook.

In an unpublished study under the writer's direction, Martin Teitz determined that flute casts in the Blueflower display a single, well defined, northward-directed mode, and that slump-fold axes display a pronounced maximum oriented east-west. Thus, both paleoslope and paleocurrents were to the north during Blueflower deposition.

The alternation of calcareous and siliciclastic turbidites in the Blueflower Formation, and the presence of boulders of shallow water carbonates, create a strong impression that two separate sources of sediment, one a major source of siliciclastic mud, silt and sand, and the other a contemporaneous carbonate platform, shed mass-flow deposits into the Blueflower basin.

Section 81AC-9

Type Section of the Blueflower and Risky formations
(Mid-point of the section is at lat. 63°25'25"N; long. 128°25'00"W)

Unit No.	Description	Thickness in metres: Unit	Thickness in metres: Total from base
	Backbone Ranges Formation		
	The Backbone Ranges Formation is about as resistant as the Risky, but more ledgy, less "monolithic" in outcrop. The Risky – Backbone contact is generally marked by a recessive notch.		
1	**Sandstone and quartzite:** alternately yellow, pale-brown weathering, with carbonate cement, and white, white weathering, with silica cement; medium grained, well to poorly sorted; thick bedded, massive		
	(not measured; section continues upward on dip slope)		
	Erosional contact: see description of upper part of Unit 9, below.		

Risky Formation

The Risky is expressed topographically as a major cliff-former of "monolithic" aspect. The recessive weathering Unit 6 forms a subtle, persistent notch. The dull yellow to dull orange cliffs of the formation form an easily mappable entity.

9 **Dolomite:** very pale grey, very fine crystalline, very sandy, partly with many, sub-millimetre, smoothly ovoid vugs (leached ooids?); weathers orange-pink-grey; very thick bedded, massive, beds lacking internal structure except indistinct, local cross-lamination — 37.5 — 114.3

13.5 m above the base, a 1.5 m thick, massive bed of sandy dolomite contains abundant, matrix-supported, rounded-tabular pebbles of dolomite.

Stylolites, prominent throughout the formation, undergo a marked, upward increase in development in Unit 9.

Dykes of coarse sandstone and grit extend at least 12 m downward from the upper contact. Above 27 m, much of the unit is a dolomite-pebble conglomerate or breccia, with a matrix of coarse, calcareous sandstone or grit. Clastic dykes reach a width of one-half metre. Large patches (pockets?) of nonbedded, gritty sandstone are present

8 **Dolomite:** sandy, and dolomitic sandstone, as Unit 5; massive, crosslaminated between spaced, metre-scale, domal stromatolites. — 6.8 — 76.8

A basal bed, up to 1 m thick, infills the underlying, erosional relief; it is dolomite after oncoid wackestone/floatstone

7 **Sandstone:** grey, very fine grained, dolomitic, yellow weathering, medium bedded; planar and trough crossbedded. — 2.0 — 70.0

Thickness given is that on the line of section; elsewhere, thickness varies from 1 to 3.6 m.

The top of the unit has a pronounced, stepped, erosional form, overlain and adjoined by dolomite of Unit 8. This is an erosional gully; the lack of sandstone clasts suggests that the gully was eroded in unconsolidated sand. Its walls are locally encrusted by finely laminated, centimetre-scale, columnal algal stromatolites.

6 A recessive weathering, persistent unit, generally covered. The basal 2 m expose parallel-laminated and crosslaminated, medium bedded sandstone, as Unit 1, plus a 20 cm bed of centimetre-scale, pseudo-columnar, LLH stromatolites. Float of dark grey shale is shed from higher parts of the unit — 7.5 — 68.0

5 Mainly **sandy dolomite** as below, minor dolomitic sandstone; weathers orange-grey to pink-grey; crosslamination widespread. — 18.0 — 60.5

Several horizons of sandy (quartz sand) stromatolites occur in the lower third, and, near the base, a 25 cm thick bed of dolomite with pseudo-columnar, centimetre-scale stromatolites. One thick, massive bed near the base bears quartz granules

4 **Dolomitic sandstone:** as below, grading to sandy dolomite, as below. 40 per cent is parallel-laminated and low-angle crosslaminated, in sets 5 to 20 cm thick. 60 per cent is simple, domal stromatolites of sandstone. The domes have up to 50 cm of relief, infilled by crosslaminated sandstone. — 12.7 — 42.5

Penecontemporaneous fracture of sandstone laminae is common. Near the base, one 40 cm thick subunit, mainly of sandy dolomite, has fenestrae; centimetre-scale, discontinuous LLH stromatolites; and one level of teepee structures

3 **Sandstone.**

Sandstone (75%): pale grey, fine grained, poorly sorted, very dolomitic, a minor part grading to sandy, very fine crystalline dolomite; weathers medium yellowish grey; thick bedded, massive, with wispy, indistinct internal lamination and low-angle crossbedding; stylolites prominent.

Sandstone (25%): medium and thick bedded, as Unit 1. Rare beds with floating flat pebbles of dolomite. — 18.5 — 29.8

Unit 3 forms the base of the main cliff of the Risky Formation

2 Recessive weathering, poorly exposed. Shale: dark grey, with one or two medium beds of sandstone, as below — 2.2 — 11.3

1 **Dolomite** and **sandstone.**

Dolomite (50%): pale grey, fine crystalline, sandy (a minor content of well rounded, medium and coarse quartz grains increases upward); apparent, relict ooids; thick bedded, massive, weathering pale pinkish grey. Stylolites are strongly developed, and marked by concentrations of quartz.

Sandstone (50%): thick beds as Unit 19, below, with minor quartzite. — 9.1 — 9.1

Unit 1 forms a resistant rib.

Contact conformable and interbedded.

Blueflower Formation

The Blueflower Formation is mainly recessive weathering, forming largely talus-covered slopes that share the colour of the dominant dark mudrocks of the formation. Continuous outcrops are found only along gulleys.

19 **Sandstone** and **shale.**

Sandstone (55%): pale grey, fine grained, very well sorted, medium and thick bedded, mainly plane-parallel laminated; carbonate cemented; weathers brown.

Shale (45%): dark grey to black, flaky. — 18.8 — 450.1

A semi-recessive weathering unit

18 **Sandstone:** pale grey, thick and medium bedded, flaggy and massive; dolomite cemented, weathering dull orange. Grain size is characteristically bimodal; a sub-mode of medium grains in a dominant fine to very fine grained population, or, higher, a sub-mode of coarse grains and granules in a medium grained population. Plane-parallel lamination is prominent, but tangential crosslamination, in 10 cm sets, also occurs; scour-and-fill on a decimetre-scale is common. Partings of shale, as below, are minor and local — 8.2 — 431.3

Dolomite (grey, fine crystalline) occurs in two, thick, massive beds with 30 to 40 per cent bimodal quartz sand and granules. Trace fossils: "trail-of-pellets"; straight feeding trace; cf. *Phycodes* sp. (not *P. pedum*)

Bedding attitude: strike 013°, dip 29°east

17 **Shale** and **sandstone.**

Shale: as below

Sandstone: 10 per cent in lower quarter, increasing to 40 per cent in the upper quarter; partly quartzitic, partly dolomitic, as Unit 15, mainly in medium beds, but thickening upward to medium and thick bedded.

In the top 2 m, angular mudcracks (synaeresis?). A few, thin convoluted beds; sole marks (flutes, grooves) persist to the top.

At the base, several beds or amalgamated beds to 1 m thick. Although parallel lamination and low-angle crosslamination (antidune?) dominate, a few, graded beds are Bouma AB units — 41.3 — 423.1

Base of unit is a 1 m thick, massive debris-flow breccia

16 **Shale** and **sandstone.**

Shale: dark grey, brown weathering, fissile. At the base, sandstone is 25 per cent, in laminae and very thin beds; mainly very fine grained and dolomitic, but a few beds carry some coarse grains. Sandstone decreases upward to less than 5 per cent. — 61.7 — 381.8

Rare pockets (decapitated load casts) of **sandstone:** 39 m above the base, there is a lens, 1 to 2 m thick, of contorted, sandy, interlaminated limestone and dolomite. This is partly in continuous folds, partly in disoriented blocks. The mass ends abruptly southward. Numerous slide-surfaces and folded slump-masses are also present.

A subunit, 47 to 54.5 m above the base, has 10 per cent sandstone beds.

Upward line of measurement is offset two gullies southward, to obtain better exposures, from Unit 15 to Unit 16.

15 **Shale** and **sandstone.**

Shale: dark grey and black, pyritic

Sandstone (10%): medium and minor thick beds; as Unit 13, but with orange weathering dolomite cement; some of these beds have quartz granules at their bases. Many of these turbiditic sandstone beds have suffered folding through post-depositional creep or flowage. Groove casts and flame structures are present — 9.4 — 320.1

(Units 14 and 15 form a coarsening-upward, thickening-upward cycle).

14	Mainly **shale** and **mudstone**, dark grey, pyritic. Sandstone beds form less than 5 to 40 per cent in various subunits. These beds are mainly thin and very thin, Bouma AB units; fine and very fine grained beds dominate, with rare thin and medium beds that are coarse grained. Many sandstone beds are tabular, but more are "beaded", lenticular, and discontinuous. A few thin sandstone beds are folded into pseudonodules. One exotic boulder is present. At the top, a 20 cm bed of massive mudstone with quartz granules – a resedimented bed. Slide surfaces and contorted slide-masses are fairly common in mudrocks throughout the unit	52.8	310.7
13	A unit of mainly **shale**, as below, characterized by its content (about 10%), of medium and rare thick beds of grey, quartz sandstone. These sandstone beds are normally graded, mostly coarse grained at the base, fine grained at the top (Bouma A units); rip-up clasts of shale are prominent, and generally concentrated in the tops of the beds. Thin and very thin beds of sandstone (as below) make up 5 to 60 per cent of various subunits. Rare flute- and groove-casts are present	29.0	257.9
12	**Shale** and **sandstone.** Mainly dark grey, silty shale. Thin sandstone beds (as below), commonly beaded, make up less than 10 per cent of the unit. Many slide surfaces and slump folds are present	21.0	228.9
11	Dark grey **mudstone** and **shale**, with subordinate sandstone. Especially near the base, the mudrock is nonfissile mudstone, probably because it is resedimented. Sandstones (10%) in the lower two thirds are mainly thin beds. Upward, sandstone increases to 40 per cent, with some medium beds, and, at the top, a thick bed (thickening-upward sequence). Especially in the lower part, sandstones are full of rip-up clasts, and their bases are so intensely load-casted as to be indefinite. Many of these thin beds are further contorted by sliding, and isolated, balled-up sandstone masses (pseudonodules) occur. Near the top, the sandstones are Bouma AB or B units, with flute-, groove- or load-casts on their bases. An isolated boulder of thrombolitic (?) dolomite occurs 23 m above the base	31.5	207.9
10	A unit consisting of upper and lower **paraconglomerates** (matrix-supported, bouldery debris-flows), separated by a 3 m thick subunit of dark grey **shale** with several thin **sandstone** beds. The boulders are polymict, but mainly carbonates; many are of stromatolitic dolomite (LLH pseudocolumns and short, true columns) and a few are of thrombolitic dolomite; many are intact, small bioherms; others are of sandy lime grainstone and coarse, calcareous sandstone. The largest boulder seen has a greatest dimension of 2.3 m. The matrix is scaly mudstone with flakes of carbonaceous shale and disrupted sandstone beds	10.2	176.4
9	Unit gradational from underlying units with bedded carbonates to overlying, purely siliciclastic units. In a matrix of shale as below, limestone beds (silty) drop out progressively upward. Upward line of measurement is offset to next gully S, to reach more continuous exposure, from Unit 8 to Unit 9	4.0	166.2
8	Recessive weathering, poorly exposed in upper part. **Limestone** and **sandstone:** as Unit 7, with the addition of 30 per cent of thin and medium beds of grey, fine grained, very calcareous, quartz sandstone, and very sandy limestone. These are planar bedded, planar laminated beds, with minor, low-angle cross-stratification	13.2	162.2
7	**Limestone:** thin and minor medium bedded, partly lenticular, sandy, lime mudstone. These are turbidites; the small content of fine grained quartz sand is supply-graded. From 5 m above the base upward, a small content, less than 5 per cent, of thin and very thin beds of calcareous quartz sandstone occur; these beds form parallel laminated Bouma B and BC units; a few have bases load-casted into underlying lime mudstone Bedding attitude: strike 154°, dip 24° northeast	21.7	149.0
6	**Limestone** and **shale.** At the base, shale (60%), limestone (40%), grading to limestone (60%), shale (40%) at the top. **Limestone:** dark grey lime mudstone in very thin beds and laminae, planar bedded. **Shale:** dark grey, calcareous, fissile. Rare very thin beds and lenses of very fine grained quartz sandstone	20.6	127.3
5	Recessive weathering, poorly exposed **shale** (as below)	7.5	106.7
4	**Sandstone** and **shale.** **Sandstone (90%):** as below, medium and thin bedded, partly lenticular, commonly with erosional bases with flute- and groove-casts, mainly Bouma AB units. **Shale (10%):** as below Unit commences at the channelled, erosional base of a 75 cm sandstone bed	9.5	99.2
3	**Shale** (as below) and **sandstone.** At the base, shale 95 per cent, sandstone 5 per cent, grading upward to 70 per cent : 30 per cent at the top. Sandstone is in thin and very thin beds, nearly all graded Bouma AB and BC turbidites; bedding is planar and persistent	10.7	89.7
2	**Sandstone** and **shale.** **Sandstone (70%):** calcareous, in medium and thin, graded Bouma AB units, fine to medium grained at their bases, very fine grained at their tops. Rip-up clasts common; a few beds are breccias. A few slump-folds, flute- and groove-casts. **Shale (30%):** dark grey, fissile Hypichnial traces, cf. *Torrowangea* sp., are present. At the gradational, basal contact, limestone beds drop out over one or two metres.	37.0	79.0
1	**Limestone:** dark grey lime mudstone, in thin and very thin beds and laminae; bedding is lenticular in part. Upward, partings of dark grey calcareous shale appear and increase. In the top 6 m, laminae of calcareous, very fine and fine grained, crosslaminated sandstone. Moderately recessive weathering, about 8 m covered in middle of unit. Trace fossils: cf. *Torrowangea* sp., common; cf. *Planolites* sp., in float only. Abrupt, concordant contact.	42.0	42.0

Gametrail Formation

Uppermost beds are dolomite, medium and thick bedded, with strong development of "presquilite" (see description of type Gametrail). These dolomite beds overlie ribbon-bedded, dark grey lime mudstone.

Bedding attitude: strike 165°, dip 23°east.

Risky Formation

Definition

The name Risky Formation is proposed here for a mappable, resistant, feature-forming unit of dolomite, sandy dolomite, dolomitic sandstone, sandstone and minor shale, that conformably overlies the Upper Proterozoic Blueflower Formation, and is unconformably overlain, wherever studied to date, by strata correlative with some part of the (?)uppermost Proterozoic and Lower Cambrian Backbone Ranges Formation.

Origin of name

The formation is named after Risky Peak, an eye-catching peak, elevation 2100 m-plus, that overlooks a pass between the drainage of Sekwi Brook and Gametrail Creek (Fig. 2). The peak is composed of Risky Formation.

The name Risky Peak is new, and appears on the 1985 edition of the 1:250 000 scale topographic map of the Sekwi Mountain map area.

Type section

The type section of the Risky Formation (in original notes, the upper part of Section 81AC-9) is continuous with the type section of the Blueflower Formation, in the Sekwi Brook area of northeastern Sekwi Mountain map area (Fig. 8). The mid-point of the section is at latitude 63°21'10"N, longitude 128°38'00"W. The section was chosen because of the superior preservation of protolith fabrics in the dolomites. A thicker section (167 m versus 114 m) is present 3 km south of Risky Peak, but preservation of protolith fabrics there is poor. The description of the type section of the Risky is appended to that of the type Blueflower Formation, above.

Description

The Risky Formation is a resistant unit composed of dolomite, sandy dolomite, dolomitic sandstone, sandstone and minor shale. In the Sekwi Brook area, the dominant weathered colour is pale pinkish orange ("peach-coloured"), but, in the June Lake panel farther west, where sandstone and quartzite are dominant and the carbonate beds are limestone, the formation weathers pale grey.

Protoliths of the characteristic, fine and very fine crystalline, thick bedded, massive dolomites, which mostly have a significant content of quartz sand (locally granules), include oncoid wackestone/floatstone, algal stromatolites, and minor fenestral lime mudstone with teepee structures. A common kind of dolomite bears a multitude of millimetre-scale, "sorted", perfectly smooth-walled, spherical and ovoid vugs; these appear to be leached ooids, and indeed, oolitic dolomite has been seen locally.

The sandstones are mainly fine grained; uncommon, coarser beds range up to very coarse grained sandstone and grit. They are mainly medium and thick bedded, with both plane-parallel lamination and crosslamination. A peculiarity of the formation is the presence at several levels of algal stromatolites composed of dolomitic sandstone. The dolomite-cemented beds weather pale orange; those cemented with a ferrous carbonate weather brown.

Although many of the thick dolomite and sandstone beds display internal primary structures, many do not. These latter may be resedimented beds. Consistent with this idea is the observation that the basal beds of the formation change markedly from place to place, which suggests that these may be deposits avalanched down the front of a prograding carbonate platform.

An erosional surface at about the middle of the formation has been recognized at two sections in the Sekwi Brook area. In the type section, this erosion surface forms a gully (cut in sand prior to consolidation?) that is at least 2.6 m deep.

A distinctive unit of breccia is common to the Sekwi Brook and southern June Lake panel areas. It consists of angular, decimetre-scale and larger blocks of dolomite and sandstone in a matrix of sandstone that is partly crosslaminated and partly contorted and slump-folded. This appears to be a slide-mass of extraordinary extent, that has not completely lost coherence. It is excellently exposed in the topographically lowest outcrops immediately north of Risky Peak (Section 81AC-14, Fig. 8) where it is 8 m thick.

In the June Lake (south) structural panel, quartz sandstones, including quartzites, are more abundant than limestone and dolomite; however, a slightly recessive weathering "break", containing grey shale, is present there, as in the Sekwi Brook area. Stromatolites are inconspicuous in the western section.

Interestingly, pyrobitumen is present in intercrystalline porosity in the Risky in the June Lake panel. The probable source is the Blueflower Formation.

Boundaries

The lower contact of the Risky Formation is interbedded and conformable. It is drawn where thick, massive beds of dolomite and/or sandstone assume clear dominance over mudrocks.

The upper contact of the Risky Formation is erosional at every section examined. In the Sekwi Brook area, the contact is a strongly developed, karstic weathering surface. The overlying formation, in the view of Fritz (1982) is the upper member of the Backbone Ranges Formation. The writer prefers the interpretation that the overlying formation is the Backbone Ranges, entire, but lacking lower, middle and upper divisions. Neither interpretation can yet be proved conclusively.

In the June Lake structural panel, the karstic features at the top of the Risky are feebly developed. The overlying formation is the Ingta, viewed by Fritz et al. (1983) as a lower submember of the upper Backbone Ranges Formation. The writer prefers the interpretation that the Ingta is either an equivalent of the basal Backbone Ranges or a pre-Backbone formation.

Historical background

The sparse previous references to the unit here named Risky Formation (Fig. 7) identify it as Map unit 11 (of Blusson, 1971). Blusson described and mapped, but did not interpret the unit, and neither noted nor mapped its presence in the June Lake anticline. Fritz (1982) equated Map unit 11 with the middle (carbonate) member of the Backbone Ranges Formation. Fritz et al. (1983) and Aitken (1984) concurred in recognizing Map unit 11 in the Goz Creek - Corn Creek area of the eastern Wernecke Mountains. Fritz et al. tentatively suggested a thin limestone unit identified near Gull Lake, deep in Selwyn Basin, as equivalent to Map unit 11, but Aitken, referring to the westward disappearance of Map unit 11 between the east and west limbs of June Lake anticline, expressed doubts about that correlation. Narbonne et al. (1985) recognized that at Goz Creek – Corn Creek, Map unit 11 comprised two dolomite units with intervening clastics.

Dimensions

Because of apparent southwestward depositional pinchout and northeastward erosional bevelling at one or more subsequent unconformities, the Risky Formation can be studied at few localities. In the Sekwi Brook area of Sekwi Mountain map area, its preserved thickness varies from less

than 114 m (type section) to at least 167 m. In the June Lake anticline, its thickness in the east limb is 84 to 97 m, but it is missing in the west limb, apparently by downslope, depositional pinchout. In central Nadaleen River map area, the most recently assigned boundaries of Map unit 11, that is, the Risky Formation, enclose 342 m of strata (Narbonne et al., 1985).

Thick dolomite and sandy dolomite occur in the cores of South Nahanni (500 feet/152 m) and Broken Skull (more than 1000 feet/305 m) anticlines. These strata were tentatively assigned to the middle member of the Backbone Ranges Formation by Gabrielse et al. (1973). Fritz (1982) concurred with that assignment and equated the middle Backbone Ranges with Map unit 11 (Risky Formation). The writer's doubts about that correlation are expressed on a preceding page.

Age

From its position relative to underlying and overlying fossiliferous formations, the Risky Formation is either latest Proterozoic (Ediacaran) or, less probably, earliest Cambrian. The only fossils yet recovered from it are the trace fossils *Planolites* sp., and cf. *Torrowangea* sp. or cf. *Gordia* sp.

The conformably underlying Blueflower Formation contains elements of an Ediacaran fauna (Hofmann, 1981). Trace fossils and shelly fossils in the overlying Ingta Formation may be either latest Proterozoic or earliest Cambrian, possibly "pre-trilobite".

Correlation

The Risky Formation (as Map unit 11) has been recognized at a few, widely spaced localities in the interior Mackenzie and easternmost Wernecke mountains, where it has been spared by eastward, erosional bevelling beneath younger formations, but has not yet changed facies southwestward to presumed siliciclastic equivalents that are part of the regional 'Grit unit'. In the present state of knowledge, correlation beyond the immediate region is unjustified.

Genesis

In the Sekwi Brook area, the Risky Formation is a typical "platform carbonate" unit interleaved with sandstones. Most of it appears to have been deposited in clear, shallow water, and in the case of the fenestral beds, probably intertidally, but the apparently resedimented beds, if correctly interpreted, could have been deposited finally in slightly deeper water at the platform edge.

The formation as seen in the June Lake panel may have been deposited in slightly deeper water, on average, than at Sekwi Brook, but the stromatolites at the top must have been built within the photic zone.

The gullied, erosional surface within the formation records an episode of lowered sea level that interrupted the accumulation of the formation on the platform.

Ingta Formation

Definition

The name Ingta Formation is proposed here for a mappable unit of distinctively coloured shale, with subordinate beds of sandstone, and, at the top, a limestone member (informal). It is neither recessive weathering nor a feature-former, except for the limestone member. It overlies the uppermost Proterozoic Risky Formation at an erosional surface, and underlies another erosional surface overlain by a quartzite-dominated unit that corresponds to the Backbone Ranges Formation or some part (upper member?) thereof.

Origin of name

The formation is named after the Ingta River, a tributary that joins Keele River 25 km west of the type section.

Type section

The type section of the Ingta Formation (Fig. 4), designated in field notes as Section 81AC-15, is in the overturned, east limb of the major anticline passing through June Lake ("June Lake anticline"), 9 km south of Keele River, at latitude 63°21'10"N, longitude 128°38'00"W. This corresponds closely to Fritz's (1979) Section 35.

Description

The shales of the Ingta Formation are mainly a distinctive green colour ("apple green"), with intervals of purple-red, and have a strongly developed platy fissility. Sandstones and minor quartzites are thin, very thin, and medium bedded, with rare thick beds; they are pale brown, green, and pale grey, and almost entirely very fine and fine grained, weathering mainly brown. The dominant primary structures are plane-parallel lamination and low-relief linguoid ripple marks, with a few groove casts and rare flute casts. A few beds display coarse-mode supply grading. Slump-folds are rare.

The limestone (locally, dolomite) member at the top of the formation consists of a lower unit of mainly pale-pellet grainstone, a middle unit of sandstone with minor limestone, and an upper unit almost entirely of stromatolitic limestone and dolomite.

In the June Lake panel, trace fossils are abundant and well preserved on bedding planes of both the green and the purple-red, platy shales.

Boundaries

The basal contact of the Ingta Formation, where it overlies carbonate rocks and carbonate-cemented sandstones

of the Risky Formation, is abrupt. Locally, near the type section, a weakly developed, karstic erosional surface is evidenced by mudstone-filled solution openings in the Risky. Near the type section, rapid lateral variation in the thickness of the upper part of the Risky Formation (above the recessive weathering, middle unit of sandstone and shale) suggests that erosion of the Risky Formation may have been significant. In the west limb of June Lake anticline, opposite the type section, the contact is concordant, based mainly on mudrock colour, and may be conformable.

The upper contact is with orthoquartzites of the Backbone Ranges Formation (according to the author), or the upper submember of the upper Backbone Ranges Formation (the alternative interpretation of Fritz et al., 1983). The thickness of the limestone member displays rapid, lateral variation and the presence of a quartzite-filled channel, 4.5 m deep, suggests that this variation is due to erosion.

Historical background

The Ingta Formation has been studied only in Sekwi Mountain map area, and only in a succession that includes distinctive formations of platformal origin. Strata of virtually identical rock type, with trace fossils, are known from the basin west of the June Lake anticline, but it is as yet premature to extend the formation name there. Accordingly, these strata comprising the new Ingta Formation, have received little mention in the literature (Fig. 7).

Blusson (1971) drew the base of his Map unit 12 so as to include the varicoloured Ingta beds within that unit, but did not describe these distinctive strata in his text. Fritz (1982) and Fritz et al. (1983) equated Map unit 11 (Risky Formation) with the middle (carbonate) member of the Backbone Ranges Formation, and, *ipso facto*, Map unit 12, including the Ingta, with the upper Backbone Ranges. The Ingta thus became the lower submember of Map unit 12, and was viewed as a deeper water facies of the upper Backbone Ranges Formation, transitional to the basinal facies to the west, where all of the thick quartzites of the type Backbone Ranges Formation have passed to mudrock-dominated equivalents. Aitken (1984) questioned that correlation, and suggested alternatives: the Ingta ("variegated formation") might be a facies of the basal Backbone Ranges; or, alternatively, might underlie the Backbone Ranges unconformably, and be missing from the Sekwi Brook area and all of the country cratonward because of erosional truncation beneath the Backbone Ranges Formation.

Dimensions

The Ingta Formation is 256 m thick at the type section, in the east limb of June Lake anticline, and 220 m in the west limb, directly opposite; the limestone member thins from 39 to 5 m between the same points. The extent of the formation, though obviously limited, is unknown, because it has been included previously with other units in the course of mapping.

Age

The Ingta Formation is earliest Cambrian at its top, but may include beds of latest Proterozoic age. The limestone member at its top has yielded a single specimen of the protoconodont *Protoherzina* cf. *P. anabarica* [Conway Morris and Fritz, 1980; the source was reported as Map unit 11 (Risky Formation)]. Conway Morris and Fritz (*op. cit.*) suggested that this occurrence indicates a position near the Precambrian-Cambrian boundary.

A further occurrence of *P. anabarica*, 7 m above the base of beds here referred to the Ingta Formation, has been reported [Nowlan et al. (1985), GSC loc. 99169, plotted on Section 11a, Fig. 44.2b, of Fritz et al. (1983)]. In discussion, Nowlan et al. (*ibid.*) assign *P. anabarica* to a position in the Precambrian-Cambrian transition interval, but below the base of the Cambrian as currently proposed for the candidate boundary stratotype in China.

From the suite of trace fossils collected from the type section of the Ingta Formation, H.J. Hofmann and G. Narbonne reported the following (written comm., 1982), the more significant of which are illustrated in Figure 6 (E to H):

Planolites sp. (GSC locs. C-94060, C-94099, C-94090)

Scolicia sensu lato (GSC loc. C-94090)

"*Neonereites*-like trails" cf. Brasier and Hewitt (1979) (GSC loc. C-94090)

grooves connected to pits

bilobate impressions; may be related to *Scolicia* (above)

Cochlichnus serpens Webby (1970) (GSC loc. C-94086)

cf. *Harlaniella podolica* in Pallii et al. (1976) (GSC loc. C-94088)

Hofmann and Narbonne commented as follows: "None of the above are age diagnostic. They could occur on either side of the Cambrian-Precambrian boundary. They are similar to forms reported from Later Proterozoic – Cambrian beds elsewhere . . . The absence of scratch marks (arthropods) (except for the bilobate marks that remotely resemble some cruzianids) is noteworthy in this lithofacies, perhaps suggesting a position below trilobites, though not necessarily Precambrian".

Correlation

Only local problems of correlation of the Ingta Formation are considered here.

The most pressing problem concerning correlation of the Ingta is: to what part, if any part, of the Backbone Ranges Formation (Gabrielse et al., 1973) does the Ingta Formation correspond? Fritz and co-workers view the Ingta as a facies of part of the upper member of the Backbone Ranges. The writer considers that it may be a facies of the lower member, or alternatively, a formation entirely "pre-Backbone Ranges" and overlain unconformably by that formation. This question is not yet resolved.

The second problem of correlation is: to what part of the basinal 'Grit unit' to the west does the Ingta correspond? Numerous geologists have noted the similarity of purple-red shales in the 'Grit unit' to the most characteristic rocks of the Ingta Formation, and, certainly, the specimens of the trace fossil *Oldhamia* sp. from Selwyn Basin sections seen by the writer (see Hofmann and Cecile, 1981) are in purple-red shales of lithology identical to trace-fossil-bearing beds of the Ingta. Purple-red shales occur in the 'Grit unit' at more than one level, however (Fritz et al., 1983), and the question as to which of these, if any, corresponds to the Ingta Formation, remains open.

Genesis

The only indicators of "shallow water" deposition seen in the Ingta Formation are the pale-pellet grainstones and algal stromatolites in the limestone member at the top. The shales with abundant trace fossils indicate an environment of low turbulent energy, and, probably, rather slow deposition. The quartzose sandstone beds may be turbidites, but, if so, bear only faintly the stamp of such emplacement; more probably, they are subtidal storm deposits. As a whole, the formation is a shallowing-upward, clearing-upward cycle that probably originated on the outer shelf.

Section 81AC-15

Type Section of the Ingta Formation
(Latitude 63°21'10"N; longitude 128°38'00"W)

Note: Because the strata are overturned, the section was measured stratigraphically downward. The order of units is presented conventionally here, and is thus reversed from the order in the original field notes. Trace fossil identifications by H.J. Hofmann and G. Narbonne are marked with an asterisk.

Unit No.	Description	Thickness in metres: Unit	Total from base
	Map unit 12 (of Blusson, 1971)		
	Backbone Ranges Formation(?) (Described from offset section on next spur south of 81AC-15)		
5	**Quartzite:** very thick bedded, white weathering. Section continues upward		
4	**Sandstone:** as Unit 1, but somewhat thicker bedded on average. From 60 m above base upward, includes massive, medium and thick beds of quartzite, greenish grey, very fine grained, white weathering (where not lichenous)	85.0	156.5
	Trace fossils from 5.5 m above base (C-089433): cf. *Planolites* sp. (4 mm diam.) cf. *Phycodes* sp. (not *P. pedum*)		
3	A resistant member, weathering pale grey and orange-rusty. **Dolomite:** grey, partly sandy, orange weathering; and **limestone:** grey, particulate texture. Both are thick bedded, massive. Basal 2 m is quartzite: grey, fine grained, thick bedded, massive	11.5	71.5
2	**Sandstone:** as Unit 1, but lacking shaly beds	16.5	60.0
1	**Sandstone:** pale brown, fine grained, well sorted, cemented by ferrous carbonate, partly pyritic; very thin to thick bedded, mostly apparently structureless, with local trough (?) crossbedding; weathers grey, rusty, lichenous. Minor subunits of sandstone; shaly, olive to pale brown, weathering pale brown	43.5	43.5
	Interval 25.5 to 28 m above base contains intensely bioturbated thin beds, with cf. *Planolites* sp. (4 mm diam.), cf. *Torrowangea* sp. (1 mm), and cf. *Phycodes* sp. (not *P. pedum*; 4 mm diam.)		
	Erosional contact. At the southward offset line of measurement, an erosional channel, 4.5 m deep, filled with quartzite, is cut into the underlying limestone.		
	Ingta Formation		
	Limestone member (Units 4, 5, 6)		
	The limestone member weathers pale grey to yellow-grey, and is more resistant than underlying units.		
6	**Limestone and dolomite:** stromatolitic. Continuous, stacked biostromes of columnar, rarely branching stromatolites, heights up to 25 cm, column diameter 2 to 8 cm	24.0	256.5
5	**Sandstone** and **limestone.** **Sandstone (80%):** very fine grained, very well sorted, medium and thin bedded, mostly plane-parallel laminated, partly calcareous and dolomitic, weathers brown, grey, lichenous **Limestone (20%):** as Unit 4, occurs as 1 m and 0.5 m beds in the lower half	7.5	232.5
4	**Limestone:** dolomitic, siliceous, nodular, thin bedded, scaly to massive, weathers hackly yellow-grey. Mostly pale-pellet grainstone; pebbles of limestone in the basal bed	7.5	225.0
3	**Sandstone** and **shale.** **Sandstone (60%):** brown-grey, green-grey, very fine grained, very well sorted, thin and minor medium planar-bedded **Shale (40%):** brown, green-grey, silty, sandy, platy All fresh bedding surfaces are green. Unit weathers green, brown, lichenous	40.5	217.5
	31.5 and 7.5 m below the top, trace fossils, including cf. *Torrowangea* sp., cf. *Phycodes* sp. (2-3 mm diam.; not *P. pedum*), cf. *Planolites* sp. (2 mm diam.), and straight feeding trace (2 mm diam.)		
2	**Shale** and **sandstone.** **Sandstone (50%):** mainly dark green with purple-red partings, very fine grained, very well sorted; thin and very thin, rarely medium bedded; linguoid current ripple marks widespread, rare groove casts **Shale (50%):** mainly green, with 15 per cent greyish purple-red to purple-red; platy	90.0	177.0
	Trace fossils abundant: At the top, C-94084, *Planolites* sp.* 19.5 m below the top, C-94086, *Cochlichnus serpens** 54 m below the top, C-94087, *Planolites* sp.* 79.5 m below the top, C-94088, cf. *Harlaniella podolica**		
1	**Shale** and **sandstone.** **Shale (90%):** mostly pale greyish green, 20 per cent purple-red; silty, sandy; platy **Sandstone (10%):** green, mostly very fine grained, in massive, medium beds, some showing subtle normal grading (supply grading of coarse mode); load-casted linguoid current ripple marks, one slump-fold at base	87.0	87.0
	Trace-fossils as in Unit 2: 30 m below top, C-94089, "trail-of-pellets" From basal 4 m, C-94090, *Planolites* sp.,* "*Neonereites*-like trails",* *Scolicia* (sensu lato),* grooves connected to pits, bilobate impressions		
	On the line of section, the contact is abrupt and concordant. On second spur south of this line, the contact has 25 cm of erosional relief, and irregular veins and pockets of shale penetrate downward up to 2.1 m from the contact.		
	Risky Formation		
	The Risky Formation is moderately more resistant than the Ingta above, and much more resistant than the Blueflower below, forming prominent, pale grey outcrops.		
5	**Limestone:** dark grey, very sandy (medium to very coarse, well rounded, quartz sand), weathers pale grey, massive, resistant; planar crosslaminated in sets 10 to 30 cm thick; texture is fine crystalline, with a relict grainstone texture	7.0	97.5
4	**Sandstone (quartzite):** pale grey, very pale brown, very fine grained, well sorted, weathers mainly near-white, minor brown; thin- and medium-bedded, plane-parallel laminated, mainly flaggy. Minor intervals of calcareous sandstone/sandy limestone and dolomite, as Unit 5. Very minor interbeds of dark grey, silty shale	23.5	90.5

3	Shale and sandstone. **Shale (60%):** grey to black, weathering dark grey, locally rusty; perfect to irregular platy fracture **Sandstone (40%):** partly as Unit 4, in very thin to medium, rarely thick beds, but largely grey to dark grey, argillaceous, very thin bedded and laminated, intergrading with shale	24.8	67.0
	Trace fossils, cf. *Planolites* sp., rare but well preserved (not collected)		
2	Sandstone and limestone. At the top, a massive non-bedded, limestone pebble to cobble conglomerate, possibly a debris-flow Lower **sandstone (85%):** dark grey, very calcareous, fine- and very fine-grained, in medium, thin and very thin beds, mainly plane-parallel laminated, flaggy, with silicified laminae **Limestone (15%):** dark grey, massive, with traces of relict grainstone texture	30.0	42.2
	21 to 24 m below the top is breccia, blocks of limestone supported by a matrix of contorted, laminated sandstone – a slide-mass(?)		
	On top of this 3 m breccia is a monomict, tabular-clast breccia of clasts of laminated sandstone. Below the 3 m breccia, confused, fragmental beds are common, with some warped bedding – slide-masses(?)		
1	Interbedded sandstone and quartzite. **Sandstone (80%):** laminated, as Unit 2. **Quartzite (20%):** grey, very fine grained, silicified, in planar, very thin beds	12.2	12.2
	Near the base, minor beds of dark grey, platy siltstone. (Unit thickness is approximate because of downslope creep)		
	Contact covered, apparently interbedded.		

Blueflower Formation

Dark grey mudrocks with sandstone beds, poorly exposed here. See Section 81AC-16.

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APPENDIX 1

Locality Data

GSC Loc. No.	Section	Formation	Metres above/below base/top
C-94060	Section 79AC-24, Sekwi Brook 63°21'10"N; 128°24'52"W	Blueflower	basal 9.5 m
C-94062	Section 79AC-24, Sekwi Brook 63°21'10"N; 128°24'52"W	Blueflower	62.3 m above base
C-94086	Section 81AC-15, June Lake panel, south 63°21'10"N; 128°38'00"W	Ingta	99 m below top
C-94088	Section 81AC-15, June Lake panel, south 63°21'10"N; 128°38'00"W	Ingta	159 m below top
C-94090	Section 81AC-15, June Lake panel south 63°21'10"N; 128°38'00"W	Ingta	basal 4 m
C-94099	Section 81AC-16, downward continuation of 81AC-15 (above) 63°21'50"N; 128°40'00"W	Blueflower	local float from Unit J, 162-203 m below top

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