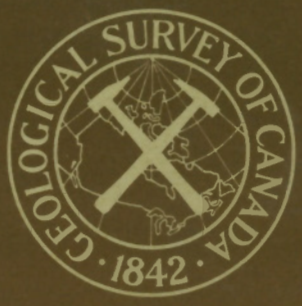

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ALEXO EQUIVALENTS IN THE JASPER REGION, ALBERTA

(Report, 4 figures, appendix)

D. J. McLaren and E. W. Mountjoy

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By

D. J. McLaren and E. W. Mountjoy

D E P A R T M E N T O F

M I N E S A N D T E C H N I C A L S U R V E Y S

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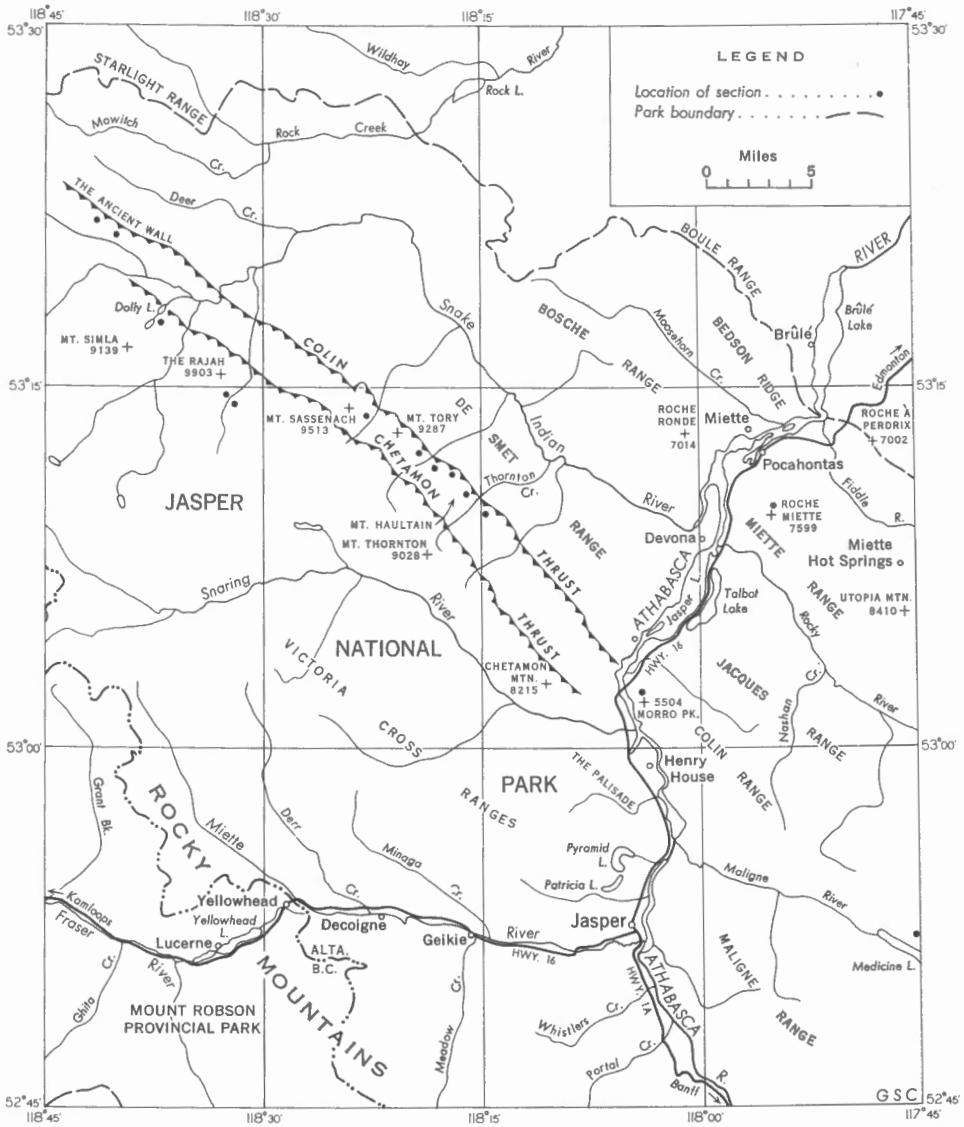

Figure 1. Index map showing locations of stratigraphic sections discussed in text

ALEXO EQUIVALENTS IN THE JASPER REGION, ALBERTA

INTRODUCTION

This summary account makes available some of the more important stratigraphic and palaeontological data and conclusions concerning beds assigned to the Alexo Formation in the Jasper area. These will be published in greater detail in a future report. In order to present a more meaningful stratigraphic classification it is necessary to revise the terminology of the beds in this interval. Type sections are described for the Sassenach Formation and the Simla and Ronde Members of the Southesk Formation.

The earlier history of terminology of the Devonian rocks of the Alberta Rocky Mountains has been summarized by Fox (1951)[1] and McLaren (1953). Beach's (1943) Fairholme Formation, modified by deWit and McLaren (1950), and now commonly considered a group, remains a generally recognized major unit for the lower part of the succession. Southeastward to Bow Valley from its type section at North Saskatchewan River Gap in Brazeau Range, the overlying Alexo Formation is also a distinct and easily recognized mappable unit. To the northwest of the North Saskatchewan, however, little unanimity has existed until now on the means of subdividing, naming, and correlating the beds immediately overlying the Fairholme.

In summary: McLaren (1956) suggested correlation of the unfossiliferous type Alexo with a sequence of beds that is fairly easily distinguished from the underlying Fairholme Group and overlying Palliser Formation northwestwards along the Front Ranges to Roche Miette. He recognized two informal members within this interval. In the vicinity of Cardinal Mountain this sequence is fossiliferous, and westwards across the ranges to Medicine Lake it thickens rapidly and becomes increasingly fossiliferous, carrying an early Famennian brachiopod fauna (McLaren, 1956, fig. 3; 1959, fig. 7).

Taylor (1957) and Hargreaves (1959) claimed that the thick "Alexo" of, e.g. Medicine Lake or Rocky Forks, was a lateral facies equivalent of the upper part of the Fairholme Group of, e.g. Roche Miette, which carries a coral and brachiopod fauna indicating a Frasnian age. This McLaren (1959) denied on palaeontological grounds, as the thick "Alexo" (here included in the Sassenach Formation) contains Famennian brachiopods.

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[1] Dates or names and dates in parentheses refer to publications listed in the References.

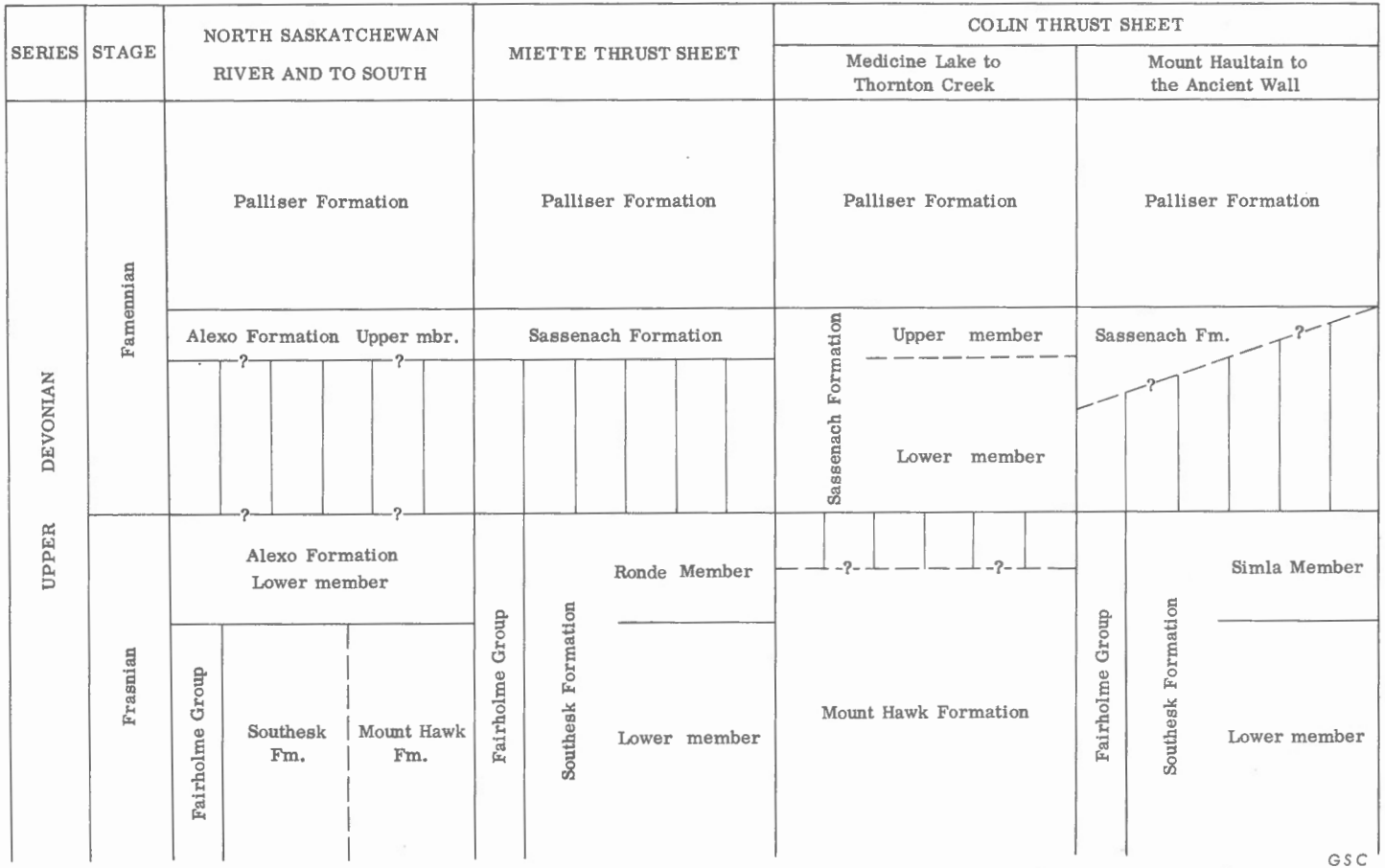

Figure 2. Formational terminology

In Miette Range, Mountjoy (1960a, 1960b) also found the Alexo Formation to be divisible into two members, with the base generally in sharp contact with underlying limestones of the Southesk Formation. However, he found that the lower member (Ronde Member of this paper), when traced southeastward, graded into fossiliferous, argillaceous limestones of the Mount Hawk Formation. This and other stratigraphic and faunal evidence caused McLaren (1959) to suggest a revision of the Alexo Formation, and to exclude the lower member of some sections.

Earlier, during the summer of 1951, McLaren examined and described several Devonian sections northwest of Jasper and had considerable difficulty in distinguishing a boundary between the Palliser and Southesk Formations, as no distinct Alexo-like lithologies intervened. In 1959 and 1960 Mountjoy mapped parts of this region and also experienced difficulty in determining the position of this boundary (Mountjoy, 1962a). He observed, however, that a thin, widespread, recessive unit (base of Simla Member of this paper) consisting of silty and argillaceous carbonates occurred close to the expected stratigraphic position of the Alexo Formation. A brief reconnaissance examination of Mount Haultain suggested that a thick "Alexo" thinned and graded northwestward into Southesk limestones and that the conspicuous recessive interval referred to above was a thin tongue of the thick "Alexo". This suggested correlation again appeared to indicate that strata with Frasnian fossils graded laterally into beds with Famennian fossils—a very anomalous situation. In order to check these correlations and to obtain critical and more detailed stratigraphic data, the key Mount Haultain area and adjacent areas were again visited by McLaren and Mountjoy in 1961.

It had previously become clear that unless a meaningful rock-stratigraphic classification in the disputed interval was achieved, the argument concerning time correlation by fossils could hardly be resolved. As described in this report, the rocks and their contained fossils in the Mount Haultain area gave the clue to the sequence of events that had occurred between the deposition of the Fairholme and Palliser Formations (see Fig. 2).

Southeast of Mount Haultain, a thick "Alexo" sequence overlies a thin tongue of Southesk, that is in turn underlain by a shaly facies of the Mount Hawk and Perdrix Formations. On Mount Haultain itself, the change from argillaceous Mount Hawk and Perdrix to a thick carbonate sequence of Southesk and Cairn takes place rapidly, and the intertonguing relations are well exposed (Mountjoy, 1962a). The "Alexo" (Sassenach Formation of this report), however, thins rapidly against this carbonate mass, changing from 600 feet to a few feet in less than 2 miles. Nowhere does it interfinger with the Southesk, but it overlies the Southesk with a sharp contact and abundant evidence of erosion of the underlying surface.

Another mile to the north, on the north face of Mount Haultain, the recessive unit referred to above (forming the base of the Simla Member) appears about 160 feet down in the Southesk Formation; the carbonates above this horizon (i.e. the upper part of the Simla) contain a Frasnian coral-brachiopod fauna. Northwestwards again, the "upper Alexo" (Sassenach) thins in places to nothing and the Palliser rests on the Southesk Formation.

This interpretation of events also allows a meaningful classification to be extended to the Jasper area from Colin Range eastwards to the Miette Range. The Ronde Member, as defined in this paper, occupies the same stratigraphic position as the Simla Member in The Ancient Wall area. It corresponds to the lower Alexo on, e.g. Roche Miette, but grades laterally into fossiliferous beds of Mount Hawk lithology, carrying a high Frasnian fauna. The Southesk is again overlain by the Sassenach Formation which is thin over carbonate-reef developments and thick over a predominantly shaly or basinal Mount Hawk and Perdrix sequence[1]. Where the Sassenach is thin, the lower part of the formation has not been recognized, but the lower contact represents a time break of varying magnitude.

Although outside the area under consideration in this report, by analogy and lithological correlation, the Alexo Formation of the type section and southeastwards into the Bow Valley region, probably contains this time break within it. It seems probable that the lower part of the Alexo is the equivalent of the Ronde and Simla Members of the Southesk, and that the upper part is equivalent to the upper Sassenach. The break between the two may coincide with the boundary between the upper and lower members of the Alexo as drawn in many sections. The upper boundary of the Fairholme Group in Bow Valley may conveniently continue to be drawn at the base of the Alexo.

By recognizing a Sassenach Formation in the Jasper region, that everywhere physically overlies the Fairholme Group as now defined, the hypothesis of interfingering Famennian and Frasnian faunas is shown to be untenable. The Sassenach, which contains the earliest Famennian fossils in the region, rests on the underlying Fairholme, of Frasnian age, with a regional disconformity. In some sections in the Jasper region, therefore, the Fairholme Group may include beds that are stratigraphically higher than the highest beds farther to the south. It remains, however, a useful major rock unit within the Alberta Rocky Mountains.

In summary, the fullest development of the Sassenach Formation occurs over a thin sequence of the Mount Hawk and Perdrix Formations. It thins against a thickening Fairholme Group towards major carbonate reef complexes, over which it may be very thin or

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[1] The term "basinal" is used in the sense of McLaren (1956, p. 16 and fig. 1).

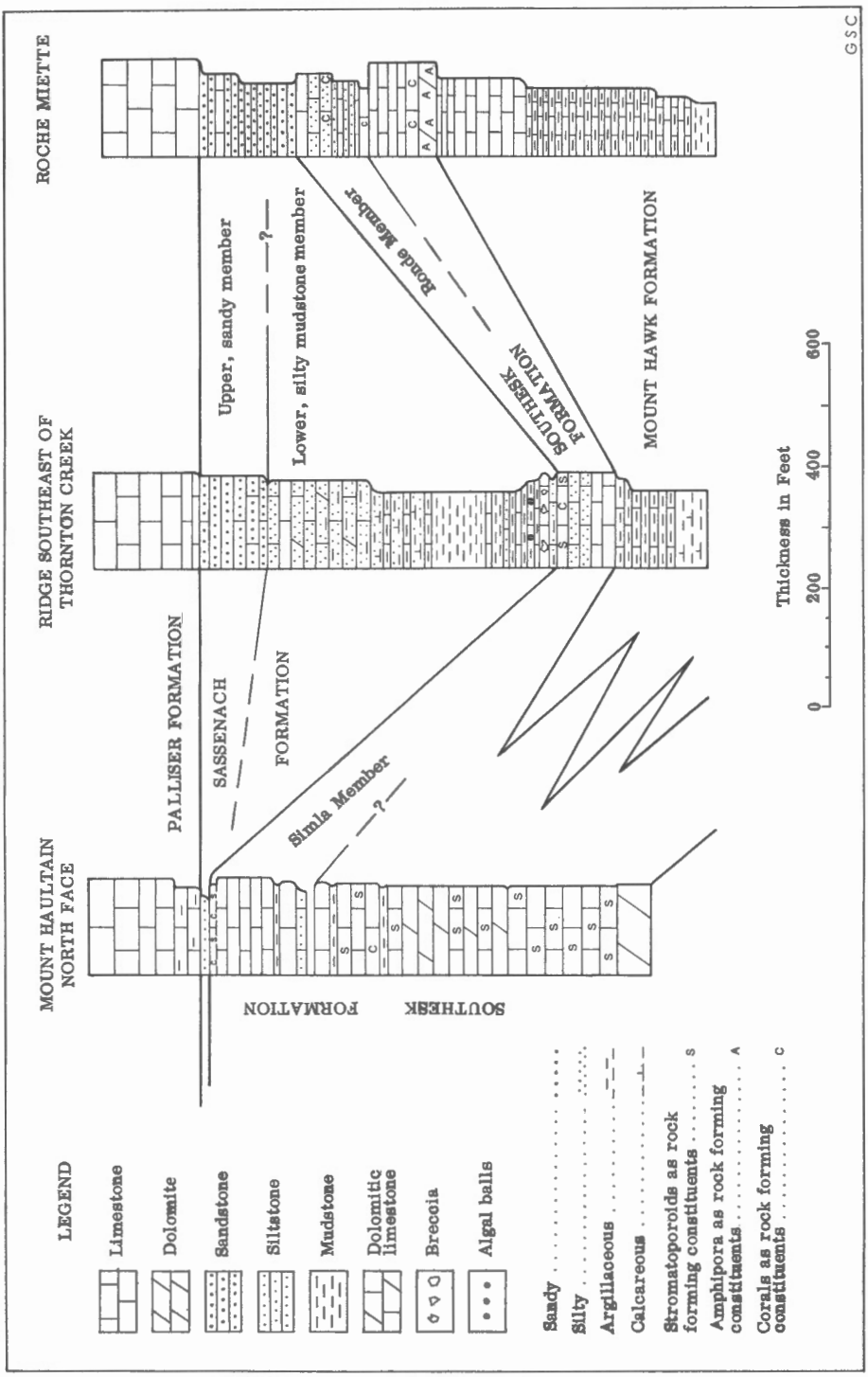

Figure 3. Generalized stratigraphic sections

absent. A broadly recognizable unit, the Simla Member of the Southesk Formation, occurs below the Sassenach in The Ancient Wall complex; a comparable unit, the Ronde Member, is present in the Miette area. These units—the Sassenach Formation above and the Simla or Ronde Member below—together constitute beds that have been called Alexo in the Front Ranges of the Jasper region. The contact between them represents an important geological boundary—a depositional break, and a major faunal change. Its recognition must have broad regional implications in the surface and subsurface Devonian of Western Canada. This disconformity is presumably the same as that postulated by Belyea (1955, pp. 24-25) in the Alberta subsurface.

SOUTHESK FORMATION

The Southesk Formation forms the upper part of reef complexes in the Front Ranges north of Jasper (The Ancient Wall reef complex, Mountjoy, 1962a); east of Jasper (Miette area, Mountjoy, 1962b); and in the vicinity of the Brazeau River (McLaren, 1956; see Belyea, 1960, for relative geographic positions). Locally, thin developments of Southesk Formation occur elsewhere above Mount Hawk strata. The Southesk is characterized by well-bedded sequences of light grey carbonates that are easily distinguished from underlying dark grey, organic carbonates of the Cairn Formation, and from overlying silty rocks of the Sassenach Formation. The Southesk-Cairn boundary is only difficult to distinguish near the reef edges, where lighter-coloured carbonates commonly occur within the Cairn Formation.

The type Southesk Formation (McLaren, 1956, p. 19) near the junction of Southesk and Brazeau Rivers consists of 528 feet of light grey thick-bedded limestones, dolomites and coral beds. It is divisible into three members (Belyea and McLaren, 1957a): a lower, coarse-grained structureless dolomite—the Peechee Member; a middle, thin dolomite (coral bed) with Amphipora, stromatoporoids and corals—the Grotto Member; and an upper, granular, thick-bedded limestone—the Arcs Member. Type sections of the members are located on the southeast end of Mount Rundle, southeast of Banff. Belyea and McLaren (1956, 1957a) have discussed the regional development of these units.

Somewhat different sequences occur in the Southesk Formation of the Miette and The Ancient Wall reef complexes (Mountjoy, 1962a, 1962b). In general very few dolomites are present in the Southesk. No thin, coral member (Grotto) was observed in The Ancient Wall complex. A thin unit bearing corals and Amphipora does occur, however, in the Miette reef complex at about the same stratigraphic position as the Grotto Member elsewhere, but correlation of units between reef complexes is difficult. The Southesk Formation is between 600 and 800 feet thick in The Ancient Wall reef complex, and between 500 and 550 feet thick in the Miette reef complex. The Southesk

gradually thins from below at the margins of the reef complexes, with successively higher beds extending greater distances over Mount Hawk strata (Mountjoy, 1960a, 1962a, 1962b).

In The Ancient Wall reef complex the Southesk Formation is divisible into a thick lower member and the overlying Simla Member. The Southesk of the Miette reef complex is divisible into four members (Mountjoy, 1962b): from bottom to top, a lower aphanitic limestone member, a coral-Amphipora member, an upper aphanitic limestone member, and the Ronde Member.

The Simla and Ronde Members apparently occupy the same stratigraphic position in the two reef complexes and both are of Late Frasnian age. The bases of the Simla and Ronde Members may not represent the same horizon, and correlation of these horizons with the base of the lower member of the Alexo Formation of McLaren (1956) cannot be demonstrated with certainty. They could represent different stratigraphic horizons. However, their late Frasnian age and stratigraphic position strongly suggest that the Ronde and Simla Members are correlative.

Simla Member

The term Simla Member is proposed for a 200-foot limestone unit and an underlying soft-weathering silty mudstone interval that overlies the remainder of the Southesk carbonates in The Ancient Wall carbonate complex. The type section is on the face of The Ancient Wall near its southeastern end and is described in the Appendix. The member is named from Mount Simla which lies immediately south of the junction of Blue Creek and Snake Indian River, in the northern part of Jasper Park.

At the type section the Simla Member is 252 feet thick including, at its base, a 41-foot interval that is largely covered. Within it there occur sporadic outcrops of argillaceous siltstones, variably calcareous and dolomitic, that form a strongly recessive zone along the face of The Ancient Wall. These are overlain by some 20 feet of dolomitic limestone and dolomite that contain an abundant and distinctive fauna of corals and a few brachiopods. The remaining 191 feet of the member is formed of prominent and cliff-forming thick-bedded limestones which weather a distinctive very light grey. These limestones are predominantly calcarenites formed of medium to coarse non-skeletal grains in a clear sparry calcite matrix, i.e. intrasparites. They are characteristically light coloured, varying from very light grey to light olive-grey on fresh surfaces. The stromatoporoid Amphipora is common at some horizons. Two- to three-foot beds of softer-weathering dolomitic limestone, in places silty, occur at wide intervals. They are commonly rubbly and argillaceous, softer weathering, and may contain abundant Amphipora and small flakes of green mudstone.

The Simla Member rests on the lower member of the Southesk with a very sharp contact. The upper beds of the lower member are strongly stromatoporoidal and coralliferous, but below, the lithology closely resembles the upper part of the Simla.

The Simla is overlain by the Sassenach Formation. At the type section the contact is well marked at the change from pure granular limestone below to softer-weathering silty dolomitic limestone above. The upper contact is not as abrupt as the lower, although, as shown on Mount Haultain to the southeast, only the highest 23 feet of the Sassenach is present and the lower several hundred feet of that formation is missing.

The Simla Member varies in thickness within the area of The Ancient Wall carbonate complex. In the creek that cuts the southeastern end of The Ancient Wall there is 186 feet, of which the lower 60 feet is covered. Only 170 feet is developed on Mount Simla on the southeast side of Dolly Lake; the recessive interval at the base is again approximately 40 feet. Along the same range, on the southeast side of The Rajah there is a total of 215 feet and southeast on the mountain opposite there is 235 feet; the recessive interval is 38 feet in both sections. Farther to the southeast, on the southeast spur of Mount Sassenach the member is 185 feet thick with 40 feet recessive. On Mount Tory (Mountjoy, 1962a) there is 213 feet (49 feet recessive); on the northwest spur of Mount Haultain there is 193 feet (35 feet recessive); and in the prominent cirque on northern face of the same mountain there is 180 feet (30 feet recessive). Within this same cirque the recessive interval ends abruptly against a massive carbonate, and the base of the member loses its identity as a mappable horizon.

Corals are rare in the upper part of the Simla Member but occur throughout, together with spherical stromatoporoids and Amphipora. At the base of the resistant upper part of the member corals become abundant and include: species of Alveolites, Syringopora, Thamnopora, and Acinophyllum; Disphyllum sp. H, Phillipsastraea sp. G, P. sp. H, and Smithiphyllum sp. N. Brachiopods are not common but a few specimens have been collected and include: Schizophoria sp., Atrypa spp., and Theodossia cf. T. keenei (Crickmay). This fauna indicates a highest Frasnian age for the member, which may be correlated with beds high in the Grumbler Group in the Upper Mackenzie region, e.g. the Kakisa and Redknife Formations (Belyea and McLaren, 1962). The interval represented by this member is commonly poorly fossiliferous farther south, but the fauna found in beds laterally equivalent to the Ronde Member of the Southesk Formation in the Miette Range probably suggests age correlation. The Simla Member, therefore, appears to be the stratigraphic equivalent of the lower member of the Alexo Formation in the Rockies south of Athabasca River (Figure 2).

Ronde Member

The term Ronde Member is proposed for about 100 feet of thin-bedded, fine-grained carbonates and silty carbonates which occur at the top of the Southesk Formation of the Miette area. The type section is on Roche Miette, 21 miles northeast of Jasper in Miette Range, in the eastern part of Jasper National Park. The member is named after Roche Ronde, 5 miles northwest of Roche Miette on the north side of the Athabasca Valley. These strata have previously been referred to or mapped as the lower Alexo Formation (Figure 3). Mountjoy (1960b) referred these strata to an informal lower member of the Alexo Formation and excluded the upper 35 feet of McLaren's (1956) lower member.

At the type section the Ronde Member is 113 feet thick. The basal 10 to 30 feet generally weathers more recessive. The Ronde consists of silty, in part argillaceous and finely laminated limestones and calcareous siltstones which may contain a few corals and stromatoporoids. Some penecontemporaneous slump structures are also present. It weathers light grey to brown, thin-bedded and recessive. Many of the carbonates in the Ronde Member are calcarenites, consisting of non-skeletal grains with some composite grains in a sparry calcite matrix or, rarely, a microcrystalline calcite matrix. Except for calcispheres, fossil fragments are absent in these limestones. These carbonates are grossly similar to underlying Southesk carbonates and are suggestive of a bank-type, shallow-water environment.

The Ronde Member overlies the upper aphanitic member of the Southesk Formation (Mountjoy, 1962b). This contact is sharp and distinct in most sections, though in a few it appears to be gradational over less than 5 feet. It is placed where the recessive, thin-bedded-weathering, argillaceous and silty carbonates change downwards to massive and resistant-weathering, aphanitic, light grey limestones.

Between 100 and 150 feet of Sassenach Formation which consists primarily of silty carbonates, occurs above the Ronde Member. The boundary between these two units is very difficult to distinguish because of similar lithologies. However, Sassenach strata generally contain more quartz silt, breccia and slump structures, and lack corals and stromatoporoids. The relationships on the southeast side of Mount Haultain (see Fig. 4) demonstrate that this contact is unconformable. With less widely spaced and more detailed observations, the position of this unconformity may eventually be more precisely determined.

The Ronde Member varies slightly in thickness within the area of the Miette reef complex (Mountjoy, 1962b). It thins southeast from the type section to about 100 feet in the Miette thrust sheet, near the southeast edge of the reef. However, between 125 and 140 feet of Ronde strata occur in sections immediately southeast and east of the reef edge in both the Miette and Nikanassin thrust sheets.

The Ronde Member extends southeastwards along Miette Range to the head of Fiddle River where it grades into the uppermost strata of the Mount Hawk Formation and can no longer be distinguished. Similar strata appear to be present in Nikanassin Range, on Bedson Ridge, on the south end of Boule Range and on Roche à Perdrix, and are tentatively assigned to the Ronde Member. This suggested correlation is based entirely on stratigraphic position and should be applied with caution; correlation of units between various thrust sheets is difficult, and the Ronde Member and overlying Sassenach Formation have similar lithologies. Elsewhere in the Miette map-area the Ronde Member is not recognized because of facies changes from silty carbonates to very argillaceous carbonates that cannot be distinguished from similar beds in the upper part of the Mount Hawk Formation. It may also be absent through non-deposition or erosion as suggested by stratigraphic relationships on Mount Haultain. Neither the Ronde Member nor the Simla Member is present in Jacques and De Smet Ranges. Thus the Ronde Member has its greatest extent in Miette Range.

The Ronde Member is generally unfossiliferous, except for occasional indeterminate corals and stromatoporoids. However, laterally equivalent Mount Hawk strata at the head of Fiddle River in Miette Range (53°0 1/2', 117°34') contain the following fossils.

GSC loc. 36908: 100 feet below base of Sassenach Formation

Thamnopora sp.
Thamnophyllum cf. T. tructense (McLaren)
Gypidula cf. G. cornuta Fenton and Fenton
Gypidula sp.
Devonoproductus sp.
Hypothyridina cf. sp. A.
Rhynchonellid (?) indet.
Atrypa sp. cf. A. ciliipes Crickmay
Atrypa sp. J
Atrypa sp. K
Theodossia keenei (Crickmay)
small spiriferid
Athyris sp.

GSC loc. 36895: 160 feet below base of Sassenach Formation

Tabulophyllum sp.
Schizophoria sp.
Atrypa sp. L
gastropods indet.

These fossils occur elsewhere in the upper part of the Mount Hawk Formation and are similar to faunas obtained from the Kakisa and Redknife Formations in the upper Mackenzie River area. They are

indicative of a late Frasnian age (Belyea and McLaren, 1962). The presence of a similar fauna near the base of the Simla Member probably suggests age correlation.

SASSENACH FORMATION

The Sassenach Formation is proposed as the 600-foot unit of silty and sandy calcareous mudstones and silty and sandy limestones that underlies the Palliser Formation and overlies the Mount Hawk Formation in the western Front Ranges in the central and northern part of Jasper Park. It corresponds very closely to the Alexo Formation of McLaren (1956) at the following sections: Deception Creek, Rocky Forks, Medicine Lake, Morro Peak, and The Palisade. The type section, on the ridge southeast of Thornton Creek, 2 1/2 miles southeast of Mount Haultain, is described in the Appendix. It is named from Mount Sassenach, a few miles to the northwest.

At the type section the Sassenach Formation is 601 feet thick and can be divided into two informally named members: the lower, silty mudstone member and the upper, sandy member. The lower member is 488 feet thick and consists mainly of dark grey to dark greenish grey quartzose silty mudstones that are variably calcareous and dolomitic and weather to a distinctive yellowish grey to yellowish orange. Some beds are more strongly calcareous and form more resistant bands in an essentially soft-weathering, recessive member. The carbonate content increases upwards, and near the top, the beds become medium- and thick-bedded, silty and argillaceous limestone.

Near the base the lithology is highly variable. The type section lies very close to The Ancient Wall reef complex whose southern limit crosses Mount Haultain. At the close of deposition of the underlying Fairholme Group, the higher parts of this complex must have been exposed to erosion, and blocks of limestone typical of the Simla Member of the Southesk Formation were washed into deeper water. Such debris is exposed in the lower beds of the Sassenach Formation in the type section. The basal 7-foot bed of the formation—a black, argillaceous and silty limestone—contains small silicified fragmentary lumps of corals and stromatoporoids and grey granular limestone. This is succeeded by about 10 feet of bedded silty argillaceous limestone and dolomite which is overlain by a highly irregular breccia bed, up to 20 feet thick. The breccia consists of lumps, up to 3 or 4 feet across, of grey limestone with stromatoporoids and corals, with smaller pebbles of limestone and abundant algal balls, all within a silty and argillaceous matrix. Higher in the succession, limestone breccias are absent but another bed of algal balls suggests current action in this vicinity at time of deposition. The lower 300 feet of the member is fossiliferous with a fauna in which brachiopods predominate.

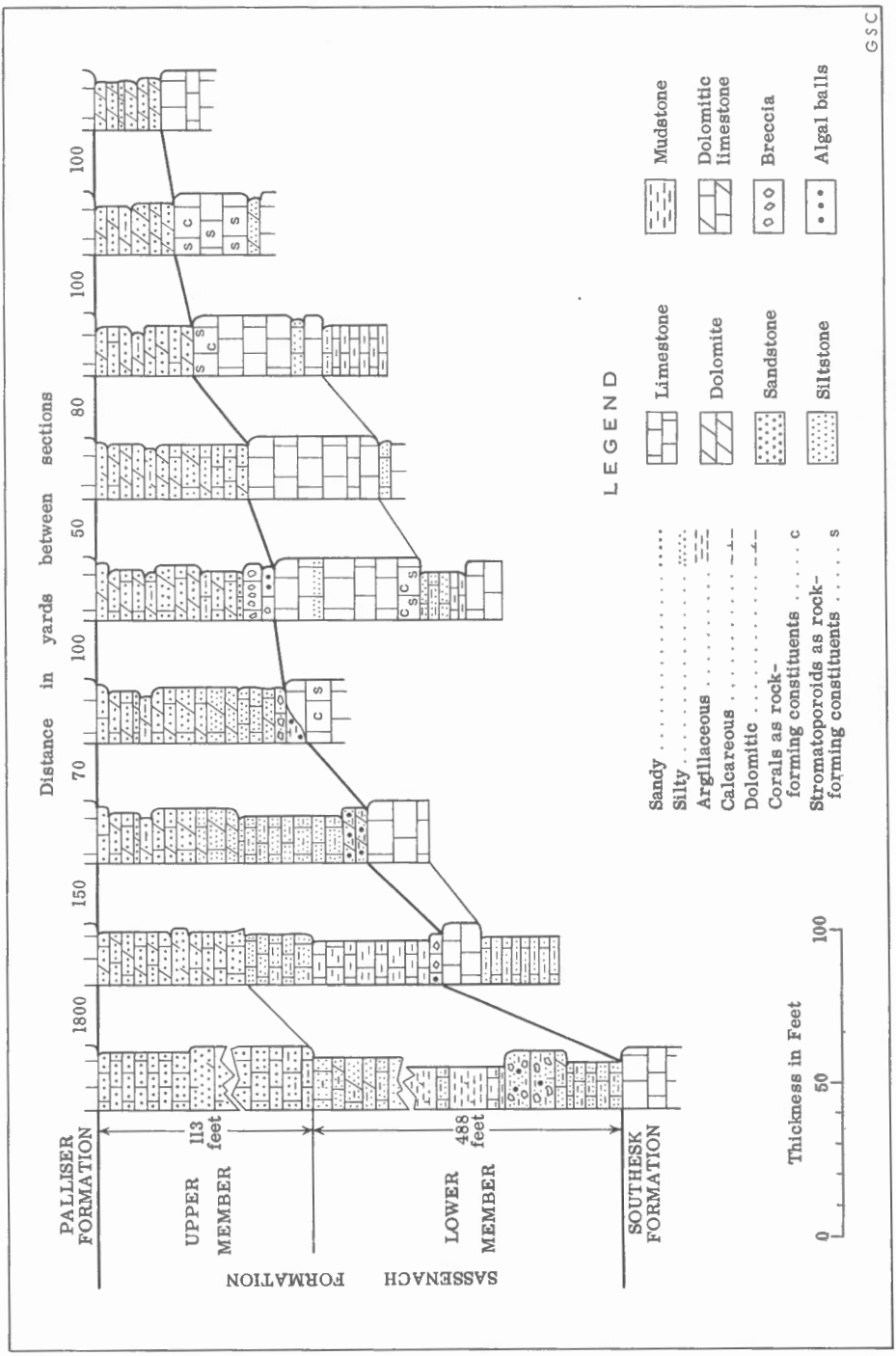

Figure 4. Changes in Sassenach Formation on southeast side of Mount Haultain

The upper member is formed of 113 feet of strongly quartzose, sandy, medium- to coarse-grained limestone and, in the middle third of the unit, calcareous sandstone. It is well bedded and relatively resistant to weathering. No fossils were seen.

The Sassenach Formation, at the type section, rests with a sharp break on a tongue of the Southesk Formation—95 feet of grey granular limestone, variably silty or dolomitic, with scattered stromatoporoid and coral fragments. This rests in turn on argillaceous limestones of the Mount Hawk. There is strong evidence of erosion at the Sassenach-Southesk boundary. The contact with the overlying Palliser Formation is sharp, being drawn where the sandy limestone of the Sassenach changes to the brownish grey to dark grey granular limestone of the Palliser. The basal beds of the Palliser appear to be unaffected in thickness or lithology between areas underlain by a thin Sassenach with a thick reefoid Southesk and areas underlain by a thick Sassenach with a thinner shaly Mount Hawk; they are seen to pass across underlying differences in lithology without change.

On the southeast flank of Mount Haultain, across Thornton Creek from the type section, the Sassenach thins along the hillside from 112 feet at the southeast end to 22 feet at the highest point that can be reached. The contact with the Southesk again shows signs of erosion, with small-scale irregularities and a local relief of 6 to 8 feet within a few yards. The lower beds contain algal balls and angular breccia beds of coral-stromatoporoid limestone of Southesk lithology, in silty argillaceous limestone. The formation appears to thin both by thinning of individual beds and by onlap over the Southesk. Successively younger beds rest against the contact and where the Sassenach is thin only the upper beds are present (Fig. 2).

Northwestwards, above The Ancient Wall carbonate mass, the Sassenach Formation thins to a relatively few feet of silty or sandy rubbly limestone, in places dolomitic and commonly with a brachiopod fauna. It is not clearly separated from the overlying Palliser, but the contact with the underlying Simla Member of the Southesk Formation is sharp. On the north face of Mount Haultain the Sassenach Formation is 15 feet thick; on the northwest spur of the same mountain only 3 feet of yellowish-orange-weathering silty dolomite represent the whole formation. On Mount Tory there is 2 feet; and on the southeast spur of Mount Sassenach a Palliser facies rests on the Southesk and the Sassenach is absent. On the southeast side of the creek that lies southeast of The Rajah there is 31 feet, and to the northwest of the same creek, about 18 feet. There is 30 feet on Mount Simla, and 23 feet at the south end of The Ancient Wall.

Southeastwards from the type section the thickness of the Sassenach remains remarkably constant within the Colin and Chetamon thrust sheets. At Morro Peak there is 620 feet (Alexo Formation of deWit and McLaren, 1950, p. 27), and at Medicine Lake

601 feet (Alexo Formation of McLaren, 1956, p. 48). Eastwards it thins across the ranges to 422 feet at Rocky Forks, 292 feet at Deception Creek, and 203 feet on the north flank of Cardinal Mountain (Alexo Formation of McLaren, 1959, p. 747 and Fig. 7). Along the Miette Range it roughly corresponds to the upper member of the Alexo Formation of McLaren (1956) and the upper part of the Alexo of Mountjoy (1960b).

The lower member contains an abundant brachiopod fauna which includes Schizophoria sp., Productella sp., "Leiorhynchus" walcotti Merriam, Cyrtiopsis mimetes Crickmay, and Athyris cf. A. angelicoides Merriam. This fauna indicates an early Famennian age for the member which may be correlated with the Trout River Formation of the Upper Mackenzie region. A fauna of this type is widespread in the North American Cordillera, being widely known as the "Cyrtospirifer Zone" of the Devil's Gate Formation of Nevada (Merriam, 1940). The upper member is fossiliferous in some sections and is characterized by species of rhynchonelloids which include Sinotectirostrum medicinale Sartenaer. It represents an early Famennian fauna which is known to occur high in the Devonian in the District of Mackenzie (P. Sartenaer, manuscript in preparation).

The Sassenach Formation may be correlated on lithological and stratigraphic grounds with the upper member of the Alexo in unfossiliferous sections along the Rocky Mountains to the southeast of the area under consideration.

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APPENDIX

The Ancient Wall

The section was measured on the face of The Ancient Wall about 1 1/2 miles northwest of the creek that cuts through it at its southeastern end. This creek flows into Blue Creek about 3 miles above its confluence with Snake Indian River, in the northern part of Jasper National Park. Most of the Palliser Formation is covered, but more of it may be seen in the gorge of the stream to the southeast. The Ancient Wall is unclimbable, and the remainder of the Southesk and all of the Cairn Formations are well exposed in the same stream valley. This section constitutes the type section of the Simla Member of the Southesk Formation; it was measured by D. J. McLaren in 1961. The lower part of the succession, not shown here, was measured by McLaren in 1951.

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Palliser Formation		
	Limestone, calcarenite, dark grey to brownish grey, medium- to coarse-grained; medium-bedded (about 3 feet) with some thin-bedded horizons; weathers medium to light grey, bedding becomes thinner on well-weathered surfaces (about 3 inches)		
19	Limestone, slightly dolomitic; slightly quartzose silty, brownish grey with light brown dolomite mottling, medium-grained; thin rubbly bedding (1/2 inch to 2 inches); yellowish-weathering; stringers of dolomite separate irregular and nodular limestone beds; traces of fossils including Athyris sp. and Aviculopecten sp.	5	341
18	Limestone, brownish grey, fine- and medium-grained, with aphanitic matrix; thick-bedded to massive; some dolomitic stringers but no true 'mottling'; cliff-forming	45	336

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	unit; rare fossils, one large productellid (GSC loc. 45955)		
17	Limestone, variably dolomitic dark brownish grey, fine-grained to cryptocrystalline with some clotted texture; thin-bedded; pale greyish yellow dolomite streaks between nodular beds; softer weathering than units above and below; shell fragments	7	291
16	Limestone, greyish brown, very coarse grained, irregular and variably sized grains in sparry calcite cement; thick-bedded (2 to 4 feet); few organic remains, traces of spot dolomitization; Cyrtiopsis(?) fragments	8 1/2	284
	Sassenach Formation (23 feet)		
15	Limestone, dolomitic, slightly silty, coarse- to fine-grained; thin rubbly bedding; fine to cryptocrystalline clotted limestone with dolomitic mottling; some coarse granular pockets and silty and possibly argillaceous stringers; soft yellowish grey weathering, forms a recessive unit; scattered fossils including productellid indet., Sinotectirostrum(?) sp., Cyrtiopsis sp., Athyris sp., bryozoan and crinoid fragments, (GSC loc. 45927)	2	275 1/2
14	Limestone, dark greyish brown, aphanitic to fine-grained; medium-bedded (3 to 8 inches), weathers thin; a few fossils: Sinotectirostrum(?) sp., Athyris sp. (GSC loc. 45941)	10	273 1/2

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
13	Limestone, variably dolomitic and slightly silty, dark grey to brownish grey, with some light greyish brown dolomite stringers; very thin, irregular, rubbly bedding; part of limestone is strongly granular, medium to coarse grained with reddish stained grains; part is fine grained to aphanitic; more silty beds alternate with beds of purer limestone; weathers soft and recessive; fossils common: "Camarotoechia" nordeggi banffensis Warren (identified by P. Sartenaer), Cyrtiopsis sp., Athyris sp. (GSC loc. 45935)	11	263 1/2
	Southesk Formation (656 feet)		
	Simla Member (252 feet)		
12	Limestone, very light grey to grey, cryptocrystalline to medium-grained calcarenite with sparry calcite matrix; medium- to very-thick-bedded (1 foot to 8 feet); weathers very light grey to off-white	77	252 1/2
11	Limestone, dolomitic, slightly quartzose silty and conglomeratic, light grey to pale greenish grey, medium- to coarse-grained; thin-bedded (1/2 inch to 4 inches); small irregular grey limestone pebbles weather out from a brownish yellow dolomite matrix, soft-weathering, recessive	2 1/2	175 1/2
10	Limestone, similar to unit 12, light-coloured and granular; abundant Amphipora in a few beds in unit	47	173

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
9	Limestone, stromatoporoidal, light grey, medium-grained; partly rubbly and fragmented with small angular pieces of greyish to yellowish green mudstone scattered throughout; grades up into very thin bedded flagstones; soft-weathering; abundant stromatoporoids—mainly Amphipora fragments (GSC loc. 45871)	2	126
8	Limestone, predominantly light grey to light olive-grey, but very variable in colour, medium- to coarse-granular in sparry calcite matrix; medium- to very-thick-bedded (1 to 8 feet); weathers very light grey to yellowish grey	43	124
7	Dolomite, calcareous, pale yellowish brown, medium-grained; thin-bedded (1/2 inch to 3 inches), laminated; weathers yellowish grey; angular fracture	2	81
6	Limestone, light grey to light olive-grey, strongly granular, very variable in grain size; strongly laminated microstructure with some small edgewise conglomerates developed in coarse rudite with sparry calcite matrix; bedding very thin to medium (1/10 inch to several inches)	18	79
5	Limestone, dolomitic, dark grey, fine- and medium-grained; thin and medium, rubbly and nodular bedding (1/2 inch to 3 inches); abundant stromatoporoids, Alveolites, a few rugose corals and one indeterminate brachiopod (GSC loc. 45952)	13	61

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
4	Dolomite, calcareous, quartzose silty, and limestone, dolomitic, light brownish grey to pale brown to greenish grey, fine- and medium-grained; thin- and medium-bedded (1 inch to 6 inches); weathers prominent greyish orange; very abundant coral fauna; Alveolites sp., Syringopora sp., Thamnopora sp., Acinophyllum sp., Disphyllum sp. H, Phillipsastraea sp. G, P. sp. H, Smithiphyllum sp. N, Schizophoria sp., Atrypa sp., Theodossia cf. T. keenei (Crickmay), gastropod indet. (GSC loc. 45918)	7	48
3	Siltstone, dolomitic, calcareous, and argillaceous, interbedded with silty, dolomitic mudstone; pale yellowish orange to greenish grey; fissile and very thin bedded; partly covered, recessive	8	41
2	Covered interval	28	33
1	Siltstone, argillaceous and dolomitic, light grey to greenish grey; regularly thin-bedded (1/2 inch to 2 inches) but not fissile; weathers pale yellowish orange; partly covered, recessive; a few fish fragments	5	5
	Lower Member (404 feet)		
	Limestone, stromatoporoidal, medium light to medium dark grey, medium-grained with sparry calcite matrix; thick-bedded (about 4 feet); very abundant spherical stromatoporoids and some corals; unit is resistant		

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	and cliff-forming; fauna includes: Syringopora sp. B, Charactophyllum sp. A, Atrypa sp., Theodossia sp., gastropod traces (GSC loc. 45931).		

Ridge Southeast of Thornton Creek

This section was measured in the vicinity of the ridge on the southeast side of Thornton Creek, about 2 1/2 miles southeast of Mount Haultain, at an approximate elevation of 6,000 feet (lat. 53°10', long. 118°14 1/2'). The base of the Palliser is prominent and easily recognized but the formation is unclimbable on the ridge and was not measured. This section constitutes the type section of the Sassenach Formation; it was measured in 1961 by D. J. McLaren.

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Palliser Formation		
19	Limestone, calcarenite, typical Palliser lithology, massive		
18	Limestone, calcarenite, dark grey to brownish grey, medium- to coarse-grained; medium-bedded; unit has constant thickness along hillside	6	702 1/2
	Sassenach Formation (601 feet)		
	Upper Sandy Member (113 feet)		
17	Limestone, quartzose sandy, medium-grey, coarse-grained; thin-bedded (2 to 4 inches); strongly laminated on weathered surfaces, with sand stringers	25	696 1/2
16	Sandstone, quartzose, slightly calcareous or dolomitic, light grey to white, medium-grained; vaguely thick-bedded; wavy, irregular laminae on weathered surfaces	38	671 1/2
15	Limestone, strongly quartzose sandy, medium to very light grey, medium- to coarse-grained; regularly thin- and medium-bedded (2 to 6 inches); some thin	50	633 1/2

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	shale interbeds in lower part, proportion of sand increases upwards; wavy laminae of sand on weathered surface		
	Lower, Silty Mudstone Member (488 feet)		
14	Limestone, quartzose silty argillaceous, variably dolomitic, medium dark grey; thin- and medium-bedded at base (2 to 8 inches), becoming medium- (2 feet) and thick-bedded (3 to 6 feet) upwards; prominent silty stringers at some horizons, with sand increasing upwards; unit weathers with distinctive banded appearance, independent of bedding; 2- to 4-inch bands of light-grey-weathering limestone alternating with or interrupted by more dolomitic yellowish to greyish orange bands; brachiopod fragments in lower part	174	583 1/2
13	Mudstone, variably silty, calcareous, dark greenish grey to dark grey; thin- to medium-bedded (2 to 4 inches); unit becomes increasingly silty and calcareous upwards; greyish-orange-weathering with silt stringers on surface; scattered brachiopods, very abundant 40 feet from base, include: productellids indet., rhynchonelloids, Cyrtiopsis mimetes Crickmay, (GSC loc. 45863)	67	409 1/2
12	Mudstone, variably silty, calcareous, dark greenish grey to dark grey; lower 20 feet is	162	342 1/2

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	soft and partly covered, becomes vaguely medium bedded (2 to 3 feet) and more resistant upwards, alternating with softer intervals; weathers yellowish grey, breaking up into small irregular elongate fragments; becomes increasingly silty upwards and slightly dolomitic; at 17 feet from base there is a 2-foot bed of coarse granular limestone, weathering orange-pink; very fossiliferous between 90 and 120 feet from base: "Leiorhynchus" lentiformis Nalivkin (identified by P. Sartenaer), Cyrtiopsis mimetes Crickmay, (GSC loc. 45867)		
11	Limestone, argillaceous, silty, greyish black, medium-grained; thick-bedded; weathers a prominent yellowish orange; very abundant brachiopods: Productella sp., "Leiorhynchus" lentiformis Nalivkin (identified by P. Sartenaer), Cyrtiopsis mimetes Crickmay, Athyris sp. (GSC loc. 45919)	5	180 1/2
10	Mudstone, calcareous, silty, brownish grey to dark grey; thin-bedded, fissile; interbedded every 6 to 12 inches with a 1- to 4-inch bed of dark grey, silty, argillaceous limestone; 10 feet from base, limestone with "Leiorhynchus" lentiformis Nalivkin (identified by P. Sartenaer) (GSC loc. 45868); 24 feet from base, a 9-inch bed of silty, dolomitic limestone, weathering prominent pale yellowish orange, with Productella sp., rhynchonelloids, Cyrtiopsis mimetes Crickmay (GSC loc. 45953)	29	175 1/2

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
9	Limestone, silty, slightly argillaceous, fine-grained, medium dark grey; largely made up of algal balls up to about 1 inch in diameter, with scattered fossils: Schizophoria sp., small rhynchonelloids, Cyrtiopsis, sp., Athyris sp., nautiloid fragment (GSC loc. 45947)	2	146 1/2
8	Limestone, argillaceous, pyritic, dark grey, medium-grained; thin-bedded; partly covered, with shale fragments in talus; upper part of unit probably grades into mudstone	11	144 1/2
7	Limestone breccia developed in silty dolomite matrix; at base of unit, silty dolomite or dolomitic siltstone, dark grey, yellowish-orange-weathering; bedded at base but upwards becomes twisted and contorted with highly irregular contact with very coarse limestone breccia consisting of very large blocks (up to 3 feet across) of very light grey granular limestone, largely composed of stromatoporoids and corals in a matrix of small limestone pebbles and algal balls enclosed, in turn, in a silty dolomite (GSC loc. 45873)	20	133 1/2
6	Limestone, argillaceous, black; thin-bedded and interbedded with black calcareous shale	3 1/2	113 1/2
5	Dolomite, silty, argillaceous, dark grey, fine-grained; regular medium-bedded (2 to 3 feet); weathers a prominent yellowish orange; algal balls abundant at top of unit	7 1/2	110
4	Limestone, strongly argillaceous, dolomitic and silty, dark grey, fine-grained; thin-bedded, with interbeds	7	102 1/2

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	of dark calcareous mudstone, and some beds of grey, granular limestone which lense out rapidly along strike, with silicified fragments (up to 1 1/2 inches across) of corals; soft-weathering and recessive; irregular thickness, varies at expense of overlying unit		
	Southesk Formation (95 feet)		
3	Limestone, medium to dark grey and brownish grey, medium-grained with sparry calcite matrix; thick-bedded (3 to 6 feet); near top is a bed with silicified stromatoporoid and coral fragments; top bed is pyritic; upper boundary is abrupt; unit is cliff-forming	13 1/2	95 1/2
2	Limestone, silty, and slightly dolomitic, very dark grey, fine-grained; very thin silty laminae break limestone up into regular thin beds (up to 3 inches); some thicker beds of grey limestone near top of unit	36	82
1	Limestone, dark grey to brownish grey, fine- and medium-grained with sparry calcite matrix; irregularly thick-bedded (2 to 6 feet); some irregular dolomitization including brown dolomite lenses several feet across; upper contact is abrupt	46	46
	Mount Hawk Formation		
	Limestone, argillaceous, dark grey to black, fine-grained; thin	25	

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	and medium rubbly bedding (2 inches to 1 foot), with black calcareous mudstone interbeds in about equal amounts, limestone increasing upwards in unit; scattered fossils: Coenites sp., Charactophyllum sp., Thamnophyllum colemanense (Warren), Gypidula cf. G. cornuta parva Fenton & Fenton, "Pugnax" sp., Atrypa spp. (GSC loc. 45946)		
	Mudstone, calcareous, yellowish to greenish grey; non-fissile, poorly bedded, but some medium (about 2-foot) beds of more strongly calcareous mudstone or argillaceous limestone; grades from unit below and into unit above	44	
	Mudstone, similar to preceding unit; fewer more-calcareous beds; weathers into elongate, angular fragments and spheroidal lumps; 50 feet from base, abundant Chonetes sp. (GSC loc. 45917)	165	

Roche Miette

This section was measured on the northeast and north spur of Roche Miette, beginning at an elevation of about 6,000 feet and ending at about 7,000 feet. It is best approached from the gravel pit along Highway 16 northwest of Roche Miette, then following the ridge of orange-weathering Cambrian strata (see Mountjoy, 1960a). It takes between 2 and 3 hours to climb to the section. Exposures are excellent.

This is the type section of the Ronde Member which includes all but the uppermost 35 feet of the lower member of the Alexo Formation of McLaren (1956), originally published by deWit and McLaren (1950, pp. 21-22). It is equivalent to the lower member of the Alexo Formation as used by Mountjoy (1960b). In general the section described below can be matched with that of deWit and McLaren, except for some modifications and reduction of thickness of some units. The Sassenach Formation corresponds to the upper member of McLaren's (1956) Alexo with the addition of the uppermost 35 feet of the lower member. The section was measured by Mountjoy in 1958.

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Palliser Formation		
35	Limestone, medium grey, medium-grained, weathers light grey in beds 1 foot to 4 feet, more resistant than underlying units. Thin section: poorly sorted, loosely packed composite grains and some skeletal debris in a matrix consisting of cryptocrystalline mud and sparry calcite.		
	Sassenach Formation (152 feet)		
34	Siltstone, slightly calcareous, light to medium grey, weathers light grey in 1-foot beds	4	265
33	Siltstone, slightly calcareous, light brown, weathers light yellow-brown in beds 1/2 foot to 2 feet	9	261

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
32	Limestone, medium grey, very fine grained, weathers light grey, resistant, one bed. Trace of fine laminations, brown-weathering and thin-bedding near middle. Thin section: well-rounded and sorted, 0.1-mm composite grains and some skeletal debris cemented by cryptocrystalline mud, largely recrystallized	15	252
31	Siltstone, calcareous, light brownish grey, finely laminated in part, weathers light to yellow-grey, recessive, beds 1 inch to 1 foot	11	237
30	Limestone, light to medium grey, very fine grained, weathers light grey, resistant in one bed. Thin section: intraclasts in sparry calcite cement	2	226
29	Siltstone, dolomitic, light to medium grey, finely laminated, weathers recessive, thin-bedded	1	224
28	Limestone, light grey, fine- to medium-grained, weathers light grey in one bed. Thin section: loosely packed, poorly sorted, well-rounded composite grains cemented by sparry calcite; numerous calcite-filled fractures	2	223
27	Dolomite, silty, light grey, weathers a light grey to yellow-grey in beds 1 inch to 8 inches	3	221
26	Limestone, medium to dark grey, very fine grained, weathers light grey in one bed. Thin section: composite grains cemented by sparry calcite	1	218

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
25	Siltstone, light grey, finely laminated, weathers yellow-grey to grey in beds 1 foot to 2 feet; gradational to adjacent strata, contains small lenses and fragments of dark grey limestone	7	217
24	Limestone, slightly dolomitic, dark grey, very fine grained, weathers light grey in 1- to 2-foot beds, resistant	5	210
23	Limestone, silty, grey, microcrystalline, weathers light grey-yellow in 1-foot beds, recessive	4	205
22	Limestone, medium grey, very fine grained, weathers light grey, one bed. Thin section: tightly packed, well-sorted and rounded cryptocrystalline composite grains cemented by microcrystalline to sparry calcite cement	2	201
21	Siltstone, and fine-grained sandstone, slightly calcareous, light brown, finely laminated, ripple-marks, some crossbedding, weathers light grey-brown in 1/4- to 6-inch beds	10	199
20	Intraformational dolomite breccia, consisting of white, microcrystalline dolomite fragments cemented by dark grey, microcrystalline dolomite; weathers light grey	.2 to .7	189
19	Dolomite, silty, light grey, microcrystalline, in part finely laminated, weathers light grey to yellow-grey in beds 1 inch to 1 foot	22	188 1/2

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
18	Partly covered; appears to be limestone as below, in part breccia, grey-yellow-weathering	5	166 1/2
17	Limestone, medium grey, very fine grained, finely laminated, weathers light grey in beds 1 inch to 1 foot	6	161 1/2
16	Limestone, argillaceous, yellow-brown, microcrystalline, thin-bedded, recessive	1	155 1/2
15	Limestone, light brownish grey, fine- to coarse-grained, weathers light grey in one bed	2	154 1/2
14	Limestone, in part a porous breccia, reddish brown, fine-crystalline, in part silty, thin-bedded	6	152 1/2
13	Siltstone, calcareous, light grey, finely laminated, weathers light grey to yellow-grey in beds 1/4 inch to 4 inches, a few limestone breccia beds, recessive	14 1/2	146 1/2
12	Limestone breccia, light brownish grey, fine-crystalline, porous, trace of fine laminations, weathers yellow-grey to grey, thin-bedded	3	132
11	Dolomite, slightly silty, micro-crystalline, in part fine-grained, light to medium grey, in part finely laminated, weathers yellow-grey to light grey in beds 3 to 18 inches, recessive.	16	129

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Southesk Formation (224 1/2 feet)		
	Ronde Member (113 feet)		
10	Limestone, dark grey, fine-grained crinoid fragments, weathers light grey in beds 1 foot to 2 feet, resistant. Thin section: tightly packed (compressed), well-sorted composite grains and crinoid ossicles with optically continuous overgrowths, cemented by micro-crystalline and sparry calcite; calcite-filled fractures	23	113
9	Dolomite, silty(?), light grey, microcrystalline, trace of laminations, weathers yellow to light grey, indistinct beds, recessive	10	90
8	Limestone, dolomitic, light brownish grey, microcrystalline, finely laminated, weathers light grey in beds up to 5 feet with 1/2- to 6-inch partings	15	80
7	Limestone, microcrystalline, in part fine- to medium-grained, dark to medium grey, numerous Thamnopora, weathers light grey in beds 1 foot to 3 feet, resistant	8	65
6	Dolomite, slightly calcareous, light grey, microcrystalline, finely laminated, weathers light grey to yellow-grey in beds 1/4 inch to 4 inches	7	57
5	Dolomite, calcareous, medium to light grey, microcrystalline, weathers light grey in beds 1 foot to 2 feet	6 1/2	50

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
4	Siltstone, light grey, finely laminated, weathers light grey to yellow-grey in beds 1/4 inch to 2 inches	9	43 1/2
3	Limestone, dolomitic, in part argillaceous, medium grey, microcrystalline, weathers medium grey, thin-bedded	7 1/2	34 1/2
2	Limestone, slightly argillaceous, light grey, microcrystalline, finely laminated, small slump structures, laminations highly contorted, weathers light grey and yellow-grey in 4-inch to 1-foot beds	8	27
1	Partly covered. A few outcrops of limestone, argillaceous, medium grey, microcrystalline, laminated, traces of Syringopora and corals, weathers medium to light grey, very recessive, beds 1 foot to 3 feet	19	19
	Upper Aphanitic Limestone Member (79 1/2 feet)		
	Limestone, light grey, crypto- to microcrystalline, weathers very light grey in 1 foot to 4 foot beds, resistant, part of underlying unit	16	
	Limestone, very fine grained, dark grey, some stromatoporoids(?), grades into dolomite, calcareous, fine-crystalline in basal 15 feet, weathers light to medium grey, massive beds greater than 1 foot	38	
	Limestone, light to medium grey, crypto- to fine-crystalline, few lenses of dark grey dolomite, Thamnopora(?), weathers light grey in one bed.	11	