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DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA
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STRATIGRAPHY OF THE LEWES RIVER GROUP (TRIASSIC), CENTRAL LABERGE AREA, YUKON TERRITORY

By
E. T. Tozer

EDMOND CLOUTIER, C.M.G., O.A., D.S.P.
QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
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PREFACE

It has been known for some time that the Triassic rocks of the central part of the Cordillera are different from those to the east and northeast, and that they contain a different fauna. The stratigraphic sequence and the fauna of the eastern succession have received considerable attention but, except for information and collections obtained incidentally during the course of regular mapping, little was known of the interior belt. The fact that many important mines are in these rocks made it imperative that a detailed study be made in order to provide a standard of reference for subsequent investigations.

One of the sequences of Triassic rocks of the interior belt known to contain fossils was the Lewes River group in southern Yukon, and this the author studied in detail. The stratigraphic sequence is described in this report and the fossils characteristic of each unit are listed. This type section will provide a standard for further studies of Triassic rock throughout the interior Cordilleran belt.

J. M. HARRISON,
Director, Geological Survey of Canada

OTTAWA, May 23, 1957

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INTRODUCTION

In south-central Yukon Territory a northwesterly trending synclinorium has preserved an extensive terrain of Mesozoic sediments in an area otherwise dominated by older rocks and Mesozoic intrusions. Lake Laberge lies near the centre of this structural feature, which extends for at least 150 miles along strike and is up to 60 miles wide. J. O. Wheeler (1956)[1] has recently shown that this synclinorium was developed on the site of a Mesozoic geosyncline which he has named the "Whitehorse trough". Wheeler has demonstrated that the older formations that flank the synclinorium today probably contributed much sediment to the trough in Mesozoic time and that a volcanic arc to the west also provided much geosynclinal fill. From Wheeler's studies it would appear that the present outline of the synclinorium corresponds fairly closely with that of the trough in which the Mesozoic rocks were deposited.

Several geologists have conducted reconnaissance surveys in this region and three units of Mesozoic sedimentary rocks have been recognized. They are: the Lewes River group (Triassic), the Laberge group (Jurassic), and the Tantalus formation (Upper Jurassic or Lower Cretaceous). Volcanic rocks believed to be of Mesozoic age are also widespread in the synclinal area. Throughout much of this area continuous rock exposures are rare, the structure is complex and fossils are generally rare or poorly preserved. These features combine to make difficult the determination of the Mesozoic succession in southern Yukon.

This report is concerned with the stratigraphy of the Lewes River group in the northern, but not northernmost, part of the synclinal area. The area studied lies within the Laberge map-area (Bostock and Lees, 1938). In particular, the area investigated comprises: the Hancock hills, which lie on the east side of the northern part of Lake Laberge; and the discontinuous range of hills that lies east of Lewes (Thirtymile) River[2] and extends from near Lower Laberge, north, to Maunoir Butte. This area lies within latitude 61°10′ and 61°35′ north, and longitude 135°00′ and 135°15′ west. (*See* Figure 2, in pocket.)

In the course of reconnaissance work in the Laberge area H. S. Bostock and E. J. Lees (Lees, 1934; Bostock and Lees, 1938) tentatively suggested that a relatively simple threefold division might exist within the Lewes

[1]Dates in parentheses are those of references cited at the end of this report.

[2]The name Yukon River now applies to the entire course of the main stream, whereas that part above the confluence with Pelly River was formerly known as Lewes River. The stretch between Lake Laberge and Teslin River is now known as "The Thirtymile".

River group. It was suggested that the group comprised an upper limestone, a middle formation of clastic rocks, and a lower unit of limestone. The writer undertook relatively detailed studies, particularly in the hills east of Lewes River valley, with two principal objects (1) to define the boundaries and establish the rock succession in the type area of the Lewes River group, and (2) to determine a sequence of faunas that might assist in elucidating the Triassic sequence in other parts of the Western Cordillera. Concerning the first object, the Lewes River group has been divided into seven formations which are designated in ascending order by the letters A to G. Formations C, E, and G consist entirely of limestone; formations B and D are composed mainly of clastic rock; and formations A and F include both limestone and clastic strata. The lowest formation (A) is believed to represent the base of the Lewes River group and to rest on andesites of Triassic or earlier age. With regard to the second object, several faunules have been collected from these formations and all are apparently of Upper Triassic age. The most widely distributed fauna in the Lewes River group is an assemblage characterized by corals, the brachiopod *Spondylospira*, pelecypods, and rare ammonites. The position of this fauna within the Upper Triassic series was formerly uncertain. It is shown to occur only in formations F and G and to represent the upper part of the Norian (mid-Upper Triassic) stage. The cosmopolitan Norian fauna with *Monotis subcircularis* occurs in formation D, below the beds carrying the *Spondylospira* assemblage. Faunules of early Upper Triassic (Karnian) age occur in formations A and C.

Field work was undertaken in 1953 and the writer was assisted by D. W. Paape, R. Lee and D. J. Nevill.

STRATIGRAPHY OF THE LEWES RIVER GROUP

Definition and Distribution

The occurrence of massive, grey, white weathering limestones on the east shore of Lake Laberge, and in the neighbourhood of Lewes (Thirtymile) River was noted by G. M. Dawson (1889) and D. D. Cairnes (1910). Cairnes named these rocks the "Braeburn limestone" and on purely lithological grounds tentatively referred them to the Carboniferous.

In 1930 W. E. Cockfield and E. J. Lees (1931) collected Upper Triassic fossils in the Laberge area, from both limestone and clastic rocks. At first they used the name "Braeburn Series" for these Triassic rocks, but Lees (1934, p. 12) later introduced the name "Lewes River Series" for the Triassic limestones and clastic rocks of the Laberge area, and restricted the use of "Braeburn limestone" to the Palæozoic limestone occurring in the region. This practice is perhaps not justified on grounds of priority, for the rocks exposed near Braeburn are of Triassic age. However, "Lewes River Series", and more recently "Lewes River group", have proved acceptable to the later workers who have dealt with the Triassic rocks of southern Yukon (Bostock, 1936; Bostock and Lees, 1938; Wheeler, 1952), and this usage is followed in the present report. Although no type section or area has been formally designated for the Lewes River group, it seems reasonable to conclude that the exposures adjacent to Lewes (Thirtymile) River may be accepted as the standard. The type sections of the seven formations recognized within the group by the writer lie on the east side of Lewes River, between Casca Creek and Maunoir Butte.

In addition to the type area with which this report is concerned, Lewes River group strata are also known in other parts of Laberge area (Bostock and Lees, 1938); in Little Salmon area, to the north (Cockfield, 1929); in the southeast part of Carmacks area, to the northwest (Bostock, 1936); and recent mapping has shown that the group occupies large parts of Whitehorse area, to the south (Wheeler, 1952). The limestones exposed east of Teslin River in Laberge area, and mapped as Lewes River group on the Laberge sheet, have not provided any Triassic fossils. Bostock and Lees (1938, p. 11) suggest that these limestones may be of Palæozoic age.

It is not known to what extent the seven formations distinguished in the type area of the Lewes River group can be recognized elsewhere in southern Yukon. There is some evidence that the two upper formations (F and G) can be recognized throughout much of Laberge area. According to Wheeler (1952) the Lewes River rocks of Whitehorse area include much volcanic material and are not very like the contemporary rocks in Laberge area. It would seem, therefore, that a considerable change in facies takes place within the Lewes River group between Laberge and Whitehorse areas.

Lower Boundary

Bostock and Lees (1938, p. 11) were unable to define the base of the Lewes River group. The only pre-Triassic fossils known in the Laberge area were obtained by Lees from a body of limestone southwest of Big Salmon. This limestone is surrounded by volcanic and intrusive rocks. The fossils include poorly preserved productids of Carboniferous or Permian age (Lees, 1934, p. 12). The rocks that provided these fossils are far removed from any known occurrence of the Lewes River group and consequently Lees was unable to determine the stratigraphic relationship between the Palæozoic and Triassic rocks.

The lowest Lewes River rocks recognized by the writer (formation A) outcrop in the lower part of Donville Creek and in the hills to the north and south. In this area the Triassic beds dip east. To the west, topographically below the Lewes River rocks, there occurs a belt of massive green andesitic rocks. The boundary between these and the Lewes River rocks parallels the strike of the Triassic strata. No primary structures were detected in the volcanic rocks. These volcanic rocks were mapped as the "Hutshi group" by Bostock and Lees, as were practically all the pre-Tertiary volcanic rocks in Laberge area. The typical Hutshi volcanic rocks are believed to be younger than the Tantalus formation (Upper Jurassic or Lower Cretaceous), according to Lees (1934, p. 29). If the volcanic rocks west of formation A are truly younger than the Tantalus beds, a fault must lie between the volcanic rocks and the Lewes River strata. No evidence for such a fault has been found; indeed, the parallel alignment of the boundary between the volcanic and Lewes River rocks with the strike of the Lewes River beds favours an argument to the contrary. The writer suggests that in this area the Lewes River rocks overlie the volcanic rocks. This cannot be definitely established, however, for there are no exposures of the contact.

Recent mapping in the region surrounding the Laberge area (Kindle, 1953; Wheeler, 1952; Muller, 1954) has shown that late Palæozoic and early Mesozoic volcanic rocks are widespread in southern Yukon. It therefore seems possible that some of the volcanic rocks mapped as "Hutshi group" in Laberge area may be older than the marine Triassic formations. Much of the Lewes River clastic rock was evidently derived from a volcanic terrain, which tends to support the suggestion that Triassic or older volcanic rocks may be present in Laberge area. The suggestion that the Lewes River group is underlain by a volcanic formation thus seems compatible with the evidence from surrounding areas.

It, therefore, seems probable that a volcanic formation underlies the Triassic sedimentary rocks in Laberge area and that formation A represents the basal unit of the Lewes River group. The fossils collected from formation A are apparently of Upper Triassic age and possibly represent the

lower part of the Karnian stage (earliest Upper Triassic). Lower and Middle Triassic faunas are unknown in the Lewes River group, but this does not conflict with the suggestion that formation A represents the base of the group. Lower or Middle Triassic faunas are not certainly known in southern Yukon, in British Columbia west of the Rocky Mountain Trench (Armstrong, 1946, p. 8; McLearn, 1953), or in southern and southeastern Alaska (Martin, 1926, p. 5). The available evidence suggests that widespread volcanicity took place between the deposition of the late Palæozoic and Upper Triassic sedimentary rocks throughout this region.

Upper Boundary

The Jurassic rocks that overlie the Lewes River group were named the "Laberge Series" by Cairnes (1910). Cairnes believed that the basal Laberge beds were composed of conglomerate that rested unconformably upon the "Braeburn limestone" (=Lewes River group). Later workers (Lees, 1934; Bostock and Lees, 1938) have shown that in some parts of Laberge area relatively fine-grained clastic rocks, with Hettangian and Sinemurian (early Lower Jurassic) fossils, lie between the lowest Laberge conglomerate and the Lewes River rocks. Lees and Bostock further suggest that in other parts of the area the conglomerate may rest directly upon the Triassic strata, perhaps with unconformity.

The writer has little to contribute to the study of this relationship for no extensive Laberge outcrops occur within the area investigated. No certain exposures of the Lewes River-Laberge contact were seen, but throughout the area mapped by the writer the two groups are structurally conformable and there is nothing to suggest that a marked angular unconformity separates the Triassic and Jurassic strata. However, as noted below, there is some evidence that a shallow erosional unconformity may occur between the two groups.

On the east shore of Lake Laberge, between 6 and 11 miles south of the outlet of the lake, the lowest Laberge strata exposed comprise black and green shales. These beds contain poorly preserved belemnites.

Farther north, at Goddard Point, the lowest Laberge rocks seen consist of dusky red weathering conglomerate, composed of poorly sorted pebbles, mainly of green volcanic rock, up to 6 inches in diameter. A covered interval separates this conglomerate from the highest Lewes River rocks (formation G).

Conglomerate also forms the lowest part of the Laberge group exposed above the Triassic section east of Lewes (Thirtymile) River. The conglomerate in this area is at least 50 feet thick, includes thin interbeds of sandstone, and contains pebbles, up to 8 inches in diameter, composed of greywacke, volcanic rock, limestone, and light coloured intrusive rock.

In this area, as at Goddard Point, a covered interval separates the Lewes River and Laberge groups. Within this area, east of Lewes (Thirtymile) River, there are variations in the highest Lewes River rocks exposed. North of Donville Creek the uppermost Lewes River limestone (formation G) underlies the Laberge beds; south of the creek the Laberge conglomerate lies adjacent to the interbedded clastic and limestone strata of formation F, and formation G is apparently not present. The apparent local absence of formation G may indicate that an interval of erosion occurred between the deposition of the Lewes River group and the Laberge conglomerate.

Subdivision

E. J. Lees (1934, p. 10) suggested that three divisions existed within the Lewes River group of the Laberge area. His divisions were a lower limestone, a middle clastic unit and an upper limestone. On the Laberge Sheet, published in 1936, and in the memoir that accompanied it (Bostock and Lees, 1938), this interpretation is again suggested. The clastic rocks of the middle division described by Lees include beds of three different facies, as follows:

1. A thick sequence of greywackes and conglomerates, with thin beds of arenaceous limestone. These beds were studied by Lees on the southeast side of Maunoir Butte and in the hills to the south. Lees found no fossils in these beds.

2. Thin-bedded, fine-grained, in part calcareous, shale and siltstone, containing *Monotis*, *Halobia* and poorly preserved ammonites. Lees studied these beds on the west side of Maunoir Butte.

3. A sequence composed of red and green greywacke, shale, and fossiliferous limestone. Lees collected a considerable fauna from these beds, which he examined in particular detail on the west side of Klusha Valley, northeast of the old Braeburn roadhouse. This area lies about 20 miles west of the localities where the other clastic rocks were examined.

In order to determine the relationship between the clastic and limestone units within the Lewes River group the writer mapped the exposures on Maunoir Butte and in the hills to the south (*see* Figure 2), that is to say in the area where Lees studied the rocks of facies 1 and 2, mentioned above. In this area several small outcrops were found in addition to those described by Lees, and these additional outcrops include some that resemble lithologically and faunally the rocks that he examined near Braeburn. The relationship of the clastic beds to one another, and to the limestones of the Lewes River group, shows that the three clastic facies recognized by Lees represent distinct formations separated by units of limestone rather than a single clastic formation. The evidence for this conclusion is as follows.

Table of Formations

Series	Stage	Group	Formation and approximate thickness (feet)	Lithology	Characteristic fossils
Upper Triassic	Norian	Lewes River	G 800–1,000	Massive, light grey, limestone	*Spondylospira lewesensis*, *Mysidea shulapsensis*, *"Variamussium" yukonensis*, *Trigonia textilis*, *"Neomegalodus"* n. sp., *Paracochloceras* sp.
			F 900	Upper member: grey limestone, green and brown greywacke, shale	
				Lower member: green, dusky red and reddish purple greywacke, shale	
			E 500	Massive, light grey, limestone	
			D 500	Grey and black siltstone, shale and argillaceous limestone	*Monotis subcircularis* *Rhabdoceras suessi*
	Karnian or Norian				*Halobia* sp., group of *H. rugosa*
	Karnian		C 500	Bedded greyish black limestone, some chert	*Mysidioptera* cf. *poyana*
			B 1,600	Grey and green greywacke, conglomerate, andesite	
			A 2,000?	Light and dark grey, mainly massive, limestone, in part feldspathic; greywacke and shale in lower part	*Trachyceras aonoides* ?

On the southeast side of Maunoir Butte (*see* Figure 3, section 5), poorly exposed argillaceous beds with *Halobia* (representing facies 2, above, of Lees) lie between two limestones. The lower limestone in this section overlies the thick sequence of greywackes, etc., (facies 1) described by Lees.

In the hills south of Donville Creek (*see* Figure 3, section 2), clastic beds with interbedded fossiliferous limestones, resembling both faunally and lithologically the rocks examined by Lees near Braeburn (facies 3), occur. These clastic beds overlie a limestone that in turn rests on argillaceous beds with *Monotis* (facies 2, of Lees).

The exposures on the southeast side of Maunoir Butte and south of Donville Creek are therefore very critical, for they establish that the three clastic facies recognized by Lees form a stratigraphic sequence, with limestone between the clastic units. In ascending order these clastic formations are: the thick sequence of greywackes, etc., (facies 1); the *Monotis* and *Halobia* bearing argillaceous beds (facies 2); and finally, highest of all, the interbedded greywackes, shales, and fossiliferous limestones (facies 3). In this account these units are named formations B, D and F, respectively.

It should also be stated that on Donville Creek the clastic beds of formation B are underlain by a unit composed of limestone with some interbedded greywacke and shale. This unit, beneath formation B, will be referred to as formation A. Formation A represents what is believed to be the basal formation of the Lewes River group.

Furthermore, the highest clastic formation (F) is overlain by a massive limestone, both in the Donville Creek area and on the east shore of Lake Laberge. The limestone constitutes the uppermost unit of the Lewes River group and is designated formation G.

In all, seven distinct formations have therefore been recognized within the Lewes River group of the Maunoir Butte-Lake Laberge area. This sequence is summarized in the table of formations (p. 7).

FORMATION A

Lithology and Fauna

On the east side of Lewes River, east of U.S. Bend, a belt of limestones with some interbedded clastic strata lies between the volcanic rocks believed to underlie the entire Lewes River group and the succeeding greywacke, etc., of formation B. This unit of limestone, etc., is referred to as formation A.

Discontinuous exposures of formation A occur along Donville Creek and in the hills to the north and south. Most of the section is concealed by drift and the structural attitude of the various limestone units can rarely be determined, owing to the massive nature of the rocks. These limestones constitute the only well exposed part of the formation and without knowing their attitude it is impossible to make a reliable estimate of the total

thickness of formation A. The order of thickness is probably 2,000-3,000 feet. In the section on Donville Creek, wherever the structure can be determined, the beds are seen to dip to the east or are vertical. No evidence of repetition of strata has been found. Intrusive masses of light coloured felsitic rock occur throughout the type area of formation A and further complicate the determination of sequence.

In the following account the outcrops encountered in traversing upstream on Donville Creek are described. Discontinuity of exposures precludes compiling this data as a section of the whole formation. Nevertheless, the consecutive outcrops are believed to represent successively higher beds in formation A.

The lowest exposures of formation A outcrop about 1,600 feet above the mouth of Donville Creek. There (fossil locality 1) the following section was measured.

Unit No.		Measured down thickness in feet	
		Unit	Total from base
3	Limestone, grey, medium-grained, fragmental; forming poorly defined beds about 1 foot thick; fossiliferous with poorly preserved spiriferids, *Myophoria* sp., *Ostrea* ? sp. (G.S.C. Catalogue No. 23395)	6.0	24.5
2	Greywacke, green, fine-grained	0.5	18.5
1	Limestone essentially as unit 3, but more clastic texture with carbonate pebbles up to 1 inch in diameter	18.0	

The next good outcrop upstream lies about 2,000 feet from the mouth of Donville Creek. It is separated from the lowest exposures, described above, by small outcrops of dark grey limestone intruded by light coloured felsite. The outcrop 2,000 feet from the creek mouth (fossil locality 2) includes about 60 feet of beds comprising interbedded greyish green, fine-grained greywacke; fine-grained greywacke consisting of alternating irregular laminæ, about $\frac{1}{10}$ inch thick, of black and greyish green colour; and medium- to thin-bedded dark grey limestone. From a laminated greywacke near the base of this sequence poorly preserved ammonites and pelecypods were collected. The pelecypods include specimens of *Halobia* or *Daonella* and the ammonites are crushed trachyceratids that resemble *Trachyceras aonoides* (Mojsisovics) in degree of involution and lateral ornament (G.S.C. Catalogue No. 23438). Unfortunately the characters of the venter cannot be seen and this determination cannot be positively established.

The next overlying beds occur at the mouth of the small tributary to Donville Creek, where about 50 feet of apparently vertical light grey limestone outcrop. Upstream from this locality, for a distance of about 750 feet, are poor exposures of black shale and grey limestone, intruded by felsite. These exposures continue to the foot of a small waterfall that occurs about 3,000 feet above the mouth of Donville Creek. At the waterfall (fossil locality 3) is exposed about 50 feet of light grey, thick-bedded, fossiliferous limestone, which apparently overlies the poor exposures of black shale and grey limestone. The fossiliferous limestone of locality 3 (G.S.C. Catalogue No. 23394) contains poorly preserved corals, brachiopods, and pelecypods. Crinoid columnals, large echinoid radioles and an occasional echinoid test also occur at this locality. East of the limestone exposed at the waterfall there are no further exposures of formation A for about $\frac{3}{4}$ mile, but north and south of the creek there are massive exposures of grey limestone that are roughly on strike with this interval.

The highest known exposures of formation A are discontinuously exposed in Donville Creek at a distance from $1\frac{1}{2}$ to $1\frac{3}{4}$ miles above the mouth of the stream. This part of the section comprises limestone with felsite intrusions. The lower limestones include medium- to coarse-grained, in part crinoidal, fragmental limestone containing much non-carbonate material, including clastic feldspar and fragments of green volcanic rock. These impurities in the limestone impart a red or brown colour to the weathered surface. Rocks of this unusual lithology have not been seen in any other formation within the Lewes River group. The clastic limestone is overlain by light grey, massive limestone, which represents the uppermost known part of formation A.

Outcrops of formation A in the hills north and south of Donville Creek form ridges of limestone separated by areas with no exposures. No outcrops of the clastic beds that occur in the lower part of the creek section have been found in these hills. The limestone in the hills bordering Donville Creek resembles that exposed in the creek and some contains poorly preserved fossils. Some of the limestone that outcrops on the eastern edge of the belt mapped as formation A is distinctly clastic in texture and resembles that occurring in the upper part of the creek section. Probably a member of such clastic limestone characterizes the upper (but not uppermost) part of formation A.

Age

The age of formation A cannot be precisely determined at present owing to the poor preservation of the fossils. If the ammonites compared with *Trachyceras aonoides* truly represent that species, Lower Karnian (earliest Upper Triassic) strata are represented. The fossils are too poorly preserved to establish this precise dating but they are nevertheless almost certainly of Upper Triassic age.

FORMATION B

Lithology and Fauna

Formation A is overlain by a sequence of rocks consisting essentially of greywacke, together with some rocks of volcanic origin, which is here termed formation B. No exposures of the contact between formations A and B occur within the area studied. However, for about 4 miles along strike, the strata assigned to formation B dip uniformly east and apparently overlie the upper limestone of formation A (*see* Plate I). The order of succession thus seems well established despite the absence of outcrops at the boundary. The exposures 3 miles south of Donville Creek, although intermittent, may be considered typical of formation B for there alone is displayed the relationship with the overlying and underlying limestones (formations C and A, respectively). The sections described by Lees (1934 p. 14) on Maunoir Butte, and in the hills 2 miles to the south, represent formation B as here defined.

Graphic measurements suggest a total thickness of about 1,600 feet for formation B at the type section south of Donville Creek. The exposures there are poor and intermittent and comprise grey and green, medium- to coarse-grained, reddish brown weathering greywacke and grey and green shale. The thickness of the type section may not represent a reliable figure, for the section north of Donville Creek described by Lees is about 2,000 feet thick without an exposed base. These variations in thickness cannot be explained; they may indicate variations in the thickness of sediment deposited but alternatively they may also be due to unrecognized, and probably unexposed, structural complications.

The following section of the beds exposed on the southeast side of Maunoir Butte illustrates the lithology of a substantial part of the formation.

Unit No.		Measured down thickness in feet: Unit	Measured down thickness in feet: Total from base
	Overlying beds: formation C Contact not exposed		
37	Covered interval	113	1,357
36	Greywacke, grey, medium- to fine-grained, weathers dusky red; interbedded with dusky red shale	50	1,244
35	Covered interval	107	1,194
34	Shale, grey, with irregular laminæ and nodules of calcareous shale	49	1,087
33	Shale, essentially as unit 34; non-calcareous beds thinly bedded, calcareous beds thicker bedded and weather brown	36	1,038
32	Greywacke, dusky green, medium- to coarse-grained, weathering in part dusky red; exposures intermittent	260	1,002

Unit No.		Measured down thickness in feet	
		Unit	Total from base
31	Greywacke, dusky green, fine-grained	46	742
30	Greywacke, dusky green, medium-grained, exposures intermittent	52	696
29	Greywacke, dusky green, medium-grained, with interbedded green shale	17	644
28	Covered interval	96	627
27	Greywacke, dusky green, medium-grained	17	531
26	Greywacke, greenish black, coarse-grained	40	514
25	Greywacke, dusky green, calcareous, fine-grained.	10	474
24	Covered interval	14	464
23	Greywacke, grey, calcareous; brown weathering bands standing out in relief	2	450
22	Greywacke, dusky green, calcareous, fine-grained; weathers brown	4	448
21	Covered interval	18	444
20	Greywacke, greenish black, coarse-grained; forms massive bed	14	426
19	Greywacke, greyish olive-green, fine-grained; weathers light brown	10	412
18	Shale, green	1	402
17	Greywacke, grey, medium- to fine-grained, in part calcareous; brown bands stand out in relief on weathered surfaces; *Mentzeliopsis* ? sp. 12 feet from top of unit (G.S.C. Catalogue No. 23423)	36	401
16	Greywacke, grey and green, fine-grained, in part very calcareous; bands of calcareous and non-calcareous greywacke, up to 3 inches thick, alternate; calcareous laminæ standing out in relief; fragmentary *Halobia* or *Daonella* sp. (G.S.C. Catalogue No. 23450)	8	365
15	Mainly covered, small outcrops suggest lithology as in unit 16	26	357
14	Greywacke, grey, fine-grained	7	331
13	Greywacke, greenish grey, fine-grained	6	324
12	Covered interval	11	318
11	Greywacke, dusky green, fine- to medium-grained, calcareous; some interbedded shale.	42	307
10	Covered interval	90	265
9	Greywacke, dusky green, medium- to very fine-grained	50	175
8	Greywacke, dusky green, fine- to very fine-grained; exposures intermittent	89	125
7	Greywacke, dusky green, medium-grained, calcareous	5	36
6	Limestone, grey, feldspathic	1	31
5	Greywacke, dusky green, medium-grained	2	30
4	Greywacke, dusky green, very fine-grained, calcareous bands	10	28
3	Greywacke, dusky green, medium- to coarse-grained	12	18
2	Shale, green	5	6
1	Greywacke, dusky green	1	1

On the northeast side of Maunoir Butte the upper part of formation B includes some volcanic rocks. About 1 mile north-northeast of the small pond within the Butte at least two bands of andesite, in part amygdaloidal, are intercalated with greywacke and shale typical of formation B. Both flows are probably less than 100 feet thick. This is the only section in which volcanic rocks have been positively identified within formation B, but similar rocks may be present in the poorly exposed and covered intervals elsewhere.

The outcrops in the hills between Maunoir Butte and Donville Creek comprise intermittent exposures of about 2,000 feet of greywacke and shale similar to that in the measured section described above. In that area, unlike the section of Maunoir Butte, poorly sorted conglomerates, composed of fragments of volcanic rock, shale, and limestone, occur in the upper part of formation B.

No detailed petrographic study of the sedimentary rocks of formation B has been made. Some thin sections were examined and the greywackes were seen to consist mainly of feldspar with abundant serpentine. In the coarse-grained varieties, fragments of porphyritic and amygdaloidal lava are commonly present. Detrital quartz is very rare in all rocks of formation B. Much of the material may constitute water-lain tuff.

From the foregoing lithological descriptions it appears that formation B includes a wide variety of clastic rocks, varying considerably in texture, but apparently essentially homogeneous in mineral composition. Much of the material in formation B was presumably derived from the breakdown of basic igneous rocks, and much may be of pyroclastic origin. The intimate connection between formation B and a volcanic terrain is also shown by the occurrence of andesite in the upper part. Nevertheless, the greater part of the formation was probably deposited in water, for the strata are generally well bedded and locally contain marine fossils.

Age

Pelecypods referable to either *Halobia* or *Daonella* occur in formation B on Maunoir Butte. Their presence, however, merely establishes that the formation is of Middle or Upper Triassic age. In view of the age assigned to formations C and A, above and below, an early Upper Triassic (Karnian) age seems probable for formation B.

FORMATION C

Lithology and Fauna

The greywackes, etc., of formation B are overlain in structural conformity by a limestone which is termed formation C. The conformable relationship between formations B and C is well displayed on Maunoir Butte and in the hills to the south. The section on the southeast side of Maunoir Butte may be considered typical (*see* Figure 3, section 5 and Plate II B).

No exposures showing the contact between formations B and C occur within the area studied. Formation C is widely distributed in the Maunoir Butte-Donville Creek area and many partial sections occur owing to repetition by faulting. On the west side of Maunoir Butte the limestone has apparently been overfolded.

The limestone of formation C is greyish black, aphanitic to fine grained and weathers light grey. It is well bedded in units from 2 to 10 feet thick. Nodules of black chert occur in some beds but are not common. Fossiliferous fragmental limestone, some of which is crinoidal, also forms a minor constituent. The total thickness exposed in the type area is about 420 feet; graphic measurements suggest that the whole formation is about 500 feet thick. Formation C possesses the most distinctive lithology of all the Lewes River limestones; in no other part of the group are well bedded, dark grey limestones present in substantial thickness. Formation C is moderately well exposed in the Maunoir Butte-Donville Creek area and the good exposures, combined with the distinctive lithology, make it an invaluable horizon marker in the interpretation of structure.

Age

Fossils are not common in formation C. The best collection was obtained at locality 5, on the east side of Lewes River valley, $1\frac{1}{4}$ miles south of Aksala Creek (G.S.C. Catalogue Nos. 23427, 23447). This collection was obtained from a thin bed of bioclastic limestone 225 feet below the highest exposures. The fauna includes a terebratuloid brachiopod identical with that determined as "cf. *Dielasma julicum* Bittner" by Lees (1934, p. 33), together with gastropods and pelecypods that include *Mysidioptera* cf. *poyana* (McLearn). Lees collected his brachiopods at Lewes Mountain, 5 miles west from this locality. The Triassic terebratuloid brachiopods of North America have not been studied sufficiently to provide a reliable basis for age determination, so that the significance of the form from formation C cannot be appraised. However, the species of *Mysidioptera* resembles closely and is perhaps identical with *M. poyana*, which occurs in the upper part of the Grey beds (Karnian) of northeastern British Columbia (McLearn, 1953, p. 1221). Furthermore, the genus *Mysidioptera* is particularly abundant in rocks of Karnian age throughout the world, and coarsely ribbed species, such as *M. poyana* are nearly confined to that stage. The evidence, although meagre, definitely favours a Karnian (early Upper Triassic) age for formation C.

FORMATION D

Lithology and Fauna

The stratigraphic interval between the limestones of formations C and E contains very few exposures, but outcrops at three localities show that a distinctive assemblage of thinly bedded rocks occupies this part of the

section. These rocks contain two faunal zones, a lower zone characterized by *Halobia*, and an upper assemblage with *Monotis*. This unit is designated formation D. The best exposures are on the west side of Maunoir Butte and this section is considered typical (*see* Figure 3, section 4; Plate II A). No complete section for formation D is exposed within the area, or are outcrops showing the upper and lower contacts present. On the southeast side of Maunoir Butte the stratigraphic interval between the limestones that lie above and below formation D is about 500 feet, so that its thickness does not exceed, and probably approximates that figure.

At the type section on Maunoir Butte (localities 6 and 7) the following sequence is exposed.

Unit No.		Measured down thickness in feet: Unit	Measured down thickness in feet: Total from base of section
	Overlying beds: formation E Contact not exposed		
2	Covered interval; abundant talus of thin-bedded, black, argillaceous limestone with *Monotis subcircularis* Gabb (G.S.C. Catalogue No. 23389).....	153	268
1	Shale and siltstone, greyish black and dark olive-grey, in part calcareous, thin-bedded; *Halobia* sp., group of *H. rugosa* Gümbel occurs throughout, *Juvavites* sp. and other poorly preserved ammonites within upper 10 feet (G.S.C. Catalogue Nos. 23406, 23422, 23424).....	115	

Formation D is also exposed on the southeast side of Maunoir Butte (locality 8), where about 30 feet of grey calcareous shale, carrying poorly preserved shells of *Halobia* (G.S.C. Catalogue No. 23410), lie between the limestones of formations C and E.

The only other outcrop area known for formation D is 4 miles southeast of the mouth of Donville Creek (locality 9). There small outcrops of black argillaceous limestone, with some talus of shale, intermittently represent a stratigraphic interval of about 10 feet. Fossils obtained at this locality (G.S.C. Catalogue Nos. 23457, 23459) include:

Monotis subcircularis Gabb
Rhacophyllites sp.
Halorites sp. indet.
Rhabdoceras suessi Hauer

The record of *Halorites* from this locality is based on a single well preserved specimen of the inner whorls of a catenate species.

Age

The fossils collected from formation D clearly show that two faunas are represented, the lower characterized by *Halobia* and the upper by *Monotis*. Lees (1934, p. 14) identified the *Halobia* from the type section of formation D as *H. ornatissima* Smith and he referred the associated ammonites to *Juvavites subinterruptus* Mojsisovics. He concluded that the *Halobia* beds were of Karnian (early Upper Triassic) age, for these species characterize that stage. The writer has examined Lees' collection together with additional material from the same locality; the fossils are unquestionably of Upper Triassic age, but the rather poor preservation does not, in the writer's opinion, permit an identification at specific level. An early Norian (mid-Upper Triassic) age seems equally possible for the *Halobia* beds of formation D.

The upper fauna with *Monotis* was correctly dated as Norian by Lees, but his statement that the fossils represent a zone near the base of the Norian cannot be accepted for it has been clearly shown by McLearn (1953, p. 1221) that *Monotis subcircularis* characterizes the late Norian, and that the genus does not occur in basal Norian strata.

Formation D, therefore, definitely includes strata of Norian age. The lower limit of the formation in terms of the International stages is not known, but it certainly does not range lower than Karnian, and, in view of the great thickness of Karnian strata in the formations below, it seems likely that formation D is entirely of Norian age.

FORMATION E

Lithology

The thinly bedded clastic rocks of formation D are overlain by limestone which is designated formation E. The stratigraphic position of formation E is best seen 4 miles southeast of the mouth of Donville Creek, where it overlies the poor but fossiliferous exposure of formation D, and is succeeded by the red and green greywackes that characterize the lower part of formation F. This section may be considered the type (*see* Figure 3, section 2). The position of formation E with respect to the underlying beds is also well displayed on the west and southeast sides of Maunoir Butte (*see* Figure 3, sections 3 and 4; Plate II A and B).

The greater part of formation E comprises medium grey, commonly fine-grained, light grey weathering, massive limestone. The lowest exposures in the type section include about 20 feet of well bedded, dark grey limestone. This lithology has not been seen at other localities, perhaps owing to the absence of exposures of the same stratigraphic interval. The massive nature of most of formation E prevents a precise measurement of its thickness, but graphic measurements suggest a figure between 400 and 500 feet.

Lithologically the limestone of formation E has no really distinctive features. Isolated outcrops cannot be distinguished from some limestone in formation A or from the unfossiliferous parts of formation G. The outcrops between Donville and Aksala Creeks mapped as formation E are so treated solely on the basis of their position with respect to the easily identified formation C. In this area a covered interval, presumably representing formation D, lies between the two limestones of formations C and E (*see* Plate II B).

No determinable fossils were collected from formation E.

Age

Formation E is presumably of Norian (mid-Upper Triassic) age for Norian strata occur both above and below.

FORMATION F

Lithology and Fauna

Formation F comprises a varied sequence of beds, including greywacke, shale, and limestone, which overlie the massive limestone of formation E. The upper beds of this formation are well exposed in the hills on the east side of Lake Laberge, but the base is nowhere exposed in this vicinity. The section considered typical occurs in the hills between Donville and Aksala Creeks (*see* Figure 3, section 3). Exposures are poor in this area but the relationship to the limestones above and below (formations G and E) may be demonstrated.

Two members may be distinguished in formation F: a lower member consisting essentially of reddish and green, commonly calcareous greywacke; and an upper member of interbedded green and grey, in part brown weathering, greywacke, green shale, and grey limestone. The limestones in the upper member are commonly fossiliferous.

The total thickness of formation F in the type area is probably about 900 feet. This figure represents an estimate of the stratigraphic interval between the limestones of formations E and G. The actual exposures of formation F are very poor but they include typical outcrops of both the lower and the upper members.

The rather distinctive dusky red and greyish purple strata of the lower member form poor outcrops in the core of the anticline on the east shore of Lake Laberge, at Goddard Point. Poor exposures of similar beds are present in the hills north and south of Donville Creek, although no exposures were found in the creek itself.

The upper member is better exposed. The following section illustrates the lithology of the uppermost beds of formation F on the east shore of Lake Laberge, 11 miles south of Lower Laberge (*see* Figure 3, section 1 and Plate III) where it is best exposed. The section was measured in vertical beds on what is interpreted as the east limb of an isoclinal anticline.

Unit No.		Measured down thickness in feet: Unit	Measured down thickness in feet: Total from base of section
	Overlying beds: formation G Contact exposed, sharp, conformable		
13	Greywacke, green, coarse- to fine-grained, somewhat calcareous; in part weathers light brown, some interbedded green shale	18	328
12	Covered interval	20	310
11	Shale, green, interbedded with limestone beds up to 2 feet thick	22	290
10	Covered interval	80	260
9	Limestone, grey, irregularly bedded; fossiliferous: cerioid corals, *Dielasma suttonensis* Lees (non Clapp and Shimer), *Spondylospira lewesensis* (Lees), *"Trigonia" textilis* Lees, *Palaeocardita* sp., etc. (G.S.C. Catalogue No. 23462)	28	188
8	Covered	60	160
7	Limestone, grey, irregularly bedded	3	100
6	Covered interval, talus of greywacke and shale	40	97
5	Limestone, as unit 7	5	57
4	Covered interval	20	52
3	Limestone, as unit 7	5	32
2	Covered interval	15	27
1	Limestone, as unit 7	12	12

Poor exposures of the upper member also occur in the Donville Creek area, along a belt paralleling that formed by scattered outcrops of red and green greywackes of the underlying lower member. There (locality 15), as on the shores of Lake Laberge, the upper member is fossiliferous with *Spondylospira lewesensis*, etc. (G.S.C. Catalogue No. 23407).

The two members distinguished in formation F of the Lake Laberge-Donville Creek area can probably also be distinguished in the section described by Lees (1934, p. 15) northeast of the old Braeburn roadhouse. In Lees' section 700 feet of "red sandstone", probably equivalent to the lower member, underlie about 1,700 feet of interbedded limestone and clastic rocks that evidently represent the upper member. There certainly appears to be a lithological similarity between the two areas, although the thickness at Braeburn given by Lees, is much greater than that estimated for the Donville Creek area.

A very varied invertebrate fauna occurs in the upper member of formation F. Fossils are abundant, widely distributed, and many fairly well preserved. They have been collected from nearly all the outcrops of this member (e.g., at localities 11, 12, 13, 14, 15, 16) and their abundance

in these beds constitutes a distinctive lithological feature. The fauna includes corals, sponges, echinoids, brachiopods, gastropods, pelecypods, and rare ammonites. This distinctive assemblage was discovered by Lees (1934) who described several new species. Many undescribed forms also occur. The following list includes the most widely distributed and characteristic species.

Spondylospira lewesensis (Lees)
Dielasma suttonensis Lees (non Clapp and Shimer)
"Variamussium" yukonensis Lees
Mysidea shulapsensis (McLearn)
Trigonia textilis Lees
Astarte cf. *appressa* Gabb
Paracochloceras sp.

The large, thick-shelled pelecypod identified by Lees as "*Megalodus* sp. nov.", which probably represents an undescribed genus, is also a common member of this fauna.

Age

The fauna of formation F is representative of an assemblage that is widely distributed in southern Yukon and in British Columbia west of the Rocky Mountain Trench. Several of these species (*"Variamussium" yukonensis*, *Mysidea shulapsensis*, and probably *Trigonia textilis*) occur in the Tyaughton group of southern British Columbia (McLearn, 1943). *Spondylospira lewesensis*, *"Variamussium" yukonensis*, *Astarte* cf. *appressa*, and *Paracochloceras* have been identified by the writer from collections made by J. A. Jeletzky from beds overlying shales with *Monotis subcircularis* on the west coast of Vancouver Island. *"Variamussium" yukonensis* has been collected by the writer from the Sutton formation (Clapp and Shimer, 1911) of Cowichan Lake, Vancouver Island. The thick-shelled pelecypod mentioned above has recently been collected by J. G. Souther on Mount Snippaker, on the Iskut River, in the Stikine River region of western British Columbia. All these faunas are of late Norian (mid-Upper Triassic) age and represent a benthonic faunal facies until recently unrecognized in deposits of this age in North America (Tozer, 1954).

FORMATION G

Lithology and Fauna

The highest formation recognized within the Lewes River group is a massive unit of limestone which is designated formation G.

This limestone is well exposed in the Hancock hills, on the east side of Lake Laberge, where it forms vertical and steeply inclined masses on the limbs of isoclinal folds that extend along the shore of the lake. It also occurs on the east side of the range of hills formed by Lewes River rocks between Donville and Aksala Creeks. (*See* Plate III.) The occurrence at

the latter place (*see* Figure 3, section 3) may be considered typical, for there the rocks are not highly disturbed and the relationship to formation F, below, and the overlying Laberge group is clear.

The limestone assigned to formation G is medium grey and weathers to a very light grey. The "white limestone summits" described by Dawson (1889, p. 157B) on the east shore of Lake Laberge are formed by this limestone. The limestone is very massive and is characteristically devoid of bedding planes; this feature makes it difficult to determine the thickness. Eleven miles south of Lower Laberge (*see* Figure 3, section 1) the limestone forms a belt about 800 feet thick separating vertical strata assigned to formation F and the Laberge group. In the type section, a graphic measurement based on the dips observed in the beds above and below suggests a thickness of about 1,000 feet for formation G.

The fauna of the formation G includes corals, brachiopods, gastropods, pelecypods, and ammonites but they are generally poorly preserved and commonly difficult or impossible to collect, owing to the massive nature of the rock.

From exposures on the east shore of Lake Laberge, $5\frac{1}{2}$ miles south of Lower Laberge (locality 17, G.S.C. Catalogue No. 23434) the following were collected:

Spondylospira lewesensis (Lees)
Dielasma suttonensis Lees (non Clapp and Shimer)

At locality 18 (G.S.C. Catalogue No. 23421), $3\frac{1}{2}$ miles northeast of the mouth of Donville Creek, a fossiliferous bed occurs near the base of the type section of formation G. From this bed were collected:

Spondylospira lewesensis (Lees)
Dielasma suttonensis Lees (non Clapp and Shimer)
Ostrea ("*Alectryonia*") sp.

The thick-shelled pelecypod that occurs in formation E also occurs at this locality.

On the east shore of Lake Laberge, $9\frac{1}{4}$ miles south of Lower Laberge (locality 19, G.S.C. Catalogue No. 23419), poorly preserved ammonites (mainly inner whorls of arcestids) together with *Posidonia* sp. were collected.

Age

The brachiopods and pelecypods from localities 16 and 17 show that formation G, in part at any rate, contains the same fauna as the underlying clastic beds of formation F and is therefore of late Norian (mid-Upper Triassic) age. The assemblage with ammonites and *Posidonia* from locality 19 represents a different faunal facies, but owing to the poor preservation this faunule does not contribute to an age determination.

COMPARISON BETWEEN TRIASSIC ROCKS OF SOUTHERN YUKON AND THOSE OF ADJACENT AREAS

McLearn (1953, p. 1207) pointed out that the Triassic rocks of Western Canada show two contrasting types of development. In the eastern system of the Cordillera, namely in the Rocky Mountains and Foothills, the Triassic formations consist mainly of calcareous sandstone, siltstone, calcareous siltstone, shale, and some limestone, and contain no volcanic rocks (*see* Figure 1). Strata of Lower, Middle and Upper Triassic age are present. The Triassic rocks of the western system of the Cordillera, west of the Rocky Mountain Trench, are very different. These Triassic rocks include, or are associated with, much volcanic rock and the only well dated faunas are of Upper Triassic age. Coral beds or reefs are known from several localities in the western system but not in the eastern development. The Lewes River group of southern Yukon clearly has the characteristics of the western facies. This relationship is borne out by the faunal and lithological similarities between the Lewes River group and the Triassic rocks of western British Columbia. The Lewes River group includes much greywacke and some volcanic rocks; the greater part of the group is certainly, and the whole is probably, of Upper Triassic age; and the varied benthonic fauna with corals that occurs in formations F and G is very similar to one occurring at several localities in southwestern British Columbia and perhaps also southeastern Alaska.

J. O. Wheeler (1952, 1956) recently mapped the Whitehorse area and his studies showed that the Lewes River group of that part of the southern Yukon synclinorium represents an even more volcanic and clastic facies than the contemporary rocks of the Laberge region. A particularly interesting section of Wheeler's occurs at Ibex River, near the west edge of the synclinorium. In this section much volcanic greywacke and breccia occurs within the Lewes River group, between a limestone with *Spondylospira lewesensis* (above) and shales with *Halobia* (below). Wheeler concluded that in Triassic time a volcanic arc lay a short distance west of Ibex River and that this arc provided much or all of the volcanic, pyroclastic, and clastic material that went to form the Lewes River group. This same volcanic arc perhaps provided the non-carbonate material that is found in formations A, B, D, and E in Laberge area.

Northeast and east of the southern Yukon synclinorium, in northeastern British Columbia, central Yukon and northern Alaska, the only known Triassic rocks are apparently of the non-volcanic facies that characterizes the Rocky Mountains and Foothills. This facies is evidently present on Yukon River, near Nation River, where Martin (1926, p. 95; *see also* Smith 1927) has described Upper Triassic shales and limestones resting on Permian (?) limestones. This same facies is also represented on and around Liard River, in northeastern British Columbia, where Lower and

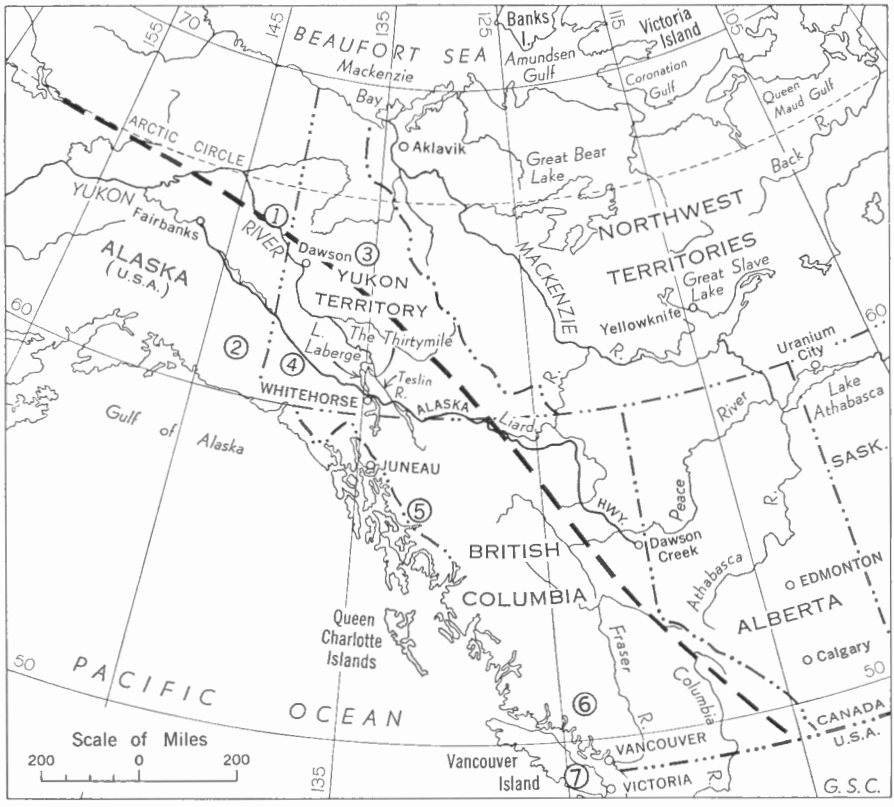

Figure 1. *Index map of British Columbia, Yukon Territory, and Alaska, showing position of Lake Laberge and the stretch of Yukon River known as "The Thirtymile". Also shown are other localities mentioned in the text. 1. Nation River; 2. Chitina Valley; 3. Rackla River; 4. Kluane area; 5. Iskut River area; 6. Tyaughton Creek area; 7. Cowichan Lake. Dashed line indicates the approximate boundary between occurrences of volcanic and non-volcanic facies of Triassic rocks. Outcropping non-volcanic formations are confined to a relatively narrow belt east and northeast of the line. Upper Triassic rocks, associated with, or resting on volcanic rocks are widely distributed west and south of the line. (In part after Cady et al., 1955.)*

Middle Triassic sedimentary rocks rest on Permian strata (McLearn and Kindle, 1950). No Upper Triassic rocks remain in this section for the Liard formation (Middle Triassic) is overlain unconformably by Lower Cretaceous beds. Upper Triassic beds were probably deposited on Liard River and removed prior to Lower Cretaceous deposition. A third possible occurrence of the non-volcanic facies is at the forks of Rackla River, some 200 miles north of the Laberge area, where Keele (1906, *see also* McLearn, 1953, p. 1213) collected *Monotis subcircularis* and other fossils. Keele's locality lies about half-way between the Liard and Nation Rivers' occur-

rences and all three are, broadly speaking, on strike with one another. This suggests that the Triassic rocks on Rackla River, like those of Liard and Nation Rivers, may represent a non-volcanic development.

The Triassic rocks west of the southern Yukon synclinorium also show a development unlike that of the Lewes River group. In the Chitina Valley, Alaska, about 200 miles west of Laberge area, the Chitistone and Nizina limestones (in part and perhaps entirely of Karnian age) and the McCarthy shale, containing the Norian *Monotis*, overlie the Nicolai greenstone (Moffit, 1938). Unlike south-central Yukon, there are apparently no volcanic rocks intercalated with the Upper Triassic sedimentary rocks in this area. A section similar to that developed in the Chitina Valley may extend southeast to the Kluane area of southwestern Yukon (Muller, 1954). The volcanic arc invoked by Wheeler to account for the source of the volcanic materials within the Lewes River group presumably formed a barrier between the area of Triassic deposition in south-central Yukon and the area typified by the Chitina Valley.

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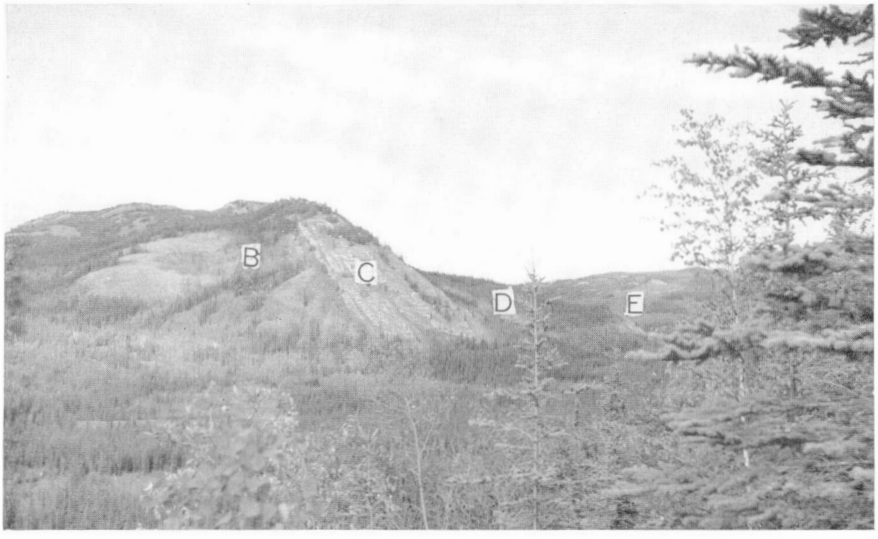
PLATE I

A. View across Lewes (Thirtymile) River towards hills between Donville and Casca Creeks. V, volcanic rocks believed to underlie Lewes River group; A, limestone outcrops of formation A; B, clastic rocks of formation B. Higher formations of Lewes River group in background.

B. Looking southeast across Lewes (Thirtymile) River towards hills north of Donville Creek. A, formation A; B, formation B; C, formation C; E, formation E. Covered interval between formations C and E probably represents formation D.

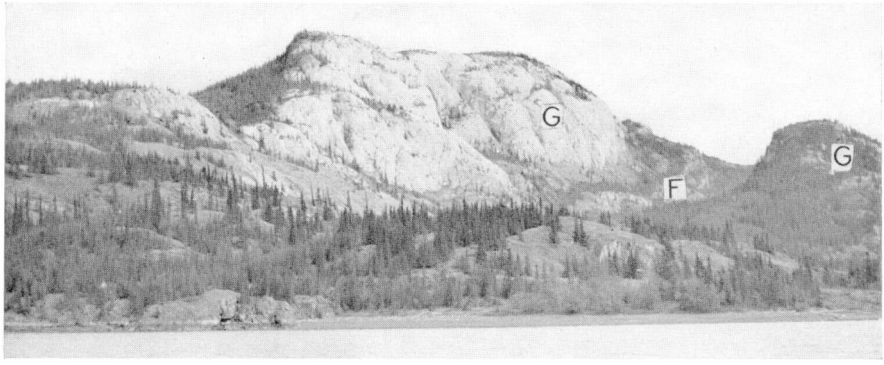
A. West side Maunoir Butte, Lewes (Thirtymile) River in foreground. D marks the locality with abundant *Monotis subcircularis* in talus, derived from formation D. Exposures of formation D with *Halobia* occur a short distance to south (right). Limestone band above point D represents formation E. Outcrops to left are of formation C apparently overturned.



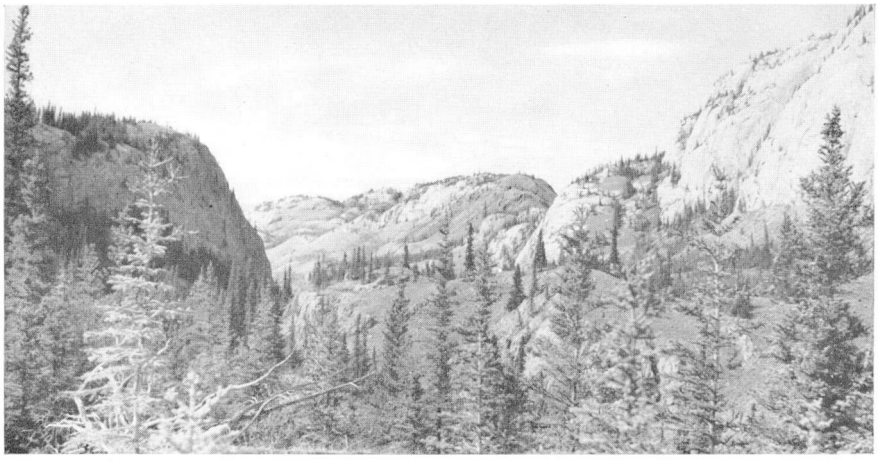
B. Southeast end of Maunoir Butte. B, formation B; C, formation C; D, mainly covered interval with small exposure of formation D; E, limestone of formation E.

PLATE III

A. Looking north across hills between Donville and Aksala Creeks, valley of Donville Creek in foreground. E, formation E; G, formation G; L, conglomerate of Laberge group. Poor outcrops of formation F occur beneath the limestone of formation G.



B. Hills on east side Lake Laberge, 10 miles south of end of lake. G represents limestone of formation G on both limbs of anticline; F marks exposures of formation F. Exposures of Laberge group in foreground.



C. Looking along strike of anticline in hills on east side Lake Laberge, 11 miles south of end of lake. Limestone of formation G to left (west) and right (east), exposures of formation F between.