GEOLOGICAL SURVEY OF CANADA

DEPARTMENT OF ENERGY, MINES AND RESOURCES

PAPER 67-10

TOARCIAN AND BAJOCIAN ROCKS AND GUIDE AMMONITES FROM SOUTHWESTERN BRITISH COLUMBIA

(Report, 4 figures and 6 plates)

Hans Frebold, H.W. Tipper and J.A. Coates

Price, $2.00

1969

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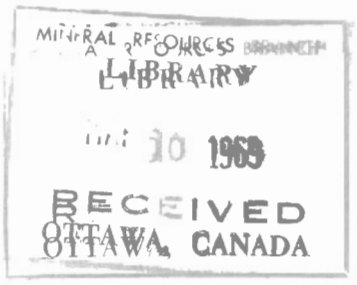

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Queen's Printer and Controller of Stationery
Ottawa, Canada
1969

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ABSTRACT

Toarcian and Bajocian guide ammonites, most of which are not previously known in southwestern British Columbia are described in relation to the stratigraphy of the beds concerned in Manning Park, Taseko Lakes and Nechako River areas.

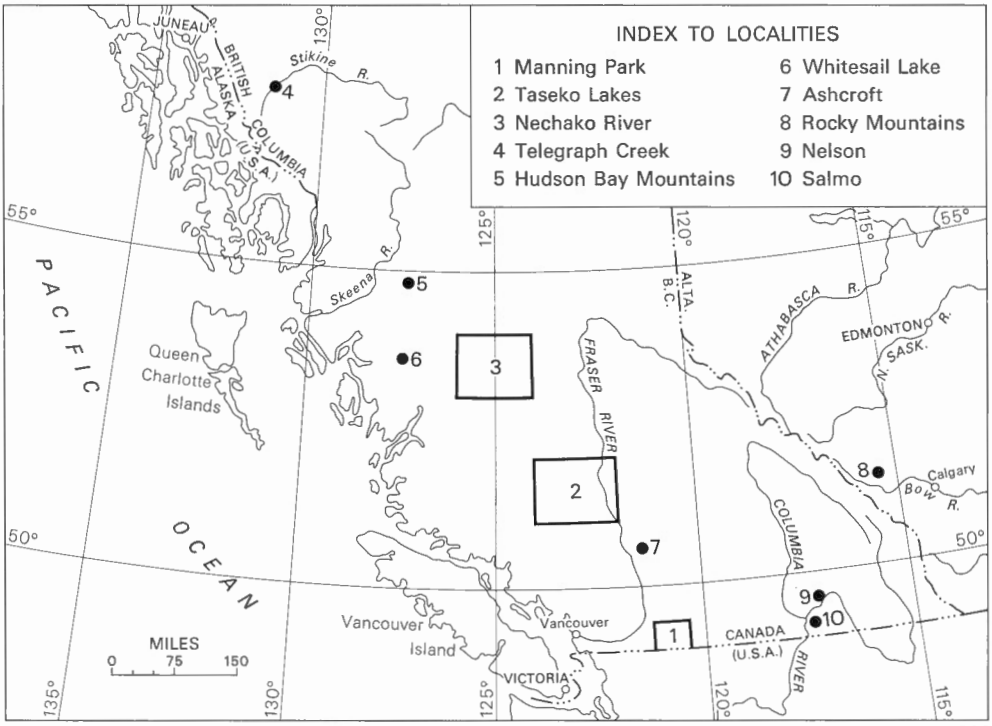

Figure 1. Locality map.

TOARCIAN AND BAJOCIAN ROCKS AND GUIDE AMMONITES FROM SOUTHWESTERN BRITISH COLUMBIA

INTRODUCTION

Recent field work in southwestern British Columbia disclosed the presence of Toarcian and Bajocian rocks in Manning Park map-area and added materially to the knowledge of Bajocian strata in Taseko Lakes map-area (Fig. 1). Fossils from these areas and from Nechako River area indicate the presence of several fossil zones in southwestern British Columbia. The stratigraphy of these areas is discussed, the main guide ammonites are described, and the age and regional correlation is briefly outlined. The sections dealing with palaeontological description and discussion as well as the regional correlation were written by H. Frebold, those covering the Bajocian stratigraphy of Taseko Lakes and Nechako River areas by H.W. Tipper, and that of Manning Park area by J.A. Coates.

STRATIGRAPHY

Manning Park Area

Prior to 1964 Lower and Middle Jurassic rocks were unknown in Manning Park area. Since 1964 field work has shown the presence in this region of two separate belts, comprising late Lower Jurassic (Toarcian) and Middle Jurassic (Bajocian) rocks, within the boundaries of the area mapped by Rice (1947, pp. 15-19), and Snow (see Cairnes, 1944) as Dewdney Creek Group (Fig. 2). The Dewdney Creek Group also includes Upper Jurassic and Lower Cretaceous rocks. Structural data indicate that the group is involved in a tight and complex synclinorial structure, with Lower and Middle Jurassic rocks exposed on the flanks and the younger rocks occupying the core.

Eastern Jurassic Belt

The eastern Jurassic belt varies from 1/4 mile to almost 1 1/2 miles wide, and has been traced northwestward from the International Boundary for 18 miles to the northern limit of the mapped area. On the east it is in contact along the Chuwanten fault with non-marine late Lower Cretaceous rocks of the Pasayten Group (Rice, 1947, pp. 19-24). On the west the belt is in probable fault contact with marine mid-Lower Cretaceous rocks of the Dewdney Creek Group. The apparent thickness of Jurassic rocks in this belt is about 6,000 feet; the true thickness is unknown.

The section strikes uniformly northwest, dips steeply to the west, and apparently represents part of the east limb of a major synclinorial structure. Reversals of the prevailing west dip have been noted only along the contacts of the belt where they may be due to drag on the bounding faults. No subsidiary folds have been recognized. Judging by the number of faults visible in the few outcrops of these poorly exposed rocks the entire belt seems to be laced with closely spaced strike and transverse faults, the net effects of which are unknown.

Manuscript received: 27 April, 1967.

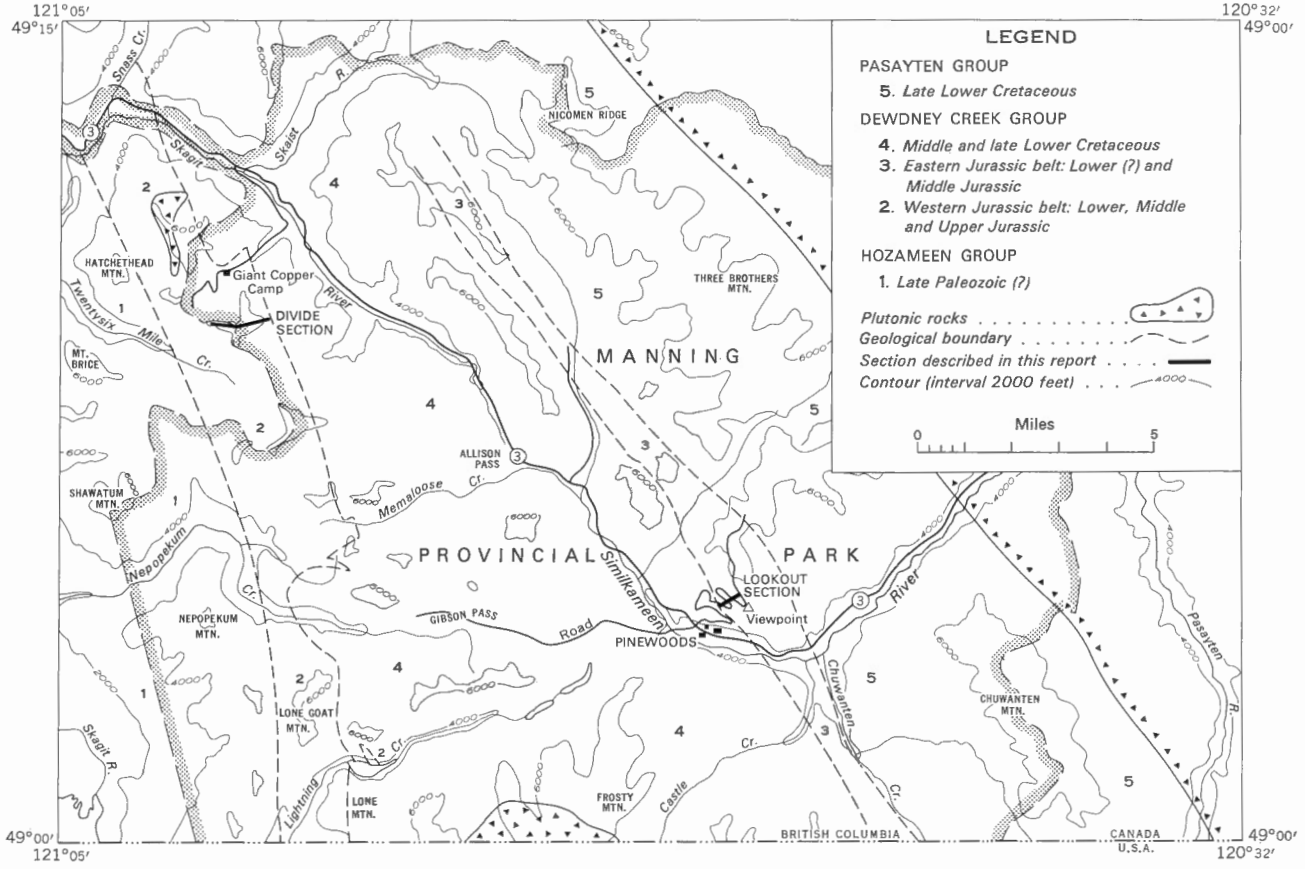

Figure 2. Distribution of Jurassic rocks, Manning Park area

The lithology of the eastern Jurassic belt is characterized by andesitic and dacitic volcanic sandstones with lesser amounts of fine-grained marine clastic rocks. Coarse-grained rocks are very common, and include volcanic conglomerates, breccia-conglomerates and breccias. Massive andesitic lavas and lava-cemented breccias outcrop in several places that may have been local centres of volcanism. Fine-grained clastic rocks are generally soft, thin-bedded argillites and shales, mainly finer-grained equivalents of the volcanic sandstones. Very soft, black or dark brown pelagic claystones are present locally but seldom crop out. Deposition by turbidity currents is indicated for some beds of the section but rapid facies changes along strike suggest a non-uniform depositional environment. Impressions of driftwood sticks and logs are abundant in some beds, indicating perhaps that land was nearby. As detritus from metamorphic and plutonic rocks was not seen, source areas may have been volcanic islands.

The eastern Jurassic belt has yielded only Early and Middle Jurassic fossils. A varied fauna, including pelecypods, brachiopods, gastropods, belemnites, corals and ammonites, has been recovered from these beds but only the ammonites include useful guide fossils. Some fossil beds, not described here, have yielded ammonites tentatively assigned to the Toarcian. The most productive ammonite beds are those exposed in the road-cuts of the middle Bajocian Lookout section that is here described in detail.

Lookout Section: This section is almost continuously exposed in road cuts along the road that winds up from Manning Park post-office at Pinewoods to a viewpoint at about 5,300 feet elevation one mile to the northeast. The base of the section is at the viewpoint and the top is at 4,900 feet elevation about 700 feet west of the second switchback below the viewpoint.

The section dips southwest with dips from 50° to 90° and averaging 68°. Few satisfactory top indicators were found but all suggested tops to the southwest. Within the section twenty-two transverse faults and five strike faults were mapped though in no case could displacement be measured. The exposures are cut obliquely across the strike of the beds at low to moderate angles, and in view of this, and the numerous faults, the measured thickness must be considered a maximum thickness rather than an approximation of the true thickness.

The Lookout section, with the possible exception of the uppermost beds, apparently represents a marine turbidite succession deposited near one or more centres of active volcanism. Outcrops show evenly bedded rocks with the beds ranging in thickness from a fraction of an inch to several tens of feet. Throughout the section the turbidite beds vary irregularly in grain size from fine breccia down to the finest claystone, though the latter is volumetrically unimportant. Graded bedding is present in some beds and the coarser beds contain angular fragments of claystone up to 2 feet in maximum dimension. In thin section the turbidites are seen to be composed mainly of epiclastic volcanic detritus with significant amounts of pyroclastic material and fragments of pelagic claystone. The epiclastic volcanic material comprises mainly whole or broken plagioclase crystals and subrounded fragments of aphanitic and porphyritic lava. Pyroclastic material consists of very angular lapilli and ash size fragments of dense or slightly vesicular lava showing rare plagioclase phenocrysts in a felted-textured groundmass of microlites. Detrital quartz and ferromagnesian minerals are rare. Plutonic, metamorphic and sedimentary rock detritus, other than the pelagic claystone, was not noted.

Commonly, but not invariably, the turbidite beds are separated by very thin partings of carbonaceous claystone in which are found the spherical, siliceous fossils of a pelagic micro-fauna. Similar microfossils are found in the claystone fragments in turbidite beds. Ammonites are found mainly as impressions on the bedding surfaces of the finer grained rocks. No other megafossils have been noted. All of the ammonites found to date indicate a Middle Jurassic (Bajocian) age.

The measured section is as follows:

	Thickness (feet)
Cretaceous rocks, fossiliferous feldspathic sandstones. Gap (some sheared and slickensided float). Probably a fault contact	155
Thin-bedded, rusty, grey, very fine to medium-grained feldspathic sandstones. Plant fragments	60
Concealed	35
Thin to medium-bedded, very fine to coarse-grained sandstones. GSC loc. 75575	76
Massive, very thick-bedded, medium grained grey-green volcanic sandstone	28
Mainly thin-bedded, very fine to fine-grained volcanic sandstones. Ripple-marks. GSC locs. 75568, 75574, 75567	117
Coarse-grained, massive, volcanic sandstone	8
Disturbed zone, mainly thin-bedded siltstones. Some coarse-grained sandstone bodies. GSC locs. 75573 and 75570	110
Massive, medium-grained, grey-green volcanic sandstone. Some breccia-size fragments	23
Mainly thin-bedded volcanic siltstones and fine-grained sandstones. GSC loc. 75571 near base	129
Coarse-grained, massive volcanic sandstone, brown-weathering	10
Mainly thin-bedded volcanic siltstone. GSC loc. 75572	37
Medium-and coarse-grained volcanic sandstone	10
Thin-bedded, shaly, rubbly weathering siltstones	73
Fine-grained volcanic breccia grading up-section to fine-grained sandstone	15

	Thickness (feet)
Thin-bedded, fine-grained volcanic sandstone. GSC loc. 75565	6
Fine-grained volcanic breccia, dark brown weathering	33
Mainly thin-bedded volcanic siltstone	35
Mainly thin-bedded claystones, siltstones and fine-grained volcanic sandstones. GSC loc. 75644	33
Fine-grained volcanic breccia, numerous claystone fragments up to block size	12
Rubbly weathering siltstone, plant fragments. GSC loc. 75560	20
Mainly dark green, fine-grained, medium-bedded volcanic sandstone	27
Mainly dark green, thin-bedded, volcanic claystones, siltstones and fine-grained sandstones	14
Massive, thick-bedded, fine to coarse-grained volcanic sandstones, highly fractured	32
Mainly laminated, thin-bedded volcanic siltstones. GSC loc. 75561	46
Dark green claystone, siltstone and fine-grained sandstone. GSC loc. 75562	24
Massive, coarse-grained volcanic sandstone, stick impressions	28
Fine- and medium-grained volcanic sandstone and thin-bedded siltstones. GSC locs. 75563 and 66983	40
Massive volcanic sandstone grading up-section from coarse to medium grained	38
Mainly thin-bedded, laminated volcanic siltstones and fine-grained sandstones. GSC loc. 75569	38
Massive, coarse-grained, dark green volcanic sandstone	37
Fine-grained volcanic sandstone and laminated siltstone	32
Fine-grained volcanic breccia, no bedding, blocks of black claystone in basal 10 feet	56
Laminated, thin-bedded siltstone and fine- and medium-grained volcanic sandstone	39

	Thickness (feet)
Massive, coarse-grained volcanic sandstone	14
Laminated siltstone and fine and medium-grained volcanic sandstone, greenish grey colour	82
Massive, coarse-grained volcanic sandstone, claystone cobbles at base, stick impressions at top	4
Dark green, thin to medium-bedded, very fine to medium-grained volcanic sandstone.....	35
Indicated thickness	1456

Base not exposed.

Western Jurassic Belt

The western belt of Jurassic rocks varies in width from 1/2 to 2 1/2 miles and has been traced for about 17 miles northwestward from the International Boundary to the northern limit of the Manning Park map-area. On the west the Hozameen fault separates the Jurassic rocks from late Palaeozoic (?) eugeosynclinal rocks of the Hozameen Group. On the east Lower Cretaceous rocks adjoin the Jurassic belt along a regular contact that, although locally faulted, appears to be a disconformity. The apparent maximum thickness of Jurassic rocks is about 12, 000 feet; the true thickness is unknown.

The western belt comprises much of the section involved in the western limb of a major synclinorium. Steep easterly and northeasterly dips prevail, except in the southern part where a large structural re-entrant is marked by a swing to southeasterly and southerly dips. Among the lesser elements of structure faulting is more important than folding. Large left-lateral offsets along transverse faults have been mapped and important displacement due to low-angle thrusts is also indicated. Strike faults are common. A few chevron folds have been recognized but are of apparently minor significance in the overall structure.

Throughout the length of the western belt the lithology is dominated by fine-grained, marine clastic rocks interbedded with considerable quantities of dacitic volcanic sandstone. Locally the volcanic sandstones are associated with massive lavas and resemble true, primary pyroclastic deposits, but for the most part they show features indicative of transport by turbidity currents or similar mechanisms. Pebbles in some sandstones are well rounded, indicating wear in a littoral or stream environment. The fine-grained clastic rocks commonly are dark coloured, hard, siliceous argillites (claystones and siltstones) showing conchoidal fracture. Pale coloured, cherty-textured interbeds appear to be siliceous tuffs in most cases. True cherts have been recognized but are very rare. Soft, 'non-siliceous' argillites and shales are locally present and these generally lack the volcanic sandstone interbeds. Lenses and beds of impure limestone up to 2 feet thick have been noted but are not common.

Fossils are rare in these rocks and their discovery requires considerable dedication. Belemnites and pelecypods occur in some sandstones and ammonite impressions occur in fine-grained rocks. The only definitive collections were made in the northern part of the belt along the Divide section, that is described in detail as follows:

Divide Section: This section (Fig. 3) transects the eastern two-thirds of the western belt of Jurassic rocks. It is located partly on the divide separating the drainage of Twentysix Mile Creek and the upper Skagit River, and partly on a spur trending northeasterly from this divide. A private road, controlled by Giant Copper Limited, provides access to a point at elevation 5,500 feet, about 1/2 mile west of the west end of the section. The base of the section is arbitrarily placed 300 feet west of the 6,350 foot summit southwest of the Giant Copper camp at the most westerly fossil locality on this divide. The top of the section is 1.3 miles to the east where a narrow gully crosses the crest of the northeast trending spur. On the east side of this gully are highly fossiliferous rocks of late Jurassic age. The best exposures in the Divide Section may be seen in the eastern part where steep, north-facing bluffs provide almost continuous outcrop over a horizontal distance of about 1/2 mile and a vertical interval of several hundred feet. The western part is more recessive and contains several short gaps and long stretches with very poor exposure.

The section strikes northwest, dips mainly to the east and essentially represents part of the west limb of a major northwest trending syncline. Superimposed on this major fold limb are lesser folds and innumerable faults so that locally the structure is complex. Lesser folds include gentle warps with an amplitude of only a few tens of feet. These gentle warps are responsible for many reversals of dip in these steeply dipping beds. Larger folds, involving perhaps several hundred feet of section, have also been recognized. These have west-dipping axial planes and near horizontal axes. In thin-bedded parts of the section they form tight, sharp-crested anticlines and synclines which pass into more open flexures in more competent strata.

Faulting has significantly influenced the present structure but the effects of faulting remain obscure. Both east-dipping and west-dipping low-angle faults have been observed. In the latter drag effects indicate a down-dip movement in some and up-dip movement in others. A number of strong transverse faults striking mainly east to northeast and dipping steeply to the north, all show oblique-slip movement with the north side offset to the west in one instance. Steeply dipping strike faults are inferred to be common though only two were actually seen. Northwest trending dykes and sills are abundant in the western part of the section and may occupy strike fault zones in some instances.

The section can be divided into a lower unit comprising mainly argillaceous rocks, and an upper turbidite sequence of thin-bedded fine clastic rocks with interbedded volcanic sandstones. The lower unit consists of recessive, dark grey, black, and dark brown argillite and shale, mainly of claystone and siltstone grain size, but including some thin beds of fine-grained sandstone. The apparent thickness of this lower unit is about 2,400 feet, of which perhaps 300 feet is made up of dykes and sills. The remainder is poorly exposed, structurally complex, and the true thickness is unknown. Ammonite impressions recovered from the lower unit are of late Early Jurassic (late Toarcian) and early Middle Jurassic (early Bajocian) age.

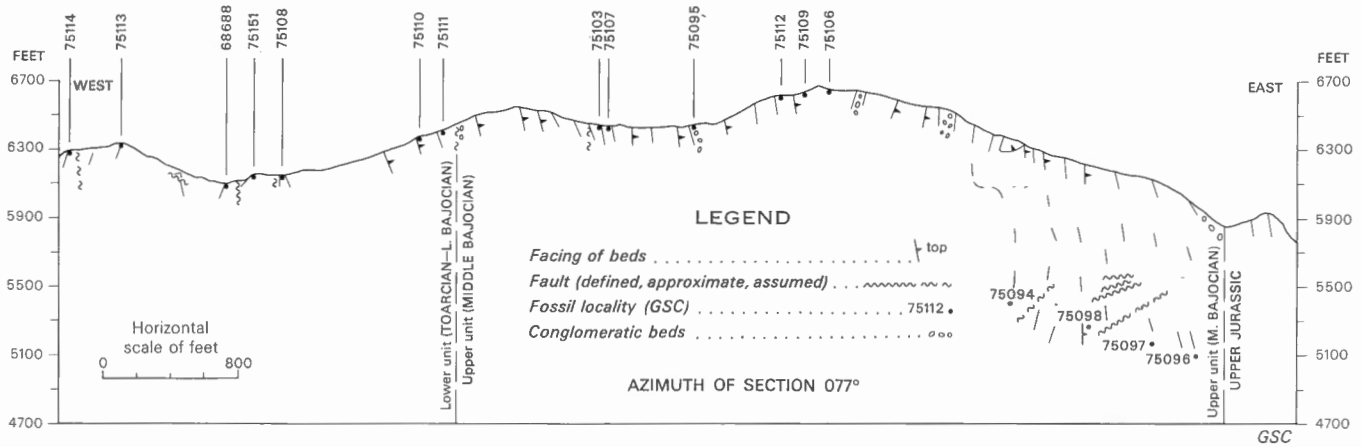

Figure 3. Divide section, Manning Park area.

The upper unit includes some argillite and shale similar to that in the lower unit but, in general, fine clastics in the upper unit are very hard, light grey to black, highly siliceous rocks. Dense-textured argillites in this unit closely resemble chert. A few thin beds of grey impure limestone and rare thin beds of pink-weathering, pure chert are also present. The coarser-grained rocks are essentially volcanic sandstones containing a minor proportion of sedimentary rock fragments. The latter include argillite and impure limestone, usually as angular chunks which in some beds are very large, up to 10 feet in maximum dimension. These sedimentary rock fragments are thought to have been plucked from the floor of the depositional basin by turbidity currents or sand flows. Volcanic clasts consist of rock fragments, plagioclase feldspar and clear, unstrained 'volcanic' quartz. Some of the coarser sandstones contain rounded and angular pebbles and cobbles of volcanic rock up to a maximum size of about 4 inches. These clasts are typically grey, weakly porphyritic rock with sparse phenocrysts of plagioclase and, less commonly, quartz in an aphanitic, almost cherty textured matrix. Plutonic and metamorphic detritus appears to be absent except at the base of the turbidite sequence where a few granitic pebbles were noted.

In part, the volcanic sandstones may be of primary pyroclastic origin as evidenced by the presence of shards, lapilli and euhedral mineral grains, but some of their content may be due to normal atmospheric erosion of a volcanic terrane. Evidence of transport by turbidity currents is given by features such as graded bedding, groove casts and flute casts. The apparent thickness of the turbidite sequence is about 4,500 feet; the true thickness is unknown. The measurement of stratigraphic thicknesses presents a difficult problem in this area because of folding, faulting, and steep terrain where the rocks are exposed. Thicknesses given in the written section are approximations, based in part on pace and compass traverses, in part on construction of cross-sections and in part on estimates made while traversing terrain too steep for measurement.

Fossils present in the turbidite sequence are mainly ammonite impressions with some pelecypods and belemnites. Determinable ammonites indicate a Middle Jurassic (middle Bajocian) age slightly younger than that of the lower unit. Fossil localities are indicated on Figure 3.

The measured section is as follows:

	Thickness (feet)
Upper Jurassic Buchia-bearing beds.	
Covered, may be fault contact.....	30
Dark grey, fine-grained argillaceous sandstone	20
Pebble conglomerate, pebbles to 4 inches of grey, aphanitic volcanic rock.....	2
Fine-grained, grey sandstone, pebbly in part	25
Mainly fine-grained, shaly, thin-bedded medium to dark grey sandstone	125

	Thickness (feet)
Hard, grey, laminated siltstones	200
Mainly fine-grained, grey, feldspathic sandstones, few shaly partings and limy nodules	180
Mainly very hard claystones and siltstones with some very fine grained light grey tuff (?)	380
Thick-bedded, fine-grained, grey volcanic sandstones with siltstone partings	35
Mainly dark grey, laminated and thin-bedded siltstones, small chevron fold	150
Thick-bedded, fine-grained sandstones; siltstone partings	55
Hornblende porphyry (appinite) sill	20
Hard laminated siltstone with fine sandstone interbeds	40
Mainly volcanic sandstone, fine-to very coarse-grained, thick-bedded	200
Thin-bedded, recessive, rust-weathering siltstones, in part highly sheared	100
Hard, thin-bedded, blocky weathering, resistant siltstones	150
Mainly very coarse grained volcanic sandstone with included siltstone blocks	100
Thin-bedded, resistant, hard siltstones	150
Shale, recessive, grey to black claystones and siltstones. GSC loc. 75109	50
Concealed	300
Shale, mainly thin-bedded siltstones	30
Medium to very coarse grained, grey volcanic sandstones, about 10% siltstones. GSC loc. 75112	500
Volcanic breccia-conglomerate with limestone and limy argillite blocks. GSC loc. 75095	50
Thin-bedded siltstone and fine-to medium-grained sandstone interbeds	170
Thin-bedded, hard siltstone	100

	Thickness (feet)
Thin-bedded, hard claystone, siltstone, minor limestone, with thick sandstone interbeds.	120
Hard, thin-bedded siltstones. GSC loc. 75107 at top of unit	100
Mainly grey volcanic sandstone	25
Hard, thin-bedded siltstone with thick sandstone inter-beds. GSC loc. 75103.	30
Concealed	45
Mainly medium-grained volcanic sandstone, siltstone interbeds, some sills	50
Gap. No outcrop except 15 foot thick hornblende porphyry dyke	200
Mainly medium-grained volcanic sandstone, some 'shale-chip' breccia	30
Concealed	50
Mainly hard, grey to black siltstones with some volcanic sandstone interbeds	220
Mainly hard, blocky weathering, thin-bedded dark grey siltstones	230
Mainly grey to black cherty argillites with coarse-grained sandstone interbeds, some sills	220
Poorly exposed, some dykes, small outcrop of breccia-conglomerate with granitic pebbles	70
Very thin bedded dark grey and brown shales, claystone to fine sandstone. GSC loc. 75111	200
Concealed	20
Dark grey shales, very thin bedded claystone to fine sandstones. GSC loc. 75110	220
Concealed	400
Soft, black to grey shale, very thin bedded. GSC loc. 75108 near top, loc. 75106 at base.	120
Several dykes or sills with shaly partings	40
Thin-bedded argillite, blocky, highly fractured. Fault (?)	50

	Thickness (feet)
Several contiguous felsitic dykes or sills	50
Sheared black argillite, few thin sills, includes 4 feet of quartz-filled fault breccia	50
Shaly claystone and siltstone, dark grey. GSC loc. 68688 near base	50
Dark grey to black argillite, very numerous sills and dykes, minor folding. GSC loc. 75113 at base.....	900
Dark grey argillite and shale, numerous dykes and sills	220
Blue-grey weathering, dark grey argillite. GSC loc. 75114 ..	40
Indicated thickness	6910
Base of section	
Underlain ? by argillites and volcanic sandstones.	

Taseko Lakes Area

The presence of Bajocian rocks in Taseko Lakes was first shown by Cairnes and Crickmay (Cairnes, 1943, pp. 5-6) who obtained one Bajocian collection along Tyaughton Creek. Work along the Yalakom River valley by G.B. Leech produced collections of ammonites in which the ammonite Tmetoceras sp. was identified (Leech, 1953, p. 23). The age is early Bajocian. These are the only previously recorded occurrences of Bajocian fossils in Taseko Lakes area.

Work by Tipper in the Taseko Lakes area from 1962 to 1964 produced several collections of Bajocian fossils that prove the widespread occurrence of early Middle Jurassic rocks. These rocks are exposed mainly as fault slices along Tyaughton Creek and Yalakom River valleys (Fig. 4). The best exposure, although faulted and intruded, occurs at the head of Relay Creek. Nowhere in this area is a completely exposed, unfaulted section known of early and middle Bajocian strata.

Rocks of early and middle Bajocian age are a succession, probably conformable, of shale, argillite, limy shale, siltstone and lesser greywacke. One or two thin beds of shaly limestone occur, particularly in the upper part. Coarse grit and conglomerate were not seen and volcanic rocks are not present, except possibly a few thin tuffaceous beds.

The thickness of these Bajocian rocks is difficult to measure because of the lack of a complete section. A minimum thickness of 900 to 1,000 feet is known in one or two part sections and the thickness of the whole section may be much greater. In only one section is there more than one

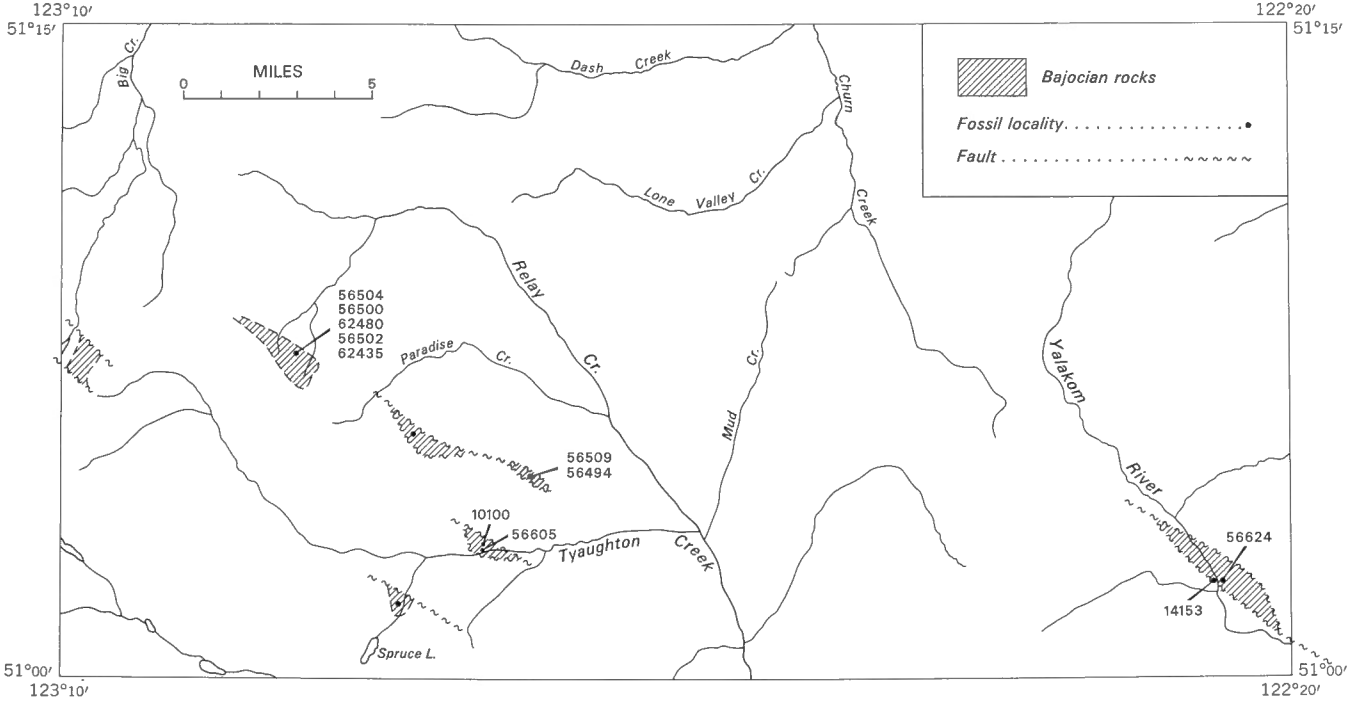

Figure 4. Fossil localities and distribution of Bajocian rocks, Taseko Lakes area. GSC

fossil zone represented and even there part of the section is covered and may be faulted.

Typically the rocks are fine-to medium-grained clastic sediments. Finely laminated carbonaceous black shales and banded argillites are characteristic of the rocks of early Bajocian age but such rock types are common throughout the section. Bedding is uniform; crossbedding, ripple-marks, or other current features were never seen; wood fragments, although not abundant, are present; most shaly rocks are carbonaceous; and the predominant colour is grey to black. An incomplete but typical part section occurs at the head of Relay Creek as follows:

	Thickness (feet)
Limestone boulder conglomerate (upper Middle Jurassic).	
Interbedded grey shaly limestone, black argillite and siltstone, grey shale, and minor grey-green greywacke; beds generally one foot to three feet thick, massive; at least three limestone bands about one foot thick near the top of the unit that are fossiliferous; GSC locs. 56504, 56500, and 62480	300+
Rusty-weathering feldspar porphyry sill	
Soft, brown-weathering banded grey to black shale with small concretions	150
Brown-weathering shaly limestone in beds 6 inches to 2 feet thick with thin interbeds of argillite; small 2 inch diameter concretions	90
Banded, dark grey argillite with minor rusty-weathering limy beds 6 inches to 1 foot thick; a few bands of greywacke 2 to 3 inches thick	145
Rusty-weathering banded argillites in beds 1/2 to 1 inch thick	115
Limy shale	10
Finely laminated black shale in bands 1/4 to 1 inch thick	60
Shale and limy shale with numerous limy concretions 3 to 5 inches diameter; partly talus covered; fragments of fossils in concretions at top of unit; GSC locs. 56502 and 62435	25
Interbedded shale and limy shale, dark to light grey, fine-grained	25
Large intrusive feldspar porphyry	
Indicated thickness	920

East of Lorna Lake a section over 1,000 feet thick of interbedded siliceous argillite and siltstone are exposed. Some beds are limy. The rocks are grey to black in colour, are well-bedded in beds 1/4 inch thick up to beds 1 foot thick, and some of coarser beds are graded. Near the top of the section poorly preserved ammonites indicate a probable Bajocian age. The age of the basal part of the section is not known; it could be Bajocian, Toarcian, or even older.

On the ridge between Cardtable Mountain and Castle Peak thinly bedded argillite, siltstone and carbonaceous shales occur. A few limestone bands yielded an early Bajocian fauna. A fault bounded section over 300 feet thick is exposed. Farther east occurs a short section of early Bajocian thinly laminated dark grey carbonaceous shales with a rich fauna of flattened Tmetoceras cf. T. scissum. To the south along Tyaughton Creek near the mouth of Bonanza Creek a short section of sedimentary rocks is exposed as follows:

	Thickness (feet)
Dark grey argillite, light grey and green fine greywacke, thinly bedded, very soft and friable; GSC locs. 10100 and 36223	25+
Covered interval	50+
Interbedded dark grey to black argillite, limy argillite, and a few coarse arenaceous beds; argillites are in places finely laminated and are black to dark grey; a bed of grey limy shale, hard and brittle occurs near the top of unit and is fossiliferous. GSC loc. 56605	150+
Indicated thickness	225+

Along both sides of the Yalakom River for 1 1/2 miles above Blue Creek an intensely faulted section of sedimentary rocks is exposed. This section differs from most sections of Bajocian rocks in that it is made up of siltstone, argillite and much greywacke. Siltstone is dark brown in beds 1/4 inch to 6 inches thick. Shales are fine-grained and black to brown, interbedded with the siltstones. Forming prominent resistant beds up to 50 feet thick are greenish grey medium-to coarse-grained greywacke. A few thin beds contain abundant feldspar and approach an arkose in composition. Rarely pebbles of shale or argillite up to 3 inches diameter are scattered through the greywacke. The bedding is less regular than that of the siltstone-shale sequence and in places the greywacke occurs as lenticular beds. The greywacke is composed of angular quartz, feldspar and dark greenish grey to black rock fragments. Wood fragments are common throughout the section. The coarser nature of these rocks than other Bajocian rocks suggests a position closer to the source area. This section is too intensely faulted to make even a rough estimate of the thickness; however it is reasonable to say it must be several hundred feet thick. The shale beds have yielded a rich early Bajocian fauna but the specimens are mainly flattened.

On the western margin of the Taseko Lakes area, 124° long., one collection of fossils was obtained from thick beds of greenish grey to dull grey greywacke. These fossils are of middle Bajocian age. The areal extent and thickness of this section is unknown.

The internal structural relations of the strata of early and middle Bajocian age are difficult to interpret as no complete section is exposed at any locality. However, the prevalence throughout the Bajocian of fine clastic sediments, the fine, even bedding, the lack of any evidence of erosion or interruption in sedimentation favours the conclusion that the lower and middle Bajocian strata are a conformable sequence in spite of an incomplete fossil record.

The base of the Bajocian is not exposed but the next lower fossiliferous group of rocks are of Sinemurian age and are of a similar lithology. There is no evidence of an unconformity below the Bajocian nor does the absence of lowermost Bajocian, Toarcian or Pliensbachian fossils in any section suggest non-deposition or erosion. Probably they have yet to be found.

The middle Bajocian rocks are believed to be overlain unconformably by conglomerates of possibly Bathonian or Callovian age (Frebold and Tipper, 1967, p. 4). Fossils of late Bajocian or Bathonian age have never been found in British Columbia.

These rocks of early and middle Bajocian age are typically fine clastic sediments that have been deposited in a basin remote from volcanic activity. In this respect they differ from the rocks of Manning Park and Nechako River areas that are dominantly of volcanic origin. The coarser sediments of the Yalakom River section and the conglomerates of the Bajocian strata farther east near Ashcroft (Crickmay, 1930) suggest a possible eastern source area, possibly the area of the Guichon Batholith (Frebold, 1957a, p. 41). However the fragmentary evidence precludes a satisfactory reconstruction of the sedimentary history.

Nechako River Area

Mapping in Nechako River area from 1949 to 1951 (Tipper, 1963) disclosed the presence of Bajocian rocks although fossil evidence was meagre. These rocks were mapped as the Hazelton Group and considered as an extension of Hazelton Group rocks in the Whitesail area and in the Hudson Bay Mountains to the west and northwest (Fig. 1). The Hazelton Group, at least the Middle Jurassic part, is largely volcanic rocks or volcanic derived sediments. One section on Kuyakuz Mountain was described as follows (Tipper, 1959, pp. 25-26):

"On Kuyakuz Mountain, the Middle Jurassic unit consists mainly of fine volcanic breccias, tuffs, argillaceous tuffs, tuffaceous shales, and argillites or shales. The apparent thickness of this section is at least 5,500 feet although some of this may be repetition. Flows are relatively unimportant, although green and reddish andesite occurs. Coarse detrital or volcanic sedimentary strata are absent, the coarsest fragments observed being a quarter inch in diameter. Most are fine-grained, well-sorted, dense strata varying in colour from black to brown, grey and purple. Grey rhyolitic tuff and brownish shales occur, ... The strata are mainly tuffaceous and

examination shows that the rock comprises angular to rounded volcanic fragments, chlorite, feldspars, magnetite, and much fine unidentified material. The rock is varied and lateral changes in composition, texture and colour are rapid..."

Fossil remains are common in this section but only one collection provided even poorly preserved ammonites. This collection, GSC loc. 21886, contains Witchellia (?) sp., a middle Bajocian ammonite.

LOCALITIES

Manning Park area

Divide section, lower unit

(see section, figure 3)

GSC loc. 75114 Ammonites gen. et sp. indet.

GSC loc. 75113 Phlyseogrammoceras aff. P. dispansiforme (Wunstorf) et P. werthi (Denckmann)
Ammonites gen. et sp. indet.

GSC loc. 68688 Tmetoceras cf. T. scissum (Benecke)

GSC loc. 75151 Ammonites incertae sedis, group 2
Grammoceras ?

GSC loc. 75108 Tmetoceras cf. T. scissum (Benecke)

GSC loc. 75110 Tmetoceras cf. T. scissum (Benecke)

GSC loc. 75111 Tmetoceras cf. T. scissum (Benecke)

Divide section, upper unit

GSC locs. 75103, 75107, 75095 Ammonite fragments, indet.

GSC loc. 75112 Teloceras ? sp. indet.

GSC loc. 75109 Chondroceras sp. indet. aff. C. ellsi (McLearn)

GSC loc. 75106 Stephanoceras sp. indet.

GSC loc. 75094, 75098, 75097, 75096 Indeterminable fragments.

Lookout section above Pinewoods

GSC loc. 75569 Otoitidae, fragments

GSC loc. 75563 Graphoceras crickmayi n. sp.

GSC loc. 66983 Graphoceras crickmayi n. sp.
Zemistephanus richardsoni (Whiteaves)

GSC locs. 75561, 75560 Ammonites incertae sedis, group 1

GSC loc. 75564 Aptychi

GSC loc. 75565 Chondroceras sp. indet. B.
Aptychi

GSC loc. 75572 Chondroceras sp. indet. aff. C. ellsi (McLearn)
Chondroceras sp. indet. A.
Ammonites incertae sedis, group 1
Aptychi

GSC loc. 75571 Aptychi

GSC loc. 75573 Stephanoceras sp. indet. (not described)

GSC loc. 75570 Chondroceras aff. C. ellsi (McLearn)

GSC loc. 75574 Stephanoceras sp. indet. (not described)

GSC loc. 75567 Stephanoceras cf. S. caamanoi (McLearn)
Fragments of Stephanoceratidae and Chondroceras (not described)

GSC loc. 75575 Stephanoceras sp. indet. (not described)

Taseko Lakes area

GSC locs. 56509, 56494 2 1/4 miles north of junction of Tyaughton Creek and Bonanza Creek; 51°04'40"N Lat., 122°52'40"W Long.
Coll. H.W. Tipper
Tmetoceras cf. T. scissum (Benecke)
Erycites aff. E. howelli (White)

GSC loc. 56624 About 300 yds. north of junction of Blue Creek and Yalakom River, on east side of river; 51°02'15"N Lat., 121°27'35"W Long.
Coll. H.W. Tipper
Tmetoceras cf. T. scissum (Benecke)
Erycites aff. E. howelli (White)

GSC loc. 14153 On the east bank of Yalakom River about 1 mile north of Blue Creek; 51°02'20"N Lat., 121°27'30"W Long.
Coll. G.B. Leech
Tmetoceras cf. T. scissum

GSC locs. 62486, 56563 On ridge 1/2 mile southwest of Cardtable Mountain; 51°05'40"N Lat., 122°57'10"W Long.
Coll. H.W. Tipper
Erycites kialagvikensis (White)

GSC loc. 56605 Tyaughton Creek, north side, 1 1/2 miles below mouth of Spruce Lake Creek; 51°02'55"N Lat., 122°54'30"W Long.
Coll. H.W. Tipper
Tmetoceras cf. T. scissum (Benecke)

GSC loc. 10100 Tyaughton Creek, north side, 1 1/2 miles below mouth of Spruce Lake Creek; 51°02'55"N Lat., 122°54'30"W Long.
Coll. C.H. Crickmay
Chondroceras marshalli (McLearn)

GSC loc. 56500 On ridge in centre of Relay Creek valley, 1 3/4 miles southwest of Relay Mountain; 51°06'55"N Lat., 123°01'35"W Long.
Coll. H.W. Tipper
Stephanoceras (Skirroceras) cf. S. kirschneri Imlay
Witchellia ? sp. indet.

GSC loc. 62480 On east bank of east fork of Relay Creek 1 3/4 miles southwest of Relay Mountain; 51°06'55"N Lat., 123°01'00"W Long.
Coll. H.W. Tipper
Stephanoceras (Skirroceras) cf. S. kirschneri Imlay

GSC loc. 51112 On mountain ridge top 1 3/4 miles northwest of Nemaia Lake; 51°28'45"N Lat., 124°00'00"W Long.
Coll. H.W. Tipper
Stemmatoceras sp. indet.
Stephanoceras sp. indet.

GSC loc. 56502 On ridge in centre of Relay Creek valley, 1 3/4 miles southwest of Relay Mountain; 51°06'55"N Lat., 123°01'40"W Long.
Coll. H.W. Tipper
Holcophylloceras cf. H. costisparsum Imlay

GSC loc. 62424 West side of Spruce Lake Creek, 1 1/2 miles from Spruce Lake; 51°02'05"N Lat., 122°57'20"W Long.
Coll. H.W. Tipper
Oedania ? sp. indet.

Nechako River area

GSC loc. 21886 On Kuyakuz Mountain, 1 1/2 miles south of peak
Coll. H.W. Tipper
Witchellia ? sp. indet.

SYSTEMATIC DESCRIPTIONS

Family Phylloceratidae Zittel, 1884
Subfamily Calliphylloceratinae Spath, 1927
Genus Holcophylloceras Spath, 1927
Holcophylloceras cf. H. costisparsum Imlay

Plate III, figure 6

Material. One specimen, GSC No. 22870, from GSC loc. 56502, Taseko Lakes area.

Description. The specimen has a diameter of 33 mm the whorl height is 19 mm and the whorl thickness 15 mm. The umbilicus is very narrow, the venter rounded and the flanks are moderately concave. A few very faint impressions considered to be possibly constrictions are present in the anterior part of the last whorl.

Comparison. The specimen is similar to the young specimens of Holcophylloceras costisparsum Imlay (Imlay, 1964, pl. 1, figs. 10-12, 14-17), on which riblets are not yet developed and constrictions are very faint. The assignment of the single specimen to Imlay's species is tentative.

Occurrence and age. No other ammonites were found associated with this specimen. Its age is lower or middle Bajocian.

Family Hildoceratidae Hyatt, 1867
Subfamily Grammoceratinae Buckman, 1904
Genus Phlyseogrammoceras Buckman, 1901
Phlyseogrammoceras aff. P. dispansiforme (Wunstorf) et P. werthi (Denckmann)

Plate I, figures 10-15

Material. Several specimens from GSC loc. 75113, Manning Park.

Description. All specimens are secondarily laterally compressed and more or less fragmentary. Some of them are imprints from which rubber casts were made. The illustrated specimens GSC Nos. 22857-22862 belong to various stages of growth. Cross-sections, suture lines and shape of the umbilical wall are not observable.

Ribs are already present at early stages of growth. They are arranged in bundles of two to four that originate from more or less elongated nodes at or close to the umbilical margin, some secondaries may be intercalated between two bundles. Some specimens have finer and more numerous ribs than others. On the inner part of the flanks the ribs are inclined forward, they swing backward somewhat below the half height of the flank and then forward again in the outer part. In some specimens the ventral keel is visible.

Comparison. The specimens are similar to most of Wunstorf's (Wunstorf, 1907) specimens of Phlyseogrammoceras dispansiforme (Wunstorf) and P. accrescens (Wunstorf) that is a synonym of P. werthi (Denckmann). Also most of Ernst's specimens (Ernst, 1923, 1924) of these two species are similar to the Manning Park specimens. The type species of the genus Phlyseogrammoceras i.e. P. dispansum Lycett, was described by Wright (1882, p. 458, pl. 67, figs. 3, 4) as a variety of "Harpoceras" variabile d'Orbigny, the type species of the genus Haugia Buckman 1888. The species of this genus have ribs somewhat similar to those of the group of P. dispansum but they are usually stronger and straighter than in Phlyseogrammoceras.

Occurrence and age. At GSC loc. 75113 small indeterminable ammonites with straight ribs and ventral keel were found associated with the described specimens. Late Toarcian (Yeovilian).

Subfamily Tmetoceratinae Spath, 1936
Genus Tmetoceras Buckman
Tmetoceras cf. T. scissum (Benecke)

Plate I, figures 1-5

Material. Many specimens from GSC locs. 56624, 56494, 56605, 56509, 14153 (Taseko Lakes area) and 75111, 75108 (Manning Park).

Description. Almost all specimens are secondarily flattened or imprints. Only a few venters are preserved.

The description is based on several selected specimens.

Specimen 22713 from GSC loc. 56624 has at a diameter of about 57 mm (the maximum diameter was larger) a whorl height of about 15 mm and an umbilical width of about 28 mm. At this diameter there are 22 straight, rather sharp, undivided ribs on the anterior half of the last whorl. Venter and suture lines cannot be seen.

Specimen 22714 from GSC loc. 75108 is fragmentary and accurate measurements could not be made. Shape and strength of the ribs are the same as in specimen 22713. There are about 45 ribs on the last whorl and about the same number on the penultimate whorl. One large constriction is present in the anterior half of the last whorl and there are two finer ribs in this constriction. Venter and suture lines are not observable.

Specimen 22715 from the same locality as specimen 22714 is the imprint of a venter from which a rubber cast was made. It shows the ventral furrow and the forward bends of the ribs in this area.

Specimen 22716 from GSC loc. 75111 is a fragmentary imprint that is similar to the above described specimens.

Specimens 22717 and 22718 from GSC loc. 14153 are small whorl fragments. They show the ventral furrow and the forward bends of the ribs on the venter. On the flanks the ribs are straight and sharp.

Comparison. The unsatisfactory preservation of the described specimens does not permit accurate identification. All specimens are considered to belong to one and the same species. Very close and probably identical is Tmetoceras scissum (Benecke).

Occurrence and age. In the Taseko Lakes area the species is associated with Erycites aff. E. howelli (White) at GSC locs. 56624, 56494 and 56509. In Manning Park no other identifiable ammonites were found associated with the species. Early Bajocian.

Family Graphoceratidae Buckman, 1905
Subfamily Graphoceratinae Buckman, 1905
Genus Graphoceras Buckman, 1898
Graphoceras crickmayi n. sp.

Plate II, figures 2-4

Material. Specimens GSC 22865, holotype and GSC 22867, paratype from GSC locs. 66983 and 75563 respectively. Specimen GSC 22866, paratype, from GSC loc. 76299 (exact locality unknown but probably identical or close to the above localities). Lookout section above Pinewoods, Manning Park. The species is named for Dr. C.H. Crickmay.

Description. The preservation of the specimens is fragmentary. Specimens 22865 and 22867 are imprints from which rubber casts were made, specimen 22866 is a secondarily flattened fragment.

No suture lines and no cross-sections are observable.

The measurements in millimetres of the holotype, the largest specimen, are as follows:

Diameter	Whorl height	Whorl thickness	Umbilical width
about 54	about 23(.42)	---	13(.24)

The species is laterally compressed, disk-like, moderately involute. The whorls are high, much higher than thick, slightly concave on inner part of flank with gentle transition from flank to the gently sloping slightly concave umbilical wall. On the holotype remnants of a moderately high ventral keel are preserved.

The sculpture consists of falcate ribs that are weaker on the inner part of the flanks than in their outer part. In the anterior half of the last whorl of the holotype the interior part of the whorl is almost entirely smooth showing only very fine lines. Some of the outer ribs join each other thus indicating occasional bifurcation. Paratype 22866 exhibits some fine ribs on the penultimate whorl.

Comparison. Species now assigned by Spiegler (1966) to the genus Graphoceras had been placed by various authors in a great number of genera

of the Graphoceratidae, as for example Leioceras, Ludwigia, Ludwigella, Brasilina, Brasilia, Hugia, Reynesia, Welschia, Graphoceras and others. The present author places this new species tentatively in Graphoceras because of its concave inner part of the flank by which according to Spiegler (1966, p. 65) Graphoceras is distinguished from Ludwigia and most species of Brasilia. A rediscussion of the systematic position of various Graphoceratidae on the basis of the very unsatisfactory material from British Columbia is, of course, impracticable.

Graphoceras concavum (Sowerby), G. cornu (Buckman) G. rudis (Buckman) G. fallax (Buckman) and others are distinguished from our specimens by the shape and number of the ribs or, in some cases by different width of the umbilicus. Other similar forms described by Buckman (loc. cit.) as Toxolioceras, Lopadoceras and Hugia now considered by Spiegler (1966, p. 85) as belonging to Oedania walkeri are apparently distinguished mainly by a more vertical umbilical wall.

Occurrence and age. The holotype and paratype 22867 occur at the same stratigraphic level as Zemistephanus richardsoni (Whiteaves). In England similar species occur in the Sowerbyi Zone.

Oedania ? sp. indet.

Plate II, figure 5

Material. One whorl fragment, GSC No. 22868, from GSC loc. 62424, Taseko Lakes area.

Description. The whorl is moderately high, cross-section about elliptic, inner part of whorl slightly concave, transition from flank to venter gentle, from flank to umbilicus sharper. Umbilical wall apparently steep. There is a high ventral keel. The ribs are falcate, not bifurcated. In the anterior part of the whorl two ribs join each other near the umbilical edge.

Comparison. The specimen is somewhat similar to Graphoceras crickmayi n. sp. It is distinguished by the steep umbilical wall and the clearly developed ribs in the lower part of the flank. There are some similarities to forms described by Buckman as Toxolioceras, Lopadoceras, Hugia and others now considered by Spiegler (1966, p. 85) as belonging to Oedania walkeri (Buckman).

Occurrence and age. The specimen is associated with another small Graphoceratid of doubtful assignment (GSC No. 22869, Pl. II, fig. 6). Similar forms occur in England in the Discites Subzone of the Sowerbyi Zone.

Family Hammatoceratidae Buckman, 1887
Subfamily Hammatoceratinae Buckman, 1887
Genus Erycites Gemmellaro, 1886
Erycites kialagvikensis (White)

Plate I, figures 6, 7

Ammonites (Lillia) kialagvikensis White, 1889, p. 69, pl. 13, fig. 7.
? Hammatoceras kialagvikensis (White) Pompeckj, 1900, p. 275.
Hammatoceras ? kialagvikensis (White) Kellum, Davies, Swinney, 1945, p. 6, figs. 4c, d.
Erycites kialagvikensis (White) Imlay, 1959, pp. 978, 980
Erycitoides (Kialagvikites) kialagvikensis (White) Westermann, 1964, p. 392, pls. 62, 63.

Material. 2 specimens, GSC 22711, 22712 from GSC loc. 62486, Taseko Lakes area. Some doubtful fragments from the same locality.

Description. The measurements of specimen 22711 in millimetres and the ratios of the diameter of 31 mm are as follows:

Diameter	Whorl height	Whorl thickness	Umbilical width
31	11(.35)	approx. 9(.29)	13(.42)

The maximum diameter of this specimen is about 42 mm but as the anterior part of the last whorl is crushed no reliable measurements can be taken at this diameter. The smaller specimen 22712 consists of inner whorls.

The species is evolute. The primary ribs are bent forward, the secondaries are rursiradiate and swing forward on the venter. On the inner whorls the point of division lies on about half the height of the flanks but is somewhat lower on the last whorl of the larger specimen. At the point of division the ribs are slightly swollen. Most of the primaries bifurcate. A very faint ventral keel is preserved on part of the last whorl of the larger specimen. The venter is rounded, the transition from the flanks to the umbilicus is very gentle.

Comparison. In their general outline and sculpture the two specimens are very similar to Erycites kialagvikensis (White).

Occurrence and age. No other ammonites were found associated with the two specimens at GSC loc. 68486, Taseko Lakes area. Early Bajocian.

Erycites aff. E. howelli (White)

Plate I, figures 8, 9

Material. One specimen GSC 22718 from GSC loc. 56624, one specimen GSC 22856, from GSC loc. 56509, Taseko Lakes area. Two other fragmentary ammonites similar to the ones described here were found at GSC loc. 56494, also in Taseko Lakes area.

Description. Specimen GSC 22718 is the imprint of the fragment of a large whorl, specimen GSC 22856 the imprint of a smaller specimen. The description is based on the rubber casts of these imprints.

None of the two specimens shows the venter or the suture line. The smaller specimen is evolute and has at a diameter of about 28 mm (the maximum diameter is larger) about 13 straight primaries in the anterior part of the whorl. Most of the primaries are subdivided at about the half height of the flanks into two secondaries. Some secondaries are intercalated. The point of division is somewhat swollen.

The large whorl fragment has strong, wide, and blunt primaries some of which are subdivided into two secondaries. The point of division lies at about half the height of the flank or on the inner half of the whorl. Some secondaries do not join the primaries.

Comparison. In their sculpture and dimensions the specimens are very similar to E. howelli (White) but as they are only fragmentary no direct identification is possible.

Occurrence and age. All the specimens were found associated with Tmetoceras cf. scissum (Benecke). Early Bajocian.

Family Sonniniidae Buckman, 1892
Genus Witchellia, Buckman, 1889
Witchellia ? sp. indet.

Plate IV, figures 6, 7

Material. Several specimens from GSC locs. 21886 and 56500, Taseko Lakes and Nechako River areas.

Description. Specimen 22871 from GSC loc. 21886, Nechako River area and 22872 from GSC 56500, Taseko Lakes area are rubber casts from imprints, that show a little more than the specimens themselves. The ribs of these moderately evolute forms are very slightly sigmoid. Some of the ribs of specimen 22871 are bifurcating and some intercalated ribs occur. Both specimens have a ventral keel. The inner whorls are not preserved and suture lines cannot be seen.

Comparison. The poor state of preservation of the material does not permit detailed comparisons. There are some similarities in the general outline to the Witchellias described by Imlay (1964) from southern Alaska. The assignment of the two described specimens to Witchellias is tentative.

Occurrence and age. The specimens collected in the Nechako River area were not found associated with other ammonites. The specimens from GSC loc. 56500, Taseko Lakes area, were associated with Stephanoceras (Skirroceras) cf. S. kirschneri Imlay. The age is middle Bajocian.

Family Otoitidae Mascke, 1907
Genus Zemistephanus McLearn, 1927
Zemistephanus richardsoni (Whiteaves)

Plate II, figure 1; Plate IV, figure 1

Ammonites richardsoni Whiteaves, 1876, p. 32, pl. 5.
Zemistephanus richardsoni (Whiteaves) McLearn, 1927, p. 72
Zemistephanus richardsoni (Whiteaves) McLearn, 1928, p. 19, pl. 9, figs. 1, 2; pl. 10, fig. 2
Zemistephanus richardsoni (Whiteaves) Arkell, 1954, p. 587, fig. 10
Zemistephanus richardsoni (Whiteaves) Imlay, 1964, p. 51, pl. 25, figs. 6, 7; pl. 26, figs. 1-7.

Material. One specimen, GSC No. 22705, from GSC loc. 66983, Manning Park.

Description. Most of the specimen is preserved as an imprint from which a rubber cast was made. A whorl fragment belonging to the same specimen shows parts of the suture line. Apparently the specimen has been laterally compressed to a considerable degree after having been embedded, so that no accurate measurements could be taken. The diameter of the flattened ammonite is 155 mm.

Due to the secondary lateral compression the umbilicus appears to be much shallower and the whorls much higher than in the holo- and paratypes of the species. The umbilical whorlseam follows at first the row of lateral nodes but rises gradually above them in the course of the uncoiling of the ammonite. At the end of the last whorl the umbilical seam is far above the lateral nodes of the penultimate whorl.

There are 20 strong primary ribs on the last and 16 on the penultimate whorl. They terminate in strong nodes. The part of the ammonite lying above the lateral nodes is covered by numerous fine riblets or striations. These striations may also extend to the inner parts of the last whorl. No real secondary ribs can be seen on this specimen.

Comparison. The holotype of the species and the specimen described by McLearn (1929) are smaller than the Manning Park specimen. As they are not compressed their whorls are lower and their umbilicus is deeper than in the Manning Park specimen, but they have the same sculpture. Some of Imlay's Alaskan specimens are also very similar but these show some of the secondary ribs that are not visible in the Manning Park specimen.

Occurrence and age. Graphoceras crickmayi n. sp. occurs almost immediately below and above Zemistephanus. Small fragments of ammonites probably belonging to Otoites or Normannites were found in beds below Zemistephanus. Middle Bajocian.

Family Stephanoceratidae Neumayr, 1875
Genus Stephanoceras Waagen, 1869
Stephanoceras cf. S. caamanoi McLearn

Plate IV, figure 3

Material. One specimen, GSC No. 22704 from GSC loc. 75567. Manning Park.

Description. The specimen is preserved as an imprint from which a rubber cast was made. Cross-section and suture line not observable.

Three whorls can be seen. The umbilical seam of the penultimate whorl is close to the row of lateral tubercles of the youngest whorl. The umbilical seam of the last whorl has risen higher above the lateral tubercles of the penultimate whorl. On the last whorl there are about 38 primary ribs, that are slightly bent forward and end in a rather fine tubercle from which usually three secondaries originate. On the penultimate whorl the number of primaries is less, i.e. about 31.

Comparisons. Compared with the types of Stephanoceras species from Queen Charlotte Islands described by McLearn (1932) the specimen most resembles S. caamanoi McLearn that is also a fine ribbed species, however, the unsatisfactory preservation of the Manning Park specimen renders detailed comparison impossible.

Occurrence. Other fossils obtained at loc. 75567 are fragments of Stephanoceras and Chondroceras.

Stephanoceras (Skirroceras) cf. S. kirschneri Imlay
Plate III, figures 1, 2; Plate IV, figure 2.

Material. 3 specimens: GSC No. 22701 from GSC loc. 62480, GSC Nos. 22702, 22703 from GSC loc. 56500. Taseko Lakes area. At the latter locality occur very poorly preserved Stephanoceratids, some of which may be young specimens of the here described species.

Description. Specimens 22701 and 22702 are preserved as imprints from which rubber casts were made. To specimen 22701 belong also some whorl fragments. Only one side of the specimen 22703 is preserved. Cross-sections could not be seen and no suture lines could be traced.

The mode of coiling and ribbing of the three specimens are very similar. The coiling becomes looser with the increase in size, i.e. the umbilical seam rises above the tubercles and the secondary ribs become more and more exposed.

The primary ribs of the inner whorls are fairly sharp, slightly bent forward. At the point of division into three to four secondaries fairly strong conical tubercles are present. The secondaries are weaker than the primaries and also slightly inclined forward. Some of them are not joining the tubercles. On the larger whorls both the primaries and secondaries become stronger and more blunt.

Comparisons. The large specimen 22701 is very similar to S. macrum (Quenstedt, 1886, 87, pl. 65, fig. 10) but the whorls are higher than in both Quenstedt's and Buckman's (1921, pl. 248) specimens of S. macrum. Very similar is also Stephanoceras (Skirroceras) kirschneri Imlay (1964, p. 47, pl. 18, figs. 1-4; pl. 19, figs. 1-6) from southern Alaska which has higher whorls than S. macrum. However, as no reliable measurements of the Canadian specimens could be obtained final identifications cannot be made.

Occurrence. Taseko Lakes area. At GSC loc. 56500 associated with Witchellia sp. indet.

Stephanoceras sensu lato sp. indet

Plate IV, figure 4

One fragment, GSC No. 22874 from GSC loc. 75106, Divide Section, Manning Park. The specimen has fine ribs that at about half the height of the flanks are subdivided in two or three secondaries. A fine tubercle is present at the point of division.

Genus Stemmatoceras Mascke 1907
Stemmatoceras sp. indet.

One badly crushed fragment from GSC loc. 51112, Taseko Lakes area. As far as comparison is possible the specimen resembles Stemmatoceras albertense McLearn. The specimen was found associated with a fragment of Stephanoceras sp. indet. and other indeterminable ammonites.

Genus Teloceras Mascke, 1907
Teloceras ? sp. indet.

The poorly preserved fragment of a depressed ammonite, GSC No. 22877. Divide Section, Manning Park. GSC loc. 75112. On the flank are fairly strong ribs that are subdivided near the ventral margin into two or three secondaries that cross the venter transversely. Point of division with nodes. Some intercalated ribs are present.

Family Sphaeroceratidae Buckman, 1920
Genus Chondroceras Mascke, 1907
Chondroceras marshalli (McLearn)

Plate III, figures 3, 4

Saxitoniceras marshalli McLearn, 1928, p. 22, pl. 8, figs. 3, 4
Chondroceras marshalli (McLearn) var. Frebold, 1957a, p. 54, pl. 25, figs. 3a, b, pl. 26, figs. 2a, b.

Material. Eight specimens from GSC loc. 10100. Taseko Lakes area. Coll. Crickmay, 1939. Two of them, GSC Nos. 22699, 22700 are here described.

Description and comparisons. The measurements in millimetres and the ratios of the diameter are as follows:

	Diameter	Whorl height	Whorl thickness	Umbilical width
GSC 22699	38	20	25	5
GSC 22700	33	17	23	3

The anterior parts of the last whorl of both specimens are crushed and not considered in these measurements.

The two specimens are smaller than the holotype of the species that has a diameter of 49.2 mm and probably represent younger whorls of the species. They differ from the holotype mainly in having a much smaller umbilical width. Their umbilicus has not been opened up at this stage of growth. They are very similar to C. marshalli (McLearn) var. (Frebold, 1957a, pl. 25, Figs. 3a, b). Both this Fernie Group specimen and the two Taseko Lakes specimens have also backward bent secondaries in common. Imlay's Alaskan specimen described as C. cf. C. marshalli is larger than the Taseko Lakes area specimens.

Occurrence. No other species or genera were found associated with this species at loc. 10100.

Chondroceras sp. indet. aff. C. ellsi (McLearn)

Plate III, figure 5; Plate IV, figure 5(a)

Material. One specimen, GSC No. 22706, from GSC loc. 75572, one specimen, GSC No. 22707 from GSC loc. 75570 (not illustrated) and one specimen GSC No. 22708 from GSC loc. 75109. All specimens from Manning Park.

Description. Specimen 22706 is preserved as a fragment representing half of the ammonite. In addition an imprint of one side and part of the venter of the entire ammonite is preserved. Preservation is poor but general outline and sculpture is observable. The diameter is about 50 mm and at this stage the umbilicus has opened up. At the beginning of the last whorl the ribs are rather fine and closely spaced, towards the mouth they became gradually stronger, more widely spaced and more forwardly inclined. There is a constriction just before the end of the whorl.

Specimen 22707 is a very poorly preserved flattened imprint that has also fine, fairly narrowly spaced ribs at the beginning of the last whorl and stronger more widely spaced ribs in its anterior part. They are, however, not as strong as in specimen 22706 and the intervals between them are smaller.

Specimen 22708 is a flattened imprint with a diameter of about 42 mm. The ribs are gradually becoming stronger and more widely spaced from the beginning to the end of the last whorl. They do not become as strong as in specimen 22706. They are subdivided into two or three secondaries. Some intercalated ribs are present.

Comparisons. It is doubtful whether the three described specimens belong to one and the same species. No detailed comparison with known species is possible, but there are some similarities to Chondroceras ellsi McLearn.

Occurrence. Specimen 22706 was found associated in one and the same piece of rock with Chondroceras sp. indet. A, described below, and fragments of small ammonites with ventral keel and falcate ribs, gen. et sp. indet. Specimen 22707 is from a slightly younger bed than 22706 in the same section. Specimen 22708 was found in another section. No other fossils were found associated with it.

Chondroceras sp. indet. A

Plate IV, figure 5(b)

Material. One specimen, GSC No. 22709, from GSC loc. 75572. Manning Park.

Description. The diameter is approximately 40 mm. Part of one side of the specimen is preserved. The size of the umbilicus is not determinable because it is covered by a fragment of another ammonite. A deep forwardly inclined constriction is present near the end of the whorl. The anterior part of the whorl is covered with numerous very fine equally spaced ribs two or three of which originate from a fine tubercle on the inner part of the flank, apparently close to the umbilical margin. The sculpture of the posterior part of the last whorl is not preserved. No visible suture line.

Comparison. The only Chondroceras with such fine ribs as the described specimen is one described by McLearn (1929, p. 17, pl. 11, fig. 3) as Defonticeras (?) sp. The Manning Park specimen is, however, much more compressed than McLearn's specimen which possibly may be due to secondary lateral compression, furthermore the ribs at the end of the last whorl of McLearn's specimen are much stronger. Such very fine ribs as are present in the described specimen also occur in Labyrinthoceras. A few specific assignment of the single and unsatisfactorily preserved specimen is not possible.

Occurrence. In one and the same piece of rock with Chondroceras sp. indet. aff. C. ellsi McLearn and small ammonites, gen. et sp. indet.

Chondroceras sp. indet. B

A very faint poorly preserved imprint of a small specifically indeterminable Chondroceras was found at GSC loc. 75565 associated with aptychi fragments.

Ammonites incertae sedis

Group 1. At GSC locs. 75560 and 75561, Manning Park, very poor imprints of small fragmentary ammonites occur which are indeterminable. Ribs are apparently restricted to the outer part of the flanks, the presence of a keel is indicated in some of the specimens. Some of them are similar to the small specimen (pl. 2, fig. 6), mentioned under Oedania (?) sp. indet. At

GSC loc. 75565 numerous fragments of aptychi were found of which a few (GSC Nos. 22879, 22880) are illustrated on pl. 2, figs. 7, 8. At GSC loc. 75572 fragments of small ammonites that are apparently similar to the ones from the lower beds are associated with Chondroceras sp. indet. aff. C. ellsi (McLearn), Chondroceras sp. indet. A. and aptychi. Still higher in the section, at GSC loc. 75571 more aptychi occur. When more and better preserved specimens of these ammonites and aptychi are available they will be described in more detail.

Group 2. One fragment of an ammonite, GSC No. 22873 (pl. 1, fig. 17) from GSC loc. 75151, Manning Park. The whorl fragment is secondarily compressed, the original cross-section is unknown. There is a ventral keel that had apparently flat zones on each side. The ribs are sigmoid and undivided. Similar fragments occur in the Microwave Tower section above Pinewoods, still undescribed. The fragments show similarities to the genus Grammoceras of the upper Toarcian.

AGE AND REGIONAL CORRELATION

The ammonites described in this report from Manning Park, Taseko Lakes and Nechako River areas have not previously been reported from these parts of southwestern British Columbia and indicate the presence of parts of the Toarcian and Bajocian stages. Hitherto Toarcian was only known from the Manning Park area, Bajocian from all three areas. At present the most complete development of the Bajocian is known from Manning Park. Bajocian zones still unknown in the two other areas may be present but have not yet been found. The occurrences of ammonite faunas in the three areas are discussed in the following pages.

The Fossil Localities and Their Faunal Content

Manning Park

Divide Section, lower unit

Upper Toarcian and Lower Bajocian

Part of the Upper Toarcian or Yeovilian substage is indicated in the Divide Section at GSC loc. 75113 from where Phlyseogrammoceras aff. P. dispansiforme (Wunstorf) et werthi (Denckmann) were identified. In northwest Europe P. dispansiforme and P. werthi are characteristic of the subzone of Phlyseogrammoceras dispansum in the lower part of the zone of Dumortieria levesquei. Other ammonites found at this locality are very fragmentary and indeterminable but seem to be very similar to the ones at GSC loc. 75114 that is a few hundred feet to the west. The ammonite fragments found at the latter locality are small, have straight ribs and have a ventral keel with a flat zone on each side. The specimens are indeterminable, however, as similar fragments occur at GSC loc. 75113 where they are associated with Phlyseogrammoceras, a late Toarcian age is considered possible.

At other localities in the lower unit of the Divide Section, i.e. at GSC locs. 68688, 75108, 75110 and 75111 flattened ammonites or their

imprints occur which in their outline and ribs are very similar to Tmetoceras scissum (Benecke) of the Lower Bajocian. Only at one of these localities association with other ammonites is indicated, i.e. at GSC loc. 75111, where the imprint of a small piece of an ammonite venter that has a low keel was found. This specimen is not determinable but could possibly belong to Erycites. Unfortunately other ammonites collected in the same lower unit of the Divide section are too poorly preserved to aid in age determination of the rocks concerned. Thus, a few small whorl fragments with keel and undivided falcoid ribs which were found at GSC loc. 75151 and which are very similar to some fragments found in the Microwave Tower Section (see under Ammonites incertae sedis, group 2) could indicate both Toarcian and Bajocian.

Divide Section, upper unit

Middle Bajocian

The ammonites found in the western part of the Divide Section are very poorly preserved and only part of them could be generically identified. Not considered in this report are the Upper Jurassic Buchia beds in the easternmost part of this section.

The generically determinable ammonites occur near the middle of the upper unit of the Divide Section. At GSC loc. 75112 an imprint of a medium sized whorl fragment suggests the genus Teloceras, at GSC loc. 75109 a Chondroceras resembling C. ellsi McLearn was found and at GSC loc. 75106 the fragmentary imprint of a fine-ribbed Stephanoceras was collected. The Humphriesianum Zone of the middle Bajocian is indicated at these three localities. It is possible that at least part of the other localities to the west and east of the established middle Bajocian belong to the Bajocian but the fossils concerned are too poorly preserved to permit a definite opinion on their age.

Summarizing it can be stated that some of the beds in the lower unit of the Divide section are late Toarcian and others early Bajocian in age. In the upper part of the Divide Section the Humphriesianum Zone of the middle Bajocian is present.

Lookout Section above Pinewoods

Middle Bajocian

The preservation of the ammonites in this section – no other megafossils were found – is in most cases very poor and permits only tentative identifications. The older beds are exposed at the Lookout, and they become younger down the road towards Pinewoods.

At the Lookout, beds with numerous plant remains are exposed. From this point several hundred feet down the road ammonites were found at GSC locs. 75569, 75563 and 66983. In this part of the section Zemistephanus richardsoni (Whiteaves), Graphoceras crickmayi n. sp. and fragments of Otoites ? or Normannites ? were connected.

The beds are considered to be approximately equivalent to the zones of Otoites sauzei and Sonninia sowerbyi of the middle Bajocian. This assignment is suggested because of the occurrence of Graphoceras and Otoitidae such as Zemistephanus richardsoni (Whiteaves).

F.H. McLearn (1949, p. 16) expressed the opinion that in the Queen Charlotte Islands the faunas with Zemistephanus and Stephanoceras were "apparently all of one fauna". However, Arkell (1954, pp. 587, 588) has pointed out that these two faunas had not been found associated with each other on the Queen Charlotte Islands and considered the Zemistephanus fauna to be slightly older than the Stephanoceras fauna; he assigned the former to the Sauzei or Sowerbyi Zone and the latter to the Humphriesianum Zone. The same relationships seem to be present in the Lookout Section.

The fossil localities 75561 and 75560, which are stratigraphically above GSC loc. 66983 with Zemistephanus, contain mainly indeterminable small ammonites. Specimens of Chondroceras were found at GSC locs. 75572 and 75565. At the former locality two species of Chondroceras are associated with fragments of small ammonites with falcate ribs and ventral keel in one and the same piece of rock. Aptychi occur at GSC locs. 75564, 75565, 75571 and 75572. The beds concerned are here called informally "Aptychi beds". The precise age of these middle Bajocian beds cannot be determined at present due to the lack of identifiable guide-ammonites.

The stratigraphically higher beds of the middle Bajocian Lookout road section has yielded Stephanoceras cf. S. caamanoi (at GSC loc. 75567) McLearn, Stephanoceras sp. indet. (at GSC locs. 75573, 75574, 75575) and Chondroceras ex aff. C. ellsi (McLearn) (at GSC loc. 75570). No more aptychi were found in this upper part of the section.

The faunal content of this part of the section suggests the Humphriesianum Zone of the middle Bajocian. It is considered to be of the same age as the middle Bajocian in the upper part of the Divide Section.

Taseko Lakes Area

In the Taseko Lakes area no Toarcian is indicated by fossils. However, as shown in the description of the sections its representation by supposedly unfossiliferous sediments is considered possible. Both lower and middle Bajocian are present in part.

Lower Bajocian

Beds containing Tmetoceras cf. T. scissum (Benecke) that in most cases is associated with species of Erycites are present at various localities but they have not been found in visible contact with older or younger beds that should be expected under normal conditions below and above them, i.e. the Toarcian and lowermost Bajocian or the middle Bajocian respectively. The localities and their fossil content are listed as follows:

GSC locs. 56509 and 56494: 2 1/4 miles north of junction of Tyaughton and Bonanza Creeks, 51°04'40"N Lat., 122°52'40"W Long. Tmetoceras cf. T. scissum (Benecke) Erycites aff. E. howelli (White).

GSC locs. 56624 and 14153: On both sides of Yalakom River for 1 1/2 to 2 miles above junction with Blue Creek; 51°02'15"N Lat., 122°27'35" W Long. The beds exposed are 75 feet to 100 feet thick. Tmetoceras cf. T. scissum (Benecke) and Erycites aff. E. howelli (White) at loc. 56624, Tmetoceras cf. scissum (Benecke) at loc. 14153.

GSC locs. 62486 and 56563 are identical. On ridge half mile southwest of Cardtable Mountain. 51°05'40"N Lat. 122°57'10"W Long. Erycites kialagvikensis (White), Holcophylloceras cf. H. costisparsum Imlay.

GSC loc. 56605, Tyaughton Creek, north side, 1 1/2 miles below mouth of Spruce Lake Creek 51°02'55"N Lat. 122°54'30"W Long. Tmetoceras cf. T. scissum (Benecke). At this locality there is a covered interval above the beds with Tmetoceras and above this interval at GSC loc. 10100 are beds containing Chondroceras marshalli (McLearn) of middle Bajocian age.

The beds with Tmetoceras cf. T. scissum (Benecke) in the Taseko Lakes area are equivalent in age to the Tmetoceras beds in the Manning Park and Whitesail areas.

Middle Bajocian

Chondroceras marshalli (McLearn) of middle Bajocian age was found at GSC loc. 10100 as already mentioned. This is the same locality as GSC loc. 56605 with the lower Bajocian Tmetoceras cf. T. scissum but is higher in the section.

A section at the head of Relay Creek, south branch, southwest of Relay Mountain, 51°08'N Lat. 123°02'W Long. contains in beds 300 feet thick the following fossil localities in descending order:

GSC loc. 56504	poorly preserved uncoiled ammonite.
GSC loc. 56500	Stephanoceras (Skirroceras) cf. S. Kirschneri Imlay and Witchellia ? sp. indet.
GSC loc. 62480	Stephanoceras (Skirroceras) cf. S. Kirschneri Imlay.

The two lower fossil localities belong to the middle Bajocian. The same age is considered for the upper fossil locality.

Farther down in the section at GSC loc. 56502 Holcophylloceras cf. K. costisparsum Imlay and at GSC loc. 62435 indeterminable ammonite fragments were found.

GSC loc. 51112 is "on mountain ridge top 1 2/3 miles northwest of Nemaia Lake; 51°28'45"N Lat. 124°00'00"W Long." Stemmatoceras sp. indet. Stephanoceras sp. indet. The age is middle Bajocian, Humphriesianum Zone.

GSC loc. 62424 is on the west side of Spruce Lake Creek, 1 1/2 miles from Spruce Lake; 51°02'05"N Lat. 122°57'20"W Long. Oedania ? sp. indet. The specimen belongs to a species similar to representatives of the genus Oedania which occur in the middle Bajocian Sowerbyi Zone of England.

Nechako River Area

No Toarcian and no lower Bajocian have been found in this area. The presence of middle Bajocian is indicated at GSC loc. 21886: Kuyakuz Mountain, 1 1/2 miles south of peak. Here several specimens of Witchellia ? sp. indet. were found. The age is middle Bajocian, Sauzei or Humphriesianum Zone.

CORRELATION WITH OTHER PARTS OF CANADA

In this report the northwest European names of stages, zones and subzones (see correlation chart, Table I) are used.

The ammonites hitherto found in the Manning Park area indicate the presence of only one subzone of the upper Toarcian Levesquei Zone i.e. the Dispansum Subzone.

The next older zone with Grammoceras thouarsense may also be present but the ammonites found in the beds concerned are too unsatisfactorily preserved for accurate identification and age determination.

It is uncertain whether other upper and lower Toarcian zones and subzones as yet not indicated by fossils are actually missing or have just not been found. Upper Toarcian is widespread in Western and Northern Canada but the beds concerned are not everywhere equivalent to one another. In some cases correlation is difficult or impossible because of the poor preservation and uncertain identification of the ammonites concerned. In some areas, as in the Nechako River and Taseko Lakes[1] areas Toarcian is not indicated at all, in other areas, as for instance in the Salmo and Nelson areas of southern British Columbia only lower Toarcian is known to be present (Frebold, 1959; Frebold and Little, 1962).

In both the Manning Park and Taseko Lakes areas the lower Bajocian (Aalenian) Zone of Tmetoceras scissum is represented. These beds are also present in the Whitesail Lake area of British Columbia (Frebold, 1951) but have not been found as yet in other parts of Canada. The slightly older early Bajocian zone of Leioceras opalinum which is well developed in the Canadian Arctic Islands (Frebold, 1957b, 1960) has been found nowhere in Western Canada and in this case a gap seems to be probable. Lower Bajocian beds younger than the Scissum Zone are unknown in southwestern British Columbia and other parts of Canada and it appears probable that these beds largely equivalent to the zone of Ludwigia murchisonae, are primarily missing.

The middle Bajocian Sowerbyi Zone has been found to be represented in the Telegraph Creek area of northwestern British Columbia (Frebold, 1964), in the Hudson Bay Mountains (McLearn, 1926) and in the Rocky Mountains (Frebold, 1957a). It is possibly also present in the Nelson and Salmo areas of southern British Columbia. Probably it has a much wider distribution in Western Canada than is known at present. In the Manning Park area this zone and the next younger zone of Otoites sauzei are probably

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[1] The author (Frebold, 1951, p. 13, 1964, Table 1) erroneously thought that Toarcian was present in the Tyaughton Lake area.

TABLE 1. Correlation of Toarcian and Bajocian beds of Manning Park and Taseko Lakes areas, southwestern British Columbia.

STAGES			NORTHWEST EUROPEAN ZONES (Middle Jurassic after Arkell, 1956; Lower Jurassic after Dean et al, 1961)	NORTHWEST EUROPEAN SUBZONES (Middle Jurassic after Arkell, 1956; Lower Jurassic after Dean et al, 1961)	SOUTHERN PARTS OF BRITISH COLUMBIA		CANADIAN ROCKY MOUNTAINS AND FOOTHILLS	NORTHWESTERN BRITISH COLUMBIA
					Manning Park and Taseko Lakes	Salmo and Nelson Areas		
MIDDLE JURASSIC	BAJOCIAN	MIDDLE	Stephanoceras humphriesianum	Teloceras blagdeni	Stephanoceras, Stemmatoceras, Teloceras, Chondroceras	Sonninia?	Chondroceras allani, Stephanoceras, Stemmatoceras, Teloceras etc.	Chondroceras allani Stephanoceratids
				S. humphriesanum				
			Otoites sauzei					
			Sonninia sowerbyi	Witchellia laeviuscula Shirbuirnia trigonalis Hyperlioceras discites	Zemistephanus, Graphoceras, Oedania?		Sonninia spp.	Sonniniids
		LOWER (AALENIAN)	Graphoceras concavum					Not identified
			Ludwigia murchisonae	Brasilia bradfordensis Ludwigia murchisonae Ancolioceras spp.	Not identified	Not identified		
			Tmetoceras scissum		Tmetoceras, Erycites			
			Leioceras opalinum		Not identified			
LOWER JURASSIC	TOARCIAN	Upper (Yeovilian)	Dumortieria levesquei	Pleydellia aalensis	in Manning Park: Not identified	Not identified	Not identified	
				Dumortieria moorei				
				Dumortieria levesquei				
				Phlyseogrammoceras dispansum	Phlyseogrammoceras			
			Grammoceras thouarsense	Grammoceras struckmanni	Grammoceras?		Grammoceras boreale	Grammoceras aff. fallaciosum
				Grammoceras striatulum				
			Haugia variabilis					
		Lower (Whitbian)	Hildoceras bifrons	Dactylioceras braunianum Peronoceras fibulatum Dactylioceras commune	Not identified		Peronoceras	Dactylioceras, Peronoceras
			Harpoceras falcifer	Harpoceras falcifer Harpoceras exaratum		Dactylioceras sp. indet. and Harpoceras cf. exaratum	Dactylioceras aff. commune, Harpoceras cf. exaratum	Harpoceras cf. exaratum
			Dactylioceras tenuicostatum					

represented in the lower part of the Lookout section above Pinewoods. As shown in the discussion of the age of the beds concerned this opinion is supported by the presence of Graphoceratidae. Apparently beds of approximately the same age are also present in the Taseko Lakes area where Oedania ? sp. indet. was found. The ammonites described by Crickmay (1930) from the Ashcroft area in British Columbia as Sonninia and Kallistephanus may also be considered as representing zones of this age as was suggested by Crickmay. Unfortunately the ammonites concerned were not illustrated. The Sauzei Zone is also present in the Queen Charlotte Islands where it is indicated by the Zemistephanus fauna (McLearn, 1949; Arkell, and Playford, 1954).

The Humphriesianum Zone that is well represented in the Manning Park and Taseko Lakes areas is widely distributed in Western Canada, both in British Columbia and Alberta. However, in certain areas, as for instance in the Harrison Lake and Nelson areas and on Vancouver Island, it has not been found.

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PLATES I-VI

(All fossil illustrations natural size)

Plate I

Figure 1. Tmetoceras cf. T. scissum (Benecke). GSC No. 22713. Lateral view. Taseko Lakes area. GSC loc. 56624. Lower Bajocian.

Figure 2. Tmetoceras cf. T. scissum (Benecke). GSC No. 22714. Lateral view. Manning Park, Divide section, GSC loc. 75108. Lower Bajocian.

Figure 3. Tmetoceras cf. T. scissum (Benecke). GSC No. 22715. Venter. Rubber cast. Manning Park, Divide section, GSC loc. 75108. Lower Bajocian.

Figure 4a, 4b. Tmetoceras cf. T. scissum (Benecke). GSC No. 22717. 4a, lateral view; 4b, venter. Taseko Lakes area. GSC loc. 14153. Lower Bajocian.

Figure 5. Tmetoceras cf. T. scissum (Benecke). GSC No. 22718. Venter. Same locality and age as specimen figures 4a, b.

Figure 6a, 6b. Erycites kialagvikensis (White). GSC No. 22711. 6a, lateral view; 6b, venter. Taseko Lakes area. GSC loc. 62486. Lower Bajocian.

Figure 7. Erycites kialagvikensis (White). GSC No. 22712. Lateral view. Same locality as specimen figures 6a, b.

Figure 8. Erycites aff. E. howelli (White). GSC No. 22856. Lateral view. Rubber cast. Taseko Lakes area. GSC loc. 56509. Lower Bajocian.

Figure 9. Erycites aff. E. howelli (White). GSC No. 22718. Lateral view. Rubber cast. Taseko Lakes area. GSC loc. 56624. Lower Bajocian.

Figures 10-15. Phlyseogrammoceras aff. P. dispansiforme (Wunstorf) et P. werthi (Denckmann). Lateral views. Fig. 10, GSC No. 22857 (rubber cast); Fig. 11, GSC No. 22858 (rubber cast); Fig. 12, GSC No. 22859; Fig. 13, GSC No. 22860; Fig. 14, GSC. No. 22861; Fig. 15, GSC No. 22862. Manning Park, Divide section, GSC loc. 75113. Upper Toarcian.

Figure 16. Ammonite incertae sedis, group 2. GSC No. 22873. Lateral view. Grammoceras ? Manning Park, Divide section, GSC loc. 75151. Upper Toarcian ?.

Figure 17. Ammonite incertae sedis, group 2. GSC No. 22878. Lateral view. Grammoceras ? Manning Park, from undescribed Microwave Tower section above Pinewoods, GSC loc. 75102. Upper Toarcian ?.

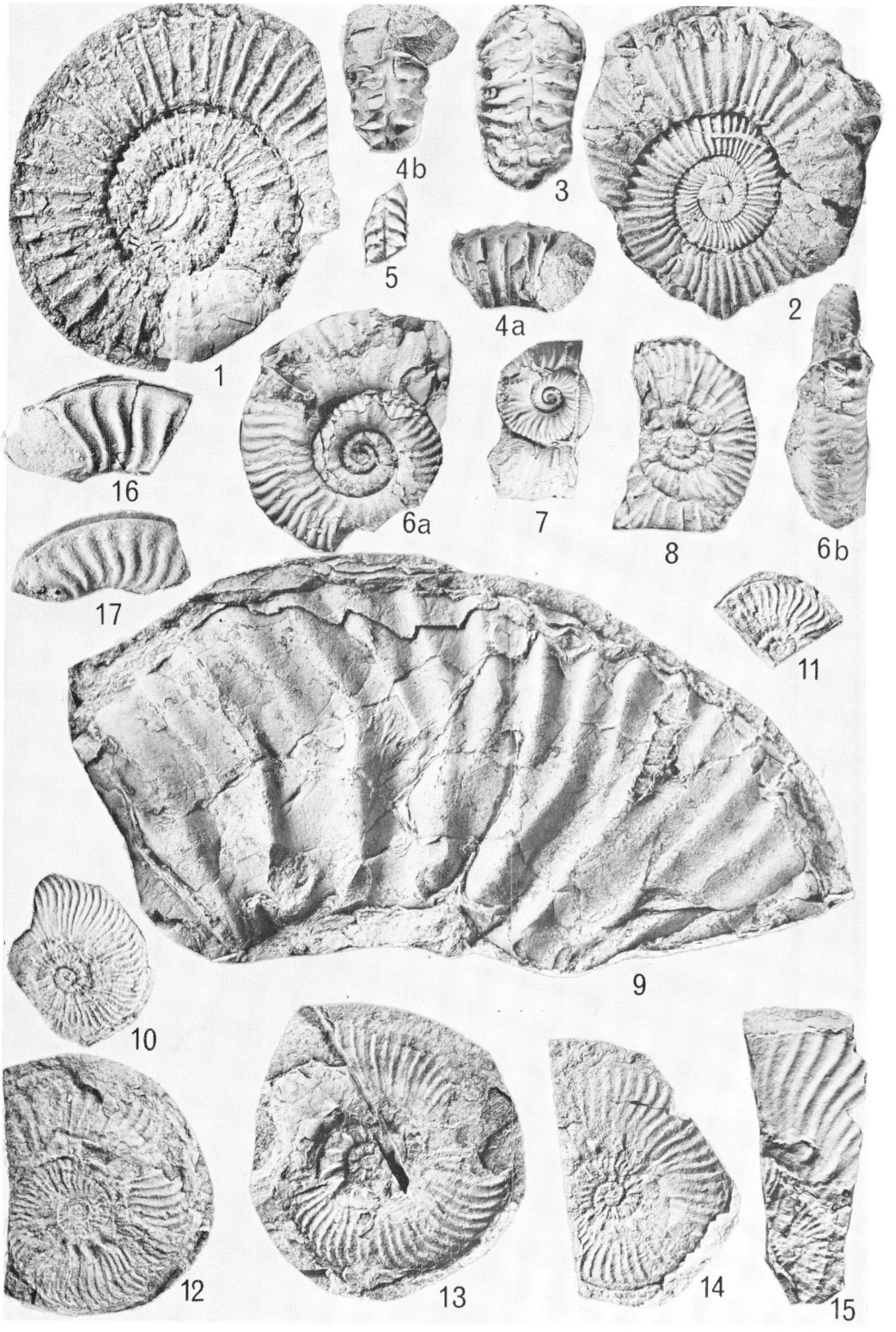
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Plate II

Figure 1. Zemistephanus richardsoni (Whiteaves), GSC No. 22705. Lateral view. Rubber cast. Manning Park, Lookout section. GSC loc. 66983. Middle Bajocian.

Figure 2. Graphoceras crickmayi n. sp. Holotype. GSC No. 22865. Lateral view. Rubber cast. Manning Park, Lookout section. GSC loc. 66983. Middle Bajocian.

Figure 3. Graphoceras crickmayi n. sp. Paratype. GSC No. 22866. Lateral view. Manning Park, probably Lookout section. GSC loc. 76299. Middle Bajocian.

Figure 4. Graphoceras crickmayi n. sp. Paratype. GSC No. 22867. Lateral view. Rubber cast. Manning Park, Lookout section. GSC loc. 75563. Middle Bajocian.

Figure 5. Oedania ? sp. indet. GSC No. 22862. Lateral view. Taseko Lakes area. GSC loc. 62424. Middle Bajocian.

Figure 6. Graphoceratid, gen.et sp. indet. GSC No. 22869. Lateral view. Taseko Lakes area, same locality as specimen figure 5. Middle Bajocian.

Figures 7, 8. Aptychi. GSC Nos. 22879, 22880. Rubber casts. Manning Park, Lookout section. GSC loc. 75565. Middle Bajocian.

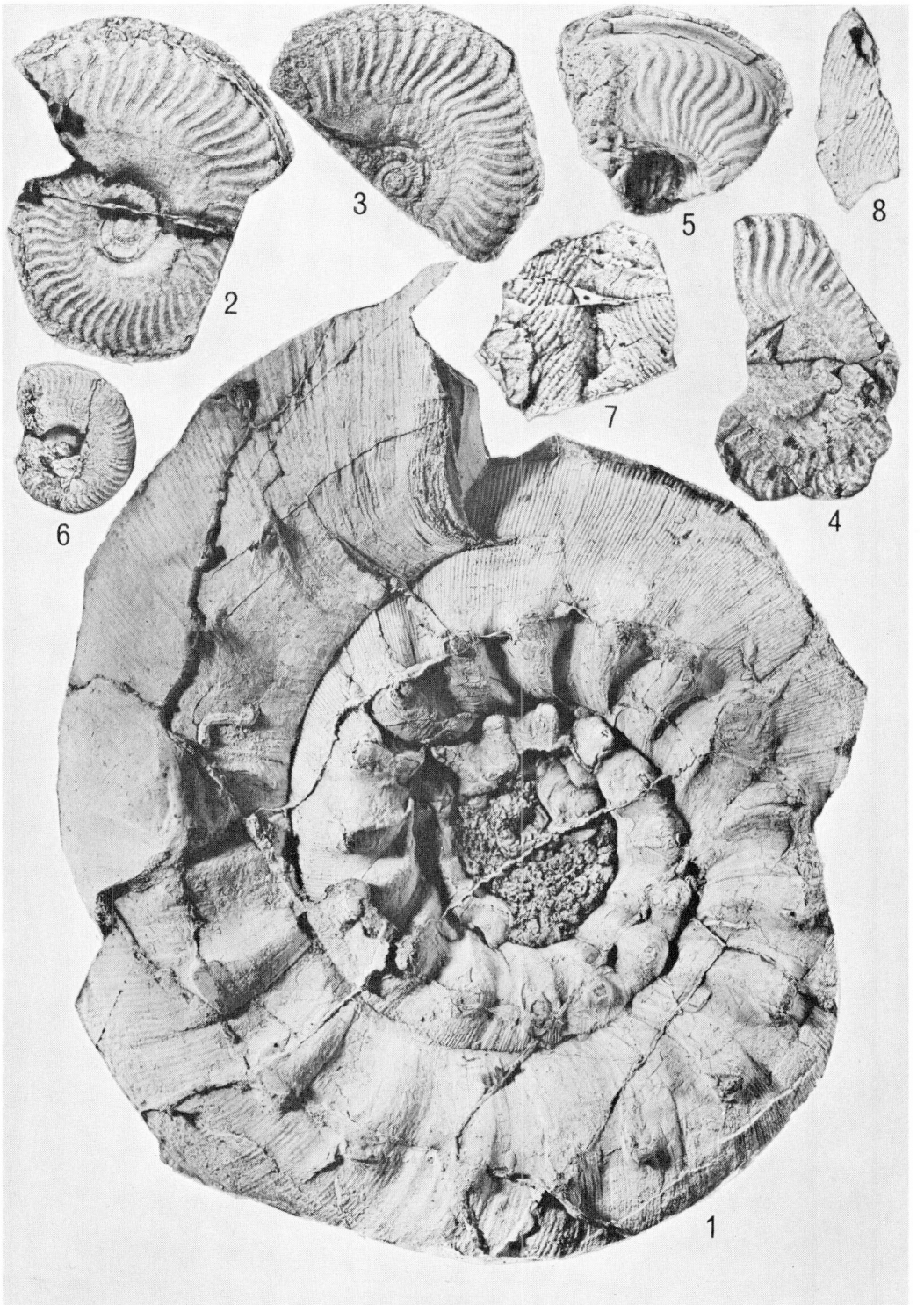
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Plate III

Figure 1. Stephanoceras (Skirroceras) cf. S. kirschneri Imlay. GSC No. 22701. Lateral view. Rubber cast. Taseko Lakes area. GSC loc. 62480. Middle Bajocian.

Figure 2. Stephanoceras (Skirroceras) cf. S. kirschneri Imlay. GSC No. 22702. Lateral view. Rubber cast. Taseko Lakes area. GSC loc. 56500. Middle Bajocian.

Figures 3, 4. Chondroceras marshalli (McLearn) GSC Nos. 22699, 22670. Lateral views. Taseko Lakes area, GSC loc. 10100. Middle Bajocian.

Figure 5. Chondroceras sp. indet. aff. C. ellsi (McLearn). GSC No. 22708. Lateral view. Rubber cast. Manning Park, Divide section. GSC loc. 75109. Middle Bajocian.

Figure 6. Holcophylloceras cf. H. costisparsum Imlay. GSC No. 22870. Lateral view. Taseko Lakes area. GSC loc. 56502. Lower or middle Bajocian.

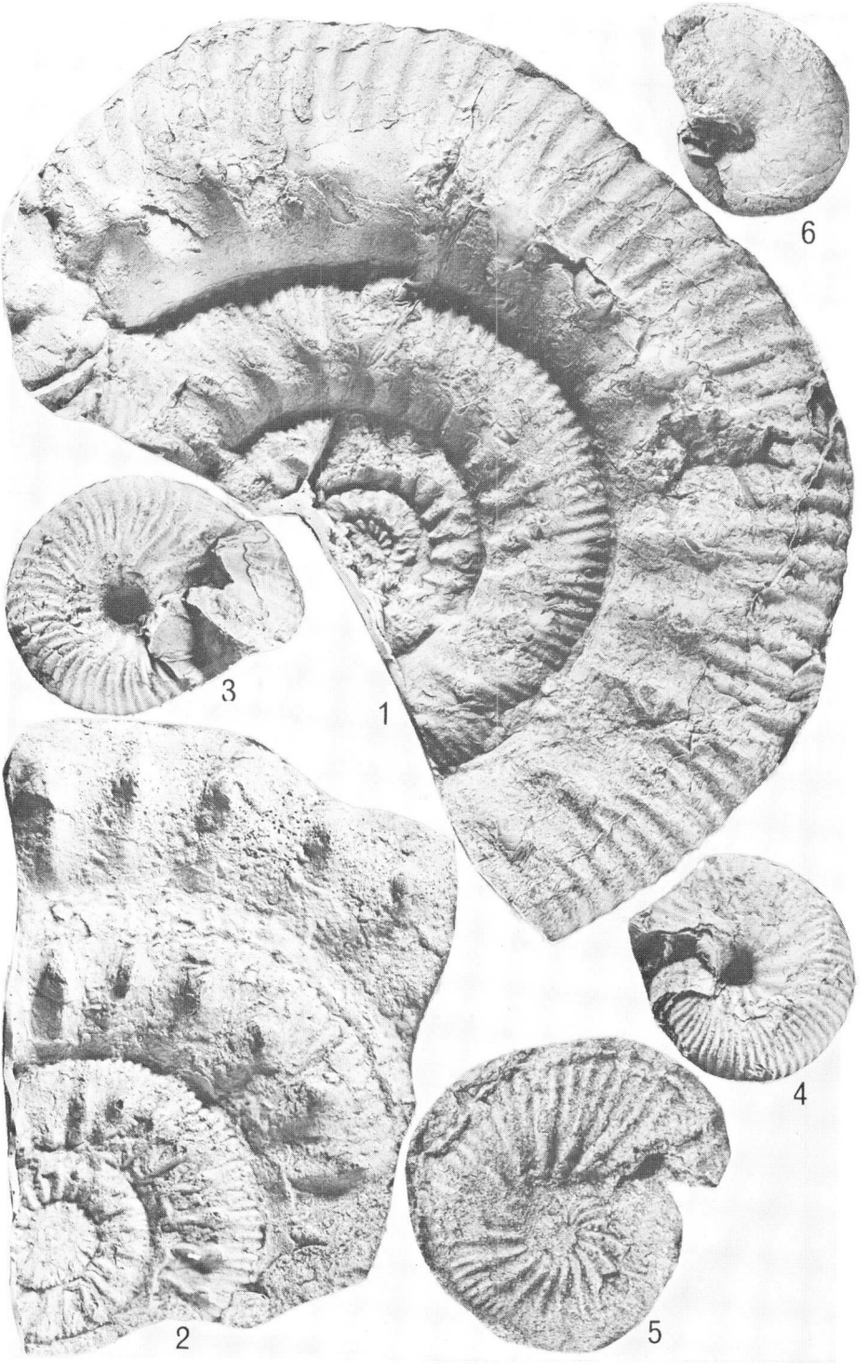
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Plate IV

Figure 1. Zemistephanus richardsoni (Whiteaves). Same specimen as Plate II, figure 1. GSC No. 22705. Suture lines. Manning Park, Lookout section. GSC loc. 66983. Middle Bajocian.

Figure 2. Stephanoceras (Skirroceras) cf. S. kirschneri Imlay. GSC No. 22703. Lateral view. Taseko Lakes area. GSC loc. 56500. Middle Bajocian.

Figure 3. Stephanoceras cf. S. caamanoi McLearn. GSC No. 22704. Lateral view. Rubber cast. Manning Park, Lookout section. GSC loc. 75567. Middle Bajocian.

Figure 4. Stephanoceras sp. indet. GSC No. 22874. Lateral view. Rubber cast. Manning Park, Divide section. GSC loc. 75106. Middle Bajocian.

Figure 5 a - d 5a, Chondroceras sp. indet. aff. C. ellsi McLearn. GSC No. 22706. Lateral view. 5b, Chondroceras ? sp. indet. A. GSC No. 22709. Lateral view. 5c, Ammonite sp. indet. GSC No. 22875. Venter. 5d, Ammonite sp. indet. GSC No. 22876. Lateral view. Manning Park, Lookout section. GSC loc. 75572. Middle Bajocian.

Figure 6. Witchellia ? sp. indet. GSC No. 22871. Lateral view. Rubber cast. Nechako River area. GSC loc. 21886. Middle Bajocian.

Figure 7. Witchellia ? sp. indet. GSC No. 22872. Lateral view. Rubber cast. Taseko Lakes area. GSC loc. 56500. Middle Bajocian.

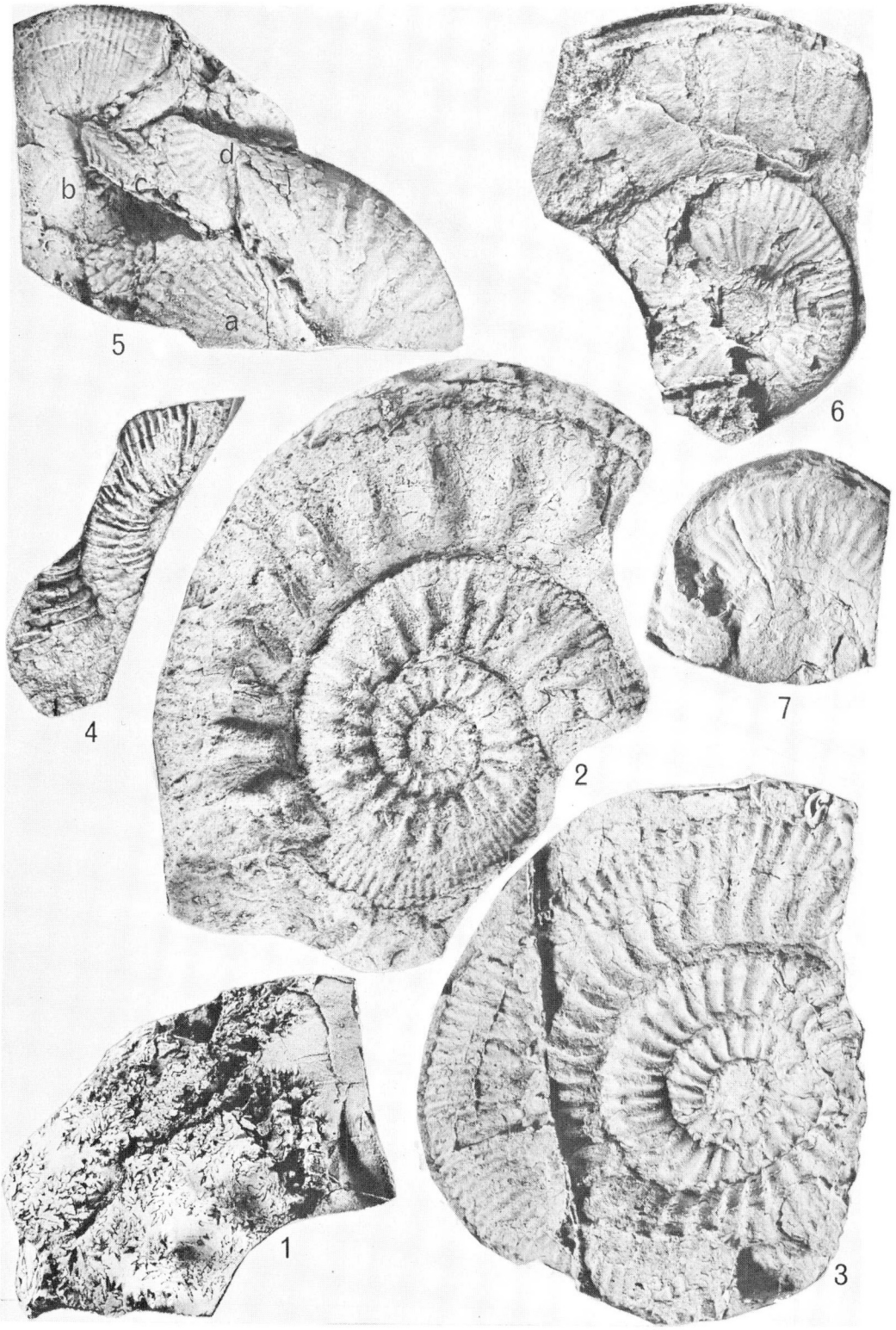
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Plate V A. Lookout Section above Pinewoods. Manning Park. L-Lookout. The middle Bajocian rocks are exposed in the three upper levels of the road of which the lowest one is concealed by trees. The lower parts of the mountain consist of Lower Cretaceous rocks.

(H. Frebold phot. 1966)

Plate V B. Middle Bajocian rocks (Humphriesianum Zone) in Lookout Section, Manning Park, at GSC loc. 75567.

(H. Frebold phot. 1966)

PLATE V

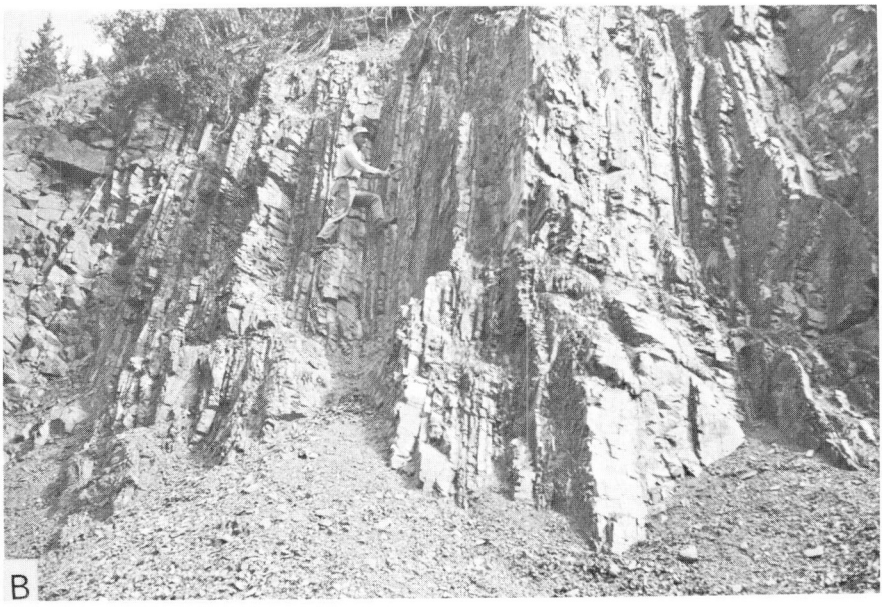

Plate VI A. Middle Bajocian beds in Snake Indian River valley, northwest of Jasper, Alberta, Rocky Mountains.
1-Toarcian. 2-Bajocian. (H. Frebold phot. 1952)

Plate VI B. Middle Bajocian rocks in eastern part of Divide Section, Manning Park, British Columbia.
(J.A. Coates phot. 1966)

The pictures illustrate the great differences in lithology and thickness (about 150 feet in the Rocky Mountains and $\pm$4500 feet in parts of southwestern British Columbia).

PLATE VI