TRIASSIC - JURASSIC BIOCHRONOLOGY OF
THE EASTERN ISKUT RIVER MAP AREA,
NORTHWESTERN BRITISH COLUMBIA

by

GENGA THAVI NADARAJU

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Department of Geological Sciences
The University of British Columbia
Vancouver, Canada

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Abstract

Norian to Early Callovian faunas in the eastern half of the Iskut River map area can be divided into three suites: a benthonic fauna consisting of bivalves, corals, and gastropods; a planktonic fauna of radiolarians; and a nektonic fauna of coleoids and ammonoids. The ammonoids (27 genera, 47 species) and radiolarians (14 genera, 18 species) are described. Other taxa are identified and listed in Appendix III.

Ammonoids, bivalves, and radiolarian of the following stages are recognized: Norian (Cordilleranus Zone and Amoenum-Crickmayi Zones), upper Hettangian - Lower Sinemurian (Canadensis Zone), Upper Pliensbachian (Kunae and Carlottense Zones), Lower Toarcian (Assemblage Zones 2-3 of Jakobs), Upper Toarcian (Assemblage Zone 6 of Jakobs), Aalenian (Erycittoides howelli assemblage zone), Lower Bajocian, Upper Bathonian, and Lower Callovian.

In the eastern Iskut River map area: i) the Stuhini Group is Norian, ii) the Jack "formation" and the basal sedimentary sequence of the Unuk River Formation are upper Hettangian to Lower Sinemurian, iii) the upper volcanic sequence of the Unuk River Formation ranges from the Lower Sinemurian to the Pliensbachian, iv) the Betty Creek Formation ranges from the Upper Pliensbachian to Lower Toarcian?, v) the Mt. Dilworth "formation" is restricted to the Upper Pliensbachian to possibly Lower Toarcian (at John Peaks), vi) the Salmon River Formation ranges from middle? Toarcian to Lower Bajocian, vii) the Eskay Creek and Troy Ridge facies of the Salmon River Formation are Aalenian to Lower Bajocian, and viii) the Ashman Formation ranges from Lower Bajocian to Lower Callovian. Regional correlations with strata elsewhere in the Bowser Basin are as follows: i) the Betty Creek and Mt. Dilworth formations are coeval with the Wolf Den Formation (Spatsizi Group) and the Nilkitkwa Formation (Hazelton Group); ii) the Salmon River Formation is coeval with the Melisson, Abou, and Quock formations of the Spatsizi Group and with the Smithers Formation of the Hazelton Group.
At the Snippaker Ridge, strata previously described as Toarcian, are now shown to be Norian in age. At the Treaty Ridge section, the Aalenian fauna below a felsic unit provided the first evidence of a younger felsic horizon in the map area; this unit represents a higher stratigraphic level than the felsic unit that constitutes the type Mt. Dilworth "formation".

Age of the stratabound mineralization at Eskay Creek is confined to Aalenian to possibly Early Bajocian. The rocks that host the Treaty Glacier alteration systems are shown to be Aalenian to Early Bajocian in age. Jurassic mineralization was therefore restricted to the Aalenian - Lower Bajocian interval.

Ammonites are locally common in siltstone and shale, benthonic faunas are abundant in coarse sandstone, and the planktonic forms are locally common in siliceous shale and limestone. The benthonic and nektonic faunas were deposited in a wide spectrum of nearshore to off-shore shallow shelf to slope/basinal environments represented by the Composite assemblage depth zones B-D of Taylor (1982). Nassellarian-spumellarion radiolarian ratios suggest that within the Salmon River Formation at Eskay Creek, both the contact zone sediments hosting the stratabound mineralization and the felsic volcanics were deposited in deeper water than the overlying andesite/pillow basalt sequence.
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CHAPTER 1

INTRODUCTION

1.1 Purpose

The Triassic-Jurassic strata of the Iskut River map area of northwestern British Columbia are undergoing intensive study in order to determine the regional geological setting associated with exploration for precious metal deposits. Regional surveys and mapping programs are presently being undertaken by the federal and provincial governments (Alldrick & Britton, 1988; Britton & Alldrick, 1988; Anderson, 1989; Alldrick et al., 1989, 1990; Britton et al., 1989, 1990b; Anderson and Thorkelson, 1990). Also, extensive property-scale mapping is being undertaken by several mining companies and the Mineral Deposit Research Unit (MDRU) based at the University of British Columbia.

Triassic-Jurassic strata in the structurally complex Iskut River map area consist of sequences of epiclastic to pyroclastic sedimentary and rhyolitic to basaltic volcanic rocks characterized by abrupt lateral and vertical facies changes. A biochronologic study based on macro- and microfossils is critical to regional and subsurface correlations, and to further refine our understanding of stratigraphic relationships and the timing of volcanism. Biochronology also has the potential to constrain the age of stratabound mineralization locally and to delimit the temporal patterns of mineralization on a regional scale. The main aim of this study is to contribute to the understanding of the paleontology and geology of the Iskut River map area as follows:

Paleontology:

i) To conduct a taxonomic study of the Triassic to Jurassic faunas collected from the Snippaker Creek and John Peaks areas (eastern Iskut River map area);

ii) To conduct a paleobathymetric analysis at the Eskay Creek site using the planktonic fauna;
iii) To conduct a paleoecological analysis on a regional scale using the benthonic and nektonic faunas;

**Correlations:**

iv) To apply high resolution biochronology to stratigraphic problems and refine correlations;

v) To constrain the age of stratabound mineralization at Eskay Creek and the age of other alteration systems in the map area;

vi) To correlate lithostratigraphic units in the Iskut River map area with other lithostratigraphic units elsewhere in the Bowser Basin.
1.2  Location, access, and topography

The Iskut River map area (104B) is located in northwestern British Columbia, in the eastern Boundary Ranges of the Coast Mountains (Fig. 1.1). This study covers the eastern portion of the map area and includes the Snippaker Creek (NTS 104B/10) and John Peaks (NTS 104B/9) 1:50,000 map areas. The only road access in the region is the Iskut Road which was recently completed to Volcano Creek. Helicopter access is essential for traverses and flycamps. Fixed wing aircraft service to the Johnny Mountain and Bronson Creek airstrips provides links with Stewart, Terrace and Smithers. Helicopter bases at Stewart, Bell-Irving crossing and Bob Quinn Lake and seasonal bases at Bronson, Eskay Creek, and Sulphurets provide links with Highway 37.

The dominant topographic features of the study area are rugged mountains, alpine glaciers, and glaciated valleys. A large portion of the John Peaks map area is covered by permanent icefields, whereas north-trending ridges, river channels, and lakes are common in the Prout Plateau.
Figure 1.1: Location of the eastern Iskut River map area in northwest British Columbia (modified from Wheeler and McFeely, 1987).
1.3 Previous Work

The Iskut River map area has attracted gold prospectors since the 1800's. Geological work, however, did not begin until the 1920's when Kerr (1948) first mapped the geology of the area. His work was incorporated into the 1:250 000 map published by the Geological Survey of Canada in 1957 as part of Operation Stikine and was the first published reference to the Jurassic sediments of the area.

Grove (1971, 1986) mapped part of the eastern portion of the map area (Stewart area) between 1964 and 1970. He provided the first detailed map (1:25 000) of the region, incorporating the regional mapping conducted by Newmont Mines Limited between 1959 and 1962. Grove established the stratigraphic framework for the region, subdividing the Lower and Middle Jurassic Hazelton Group into three formations, in ascending order: the Unuk River, Betty Creek, and Salmon River. His maps and report include some fossil localities, identifications, and ages. The fossils were identified by W.R. Danner at the University of British Columbia and by paleontologists of the Geological Survey of Canada (Ottawa). In the Stewart region, Alldrick (1987) identified the presence of the Mt. Dilworth "formation" between the Betty Creek and Salmon River formations.

Mapping at specific sites has been conducted as part of several thesis projects. Kirkham (1963) mapped areas between Brucejack Lake and Mitchell Glacier (1:12 000), Donnelly (1976) worked on the Kay Claims (Eskay Creek area), and Gunnings' (1986) thesis focussed on the stratigraphy and structure of the Prout Plateau area. Both Donnelly and Gunning had brief fossil reports in their theses based on identifications by Howard Tipper of the Geological Survey of Canada (Cordilleran Division).

In 1987 and 1988 the British Columbia Geological Survey mapped 150 square kilometres around Bronson Creek (Lefebure and Gunning, 1989). At the same time the Geological Survey of Canada began mapping the entire NTS104B map area (Anderson, 1989; Anderson and Thorkelson,
1990; Anderson and Bevier, 1990) and produced a regional geologic framework for the area.

The geology and mineralization of the Sulphurets, Unuk, and Snippaker areas has been described in maps and reports by Alldrick and Britton (1988), Alldrick et al. (1989, 1990), Britton and Alldrick (1988), Britton et al. (1989, 1990b) and Read et al. (1989). Fossil localities are marked on their maps which include compilations of published and unpublished fossil reports.

The recently established Mineral Deposit Research Unit at the University of British Columbia began studies of the major mineral deposits in the region. Their research includes the regional and local stratigraphy and the structural style of the Prout Plateau. Property scale mapping is also being conducted at specific sites by mining companies.

Paleontological field work commenced in 1989. Smith and Carter (1990) presented preliminary observations and discussed the various types of Jurassic faunas in the Unuk Valley.
1.4 Methods

1.4.1 Samples

Fossils collected by the author during the 1991 field season and additional collections made by geologists of the Geological Survey of Canada, mining companies, and the Mineral Deposit Research Unit were the basis of the present study. Fossils collected during previous studies (Grove, 1986; Donnelly, 1976; Smith and Carter, 1990) and preexisting collections from the Geological Survey of Canada were also available.

Most of the macrofossil collections were made from isolated outcrops. Microfossil collections were made from isolated outcrops and from systematic sampling of drill cores. Stratigraphic sections described in this report were measured by geologists of the Geological Survey of Canada, Mineral Deposit Research Unit, Oroquest, and Homestake Mineral Development Company.

1.4.2 Lab Techniques

1.4.2.1 Macrofossils

Most of the ammonoids and bivalves were preserved as molds whereas the corals and sponges were predominantly recrystallized. Where specimens were preserved as external molds, latex casts were made to get the positive imprint of the shell. Specimens preserved in concretions were extracted and cleaned. Well preserved specimens were photographed using black and white Kodak Technical Pan film.

The quantitative and qualitative taxonomic descriptions for the ammonoids conform with the AMMON database developed at the University of British Columbia (Smith, 1986). In identifying ammonites, some use was made of the interactive image database system being developed by Liang (Liang, 1991, 1992).
1.4.2.2 Microfossils

Samples were broken into centimetre size pieces and processed using standard acid digestion (glacial acetic acid), wet sieving, and drying (for details see Appendix I). Radiolarians were picked from the sediment fractions with the aid of a binocular microscope and a 002 camel hair brush. Since radiolarians are not abundant in the samples, all specimens were picked and examined and, where necessary, some samples were processed twice. In addition to radiolarians, other fossils such as sponge spicules, wood and plant materials, foraminifera, and ostracods were picked. Radiolarian were mounted on aluminium scanning electron microscope stubs, coated with gold palladium, and photographed using the scanning electron microscope (technique modified from DeWever, 1980; details in Appendix II). The identification of taxa to generic and specific level is based on comparison with figures and descriptions from the literature. The scanning electron microscope photographs were taken at the UBC Semco NanoLab 7 and using the scanning electron microscope facilities at the Geological Survey of Canada in Vancouver.
CHAPTER 2

GEOLOGY AND STRATIGRAPHY

The purpose of this chapter is to introduce the setting of the study area within the context of physiographic belts of Canadian Cordillera and at the northwest margin of the Bowser Basin (Fig. 2.1). The stratigraphy around the basin margin is briefly described and the lithostratigraphic units recognized in the eastern Iskut River map area are discussed in detail. In concluding the chapter, an outline is presented of some of the stratigraphic and other related problems that are to be addressed in this study.

Figure 2.1: Canadian Cordillera: Physiographic Belts (modified from Wheeler and McFeely, 1987).
Regional setting

The Canadian Cordillera can be divided into five physiographic belts from west to east, the Insular Belt, the Coast Belt, the Intermontane Belt, the Omineca Belt, and the Foreland Belt (Fig. 2.1). The Intermontane Belt, within which the study area is located is composed of crustal fragments (terranes) that are commonly fault bounded and characterized by more or less distinct tectonostratigraphic assemblages. This belt contains Stikinia, Quesnellia, and Cache Creek terrane (Fig. 2.2), which probably represent, at least in part, late Paleozoic to Mesozoic island arc and backarc systems and oceanic terranes which may represent subduction complex analogues. The Iskut River map area is located in the northern part of Stikinia which is bordered to the east by the Cache Creek terrane and Quesnellia and to the west by the Coast Plutonic Complex (Fig. 2.1 - 2.2).

Situated within the Intermontane Belt and extending into the northeastern part of the Iskut River map area is the Bowser Basin, a major sedimentary depositional centre, 400 km x 250 km in size (Fig. 2.3). The basin contains Middle Jurassic to Tertiary marine and non-marine sediments. It is bordered to the north and south by the Stikine and Skeena arches respectively, to the east by the Omineca Crystalline Belt and to the west by the Coast Plutonic Complex (Fig. 2.1). Pre-Middle Jurassic sediments, are exposed around its margins. They have been studied in some detail because of their importance in understanding the tectonic evolution of the Stikinia and because they host economically important mineral deposits. This study examines the paleontology and Mesozoic strata of the Iskut River map area and compares it with coeval assemblages around the Bowser Basin.
Figure 2.2: Tectonic terrane map of the Canadian Cordillera (from Armstrong et al., 1989).
Figure 2.3: i) The Bowser Basin; ii) Distribution of Lower - Middle Jurassic volcanics and associated sediments of the Hazelton Group and Middle - Upper Jurassic marine and non-marine sediments of the Bowser Lake, Skeena, and Sustut groups; and iii) NTS topographic 1:250,00 scale map areas referred in text.
2.2 Stratigraphy: Bowser Basin margin

2.2.1 Introduction

Stikinia stratigraphy consists of Paleozoic limestones, volcanics and cherts (Stikine or Asitka assemblage; Monger, 1977), Triassic igneous and minor sedimentary rocks (Stuhini Group), Lower to Middle Jurassic volcanics and associated sedimentary rocks (Cold Fish volcanics, Hazelton Group, Toodoggone volcanics, and Spatsizi Groups), overlain by marine to non-marine sedimentary rocks (Middle to Upper Jurassic Bowser Lake Group and the Cretaceous to Tertiary Skeena, Ksalka, and Sustut groups).

The Mesozoic record begins with the Late Triassic alkaline basaltic and andesitic island-arc volcanic rocks of the Takla-Stuhini groups. During this period the belt was characterized by chains of volcanic-islands marginal to the continent (Tipper and Richards, 1976).

During the Early and Middle Jurassic, calc-alkaline island-arc basalt to rhyolitic volcanic and sedimentary rocks of the Hazelton-Spatsizi groups and the Toodoggone volcanics were deposited (Tipper and Richards, 1976; Thomson et al., 1986; Thorkelson, 1988; Marsden and Thorkelson, 1992). Deposition was accompanied by uplift of Late Paleozoic rocks to the north and Late Triassic rocks to the south, splitting the depositional area into a northern predominantly sedimentary basin (Whitehorse Basin) and a volcanic trough in the south (Hazelton Trough). A more recent study of the evolution of the Hazelton trough suggests that it developed in response to the extension of the Stikinia during the Late Triassic and/or Early Jurassic (Marsden and Thorkelson, 1992).

During the later stages of deposition of the Hazelton-Spatsizi groups and Toodoggone volcanics, uplift of the Skeena Arch to the south and the Stikine Arch to the north divided the Hazelton trough into two separate basins, the Bowser Basin to the north and the Nechako Basin to the south (Tipper and Richards, 1976; Fig. 2.3). From the Middle Jurassic to the Oxfordian, marine and non-
marine sedimentary rocks of the Bowser Lake Group were deposited in the Bowser Basin. This was followed by the deposition of the Skeena, Ksalka, and Sustut groups during the Cretaceous and Tertiary.

Formal lithostratigraphic units for the Mesozoic were established by Tipper and Richards (1976), Thomson et al. (1986), and Grove (1986) (Table 2.1). In the Spatsizi map area, in the northern margin of the basin, Lower and Middle Jurassic strata are dominated by the Cold Fish volcanics and the volcanlastic sediments of the Spatsizi Group (Thomson et al., 1986). In the southeastern and northwestern regions of the basin, the Lower and Middle Jurassic strata are dominated by volcanics and sediments of the Hazelton Group (Grove, 1986; Tipper and Richards, 1976). Throughout the Bowser Basin, the Lower and Middle Jurassic strata are conformably, nonconformably, or gradationally overlain by the Ashman Formation of the Bowser Lake Group (Tipper and Richards, 1976).

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<td>Wolf Den Fm.</td>
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Table 2.1: Stratigraphic nomenclature of the Early and Middle Jurassic units in the Bowser Basin.
2.2.2 Regional Stratigraphy

2.2.2.1 Paleozoic Stikine (or Asitka Assemblage)

The Paleozoic rocks were assigned to the Stikine Assemblage by Monger (1977) and to the Asitka Assemblage by Wheeler and McFeely (1991). This assemblage contains a Devonian to Permian succession of sedimentary rocks with interbedded volcanics (Anderson, 1989; Read et al., 1989). The rocks are regionally extensive along the northwestern fringe of the basin in the Telegraph Creek and Iskut River map areas.

2.2.2.2 Upper Triassic Stuhini (or Takla) Group

The Carnian to Norian Stuhini Group is a volcanic-sedimentary sequence that outcrops along the northwestern (Telegraph Creek and Iskut River map areas) and eastern (McConnell Creek, Hazelton, and Smithers map areas) margins of the Bowser Basin. Along the eastern margin of the basin the outcrops contain distal turbiditic argillites, volcanic sandstones, and pillowed augite porphyritic basalts (Monger and Church, 1977; Tipper & Richards, 1976). Along the northwestern Bowser Basin margin, volcanogenic sediments, turbidites, and basalts occur (Souther, 1971; Monger, 1977; Anderson, 1989; Henderson et al., 1992).

2.2.2.3 Lower to Middle Jurassic Hazelton Group

2.2.2.3.1 Terrace, Smithers, McConnell, and Hazelton map areas

Tipper and Richards (1976) described the Hazelton Group in northcentral British Columbia as basaltic to rhyolitic volcanic rocks and sedimentary rocks deposited during the Early and Middle Jurassic. The group comprises many different facies ranging from Sinemurian to Bajocian. Tipper and Richards divided the Hazelton Group into three formations: Sinemurian volcanics of the Telkwa Formation; Lower Pliensbachian to Middle Toarcian sediments and tuffs of the Nilkitkwa Formation; and Middle Toarcian to middle Bathonian (or Callovian) volcanioclastics of the Smithers Formation.
Figure 2.4: Correlation chart of Mesozoic strata along the margins of the Bowser Basin (sources given in references and text).
(Fig. 2.4). The volcanics of the Telkwa Formation are regionally extensive, occurring in all four map areas (Fig. 2.4). The Nilkitkwa Formation, representing a proximal facies, was deposited within the Nilkitkwa depression and consists of two mafic lava units (Carruther and Ankwell Members) and a rhyolitic to basaltic unit (Red Tuff Member). The Smithers Formation represents a more medial to distal facies of marine sandstone and siltstone, with minor volcanic breccia and tuff from eroding highlands of older Hazelton Group. The Toarcian to middle Bajocian Yuen Member recognized within this formation is a thinly bedded, black and light tuffaceous siltstone unit.

2.2.2.3.2 Spatsizi map area

Along the northern and northeastern margin of the basin, strata correlative with Hazelton Group are represented by the Cold Fish volcanics and rates of the coeval Spatsizi Group. The Spatsizi Group is a flysch succession, partly tuffaceous, that overlies and interfingers with the Lower Jurassic volcanics of the Hazelton Group (Thomson et al., 1986). The Cold Fish volcanics are coeval in part with the Telkwa Formation to the south and comprise subaerial calc-alkaline rhyolite, andesitic and basaltic breccias, tuffs, and flows. Thomson et al. (1986) created the Spatsizi Group divided into five formations: the Pliensbachian Joan Lake Formation; the Pliensbachian to Toarcian Wolf Den Formation; the Toarcian Melisson Formation; the Aalenian Abou Formation; and the Bajocian Quock Formation (Fig. 2.4). The Spatsizi Group comprises a sequence of marine sediments, mainly shale and tuffaceous shale, with minor siltstone, sandstone, conglomerate, and limestone. The Spatsizi Group sediments are coeval with the sediments of the Nilkitkwa and Smithers formations to the south (Fig. 2.4). The Quock Formation, a thinly bedded, black and light tuffaceous siltstone unit known colloquially as the "Pyjama Beds" is lithologically similar to the Yuen Member (Smithers Formation) in the Smithers map area.
2.2.2.3.3 *Telegraph Creek map area*

Souther (1972) recognized three units within the Hazelton Group in the Telegraph Creek map area: an Hettangian to Upper Toarcian lower unit of granitoid conglomerate, greywacke, and fragmental volcanic rock; an Upper Toarcian to Lower Bajocian medial unit of shale and siltstone; and an upper unit of sedimentary rock with mafic pillow lava (Fig. 2.4). Read *et al.* (1989) included in the lower unit recognized by Souther an andesitic to rhyolitic volcanic sequence that crops out in the southeast of the map area and which can be traced south into the Iskut River map area. The upper unit forms a north trending belt of marine lava extending south to the Eskay Creek facies of the Salmon River Formation (Anderson and Thorkelson, 1990).

2.2.2.4 *Bowser Lake Group*

The Bowser Lake Group is regionally extensive, consisting of a thick sequence of Middle to Upper Jurassic shale, siltstone, and conglomerate. The basal contact is commonly characterized by a chert-pebble conglomerate. According to Tipper and Richards (1976), the base of the Bowser Lake Group is time-transgressive and could range from Upper Bajocian to Upper Bathonian. The group was subdivided into the Ashman Formation and the informal Trout Creek formation by Tipper and Richards (1976). In the northern part of the basin, the Ashman Formation is dominated by black shale and siltstone with chert-pebble conglomerate lenses; towards the south, in the Smithers map area, the strata consist of an interbedded volcanic assemblage of green and grey feldspathic, andesitic breccia, tuffs, and flows. The Trout Creek "formation" is an alluvial-deltaic slope sequence, was deposited during a Callovian marine regression (Tipper and Richards, 1976).
2.3 Stratigraphy: Eastern Iskut River map area

2.3.1 Introduction

The eastern Iskut River map area is occupied by the Paleozoic Stikine Assemblage, the Mesozoic Stuhini-Hazelton groups, the Bowser Lake Group overlap assemblage, and the Tertiary Coast Plutonic Complex (Fig. 2.5). Mesozoic strata and intrusions dominate the geology of the area and host many of the mineral deposits. During mapping and evaluation of the metallogeny of the area, the lithostratigraphy has evolved.

Figure 2.5: The eastern Iskut River map area (modified from Anderson, in press).
Grove (1971, 1986) published the first detailed geologic maps (Unuk River, Anyox, and Salmon River map sheets) for the Stewart area. The Unuk River map sheet covers the eastern half of the Iskut River map area (Fig. 2.6). Grove subdivided the Hazelton Group into three formations: the Hettangian to Upper Toarcian Unuk River Formation, the Toarcian to middle Bajocian Betty Creek Formation, and the Bajocian to Upper Oxfordian Salmon River Formation (Fig. 2.7).

The British Columbia Ministry of Energy, Mines and Petroleum Resources published the Snippaker, Unuk, and Sulphurets geologic map sheets (Fig. 2.6, 1:50,000). The stratigraphy and structure of the Sulphurets map area was established by Britton and Alldrick (1988) and Henderson et al. (1992); the Unuk map area by Britton et al. (1989) and Alldrick et al. (1989); the Snippaker map area by Britton et al. (1990b) (Fig. 2.7). Anderson (1989) and Anderson and Thorkelson (1990) presented a regional stratigraphic framework for the Mesozoic stratigraphy (Fig. 2.7). More localized stratigraphic and structural studies have been conducted by Lewis (1992b) at the Prout Plateau, Lewis and Thompson (1992) and Lewis et al. (1993; Fig. 2.7) in the Treaty Ridge area, and Bartsch (1992) and Britton et al. (1990a) in the Eskay Creek area (Fig. 2.6).

The regional stratigraphy of the eastern Iskut River map area adopted by this study is of Anderson and Thorkelson (1990; Fig. 2.7) and Anderson (in press). In addition, work by others as summarized in figure 2.7 are also mentioned.

2.3.2 Stratigraphic Units

2.3.2.1 Upper Triassic Stuhini Group

The Upper Triassic Stuhini Group which consists of volcanic and sedimentary rocks is widespread and varies from east to west. East of the Unuk River an eastern facies represented by two lithologic sequences are seen (Henderson et al., 1992). A lower sequence occurs in the core of the McTagg anticlinorium and on ridges north and south of the East McTagg Glacier. This sequence is
Figure 2.6: i) Eastern Iskut River map area which includes the Snippaker Creek (104B/10) and John Peaks (104B/9) map areas and Snippaker, Unuk, and Sulphurets map sheets (in part)

ii) Location of Eskay Creek, Treaty Ridge, Lyon Creeks, and John Peaks areas.
Figure 2.7: Stratigraphic nomenclature and unrevised age designation of the Upper Triassic - Middle Jurassic units in the eastern Iskut River map area. (The numbers F1-F18 designated for fossil localities are mentioned only in Chapter 2).
divided into a sedimentary unit (thin-bedded, argillaceous turbiditic, fine-grained sandstone, and thick bedded sandstone) and a volcanic unit (flows and pyroclastic and epiclastic rocks north and east of John Peaks). Sandstone dykes, soft-sediment folds and slumps, and ball and pillow structures are common within the turbidites of the lower sequence. The upper sequence includes graded thin-bedded siltstone and mudstone with thicker sandstone beds and local lenses of granitoid boulder conglomerate. This sequence is exposed at the toe of Jack Glacier, the head of Atkins Glacier, and on the ridge north of Mitchell Glacier.

West of Unuk River, a widespread exposure of Triassic rocks occurs west of Harrymel Creek where two lithostratigraphic sequences are recognized (Britton et al., 1989; Grove, 1986). These strata constitute a western facies. A lower unit of thin bedded siltstone, fine-grained wackes, impure limestone and andesitic tuffs and a poorly exposed upper sequence of andesitic tuff and flows with minor limestone lenses. Further east, to the south of Snippaker Peak, Triassic strata are mappable separately as sedimentary, intermediate volcanic, basaltic tuff, and dacitic tuff units (Unit 2 of Britton et al., 1990b; Fig.2.7).

2.3.2.2 Lower Jurassic Sequences

Lithofacies within the Lower Jurassic rocks are variable and laterally discontinuous, leading to correlation problems. In addition to the problems in lithofacies variation, a structural discontinuity that parallels the south Unuk River and Harrymel Creek Fault makes it difficult to correlate Jurassic strata between the eastern and western parts of the map area (Britton et al., 1989). To the east of the Harrymel Creek fault, four lithostratigraphic units (Jack, Unuk River, Betty Creek, and Mt. Dilworth formations) are known. To the west, only the Betty Creek Formation is recognized.

2.3.2.2.1 Jack "formation"

This unit was previously assigned to the Triassic-Jurassic transitional unit by Anderson and
Thorkelson (1990) and to the Unuk River Formation by Britton and Alldrick (1988; Fig. 2.7). The Jack "formation" was introduced by Henderson et al. (1992) based on the structural and stratigraphic studies of the Sulphurets map area. Since a type section is not designated to this unit, it is not a formally defined unit. The Jack "formation" is a sedimentary succession at the base of the Hazelton Group resting unconformably on the Triassic Stuhini Group (Henderson et al., 1992; Fig. 2.7). Typical lithology consists of interbedded, fossiliferous, limy sandstone, and siltstone occurring above a basal granitoid and limestone boulder conglomerate. The reference area for this unit is at the toe of Jack Glacier and the unit can be traced eastward to the Treaty Ridge area and southwestward to the John Peaks area (Henderson et al., 1992; Fig. 2.6).

2.3.2.2.2 **Unuk River Formation (Andesitic sequence)**

The Unuk River Formation was originally defined as an andesitic sequence of lava flows, pyroclastic and epiclastic rocks, and clastic sedimentary rocks (Grove, 1986). Alldrick and Britton (1988) revised the definition, and included the regionally recognizable feldspar porphyritic andesitic flows and tuffs, and also two continuous siltstone members of the sequence. The colour of the rocks grades from bright red to green. This unit hosts all the major mineral deposits in the Stewart area (Fig. 2.6). The type area is along the east side of the Unuk River. The base of the unit has not been identified and the upper contact ranges from conformable to unconformable.

In the Iskut River map area, the Unuk River Formation is characterized by a lower sedimentary sequence and an upper volcanic sequence. The total thickness of the formation reaches more than 2,000 metres and the base was not observable. The lower sedimentary sequence consists of turbiditic sediments overlain by mafic to intermediate lava and volcaniclastic rocks; east of Unuk River these are included in the Jack "formation" (Henderson et al., 1992). The upper volcanic sequence consists of andesitic lava and tuffaceous rocks that in some areas is capped by subaerially extruded hornblende-plagioclase-orthoclase andesites and dacites.
The strata are best exposed from the Atkins Glacier area to the McTagg, Mitchell, and Sulphurets drainage area (Britton et al., 1989; Fig. 2.6). Around Bruce Jack Lake, the uppermost strata are distinguished by the appearance of coarse potassium-feldspar phenocrysts in a plagioclase-hornblende-phryic andesite (the Premier porphyry). The andesitic sequence is also exposed west of the Eskay Creek area (Edmunds, Homestake, pers. comm. 1992).

West of the Unuk River, poorly exposed andesitic rocks occur on the south slopes of Johnny Mountain, Snippaker Mountain, and southeast of Crater Creek. Due to the unknown stratigraphic position of these outcrops, the strata are not included within the Unuk River Formation are tentatively assigned as the Lower Jurassic Unit 3A by Britton et al. (1990b; Fig. 2.7).

2.3.2.2.3 Betty Creek Formation (Pyroclastic-Epiclastic sequence)

This unit was initially defined by Grove (1971) as a member of the Bowser Assemblage but was subsequently redefined as a formation within the Hazelton Group (Grove, 1986). The Betty Creek Formation is characterized by a complex succession of distinctively bright red and green pyroclastic-epiclastic rocks intercalated with andesitic volcanic rocks, pillow lavas, chert, and carbonate lenses. The type area is along the canyon of Betty Creek.

In the study area, strata consisting of maroon to green andesitic-dacitic tuffs and flows, hematitic mudstone, siltstone, sandstone, and local occurrences of pillow lavas and conglomerates are included within the Betty Creek Formation. The unit has conformable, locally gradational contacts and the thickness varies from 120 - 700 metres (Britton and Alldrick, 1988). The hematitic mudstone within the sequence implies deposition in a subaerial environment, or in shallow, oxygenated water (Britton and Alldrick, 1988).

East of Unuk River, the Betty Creek Formation is exposed north of Mitchell glacier and north
of Bruce Jack Lake and John Peaks. West of the Unuk River, it crops out along the headwaters of Eskay Creek and east of Lyons Creek.

2.3.2.2.4 **Mt. Dilworth "formation" (Felsic Volcanic sequence)**

A predominantly felsic pyroclastic rock which was previously included in the lower Salmon River Formation (Grove, 1986). The unit was identified as a mappable regional marker in the Stewart area by Alldrick (1987) who designated Mt. Dilworth as the reference area (Fig. 2.5). A type section has not been designated to this unit and as such it is not a formally defined unit. The unit reaches a thickness of 75 to 150 metres, has a conformable contact with the underlying Betty Creek Formation, and an unconformable contact with the overlying Salmon River Formation (Britton and Alldrick, 1988). This unit represents a short lived volcanic event and is dated at 197 ± 14 Ma at Monitor Lake near Stewart (Brown, 1987). Good exposures of the felsic sequence can be seen east of the Bowser River and from the toe of Treaty Glacier to Mitchell Glacier. Britton *et al.* (1988) tentatively included a felsic sequence that forms a tight anticline-syncline pair between Unuk River and Harrymel Creek into the Mt. Dilworth "formation". Bartsch (1992) demonstrated that this sequence is part of a Middle Jurassic sequence. The Mt. Dilworth "formation" has not been found west of Harrymel Creek (Hancock, 1990; MacLean, 1990).

2.3.2.3 **Middle Jurassic Sequence**

2.3.2.3.1 **Salmon River Formation (Siltstone sequence)**

The Salmon River Formation was first defined by Schofield and Hanson (1922) on the basis of mapping in the Salmon River district (near Mt. Dilworth, Fig. 2.5). It is a thick assemblage of complexly folded, colour banded siltstones and lithic wackes, primarily of mafic and felsic volcanic provenance. The lower part of the unit is marked by extensive thick lenses of grey weathering greywacke, rhyolite, cherts, and carbonate lenses. Siltstones are the most common rocks. The type area
for the unit is at the summit slopes and western cliffs of Mt. Dilworth and Troy Ridge (Fig. 2.5)

In the study area this unit represents a transitional unit between the mostly volcanic Hazelton Group and the wholly sedimentary rocks of the Bowser Lake Group. It is generally characterized by dark grey and tuffaceous siltstone and fine-grained sandstone. Two sequences are recognized (Anderson and Thorkelson, 1990). The lower sequence consists of belemnite- and Weyla-bearing limey sandstone with an unconformable basal contact.; the upper sequence is characterized by a lateral facies changes from the east to the west. Anderson and Thorkelson (1990) divided the upper sequence of the Salmon River Formation into three facies: an eastern Troy Ridge facies of black, cherty, radiolarian-bearing shale and white weathered, reworked felsic tuffs; a medial Eskay Creek facies of limestone, limy or cherty siltstone, and shale interfingerung with and overlain by thick pillow lava and pillow lava breccia; and a western Snippaker Mountain facies of undated andesitic lava and breccia overlying sandy limestone, limy conglomerate and sandstone. Overall, the Salmon River Formation reaches a thickness of more than 1000 metres.

East of the Unuk River, rocks assigned to the Salmon River Formation occur either locally above, or interbedded with a felsic unit considered to be the Mt. Dilworth Formation by Henderson et al. (1992). The base and top of the Troy Ridge facies of the Salmon River Formation are seen on the ridge north of South Treaty Glacier and on the nunataks of Knipple Glaciers. The lithology of the Troy Ridge facies consists of dark to light and rusty weathering mudstone and tuffaceous siltstone which is known as the "pyjama beds" (a colloquial term first applied to the rocks of the Quock Formation in the Spatsizi map area). Near Treaty Ridge and west of John Peaks and around the Eskay Creek area, the lithology changes to thick units of pillowed and columnar jointed amygdaloidal basalt and heterolithic breccia, with mafic and felsic volcanic sedimentary clasts occurring in the upper sequence of the Salmon River Formation (Eskay Creek facies). In the Snippaker Peak area, the upper sequence of the formation consists of andesitic lava and breccia (Snippaker Mountain facies). The Salmon River
Formation passes gradationally upward into interbedded siltstone and mudstone of the Bowser Lake Group.

2.3.2.3.2 Ashman Formation (Bowser Lake Group)

An overlap assemblage of basinal marine and nonmarine sedimentary rocks is called the Ashman Formation, first defined in the Smithers map area (Tipper and Richards, 1976). The unit consists of thick bedded siltstone, pencil shale, and sandstone with thin lenses and sheets of chert-pebble conglomerate. Much of the northeastern part of the map area is underlain by the sediments of the Ashman and other formations of the Bowser Lake Group.
2.4  *Stratigraphic Problems*

The Mesozoic strata dealt within this study are conventionally divided into the Norian Stuhini Group, the Lower and Middle Jurassic Hazelton Group (Jack, Unuk River, Betty Creek, Mt. Dilworth, and Salmon River formations), and the Middle Jurassic Bowser Lake Group (Ashman Formation). The Triassic-Jurassic strata are predominantly volcanogenic and difficult to correlate. Therefore, it is important that these strata be well-dated. Existing fossil reports have been helpful in providing some age constraints to the lithostratigraphic units (F1-F14; Figure 2.7). K-Ar and U-Pb dates are primarily restricted to intrusive rocks, and where they have been obtained from a few stratigraphic intervals, the results contain large errors. This study entails a compilation of the biostratigraphy of the region based on all previous fossil collections in addition to new collections. In refining the age of lithostratigraphic units, this study will also address the following specific problems:-

**Correlation:**

a)  **The relationship between the Jack and Unuk River formations:**

The strata that underlie the Betty Creek Formation are presently assigned to either the Jack "formation" or to the Unuk River Formation, west and east of Bowser River respectively. These units are lithologically similar and occur below a volcano-sedimentary sequence. Fossils collected from these units will help in evaluating their temporal and spatial relationships.

b)  **The regional distribution of Mt. Dilworth "formation":**

The Mt. Dilworth "formation" is a widespread felsic unit recognized as a regional marker. At its reference section at Mt. Dilworth (Alldrick, 1987; 1991), the unit lies between the Betty Creek and the Salmon River formations. This unit can be traced to the John Peaks area where it is dated 189 ± 2 Ma (Upper Pliensbachian - Lower Toarcian?).
A felsic unit is seen in the Treaty Ridge area marked as Unit 4 by Lewis et al. (1992; Fig. 2.7) and at the Eskay Creek area. In constraining the age, this study will evaluate the regional extent of this unit.

c) **The regional distribution of the lower sequence of the Salmon River Formation:**

The lower sequence of Salmon River Formation is regionally recognized based on lithologic similarity consisting of fossiliferous limy sandstone (F12; Fig. 2.7). Though the lower sequence is lithologically distinctive, its lateral continuity is not seen on a regional scale. Fossils collected from the lower sequence at various localities provide a test of the temporal correlation.

d) **The relationship of the Eskay Creek, Troy Ridge, and Snippaker Ridge facies:**

The upper sequence of the Salmon River Formation is characterized by facies changes from the east to the west (Anderson and Thorkelson, 1990; Fig. 2.7). Though these facies are stratigraphically equivalent, their temporal relationships are unknown. Fossils collected from the Eskay Creek facies and Troy Ridge facies will assist in the interpretation of the relationships of these facies.

**Mineralization:**

e) **Timing of the Treaty Ridge alteration system:**

The age of the rocks that host the mineralization in the Treaty Ridge area is poorly constrained. Biostratigraphic information from the Treaty Ridge Section (Fig. 2.7) will contribute to the understanding of the timing of the alteration system.

f) **Age of the Eskay Creek stratabound mineralized unit:**

The age of the stratiform, high grade polymetallic deposit hosted in the Hazelton Group at
Eskay Creek (Britton et al., 1990a) is poorly constrained. Sampling from core samples will further constrain the age of the mineralized zone.
CHAPTER 3 BIOCHRONOLOGY AND BIOSTRATIGRAPHY

3.1 Introduction

The Iskut River area is not ideal for the application of biochronology. Fossil preservation is generally poor, localities sparse, and yields often low. Furthermore, it is rare to have a stratigraphic sequence of fossil localities at a given site which means that the biostratigraphy has to be pieced together from isolated localities across the region. These conditions presumably result from a combination of rapid sediment accumulation rates, rapid facies changes, the diagenesis of volcanic-rich strata, tectonic complications, and limited exposure.

Under these circumstances it is critical that the zonal schemes forming the basis of the biochronology be well defined and tested repeatedly in areas where geological and sampling conditions are more favourable. The aims of this chapter, therefore, are:

a) to give the definition and documentation of the time-rock units (stages and zones) that are dealt with in this report, and
b) to document the faunal associations in the Iskut River area that indicate the presence of these units.

3.1.1 Ammonites

Ammonoids have a long history of biostratigraphic utilization, particularly in Mesozoic stratigraphy. In the early 1800's Oppel and his student Quenstedt developed the first ammonite zonal scheme for the Jurassic. With time, their work underwent modifications as summarized for the Lower Jurassic in the classic work by Dean et al. (1961) who established the standard northwest European zonation (Fig. 3.1). Even within Europe, however, there is evidence of provincialism between northwest Europe and the Mediterranean region and regional zonal schemes are necessary (Callomon, 1984).
<table>
<thead>
<tr>
<th>STAGE/AGE (Ma)</th>
<th>NORTH AMERICAN AMMONITE ZONES</th>
<th>NW EUROPEAN STD. AMMONITE ZONES</th>
<th>N. AMERICAN RADIOLARIA ZONES</th>
</tr>
</thead>
<tbody>
<tr>
<td>CALLOVIAN</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>161.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BATHONIAN</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>166.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BAJOCEAN</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>173.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AALENIAN</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>178.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOARCian</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>187.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PLIENSCHIAN</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>194.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SINEMURIAN</td>
<td></td>
<td></td>
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<tr>
<td>200.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HETTANGIAN</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>208.0</td>
<td></td>
<td></td>
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</tbody>
</table>
Work on the Jurassic ammonites of North America by earlier workers such as Frebold and Imlay relied on the northwest European zonal scheme. However, as work progressed in North and South America, significant paleobiogeographic differences with Europe became apparent. North American faunas contain endemic Pacific taxa as well as showing close affinities to faunas of the Tethyan realm rather than the Boreal realm (of which northwest Europe is a part).

The Lower and Middle Jurassic standard and assemblage zones for North America calibrated with the northwest European standard zones are shown in figure 3.1. The formally described standard ammonite zones for the Lower Jurassic of North America are the Canadense Zone (Frebold, 1967) and the Imlayi to Carlottense zones of the Pliensbachian (Smith et al., 1988). These zones have been recognized and tested regionally and are defined by type sections. Local assemblage zones for the Sinemurian have been described (Palfy, 1991; Palfy et al., in press) while North American assemblage zones have been established for the Toarcian (Jakobs, 1992; Jakobs et al., in press), the Aalenian (Poulton and Tipper, 1991), and the Bajocian (Hall and Westermann, 1980). The boreal sequences for the Bathonian and Callovian faunas of North America are zoned (Poulton, 1987) but zonation work is yet to be done for the endemic and mixed faunal sequences. However, the stratigraphic ranges of certain genera (*Lilloettia*, *Iniskinites*, and *Kepplerites*; Fig. 3.1) are known (Frebold, 1978; Callomon, 1984).

### 3.1.2 Radiolaria

Detailed work by Pessagno and Blome (1982, 1986), Pessagno and Whalen (1982), and Mitzutani and Koike (1982) has demonstrated that Jurassic radiolarian assemblages from both the Boreal and Tethyan regions are quite diverse. Pessagno et al. (1987a) established a preliminary radiolarian zonation for the Jurassic of North America (Fig. 3.1). In establishing this zonation, they also attempted to calibrate the radiolarian zones with the northwest European ammonite zones (Fig. 3.1).
A synthesis of the published relative ranges of ammonite and radiolarian taxa in the Lower Jurassic of North America is being assembled by Smith et al. (in review), as a first step toward establishing and calibrating formal zonations.

3.2  Biochronology in the eastern Iskut River map area

3.2.1  Norian

3.2.1.1  Cordilleranus Zone (ammonoid zone)

This Upper Norian Cordilleranus Zone was introduced by Tozer (1979a) who designated a type locality in the Pardonet Formation at Mount Ludington, northeastern British Columbia (Fig. 3.2). The index species for the zone is *Gnomohalorites cordilleranus*. This zone contains several species of ammonoids of the genera *Placites, Metasibirites, Nassichukites, Gnomohalorites, Paraguembelites, Rhabdoceras, Peripleurites, Rhacophyllites,* and *Lissonites*. Of significance to this study is the bivalve *Monotis* cf. *subcircularis*, a species known worldwide, and believed to be restricted to the Cordilleranus Zone (Tozer, 1979a; Westermann, 1973; Silberling and Tozer, 1968).

<table>
<thead>
<tr>
<th>PERIOD</th>
<th>STAGE</th>
<th>SUBSTAGE</th>
<th>PROPOSED SCHEME (Tozer, 1979)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Triassic Series (Part)</td>
<td>Norian Stage (Part)</td>
<td>Upper Norian (=Sevatan) (= Rhaetian) Substage</td>
<td>Crickmayi Zone</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Late Middle Norian</td>
<td>Amoenum Zone</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cordilleranus Zone</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Columbianus Zone</td>
</tr>
</tbody>
</table>

Figure 3.2: Zonal scheme for the Norian (from Tozer, 1979a).
The zone is recognized in the eastern Iskut River map area by the occurrence of *Monotis* cf. *subcircularis* at localities 3 and 6 (App. IV).

3.2.1.2 *Amoenum*-Crickmayi zones

The middle Upper Norian Amoenum Zone is described from the *Cassianella* beds of the Tyaughton Group, southeastern British Columbia (Tozer, 1979a; Fig. 3.2). The index species is *Cochloceras amoenum*. These beds overlie the beds containing *Monotis subcircularis* (Cordilleranus Zone). Other ammonoids occurring in the zone are *Placites polydactylus*, *Rhabdoceras suessi*, *Rhacophyllites* sp., arcestids, and cladiscitids. Abundant benthonic bivalves, echinoids, brachiopods, and corals are associated with the ammonoids (Tozer, 1967).

The Crickmayi Zone, also represented in the Tyaughton Group from a green sandstone and conglomerate unit that overlies the *Cassianella* beds, is represented by the index species *Choristoceras crickmayi*. The only other ammonoid from this locality is *Arcestes* sp. indet. In the Sutton Formation of Cowichan Lake on Vancouver Island forms such as *Cladiscites* sp., *Cycloceltites* cf. *C. arduini*, *Rhabdoceras suessi*, and *Choristoceras suttonense* that are recognized in the Amoenum Zone and range upward into this zone. The bivalve *Myophoria suttonensis* occurs both at the type locality and in the Sutton Formation.

The genera *Rhacophyllites*? sp., *Placites* sp., and *Cladiscites* sp. along with a diverse assemblage of benthonic bivalves, corals, brachiopods, gastropods, and sponges occur at localities 1 and 2, south of Snippaker Mountain (App. V). The presence of *Cladiscites* sp. suggests that these localities probably straddle both the Amoenum and Crickmayi zones.
3.2.2 Upper Hettangian/Lower Sinemurian

3.2.2.1 Canadensis Zone

The Canadensis Zone was first introduced by Frebold (1967) when dealing with the Hettangian of the Taseko Lakes area. This zone is now thought to straddle the Hettangian-Sinemurian boundary, correlating in part with the Angulata and Bucklandi zones of Europe (Guex and Taylor, 1976; Bloos, 1983; Taylor, 1990; Palfy et al., in press, Fig. 3.1). The index species for this zone is Badouxia canadensis which is common throughout the zone except, perhaps, the topmost part. Eolytoceras tasekoi is confined to the zone. Badouxia columbiae and Metophioceras spp. are restricted to the upper part of the zone (Frebold, 1967; Taylor, 1990). Other taxa common throughout the zone in the Taseko Lakes area include Charmasseiceras marmoreum and several species of the genera Paracaloceras and Badouxia. In the Queen Charlottes Islands, sporadic occurrences of Angulaticeras cf. ventricosum, Sulciferites marmoreus, and Sulciferites cf. trapezoidalis are recorded throughout the zone and Vermiceras ex. gr. coregonense is found typically in the lower part (Palfy, 1991). The possible new species Vermiceras sp. occurs only at the top of the zone in the Queen Charlotte Islands (Palfy, 1991).

The localities of the zone in this study are 10, 11, 12, 13, and 15, east of Unuk River and locality 14, west of Unuk River (App. IV). East of Unuk River the ammonites include Badouxia cf. canadensis, Paracaloceras rursicostatum, Paracaloceras cf. coregonense (?), Alsatitis sp., and Canavarites sp. and west of Unuk River the ammonites include Paracaloceras cf. multicostatum and Paracaloceras sp.

3.2.3 Upper Pliensbachian

3.2.3.1 Kunae Zone

The Kunae Zone was introduced by Smith et al. (1988) who designated a section in Fannin Bay, Queen Charlotte Islands as stratotype. Reference sections for the zone are located in the Wallowa
Mountains of Oregon and in the Tulsequah area of British Columbia. The zone is only approximately
correlative with the northwest Europe Margaritatus Zone (Fig. 3.1) in that its base is marked by the
first appearance of *Fanninoceras*, an east Pacific genus that appears slightly before *Amaltheus* which
marks the base of the Margaritatus Zone. Dactylioceratids are rare but hildoceratids are common.

Several species of *Protogrammoceras* and *Arieticeras* are common in this zone but also range above
the zone whereas *Leptaleoceras*, *Fuciniceras*, and *Fontalliceras* are restricted to the zone. *Amaltheus
stokesi* is rare and only found in the lower part of the zone.

Three localities containing the Kunae zone fauna are recognized in the map area. At locality
18, west of Lyons Creek (App. IV), the ammonites include *Arieticeras* cf. *algovianum*, *Arieticeras* sp.,
*accuratum*, and *Leptaleoceras* sp and at localities 19 and 20, north of John Peaks, *Arieticeras* cf.
*algovianum* and *Leptaleoceras* sp. are present (App. IV).

### 3.2.3.2 Carlottense Zone

The Carlottense Zone of the upper Upper Pliensbachian established by Smith *et al.* (1988), is
approximately correlative to the Spinatum Zone of northwestern Europe (Fig. 3.1). The index species
is *Fanninoceras carlottense* which is confined within the zone. *Tiltoniceras propinquum*, a species
widely distributed in North America occurs in this zone but also ranges into the Lower Toarcian
(Jakobs, 1992; Jakobs *et al.*, in press, Fig. 3.1). Other characterizing taxa are numerous species
belonging to *Protogrammoceras* and *Lioceratoides*. *Protogrammoceras kurrianum* is confined within
the zone (=Upper Margaritatus - Spinatum zones; Howarth, 1992). There is no suitable stratotype for
the zone, but reference sections have been designated in the Tulsequah area of British Columbia, in the
Fannin Formation of the Queen Charlotte Islands, and in the Sunrise Formation of Nevada.

In this study, *Tiltoniceras* cf. *propinquum* is found at locality 21 (App. IV) and
Protogrammoceras cf. kurrianum, Protogrammoceras sp., Lioceratoides? sp., and fragments of Hildoceratidae ammonites are found at locality 23 (App. IV), east of Eskay Creek. The presence of Protogrammoceras cf. kurrianum is indicative of the Carlottense Zone.

3.2.4 Toarcian

3.2.4.1 Lower Assemblage Zones 2/3 of Jakobs, 1992

Assemblage zones 2 and 3 of Jakobs (1992) contain the index species Hildaites levisoni and Leukadiella ionica respectively. The base of the Assemblage Zone 2 is marked by the first appearance of Harpoceras cf. exaratum above the last occurrence of Tiltoniceras and Taffertia. The base of Assemblage Zone 3 is marked by the first appearance of Peronoceras above the last appearance of Hildaites levisoni.

Assemblage Zone 2 is recognized in the North America Cordillera by the co-occurrence of species of Harpoceras, Hildaites, and Dactylioceras. Harpoceras cf. H. exaratum and Harpoceras chrysanthemum extend into Assemblage Zone 3. In the Toyora Group of Japan, occurring abundantly with Harpoceras chrysanthemum is the species Dactylioceras helianthoides (D. helianthoides Zone of Hirano, 1973). Harpoceras cf. serpentinum is confined to the zone.

Common genera in the Assemblage Zone 3 are Peronoceras, Rarenodia, Leukadiella, Paroniceras, and Phymatoceras. Confined to the zone are several species of Peronoceras, Leukadiella, Paroniceras, and Rarenodia.

Straddling Assemblage zones 2 and 3 are Dactylioceras sp., Dactylioceras cf. commune and Dactylioceras athleticum.

The presence of few species belonging to the Dactylioceras including Dactylioceras athleticum and Dactylioceras helianthoides in this study possibly indicate the presence of Assemblage
Zone 2/3 boundary at locality 26, south of Tim Williams glacier (App. V).

3.2.4.2 Assemblage Zone 6 of Jakobs, 1992

This assemblage zone was proposed by Jakobs (1992) based on the stratotype in the Phantom Creek Formation in the Queen Charlotte Islands (Fig. 3.1). The index species for the zone is *Yakounia yakounensis*. The base is marked by the first appearance of *Pleydellia* above the last occurrence of *Phymatoceras*. Other characteristic species in the zone belong to *Pleydellia*, *Hammatoceras*, *Yakounia*, *Sphaerocoeloceras*, and *Dumortieria*; all disappear either at the top of the zone or within the zone. Only *Hammatoceras speciosum* and *Pseudolioceras compactile* may extend into the Aalenian. The fauna of this zone is quite diverse in North America. The genus *Yakounia* has previously been referred to *Haugia* by Imlay (1981) and Frebold (1967), a genus restricted to the Middle Toarcian.

This zone is represented at localities 27 and 28 by *Pleydellia* cf. *maudensis* and *Pleydellia* sp. (App. IV).

3.2.4.3 Toarcian - general

The co-occurrence of belemnites and *Weyla* has often been used to date Toarcian units in northwestern British Columbia. A survey of the global distribution of *Weyla* was conducted by Damborenea and Manceñido (1979) who concluded that *Weyla* originated in Canada during the Early Jurassic, and spread along the Pacific coast of America to Patagonia in the Sinemurian and persisted in all areas until Toarcian time. Belemnites first appeared in the Early Jurassic and range through the Jurassic until the Cretaceous (Doyle, 1987). In Canada they have been found in rocks as old as the Sinemurian (Frebold and Little, 1962; Palfy, pers. comm., 1993). Belemnites have radially fibrous guards (Fig. 3.3b), a characteristic feature that distinguishes them from the belemnite-like coleoids (aulacocerids) (Jeletzky, 1966). The belemnite-like coleoids present in the Upper Paleozoic to Triassic
strata resemble the belemnites in the possession of tellum (guard-like structure) and phragmacone (Jeletzky, 1966). The tellum differs from the radially fibrous guard of belemnites in having a concentric structure (Fig. 3.3a).

A particular group of belemnites called the dicoelitids do not appear in North America until the Toarcian and range into the Kimmeridgian (Jeletzky, 1980). The dicoelitid belemnites are forms which have radially fibrous guards bearing two grooves (Fig. 3.3c). In northwestern British Columbia, they appear to be restricted to the Middle and Upper Toarcian (Jeletzky, 1980). According to Jeletzky (1980), these doubly grooved dicoelitid belemnites are descended from European hastitid belemnites that migrated via the Hispanic Corridor to the eastern Pacific Ocean in the latest Pliensbachian or earliest Toarcian.

Thus, it is a misconception to recognize the Toarcian based on the association of *Weyla* and belemnites. However, the association of dicoelitid belemnites and *Weyla* could be used to indicate a Toarcian age.

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**Figure 3.3:** Guard structure of belemnite and dicoelitid belemnite; and tellum structure of aulococerid.
Dicoelitids belemnites have been reported from localities 28 and 29 (App. IV). At locality 28, dicoelitids are associated with the Toarcian ammonite *Pleydellia cf. maudensis*. At locality 29, the specimens are poorly preserved and are only tentatively identified as dicoelitids. They are found associated with indeterminate bivalves. The association of *Weyla* and belemnites is seen at localities 31 and 32 (App. IV), constraining the age of these outcrops to the Sinemurian to the Toarcian. Confidently assigning these outcrops to Toarcian based on the *Weyla*-belemnite association, as previously reported (Report J4-1991-HWT), is therefore questionable.

3.2.5 **Aalenian**

3.2.5.1 *Erycitoides howelli* assemblage zone

The *Erycitoides howelli* assemblage zone was originally defined in southern Alaska by Kellum *et al.* (1945) and Westermann (1964) and was recently recognized as an assemblage zone for western Canada by Poulton and Tipper (1991). The correlation of this zone with the European Standard zones is difficult because of the sparse isolated occurrences of Aalenian fossils in Canada. However, the presence of *Planammatoceras* indicates that it may appear as low as the European Murchisonae Zone. Some of the genera and species that are included in this zone are *Tmetoceras kirki*, *T. flexicostatum*, *Tmetoceras* sp., *Planammatoceras* sp., *Lissoceras* sp., *Pseudolioceras cf. whiteavesi*, and *Pseudolioceras* sp.

This zone is represented in the Treaty Ridge section, at locality 39 (App. IV) by the ammonites *Tmetoceras cf. kirki*, *Pseudolioceras* sp., and *Leioceras* sp. North of Mitchell glacier at locality 40 (App. IV) both *Planammatoceras cf. planinsigne* and *Planammatoceras* sp. are present.
3.2.5.2 Aalenian - general

Radiolarian of Aalenian age have been described from east-central Oregon and include some members of the families Farcidae, Hilariisiregidae, and Ultraporidae (Pessagno et al., 1986) and the genera Perispyridium and Turanta (Pessagno and Blome, 1982). Additional data on the distribution of Aalenian radiolaria in the Queen Charlotte Islands is found in Carter and Jakobs (1991). The following genera and species are found in the study area: Archaeohagiastrum longipes, Paronaella variabilis, Emiluvia spp., Parvicingula spp., and Spongostaurus. These occur at localities 42, 43, 46-48 (App. IV) and constrain the age of these strata to Aalenian, possibly Early Bajocian.

<table>
<thead>
<tr>
<th>RADIOLARIAN TAXA</th>
<th>Pliensbachian</th>
<th>Toarcian</th>
<th>Aalenian</th>
<th>Bajocian</th>
</tr>
</thead>
<tbody>
<tr>
<td>Archaeohagiastrum longipes</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Emiluvia sp. A</td>
<td></td>
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<tr>
<td>Paronaella variabilis</td>
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<tr>
<td>Spongostaurus sp. A.</td>
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<tr>
<td>Spumellaria indet. C</td>
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<tr>
<td>Parvicingula sp. B</td>
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<td>Perispyridium aff. gouldi</td>
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<td>Parvicingula sp. C</td>
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<td>Pseudocrucella cf. sanfilippae</td>
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<tr>
<td>Emiluvia sp. B</td>
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<tr>
<td>Stichocapsa convexa</td>
<td></td>
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</tbody>
</table>

Figure 3.4: Eastern Iskut River map area: Radiolaria biochronology.
3.2.6 Lower Bajocian

The Lower Bajocian of Western Canada is characterized by a diverse assemblage of cosmopolitan forms (Taylor et al., 1984). Some of the commonly occurring genera in British Columbia include Sonninia, Stephanoceras, Chondroceras, Zemistephanus, Arkellocceras, and Eudmetoceras.

The only Bajocian ammonites found in the map area belong to the family Stephanoceratidae. In the Treaty Ridge section at locality 49 (App. IV), three specimens of Zemistephanus sp. were found, and in the Eskay Creek section at locality 50 (App. IV), two float specimens of Stephanoceras sp. were found.

3.2.7 Upper Bathonian/Lower Callovian

The endemic Bathonian to Callovian faunas of western Canada are not fully understood and their stratigraphic ranges are incompletely known (Poulton et al., 1991; Callomon, 1984). Some of the families that span this time interval that occur in the Iskut River area are the Sphaeroceratidae, the Kosmoceratidae, and the Perisphinctidae. The perisphinctid ammonites are widespread in western Canada but their significance awaits detailed taxonomic and biostratigraphic studies (Hall et al., 1991, Poulton et al., 1991). Species of Sphaeroceratidae are common in the Bathonian to Callovian rocks of north-central British Columbia (e.g., Smithers map area). The stratigraphic ranges of certain genera are known and useful in providing age constraints for Upper Bathonian and Lower Callovian strata. The genus Iniskinites does not range above the Upper Bathonian in North America, whereas Lilloettia ranges from the Upper Bathonian to Lower Callovian (Frebold, 1978). The genus Kepplerites of the family Kosmoceratidae found associated with Lilloettia is abundant in the Callovian in British Columbia (Smithers map area: Jakobs, 1987; Tipper and Richards, 1976). Their stratigraphic range in western Canada is from the Upper Bathonian to Lower Callovian (Frebold, 1978).
The Upper Bathonian is recognized by the presence of *Iniskinites* at localities 57, 58, and 59, south of Tom Mackay Lake and locality 60 of the Eskay Creek section (Fig. 3.3-3.4, 3.9). Upper Bathonian to Lower Callovian strata are seen at localities 61 and 62 of Eskay Creek Section, and at locality 63 of the Treaty Ridge section (Fig. 3.3 - 3.4, 3.8).
3.3. Biostratigraphy of the eastern Iskut River map area

The biostratigraphic study of the eastern Iskut River map area is based on fossil collections from 116 localities (Fig. 3.5 - 3.8); most are isolated outcrops (App. IV and V). Only six localities are in continuously exposed sections: locality 18 from the Lyons Creek Section (Fig. 2.6 and 3.9) and localities 30, 31, 39, 49, 56, and 63 from the Treaty Ridge Section (Fig. 2.6 and 3.10).

Fossil localities plotted on two generalized sections of the Hazelton and Bowser Lake groups are illustrated in figures 3.11- 3.12. Their locations are shown in figure 2.6. The Eskay Creek Section is exposed east of the Eskay Creek camp to Argillite Creek (Fig. 2.6 and Fig. 3.11). The John Peaks Section is exposed north and south of John Peaks (Fig. 2.6 and Fig. 3.12).

<table>
<thead>
<tr>
<th>Figures 3.5 - 3.8</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LEGEND</strong></td>
</tr>
<tr>
<td><strong>Stages</strong></td>
</tr>
<tr>
<td>N = Norian</td>
</tr>
<tr>
<td>HS = upper Hettangian/</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>UP = Upper Pliensbachian</td>
</tr>
<tr>
<td>LT = Lower Toarcian</td>
</tr>
<tr>
<td>UT = Upper Toarcian</td>
</tr>
<tr>
<td>uA = upper Aalenian</td>
</tr>
<tr>
<td>A = Aalenian - possibly L. Bajocian</td>
</tr>
<tr>
<td>LB = Lower Bajocian</td>
</tr>
<tr>
<td>UB = Upper Bathonian</td>
</tr>
<tr>
<td>BC = Upper Bathonian/Lower Callovian</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Biozones</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cr = Cordilleranus Zone</td>
</tr>
<tr>
<td>Cn = Canadensis Zone</td>
</tr>
<tr>
<td>Kn = Kunae Zone</td>
</tr>
<tr>
<td>Cl = Carliottense Zone</td>
</tr>
<tr>
<td>Eh = Erycitoides howelli assemblage zone</td>
</tr>
<tr>
<td>Z2/3 = Assemblage zones 2-3</td>
</tr>
<tr>
<td>Z6 = Assemblage Zone 6</td>
</tr>
</tbody>
</table>
Figure 3.5: Biostratigraphy of eastern Iskut River map area: Ammonoid
Figure 3.6: Biostratigraphy of the eastern Iskut River map area: Bivalves and Corals
**Figure 3.7: Biostratigraphy of the eastern Iskut River map area: Other Fauna**
### BIOCHRONOLOGY AND BIOSTRATIGRAPHY

| STAGE→ | A | A | A | A | A | A | ←STAGE   |
| ZONE→  |   |   |   |   |   |   | ←ZONE   |
| LOCALITIES→ | 42 | 43 | 44 | 45 | 46 | 47 | 48 | ←LOCALITIES |
| RADIOLARIA |   |   |   |   |   |   |   | RADIOLARIA |
| Aceniotyle (?) sp. |   |   |   |   |   |   |   | Aceniotyle (?) sp. |
| Archaeocenosphaera sp. |   |   |   |   |   |   |   | Archaeocenosphaera sp. |
| Archaeohaglastrum longipes |   |   |   |   |   |   |   | Archaeohaglastrum longipes |
| Crucella sp. |   |   |   |   |   |   |   | Crucella sp. |
| Emiluvia (?) aff. moresbyensis |   |   |   |   |   |   |   | Emiluvia (?) aff. moresbyensis |
| Emiluvia sp. A |   |   |   |   |   |   |   | Emiluvia sp. A |
| Emiluvia sp. B |   |   |   |   |   |   |   | Emiluvia sp. B |
| Hsuum sp. |   |   |   |   |   |   |   | Hsuum sp. |
| Napor sp. |   |   |   |   |   |   |   | Napor sp. |
| Paronaella variabilis |   |   |   |   |   |   |   | Paronaella variabilis |
| Parvicingula sp. B |   |   |   |   |   |   |   | Parvicingula sp. B |
| Parvicingula sp. indet. A |   |   |   |   |   |   |   | Parvicingula sp. indet. A |
| Perispyridium sp. cf. P. gouldi |   |   |   |   |   |   |   | Perispyridium sp. cf. P. gouldi |
| Praeconocaryomma sp. |   |   |   |   |   |   |   | Praeconocaryomma sp. |
| Pseudoocrucella sp. cf. P. sanfilippoae |   |   |   |   |   |   |   | Pseudoocrucella sp. cf. P. sanfilippoae |
| Spongostaurus sp. A |   |   |   |   |   |   |   | Spongostaurus sp. A |
| Stichocapsa cf. convexa |   |   |   |   |   |   |   | Stichocapsa cf. convexa |
| Stichocapsa sp. indet. |   |   |   |   |   |   |   | Stichocapsa sp. indet. |
| Spumellaria indet. A |   |   |   |   |   |   |   | Spumellaria indet. A |
| Spumellaria indet. B |   |   |   |   |   |   |   | Spumellaria indet. B |
| Spumellaria indet. C |   |   |   |   |   |   |   | Spumellaria indet. C |
| Spumellaria indet. D |   |   |   |   |   |   |   | Spumellaria indet. D |
| Spumellaria indet. E |   |   |   |   |   |   |   | Spumellaria indet. E |
| Nassellarian indet A |   |   |   |   |   |   |   | Nassellarian indet A |
| Nassellarian indet B |   |   |   |   |   |   |   | Nassellarian indet B |

**Figure 3.8:** Biostratigraphy of the eastern Iskut River map area: Radiolaria.
Figure 3.9: Lyons Creek stratigraphic section (modified from Smith and Carter, 1990).
BONDER LAKE GROUP

UNIT 5

Loc. 63

Mudstone, siltstone, and sandstone.

Loc. 56

5a : Fossiliferous calcareous sandstone

5b : Mudstone to siltstone; fossiliferous; Pyjama beds' top of unit

5c : Basal fossiliferous shale. Changes upsection to siliceous shale and sandstone (pyjama beds). Interspersed by conglomerate and tuffaceous shale lenses.

Loc. 49

4a : Well stratified felsic pyroclastio-epiclastic rocks.

4b : Cliff-forming tuff, lapilli tuff, and volcanic breccia

4c : Welded lapilli tuff flows

4d : Sandstone & conglomerate with volcanic fragments.

HAZELTON GROUP

UNIT 4

Loc. 39

Well stratified felsic pyroclastio-epiclastic rocks.

4a : Welded ash & lapilli tuff

4b : Caliche-forming tuff, lapilli tuff, & volcanic breccia

4c : Welded lapilli tuff flows

4d : Sandstone & conglomerate with volcanic fragments.

UNIT 3

Intermediate to mafic volcanic flows, breccia, & epiclastic rocks.

Loc. 32

Intermediate composition volcanic breccia, pyroclastic flows and epiclastic rocks.

2a : Pillowed flow, broken pillow breccia

2b : Monolithic volcanic breccia grade upward to heterolithic volcanic breccia to conglomerate

UNIT 2

Loc. 29

Marine sedimentary succession.

2a : Pebble conglomerate, bioclastic silty limestone sandstone (Bivalves + belemnites)

2b : Fossiliferous mudstone-siltstone with abundant belemnites

2c : Heterogeneous conglomerate, breccia. Gast changes from mudstone dominate to volcanic detritus upsection

2d : Turbiditic mudstone & sandstone intruded 250m silt. Aalenian ammonites occur in sandstone 2m below top of unit.

2e-f : Tuffaceous mudstone & sandstone, bioclastic sandstone and minor phyllicous beds.

UNIT 1

Loc. 29

Intermediate composition volcanic breccia, pyroclastio-epiclastic rocks.

1a : Coarse volcanic breccia & conglomerate

1b : Welded lapilli tuff

1c-f : Epiclastic sandstone & conglomerate
- mudstone-siltstone turbidites; thickly-bedded sandstone and lenticular conglomerate layers

- massive and pillow basalt flows and basaltic volcanic breccia; intercalated mudstone; "pajama" tuff + argillite beds

- felsic welded lapilli tuff with good eutaxitic fabric; overlain by mudstone, and massive, flow banded to brecciated rhyolite

- intercalated mudstone/siltstone, sandstone, subordinate conglomerate; minor andesitic tuff

- thickly-bedded to massive tuffaceous sandstone and conglomerate, coarse-grained to blocky andesitic tuff and volcanic breccia; subordinate intercalated sandstone and siltstone

- sandstone, locally conglomeratic; cross-stratification common; locally fossiliferous

- mafic to felsic tuff to block tuff; tuffaceous, cpx-bearing sandstone; volcanic cobble conglomerate; slatey argillite and mudstone

Figure 3.11: Generalized stratigraphic section for the Eskay Creek area (modified from Homestake, in prep.)
Figure 3.12: Generalized stratigraphic section for the John Peaks area (from Lewis, in prep.).
CHAPTER 4  
REGIONAL CORRELATIONS

In dealing with the problems summarised at the end of Chapter 2, the aims of this chapter are 
a) to present refinements to the correlation of lithostratigraphic units within the eastern Iskut River map 
area (Fig. 4.1-4.2),  b) to discuss the regional correlation of these units with those elsewhere in the 
Bowser Basin (Fig. 4.3), and c) to discuss the application of biochronology to constraining the age of 
stratabound mineralization in the eastern Iskut River map area (Fig. 3.11, 4.4 - 4.5).

4.1  Eastern Iskut River map area

4.1.1  Lithostratigraphic Units

4.1.1.1  Stuhini Group

The Norian fossils of the study area are from beds assigned to the Triassic Stuhini Group. In 
the western facies the Norian fossils occur in a sandstone bed whereas in the eastern facies they occur in 
shale/siltstone beds (Fig. 4.1).

In the western facies exposed at localities 1 and 2 (App. IV), the Norian fossils occur in 
sandstone beds within a sequence of at least 300 metres of matrix supported, polymict pebble to cobble 
conglomerate with minor siltstone and wacke interbeds. This sequence grades laterally and upward into 
green volcanic conglomerate and lithic lapilli tuff (Britton et al., 1990b). The sandstones were 
stratigraphically equivalent to sandstones exposed at localities 29, 31, and 32 (App. IV) that have 
yielded Weyla and belemnites. It was therefore included in the Toarcian upper Lower Jurassic part of 
the Salmon River Formation which unconformably overlies the Triassic western facies (Anderson and 
Thorkelson, 1990). Given its Norian age as demonstrated in this thesis, the sequence can now be 
included in the western facies of the Stuhini Group.

In the eastern facies, Norian fossils have been reported from locality 3 by Gunning
<table>
<thead>
<tr>
<th>STAGE</th>
<th>NORTH AMERICAN STANDARD &amp; ASSEMBLAGE ZONES</th>
<th>OTHER FAUNA</th>
<th>GENERALIZED LITHOSTRATIGRAPHY</th>
<th>ROCK UNITS (this study)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CALLOVIAN</td>
<td></td>
<td>Lilloetia Keppelerites Cobbantes</td>
<td>Iniskinites</td>
<td>Ashman Formation</td>
</tr>
<tr>
<td>BATHONIAN</td>
<td></td>
<td></td>
<td></td>
<td>Salmon River Formation</td>
</tr>
<tr>
<td>BAJOCIAN</td>
<td></td>
<td>Stephanoceras Zemistephanus</td>
<td>Radiolaria</td>
<td></td>
</tr>
<tr>
<td>AALENIAN</td>
<td>Eryctoides howelli zone</td>
<td></td>
<td></td>
<td>Unuk River Formation</td>
</tr>
<tr>
<td>TOARCIAN</td>
<td>Asemblage Zone 6</td>
<td>Weyla Belemnite</td>
<td></td>
<td>Mt. Dilworth fm.</td>
</tr>
<tr>
<td></td>
<td>Assemblage Zone 2-3</td>
<td></td>
<td></td>
<td>Betty Creek Fm.</td>
</tr>
<tr>
<td>PLIENSICHIAN</td>
<td></td>
<td></td>
<td></td>
<td>Unconformable contact</td>
</tr>
<tr>
<td>SINEMURIAN</td>
<td>Canadensis Zone</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HETTANGIAN</td>
<td></td>
<td></td>
<td></td>
<td>Stuhini Group</td>
</tr>
<tr>
<td>NORIAN</td>
<td>Amoenum-Crickmayi Zone</td>
<td>Cordilleranus Zone</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 4.1: Eastern Iskut River map area: i) Summary chart of biozones and other faunas recognized; ii) the generalized lithostratigraphy; and iii) the rock units.
This study recognizes additional localities (4, 5, and 6; App. IV) yielding Norian fossils west of Unuk River from shale and sandstone beds that are interbedded locally with lenses of granitoid boulder conglomerate at the toe of Jack Glacier and regionally overlie volcanic rocks of the Stuhini Group. The strata extend to the northeast valley wall near the toe of Atkins Glacier where they are unconformably overlain by the Lower Jurassic conglomeritic, fossiliferous, limey siltstone, and sandstone of the Jack "formation" (Henderson et al., 1992).

4.1.1.2 Unuk River Formation/Jack "formation"

The upper Hettangian/Lower Sinemurian fossils in the Iskut River map area identified in this study are restricted to sandstones of the middle sedimentary sequence of the Unuk River Formation or the Jack "formation" (Fig. 4.1-4.3).

East of Unuk River, the sandstones rest unconformably on the Triassic Stuhini Group and are assigned to the Jack formation (Henderson et al., 1992). This unit can be traced eastward to the Treaty Creek area (Henderson et al., 1992; Lewis et al., 1993) where it is overlain by a Middle Jurassic volcano-sedimentary sequence characterized by mafic to felsic volcanic compositions. West of Unuk River the sandstones are included within the Unuk River Formation (Homestake, pers. comm, 1992; Britton and Alldrick, 1988; Grove, 1986). The Unuk River Formation is overlain by volcano-sedimentary rocks of andesitic tuff/wacke and minor conglomerate and shale and underlain by mudstone and siltstone and can be traced south to the Coultier Creek fault and east of the Eskay Creek camp. The base of this unit was not visible.

The Jack "formation" is a sedimentary succession between the Hazelton Group and the Stuhini Group whereas the Unuk River Formation is characterized by a lower sedimentary sequence and an upper volcanic sequence both of which have been assigned to the Hazelton Group. The assignment of the sandstones yielding the upper Hettangian/Lower Sinemurian fossils to two separate formations is
Figure 4.2: Eastern Iskut River map area: Biostratigraphic correlation and lithostratigraphy.
questioned in this study. The units are similar in lithology, are coeval, and occur stratigraphically below a volcano-sedimentary sequence. It is proposed to retain the assignment of the Unuk River Formation and designating the informal Jack "formation" as a member of the Unuk River Formation.

4.1.1.3 Betty Creek Formation

The Betty Creek Formation has yielded Late Pliensbachian and possibly Early Toarcian fossils. The fossils are found in shale with local occurrences in limestone. These beds, at least at two localities occur within a volcano-sedimentary sequence. Within the Iskut River map area, the Late Pliensbachian fossils appear to be restricted to the Unuk valley (Fig. 4.1-4.2).

The Early Toarcian *Dactylioceras* from south of Tim Williams glacier were from a fossiliferous, polymictic basal conglomerate intercalated with argillite and siltstone and overlain by quartzose sandstone conglomerate with minor lithic and crystal tuff (App. V). Grove (1986) assigned these outcrops to the upper member of the Unuk River Formation. These outcrops could be part of the Betty Creek Formation or the Salmon River Formation. However, no information is available on the thickness of the member or its stratigraphic position and we were also unsuccessful in locating the fossil site.

Until further collections become available the assignment of a Early Toarcian age to the Betty Creek Formation must remain tentative.

4.1.1.4 Mt. Dilworth "formation"

The Mt. Dilworth formation represents a widespread felsic unit in the map area but contains no fossils. At John Peaks, based on U-Pb date and fossil collections occurring above the unit, the age of the unit is constrained to Upper Pliensbachian. At Eskay Creek, based on fossil collections occurring in the Betty Creek Formation and the overlying Salmon River Formation, the age of this unit is
constrained to Upper Pliensbachian to Aalenian, possibly Lower Bajocian (Fig. 4.2). Therefore, the felsic unit exposed in the southern and southwestern region of the map area is probably no younger than the Upper Pliensbachian.

A felsic unit is also exposed at the Treaty Ridge area (Unit 4 of Lewis et al., 1993; Fig. 4.2). This unit continues west and south of the Treaty glacier area and regionally westward around the McTagg anticlinorium to John Peaks where it appears to be equivalent to the felsic volcanics rocks mapped as Mt. Dilworth formation (Lewis, 1992b). On lithologic grounds, these two units have been assumed to be equivalent. New finds of Aalenian and Bajocian fossils below and above the felsic unit respectively constrains the age from Aalenian to Lower Bajocian. Therefore, two felsic units are now recognized in the map area.

4.1.1.5 Salmon River Formation

Toarcian, Aalenian, and Early Bajocian fossils are from the siltstone sequence of the Salmon River Formation (Fig. 4.1-4.2).

The Toarcian in the Iskut River map area is marked by a diverse faunal assemblage. Fossiliferous sandstone beds have been included in the basal Salmon River Formation (dated as Toarcian at its type area at Troy Ridge; Anderson and Thorkelson, 1990). The shale beds containing Late Toarcian ammonites outcropping east and west of Nickel Mountain are tentatively assigned to Unit 4 by Britton and Alldrick (1988; Fig. 2.7). Based on the stratigraphic position and age, this unit may well be included in the Salmon River Formation.

At Eskay Creek, Aalenian and possibly Early Bajocian fossils occur above the felsic horizon included in the Salmon River Formation (Homestake, pers. comm., 1993). At the Treaty Glacier area, Aalenian fossils occur in a siltstone sequence designated as Unit 2 by Lewis et al. (1993)
4.1.1.6 Ashman Formation

The Ashman Formation has yielded Late Early Bajocian to Early Callovian fossils. Bajocian fossils are rare in the map area. Only one locality at the Treaty Ridge section had in situ Bajocian fossils preserved in sandstone beds. The Late Bathonian to Early Callovian fossils occur in shale beds that are also part of the Ashman Formation (Lewis, 1992b; Anderson and Thorkelson, 1990; Anderson, 1989; Britton et al., 1989; Grove, 1986).
4.2 Correlations with sub-Bowser Lake Group Units in Bowser Basin

4.2.1 Unuk River Formation (Jack "formation")

The Canadensis Zone of the basal Unuk River Formation (and Jack "formation") has also been recognized in the Telegraph Creek map area to the north, where Souther (1972) reported *Badouxia canadensis* from his Hettangian to Upper Toarcian lower unit (Fig. 4.3).

4.2.2 Betty Creek Formation

The Kunae and Carlottense zones that occur in the Betty Creek Formation of the Iskut River map area are also recognized in other parts of the Bowser Basin region notably in the McConnell (Smith et al., 1984; Tipper and Richards, 1976), Spatsizi, and Telegraph Creek (Thomson and Smith, 1992; Thomson et al. 1986; Smith et al., 1984) map areas (Fig. 4.3). In the Spatsizi map area, the zones are recognized in the Wolf Den Formation of the Spatsizi Group, an Upper Pliensbachian to Middle Toarcian dark-grey to black shale unit with calcareous concretions and minor tuff beds. In the McConnell map area, the faunal zones occur in the Nilkitkwa Formation (Hazelton Group), a Pliensbachian to Middle Toarcian fine grained greywacke, andesitic to rhyolitic tuff and breccia, shale, siltstone and limestone.

4.2.4 Mt. Dilworth"formation"

This rock unit is probably coeval with the Wolf Den and Nilkitkwa formations (Fig. 4.3).

4.2.5 Salmon River Formation

Toarcian fossils are found in the Hazelton, McConnell, Smithers, Spatsizi, and Telegraph Creek map areas (Jakobs, 1992). They are abundant in the Smithers and McConnell map areas, occurring in the upper part of the Pliensbachian to Middle Toarcian Nilkitkwa Formation, and in the basal Smithers Formation which ranges from Middle Toarcian to Middle Bathonian (Fig. 4.3).
Figure 4.3: Correlation chart of Mesozoic strata along the margins of the Bowser Basin (source given in references and text).
Toarcian fossils are also found in the Spatsizi map area, occurring within the Pliensbachian to Middle Toarcian Wolf Den Formation and also the Toarcian Melisson Formation.

Fossils of Aalenian to Early Bajocian age within the Bowser Basin region also occur in the Spatsizi, Smithers, Hazelton, Terrace, and McConnell map areas. Aalenian to Early Bajocian fossils have been collected from sedimentary rocks within mainly volcanic sequences of the Middle Toarcian to middle Bajocian Smithers Formation (Poulton and Tipper, 1991, Tipper and Richards, 1976). To the north in the Spatsizi map area, Aalenian and Bajocian faunas have been found respectively in the poorly exposed sedimentary sequences of the Aalenian Abou Formation and the Bajocian Quock Formation (Poulton and Tipper, 1991, Thomson et al., 1986). Both the Smithers Formation (Yuen Member) and the Quock Formation consist of banded tuffaceous shale known colloquially as the 'pyjama beds', which are also found in the Troy Ridge facies of the Salmon River Formation.

In the Iskut River map area, the Toarcian, Aalenian, and the Aalenian/?Lower Bajocian fossils occur in the Salmon River Formation. The unit is therefore coeval in part with the Melisson, Abou, and Quock formations to the north and Smithers Formation to the south and southeast (Fig. 4.3).

4.2.6 Ashman Formation

The sedimentary unit assigned to the Ashman Formation in the Iskut River map area is slightly older than the mainly Bathonian basal Bowser Lake Group to the southeast in the Smithers map area (Tipper and Richards, 1976) and to the northeast in the Spatsizi map area (Yorath, 1991; Rickett et al., 1992). In the study area, rocks containing the Lower Bajocian fauna are included in the basal Bowser Lake Group.
4.3  **Mineralization: Age Constraints**

The eastern Iskut River map area is part of British Columbia’s Golden Triangle, so called because of the rich base and precious metal deposits contained within the Mesozoic rocks (Fig. 4.4). All major deposits in the map area are classified into four non-genetic categories: stratabound, intrusive contacts, veins, and dissemination (Britton and Alldrick, 1988; Britton et al., 1989, 1990b). In the Snippaker map sheet the deposits, some of which are already being mined, are found in veins cross-cutting the Upper Triassic-Lower Jurassic strata. Mineralization is associated with early Jurassic plutonism (Britton et al., 1990b). In the Unuk River map sheet, intrusive type mineralization occurs in the Lower Jurassic rocks, whereas the stratabound mineralization was initially thought to be constrained to upper Lower Jurassic to lower Middle Jurassic rocks. In the Sulphurets map area, mineralization is related to rocks intruding Lower Jurassic units, notably in the Unuk River Formation.

This study shows that mineralization also occurs in the Middle Jurassic in the eastern Iskut River map area. Two properties still being explored are the Eskay Creek and Treaty Glacier areas (Fig. 4.4) where mineralization occurs in Aalenian to Lower Bajocian rocks.

4.3.1  **Eskay Creek Stratabound Mineralization**

The stratabound mineralization at Eskay Creek occurs in mudstones within a sequence of felsic volcanics (Fig. 3.12). The deposit occurs over a strike length of 1800 metres (Britton et al., 1989) and is known as the 21 Zone Deposit. The strata that host the mineralization were initially dated as Toarcian to possibly Bajocian based on fossils occurring both below and above the mineralization. Age is now constrained to Aalenian to possibly Lower Bajocian, as summarised in figure 3.11.
Figure 3.5: Eastern Iskut River map area: Major mineral deposit location.

- Gold-Silver Deposit with significant reserves
- Gold-Silver Project Under Exploration
4.3.2 Treaty Ridge Alteration system

The Treaty Ridge area is underlain by rocks of both the Bowser Lake Group and the Hazelton Group, that are complexly folded and faulted (Alldrick and Britton, 1988; Fig. 4.5a). Two prominent gossans designated as the main gossan and the north gossan, lie on the upper block of a southeast trending thrust fault, causing the Hazelton Group strata to rest above the Bowser Lake Group (Lewis and Thompson, 1992).

Extensive alteration within the gossans has hampered the identification and mapping of the units cross-cut by the alteration system. Preliminary interpretations indicated that the system was affecting primarily the Lower Jurassic Betty Creek and Mt. Dilworth formations, and part of the Middle Jurassic Salmon River Formation (Lewis and Thompson, 1992). Exposures of these two gossans are separated by the Treaty Glacier and a section of unaltered rocks at the north end of the nunatak, a sequence called the Treaty Ridge Section by Lewis et al. (1993) (Fig. 4.5b). At this section, Unit 4 rocks shown on the basis of this study to be Aalenian to Early Bajocian in age, can be traced to the west and south and correlated with the strata affected by the alteration systems (Fig. 4.5b). The alteration zones cut across 200 metres of stratigraphy (Lewis et al., 1993) but the lower contact is not exposed. Based on the correlation with the Treaty Ridge stratigraphy, this system is Middle Jurassic in age between the Aalenian and the Lower Bajocian stages. According to Lewis and Thompson (1992), one possible explanation for the cross-cutting alteration is that it formed in the upper part of a magmatic-hydrothermal system. Jurassic magmatism, alteration, and mineralization apparently ceased with the onset of clastic sedimentation in the Bowser Basin in the Early Bajocian to Bathonian (Lewis et al., 1993).
TREATY GLACIER AREA
Legend
Bowser Lake Group
5 mudstone, siltstone, sandstone
Hazelton Group
4 felsic flows, pyroclastics, mudstone
3 int. to mafic flows, breccias
2 mudstone, sandstone, felsic tuff
1 int. pyroclastic and epiclastics

Alterations
snowfields, glacier
fault (approx., inferred)

Figure 4.5a: Treaty Ridge area
(modified from Lewis et al., 1993).
Figure 4.5b: Stratigraphic sections of Treaty Ridge, north, and south gossans (modified from Lewis et al., 1993).
CHAPTER 5  
PALEOECOLOGY

5.1 Introduction

A faunal community is a system of organisms living together and linked by their effects on one another and by their responses to and influences upon the environment they share. Recognizing fossil communities is helpful in interpreting past environments. Figure 5.1 depicts a shallow shelf setting and the different modes of life of various organisms common in this study. The aims of this chapter are a) to analyse the faunas in terms of their depositional environment and b) to discuss the paleoenvironmental implications.

Figure 5.1: Dwelling organisms in a shallow shelf setting (from McKerrow, 1978)
Taylor (1982) proposed a model which emphasizes the paleobathymetric distribution of the benthonic and nektonic faunas of the Jurassic Snowshoe Formation in Oregon. The Snowshoe Formation is part of a thick Jurassic volcaniclastic sequence in a forearc-basin setting (Brook, 1979). In the Suplee-Izee area fossiliferous Bajocian members of the Snowshoe Formation record a transgressive sequence from east to west. The progressively nearshore to offshore trends and inferred hydrodynamic regimes are indicated by the geometry of the basin, sedimentary structures and textures, and the abundance of tuff beds combined with changes in the faunas. Four composite assemblage depth zones were proposed, based on the faunal content and the lithology (Fig. 5.2). Taylor demonstrated that the patterns recognized within the Snowshoe Formation are applicable over a wide geographic area, including epeiric and eugeosynclinal seas and they provide a model of general significance for much of the Jurassic (Taylor, 1982). The Hazelton Group strata in the Iskut River map area consist of volcano-sedimentary sequences that display rapid bio- and lithofacies changes. The paleoenvironment analysis presented in this section is based on selected localities using the benthonic and nektonic faunal content combined with lithology (Fig. 5.3-5.4). The analysis is presented in a chronologic order from the Lower to Middle Jurassic.

**Figure 5.2:** Composite Depth Assemblage Zones A - E of Taylor (1982).
5.2 The Benthonic and Nektonic Fauna

Benthonic forms dominate the Iskut faunas (Table 5.1; Fig. 5.3- App. VI-V). Bivalves are most widespread, diverse, and locally abundant but bryozoans, brachiopods, corals, crinoids, gastropods, and sponges also occur. The gastropods, although not abundant, are widespread in the map area. Except for the Snippaker Ridge localities, the corals are primarily the small solitary scleractinian variety. Abundant sponges are found only at one locality. Other benthonic organisms (crinoids, bryozoans, brachiopods) are rare and found at few localities. The benthonic fauna is predominantly found preserved in sandstone with few occurrences in limestone and shale.

The widespread ammonoids and belemnoids make up the nektonic fauna (Table 5.1). The ammonoids are predominantly found preserved in shale with local occurrence in sandstone. The belemnoids on the other hand are abundant in both the lithologies.

<table>
<thead>
<tr>
<th>MODE OF LIFE</th>
<th>FAUNAL GROUP</th>
<th>RELATIVE OCCURRENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benthonic</td>
<td>Bivalves</td>
<td>A,W</td>
</tr>
<tr>
<td></td>
<td>Brachiopods</td>
<td>R,O</td>
</tr>
<tr>
<td></td>
<td>Bryozoans</td>
<td>R,O</td>
</tr>
<tr>
<td></td>
<td>Corals</td>
<td>A,W</td>
</tr>
<tr>
<td></td>
<td>Crinoids</td>
<td>R, S</td>
</tr>
<tr>
<td></td>
<td>Gastropods</td>
<td>A,W</td>
</tr>
<tr>
<td></td>
<td>Sponges</td>
<td>A,O</td>
</tr>
<tr>
<td>Nektonic</td>
<td>Ammonoids</td>
<td>C,W</td>
</tr>
<tr>
<td></td>
<td>Belemnoids</td>
<td>C,W</td>
</tr>
<tr>
<td></td>
<td>Nautiloid</td>
<td>R,O</td>
</tr>
<tr>
<td>Planktonic</td>
<td>Foraminifera</td>
<td>R,O</td>
</tr>
<tr>
<td></td>
<td>Ostrocode</td>
<td>R,O</td>
</tr>
<tr>
<td></td>
<td>Radiolaria</td>
<td>C,S</td>
</tr>
<tr>
<td>Others</td>
<td>Trace Fossil</td>
<td>R,S</td>
</tr>
<tr>
<td></td>
<td>Stromatolite</td>
<td>R,O</td>
</tr>
</tbody>
</table>

Table 5.1: Triassic-Jurassic fauna of the eastern Iskut River map area. (A=Abundant \( \geq 10 \) specimens; C=Common \( \approx 9 \) specimens; R=Rare \( \approx 3 \) specimens; W=Widespread; S=Sparse; O=only one locality)
### Abbreviations

<table>
<thead>
<tr>
<th>Stages</th>
<th>Biozones</th>
<th>Rock Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>N      = Norian</td>
<td>Cr = Cordilleranus Zone</td>
<td>St = Stuhini Group</td>
</tr>
<tr>
<td>HS     = upper Hettangian/ Lower Sinemurian</td>
<td>Cn = Canadensis Zone</td>
<td>Jk = Jack formation</td>
</tr>
<tr>
<td>UP     = Upper Pliensbachian</td>
<td>Kn = Kunae Zone</td>
<td>Uk = Unuk River Formation</td>
</tr>
<tr>
<td>UT     = Upper Toarcian</td>
<td>C1 = Carlottense Zone</td>
<td>BCr = Betty Creek Formation</td>
</tr>
<tr>
<td>LT     = Lower Toarcian</td>
<td>Eb = Erycitoidea howelli assemblage zone</td>
<td>SR = Salmon River Formation</td>
</tr>
<tr>
<td>TC     = Toarcian to Callovian</td>
<td>A2/3 = Assemblage zones 2-3</td>
<td>As = Ashman Formation</td>
</tr>
<tr>
<td>uA     = Upper Aalenian</td>
<td>A6 = Assemblage Zone 6</td>
<td>MJ = Middle Jurassic</td>
</tr>
<tr>
<td>LB     = Lower Bajocian</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UB     = Upper Bathonian</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BC     = Upper Bathonian/Lower Callovian</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Figure 5.3: Eastern Iskut River map area: Benthonic and Nektonic Fauna.
5.2.1 Upper Triassic

Within the western facies of the Stuhini Group at localities 1 and 2 (App. V), calcareous sandstone beds contain diverse and abundant assemblages of Norian ammonoids, belemnoids, bivalves, corals, sponges, gastropods, and bryozoans. The rich diversity of the fauna and the lithology is probably indicative of a nearshore shallow shelf environment (Fig. 5.4). This assignment is further supported by the presence of thalamid sponges (Nevadathalamia sp.) and corals that in modern oceans are restricted to the shallow neritic zone (≈1-100m).

![Figure 5.4](image-url): Upper Triassic: Depth analysis for localities 1 and 2 at Snippaker Ridge.

5.2.2 Lower Jurassic

The faunas from the interbedded limy sandstone and siltstone unit (Jack "formation") at localities 10 and 13 consist of ammonites, bivalves, belemnoids, gastropods, and corals (App. IV and Fig. 5.3). This unit is more than 100 metres thick, rests unconformably on conglomerates, and is overlain by a turbiditic sequence of carbonate, mudstone, and sandstone (Henderson et al., 1992). Most of the bivalves are thick-shelled (Camptonectes, Weyla, Gryphaea) and their modes of life ranged from bysally attached to free lying. Corals and gastropods are small and rare. Overall, the lithology and the faunal composition indicate a fairly nearshore setting, in a shallow to moderate water depth, corresponding to the assemblage depth zone B-C1 of Taylor (1982; Fig. 5.5).
The assemblage depth zone B-C is also recognized higher in the stratigraphic succession in a limey sandstone sequence of the basal Salmon River Formation (Localities 29, 31-32; App. IV and Fig. 5.3). These sequence extends from the Jack Glacier to the Treaty Glacier east of Unuk River, and on the west side appears to be restricted to the northern part of the map area. The beds containing bivalves, corals, and belemnites are more than 10 metres thick and consist of limy sandstone and siltstone. The bivalves are relatively small, ornate, thick shelled and dominated by the byssally attached genus *Weyla*, a common mode of life in a shallow shelf setting.
East of Lyons Creek, a 180 metres thick shale interbedded with siltstone yielded Late Pliensbachian ammonites and rare bivalves (Locality 18; App. IV and Fig. 5.3). The strata were probably deposited in relatively deep water, corresponding to assemblage depth zone D, an off-shore slope to basinal environment (Fig. 5.5). Shale beds with Pliensbachian fossils located north of John Peaks (Loc. 19 and 20) and east of Eskay Creek (Loc. 23), with Lower Toarcian ammonites located south of Tim Williams glacier (Loc. 26), and with Upper Toarcian ammonites located east of Nickel Mountain (Loc. 27 and 28) have similar faunal content and lithology and are assigned to the assemblage depth zone D (App. IV and Fig. 5.3).

5.2.3 Middle Jurassic

At the Treaty Ridge section at (locality 39; App. IV), a 125 metre thick Middle Jurassic sequence consists of turbiditic mudstone and sandstone. The mudstone is platy, dark, grey, and graded and the sandstone is fine, medium, and coarse grained. Abundant ammonites and a few encrusting bivalves occur in these beds that appear to have been deposited in relatively deep water corresponding to the composite assemblage depth zones C-D of Taylor (1982). Bivalves attempting to grow on ammonites, presumably to gain a firm substrate that was slightly elevated above the oxygen-poor surface provide further evidence for the assignment to the depth zone.

At the Treaty Glacier section (Locality 49; App. IV) the strata consists of shale, siltstone with tuff layers, and fossiliferous limey sandstone beds. The fauna consists of small, ornate bivalves, gastropods, belemnites, and rare ammonites. The lithology and faunal content suggest a composite assemblage depth zone C of Taylor (1982; Fig. 5.5).

Bowser Lake Group localities (57-63; App. IV) occur in shale and siltstone with minor conglomerate yielding Late Bathonian to Early Callovian ammonites. In general, these localities correspond to the composite assemblage depth zone D of Taylor (1982). This conclusion is supported
by the absence of benthonic macrofauna.

Localities 54 and 55 (App. IV), on the Mitchell nunatak and north of Mitchell glacier, are sandstone beds with abundant bivalves, gastropods, and rare corals. These fossiliferous beds correspond to the composite assemblage depth zone B of Taylor (1982).

5.2.4 Summary

The conclusions of the paleobathymetric analysis are as follows:

a) The Upper Triassic to Middle Jurassic marine sedimentary strata were deposited in a wide spectrum of nearshore shallow shelf to off-shore slope/basinal environments. In the western facies Upper Triassic sedimentary rocks, a shallow shelf environment is evident. In the Lower and Middle Jurassic sedimentary rocks, the composite depth zones B, C, and D of Taylor are recognized (Fig. 5.6).

b) High diversity faunas in sandstones are particularly evident in some of the Norian, Upper Hettangian/Lower Sinemurian, Toarcian, and Lower Bajocian strata.

c) Low diversity benthonic fauna and high diversity nektonic fauna in shale and siltstones are common in the Upper Pliensbachian, Lower Toarcian, Upper Toarcian, Aalenian, Upper Bathonian, and Lower Callovian strata.

A combination of faunal, sedimentological, and stratigraphic evidence strongly suggests that diverse faunas were largely restricted to shallow water, with the diversity falling towards the offshore. This is consistent with depth limits of 50-100 m as suggested by Hallam (1975) for diverse and abundant benthonic faunas. As the diversity of the benthonic fossils decreases, the abundance of the nektonic fossils increases.
## Generalized Lithostratigraphy

<table>
<thead>
<tr>
<th>STAGE</th>
<th>Composite Assemblage Depth Zone of Taylor (1962)</th>
<th>GENERALIZED LITHOSTRATIGRAPHY</th>
<th>ROCK UNITS (this study)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CALLOVIAN</td>
<td></td>
<td></td>
<td>Ashman Formation</td>
</tr>
<tr>
<td>BATHONIAN</td>
<td></td>
<td></td>
<td>Salmon River Formation</td>
</tr>
<tr>
<td>BAJOCIAN</td>
<td></td>
<td></td>
<td>Mt. Dilworth Fm.</td>
</tr>
<tr>
<td>AALENIAN</td>
<td></td>
<td></td>
<td>Betty Creek Fm.</td>
</tr>
<tr>
<td>TOARCian</td>
<td></td>
<td></td>
<td>Unuk River Formation</td>
</tr>
<tr>
<td>PLEISBACHIAN</td>
<td></td>
<td></td>
<td>Jack Fm.</td>
</tr>
<tr>
<td>SINEMURIAN</td>
<td></td>
<td></td>
<td>Stuhini Group</td>
</tr>
<tr>
<td>HETTANGIAN</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NORIAN</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Legend
- Sandstone
- Pillow basalts
- Felsic volcanic rocks
- Mafic and intermediate volcanics rocks
- Limestone
- Shale
- Conglomerate

### Figure 5.6: Eastern Iskut River map area: Biostratigraphy, Lithostratigraphy, and Composite Depth Assemblage Zones.
5.2.5 Discussion

The Stuhini Group is divided into an eastern and western facies. In the western facies, the presence of a diverse and abundant benthonic fauna at a few localities along the Snippaker Ridge suggests shallower water, perhaps related to volcanic islands.

Following the deposition of Upper Triassic rocks, there was an internal of erosion and non-deposition at least as recorded east of the Unuk River. This is indicated by the unconformable contact between Triassic conglomerate and the Hettangian/Sinemurian Jack "formation" (Henderson et al., 1992).

Shallow marine conditions persisted in some areas from the Late Hettangian to at least the Early Sinemurian with the deposition of sandstones of the Jack "formation", probably on the periphery of a paleotopographic high, where diverse benthonic and nektonic organisms flourished (Composite assemblage depth zone B-C1).

In the Upper Pliensbachian parts of the Betty Creek Formation, the composite assemblage depth zone D is recognized at various localities in the Unuk valley. This implies that the deposition of the shales in the Unuk valley during the Late Pliensbachian was in a relatively deep water (basinal) environment, possibly a back arc basin.

During the Toarcian, the widespread deposition of fossiliferous, limy sandstone and composite assemblage depth zone B-C faunas is seen in the area between the Jack and Treaty glaciers. The sandstone overlies a relatively thin volcanic sequence. In the Unuk valley, deeper water environment existed, at least in the Late Toarcian, marked by the occurrence of Late Toarcian ammonites in shale at locality 21 corresponding to composite assemblage depth zone D.

Marine conditions persisted into Aalenian time in most of the region. At Treaty Ridge, an offshore deep water setting is marked by the composite assemblage depth zone D. Within the Unuk
valley, around the Eskay Creek area, the deeper water environment persisted, with the deposition of shale containing radiolarians and belemnites (discussed in Section 5.3). Both these areas are associated with mineralization, consisting of stratabound mineralization at Eskay Creek and a hydrothermal alteration system at the Treaty nunatak. The Aalenian age probably represents a period of widespread and localized submarine volcanism.

At the Treaty Ridge section, sandstone yielding Bajocian faunas of composite assemblage depth zone C is seen. Volcanism ceased probably in the Bajocian. The interval between the Late Bajocian and Early Bathonian probably represents widespread subaerial conditions, although no faunas representing this time span have been identified to date. During the Upper Bathonian to the Lower Callovian marks widespread marine conditions prevailed as indicated by the presence of faunas of composite assemblage depth zone D, especially in the northern and northeastern part of the map area.

In conclusion, during the Norian, shallow water conditions prevailed west of Unuk River. The shallow marine conditions also persisted in the eastern region, recorded in the Upper Hettangian-Lower Sinemurian strata. Deep water conditions prevailed in the Unuk valley during the Late Pliensbachian, probably coeval with the development of back or intra-arc basins. The Toarcian is marked by moderate to deep water conditions that were widespread in the northern part of the map area, and that persisted until the Early Callovian.
5.3 *Planktonic Fauna*

The planktonic fauna consists of radiolarians, foraminifers, and ostracodes but the latter two groups were rarely found in the map area and are not discussed here. The radiolarians were retrieved from calcareous shale of core samples (Localities 46, 47; 48; Fig. 3.11) and limestone concretions found from outcrop (Localities 42 - 45; Fig. 3.11) and are dated Aalenian to possibly Lower Bajocian.

5.3.1 *Ecology*

Radiolaria are marine planktonic protozoans which inhabit all modern seas, climate zones and water depths (Haeckel, 1887a). The radiolarians described in this study are polycystines possessing skeletons of almost pure opaline silica. They can be divided into two groups: the radially symmetrical spumellarians and the helmet-shaped nassellarians.

An understanding of the ecology of radiolarians is primarily based on studies conducted on living forms. The ecology of fossil radiolarians is based mainly on Cenozoic forms, with little known of the environmental habits of Mesozoic faunas. Polycystine radiolarians are primarily herbivores or suspended-organic feeders, and are a significant component of the pelagic ecosystem (Casey, 1977). The life span of living radiolarians is generally less than one month (Casey *et al.*, 1971). Studies show an average density of 82,000 individuals per cubic metre with the highest density between 25 m and a few hundred metres depth (Casey *et al.*, 1971). The polycystines are found at depth, from 0-5000 metres. Their regional distribution and dispersal, as with other pelagic organisms, is dependent on temperature, salinity, light, ocean currents, water chemistry, biologic competition, and accidental agencies that affect the transport of planktonic forms. The interaction of these factors determines the horizontal and vertical distributions of radiolarians in the oceans.

Haeckel (1887a) studied the depth distribution of radiolarians and recognized three bathymetric associations; a pelagic zone, a zonarial zone, and an abyssal zone. He also noted changes in the
morphology and preservation of skeletons with depth. His conclusions can be summarized as follows:

a) The pelagic zone (≈0-50m) has significant light penetration and contains more spumellarians than nassellarians. The generally spherical skeletons are more delicate than those of abyssal forms. In addition, some species may be much smaller than related abyssal forms.

b) The zonarial zone (≈50-3500m) has a predominance of spumellarians in the upper layer with the percentage of nassellarians increasing with depth.

c) The abyssal (>3500m) region is dominated by nassellarians with minor spumellarians. These deeper water forms are generally larger and more robust than shallower forms.

More recent work by Casey (1977), Renz (1976), and Petrushevskaya (1966, 1971a,b), show depth distribution of polystine radiolaria similar to Haeckels. The relative abundance of nassellarians and spumellarians has also been used to define sequence boundaries (McMillen, 1979) and to record sea-level changes (Casey & Bauer, 1976; Carter, 1985).

The nassellarian to spumellarian ratio was applied in this study to determine the relative paleo depth during the Aalenian and Lower Bajocian at Eskay Creek (Fig. 2.6 and 3.11). The relative abundance of spumellarians and nassellarians in each sample is shown in Table 5.2. Only samples which yielded more than 50 individuals were used for the analysis. Because this includes only six samples, the conclusions concerning water depth should be considered tentative. The radiolarians retrieved from samples in the mineralized zone contain twice as many nassellarians as spumellarians, suggesting that the mineralized strata may have been deposited in deeper water, fairly distant from the ancient shore line. The radiolarians retrieved from the pillow basalt sequence are dominated by spumellarians with very few nassellarians, suggesting a shallower environment, with closer proximity to the ancient shore line.
Figure 5.7: Generalized stratigraphic section for the Eskay Creek area (modified from Homestake, in prep).
This radiolarian analysis agrees with the depth distribution of Lower and Middle Jurassic radiolarians in the Queen Charlotte Islands (Carter, 1985). Carter's work was based on 15 samples, each one containing over 100 individuals. Samples containing a high percentage of nassellarians were found in shales indicating deposition in deeper water, whereas those with high percentages of spumellarians were from sandstone.

<table>
<thead>
<tr>
<th>Loc. No.</th>
<th>Field No.</th>
<th>GSC No.</th>
<th>Sediment type</th>
<th>Spumellarians (S)</th>
<th>Nassellarians (N)</th>
<th>% (S)</th>
<th>% (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>46</td>
<td>CA89-89.54.2</td>
<td></td>
<td>Argillite</td>
<td>41</td>
<td>95</td>
<td>30</td>
<td>70</td>
</tr>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>48</td>
<td>CA89-426.40.7</td>
<td>C-159484</td>
<td>Calcareous shale</td>
<td>67</td>
<td>75</td>
<td>47</td>
<td>53</td>
</tr>
<tr>
<td>43</td>
<td>GTN-31e</td>
<td>C-201418</td>
<td>Carbonate concretion</td>
<td>40</td>
<td>9</td>
<td>82</td>
<td>18</td>
</tr>
<tr>
<td>44</td>
<td>GTN-33</td>
<td>C-201419</td>
<td>Carbonate concretion</td>
<td>60</td>
<td>19</td>
<td>76</td>
<td>24</td>
</tr>
<tr>
<td>45</td>
<td>GTN-34</td>
<td>C-201420</td>
<td>Carbonate concretion</td>
<td>58</td>
<td>16</td>
<td>78</td>
<td>22</td>
</tr>
<tr>
<td>42</td>
<td>PLS-76 (float)</td>
<td>C-201628</td>
<td>Carbonate concretion</td>
<td>148</td>
<td>73</td>
<td>67</td>
<td>33</td>
</tr>
</tbody>
</table>

Table 5.2: Relative abundance spumellarians and nassellarians. (O=outcrop samples, D=drill core samples.)

5.3.2 Discussion

In the modern oceans, radiolarians are found almost exclusively in the open ocean and are rare on the shelf (Kling, 1978). They are however, an important constituent of ancient shelf assemblages (Casey et al., 1981; Carter, 1985). The presence of abundant silica in seawater is necessary for the growth and proliferation of radiolarians, and undoubtedly contribute to their preservation in bottom sediments (Riedel, 1959). It is possible radiolarian growth maybe accelerated by the introduction of silica from submarine volcanism, although definite evidence is still lacking. Radiolarians retrieved from the Iskut River region were collected from sediments probably deposited in a moderate to deep water back-arc basin (Anderson and Thorkelson, 1990).
The Middle Jurassic strata of the Hazelton Group at Eskay Creek comprise a heterogeneous but distinctive assemblage of volcanic rocks deposited in a marine environment including: rhyolite, felsic breccia, andesites, pillow basalts, argillite, and precious metal deposits. The large amount of volcanic activity probably produced a high level of silica in the water column and could have aided the preservation of radiolarians in the sediments (CA89-89.54.2). Preservation in this sample is poor however, due to its occurrence in shale, where compaction and dissolution have destroyed most skeletal details. After deposition of the sedimentary/felsic sequence, a phase of intermediate volcanism resulted in the deposition of andesites followed by a pillow basalt sequence indicative of submarine volcanism. Cherts found interbedded with the pillow basalts indicate the introduction of silica from volcanic sources. Carbonate concretions collected from within the pillow basalt sequence are probably chemical sediments in which the radiolarians are preserved (Samples CA89-426.40.7, GTN31,33,34 & PLS-76).

The results from nassellarian-spumellarian ratios suggest that, within the Middle Jurassic Hazelton sequence (Salmon River Formation) at Eskay Creek, the sediments hosting the stratabound mineralization were deposited in a deeper environment than the overlying andesite/pillow basalt sequence (Fig. 5.7 for stratigraphic details). The relatively deeper environment for the sediments agrees with pollen analysis conducted by Dr. Glenn Rouse at the University of British Columbia. The sediments contained dinocysts and broken leaf or algae fragments which probably have been transported a distance and deposited away from a shelf environment (Rouse, pers comm, 1993). This is further supported by the fact there are no wood fragments in the sediments analyzed.
CHAPTER 6 SYSTEMATIC PALEONTOLOGY

6.1 Introduction

This chapter presents the description of fauna which are important in providing age constraints; the ammonoids and the radiolaria. Other identified fossils are provided in Appendix III.

6.1.1 Ammonoids

The classification of Phylloceratina generally follows that of Arkell et al. (1957) and the classification of the Ammonitina generally follows that of Donovan, Callomon and Howarth (1981).

The synonymy list is in accordance to with Matthews (1973) where type material is marked with an "*" and specimens compared with type specimens are marked with a "v".

Preservation is poor and mostly in the form of molds that are flattened and, at some localities, slightly deformed. Some specimens are complete and preserved in calcareous concretions. Suture lines are rarely evident. Due to the state of preservation, the recommendations of Bengston (1988) are followed regarding the use of open nomenclature. In addition, Mathews' (1973) "cf." and "?" are used, i.e. "cf." means uncertainty mainly due to incomplete preservation whereas "?" is used to express uncertainty because of provisional identification. Identifications are based on comparing specimens with specimens figured by other authors, and with type specimens at the Geological Survey of Canada, Vancouver and the University of British Columbia.

Locality information for the collections studied are summarized in figures 3.5 - 3.8. Appendix III can also be used as a reference to the localities. The fossil localities are marked on a 1:50,000 scale map sheet attached as Appendix IV.
The morphologic terminology used in the systematic descriptions of ammonoid follows that of Smith (1986). All measurements for the ammonoids are in millimeters with the symbol \( \approx \) preceeding approximate figures. Abbreviations used for the measurements are as follows:

\[
\begin{align*}
D & = \text{Shell diameter} \\
UD & = \text{Umbilical diameter at diameter} = D \\
U & = \frac{(UD/D) \times 100}{(U/D) \times 100} \\
WH & = \text{Whorl height at diameter} = D \\
WW & = \text{Whorl width at diameter} = D \\
WW/WH & = \frac{(WW/WH) \times 100}{(WW/WH) \times 100} \\
PRHW & = \text{primary ribs per half whorl, counted on the larger, or adoral half whorl diameter} = D.
\end{align*}
\]

6.1.2 Radiolaria

The earliest classification for Radiolaria, was based on geometry of test shape Haeckel (1887a,b). The present radiolarian taxonomy generally follows the polycystine systematic classification of Riedel (1967, 1971), with some modifications by Baumgartner (1980), Deflandre (1963), De Wever (1981, 1984), Dumitrica (1978), Kozur and Mostler (1972), Pessagno(1973, 1976, 1977a,b, 1979), Pessagno and Blome (1980), Pessagno and Whalen (1982), and Pessagno, Whalen, and Yeh (1986). The definition of taxa is based on diagnostic external features of the cortical shell that are visible with the binocular microscope and the scanning electron microscope. A brief synonymy is given for hypotypes.
6.2  Systematic Descriptions

6.2.1  Phylum Mollusca

Order CERATITIDA HYATT 1884
Suborder CERATITACEAE MOJSISOVICS 1879
Superfamily ARCESTACEAE MOJSISOVICS 1875
Family CLADISCITIDAE ZITTEL 1884
Genus Cladiscites MOJSISOVICS 1879

TYPE SPECIES: Ammonites tornatus BRONN 1832; SD Diener 1915.

REMARKS: Midvolute form with subrectangular whorl section. Ornamentation consists of fine striations and the septal sutures have bifid saddles. Cladiscites is found worldwide from the Carnian to the Norian (Donovan et al., 1981). In western North America, the genus occurs in the Upper Norian Amoenum-Crickmayi zones (Tozer, 1967; 1979a & b).

Cladiscites sp. indet.
Pl. III, Fig. 5

MATERIAL: 1 poorly preserved fragment.

DESCRIPTION: Medium sized, midvolute form with subrectangular whorl section. Fine striations are present on the inner whorl.

OCCURRENCE AND AGE: Locality 1, on ridge south of Snippaker Mountain (Stuhini Group). Amoenum-Crickmayi zones - Late Norian.
Superfamily PINACOCERATAEAE MOJSISOVICS 1879
Family GYMNITIDAE WAAGEN 1895
Genus Placites MOJSISOVICS 1896

TYPE SPECIES: Pinacoceras platyphylum MOJSISOVICS 1873.

SYNONYMS: Paragymnites HYATT 1900; Paraplacites KUTASSY 1928

REMARKS: Occluded, smooth shell with ellipsoidal whorl section and plain venter. Placites is found worldwide from the Carnian to the Norian (Donovan et al., 1981). This genus ranges from the Middle - Upper Norian in western North America (Tozer, 1967).

Placites sp. indet.
Pl. III, Figs. 3 and 6

MATERIAL: Fourteen poorly preserved specimens.

DESCRIPTION: Involute form with ellipsoidal whorl section and plain venter. Septal sutures present on some specimens and appear to be di- to tri-phylliac.

DISCUSSION: Most of the specimens are quite weathered and therefore the true sutures are not preserved. The volution and septal sutures preserved on some specimens allowed a generic assignment.

OCCURRENCE AND AGE: Localities 1 and 2, on ridge south of Snippaker Mountain (Stuhini Group). Amoenum-Crickmayi zones - Late Norian.
Systematic Paleontology

Order AMMONOIDEA ZITTEL 1884

Suborder PHYLLOCERATINA ARKELL 1950

Superfamily PHYLLOCERATAEAE ZITTEL 1884

Family DISCOPHYLLITIDAE SPATH 1927

Genus Rhacophyllites ZITTEL 1884

Type Species: Ammonites neojurensis QUENSTEDT 1845

Synonyms: Diphyllites JULIEN 1911; Triphyllites JULIEN 1911; Tragorhacoceras SPATH 1927

Remarks: Moderately evolute form with ogival whorl section and plain, arched venter. Rhacophyllites is found worldwide from the Carnian to the Norian. (Donovan et al., 1981).

Rhacophyllites? sp. indet.
Pl. III Fig. 1

Material: 1 medium sized specimen and three small specimens.

Description: Midvolute form with ogival whorl section. Plain, arched venter and umbilical wall convex.

Discussion: The surface of the shell has been removed by weathering, exposing the eroded sutures. The whorl section is not discernable due to the weathering and therefore the generic identification is questionable.

Occurrence and Age: Locality 1, on ridge south of Snippaker Mountain (Stuhini Group). Amoenum-Crickmayi zones - Late Norian.
Family PHYLLOCERATIDAE ZITTEL 1884
Subfamily PHYLLOCERATINAЕ ZITTEL 1884
Genus Phylloceras SUSS 1865

TYPE SPECIES: Ammonites heterophyllus SOWERBY 1820.

SYNONYMS: Rhacoceras HYATT 1867; Xeinophylloceras BUCKMAN 1921; Heterophylloceras KOVACS 1939; Zetoceras KOVACS 1939

REMARKS: Involute, ellipsoidal to oval whorl section and a gentle umbilical slope. Ornamentation consists of dense, fine radial growth lines. Septal sutures are tri- and commonly di-phyllic.

AGE AND DISTRIBUTION: This genus is found worldwide from the Early Jurassic (Hettangian) to the Cretaceous (Valanginian). They are commonly found in some Tethyan faunas, particularly in the circum-Mediterranean region.

Phylloceras spp. indet.
Pl. XII, Fig. 3, Pl. XIII, Fig. 12

MATERIAL: One fairly well preserved specimen in calcareous siltstone and a fragment of a large specimen.

MEASUREMENTS:

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<tr>
<th>SPECIMEN</th>
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<th>UD</th>
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<td>-</td>
<td>47.5</td>
<td>25.0</td>
<td>0.53</td>
<td>-</td>
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DESCRIPTION: Occluded shell with an ellipsoidal whorl section and rounded venter with convex flanks. Umbilical wall low with rounded shoulder. Ornamentation consists of fine striae. Sutures appear to be di- to tri-phyllic.

DISCUSSION: Despite a relatively well preserved specimen, it is difficult to assign a specific identification.

OCCURRENCE AND AGE: Locality 40, north of Mitchell Glacier (Salmon River? Formation) and locality 90, north of Atkins Glacier. Locality 40 - Upper Aalenian and locality 90 - Jurassic.

Superfamily PSILOCERATAEAE HYATT 1867
Family ARRIETITIDAE HYATT 1875
Subfamily ALSATITINAE SPATT 1924

Genus Badouxia GUÉX and TAYLOR, 1976

TYPE SPECIES: Psiloceras canadense FREBOLD, 1951.

REMARKS: Midvolute form with a rounded to ellipsoid whorl section. Ribs are prorsiradiate, strong on the lower flank and fade as they approach the venter. Ribs cross the venter by forming a chevron of weak primary or faint secondary ribs. Simple septal sutures.

AGE AND DISTRIBUTION: Badouxia is widely distributed around the Pacific margin with occurrences in Alaska, British Columbia, Oregon, Nevada, Peru, Chile, and northwestern Siberia (Taylor et al., 1984). Although its stratigraphic position is controversial, it is interpreted as uppermost
Hettangian to basal Sinemurian (Palfy, 1991).

*Badouxia* cf. *canadensis* FREBOLD 1951

Pl. VIII, Figs. 1-3

cf. 1951a *Psiloceras canadense* FREBOLD p. 3, pl. 4-6, pl. 2, fig. 1; pl. 3, fig. 1
(non pl. 1, figs. 1-3 = *Badouxia oregonensis*).

1962 *Waehneroceras* sp. CORVALAN, p. 158, pl. 1, fig. 4

1964b *Psiloceras canadense* FREBOLD Frebold p. 6, pl. 1, figs. 1-5.

1967 *Psiloceras canadense* FREBOLD Frebold p. 18, pl. 1, figs. 1-3.

1981a *Calocerat oregonensis* FREBOLD Hillebrandt p. 503, pl. 1, fig. 5.


1985 *Psiloceras canadense* (FREBOLD) O'Brien p.24-26, pl. 2, fig. 2

1985 *Psiloceras canadense* (FREBOLD) Prinz p. 188, pl. 2, fig. 4.

1987 *Badouxia* cf. *canadensis* (FREBOLD) Quinio Sinn pl. 1, fig. 11.

1989 *Badouxia canadensis* (Frebold), Riccardi et al. pl. 2, figs. 3-4.

1991 *Badouxia canadensis* (Frebold), Palfy, p. 98, pl. 5, figs. 1,2, and 6

**MATERIAL**: Nine specimens preserved as internal moulds.

**MEASUREMENTS**:

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<td>10.0</td>
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<td>1.0</td>
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<tr>
<td>C-201453c</td>
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<td>6.0</td>
<td>57.7</td>
<td>4.0</td>
<td>10.0</td>
<td>2.5</td>
<td>13</td>
</tr>
</tbody>
</table>

**DESCRIPTION**: Midvolute form with an elliptical whorl section reaching its greatest width near the middle of the flank. Umbilicus narrow, each whorl embraces nearly half of the preceding one.

Rounded, plain venter. Umbilical wall is steep and high and the umbilical shoulder is defined.

Ornamentation consists of straight ribs that arise at the umbilical shoulder becoming progressively sharper and thicker to mid-flank and then fading at the ventro-lateral shoulder.
DISCUSSION: This species is abundant in the Tyaughton Creek and the Takeso Lakes areas (Frebold, 1967), where it occurs with other species such as *Paracaloceras rursicostatum* and *Paracaloceras coregonense*, which also occur in the present study area. In the Queen Charlotte Islands, it occurs with *Vermiceras (Paracaloceras) coregonense* and *Metaphioceras rursicostatum* (Palfy, 1991).

OCCURRENCE AND AGE: This species has been reported from Peru (Prinz, 1985), Chile (Hillebrandt, 1981a; Quinzio Sinn, 1987), Argentina (Riccardi *et al.*, 1989), and northeast Siberia (Repin, 1977). It is characteristic of the Canadensis Zone in North America and found only in the allochthonous terranes.

Localities 11 and 12, east of Atkins Glacier (Jack formation). Canadensis Zone - Late Hettangian to Early Sinemurian.

Genus *Alsatites* HAUG 1894

TYPE SPECIES: *Ammonites liasicus* d'ORBIGNY 1884.

SYNONYMS: *Gonioptychoceras* LANGE 1941; *Proarietites* LANGE 1922

REMARKS: Extremely evolute shell with a broad venter and blunt, dense primary ribbing. Smooth venter on the inner whorls, becoming carinate on the outer whorl. *Alsatites* has no ventral sulci flanking the keel, which separates it from other bisulcate genera in the Family Arietidae. This genus is known from the Liasicus Zone in northwest Europe (Dean *et al.*, 1961) and in North America it has been reported in the Sinemurian strata (Palfy, 1991).
Alsatites? cf. proaries? (NEUMAYR)
Pl. VI, Fig. 1

cf.? 1991 Alsatites cf. proaries (NEUMAYR) Palfy, pl. 16, fig. 5.

MATERIAL: One fairly large specimen preserved as an internal and external mould in sandstone.

DESCRIPTION: Evolute, ellipsoidal shell with many whorls. Ornamentation consist of simple ribs that are dense and fine on the inner whorls becoming coarser and blunter on the outer whorl. Flanks are convex. No keel observed due to the state of preservation.

DISCUSSION: The specimen resembles to Paltechioceras which is found in the Upper Sinemurian. The Iskut specimens in found in association with Paracaloceras rursicostatum which is restricted to the Upper Hettangian to Lower Sinemurian Canadensis Zone.

OCCURRENCE AND AGE: Locality 10, south of Atkins Glacier (Jack formation). Canadensis Zone - Late Hettangian to Early Sinemurian.

Genus Canavarites HYATT 1900

TYPE SPECIES: Ammonites discretus SOWERBY in Delabeche, 1831

REMARKS: Involute form with wide ellipsoidal whorl section. A small keel is present at the early stage of development and becomes blunt on the outer whorls. Ornamentation consist of strong, simple, radial ribs on the whorl sides which are slightly prorsiradiate. Ribs about 20-25 per whorl. Canavarites ranges from Upper Hettangian to Lower Sinemurian (Donovan et al., 1981) and has been
reported from the Canadensis Zone at the Taseko Lakes area in western Canada (Tipper, pers. comm., 1992).

Canavarites sp. indet.
Pl. VIII, Figs. 4 and 5

MATERIAL: Three internal mould fragments.

DESCRIPTION: Wide ellipsoidal whorl section. Venter has a very blunt keel, bordered by ventral sulci. Umbilical shoulder is vertical. Ribbing is simple, straight, and radial beginning at the umbilical shoulder and trending rectiradiately up the flanks and fading as it approaches the ventral sulci.

DISCUSSION: Generic assignment is based on the wide ellipsoidal whorl shape and the ornamentation. More specimens are required for a specific identification.

OCCURRENCE AND AGE: Locality 11, east of Atkins Glacier (Jack formation). Canadensis Zone - Late Hettangian to Early Sinemurian.

Family ARIETIDAE HYATT 1875
Subfamily ARIETITINAE HYATT 1875
Genus Paracaloceras SPATH 1923b

TYPE SPECIES: Ammonites coregonense (Sowerby, 1831)

REMARKS: Evolute form with a ellipsoidal whorl section increasing in height and wide umbilicate. Venter carinate-bisulcate that developed during ontogeny. Ornamentation consists of either simple,
strong, straight, fine rursiradiate ribs or simple prorsiradiate ribs.

Donovan and Forsey (1973) included *Paracaloceras* as a subgenus of *Vermiceras*. The main difference between *Paracaloceras* and *Vermiceras* is that the latter possess only a shallow keel flanked by faint if any sulci whereas the former develops a more strongly carinate-sulcate venter.

**AGE AND DISTRIBUTION**: This genus, descended from *Alsaites* includes a wide range of Late Hettangian to Early Sinemurian species (Taylor, 1990) and occurs in the Canadensis Zone of Nevada (Taylor, 1990) and the Taseko Lakes area (Frebold, 1967). The genus is also characteristic of the Mediterranean Province in Europe (Wahner, 1886, 1888), Himalayas, and Timor (Guex and Taylor, 1976).

*Paracaloceras* cf. *rursicostatum* FREBOLD 1967

Pl. V, Fig. 3

v cf. 1967 *Paracaloceras* cf. *rursicostatum* FREBOLD, p. 26, pl. 7, figs. 1a-c, 2a; pl. 9, fig. 1.


cf. 1989 *Vermiceras (P.*)* cf. *rursicostatum* FREBOLD, Riccardi et al., pl. 2, fig. 6.

?cf. 1991 *Metophioceras (P.*)* cf. *rursicostatum* FREBOLD, Palfy, p. 115-116 pl. 7, fig. 1

**MATERIAL**: 1 partially preserved specimen in a buff coloured sandstone.

**DESCRIPTION**: Evolute form with a wide umbilicus. Flanks convex. Ribs are strong, widely spaced, more or less concave with a rursiradiate trend.

**DISCUSSION**: In the holotype, the last preserved whorl has a rectangular cross-section. The preceeding whorl is quadrate with slightly convex flanks and a fairly high, median keel, with deep furrows and a keel at the ventro-lateral border. This species is very similar to *P. coregonense*
(Sowerby) except for the rursiraditate ribbing. Assignment to the species is primarily based on the ribbing pattern.

**OCCURRENCE AND AGE:** This species occurs in the Canadensis Zone in British Columbia (Frebold, 1967), Argentina (Riccardi et al., 1989), and Alaska, (Imlay, 1981). In Nevada, the species ranges higher than the range of *Badouxia canadensis* (Taylor, 1990)

Locality 10, east of Atkins glacier (Jack formation). Canadensis Zone - Late Hettangian - Early Sinemurian.

*Paracaloceras cf. multicostatum* FREBOLD 1967
Pl. V, Fig. 1

v cf. 1967 *Paracaloceras multicostatum* FREBOLD p. 25-26, pl. 7, figs. 8a-b; pl. 8, fig. 5

**MATERIAL:** One specimen in buff coloured sandstone.

**MEASUREMENTS:**

<table>
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<th>UD</th>
<th>U</th>
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<td>58.6</td>
<td>19.6</td>
<td>-</td>
<td>-</td>
<td>33</td>
</tr>
</tbody>
</table>

**DESCRIPTION:** Evolute form with a wide umbilicus. Flanks slightly convex and ornamentation consists of numerous simple ribs that trend prorsiradiately on the outer part of the flanks.

**DISCUSSION:** The specimen has close resemblance to *Paracaloceras cf. coregonense* but differs by having more numerous and finer ribs. Holotype = 57 ribs on the last whorl.
**OCCURRENCE AND AGE:** This species is described from the Canadensis Zone of the Taseko Lakes area (Frebold, 1967).

Locality 14, east of Eskay Creek (Unuk River Formation). Canadensis Zone - Late Hettangian to Early Sinemurian.

*Paracaloceras cf. coregonense*? (Sowerby)

Pl. V, Fig. 2

- **MATERIAL:** One small specimen preserved as an external mould in a buff coloured sandstone.

- **DESCRIPTION:** Evolute form with many whorls. Flanks convex. Ribbing is rectiradiate and rounded with prominent ribs on the inner whorls which may be blunt on the outer whorl.

**OCCURRENCE AND AGE:** *Paracaloceras coregonense* is recorded from the Marmoreum Zone in the Mediterranean Province of Europe. It also occurs in the Himalayas (Diener, 1908) and Timor (Rothpletz, 1892; Krumbeck, 1923). In British Columbia the species is found in the Canadensis Zone of the Taseko Lakes area (Frebold, 1967).

Locality 13, east of Atkins Glacier (Jack formation). Canadensis Zone - Late Hettangian to Early Sinemurian.
Paracaloceras sp. indet.
Pl. V, Fig. 4

MATERIAL: One fairly large fragment preserved as an internal mould in buff coloured sandstone.

DESCRIPTION: Midvolute form with whorl section increasing in height. Venter probably bisulcate with a keel but preservation is too poor to confirm the presence of a keel. Ribs rectiradiate on the inner whorls but have a prosradiate trend on the outer whorl.

DISCUSSION: The specimen resembles P. cf. grunowi figured by Taylor (1990; pl. 1. figs. 1,2; pl. 2, fig. 1) from the Canadensis Zone in Nevada. Better preserved specimens are required to confirm the specific identification.

OCCURRENCE AND AGE: Locality 14, east of Eskay Creek (Unuk River Formation). Canadensis Zone - Late Hettangian to Early Sinemurian.

Superfamily EODEROCERATACEAE SPATH 1929
Family AMALTHEIDAE HYATT 1867
Genus Amaltheus DE MONTFORT 1808

TYPE SPECIES: Amaltheus margaritatus DE MONTFORT 1808

SYNONYMS: Nordamaltheus REPIN 1968; Proamaltheus LANGE 1932; A. (Pseudoamaltheus) FREBOLD 1922; A. (Amaltheus) DE MONTFORT 1808

REMARKS: Oxycones with moderately open umbilicus and serrated keel. Ornamentation consists of
gently sigmoidal or strigate ribbing, lateral tubercles on some, and a rostrate aperture.

**AGE AND DISTRIBUTION**: Upper Pliensbachian Margaritatus - Spinatum Zone. The genus is restricted to the Boreal and mix-faunal province. It is widely reported from western and Arctic Canada (Frebold, 1964, 1966, 1969, 1970, 1975; Frebold and Tipper, 1967; Smith and Tipper, 1986).

*Amaltheus cf. stokesi (J. Sowerby) 1818*  
Pl. IX, Fig. 13

- 1818 *Ammonites stokesi* J. Sowerby p. 205, pl. 191.  
- 1958a *Amaltheus stokesi* (J. Sowerby) Howarth p. 3, pl. 1, figs. 5-7, 12-14, pl. 2, figs. 1, 3, 10, Textfigs. 4-5.  
- 1964a *Amaltheus stokesi* (J. Sowerby) Frebold p. 9, pl. 2, figs. 2-6.  
- 1964b *Amaltheus stokesi* (J. Sowerby) Frebold pl. 6, figs. 6, 7, 13.  
- 1975 *Amaltheus stokesi* (J. Sowerby) Frebold, p. 10, pl. 4, figs. 3-4.  
- cf. 1988 *Amaltheus stokesi* (J. Sowerby) Smith et al., pl. 4, figs. 15-16.  

**MATERIAL**: Two fragments preserved as external moulds in black shale.

**DESCRIPTION**: Involute form with an oxycone whorl section. Ribs are strong, slightly sigmoidal, and curve forward rather strongly on the flanks, where they bifurcate or trifurcate and then merge with chevrons on the venter.

**OCCURRENCE AND AGE**: This species is associated with *Ammonites bifurcus* in Loney Creek, British Columbia, and with *Arietoceras algovianum* and *Leptaleoceras accuratum* (a synonym of *L. pseudoradians*) in northwestern British Columbia and in southern Yukon (Frebold et al., 1967). Rare
occurrences are in the Queen Charlotte Islands and southern Alaska (Smith et al., 1988).

Locality 18, east of Lyons Creek (Betty Creek Formation). Kunaue Zone - Late Pliensbachian.

Superfamily EODERO CERATACEAE SPATH 1929

Family DACTYLO CERATIDAE HYATT 1867

Genus Dactylioceras HYATT 1867

TYPE SPECIES: Ammonites communis SOWERBY 1815.

SYNONYMS: Arcidactylites BUCKMAN 1926; Microdactylites BUCKMAN 1926; Anguidactylites BUCKMAN 1926; Leptodactylites BUCKMAN 1926; Peridactylites BUCKMAN 1926; Toxodactylites BUCKMAN 1926; Vermidactylites BUCKMAN 1926; Xeino dactylites BUCKMAN 1926; Orthodactylites BUCKMAN 1926; Athlodactylites BUCKMAN 1927; Curvidactylites BUCKMAN 1927; Koinodactylites BUCKMAN 1927; Nomodactylites BUCKMAN 1927; Parvidactylites BUCKMAN 1927; Simplidactylites BUCKMAN 1927; Rakusites GUEX 1971; Eodactylites SCHMIDT-EFFING 1972

REMARKS: Evolute form with a planulate whorl section. Ribs simple to bifurcating which pass across venter straight or with a gentle forward inclination.

AGE AND DISTRIBUTION: Found world-wide in the Lower to Middle Toarcian. In Europe the genus occurs in the Tenuicostatum - Bifron zones and may range down into the Upper Pliensbachian Spinatum Zone (Donovan et al., 1981). In western Canada, it is found in the Fernie area (Frebold, 1976; Hall, 1987), the Queen Charlotte Islands (Cameron and Tipper, 1985), and the Spatsizi map area (Taylor et al., 1984; Thomson and Smith, 1992).
**Dactylioceras cf. helianthoides** YOKOYAMA 1904

Pl. X, Figs. 12 and 13

cf. 1904  *Dactylioceras helianthoides* YOKOYAMA p. 16-17, pl. 4, fig. 4-6.
cf. 1956  *Dactylioceras helianthoides* YOKOYAMA Arkell, pp. 421-422.
cf. 1964b *Dactylioceras* sp. Frebold p. 11, pl. 5, figs. 7-8.

**MATERIAL**: Three specimens preserved as internal and external moulds in black shale.

**DESCRIPTION**: Fairly evolute form with an elliptical whorl section. Ornamentation consists of primary, secondary, intercalatory ribs, and tubercles. Primary ribs are fine, straight and arise from the umbilical seam and proceed radially. A row of tubercles occurs on the ventro-lateral shoulder from which secondary ribs arise, or one third the flank height. Low expansion rate. Whorls enlarge slowly.

**DISCUSSION**: The species is similar to *D. gracile* (Simpson) from southern France, *D. acanthus* (Buckman) (Imlay, 1968; p. C30), and *D. aff. semicelatum* (Simpson) (Frebold *et al.*, 1967; p. 17) but differs in terms of ribs density, longer intercalotary ribs, prominent tubercles. (Hirano, 1961).

**OCCURRENCE AND AGE**: The species is described from *D. heliothoides* Zone of the Jurassic Toyora Group of Japan which spans the Falcifer/Bifrons zones of northwest Europe.

Locality 26, south of Tim Williams glacier. Assemblage zones 2-3 - Early Toarcian.

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**Dactylioceras cf. athleticum** (SIMPSON 1855)

Pl. X, Fig. 10 and 15

cf. 1976  *Dactylioceras athleticum* (SIMPSON) Schlegelmilch p. 74, pl. 39, fig. 1.
MATERIAL: Three specimens preserved as moulds in black shale.

DESCRIPTION: Shell evolute and slowly expanding with an elliptical whorl section. Ribs, which are evenly spaced are fine, straight and give rise to weaker secondary ribs at the ventro-lateral shoulder. The secondaries cross the venter with a moderately strong adoral arch and are separated by intercalatory ribs.

DISCUSSION: The specimens also show a close resemblance to *D. commune* but the latter has a more quadrate whorls with less dense and more rectiradiate ribbing.

OCCURRENCE AND AGE: This species has been reported from northwest Germany where it is restricted to the Middle Toarcian Bifrons Zone (Weitschat, 1973). In the southern Canadian Rocky Mountain, the species occurs in beds assigned to the Lower Toarcian Falciferum Zone by Hall (1987).

Locality 26, south of Tim Williams glaciers. Assemblage zones 2-3 - Early Toarcian.

*Dactylioceras* sp. indet.
Pl. X, Fig. 7, 8, 9, and 14

MATERIAL: Fourteen specimens preserved as moulds in shale.

DESCRIPTION: Evolute shell with elliptical whorl section. Ornamentation consist of numerous, fine, evenly spaced ribs.

DISCUSSION: The specimens are small (*D* ≈10-25mm) and some are distorted making identification to species level difficult.
OCCURRENCE AND AGE: Locality 26, south of Tim Williams glacier. Assemblage zones 2-3 - Early Toarcian.

Superfamily HILDOCERATACEAE HYATT 1867
Family HILDOCERATIDAE HYATT 1867
Genus Fuciniceras HAAS 1913

TYPE SPECIES: Harpoceras lavinianum MENEGHINI in Fucini, 1900.


REMARKS: Similar to Protogrammoceras but ribs trend rursiradiately on the upper flank and do not project onto the venter.

AGE AND DISTRIBUTION: Fuciniceras is a Tethyan form and ranges from the Ibex to Margaritatus zones (Wiedenmayer, 1980). The genus is common in the Upper Pliensbachian but not abundantly found.

Fuciniceras sp. indet.

MATERIAL: Two fragments preserved as external moulds in black shale.

DESCRIPTION: Evolute shell with a flat-sided whorl section. Ornamentation consists of rectiradiate ribs on the lower third of the flank and rursiradiate ribs on the upper two thirds.
DISCUSSION: The specimens are assigned to *Fuciniceras* based on ornamentation. Although poor preservation does not allow a specific identification, the specimens are comparable to type material from the Spatsizi map area (Thomson and Smith, 1992).

OCCURRENCE AND AGE: Locality 18, east of Lyons Creek (Betty Creek formation). Kunae Zone - Late Pliensbachian.

Genus *Lioceratoides* Spath 1919


SYNONYMS: *Neolioceratoides* Cantuluppi 1970; *Nagaticeras* Matsumoto 1947; *Praelioceras* Fucini 1929; *Platyharpites* Buckman 1927

REMARKS: Midvolute to involute shell with an ellipsoidal to ogival whorl section. The venter has a narrow keel, flanked by two narrow flat zones that incline towards, and are separated from the flanks by an obtuse ventral shoulder. Flanks are convex, umbilical edge is rounded, and the umbilical slope ranges from gentle to moderately steep.

Ornamentation consists of a moderately sinuous ribbing which appears on the inner whorls at a diameter of approximately 5mm changing to a strongly projected, falciform ribbing on the outer whorls. The ribs arise just above the umbilical seam, trend prorsiradially to about two-thirds of the whorl height, and then fade along the ventral shoulder.

AGE AND DISTRIBUTION: *Lioceratoides* is characteristic of the Tethyan Realm and is found in the Iberian Peninsula, Morocco, Italy, Japan, and the Western Cordillera of North America. It is most
commonly found in the Upper Pliensbachian (Margaritatus Zone - Spinatum Zone) but in the Mediterranean region and in North America it ranges from the Domerian to the basal Toarcian.

*Lioceratoides?* sp. indet.
Pl. X, Fig. 2

**MATERIAL**: One poorly preserved external mould in calcareous shale.

**MEASUREMENTS**:

<table>
<thead>
<tr>
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<th>D</th>
<th>UD</th>
<th>U</th>
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</table>

**DESCRIPTION**: Shell midvolute with moderate expansion. The venter is keeled, the umbilical slope is gentle, and the flanks convex. Ornamentation consist of falcoid ribs of moderate density that arise at about two fifth the height of flank, gently bend adapically, then swing foreword and project adorally a short distance before fading completely just below the ventral shoulder.

**OCCURRENCE AND AGE**: Locality 23, along Eskay Creek (Betty Creek Formation). Probably Late Pliensbachian (Carlottense Zone).

**Genus Protogrammoceras** SPATH 1913

**TYPE SPECIES**: *Grammoceras bassanii* FUCINI 1900; SD Spath, 1919.

**SYNONYMS**: *Paltarpites* BUCKMAN 1922; *Argutarpites* BUCKMAN 1923; *Bassaniceras* FUCINI 1923; *Eoprotogrammoceras* CANTALUPPI 1970; *Neoprotogrammoceras* CANTALUPPI 1970
REMARKS: Midvolute to involute shell with compressed shell. Umbilical wall low and may be steep to shallow. Ornamentation consists of falcoid ribs that project strongly onto the carinate venter. Similar to *Fuciniceras* which differs by having less strongly projected ribs than *Protogrammoceras*.

AGE AND DISTRIBUTION: *Protogrammoceras* is abundant in the Tethyan region and common in other parts of the world (e.g. Europe, North Africa, Madagascar, Somalia, Arabia, Pakistan, Japan, Siberia, and western North America (Howarth, 1973; 1992). It ranges in age from the Early Pliensbachian (Jameson Zone) to Early Toarcian (Tenuicostatum Zone) in Europe (Donovan *et al.*, 1981).

*cf. 1922* *Paltarpites paltum* BUCKMAN p. 362a, b.
*1934 Polypectus kurrianus* OPPEL Monestier p. 90, pl. 5, fig. 23.
*1964 Harpoceras* cf. *H. exaratum* (YOUNG and BIRD) Frebold p. 16, pl. 6, figs. 1-5.
*1970 Paltarpites paltus* BUCKMAN Frebold p. 443, pl. 14, figs. 5-7.
*1971a Paltarpites paltus* BUCKMAN Hirano p. 115, pl. 19, figs. 7-8.
*1977 Paltarpites paltus* (BUCKMAN) Wiedenmayer p. 94, pl. 17, fig. 10.
cf. *1983 Protogrammoceras paltum* (BUCKMAN) Hall and Howarth p. 1470, figs. 3a-d.
*1992 Protogrammoceras kurrianum* (Oppel), Howarth, p. 60-61, pl. 3, figs. 3-4.

MATERIAL: Two specimens preserved in black shale. One specimen is preserved as both internal and external moulds.
MEASUREMENTS:

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DESCRIPTION: Moderately involute and compressed shell with an ogival whorl section. Umbilical wall moderately steep and umbilical edge convex. Flanks are convex. Venter inflated with a high keel and rounded ventral shoulders. Ornamentation consists of dense, falcoid, and flat-topped ribs that are strongly projected along the venter.

DISCUSSION: The species is different than *Protogrammoceras paltum* by having a more finely ribbed, evenly rounded whorl section and a more gently falcoid ribs.

OCCURRENCE AND AGE: This species ranges from the Upper Margaritatus to the Spinatum zones. It has been reported from England, France, Germany, Switzerland, Italy, western Canada, and Oregan (Howarth, 1992).

Locality 23, along Eskay Creek (Betty Creek Formation). Carlottense Zone - Late Pliensbachian.

*Protogrammoceras cf. nipponicum* (MATSUMOTO) 1947
Pl. IX, Fig. 14

? 1947 *Protogrammoceras nipponicum* (MATSUMOTO) Matsumoto and Ono p. 27, pl. 2, fig. 3.
cf. 1971a *Protogrammoceras nipponicum* (MATSUMOTO) Hirano p. 122-125, pl.18, figs. 1-5.
MATERIAL: One well preserved specimen in black shale.

MEASUREMENTS:

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DESCRIPTION: Involute and compressed shell with a carinate venter. Ribbing falcoid, fine, and moderate in width. Ribs begin at the umbilical wall, trend rursiradiately to one third of the flank height and then project prorsiradiately to the ventral shoulder, fading near the keel.

DISCUSSION: This form is similar to *P. isseli* and *P. inseparabilis* except that it possess more falcoid ribs (Hirano, 1971a). It also resembles *P. celebratum* but has a stronger keel and striae.

OCCURRENCE AND AGE: Known from the Protogrammoceras nipponicum Zone from the Toyora Group in Japan (Hirano, 1971a) which ranges from Upper Pliensbachian to Lower Toarcian. The species occurs in the Upper Pliensbachian in northeastern Oregon (Imlay, 1968; Smith, 1981).

Locality 18, east of Lyons Creek (Betty Creek Formation). Kunae Zone - Late Pliensbachian.

Protogrammoceras spp.

MATERIAL: Six poorly preserved imprints in calcareous shale.

DESCRIPTION: Fairly involute and compressed shell with probably an ellipsoidal whorl section. Flanks are slightly convex and ventrolateral shoulder is rounded. Ribs are fine, dense, flat topped, falcoid, bend at two-thirds of the flank, and are strongly projected along the venter.
DISCUSSION: These poorly preserved specimens may contain representatives of Protogrammoceras kurrianum which is found at the same locality. Preservation is too poor however, to confidently identify them.

OCCURRENCE AND AGE: Locality 23, along Eskay Creek (Betty Creek Formation). Carlottense Zone - Late Pliensbachian.

Genus Pseudolioceras BUCKMAN 1889

TYPE SPECIES: Ammonites compactilis SIMPSON in Buckman, 1889.

SYNONYMS: ?Buckmanites GUÉX 1973; Tugurites KALACHEVA and SEY 1970; Osperleioceras KRMHOLZ 1963; Pseudowalkericeras MAUBEUGE 1949; Praehaploceras MONESTIER 1931

REMARKS: A homeomorph of Leioceras but differs by having a hollow keel instead of a solid keel and smoother aptchi.

AGE AND DISTRIBUTION: Pseudolioceras occurs worldwide and ranges from the Middle Toarcian Bifrons Zone to the Early Bajocian Laeviuscula Zone. It is abundant in the Toarcian and the Aalenian of Europe, the former USSR, and northern Canada (Poulton and Tipper, 1991).

Pseudolioceras sp. indet.
Pl. XI, Fig. 8 and 9, P. XII, Fig. 6

MATERIAL: Seven imprints in black-grey shale.
DESCRIPTION: Moderately involute, compressed shell with a sharp, carinate venter. Ornamentation consists of fine, undivided falcoid ribs which are prominent on the upper part of the flanks and fade on the lower part.

DISCUSSION: The specimens resemble *Pseudolioceras mclintocki* from Arctic Canada and Arctic Alaska (Frebold, 1964b, pl. 10, figs. 4-8, 12; Imlay, 1976, pl.1, figs. 1-5, 7). However, they have smaller umbilicus and sparser, weaker ribbing but due to poor preservation, the specific assignment is uncertain.


Genus *Tiltoniceras* BUCKMAN 1913

TYPE SPECIES: *Tiltoniceras costatum* BUCKMAN 1913 (=*T. antiquum*, Wright, 1882).

SYNONYMS: *Pacificeras* REPIN 1970.

REMARKS: Involute, compressed shell bearing a sharp keel on the venter. Umbilical edge is sharp and the umbilical wall is rounded. Ornamentation consist of gently falcate ribbing that is slightly blunt and strongly projected onto the venter. On some species the ribbing is faint and varies with strength to flexous lirae projecting on the venter.

AGE AND DISTRIBUTION: This genus occurs in the Upper Pliensbachian Spinatum Zone to Lower Toarcian Tenuicostatum Zone. It is found in England, northwest Germany, France, Bulgaria(?),
western Canada, and northeast Siberia (Whiteaves, 1884; Dean et al., 1961, Fischer, 1975; Smith et al., 1988; Howarth, 1992).

*Tiltoniceras cf. propinquum* (WHITEAVES 1884)  
Pl. X, Fig. 3

<table>
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<td>1884</td>
<td><em>Schloenbachia propinqua</em> WHITEAVES p. 274, pl. 33, fig. 2a.</td>
</tr>
<tr>
<td>1930</td>
<td><em>Harpoceras propinquum</em> (WHITEAVES) McLearn p. 4.</td>
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<tr>
<td>1932</td>
<td><em>H. propinquum</em> (WHITEAVES) McLearn p. 66, pl. 6, figs. 1-4; pl. 7, fig. 3.</td>
</tr>
<tr>
<td>1944</td>
<td><em>H. propinquum</em> (WHITEAVES) Shimer and Shrock, pl. 240, figs. 13-14.</td>
</tr>
<tr>
<td>1964b</td>
<td><em>H. propinquum</em> (WHITEAVES) Frebold, pl. 8, figs. 4-5, 7</td>
</tr>
<tr>
<td>1988</td>
<td><em>Tiltoniceras propinquum</em> (WHITEAVES) Smith et al., pl. 5, figs. 1-4.</td>
</tr>
<tr>
<td>1992</td>
<td><em>Tiltoniceras propinquum</em> (WHITEAVES) Thomson and Smith p. 39, pl. 15, figs. 4-9.</td>
</tr>
</tbody>
</table>

**MATERIAL**: Two specimens preserved in carbonate concretions.

**DESCRIPTION**: Involute, compressed and ellipsoidal shell with a sharp carinate venter. No ornamentation is observed on the larger specimen. On the smaller specimen, ornamentation consists of very faint, falcoid ribs that become flexuous lirae toward the venter.

**DISCUSSION**: Assignment to this genus is based on the sharp keel, generally smooth shell, and faint falcoid ribbing on the small specimen. The specimens resemble *T. propinquum* from the Spatsizi map area (Thomson and Smith, 1992), where it occurs with *Protogrammoceras* spp. and *Fanninoceras*. In the Iskut River map area, *Protogrammoceras* spp. and *Protogrammoceras* cf. *kurianum* have been found stratigraphically above *T. cf. propinquum* but *Fanninoceras* has not been found.

**OCCURRENCE AND AGE**: This species is abundant at the type locality in the Queen Charlotte Islands and elsewhere in British Columbia (Smith et al., 1988; Thomson and Smith, 1992). In North America the species ranges from the Upper Pliensbachian to the Lower Toarcian. In Russia it occurs
only in the Toarcian (Dagis, 1974).

Locality 21, along the headwaters of Eskay Creek (Betty Creek Formation). Kunae Zone - Late Pliensbachian.

Subfamily ARIETICERATINAE HOWARTH 1955

Genus Arieticeras Oppel 1862

TYPE SPECIES: Ammonites algovianus Oppel 1862.


REMARKS: Evolute shell with an elliptical to quadrate whorl section. Venter carinate, flanked by flat zones or shallow sulci. Ribs strong, simple, straight to moderately sinuous with dense to distant spacing. On the adult specimens, the ribbing fades and becomes striae on the outer whorl. It is associated with Protogrammoceras, Fontanelliceras and Leptaleoceras but rarely associated with Amaltheus (Imlay, 1984). Arieticeras closely resembles Leptaleoceras and Oregonites (Wiedenmayer, 1980). Arieticeras differs from Leptaleoceras by having coarser and sparser ribs and a sulcate venter. Oregonites has very irregular, often paired ribs and a generally wide ellipsoidal whorl section.

AGE AND DISTRIBUTION: Arieticeras is a Tethyan form, common in southern Europe and northern Africa. Arieticeras is also found in South America (Hillebrandt, 1981b), in the Tulsequah area (Frebold, 1969) and the Spatsizi map area (Thomson and Smith, 1992) of northwestern British Columbia; in the Whitehorse area of the southern Yukon (Frebold, 1964, 1970; Frebold and Tipper,
1970), in the Talkeetna Mountains of southern Alaska (Imlay, 1981), and in the western United States (Imlay, 1968; Smith, 1981). It is characteristic of the Domerian and most abundant in the Algovenian Zone of the Tethyan region (= to Margaritatus Zone of the northwest European Province) (Wiedenmayer, 1980; Braga, 1983).

*Arieticeras* cf. *algovianum* (OPPEL 1862)
Pl. IX, Figs. 3, 9, 10, and 15

**MATERIAL** : Fourteen specimens preserved as external and internal mould fragments in black shale.

**DESCRIPTION** : Evolute shell with an oval to rectangular whorl section. Flanks convex. Venter has a high sharp keel bordered by shallow furrows. Ribs are more or less rursiradiate to slightly sigmoidal.

**DISCUSSION** : This species is very similar to *A. ruthenense* and *A. domarense* which are closely related species but they have denser ribs than *A. algovianum*. *A. algovianum* is associated with *Amaltheus stokesi* in northern British Columbia and the Yukon (Smith *et al.*, 1988, Thomson and Smith, 1992).

**OCCURRENCE AND AGE** : This species is common in the Upper Pliensbachian of Tethys. It has

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**1862** *Ammonites algovianus* OPPEL p. 137

**1927** *Arieticeras algovianum* (OPPEL) Schroeder p. 35, pl. 9, figs. 6-7.

**1964a** *Arieticeras algovianum* (OPPEL) Frebold p. 13, pl. 3, figs. 4-5; pl. 4, fig. 2.

**1964b** *Arieticeras* cf. *A. algovianum* (OPPEL) Frebold p. 13, pl. 3, fig. 3; pl. 5, fig. 3, *non* fig. 2.


been reported from Morocco, Spain, southern France, Italy, Switzerland, and southern Germany. In North America, it occurs in western United States, British Columbia, and southern Yukon, where it is found associated with *Leptaleoceras* and *Fanninoceras* (Smith et al., 1988).

Localities 19 and 20, north of John Peaks and locality 18, east of Lyons Creek (Betty Creek Formation). Kunae Zone - Late Pliensbachian.

* Arieticeras sp. indet.  
  Pl. IX, Figs. 1, 3, 5, and 8

**MATERIAL**: Forty six specimens preserved as external and internal mould fragments in black shale.

**DESCRIPTION**: Venter with low keel bordered by shallow furrows. Ornamentation consists of low, moderately spaced ribs that trend slightly rursiradiately on the flanks and then fade along the ventral shoulder.

**OCCURRENCE AND AGE**: Found at localities 20, north of John Peaks and at localities 18 and 19, east of Lyons Creek (Betty Creek Formation). Kunae Zone - Late Pliensbachian.

**Genus Leptaleoceras** Buckman 1918

**TYPE SPECIES**: *Leptaleoceras leptum* Buckman 1918

**SYNONYMS**: *Sequentia* Fucini 1931; *Trinacrioceras* Fucini 1931; *Ugdulenia* Cantuluppi 1970

**REMARKS**: Evolute, compressed shell with elliptical whorl section. Venter narrow and strongly
carinate. Keel flanked by narrow flat zones that become sulcate on the body chamber of some species. Flanks convex, ventrolateral shoulder rounded. Ribs are dense, sinuous (obscure, gently flexuous) and arise at or just above the umbilical shoulder and trend more or less rectiradiately on the flanks, then fade out at the ventrolateral shoulder where they project slightly. Innermost whorls up to 10mm, are smooth. It differs from *Arieticeras* by its greater rib density and the non-sulcate venter observed on all but the body chamber of some species of *Leptaleoceras* (e.g. *L. accuratum* and *L. insigne*) (Thomson and Smith, 1992).

**AGE AND DISTRIBUTION** : This genus is a Tethyan form and occurs in the Upper Pliensbachian.

It is commonly associated with *Arieticeras algovianum* and in western North America is associated with *Arieticeras* and *Fanninoceras* (Smith *et al.*, 1988).

*Leptaleoceras* cf. *accuratum*? (FUCINI, 1931)
Pl. IX, Fig. 4

1931 *Arieticeras* (?) *accuratum* FUCINI p. 107, pl. 8, fig. 10.
cf. 1964a *Leptaleoceras pseudoradians* (REYNES) Frebold p. 15, pl. 4, *non* pl. 5, figs. 4-5.
1981 *Arieticeras* cf. *A. domarense* (MENEGHINI) Imlay p. 39, pl. 10, fig. 15; *non* figs. 1-2, 6-14, 22.
cf. 1983 *Leptaleoceras accuratum* (FUCINI) Braga p. 256, pl. 11, figs. 27-29; pl. 12, figs. 1-10.
cf. 1988 *Leptaleoceras aff. accuratum* (FUCINI) Smith *et al.* pl. 4, fig. 9.

**MATERIAL** : Three specimens preserved as internal and external moulds in shale.
DESCRIPTION: Evolute, compressed shell with an ogival whorl section. Umbilical wall gentle and umbilical shoulder rounded. Flanks convex with a rounded ventro-lateral shoulder rounded. Venter carinate bordered on both sides by fairly large shallow furrows. Ornamentation consists of sigmoidal ribs that are numerous, undivided with a rursiradiate trend on the ventro-lateral shoulder.

DISCUSSION: The specimens compare well with the type material from the Spatsizi map area (Thomson and Smith, 1992), especially the rib density. In northwest Canada they are found associated with *Arietice ras algovianum* and *Amaltheus stokesi*.

OCCURRENCE AND AGE: In North America, the species is found in the Spatsizi map area (Thomson and Smith, 1992), southern Yukon (Frebold, 1964a), southern Alaska (Imlay, 1981). In Europe it is found in Tethyan sediments within the range of *A. algovianum* (Wiedenmayer, 1977; Braga, 1983).

Locality 20, north of John Peaks (Betty Creek Formation). Kunae Zone - Late Pliensbachian.

*Leptaleoceras* sp. indet.
Pl. IX, Fig. 7

MATERIAL: Thirty nine specimens preserved as fragmental external and internal mould fragments in shale.

DESCRIPTION: Evolute, compressed shell with probably an ellipsoidal whorl section. Venter carinate bordered on both sides by fairly large shallow furrows. Ornamentation consists of sigmoidal ribs that are numerous and undivided.
DISCUSSION: Generic assignment is based on the rib density. The specimens may well belong to the species *L. cf. accuratum*, found in the same collection.

OCCURRENCE AND AGE: Localities 20, north of John Peaks and 18, east of Lyons Creek (Betty Creek Formation). Kunae Zone - Late Pliensbachian.

Subfamily GRAMMOCERATINAE BUCKMAN 1905

Genus *Pleydellia* BUCKMAN 1899

**TYPE SPECIES**: *Pleydellia comata* BUCKMAN 1899

**SYNONYMS**: *Cotteswoldia* BUCKMAN 1902 (= *Gotteswaldia* THEOBALD 1950); *Canavaria* BUCKMAN 1902 (non GEMELELLARO 1886) (= *Canavarina* BUCKMAN 1902); *Walkeria* BUCKMAN 1902 (= *Walkericeras* BUCKMAN 1913)

REMARKS: Involute to evolute shell. Whorls tall and compressed and whorl section lanceolate to oxycone. Umbilical shoulder moderately rounded to abrupt. Venter carinate and some specimens have weak ventro-lateral shoulders. Ribs prorsiradiately on the upper flank to the venter and is sinuous and some fade away on the inner or outer half of the whorl sides.

**AGE AND DISTRIBUTION**: Found worldwide in the uppermost Upper Toarcian (Jakobs, 1992).

*Pleydellia cf. maudensis* JAKOBS 1992
Pl. X, Fig. 6 and 16

1981 *Haugia cf. compressa* BUCKMAN Imlay p. 43, pl. 12, figs. 3, 7, 9.
1981 *Haugia cf. grandis* BUCKMAN Imlay p. 42, pl. 12, figs. 4, 10, 15.
1981 *Brodieia cf. B. tenuicostate var. nodosa* JAWORSKI Imlay p., 42, pl. 2, fig. 8
1991  *Phlysoogrammoceras (?)* sp. Tipper et al. pl. 7, fig. 3.

v cf. 1992 *Pleydellia maudensis* Jakobs p. 276-277, pl. 18, fig. 1, pl. 20, fig. 1; pl. 22, figs. 1-3.

**MATERIAL**: Seven specimens preserved as external and internal mould fragments in grey shale.

**DESCRIPTION**: Involute shell and compressed whorl section. Venter carinate. Umbilical shoulder rounded. Ribs curve forward to meet the venter and are slightly sinuous on the last whorl. Faint ribbing observed on the inner whorls.

**DISCUSSION**: The specimens from locality 27 was formerly identified as *Haugia* by Frebold (GSC Report No. J-15-1971-HF in Grove, 1986). *Haugia* has a tall, hollow keel, straighter ribs that tend to fade on the outer whorls. *Phlysoogrammoceras* has a similar ribbing pattern as well as a steep to undercut umbilical wall on the outer whorl. The whorl section is much more compressed and the venter is sharp, lacking the ventral-sulci (Jakobs, 1992). Other Toarcian forms that are similar to *Pleydellia* are *Psuedolilla* and *Gruneria*.

**OCCURRENCE AND AGE**: This species is found in Alaska, in the Fernie area of British Columbia, and in the Queen Charlotte Island (Jakobs, 1992). The species is characteristic of Assemblage Zone 6 of Jakobs (1992).

Localities 27 and 28, west ridge of Nickel Mountain (Salmon River Formation). Assemblage Zone 6 - Late Toarcian.

*Pleydellia* sp. indet.

Pl. X, Fig. 11

**MATERIAL**: Sixteen specimens preserved as external and internal mould fragments in grey shale.
DESCRIPTION: Involute shell with compressed whorl section. Venter carinate. Ornamentation consists of rursiradiate ribs that fade out at the ventro-lateral shoulder. These specimens are more coarsely ribbed than *P. maudensis*.

OCCURRENCE AND AGE: Localities 27 and 28, west ridge of Nickel Mountain (Salmon River Formation). Assemblage Zone 6 - Late Toarcian.

Subfamily TMETOCERATINAE SPATH 1936

Genus *Tmetoceras* BUCKMAN 1865

TYPE SPECIES: *Ammonites scissus* BENECKE 1865

SYNONYMS: *Tmetoites* WESTERMANN 1964

REMARKS: Advolute form subquadrate to subcircular whorl section. Ribbing is simple, sharp, wiry, and straight, interrupted on the venter by a deep median groove. There is succession of three species of *Tmetoceras* in southern Alaska (Westermann, 1964b). The younger ones (Upper Aalenian) are larger, with a narrower ventral groove and strongly curved ribs. The oldest species (Lower Aalenian; *Tmetoceras scissum*) has a more rounded whorl section (which could be due to the good preservation). Where Aalenian strata occur in the western Cordillera, *Tmetoceras* is always present (Poulton and Tipper, 1991). They occur in great quantities, covering the bedding planes, in association with small encrusting bivalves.

AGE AND DISTRIBUTION: The genus is known in western Cordillera occurring in the Late Aalenian Concavum Zone (Poulton and Tipper, 1991). It has been reported from the Whitesail Lake
and Taseko Lakes areas (Frebold, 1951b, Frebold et al., 1969) and Alaska (Westermann, 1964).

*Tmetoceras cf. kirki* WESTERMANN 1964
Pl. XI, Figs. 2, 3, 5, 6, 7, and 10

1963  ?*Tmetoceras scissum* (BENECKE) Rieber pl. 8, figs. 2-3.
1964b *Tmetoceras (T.) kirki* WESTERMANN p. 437-438 pl. 72, figs. 4-6, ?, 8-10
Text figs. 35-36.
cf. 1972  ?*Tmetoceras scissum* (BENECKE) Westermann and Riccardi p. 22 pl. 1 (part)
cf. 1991 *Tmetoceras kirki* (WESTERMANN) Poulton and Tipper p. 28, pl. 2,
figs. 1-12.

**MATERIAL** : Twenty-five specimens preserved as external moulds in black shale.

**MEASUREMENTS** :

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**DESCRIPTION** : Advolute to slightly involute forms with a strongly compressed shell.
Ornamentation consists of sharp, wiry ribs that are moderately to densely spaced and are more or less irregularly flexous. The ribs are narrowly interrupted and subcontinuous across a ventral groove.

**DISCUSSION** : This species is the youngest representative of Westermans' (1964) *Tmetoceras* lineage, equivalent to the *Erycitoides howelli* zone (Poulton and Tipper, 1991). It accounts for at least half, if not more, of the *Tmetoceras* specimens in Western Canada.
OCCURRENCE AND AGE: The species is widespread in western Canada and is known in the Smithers, Whitesail, Spatsizi, and Taseko Lake map areas (Poulton and Tipper, 1991) and Alaska (Westermann, 1964). In western Canada, it is associated with Plannamatoceras (?), Erycitoides, and Pseudolioceras whiteavesi (Poulton and Tipper, 1991).

Locality 39 of the Treaty Glacier section. Upper Erycitoides howelli zone - Late Aalenian.

Subfamily LEIOCERATINAE SPATH 1936
Genus Leioceras HYATT 1867

TYPE SPECIES: Nautilus opalinus REINECKE 1818

SYNONYMS: Leioceras BAYLE 1878 (obj); Cypholioceras BUCKMAN 1899; ?Ancolioceras BUCKMAN 1899

REMARKS: Involute shell. Smooth or finely ribbed with lappets.

AGE AND DISTRIBUTION: Lower Aalenian (T. westermanni - T. scissum zone). Occurs worldwide in the Tethyan regions. In British Columbia, it has been reported from the Spatsizi map area (Poulton and Tipper, 1991).

Leioceras? sp. indet.
Plate XI, Fig. 4

MATERIAL: Numerous small imprints covering the bedding surfaces of shale.

DESCRIPTION: Involute forms with a sharp venter and smooth shell. Few specimens have faint fine
undivided falcoid ribs on the flanks. The specimens are small with diameters ranging from 14 to 18 mm.

**DISCUSSION** : Generic identification is based on the volution and the smooth shell. This genus looks very close to *Leioceras opalinum* (Frebold, 1960, Pl. 6, Fig. 1-4, Pl. 7, Fig. 1). In the Spatsizi map area, *Leioceras* occur with *Tmetoceras kirki*, probably *Planammatoceras* and *Erycitoides howelli*, suggesting upper but not uppermost Aalenian (Poulton and Tipper, 1991). Since *Leioceras* is only known to occur in the Lower Aalenian, the generic assignment of the material from the Spatsizi is questionable. The generic assignment is also questionable in this study due to its occurrence with *T. kirki*.


Subfamily HAMMOCERATINAe BUCKMAN 1887

Genus *Planammatoceras* BUCKMAN 1922

**TYPE SPECIES** : *Planammatoceras planiforme* BUCKMAN 1922

**SYNONYMS** : *Parammatoceras* BUCKMAN 1925

**REMARKS** : Involute to evolute shell with an ogival whorl section. Venter has a high, floored keel and the ribbing is sinuous. Ornamentation consists of distinct lengthened primaries, some flared on the inner whorls, with or without lateral tubercles, and with secondary ribs arising at two-thirds of the flank height. Ribs become sigmoidal and fade toward the aperture.
AGE AND DISTRIBUTION: *Planammatoceras* spans most of the Aalenian stage and occur worldwide (Westermann and Riccardi, 1982; Hillebrandt and Westermann, 1985). In western Canada, this genus is found in the Taseko Lakes, Spatsizi, and the Laberge map areas (Poulton and Tipper, 1991).

Subgenus *Planammatoceras* Buckman 1922

REMARKS: Similar to *Planammatoceras* but more midvolute to evolute and tending to be tuberculate.

*Planammatoceras* (P.) *cf. planinsigne* (Vacek 1886)

Pl. XI, Figs. 1 and 2

*cf. 1982 Planammatoceras* (P.) *aff. P. planinsigne* (Vacek) Westermann and Riccardi p. 21-22, pl. 2, fig. 1

MATERIAL: Three specimens preserved as internal moulds in carbonate concretions.

MEASUREMENTS:

<table>
<thead>
<tr>
<th>SPECIMEN</th>
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<th>U</th>
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<th>WW</th>
<th>WW/WH</th>
<th>PRHW</th>
</tr>
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<td>16.0</td>
<td>24.4</td>
<td>27.5</td>
<td>≈16.4</td>
<td>0.6</td>
<td>-</td>
</tr>
<tr>
<td>C-201641b</td>
<td>≈59.4</td>
<td>15.6</td>
<td>26.3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

DESCRIPTION: Moderately evolute shell, with an ogival to compressed whorl section and deep umbilicus. Narrow, vertical umbilical slope. Flanks are subparallel near the umbilical shoulder and then converge gradually to the acute venter which has a high hollow floored keel. Ornamentation consists of prominent and somewhat projected primaries which, on the two outer whorls, ends at
approximately two fifth the whorl height in blunt bullae. Three to four dense rectiradiate secondaries, arise from the bullae and are slightly projected on the ventro-lateral shoulder and reach the keel. On the body chamber, the secondaries become blunt and widely spaced.

**DISCUSSION**: Assignment to *Planammatoceras* is based on the sinuous ribbing, the moderately long primaries with tubercles.

**OCCURRENCE AND AGE**: The species occurs in the European Lower Murchisonae Zone, mainly in the Mediterranean and submediterranean provinces. It is found in Iran, central Japan (Sato, 1954; 1962), northern Chile (Westermann and Riccardi, 1982), and west-central Argentina (Westermann and Riccardi, 1972b).


*Planammatoceras* sp. indet.

Pl. XI, Fig. 5

**MATERIAL**: Two specimens preserved as internal and external moulds in carbonate concretions.

**MEASUREMENTS**:

<table>
<thead>
<tr>
<th>SPECIMEN</th>
<th>D</th>
<th>UD</th>
<th>U</th>
<th>WH</th>
<th>WW</th>
<th>WWWH</th>
<th>PRHW</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-201641c</td>
<td>44.3</td>
<td>14.0</td>
<td>31.6</td>
<td>17.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**DESCRIPTION**: Midvolute form with an ellipsoidal whorl section. Flanks are flat, umbilical wall is straight, umbilical shoulder is rounded, and venter is rounded and carinate. Ribs are distant and straight till mid-flank and trend rursiradiately to the venter. No bullae were observed in the specimens.
DISCUSSION: Due to the poor preservation no specific identification is possible. The generic assignment is primarily based on the sinuous ribbing and the volution. One of the specimen has a close resemblance to *P. (Pseudaptetoceras) klimakomphalum* figured by Westermann and Riccardi (1982, figs. 4c-e).


Superfamily STEPHNOCERATAECEAE NEUMAYR 1875
Family STEPHANOCERATIDAE NEUMAYR 1875

Genus *Stephanoceras* WAAGEN 1869

TYPE SPECIES: *Ammonites humphriensianus* SOWERBY 1825, SD Buckman, 1898.

DESCRIPTION: Moderately stout, tuberculate planulate, sharp ribbing, entire on the venter and collared and lipped aperture.

AGE AND DISTRIBUTION: Middle Bajocian. Occurs worldwide.

*Stephanoceras* sp. indet.
Pl. XII, Figs. 7 and 8

MATERIAL: Two specimens preserved as external moulds in shale.
DESCRIPTION: Midvolute form with a deep umbilicus. Ribbing consists of primaries and secondaries. Primary ribs are fine, sharp and approximately spaced and end with small tubercles on the middle of flank, where four secondary ribs per primary rib originate. The secondary ribs are closely spaced, very fine, and separated by intercalatory ribs. The venter of the specimens was not observed. Ribs are inclined slightly forward. In the illustrated specimen, the ribs look strongly inclined due to distortion.

DISCUSSION: Assignment to the generic level is based on rib patterns. The specimens also have similarity to the genus *Kepplerites* but the latter is evolute.

OCCURRENCE AND AGE: Found as float specimens at locality 50, east bank of Argillite Creek (probably from the Ashman formation). Early Bajocian.

Genus *Zemistephanus* MCLEARN 1927

TYPE SPECIES: *Ammonites richardsoni* WHITEAVES 1876.

REMARKS: Marked uncoiling of the body chamber, low position of the tubercles on the flanks of the body chamber, a tendency for the tubercles to weaken near the aperture of the large, adult specimen (Hall and Westermann, 1980).

SYSTEMATIC PALEONTOLOGY

Zemistephanus sp. indet.
Pl. XII, Figs. 9 and 10

MATERIAL: Two specimens and a dozen fragments with ventral imprints.

DESCRIPTION: Midvolute form with a deep umbilicus. Whorls are depressed and broad with an arched venter. Ornamentation consists of sharp primary ribs and stout tubercles at mid-flank, and fine dense secondaries that arise from the tubercles.

DISCUSSION: Hall et al. (1991), noted that one of the characteristic of the genus Kepplerites is faint, dense secondary ribs that start from conical tubercles, which the specimens from the Iskut River map area have. The specimens has close resemblance to Zemistephanus richardsoni (Hall et al., 1991, Pl. 6.3; Fig. 5). however better preserved material is required for the specific identification.


Family SPHAEROCERATIDAE BUCKMAN 1920
Subfamily EURYCEPHALITINAE THIERRY 1976

Genus Iniskinites IMLAY 1975

TYPE SPECIES: Kheraiceras magniforme IMLAY 1953B.

REMARKS: Involute shell with a moderate wide ellipsoidal whorl section, and stout to globose shell. Very small umbilicus on the septate whorls, an accentric shaped body chamber and ribs that become stronger ventrally and adorally. Ribs are low to high, sharp to rounded, radial to gently flexuous,
dividing on the inner or midflank, and becoming coarser on the adult body chamber. Includes many southern Alaska ammonites which are inflated and finely ribbed and were previously described as *Kheraiceras* (Imlay, 1975). The inner whorls of *Iniskinites* are similar to *Megasphaeroceras* and *Lilloettia* but the body chamber differs in the increasing coarseness of the ribbing, and the stronger egression than in *Lilloettia*. All North and South American species included in *Iniskinites* appear to be macroconchs (Riccardi & Westermann, 1991).

**AGE AND DISTRIBUTION**: *Iniskinites* is represented from southern Alaska (Imlay 1953, 1975, 1980) central and western British Columbia (Tipper and Richards, 1976; Frebold 1978, 1979), and the northern Yukon (Frebold, 1978; Poulton, 1987) and assigned to the Upper Bathonian.

*Iniskinites* cf. *intermedius* IMLAY 1953

Pl. XVI, Fig. 1,2, and 3

* cf. 1953 *Kheraiceras intermedium* IMLAY p. 81, pl. 31, figs. 1-4, pl. 32, figs. 2-4, 7-8.


**MATERIAL**: Four whorl fragments.

**DESCRIPTION**: Globose shell, finely ribbed with a deep umbilicus. Flanks convex. The ribs are sharp, numerous, bifurcate below the middle of the flanks, though some undivided ribs are also present. There are also some intercalated ribs between the rib pairs. All ribs incline gently from the umbilical shoulder with rursiradiate trend on the venter.

**DISCUSSION**: Similar to *Iniskinites martini* (Imlay, 1953b; p. 80, pl.32, figs. 1, 4, 6) but differs in being smaller, more compressed, ribbing higher and sparser on the body chamber. The generic and
specific assignments are based on the convexity of the shell and the rib patterns.

**OCCURRENCE AND AGE** : Locality 57, south of Tom Mackay Lake (Ashman formation). Late Bathonian.

*Iniskinites* indet. sp. A  
Pl. XV, Figs. 3 and 4

**MATERIAL** : Two specimens, one of which is flattened.

**MEASUREMENTS** :

<table>
<thead>
<tr>
<th>SPECIMEN</th>
<th>D</th>
<th>UD</th>
<th>U</th>
<th>WH</th>
<th>WW</th>
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<tr>
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<td>C-201434h</td>
<td>74.8</td>
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<td></td>
<td>≈37.2</td>
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**DESCRIPTION** : Involute and globose shell. The primary ribs are closely spaced on the inner whorls, but become less dense and sharper on the outer whorl. Secondary and intercalatory ribs arise at half of the flank height. Ribs are strongly curved and project towards the venter. Ribs are sharp but become coarser toward the body chamber. Body chamber is accentric to hook shaped. Flanks convex.

**DISCUSSION** : Specimen C-201434g closely resembles *I. gulisonai* figured in Riccardi and Westermann (1991; pl. 14, fig. 4-6; pl. 15, fig. 1a-b) except that the body chamber of specimens figured by Riccardi and Westermann is smooth. However due to the state of preservation of the body chamber of the specimen enables the specific identification. Specimen C-201434f looks more compressed than C-201434g but probably belonging to the same species.
OCCURRENCE AND AGE: Locality 60, east bank of Argillite Creek (Ashman formation). Late Bathonian.

_Iniskinites_ indet. sp. B
Pl. XVI, Fig. 8

MATERIAL: Twenty-seven specimens with one flattened.

DESCRIPTION: Globose form with coarse ribbing. Primary ribs till mid-flank, where secondary and intercalatory ribs originate. All ribs are quite prominent but rounded, almost as wide as the interspaces.

DISCUSSION: The ribbing pattern look similar to _I. tenasensis_ figured in Imlay (1975) and _I. crassus_ figured in Westermann and Riccardi (1991). Better preserved specimens are required to provide a specific assignment.

OCCURRENCE AND AGE: Locality 60, south of Tom Mackay Lake, from the Ashman formation. Late Bathonian.

_Iniskinites_ sp. indet. C
Pl. XVI, Fig. 4, 5, and 6

MATERIAL: Seven specimens with one flattened

DESCRIPTION: Involute to compressed shell. Very finely ribbed with secondary and intercalatory ribs arising at mid-flank and becoming coarser towards the body chamber. Body chamber slightly hook-shaped.
OCCURRENCE AND AGE: Locality 59, east of Mackay lake, from the Ashman formation. Late Bathonian.

Genus *Lilloettia* CRICKMAY 1930

TYPE SPECIES: *Lilloettia lilloentensis* CRICKMAY 1930

SYNONYMS: ?*Buckmaniceras* CRICKMAY 1930

REMARKS: Involute to occluded shell with rounded whorl section. Primary ribs flexuous and projected, dividing at about mid-flank into secondaries which cross the venter without interruption. Ribbing at the end of the phragmocone progressively fades away on the flanks and becomes rounded on the venter. Species belonging to *Lilloettia* are closely related to each other (Frebold and Tipper, 1967).

AGE AND DISTRIBUTION: Ranges from Late Bathonian to early Early Callovian (Calloman, 1984). The genus is characteristic of east Pacific realm and found in western British Columbia, Oregon, southern Mexico, and Argentina Andes (Taylor *et al.*, 1984). In the southern Canadian Rocky Mountains, Queen Charlotte Islands, Montana, and southern Alaska the early Callovian is also represented by the presence of the genus *Kepplerites* (Frebold and Tipper, 1967).

*Lilloettia cf. lilloentensis?*

Pl.XIV, Figs. 3, 4, 5, 7, 11, and 12

<table>
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<tr>
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<tr>
<td>1930</td>
<td><em>Lilloettia lilloentensis</em> CRICKMAY p. 62, pl. 18, figs. 1-4.</td>
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<tr>
<td>1953b</td>
<td><em>Lilloettia lilloentensis</em> (CRICKMAY) Imlay p.77, pl. 30, figs., 1,2,4, 8</td>
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<tr>
<td>cf.?</td>
<td>1967 <em>Lilloettia lilloentensis</em> (CRICKMAY) Frebold and Tipper, p. 11, pl. 1, figs. 7,8; pl. 3, fig. 3.</td>
</tr>
<tr>
<td>cf.?</td>
<td>1978 <em>Lilloettia lilloentensis</em> (CRICKMAY) Frebold p. 8, pl. 8, figs. 103.</td>
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</tbody>
</table>
Lilloettia lilloentensis (CRICKMAY) Arthur et al. p.35-36, p. 3, figs.3-6.

MATERIAL:

DESCRIPTION: Involute form with compressed shell. Inner whorl bears fine, dense, prorsiradiate ribs that divide at the middle of the flank into two secondary and intercalatory ribs. On the outer whorl, the ribs are fine adorally and become rapidly coarser and widely spaced adapically.

DISCUSSION: Assignment to Lilloettia cf. lilloentensis is based on the whorl shape, the extremely small umbilicus and the characteristics of the ribs, which are fine adorally and become coarser adapically on the outer whorl and dissappear anteriorly on the body chamber.

OCCURRENCE AND AGE: This species is occurs in southern Alaska (Imlay, 1953b), Smithers area (Frebold, 1978), Taseko Lakes region (Frebold and Tipper, 1967) and Harrison lake area (Crickmay, 1930; Arthur et al., 1993).

Localities 60 and 62, east bank of Argillite Creek, from the Ashman formation. Late Bathonian - Early Callovian.

Lilloettia sp. indet. A
Pl. XVI, Figs. 7, 11, and 14

MATERIAL: Two specimens in concretions and a few fragments.
### MEASUREMENTS:

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<td>17</td>
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<tr>
<td>C-201416b</td>
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<td>-</td>
<td>-</td>
<td>51.7</td>
<td>56.9</td>
<td>-</td>
<td>-</td>
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</table>

**DESCRIPTION**: Occluded shell with an oval whorl shape and plain venter. Inner whorl bears fine, dense rectradiate ribs that divide at the middle of the flank to secondaries and intercalotary ribs. The outer whorls have ribs that are fine adorally but become coarser and widely spaced adapically.

**DISCUSSION**: The closest species that resemble the specimens is *I. bosei* recognized in Central America (Sandoval *et al.*, 1989) and New Zealand (Westermann and Hudson, 1991). However, *I. bosei* is known in the Upper Steinmanni zone (Late Bathonian) differs by having coarse ribs adapically that diminishes towards the umbilicus on the body chamber. The specimens also differs from *L. tipperi*, where the latter is very finely ribbed throughout the whorls.

**OCCURRENCE AND AGE**: Locality 61, west bank of Argillite Creek, from the Ashman formation. Late Bathonian - Early Callovian.

*Lilloettia* sp. indet. B
Pl. XVI, Fig. 9 and 14

**MATERIAL**: Four specimens in concretions.

**DESCRIPTION**: Involute shell with an oval whorl section. Ornamentation consists of fine ribs that bend toward the venter. Venter rounded. Ribs on the last whorl bend forward at the umbilical shoulder and trend rursiradiately toward the venter.
DISCUSSION: These specimens may well be juvenile representative of *I. sp. A*, found in the same concretion.

OCCURRENCE AND AGE: Locality 61, west bank of Argillite Creek, from the Ashman formation. Late Bathonian - Early Callovian.

*Lilloettia* sp. indet. C
Pl. XVI, Figs. 9, 10, 12, and 13

MATERIAL: Seventeen fragments.

MEASUREMENTS:

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<tr>
<td>C-175775b</td>
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<td>-</td>
<td>-</td>
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<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>C-175775c</td>
<td>29.4</td>
<td>-</td>
<td>-</td>
<td>17.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

DESCRIPTION: Involute form with compressed shell. Ornamentation consists of very fine, sharp ribs. Primary ribs swing forward at the umbilical shoulder and secondary and intercalatory ribs start at 1/3 the flank height and trend rursiradiately toward the venter.

DISCUSSION: The specimens closely resembles *L. mertanywoodi* with respect to the ornamentation.

OCCURRENCE AND AGE: Locality 63, of the Treaty Ridge section, from the Ashman formation. Late Bathonian - Early Callovian.
Family KOSMOCERATIDAE HAUG 1887
Subfamily GOWERICERATINAE BUCKMAN 1926
Genus *Kepplerites* NEUMAYR and UHLIG 1892

**Type Species**: *Ammonites keppleri* OPPEL 1862

**Synonyms**: *Gowericas* BUCKMAN 1921; *Galilaeiceras* BUCKMAN 1922; *Galileanus* BUCKMAN 1922; *Galilaeites* BUCKMAN 1922; *Cerericeras* BUCKMAN 1922; *Torricelliceras* BUCKMAN 1922

**Remarks**: Midvolute shell. Inner whorls finely ribbed with tabulate or grooved venter and outer whorl has a rounded venter. Ribs becoming fasciculate and tending to be smooth, and aperture simple.

**Age and Distribution**: Described in northwest Europe, Spitzbergen, the Trans-Caucasus area and North America with minor occurrences elsewhere (Poulton, 1987). Late Bathonian to Early Callovian.

*Kepplerites* sp. indet.

**Material**: Sixteen crushed fragments and three specimens with ventral imprints.

**Description**: Widely spaced primaries end in tubercles somewhat above the middle of the flanks, where they subdivide into several, mostly two secondaries. Some secondaries are intercalated.

**Occurrence and Age**: Locality 63, of the Treaty Ridge section, probably from the Ashman formation. Late Bathonian - Early Callovian.
Family PERISPINCTACEAE STEINMANN 1890
Subfamily LEPTOSPINCTINAE ARKELL 1950

Genus Cobbanites IMLAY 1962

**TYPE SPECIES**: *Cobbanites talkeetnanus* IMLAY 1962.

**REMARKS**: Evolute form with ellipsoidal whorl section. This genus is characterized by bearing prorsiradiate ribbing and deeply impressed forwardly inclined constrictions, by developing a smooth body chamber and by bearing strongly arched ribs on the venter in the inner whorls of some species. The primary ribs on the small innermost whorls are prominent, are radial, or inclined slightly forward, most of them bifurcate near the middle of the flanks, and along the zone of furcation, they become strongly swollen.

**AGE AND DISTRIBUTION**: This genus has been reported from southern Alaska and Montana (Imlay, 1962, 1980b; Frebold, 1957). It was formerly identified as Late Bathonian to Early Callovian by Imlay (1962). More recent work by Hall (1988) in western Canadian Rocky Mountains, identified *Cobbanites* occurring from the Lower Bathonian rocks.

*Cobbanites* sp. A
Pl. XIV, Fig. 2

**MATERIAL**: One fairly large specimen preserved as external mould in shale.

**DESCRIPTION**: Fairly evolute form with compressed shell. Primary ribs sharp and close to each other on the inner whorl. On the outer whorl, the ribs are distant and blunt, bifurcate 2/3 of the flank, and become smooth and broad toward the body chamber. Ribs trend rectiradiately in the inner whorls.
and slightly rursiradiately on the outer whorl.

**DISCUSSION :** The generic assignment is based on the volution and the ornamentation, particularly the smooth body chamber. However, the presence of constriction, which is characteristic of this genus is not observed due to the poor state of preservation of the specimen.

**OCCURRENCE AND AGE :** Locality 60, east bank of Argillite Creek, from the Ashman Formation. Late Bathonian.

*Cobbanites* sp. B
Pl. XIV, Fig. 6

**MATERIAL :** One large fragment.

**DESCRIPTION :** Fairly evolute form. Ribbing sharp and triangular in cross-section. The primary ribs bifurcate and incline slightly forward. Constriction developed in the inner whorl.

**DISCUSSION :** The specimen is assigned to the genus *Cobbanites* due to the rib shape and the presence of constrictions. The specimens has very close resemblance to the Oxfordian *Perisphinctes* (*Dichotomosphinctes*) cf. *muhlbachii* of Imlay (1961, pl. 4, fig. 6), however, due to its association with *Lilloettia* and *Iniskinites*, clearly removes it from that generic identification.

**OCCURRENCE AND AGES :** Locality 60, east bank of Argillite Creek, from the Ashman formation. Late Bathonian.
Cobbanites sp. C
Pl. XV, Fig. 1 and 2

MATERIAL: 1 large whorl fragment preserved as external mould in shale.

DESCRIPTION: Fairly evolute form with compressed whorls bearing simple ribs. The ribs in the inner whorl are inclined slightly forward, sharp, prominent, and closely spaced. On the outer whorl, they trend rursiradiately, bifurcate at the venter and become blunt and widely spaced as they approach the body chamber. Fine striations/lirae are observed on the body chamber. Constrictions are developed in the inner whorls.

OCCURRENCE AND AGES: Locality 60, east bank of Argillite Creek, from the Ashman formation. Late Bathonian.
6.2.1  Phylum Protozoa

Subclass RADIOLARIA MULLER 1858
Order POLYCYSTINA EHRENBERG 1838,
  emend. RIEDEL 1967b

Genus Acaeniotyle FOREMAN 1973

TYPE SPECIES: Xiphosphaera umbilicata RUST 1898

REMARKS: Spherical to ellipsoidal shell with a surface of large porous nodes from which two or
  more spines extend (Foreman, 1973).

AGE AND DISTRIBUTION: Foreman (1973) and Pessagno (1977a) documented this genus as Late
  Jurassic to Lower Cretaceous in age. Carter et al. (1988) described similar forms from the Toarcian to
  Bajocian beds of the Queen Charlotte Islands, but queried genus assignment due to variations in the
  morphology (smaller, knob-like nodes, with fewer perforations).

Acaeniotyle (?) sp. indet.
  Pl. XIX, Fig. 7

REMARKS: Test subspherical, slightly flattened with three long tribladed spines (one broken).
  Cortical shell has strong nodes that are connected by bars forming oval pores. Poor preservation limits
  further description. This form is grossly similar to Acaeniotyle? ghostensis CARTER (pl. 9, fig. 6;
  Carter et al., 1988) from the Upper Toarcian of the Queen Charlotte Islands.
OCCURRENCE: Locality 46, 21A Contact Zone (Salmon River Formation).

Genus *Archaeocenosphaera* PESSAGNO and YANG 1989

**TYPE SPECIES:** *Archaeocenosphaera ruesti* PESSAGNO and YANG 1989

**AGE AND DISTRIBUTION:** Paleozoic? Triassic to Cretaceous so far as is known. Occurs in both Tethyan and Boreal realms.

*Archaeocenosphaera* sp. indet.
Pl. XIX, Fig. 3

**REMARKS:** Spherical test with uniform, hexagonal pores, lacking spines.

OCCURRENCE AND AGE: Locality 46, 21A Contact Zone (Salmon River Formation).

*Archaeohagiastrum longipes* BAUMGARTNER
Pl. XVII, Fig. 6

*Tetratrabs* sp. aff *T. gratiosa* BAUMGARTNER in Carter et al., 1988, p. 30, Pl. 7, Fig. 10. *Tetratrabs* sp. aff. *T. zealis* (OZVOLDOVA) in Carter and Jakobs, 1991, p. 344, Pl. 2, Fig. 7.

*Archaeohagiastrum longipes* BAUMGARTNER n.sp. Pessagno et al. (in prep).

**REMARKS:** Large form with test composed of four slender rays with a few nodes present on the external beams. Pores are obscured due to poor preservation.
OCCURRENCE AND AGE: The species occurs in the uppermost Toarcian to Aalenian in the Queen Charlotte Islands (Carter et al., 1988). In east-central Oregon, it is present in the Lower Bajocian Snowshoe Formation (Pessagno and Whalen, 1982). It is also found in the Mediterranean region.

Locality 42, east bank of Argillite Creek (Salmon River Formation). Uppermost Toarcian to Aalenian.

Genus *Crucella* Pessagno 1971

emend. Baumgartner 1980

TYPE SPECIES: *Crucella messinae* Pessagno 1971

REMARKS: Four rayed Patulibracchiinae lacking brachiopyle, with either a central spine or central and lateral spines, may or may not have patagium. (Baumgartner, 1980).

OCCURRENCE AND AGE AND DISTRIBUTION: Triassic (Rhaetian) to Late Cretaceous, worldwide

*Crucella sp.*
Pl. XVII, Figs. 3 and 4

REMARKS: Test quite inflated with four short, stout rays that taper to short triradiate spines. Central area of the test is composed of irregular pore frames that become larger in the direction of the spines. These species resembles *Crucella theokaftenses* Baumgartner (pl. 8, fig. 19-22, pl. 12, fig. 1; Baumgartner, 1980) but differs in having shorter spines.

OCCURRENCE: Locality 46, 21A Contact Zone (Salmon River Formation).
Genus *Emiluvia* FOREMAN 1973
emend. PESSAGNO 1977a

**TYPE SPECIES**: *Emiluvia chica* FOREMAN 1973

**REMARKS**: Rectangular test with four spines, one at each corner, forming a cross. Surfaces of the cortical shell are planiform; sides are concave to vertical. Cortical shell composed of two layers: an inner layer with massive polygonal pore frames and an outer layer consisting of nodes connected by bars forming triangular, rectangular or irregularly polygonal pore frames. Primary spines triradiate, composed of longitudinal ridges and grooves.

**AGE AND DISTRIBUTION**: Lower Jurassic (Toarcian) to Late Jurassic. Worldwide in Tethyan and Boreal faunal provinces.

*Emiluvia (?)* aff. *moresbyensis* CARTER
Pl. XVII, Figs. 9


**REMARKS**: Test square with some nodes preserved on the surface of illustrated specimen. The sturdy long tri-bladed spines have wide, rounded ridges and narrow, deep grooves.

**OCCURRENCE AND AGE**: This species is found in Upper Toarcian strata of the Queen Charlotte Islands (*Carter et al.*, 1988).

Locality 42, east bank of Argillite Creek (Salmon River Formation). Range Middle Toarcian -
Aalenian (Carter, pers. comm., 1993)

*Emiluvia* sp. A
Pl. XVII, Figs. 2

**REMARKS**: Test cruciform with nodose outer surface. The test has massive, tri-bladed spines of medium length having sharp ridges, wide grooves and fine, sharp tips. Similar to *Emiluvia* aff. *pessagnoi* figured by Carter et al., 1988 (pl. 4, fig. 4) from the Queen Charlotte Islands

**OCCURRENCE AND AGE**: Similar forms are seen in the Aalenian strata of the Queen Charlote Islands (Carter, pers comm., 1993).

Locality 42, east bank of Argillite Creek (Salmon River Formation). Aalenian to lower Bajocian (Carter, pers. comm., 1993)

*Emiluvia* sp. B
Pl. XVII, Fig. 1

**REMARKS**: Test square with poorly preserved nodes on the surface. The short, strongly tapering, tri-bladed spines have wide, rounded ridges and narrow, deep grooves.

**OCCURRENCE AND AGE**: Locality 48, 21A Zone (Salmon River Formation). Probably Aalenian (Carter, pers. comm., 1993)
Genus *Hsuum* PESSAGNO 1977a

**TYPE SPECIES**: *Hsuum cuestaense* PESSAGNO 1977a

**REMARKS**: Elongate, conical, multi-segmented shell with an apical horn. Pores irregularly arranged in the proximal two to three segments and regularly arranged on more distal segments. The distinct, longitudinal, and continuous costae are separated by one to four longitudinal rows of pores which cover almost the entire distal shell surface.

**AGE AND DISTRIBUTION**: Early Jurassic (E. Pliensbachian) - Early Cretaceous (Late Valanginian). This genus occurs in Alaska, British Columbia, Oregon, California, Baja California, Sarawak, Oman, Turkey, Romania, Greece, Italy, and Puerto Rico.

*Hsuum* sp

Pl. XVIII, Fig. 4

**REMARKS**: Elongate. Slim test with longitudinal, continuous costae and a short apical horn.

**OCCURRENCE**: Locality 48, 21A Zone (Salmon River Formation).

Genus *Napora* PESSAGNO 1977a

**TYPE SPECIES**: *Napora bukryi* PESSAGNO 1977a

**REMARKS**: Dicyrtid test with rounded cephalis and large subglobular thorax. Cephalis has a prominent apical horn with longitudinal ridges and grooves and sometimes with subsidiary spines.
Thorax has coarse, polygonal (usually hexagonal) pore frames and large aperture at the base. Three slightly curved feet with longitudinally developed ridges and grooves extend from the base of the thorax.

**OCCURRENCE AND AGE AND DISTRIBUTION**: Early Jurassic (Late Sinemurian?, Early Pliensbachian) to Late Cretaceous. Boreal and Tethyan realms.

*Napora* sp.
Pl. XIX, Fig. 9

**REMARKS**: Dicytrid test with large subglobular thorax having a triangular aperture at the base. Remains of foot attachments visible on the thorax.

**OCCURRENCE**: Locality 46, 21A Contact Zone (Salmon River Formation).

*Genus Paronaella* **PESSAGNO** 1971
*emend.* **BAUMGARTNER** 1980

**TYPE SPECIES**: *Paronaella solanoensis* **PESSAGNO** 1971

**REMARKS**: Three-armed forms whose internal structure is composed of uniform layers of meshwork arranged parallel to the equatorial plane of the test. Outer layers of meshwork composed of irregularly arranged polygonal pore frames. Arms have bulbous or expanded ray tips with or without terminal spines.

**AGE AND DISTRIBUTION**: Early Jurassic - Late Cretaceous, worldwide.
Paronaella variabilis CARTER 1988
Pl. XVII, Fig. 7

Paronaella variabilis in Carter et al. 1988, p. 41, pl. 11, figs. 1-3.

REMARKS: Three rayed form with a moderately slender to elliptical, wedge, or club-shaped tip. Rays are cylindrical to subrectangular in cross-section and terminate in numerous spines which are not preserved on the illustrated specimen. Pore frames of coarse to medium size, becoming finer on the ray tips.

OCCURRENCE AND AGE: This species ranges from the Upper Pliensbachian to Aalenian in the Queen Charlotte Islands (Carter et al., 1988).

Locality 42, east bank of Argillite Creek (Salmon River Formation). Late Pliensbachian to Aalenian.

Genus Parvicingula PESSAGO 1977a

TYPE SPECIES: Parvicingula santabarbaraensis PESSAGO 1977a

REMARKS: Elongate, cylindrical test, with strong circumferential ridges and a well developed horn. The test often has more than 30 post-abdominal chambers which increase in width and height away from the cephalis; chambers possess three rows of offset polygonal pores.

AGE AND DISTRIBUTION: Lower Jurassic (Middle Toarcian) to Early Cretaceous. It occurs worldwide in the boreal realm and in the northern part of the Tethyan realm.
Parvicingula sp. B
Pl. XVIII, Fig. 1, 7

Parvicingula sp. B, in Carter et al., 1988, p. , pl. 18, fig. 3 and 4.

OCCURRENCE AND AGE: The species occurs in the Lower Bajocian strata of the Queen Charlotte Islands (Carter et al., 1988).

Locality 48, 21A Contact Zone (Salmon River Formation). Early Bajocian.

Parvicingula sp. indet. A
Pl. XVIII, Fig. 5

REMARKS: Short, conical test with three rows of offset pores per chamber and strong circumferential ridges.

OCCURRENCE: Locality 46, 21A Contact Zone (Salmon River Formation).

Genus Perispyridum DUMITRICA 1978

TYPE SPECIES: Trilonche (?) ordinaria PESSAGNO 1977b

OCCURRENCE AND AGE AND DISTRIBUTION: Aalenian (Toarcian?) to Late Tithonian.

Romania, Greece, Italy, southern Switzerland, Austria, Atlantic basin, Austria, California, east-central Mexico, Baja California, east-central Oregon, western Washington, Alaska.
Perispyridium sp. cf. *P. gouldi* MACLEOD
Pl. XVIII, Figs. 8 and 10

cf. *Perispyridium gouldi* in MacLeod 1988, p. 299, pl. 1, fig. 2, 5, 8, and 11.

**REMARKS**: Test shape and spines are similar to *P. gouldi* but poor preservation prohibits positive identification.

**OCCURRENCE AND AGE**: *P. gouldi* ranges from Upper Toarcian - Lower Bajocian. Occurs in the Queen Charlotte Islands (Carter, pers. comm., 1993) and east-central Oregon (MacLeod, 1988).

Locality 42, east bank of Argillite Creek (Salmon River Formation). Upper Toarcian to Lower Bajocian.

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Genus *Praeconocaryomma* PESSAGNO 1976

**TYPE SPECIES**: *Praeconocaryomma universa* PESSAGNO 1976

**REMARKS**: Large subspherical test with small, closely spaced mammæ (knob shaped) which are connected to one another by heavy bars. Intermammary areas contain large polygonal pore frames.

**AGE AND DISTRIBUTION**: Early Jurassic (Late Pliensbachian) to Late Cretaceous (Middle Campanian). Occurs worldwide.
Praeconocaryomma sp.
Pl. XIX, Fig. 6

REMARKS: Spherical test with closely spaced mammae interconnected by thin bars which form mostly triangular pores in the intermammary area.

OCCURRENCE: Locality 46, 21A Contact Zone (Salmon River Formation).

Genus Pseudocrucella BAUMGARTNER 1980

TYPE SPECIES: Crucella sanfilippoae PESSAGNO 1977a

AGE AND DISTRIBUTION: Middle Jurassic to Barremian. Worldwide.

Pseudocrucella sp. cf. P. sanfilippoae (PESSAGNO)
Pl. XIX, Fig. 8, Pl. XVIII, Fig. 7

cf. Crucella sanfilippoae in Pessagno, 1977a, p. 72, pl. 2, figs. 15-16.
Pseudocrucella sanfilippoae (PESSAGNO) in Carter et al., 1988, p. 29, pl. 7, figs. 1, 4.

REMARKS: This species has meshwork composed of linearly arranged square pore frames having massive nodes at their vertices. The short spines are triradiate in axial section proximally and circular distally. These specimens have shorter spines than P. sanfilippoae s.s. but are probably conspecific with the form figured by Carter (1988) as P. sanfilippoae.

OCCURRENCE AND AGE: This species ranges from the late Middle/early Late Toarcian to Early Bajocian in the Queen Charlotte Islands (Carter et al., 1988).
Locality 46, 21A Contact Zone (Salmon River Formation). Late Middle/early Late Toarcian to Early Bajocian

Genus *Spongostaurus* HAECKEL 1882

**TYPE SPECIES**: *Spongostaurus cruciatus* HAECKEL 1887

*Spongostaurus* sp. A

Pl.XVII, Fig. 5

*Spongostaurus* sp. A in Carter *et al.*, 1988, p. 45, pl. 10, fig. 12

**REMARKS**: Subspherical test with convex surfaces and four medium length triradiate equatorial spines. Spines have rounded ridges and angular grooves. This form resembles *Spongostaurus* sp. A of Carter *et al.* (1988) but has shorter spines.

**OCCURRENCE AND AGE**: *Spongostaurus* sp. A occurs in the Upper Toarcian - Aalenian? of the Queen Charlotte Islands (Carter *et al.*, 1988).

Locality 42, east bank of Argillite Creek (Salmon River Formation). Upper Toarcian - Aalenian?

Genus *Stichocapsa* HAECKEL 1882

**TYPE SPECIES**: *Stichocapsa jaspidea* RÜST, 1885
Stichocapsa cf. convexa YAO
Pl. XIX, Figs. 1 and 2

cf. Stichocapsa convexa in Yao, 1979, p. 35, Pl. 5, figs. 14-16; Pl. 6, Figs. 1-7.
Stichocapsa convexa(YAO) in Carter et al., 1988, p. 62, pl. 6, fig. 5 and 6.

OCCURRENCE AND AGE: Occurs in latest Toarcian to early Bajocian strata of Queen charlotte Islands. The upper range is unknown.

Locality 46, 21A Contact Zone (Salmon River Formation).

Stichocapsa sp. indet.
Pl. XIX, Fig. 4

OCCURRENCE: Locality 46, 21A Contact Zone (Salmon River Formation).

Spumellaria indet. A
Pl. XIX, Fig. 5

REMARKS: Spherical test with numerous short radial triradiate spines. Cortical shell appears to have a nodose surface.

Spumellaria indet. B
Pl. XIX, Fig. 10

REMARKS: Poorly preserved ellipsoidal test.
OCCURRENCE AND AGE: Locality 42, east bank of Argillite Creek (Salmon River Formation).

Spumellaria indet. C
Pl. XVIII, Fig. 6

REMARKS: Subspherical, highly nodose test with six spines, four in the horizontal plane, two in the vertical plane.

OCCURRENCE AND AGE: Locality 42, east bank of Argillite Creek (Salmon River Formation).
Upper Toarcian to Aalenian so far as known (Carter, pers comm., 1993).

Spumellaria indet. D
Pl. XVII, Fig. 8

REMARKS: Specimen is probably either Crucella or Higumastra but preservation is too poor for accurate determination.

OCCURRENCE: Locality 42, east bank of Argillite Creek (Salmon River Formation).

Spumellaria indet E
Pl. XIX, Figs. 11

REMARKS: Test is disc-shaped with planiform surface and vertical sides. Composed of spongy meshwork.

OCCURRENCE: Locality 42, east bank of Argillite Creek (Salmon River Formation).
Nassellarian indet. A
Pl. XVIII, Figs. 2

OCCURRENCE: Locality 46, 21A Contact Zone (Salmon River Formation).

Nassellarian indet. B
Pl. XVIII, Figs. 3

OCCURRENCE: Locality 48, 21A Contact Zone (Salmon River Formation).
CHAPTER 7  CONCLUSIONS

This thesis presents the first detailed compilation of Norian to Early Callovian faunas in the eastern half of the Iskut River map area.

a) On a regional scale, three suites of faunas are distinguishable: a benthonic fauna dominated by bivalves, corals, and gastropods; a planktonic fauna of radiolarians; and a nektonic fauna of coleoids and ammonoids.

b) Faunas described include both ammonoids (27 genera, 47 species) and radiolarians (14 genera, 18 species). Taxa identified but not described are listed in Appendix III.

c) Ammonoids, bivalves, and radiolarian of the following stages are recognized: Norian (Cordilleranus Zone and Amoenum-Crickmayi Zones), upper Hettangian - Lower Sinemurian (Canadensis Zone), Upper Pliensbachian (Kunae and Carlottense Zones), Lower Toarcian (Assemblage Zones 2-3 of Jakobs), Upper Toarcian (Assemblage Zone 6 of Jakobs), Aalenian (Erycitoides howelli assemblage zone), Lower Bajocian, Upper Bathonian, and Lower Callovian.

d) In the eastern Iskut River map area: i) the Stuhini Group is Norian, ii) the Jack "formation" and the basal sedimentary sequence of the Unuk River Formation are upper Hettangian to Lower Sinemurian, iii) the upper volcanic sequence of the Unuk River Formation ranges from the Lower Sinemurian to the Pliensbachian, iv) the Betty Creek Formation ranges from the Upper Pliensbachian to Lower Toarcian?, v) the Mt. Dilworth "formation" is restricted to the Upper Pliensbachian to possibly Lower Toarcian (at John Peaks), vi) the Salmon River
Formation ranges from middle Toarcian to Lower Bajocian, vii) the Eskay Creek and Troy Ridge facies of the Salmon River Formation are Aalenian to Lower Bajocian, and viii) the Ashman Formation ranges from Lower Bajocian to Lower Callovian.

e) Regional correlations with strata elsewhere in the Bowser Basin are as follows: i) the Betty Creek and Mt. Dilworth formations are coeval with the Wolf Den Formation (Spatsizi Group) and the Nilkitkwa Formation (Hazelton Group); ii) the Salmon River Formation is coeval with the Melisson, Abou, and Quock formations of the Spatsizi Group and with the Smithers Formation of the Hazelton Group.

f) At Snippaker Ridge, strata previously described as Toarcian are now shown to be Norian in age.

g) The recognition of an Aalenian fauna below a felsic unit (Unit 4) at the Treaty Ridge section provides the first evidence of a younger felsic horizon in the map area. This unit represents a higher stratigraphic level than the felsic unit that constitutes the type for the Mt. Dilworth "formation". The Upper Pliensbachian to Lower Toarcian? felsic succession mapped elsewhere as the Mt. Dilworth "formation" does not extend north to the eastern Iskut River map area.

h) In the Eskay Creek area, the age of the stratabound mineralization is confined to Aalenian to possibly Early Bajocian. At the Treaty Ridge Section, Unit 4 rocks shown to be Aalenian to Early Bajocian in age, can be traced a few kilometers to the west and south regionally and correlated with the Treaty Glacier alteration system.
CONCLUSIONS

i) Stratabound mineral deposits at Eskay Creek and the alteration system at Treaty Glacier suggest that Jurassic mineralization was restricted to the Aalenian - Lower Bajocian interval.

j) In terms of depositional settings of these faunas, ammonites are locally common in siltstone and shale, benthic faunas are abundant in coarse locally limy sandstone, and the planktic forms are locally common in siliceous shale and limestone. The faunas were deposited in a wide spectrum of nearshore to off-shore shallow shelf to slope/basinal environments. Composite assemblage depth zones B-D of Taylor (1982) are represented in the area.

k) Nassellarian-spumellarian ratios suggest that within the Salmon River Formation at Eskay Creek, both the contact zone sediments hosting the stratabound mineralization and the felsic volcanics were deposited in deeper water than the overlying andesite/pillow basalt sequence.
REFERENCES


REFERENCES


Baumgartner, P.O. 1980. Late Jurassic Hagiastridae and Patulibracchiidae (Radiolaria) from the Argolis Peninsula (Peloponnesus, Greece), Micropaleontology v. 26(3), p. 274-322, pl. 1-12.


REFERENCES


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Pálfy, J., Smith, P. L. & Tipper, H. W. Sinemurian (Lower Jurassic) ammonite biostratigraphy of the Queen Charlotte Islands, British Columbia. Geobios [In press].


REFERENCES


REFERENCES


REFERENCES


Smith, P.L., Beyers, J.M., Carter, E.S., Jakobs, G.K., Pálfy, J., Pessagno, E.A. Jr., and Tipper, H.W. Jurassic taxa, ranges and correlation charts for the Circum-Pacific, 6.1 North America (Lower Jurassic) - Newsletter on Stratigraphy. in review.


APPENDIX I
Processing Technique for Radiolaria

Following is the procedure to extract radiolaria from limestone and shale.

1) Crush sample using a rock crusher or a hammer to fragments of approximately 2-3 centimetres in size.

2) Weight sample to about 500g.

3) Place sample in a large plastic bucket (11 litre size). Fill the bucket with 70% water, 20% acid soup (used acid mixed with water), and 10% pure glacier acetic acid. A steady bubbly action is desired.

4) Place bucket in a fume hood and leave for a week or until reaction has ceased.

5) Pour sample and acid through a stack of 2 sieves, 20 mesh (841 m) and 200 mesh (75 m). Wash, dry and retain the coarse fraction (from the 200 mesh) for further use if needed.

6) Wash the fine portion (the residue) and place in a crucible and leave in an oven to dry.

7) The sample is then ready to be picked for microfossil.
APPENDIX II
Mounting Technique for Radiolaria


This procedure uses nail polish as a mounting medium - dark red polish is best as it permits estimation of thickness of the coat. If too thick (polish distinctly red) specimens may sink too deeply into the polish, the lattice will fill with polish and obscure the pores. Nail polish is safe to use in an SEM but should be allowed to dry 24 hours before placing stub in the instrument.

1. On a watchglass, dissolve dark red nail polish in small amount of acetone.

2. Invert a clean standard aluminium SEM stub and dip surface in polish to achieve an even coating. Place stub in a holder and let dry overnight.

3. Transfer Radiolaria to the stub under a binocular microscope (selected specimens plus several extras,) using a fine brush and distilled water. Orient in desired positions.

4. Carefully place stub (in holder) in petri dish. Moisten a small piece of folded tissue with acetone and place in dish alongside stub. Put lid on petri dish. Thirty seconds to one minute is usually sufficient time to embed some spines in the softened polish and obtain good electrical contact.

5. After taking stub from dish, wait one minute for polish to reharden then place stub under microscope and, using a fine wire or dry brush, prod one of the extra specimens. If it moves return stub to petri dish for additional time, if it breaks you can be reasonably confident other specimens are secure.

6. Clean off any debris with a damp brush. This last step is especially important as minute flecks of dust, clay or broken radiolarians will be most conspicuous on the even black backgrounds of SEM photomicrographs.
APPENDIX III

Appendix III is a compilation of all available fossil data from the eastern Iskut River (104B) map area. The data is compiled into different sections where they are ordered in a chronologic order - oldest to youngest. The sections are as follows:

a) Localities yielding diagnostic fossils.
b) Localities yielding poorly preserved fossils.
c) Localities sampled to process for radiolaria: barren.
d) Core samples processed for radiolaria: barren

The data is presented in the following format:

<table>
<thead>
<tr>
<th>Locality</th>
<th>GSC Locality #</th>
<th>Field No. (year collector-#)</th>
<th>{specimens not seen}</th>
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</table>

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<tr>
<th>Geographic location</th>
<th>UTM coordinates and/or longitudes/latitudes</th>
<th>group or formation</th>
<th>specimen from a section</th>
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<thead>
<tr>
<th>Fossil Group</th>
<th>Genus or species</th>
<th>Biozone and/or Age</th>
</tr>
</thead>
</table>

GSC Report No. {Report #-year-identified by} and/or {reference}

{Locality} : adapted from author's Masters thesis
Collection with different GSC numbers that are from the same area and unit are grouped and given one locality number.

{GSC Locality #} : GSC Catalogue Number

Field No. (year collector-#) : Year, initial of collector, and sample number
{specimens not seen} : if the specimens were not viewed.

{Geographic location} : Description of locality provided by the collector

{UTM coordinates and/or longitudes/latitudes} : Coordinates provided by the collector

{group or formation} : As provided by the collector
[specimen from a section]: As provided by the collector

{Fossil Group}: Various fossil groups represented in the collection

{Genus or species}: Genus or species identified. Re-identified specimens are followed by (=new name)

{Biozone and/or Age}: Age

GSC Report No., {Report #-year-identified by} and/or {reference}: Original identifications. In certain instances the collections were examined and the identifications and age may have been updated. Some collections that were not seen but the identification may have been tentatively updated based on similar collections from the same area. Both these are followed by the statement (age revised in this study).

Initials of Paleontologists and sample collectors

AJM = James McDonald (Mineral Deposit Research Unit, UBC)
AT = Bob Anderson (Geological Survey of Canada, Vancouver)
ATG = Mike Gunning (Geological Survey of Canada, Ottawa)
ATB = Joera Beekmann
CE = Carl Edmunds (Homestake Mineral Development Company)
DON = Mike Donnelly (UBC)
ESC = Elizabeth Carter (Carter Consultant, Portland)
ETT = Tim Tozer (Geological Survey of Canada, Vancouver)
EWG = Edward Grove (Geological Survey of Canada)
GJ = Gary Johannson (UBC)
GTN = Genga Nadaraju (UBC)
HF = Hans Frebold (Geological Survey of Canada, Ottawa)
HSA = Jack Henderson (Geological Survey of Canada, Ottawa)
HSM = Mary Henderson (Geological Survey of Canada, Ottawa)
HWT = Howard Tipper (Geological Survey of Canada, Vancouver)
JAJ = Jeletzky (Geological Survey of Canada, Ottawa)
JB = Jim Britton (B.C. Department of Mines, Energy and Petroleum Resources, Victoria)
JG = John Payne (Granges Inc., Vancouver)
JH = Jan Hammond
JM = James Moore
KH = Kirk Hancock (British Columbia Geological Survey Branch, Victoria)
KQ = Rod Kirkham (British Columbia Geological Survey Branch, Victoria)
MM = Mary MacLean (British Columbia Geological Survey Branch, Victoria)
PDL = Peter Lewis (Mineral Deposit Research Unit, UBC)
PLS = Paul Smith (UBC)
SH = Steve Hiebert (British Columbia Geological Survey Branch, Victoria)
TPP = Terry Poulton (Geological Survey of Canada, Ottawa)
WR = Wes Raven (Orequest)
V = Vicky P. Van Damme
Localities with diagnostic fossils (Loc. 1-64)

LOC. 1a  C-101284  Field No. 85 AT-166  not seen

2 km SE of Snippaker Mountain
56° 38' 57"/130° 57' 47"
Stuhini Group

Ammonoid
   *Polylectus?* sp.
Bivalves
   *Weyla* cf. *acutiplicata* (MEEK) (= Pectinids)
   *Weyla* sp. (= Pectinids)
Coleoid
   *s*
Gastropods

Amoenum-Crickmayi Zone: Upper Norian

GSC Report No. J22-1986-HWT (age revised in this study)

LOC. 1b  C-177387  Field No. 91 GTN-50
         C-101262  Field No. 84 CG-(SP-F)

2 km SW of Snippaker Mountain
56° 39' 10"/130° 57' 50"; 379500E/6280250N
Stuhini Group

Ammonoid
   *Placites* sp.
   *Rhacophyllites* sp.
   *Cladiscites* sp.
Bivalves
   *Myophoria* sp.
   *Pinna* sp.
   *Weyla* sp. = Pectinids
   *Trigonia* sp.
   *Gryphaea* sp.
Corals
   *Thamnastrea* sp.
   *Thecosmilia* sp.
   *Montlivaltidae* indet.
Sponge
   *Nevadathalamia* sp.

Amoenum-Crickmayi Zone: Upper Norian

GSC Report No. (for C-101262) J1-1985-HWT (age revised in this study)

LOC. 2  C-117480  Field No. 84 AT

Snippaker Ridge, south of Snippaker Peak
379630E/6279850N
APPENDIX

Stuhini Group

Ammonoid
  *Phylloceras* sp. (=*Placites* sp.)
Bivalves
  *Weyla* sp. (=Pectinids)
Rhynchonellid brachiopods
Coleiod
Gastropods

Amoenum-Crickmayi Zone: Upper Norian

GSC Report No. J1-1985-HWT (age revised in this study)

---

LOC. 3  C-118983  Field No. 85 ATG-88-3  not seen

East of junction of Unuk River and Storie Creek
417350E/6272190N
Stuhini Group

Bivalves
  *Monotis alaskana* SMITH
  *Monotis subcircularis* GABB
Coleoid

Part of the Cordilleranus Zone: Upper Norian

GSC Report No. TR-3-1986-ETT *(in Gunning, 1986)*

---

LOC. 4  C-201634  Field No. 91 JG-265

SW of Ceperly Glacier
421450E/6273625N
Stuhini Group

Bivalves
  *Monotis* sp.

Norian

---

LOC. 5  C-201635  Field No. 91 JG-304

Head of Jack Glacier, ridge south of Roansfell and Ceperly glaciers
424450E/6272450N
Stuhini Group

Bivalves
  *Monotis* sp.

Norian

---

LOC. 5  C-143457  Field No. 87 AT-27-14  not seen

Head of Jack Glacier, ridge south of Roansfell and Ceperly glaciers
APPENDIX

424650E/6272300N
Stuhini Group

Trace Fossils
*Helminthoida? or Helminthopsis?* sp.
*Chondrites?* sp.

Probably Triassic - Jurassic


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<td>SE of Ceperly Glacier 422975E/6273850N</td>
<td>Stuhini Group</td>
</tr>
<tr>
<td></td>
<td>Ammonoid Bivalves</td>
<td></td>
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<tr>
<td></td>
<td><em>Monotis</em> cf. <em>subcircularis</em> GABB</td>
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<td></td>
<td>Part of Cordilleranus Zone : Upper Norian</td>
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Se of Ceperly Glacier, 4630' elevation 400240E/6265730N
Formation: ?

Ammonoid
*Halobia* sp.

Triassic (Carnian-Norian)


<table>
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<tr>
<th>LOC. 7</th>
<th>C-167526</th>
<th>Field No. 90 JB-19-3</th>
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</thead>
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<tr>
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<td>Head of Lyons Creek, 4630' elevation 400240E/6265730N</td>
<td>Stuhini Group</td>
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<td><em>Halobia</em> sp.</td>
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<td></td>
<td>Ammonoid Bivalves</td>
<td></td>
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<tr>
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<td>Probably Upper Triassic</td>
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Corals
   *Heptastylis?* sp.
Gastropods

Upper Triassic - according to collector

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<td>C-201608</td>
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<td>C-201609</td>
<td>Field No. 91 PLS-4</td>
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</table>

Between Atkins and Treaty glaciers
427200E/6273200N
Formation: Jack (informal)

Ammonite
   *Paracaloceras* sp.
Bivalves
   *Weyla cf. alata* von Buch
   *Camptonectes* sp.
   *Pleuromya* sp.
   *Eopecten* sp.
Corals
Gastropods

Upper Hettangian - Lower Sinemurian

<table>
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<th>LOC. 10a</th>
<th>C-201631</th>
<th>Field No. 90 WR-1</th>
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</table>

Ridge between Atkins and Treaty glaciers
427200E/6273200N
Formation: Jack (informal)

Ammonite
   *Paracaloceras cf. rursicostatum* Frebold
   *Alsatites cf. proaries?* Neumayr
Bivalves
   *Camptonectes* sp.

Canadensis Zone:
Upper Hettangian - Lower Sinemurian

<table>
<thead>
<tr>
<th>LOC. 10b</th>
<th>C-105276</th>
<th>Field No. KQ 91-121A</th>
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</table>

Ridge north of Atkins Glacier
56° 36' 20"/130° 11' 00"
Formation: Jack (informal)

Bivalves
   *Plagiostoma* sp.
   *Weyla acutiplicata* (MEEK)
   *Weyla alata* von Buch
   *Homomya?* sp.
   *Lima* sp.
Atractites (?) sp.
Corals
Echinoid
Gastropods

Probably Upper Sinemurian or Lower Pliensbachian


LOC. 10c C-143453 Field No. 87 JB-27-14 not seen

East of Atkins Glacier
427200E/6273400N
Formation: Jack (Informal)

Bivalves
Weyla acutiplicata MECK
Gastropods

Lower Jurassic, probably Sinemurian-Pliensbachian


LOC. 11 C-201453 Field No. 91 HSA-286

East of Atkins Glacier, 1.5km north of locality 10.
427150E/6275000N
Formation: Jack (Informal)

Ammonite
Badouxia canadensis FREBOLD
Canavarites sp.
Bivalves
Weyla sp.
Belemnoid

Canadensis Zone:
Upper Hettangian - Lower Sinemurian

LOC. 12 C-201457 Field No. 91 HSM-38

2 km North of Rounsfell and Atkins glaciers
425050E/6277600N
Formation: Jack (Informal)

Ammonite
Badouxia canadensis FREBOLD
Bivalves
Gryphaea sp.
Belemnoid

Canadensis Zone:
Upper Hettangian - Lower Sinemurian
LOC. 13 C-175779 Field No. 91 AT-169F

1.75 km ESE of toe of Atkins Glacier
6 km west of toe of Treaty Glacier (Headwaters of Treaty Creek), 6400'
426930E/6275025N
Formation: Jack (Informal)

Ammonite
*Paracaloceras cf. coregonense* (SOWERBY)
Bivalves
*Weyla* sp.
Gastropods

Upper Hettangian - Lower Sinemurian

LOC. 14 C-201415 Field No. 91 GTN-28b

2.7 km NW from the junction of Unuk River/Storie Creek
409700E/6274650N
Formation: Unuk River or Jack *Eskay Creek Section*

Ammonite
*Paracaloceras cf. multicostatum* FREBOLD
*Paracaloceras* sp.
Bivalves
*Weyla* sp.
Echinoid
Gastropods
Wood imprint

Canadensis Zone:
Upper Hettangian - Lower Sinemurian

LOC. 15 C-44416 Field No. 60 EWG-6

On ridge south of toe of Treaty Glacier, 1,690m
418777E/6276737N; 56° 36' 00"/130° 20' 00"
Formation: Jack (Informal) *John Peaks Section*

Ammonite
*Psiloceras canadensis (=Badouxia canadensis* FREBOLD)
Bivalves
*Weyla* sp.
*Pleuromya?* sp.
*Entolium?* sp.
*Lima?* sp.
*Oxytoma?* sp.
Gastropods

Canadensis Zone:
Upper Hettangian - Lower Sinemurian

GSC Report No. J-1-1962-HF in Grove, 1986 (age revised in this study)
LOC. 16  C- 86264  Field No. 67 EWG-F10
West side of Twin John Peaks, 1950m
56° 33' 00"/130° 25' 00"
Formation: Betty Creek

Bivalves
Weyla sp.,
Cardinia? sp.

Probably Hettangian or Sinemurian


LOC. 17  C-143465  Field No. 88CR-BCAA-711  not seen
West of Jack Glacier, east of Bruce Glacier
417615E/6274360N
Formation: Betty Creek

Bivalves
Weyla? sp.

Probably Sinemurian or Pliensbachian


LOC. 18a C-101276  Field No. 85 ATB-160
3.5km W of junction of Lyons and Harrymel creeks
56° 31' 23"/130° 37' 02"; 400470E/6265280N
Formation: Betty Creek

Ammonite
Amaltheus cf. stokesi (SOWERBY)
Leptaleoceras cf. accuratum (FUCINI)
Arieticeras spp.

Bivalve
Kunae Zone: Upper Pliensbachian

GSC Report No.  J22-1986-HWT (revised in this study)

LOC. 18b C-201612  Field No. 89 PLS-56
3.5km W of junction of Lyons and Harrymel Creeks
400540E/6265250N; 56° 31' 01"/130° 36' 15"
Formation: Betty Creek

Ammonite
Arieticeras cf. algovianum (OPPEL)

Kunae Zone: Upper Pliensbachian
Report No. in Smith and Carter (1990) (revised in this study)

LOC. 18b  C-201613  Field No. 89 PLS-55

3.5km W of junction of Lyons and Harrymel Creeks
400540E/6265250N; 56° 31' 01"/130° 36' 15"
Formation: Betty Creek  
Lyons Creek Section

Ammonite
Amaltheus cf. stokesi (Sowerby)
Arieticeeras cf. algovianum (Oppel)
Arieticeeras sp.

Kunae Zone: Upper Pliensbachian

Report No. in Smith and Carter (1990) (revised in this study)

LOC. 18b  C-201614  Field No. 89 PLS-57F

3.5km West of junction of Lyons and Harrymel Creeks
400540E/6265250N; 56° 31' 01"/130° 36' 15"
Formation: Betty Creek  
Lyons Creek Section

Ammonite
Arieticeeras sp.
Leptaleoceras sp.

Kunae Zone: Upper Pliensbachian

Report No. in Smith and Carter (1990)

LOC. 18b  C-201615  Field No. 89 PLS-58&F

3.5km West of junction of Lyons and Harrymel Creeks
400540E/6265250N; 56° 31' 01"/130° 36' 15"
Formation: Betty Creek  
Lyons Creek Section

Ammonite
Leptaleoceras sp.
Arieticeeras sp.

Kunae Zone: Upper Pliensbachian

Report No. in Smith and Carter (1990)

LOC. 18b  C-201616  Field No. 89 PLS-60

3.5km West of junction of Lyons and Harrymel Creeks
400540E/6265250N; 56° 38' 17"/130° 26' 30"
Formation: Betty Creek  
Lyons Creek Section
Ammonite
_Arieticeras_ sp.
Upper Pliensbachian

Report No. _in_ Smith and Carter (1990)

<table>
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<tr>
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<td>400540E/6265250N</td>
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<td>Formation: Betty Creek</td>
<td>Lyons Creek Section</td>
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Ammonite
_Arieticeras?_ sp.
Most likely Upper Pliensbachian

GSC Report No. _in_ Smith and Carter (1990)

<table>
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<tr>
<td>400540E/6265250N; 56° 31' 01&quot;/130° 36' 15&quot;</td>
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<td></td>
</tr>
<tr>
<td>Formation: Betty Creek</td>
<td>Lyons Creek Section</td>
<td></td>
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</tbody>
</table>

Ammonite
_Arieticeras cf. algovanum_ (OPPEL)
_Protoagrammoceras cf. nipponicum_ (MATSUMOTO)
_Leptaleoceras cf. accuratum_ (FUCINI)
_Fuciniceras_ sp.
Kunae Zone: Upper Pliensbachian

Report No. _in_ Smith and Carter (1990) (revised in this study)

<table>
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<td>3.5km W of junction of Lyons and Harrymel Creeks</td>
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<tr>
<td>400370E/6265025N; 56° 30' 54&quot;/130° 36' 28&quot;</td>
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<tr>
<td>Formation: Betty Creek</td>
<td>Lyons Creek Section</td>
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</table>

Ammonite
_Arieticeras_ sp.
Upper Pliensbachian

Report No. _in_ Smith and Carter (1990)

<table>
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<th>Field No. 89 PLS-41</th>
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<td>Lyons Creek</td>
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<tr>
<td>411950E/6278125N; 56° 38' 28&quot;/130° 26' 02&quot;</td>
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</table>
APPENDIX

Formation: Betty Creek

Ammonite
*Arieticeeras* sp.

Upper Pliensbachian

Report No. in Smith and Carter (1990)

---

**LOC. 19**

C- 44419

Field No. 60 EWG-9

West side of Twin John Peaks, 1890m
412910E/6268025N; 56° 34' 00"/ 130° 25' 00"

Ammonite
*Arieticeeras* cf. *algovianum* (OPPEL)
Bivalves
*Weyla* sp.

Kunae Zone: Upper Pliensbachian


---

**LOC. 20**

C-177159

Field No. 91 PDL-664

North of John Peaks
412730E/6269530N

Ammonite
*Arieticeeras* cf. *algovianum* (OPPEL)
*Arieticeeras* sp.,
*Leptaleoceras* cf. *accuratum* (FUCINI)

Kunae Zone: Upper Pliensbachian

---

**LOC. 21**

C-201436

Field No. 91 GTN-7

Field No. 91 GTN-8

Headwaters of Eskay Creek, NE of EC camp
411600E/6277800N

Ammonite
*Tiltoniceras* cf. *propinquum* (WHITEAVES)

Upper Pliensbachian

---

**LOC. 21**

C-201620

Field No. 89 PLS-43

Eskay Creek
4115754E/6277825N; 56° 38' 19"/ 130° 26' 30"
Formation: Betty Creek  

**Ammonite**
- Hildoceratacea indet.
- Coleoid

**Pliensbachian - Toarcian**

**LOC. 22  C-201438**  
Field No. 91 GTN-9

Headwaters of Eskay Creek, NE of EC camp
411600E/6277780N
Formation: Betty Creek  

**Eskay Creek Section**

**Bivalves**
- *Weyla* sp.

**Corals**

**Lower Jurassic**

**LOC. 22  C-201605**  
Field No. 90 AJM-216

Headwaters of Eskay Creek beside fault
411600E/6277780N
Formation: Betty Creek  

**Eskay Creek Section**

**Bivalves**
- *Weyla* sp.

**Corals**

**Lower Jurassic**

**LOC. 22  C-201623**  
Field No. 89 PLS-62

Eskay Creek
411600E/6277775N
Formation: Betty Creek  

**Eskay Creek Section**

**Bivalves**
- *Weyla* sp.

**Corals**

**Lower Jurassic**

**LOC. 23  C-201604**  
Field No. 90 AJM-206

North of EC camp, along Eskay Creek
411900E/6278200N
Formation: Betty Creek  

**Eskay Creek Section**

**Ammonite**
- *Protogrammoceras cf. kurrianum* (BUCKMAN)
- *Lioceratoides?* sp.
Upper Pliensbachian - Lower Toarcian?

LOC. 23  C-201622  Field No. 89 PLS-25

Eskay Creek
411750E/6278050N
Formation: Betty Creek

Ammonite
Protogrammoceras spp.

Upper Pliensbachian - Lower Toarcian?


LOC. 23  C-93581  Field No. Donnelly 2

Upper Eskay Creek
411600E/6278000N
Formation: Betty Creek

Ammonite
Pallarpites sp. (=Protogrammoceras cf. kurrianum (BUCKMAN))

Upper Pliensbachian - Lower Toarcian?

Report No. HWT (in Donnelly, 1976) (revised in this study)

LOC. 24  C-143462  Field No. 88W-BCAA6-4  not seen

Tributary to Eskay Creek
412200E/6277900N
Formation: Salmon River? or Spatsizi?

Ammonite
Probably Pliensbachian


LOC. 25  C-201629  Field No. 89 PLS-80

Argillite Creek
410450E/6277652N; 56° 38' 12"/ 130° 27' 39"
Formation: Salmon River?

Radiolarian
Canoptum cf. anulatum

Lower Pliensbachian - Lower Toarcian?

Report No. ESC - 1989
LOC. 26  C- 87061  Field No. 70 EWG-B

East side of small unnamed glacier 7.2km, south of Treaty Creek, 1450m
56° 32' 00"/130° 02' 00" ; 436450E/6265700N
Formation: Unuk River ? Salmon River ?

**Ammonite**

*Dactylioceras* sp.

(=*Dactylioceras* cf. *helianthoides* (YOKOYAMA)
    *D. cf. athleticum* (SIMPSON)
    *Dactylioceras* sp.)

**Bivalves**

Lower Toarcian : Assemblage Zone 2-3 (Jakobs, 92)


LOC. 27  C- 86273  Field No. 70 EWG-122

West ridge of Nickel Mountain, 1705m
56° 44' 00"/130° 35' 30" ; 395200E/6271350N
Formation: Salmon River

**Ammonite**

*Haugia* sp. (=*Pleydellia* cf. *maudensis* JAKOBS)

**Belemnoid**

Upper Toarcian : Assemblage Zone 6 (Jakobs, 92)


LOC. 28  C-143467  Field No. 89 KH-2-8-18

C-143468  Field No. 89 KH-2-9-19

West scree slopes E. and L. Nickel
395500E/6271400N
Formation: Salmon River

**Ammonite**

*Pleydellia maudensis* JAKOBS

*Pleydellia*? sp.

Upper Toarcian : Assemblage Zone 6 (Jakobs, 92)

**Report No.** GK (Jakobs, 1992)

LOC. 29  C-118982  Field No. 85 ATG-84  not seen

C-118980  Field No. 85 ATG-83-4

6km east of Unuk River-Storie Creek junction
417000E/6274400N; 56° 36' 30"/130° 21' 05"
Formation: Salmon River
Belemnites
Conodicoelities sp.
Panopea sp.
Bivalves

Middle - Upper Toarcian

GSC Report No. Km-2-1986-JAJ

LOC. 30 C-201630 Field No. 89-PLS-82

Treaty Ridge, east of South Treaty Glacier
433600E/6272770N; 56° 35' 50"/130° 04' 47"
Formation: Salmon River
Radiolaria
Perispyridium sp.

Upper Middle Toarcian

GSC Report No. ESC-1989

LOC. 31 C-175918 Field No. 89 AT-165-1

Treaty Ridge, east of South Treaty Glacier
432980E/627330N
Formation: Salmon River
Belemnite
Bivalves
Weyla sp.

Upper Middle Toarcian?


LOC. 32 C-175917 Field No. 89 AT-2F not seen

6.25 km west of headwaters of Treaty Creek
426990E/6275100N
Formation: Salmon River
Belemnites
Bivalves
Weyla alata VON BUCH
Weyla bodenbenderi (?)
Corals
Gastropods

Lower Jurassic, probably Toarcian

LOC. 33  C-177157  Field No. 91 PDL-609
Treaty Nunatak
431100E/6270960N
Formation: Salmon River
Bivalves
   *Trigonia* sp.

Probably Middle Jurassic

LOC. 34  C-167502  Field No. 89 SH-15-1 not seen
Nunatak in lower Treaty Glacier
431100E/627250N
Formation: Salmon River
Bivalves
   *Myophorella* sp.
   *Thracia?* sp.
   *Camptonectes?* sp.
Belemnite
Gastropods
Middle Toarcian to Oxfordian


LOC. 35  C-104582  Field No. 89 KQ-1210 not seen
Near top of ridge of south of east arm of Treaty Glacier
431820E/6271670N
Formation: Salmon River?
Ammonite
Bivalves
   *Trigonia* sp.
Belemnite
Rhynochonellid brachiopod
Jurassic, probably Middle Toarcian - Callovian

GSC Report No. J2-1990-TPP

LOC. 36  C-143463  Field No. 88W JB-BCAA-8-8 not seen
Upper Argillite Creek (Prout Plateau)
410150E/6277200N
Hazelton or Spatsizi Group?
Belemnite
Toarcian - Cretaceous
APPENDIX


LOC. 37 C-118985 Field No. 90 ATG-2(F) not seen

1/2 km east of south end of Tom Mackay Lake
56° 36’ 45”/130° 32’ 02” ; 405830E/6275110N
Formation: ?

Belemnite Toarcian to Upper Lower Cretaceous


LOC. 38 C-143496 Field No. 89 MM-1-1a not seen

Ridge south of Snippaker Creek-Pins Ridge
392210E/6268650N
Formation: ?

Bivalves

*Lima? sp.
*Inoceramus? sp.
*Gryphaea? sp.
*Rhynchonellid brachiopod

Middle Toarcian - Callovian, most likely Callovian but older ages cannot be ruled out


LOC. 39 C-175772 Field No. 91 GJ-099
C-201610 Field No. 92 PDL-886

1.3 km SSW (219°) of head of Treaty Creek
432609E/6273674N
Formation: Salmon River? Treaty Ridge Section (Unit 3)

Ammonite,

*Tmetoceras cf. kirki WESTERMANN
*Tmetoceras sp.
*Leioceras sp.
*Pseudolioceras sp.

Bivalves

*Inoceramus sp.

Upper Aalenian

LOC. 40 C-201641 Field No. 92 CE-2

North of Mitchell Glacier, ridge east of Iron Cap
427202E/6267670N
Formation: Salmon River?
Ammonite

Plannamatoceras (P.) cf. planinsigne (VACEK)
Phylloceras sp.

Bivalves

Pleuromya sp.
Pholadomya sp.
Cardinia sp.

Part of the Erycitoides howelli Zone : Upper Aalenian

LOC. 41 C-105272 Field No. 91 KQ-61 not seen

North of Mitchell Glacier, ridge east of Iron Cap
56° 33' 00"/130° 11' 30"
Formation: Salmon River?

Bivalves

Pleuromya sp.

Probably Middle Jurassic


LOC. 42 C-201628 Field No. 89 PLS-76

Upper Argillite Creek
409975E/6275925N; 56° 37' 50"/130° 28' 03"
Formation: Salmon River?

Radiolarian

Archaeohagiastrum longipes BAUMGARTNER
Emiluvia (?) aff. moreshyensis CARTER
Emiluvia sp. B
Paronaella variabilis CARTER
Perispyridium sp. cf. P. gouldi MACLEOD
Spongostaurus sp. A
Spumellaria indet. A
Spumellaria indet. B
Spumellaria indet. C
Spumellaria indet. E

Aalenian, possibly Lower Bajocian

LOC. 43 C-201418 Field No. 91 GTN-31c

East of Argillite Creek (Contact Zone)
410700E/6277800N
Formation: Mt. Dilworth

Coleoid
Radiolarian
<table>
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<tr>
<th>LOC. 44</th>
<th>C-201419</th>
<th>Field No. 91 GTN-33</th>
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<tr>
<td>Spumellaria indet. D.</td>
<td>Probably Aalenian - Lower Bajocian</td>
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<tr>
<td>East of Argillite Creek (Contact Zone)</td>
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<td>Formation: Mt. Dilworth</td>
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<tr>
<td>Radiolarian</td>
<td>Nassellarian sp. indet.</td>
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<td>Spumellaria sp. indet.</td>
<td>Probably Aalenian - Lower Bajocian</td>
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<td>East of Argillite Creek (Contact Zone)</td>
<td>410700E/6277800N</td>
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<tr>
<td>Formation: Mt. Dilworth</td>
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<tr>
<td>Stichacopsis cf. convexa</td>
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<th>LOC. 45</th>
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<th>Field No. 91 GTN-34</th>
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<tbody>
<tr>
<td>Nassellarian indet.</td>
<td>Spumellaria indet.</td>
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<tr>
<td>East of Argillite Creek (Contact Zone)</td>
<td>410350E/6277400N</td>
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<tr>
<td>Formation: Mt. Dilworth</td>
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<table>
<thead>
<tr>
<th>LOC. 46</th>
<th>C-159453</th>
<th>Field No. 91 GTN89-89.54.2</th>
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<tr>
<td>Eskay Creek Camp</td>
<td>411450E/6278000N</td>
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</tr>
<tr>
<td>Core sample</td>
<td>Formation: Salmon River</td>
<td></td>
</tr>
<tr>
<td>Radiolaria</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acaeniotyle (?) sp.</td>
<td>Archaeocenosphaera sp.</td>
<td></td>
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<tr>
<td>Crucella sp.</td>
<td>Napora sp.</td>
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<tr>
<td>Parvicingula sp. indet. A</td>
<td>Praeconocaryomma sp.</td>
<td></td>
</tr>
</tbody>
</table>
***APPENDIX***

Pseudocrucella sp. cf. P. sanfilippoae (Pessagno)

Stichocapsa cf. convexa YAO

Spumellaria indet. E

Nassellarian indet. A

Aalenian - possibly Lower Bajocian

---

LOC. 47  C-159464

Eskay Creek Camp

Core sample (411450E/6278000N)

Formation: Salmon River

Radiolaria

Stichocapsa sp.

Praeconocaryomma sp.

Aalenian - possibly Lower Bajocian

---

LOC. 48  C-159484

Eskay Creek Camp

Core sample (411450E/6278000N)

Formation: Salmon River

Radiolaria

Emiluvia sp. B

Hsuum

Parvicingula sp. B

Nassellarian indet. B

Aalenian - possibly Lower Bajocian

---

LOC. 49  C-175774

1.4 km SSW (200') of head of Treaty Creek

433030E/6273390N

Formation: Salmon River

Treaty Ridge Section (Unit 5)

Ammonite

Zemistephanus sp.

Bivalves

Aucella sp.

Upper Lower Bajocian

---

LOC. 50  C-93590

Field No. 76 DON-3

Field No. 76 DON-3

Float from upper Argillite Creek

410500E/6277700N

Formation: Ashman?

Eskay Creek Section

Ammonite

Stephanoceras sp.
APPENDIX

Lower Bajocian

GSC Report No. HWT (in Donnelly, 1976)

LOC. 51	C-201611	Field No. 92 JT-1038

Treaty Ridge gosson
429404E/6274803N
Formation: Ashman

Ammonite

Sonninid gen. indet.
Probably Bajocian

LOC. 52	C-201425	Field No. 91 GTN-46b

Nunatak, center of Mitchell Glacier
427100E/6263650N
Formation: Betty Creek

Corals, Bivalves

Plagioistoma sp.
Most probably Middle Jurassic

LOC. 52	C-105275	Field No. 91 KQ-95C

Top of high ridge between Mitchell Glacier and Hanging Glacier to the south
56° 30' 30"/130° 11' 40"
Formation: ?

Gastropods
Indeterminate


LOC. 53	C-105273	Field No. 91 KQ-71

Small nunatak in high icefield between Mitchell and Knipple glaciers.
56° 30' 10"/130° 09' 10"
Formation: Salmon River

Bivalves

Plagioistoma? sp.
Cucullaea? sp.
Lima sp.
Myophorella sp.
Pleuromya sp.

Middle Jurassic; probably Lower Bajocian

LOC. 54a  C-201450  
Field No. 91 GTN-47  
North of Mitchell Glacier, east of Iron Cap + Fault  
425270E/6267850N  
Formation: Betty Creek?
Bivalves
   Trigonia sp.  
   Vaugonia sp.  
   Myophorella sp.  
Corals  
Gastropods  
Most probably Middle Jurassic

LOC. 54a  C-102254  
Field No. 86 KQ-59  
not seen  
Near top of bare rock face, head of Treaty Glacier  
56° 33' 5"/130° 13' 00"  
Formation: Salmon River?
Bivalves
   Myophorella sp.  
   Trigonia sp.  
Gastropods  
Probably Middle Jurassic


LOC. 54b  C-143461  
Field No. 88A-JB-BCAA2525  
not seen  
North side of Mitchell Glacier  
426430E/6267200N  
Formation: Salmon River?
Bivalves  
Trigoniids  
Probably Middle Jurassic


LOC. 54c  C-190446  
Field No. 90-HSA  
not seen  
Slope north of Mitchell glacier, east of Bruce Jack lineament 5900'.  
425900E/6267800N  
Formation: Salmon River?
Bivalves  
Myophorella sp.
Trigonia sp.  
Middle Jurassic, probably Lower Bajocian/Callovian?


LOC. 55  C- 86259  
Field No. 67 EWG-F-1

East of Sulphurets Creek, east of Bruce Glacier, 1400m
56° 36' 00"/130° 17' 20"; 420625E/6273100N
Formation: Salmon River

Ammonite,
Sonninia? sp.

Bivalves
Trigonia aff. T. guhsani McLEARN

Coleoid
Ctenostreon? aff. gikshanensis McLEARN

Gastropods

Probably Middle Bajocian

GSC Report No. JAJ & HF (in Grove, 86)

LOC. 56  C-175773  
Field No. 91 GJ-100

1.4 km SSW (200°) of head of Treaty Creek
432920E/627340N
Formation: Salmon River

Ammonite
Eudmetoceras? sp.

Bivalves
Weyla? sp. or Pectinid

Corals
Gastropods

Probably Lower Bajocian?

LOC. 57a  C-101258  
Field No. 84 AT-77F  not seen

0.3 km S of Tom Mackay Lake
406250E/6274700N; 56° 36' 34"/130° 31' 32"
Formation: Ashman

Ammonite
Iniskinites sp.

Upper Bathonian

LOC. 57a  C-201440  
Field No. 91 GTN-12

South end of Tom Mackay Lake
406320E/6274725N
Formation: Ashman

Ammonite

_Iniskinites_ spp.

Upper Bathonian

LOC. 57a  C-201601  
Field No. 90 AJM-190  
C-201602  
Field No. 90 AJM-191

Traverse from NW corner to southern end of Tom Mackay Lake
406320E/6274725N
Formation: Ashman

Ammonite

_Iniskinites_ sp.

Upper Bathonian

LOC. 57a  C-201624  
Field No. 89 PLS-27

South of Tom Mackay Lake
406325E/6274710N
Formation: Ashman

Ammonite

_Iniskinites cf. intermedius_ IMLAY

Upper Bathonian

LOC. 57b  C-101259  
Field No. 84 AT-78F  
not seen

0.5 km SSE of Tom Mackay Lake
56° 36' 20"/130° 31' 44"; 406140E/6274340N
Formation: Ashman

Ammonite

_Iniskinites_ sp.

Upper Bathonian


LOC. 57c  C-118984  
Field No. 85 ATG-95

South end of Tom Mackay Lake.
406095E/62741608N; 56° 36' 34"/130° 31' 32"
Formation: Ashman
Ammonite
_Iniskinites cf. yukonensis_ FREBOLD

Upper Bathonian


LOC. 57d  C-118987  Field No. 85 ATG-110F  not seen

South end of Tom Mackay Lake.
56° 36'41"/130° 31'47" ; 405875E/6274330N
Formation: Ashman

Ammonite
_Iniskinites sp._

Upper Bathonian


LOC. 57e  C-201448  Field No. 91 GTN-44

SW end of Tom Mackay lake
406150E/6275225N
Formation: Ashman

Ammonite
_Iniskinites sp._

Bivalves

Upper Bathonian


LOC. 58  C-86266  Field No. 67 EWG-F-5  not seen

South end of Tom Mackay Lake
56° 36'00"/130° 31'00"
Formation: Ashman

Ammonite
_Kheraiceras_ sp. (=_Iniskinites sp._)

Upper Bathonian

LOC. 59  C-201447  Field No. 91 GTN-43

1.5 km SW of peak 4323'
407430E/6274525N
Formation: Ashman

Ammonite
_Iniskinites sp._
Upper Bathonian

LOC. 60  C-201434  Field No. 91 GTN-29
East bank of Argillite Creek
410475E/6277575N
Formation: Ashman
Eskay Creek Section
Ammonite
  *Iniskinites* spp.
  *Lilloettia* spp.
  Perisphinctidae gen. indet.
  *Cobbanites* spp.

Upper Bathonian

LOC. 60  C-201603  Field No. 90 AJM-205
East bank of Argillite Creek
410475E/6277575N
Formation: Ashman
Ammonite
  *Iniskinites* sp.

Upper Bathonian

LOC. 61  C-201416  Field No. 92 GTN-30b
West bank of Argillite Creek
411050E/6277650N
Formation: Ashman
Eskay Creek Section
Ammonite
  *Lilloettia* spp.

Upper Bathonian - Lower Callovian

LOC. 62  C-201435  Field No. 89 PLS-78
Field No. 91 GTN-2
East bank of Argillite Creek
411450E/6279250N
Formation: Ashman
Eskay Creek Section
Ammonite
  *Lilloettia* sp.

Upper Bathonian - Lower Callovian

LOC. 63  C-175775  Field No. 91 GJ-101
1.5 km S (185°) of head of Treaty Creek
433068E/6273350N
Formation: Salmon River

_Treaty Ridge Section_

Ammonite
Lilloettia sp.
Kepplerites sp.

Upper Bathonian to Lower Callovian

LOC. 64 C- 86263

Field No. 67 EWG-F-8

North of Mitchell Glacier
56° 33' 00"/130° 13' 00"; 425140E/6267520N
Formation: Salmon River? Ashman?

Ammonite
Amoeboceras sp.

Bivalves
Ostrea sp.
Plueromya
Trigonia? sp.

Belemnoid
Gastropods

Oxfordian

_GSC Report No. J15-71-HF (age revised in this study)_
### Localities with poorly preserved fossils (Loc. 65-116)

<table>
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<tr>
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<th>Field No.</th>
<th>Coordinates</th>
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<th>Age</th>
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<tr>
<td>65</td>
<td>C-86265</td>
<td>South of Twin John Peaks, 1340m</td>
<td>Betty Creek</td>
<td>Probably Lower Jurassic</td>
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<td>56° 31' 00&quot;/130° 26' 00&quot;</td>
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<tr>
<td></td>
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<td>SW slope of Twin John Peaks, 1340m</td>
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<tr>
<td></td>
<td></td>
<td>411560E/6264590N</td>
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<td>Field No. 67 EWG-F9</td>
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<td>66</td>
<td>C-177156</td>
<td>South of John Peaks</td>
<td>Salmon River</td>
<td>Probably Lower Jurassic</td>
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<td>411560E/6264590N</td>
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<td>67</td>
<td>C-177162</td>
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<td>C-177161</td>
<td>North of John Peaks</td>
<td>Betty Creek?</td>
<td>Probably Lower Jurassic</td>
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<td></td>
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<td>412980E/6270400N</td>
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<td>Field No. 91 PDL-730</td>
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</table>
South John Peaks
412050E/6262800N
Formation: Betty/Dilworth

Bivalves

LOC. 70 C-201640 Field No. 91 JG-88

North of Jack Glacier
417900E/6275250N
Formation: Unuk River

Bivalves

Grammotodon? sp.
Astarte cf. ?meeki

LOC. 71 C-44413 Field No. 60 EWG-3 not seen

West side of Jack Glacier, 1310m.
56° 35' 00"/130° 21' 00"
Formation: Unuk River

Bivalves

Weyla sp.

LOC. 72 C-44412 Field No. 60 EWG-2 not seen

West side of Jack Glacier, 1310m
56° 37' 00"/130° 20' 00"
Formation: Unuk River

Bivalves

Pecten sp.
Belemnoid

LOC. 73 C-201636 Field No. 91 JG-314

West of Bruce Glacier
414150E/6271750N
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<td>Field No. 87-JB-33-6B</td>
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<td>LOC.</td>
<td>C-201443</td>
<td>Field No. 91 GTN-37</td>
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<tr>
<td>LOC.</td>
<td>C-201444</td>
<td>Field No. 91 GTN-38</td>
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</table>

Formation: Unuk River

- **Bivalves**
- **Gastropods**

Probably Lower Jurassic

---

**LOC. 74**

South end of Tim Williams nunatak
437100E/6265100N
Formation: Unuk River?

**Bivalves or Brachiopod**

Middle Jurassic?


---

**LOC. 74 C-143454**

South end of Tim Williams nunatak
437250E/6265300N
Formation: Unuk River?

**Bivalves**

- *Weyla* sp.
- *Ostreid*

**Gastropods**

Lower Jurassic?


---

**LOC. 75 C-201443**

SE side of Dove Lake
410190E/6275300N
Formation: ?

**Wood imprint**

Probably Lower Jurassic

---

**LOC. 76 C-201444**

East of a meadow area due NE of a small unnamed lake
410225E/6274750N
Formation: ?

**Ammonite**

**Bivalves**

**Corals**

**Wood imprints**
APPENDIX

Probably Lower Jurassic

LOC. 77  C-201445  Field No. 91 GTN-40
Along creek (east) due north of unnamed lake
410350E/6275000N
Formation: Betty Creek

Bivalves
  *Weyla* sp.
Coleoids
Wood imprints

LOC. 78  C-201424  Field No. 91 GTN-41
NE of unnamed lake
411040E/6276300N
Formation: Betty Creek

Bivalves
Gastropods
Wood

LOC. 79  C-201446  Field No. 91 GTN-42
NE of small unnamed lake (Float)
410850E/6276150N
Formation: Betty Creek

Ammonite?
Bivalves
Crinoid
Coleoid

LOC. 80  C-201413  Field No. 91 GTN-26a
North of Sib Lake
408450E/6274250N
Formation: Unuk River/Betty Creek?

Bivalves
  *Weyla* sp.
  *Pleuromya* sp.
Brachiopod
  Rhynchosomal gen. indet.
Crinoid  Probably Lower Jurassic

LOC. 81  C-201414  Field No. 91 GTN-27

West of Gap Lake
408850E/6275050N
Formation: ?

Bivalves  Probably Lower Jurassic

LOC. 82  C-201439

SE of EC camp (east of core racks), bank of waterfall
411440E/6277600N
Formation: Betty Creek?

Bivalves  Probably Lower Jurassic

LOC. 83  C-143470  Field No. 89 KH-7-2-3A  not seen

East slope of Sericite Ridge, below seeps
385690E/6274340N
Formation:?

Bivalves  
Weyla? sp.  Probably Lower Jurassic

GSC Report No. J4-1990-HWT

LOC. 84  C-143485  Field No. 89 JB-38-14A  not seen

3km NE of Lehua Mountain summit
392500E/6264810N
Formation:

Bivalves  
Weyla? sp.  Probably Lower Jurassic but indefinite

GSC Report No. J4-1990-HWT

LOC. 85  C-65438  Field No. 81 JM-H-60F  not seen
APPENDIX

8.5 km at 142° from junction of Forest Kerr Creek and Iskut River, 4000'
56° 40' 38"/130° 34' 55" ; 403950E/6282430N
Formation: ?

Bivalves
   *Trigonia* sp.
Gastropods
Scleractinian Corals

Probably Lower to Middle Jurassic


LOC. 86a C-95439  Field No. 81 JM-H-63F  not seen

1.6 km at 86° from junction of Forest Kerr Creek and Iskut River
56° 44' 25"/130° 37' 42" ; 400580E/6292210N
Formation: ?

Ammonite
Bivalves
   *Isocyprina?* sp.
   *Pronoella?* sp.
   *Astarte?* sp.
   *Vaugonia?* sp.
Ostreoidae indet.
Belemnite
Brachiopod

Probably Middle Jurassic to Lower Upper Jurassic


LOC. 86b C-95438  Field No. 81 JM-H-60F  not seen

8.5 km at 142° from junction of Forest Kerr Creek and Iskut River
403950E/6282430N
Formation: ?

Ammonite
Bivalves
   *Trigonia* sp.
Gastropod
Coral

Probably Lower to Middle Jurassic


LOC. 87 C-86267  Field No. 67 EWG-F-3

Between Bruce and Jack glaciers
Appendix

56° 37' 00"/130° 21' 00"; 416900E/6275000N
Formation: Salmon River

Ammonite
Bivalves
   *Trigonidae* sp.
Belemnoids

Probably Middle Jurassic

GSC Report No. JAJ & HF; Grove, 86

LOC. 88 C-143458 Field No. 88A-JB-BCAA10-6 not seen

West side of Bruce Glacier
415130E/6272650N
Formation: Salmon River

Bivalves
Scleractinian Corals

Middle Jurassic (according to collector)


LOC. 89 (specimen on loan) Field No. 91 V-1

3km east from toe of Atkins Glacier
428475E/6275990N
Formation: Mt. Dilworth

Ammonite
   *Phylloceras* sp.

Middle Jurassic (according to collector)

LOC. 90 C-201441 Field No. 91 GTN-19a

North of Atkins Glacier
425575E/6277490N
Formation: Salmon River

Ammonite
Bivalves
   *Trigonidae* sp.
   *Myophorella* sp.
   *Astartidae* sp.
   *Oxytoma*? sp.
   *Gryphaeidae*? sp.
Coleoid

Probably Lower to Middle Jurassic
<table>
<thead>
<tr>
<th>LOC.</th>
<th>Field No.</th>
<th>Location and Details</th>
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</table>
| 91    | C-201442   | North of Atkins Glacier  
425425E/6277325N  
Formation: Salmon River  
Bivalves, Gastropods, Corals  
Probably Middle Jurassic |
| 92    | C-175768   | 4.9 km S (172°) of head of Treaty Creek  
434000E/6269770N  
Formation: Ashman?  
Ammonite  
Bivalve  
Probably Middle Jurassic |
| 93    | C-175770   | 1.3 km SW (222°) of head of Treaty Creek  
432450E/6273680N  
Formation: Salmon River  
Indeterminate |
| 94    | C-44411    | On ridge 2.6 km east of King Creek, 1580m  
56° 31' 00"/130° 42' 00"  
Formation: Betty Creek  
Ammonite  
Bivalves  
Belemnoid  
Probably Lower Jurassic |
| 95    | C-86261    | On ridge 2.6 km east of King Creek, 1580m  
56° 31' 00"/130° 41' 00"  
Formation: Unuk River  
not seen |
Bivalves

Probably Middle Jurassic


LOC. 96 C-201427

Field No. 91 GTN-49a

North of Pumphouse Lake (Contact Zone)
411900E/6278830N
Formation: Salmon River

Bivalves
Belemnite

Probably Middle Jurassic

LOC. 97 C-177153

Field No. 91 PDL-480

South of Tom Mackay Lake
407480N/6274440N
Formation: Ashman

Ammonite

Probably Middle Jurassic

LOC. 97a C-201449

Field No. 91 GTN-45

SW end of Tom Mackay Lake near a small lake
405875E/6275130N
Formation: Ashman

Ammonite
Iniskinites? sp.
Bivalves
Pectinids gen.
Belemnite

Middle Jurassic - probably Upper Bathonian

LOC. 97b C-177154

Field No. 91 PDL-553

Mackay Lake
405850E/6275100N
Formation: Salmon River?

Bivalves

Probably Middle Jurassic

LOC. 98 C-86268

Field No. 67 EWG-F-6

Elevation 1,070m, on slope south of ridge 2.4 km
northeast of Tom Mackay Lake  
56° 40' 00"/130° 25' 00"
Formation: Ashman?

Ammonite
Bivalves
*Inoceramus* sp.

Probably Middle Jurassic

GSC Report No. JAJ & HF (*in* Grove, 86)

<table>
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<tr>
<td>400540E/6265250N</td>
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<tr>
<td>Formation: Betty Creek</td>
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<tr>
<td>Foraminifera</td>
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<tr>
<td>Ostracodes</td>
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<tr>
<td>Indetermined</td>
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</table>

| LOC. 100 | C-201626 | Field No. 89 PLS-53 |
| LOC. 100 | C-201627 | Field No. 89 PLS-60 |
| 3.5km W of junction of Lyons and Harrymel creeks |
| 400540E/6265250N |
| Formation: Betty Creek |
| Plant |
| Indetermined |

| LOC. 101 | C-143494 | Field No. 89 MM-26-4b |
| not seen |
| Sleepwalk ridge |
| 38252E/6265440N |
| Formation: ? |
| Bivalves |
| Indeterminate |

GSC Report No. J4-1990-HWT

| LOC. 102 | C-143500 | Field No. 89 MM-21-1b |
| not seen |
| South Eskay Creek (gosson gulch) |
| 409300E/6275720N |
| Formation: ? |
Woody material

Unknown

GSC Report No. J4-1990-HWT

LOC. 103 C-143499

Field No. 89 MM-19-8b

not seen

East of Snippaker Mountain
380540E/6281040N
Formation: ?

Organic fragments

Unknown

GSC Report No. J4-1990-HWT

LOC. 104 C-143497

Field No. 89 MM-11-1

not seen

1 km SW of Tom Mackay Lake
405410E/6274570N
Formation: Ashman?

Indeterminate fossils

Unknown

GSC Report No. J4-1990-HWT

LOC. 105 C-167546

Field No. 90 JH-19-113

not seen

North of Lyons Creek
400470E/6265600N
Formation:

Organic or inorganic structures
(-rounded and elongate)

Indetermined


LOC. 106 C-167523

Field No. 90-JB-19-1A

not seen

Head of Lyons Creek

FORMATION:

Organic structures
(rounded and elongate)

Indetermined
**APPENDIX**


<table>
<thead>
<tr>
<th>LOC. 107</th>
<th>C-143471</th>
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**GSC Report No. J4-1990-HWT**

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**GSC Report No. J4-1990-HWT**

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**GSC Report No. MJO; unpub. report to BCGSB (1990)**

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**GSC Report No. 8 ETT-1989**

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South of Cinder Mountain/East of Cone Glacier
400220E/6269120N
Formation: ?
Wood fragments

GSC Report No. J4-1990-HWT

LOC. 112  C-201632  Field No. 92 DK-2

East of Eskay Creek Camp
412700E/6276900N
Formation: Betty Creek

Ammonite
Bivalves
  Weyla sp.
Coleiod

LOC. 113  C-175764  Field No. 91 GJ-073

3km NE (32°) of head of Treaty Creek
435010E/6277000N
Formation: Ashman?

Bivalves
  Buchia sp.

LOC. 114  C-175765  Field No. 91 GJ-074

5.3 km NE (53°) of head of Treaty Creek
437670E/6277630N
Formation: Ashman?

Ammonite
  Stephanoceras? sp.
Bivalves
  Buchia

LOC. 115  C-175766  Field No. 91 GJ-074

5.3 km NE (53°) of head of Treaty Creek
437670E/6277630N
Formation: Ashman?
Ammonite
Bivalves
*Buchia*

Upper Jurassic

---

**LOC. 116 C-175767**

Field No. 91 GJ-078

5.1 km NE (36°) of head of Treaty Creek
436340E/6278560N
Formation: Ashman?

Bivalves
*Buchia*

Upper Jurassic
c) **Processed for radiolarian: barren samples (Loc. 117-143)**

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<td>Headwaters of Eskay Creek, NE of EC camp</td>
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APPENDIX

North of Atkins Glacier
425575E/6277490N
Formation: Salmon River

LOC. 125 C- 201408 Field No. 91 GTN-20
North of Atkins Glacier
425430E/6277230N
Formation: Salmon River

LOC. 126 C- 201409 Field No. 91 GTN-22
North of Atkins Glacier
425200E/6276830N
Formation: Salmon River

LOC. 127 C- 201410 Field No. 91 GTN-23
North of American Fibre camp
407700E/6273600N
Formation: ?

LOC. 128 C- 201411 Field No. 91 GTN-24
North of American Fibre camp
407800E/6273650N
Formation: ?

LOC. 129 C- 201412 Field No. 91 GTN-25
North of Sib Lake
408400E/6274200N
Formation: ?

LOC. 130 C- 201413 Field No. 91 GTN-26b
North of Sib Lake
408450E/6274250N
Formation: ?

LOC. 131 C- 201415 Field No. 91 GTN-28a
East of Dove Lake, NW of Feet Lake
409700E/6274650N
Formation: ?
LOC. 132  C- 201416  
Field No. 91 GTN-30a  
West bank of Argillite Creek  
411050E/6277650N  
Formation: Ashman  

LOC. 133  C- 201417  
Field No. 91 GTN-31b  
East of Argillite Creek (Contact Zone)  
410700E/6277800N  
Formation: Mt. Dilworth  

LOC. 134  C- 201421  
Field No. 91 GTN-35  
West bank of Argillite Creek  
410000E/6277150N  
Formation: Ashman  

LOC. 135  C- 201422  
Field No. 91 GTN-36  
West bank of Argillite Creek  
410500E/6277825N  
Formation: Ashman  

LOC. 136  C- 201423  
Field No. 91 GTN-39  
Along creek due north of unnamed lake  
410290E/6274990N  
Formation: Betty Creek  

LOC. 43  C- 201425  
Field No. 91 GTN-46a  
Nunatak, center of Mitchell glacier  
427100E/6263650N  
Formation: Betty Creek  

LOC. 137  C- 201426  
Field No. 91 GTN-48  
East of Iron Cap and fault  
427200E/6267900N  
Formation: Salmon River?  

LOC. 138  C- 201427  
Field No. 91 GTN-49b  
North of Pumphouse Lake (Contact Zone)  
411900E/6278830N
Formation: Mt. Dilworth

LOC. 139 C- 201430
Field No. 91 GTN-51
Underground, Zone 21B (Contact Zone)
411450E/6278000N
Formation: Mt. Dilworth

LOC. 140 C- 177151
Field No. 91 PDL-409
Tom Mackay lake
405940E/6276340N
Formation: Salmon River

LOC. 141 C- 177152
Field No. 91 PDL-453
West of Tom Mackay lake
404980E/6274600N
Formation: Betty Creek

LOC. 142 C- 177158
Field No. 91 PDL-547
Barb Lake
405640E/6272360N
Formation: Betty/Salmon?

LOC. 143 C- 177155
Field No. 91 PDL-554
NE of Tom Mackay Lake
405910E/6275960N
Formation: ?
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Explanation of Plate I
(all figures natural size unless otherwise indicated)

*Norian*

**Fig. 1, 3:** *Nevadathalamia* sp. indet.
Stuhini Group, GSC C-177387a,b (91 GTN-50),

**Fig. 2:** *Nevadathalamia* sp. indet.
Stuhini Group, GSC C-101262a (84-AT-SP-F),
Explanation of Plate II
(all figures natural size unless otherwise indicated)

**Norian**

Fig. 1 : Colonial scleractinian coral  
Stuhini Group, GSC C-177387c (91 GTN-50),  
Loc. 1 - Crickmayi-Amoenum zones.
Explanation of Plate III
(all figures natural size unless otherwise indicated)

Norian

Fig. 1:  *Rhacophylites* sp. indet.
Stuhini Group, GSC C-177387d (91 GTN-50),
Loc. 1 - Crickmayi-Amoenum zones.

Fig. 2, 4:  Gastropods gen indet.
Stuhini Group, GSC C-177387e, f (91 GTN-50),
Loc. 1 - Crickmayi-Amoenum zones.

Fig. 3, 6:  *Placites* sp. indet.
Stuhini Group, GSC C-177387g, h (91 GTN-50),
Loc. 1 - Crickmayi-Amoenum zones.

Fig. 5:  *Cladiscites* sp. indet.
Stuhini Group, GSC C-177387i (91 GTN-50),
Loc. 1 - Crickmayi-Amoenum zones.
Explanation of Plate IV
(all figures natural size otherwise indicated)

**Norian**

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Explanation of Plate V
(all figures natural size unless otherwise indicated)

Upper Hettangian - Lower Sinemurian

Fig. 1: *Paracaloceras cf. multicostatum* FREBOLD
Unuk River Fm., GSC C-201415a (91 GTN-28b),
Loc 14 - Canadensis Zone. Lateral view of latex cast of external mould.

Fig. 2: *Paracaloceras cf. coregonense?* (SOWERBY)
Jack "fin.", GSC C-175779a (91 AT-169F),
Loc. 13 - Canadensis Zone.
Lateral view of latex cast of internal mould of inner whorls.

Fig. 3: *Paracaloceras rursicostatum* FREBOLD
Jack "fm.", GSC C-201631a (90 WR-1),
Loc. 10 - Canadensis Zone.
Lateral view of latex cast of external mould.

Fig. 4: *Paracaloceras sp. indet.*
Unuk River Fm., GSC C-201415b (91 GTN-28b),
Loc. 14 - Canadensis Zone.
Lateral view of internal mould.
Explanation of Plate VI
(all figures natural size unless otherwise indicated)

**Upper Hettangian - Lower Sinemurian**

Fig. 1: *Alsaites cf. proaries? NEUMAYR*
Jack "fm.", GSC C-201631b (90 WR-1),
Loc. 10 - Canadensis Zone.
Lateral view of internal mould.
Explanation of Plate VII
(all figures natural size unless otherwise indicated)

Upper Hettangian - Lower Sinemurian

Fig. 1: *Weyla cf. alata* VON BUCH
Jack "fm.", GSC C-201453a (91 HSA-286), Loc. 11 - Canadensis Zone.
1a: Right valve - internal mould with some shell material.
1b: Left valve - internal mould with some shell material.

Fig. 2: *Camptonectes?* sp. indet.
Jack "fm.", GSC C-201606a (89 PLS-1), Loc. 10 - Canadensis Zone.
2a: Left valve.
2b: Side view.

Fig. 3: *Pleuromya?* sp. indet.
Jack "fm.", GSC C-201606b (89 PLS-1), Loc. 10 - Canadensis Zone.
3a: Left valve of internal mould.
3b: Top view of internal mould.

Fig. 4: *Eopecten* sp. indet.
Jack "fm.", GSC C-201606c (89 PLS-1), Loc. 10 - Canadensis Zone.
Left valve of internal mould.

Fig. 5: *Weyla cf. alata* VON BUCH
Jack "fm.", GSC C-201606d (89 PLS-1), Loc. 10 - Canadensis Zone.
5a: Right valve - internal mould with some shell material.
5b: Left valve - internal mould with some shell material.
Explanation of Plate VIII
(all figures natural size unless otherwise indicated)

*Upper Hettangian - Lower Sinemurian*

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<td>7, 8</td>
<td>Solitary scleractinian coral</td>
<td>Jack &quot;fm.&quot;*, GSC C-201608a, b (90 PLS-3), Loc. 10 - Canadensis Zone.</td>
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<td><em>Gastropoda</em> gen indet.</td>
<td>Jack &quot;fm.&quot;*, GSC C-175779b, c (91 AT-169F), Loc. 13 - Canadensis Zone.</td>
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<td><em>Gryphaea</em> sp. indet.</td>
<td>Jack &quot;fm.&quot;*, GSC C-201457b (91 HSM-38), Loc. 12 - Canadensis Zone.</td>
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Explanation of Plate IX
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*Upper Pliensbachian*

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<td>Leptaleoceras cf. accuratum? FUCINI</td>
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<td>Arieticeras sp. indet.</td>
<td>Betty Creek Fm., GSC C-177159b (91 PDL-664), Loc. 20 - Kunae Zone. Lateral view of internal mould.</td>
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<td>Betty Creek Fm., GSC C-44419d (60 EWG-9), Loc. 19 - Kunae Zone. 6a: right valve. 6b: top view.</td>
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<td>7</td>
<td>Leptaleoceras sp. indet.</td>
<td>Betty Creek Fm., GSC C-101276a (85 AT-B-160), Loc. 18 - Kunae Zone. Lateral view of latex cast of external mould.</td>
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<td>8</td>
<td>Arieticeras sp. indet.</td>
<td>Betty Creek Fm., GSC C-101276b (85 AT-B-160), Loc. 18 - Kunae Zone. Lateral view of latex cast of external mould.</td>
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<td>9, 10</td>
<td>Arieticeras cf. algovianum? (OPPEL)</td>
<td>Betty Creek Fm., GSC C-101276c, d (85 AT-B-160), Loc. 18 - Kunae Zone. Lateral view of latex cast of external mould.</td>
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Betty Creek Fm., GSC C-101276f (85 AT-B-160), Loc. 18 - Kunae Zone.  
Lateral view of internal mould.

Fig. 14: *Protogrammoceras cf. nipponicum* (MATSUMOTO)  
Betty Creek Fm., GSC C-201619a (89 PLS-39), Loc. 18 - Kunae Zone.  
Lateral view of latex cast of external mould.

Fig. 15: *Arieticeras cf. algovianum* (OPPEL)  
Betty Creek Fm., GSC C-201619b (89 PLS-39), Loc. 18 - Kunae Zone.  
Lateral view of latex cast of external mould.
Explanation of Plate X
(all figures natural size unless otherwise indicated)

Upper Pliensbachian/Lower Toarcian

Fig. 1 : Protoagnostoceras cf. kurrianum (BUCKMAN)
Betty Creek Fm., GSC C-93581 (Donnelly-2),
Loc. 23 - Carlottense Zone?
Lateral view of internal mould.

Fig. 2 : Lioceratoides? sp. indet.
Betty Creek Fm., GSC C-201604a (90 AJM-206),
Loc. 23 - Carlottense Zone.
Lateral view of latex cast of external mould.

Fig. 3 : Tiltoniceras cf. propinquum (WHITEAVES)
Betty Creek Fm., GSC C-201436 (91 GTN-7),
Loc. 21 - Carlottense Zone.
3a: ventral view of internal mould of whorl fragment.
3b: lateral view of internal mould of whorl fragment.

Fig. 4 : Protoagnostoceras cf. kurrianum (BUCKMAN)
Betty Creek Fm., GSC C-201604b (90 AJM-206),
Loc. 23 - Carlottense Zone.
Lateral view of internal mould of whorl fragment.

Fig. 5 : Weyla sp. indet.
Betty Creek Fm., GSC C-201623 (89 PLS-62),
Loc. 22 - Lower Jurassic.
Right valve of internal mould.

Fig. 6, 16 : Pleydellia cf. maudensis
Betty Creek/Salmon River Fm., GSC-86273a, b (70 EWG-122),
Loc. 27 - Assemblage Zone 6 of Jakobs.
Lateral view of internal mould.

Fig. 7, 8, 9, 14 : Dactylioceras sp. indet.
Unuk River Fm.?, GSC C-87061a-d (70 EWG-B),
Loc. 26 - Assemblage Zones 2-3.
Lateral view of latex cast of external mould.

Fig. 10, 15 : Dactylioceras cf. athleticum (SIMPSON)
Unuk River Fm., GSC C-87061e, f (70 EWG-B),
Loc. 26 - Assemblage Zones 2-3.
10: lateral view of internal mould.
15: lateral view of latex cast of external mould.
Fig. 11: *Pleydellia* sp. indet.
Betty Creek/Salmon River Fm., GSC-86273c (70 EWG-122),
Loc. 27 - Assemblage Zone 6 of Jakobs.
Lateral view of internal mould.

Fig. 12, 13: *Dactylioceras cf. helianthoides* (YOKOYAMA)
Unuk River Fm.?, GSC C-87061g, h (70 EWG-B),
Loc. 26 - Assemblage Zones 2-3.
Lateral view of latex cast of external mould.
Explanation of Plate XI
(all figures natural size unless otherwise indicated)

Toarcian - Aalenian

Fig. 1 : *Conodicoelites* sp. aff. *C. meyrati* (OOSTER)
Salmon River Fm., GSC C-86273 (70 EWG-122),
Loc. 27, (From Jeletzky, 1980).
1a: ventral view.
1b: lateral view.
1c: dorsal view.
1d: apical view (x2).
1e: cross-section of oral end.

Fig. 2, 3, 5, 6, 7 : *Tmetoceras* cf. *kirki* WESTERMANN
Salmon River Fm.?, GSC C-175772a, b, c, d, e, f (91 GJ-099),
Loc. 39 - *Erycitoides howelli* zone.
Lateral view of latex cast of external mould.

Fig. 4 : *Leioceras*? sp. indet.
Salmon River Fm.?, GSC C-201610a (92 PDL-886),
Loc. 39 - *Erycitoides howelli* zone.

Fig. 8 : *Pseudolioceras* sp. indet.
Salmon River Fm.?, GSC C-175772g (91 GJ-099),
Loc. 39 - *Erycitoides howelli* zone.
Lateral view of latex cast of external mould.

Fig. 9 : *Pseudolioceras* sp. indet.
Salmon River Fm.?, GSC C-201610b (92 PDL-886),
Loc. 39 - *Erycitoides howelli* zone.
Lateral view of latex cast of external mould.

Fig. 10 : *Tmetoceras* cf. *kirki*? WESTERMANN
Salmon River Fm.?, GSC C-275772h (91 GJ-099),
Loc. 39 - *Erycitoides howelli* zone.
10a: Arrow pointing to the ventral imprint.
10b: Arrow pointing to the venral imprint (x3).
Explanation of Plate XII
(all figures natural size unless otherwise indicated)

*Aalenian - Lower Bajocian*

**Fig. 1, 2:** *Planammatoceras cf. planinsigne* VACEK
Salmon River Fm., GSC C-201641a, b (92 CR-2),
Loc. 40 - *Erycitoïdes howelli* zone.
Lateral view of internal mould.

**Fig. 3:** *Phylloceras* sp. indet.
Salmon River Fm., GSC C-201641c (92 CR-2),
Loc. 40 - *Erycitoïdes howelli* zone.
Lateral view of internal mould.

**Fig. 4:** *Cardinia* sp. indet.
Salmon River Fm., GSC C-201641d (92 CR-2),
Loc. 40 - *Erycitoïdes howelli* zone.
Internal mould of left valve.

**Fig. 5:** *Planammatoceras* sp. indet.
Salmon River Fm., GSC C-201641e (92 CR-2),
Loc. 40 - *Erycitoïdes howelli* zone.
Lateral view of internal mould.

**Fig. 6:** *Pseudolioceras* sp. indet.
Salmon River Fm., GSC C-201610c (92 PL-886),
Loc. 39 - *Erycitoïdes howelli* zone.
Lateral view of latex cast of external mould.

**Fig. 7, 8:** *Stephanoceras* sp. indet.
Ashman Fm?, GSC C-93590/93591 (76 DON-3),
Loc. 50 (Float) - Lower Bajocian.
Lateral view of latex cast of distorted external mould.

**Fig. 9, 10:** *Zemistephanus* sp. indet.
Ashman Fm., GSC C-175774a,b (91 GJ-100),
Loc. 49 - Lower Bajocian.
Lateral view of latex cast of external mould.
### Explanation of Plate XIII
(all figures natural size unless otherwise indicated)

#### Middle Jurassic

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<td>Salmon River Fm., GSC C-201425 (91 GTN-46), Loc. 52 - probably Middle Jurassic</td>
<td>Latex cast of external mould.</td>
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<tr>
<td>Fig. 2, 4, 6</td>
<td><em>Trigonia</em> sp. indet.</td>
<td>Salmon River Fm., GSC C-201450a, b, c (91 GTN-47), Loc. 54 - probably Middle Jurassic</td>
<td>Latex cast of external mould.</td>
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<td>Fig. 3, 5</td>
<td><em>Myophorella</em> sp. indet.</td>
<td>Salmon River Fm., GSC C-201450d, e (91 GTN-47), Loc. 54 - probably Middle Jurassic</td>
<td>Latex cast of external mould.</td>
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<td>Fig. 7</td>
<td>Belemnite</td>
<td>Salmon River Fm., GSC C-175918 (89 AT-165-1), Loc. 31 - probably Middle Jurassic</td>
<td>Guard structure.</td>
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<td>Fig. 8, 9</td>
<td>Pectinid Bivalve</td>
<td>Ashman Fm., GSC C-201449 (91 GTN-45), Loc. 58 - probably Upper Bathonian</td>
<td>Latex cast of external mould.</td>
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<td>Fig. 10, 11</td>
<td><em>Vaugonia</em> sp. indet.</td>
<td>Salmon River Fm., GSC C-201450f (91 GTN-47), Loc. 54 - probably Middle Jurassic</td>
<td>Latex cast of external mould.</td>
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<td>Fig. 12</td>
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Explanation of Plate XIV
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*Upper Bathonian*

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| 1    | *Iniskinites* sp. indet.  
Ashman Fm., GSC C-201434a, b (91 GTN-29), Loc. 60 - Upper Bathonian.  
Lateral view of latex cast of external mould. |
| 2    | *Cobbanites* indet. sp. A  
Ashman Fm., GSC C-201434c (91 GTN-29), Loc. 60 - Upper Bathonian.  
Lateral view of latex cast of external mould. |
| 3, 4, 5, 7, 12 | *Lilloettia* cf. *lilloentensis*? Crickmay  
Ashman Fm., GSC C-201434d, e, f, g, h (91 GTN-29), Loc. 60 - Upper Bathonian.  
Lateral view of latex cast of external mould. |
| 6    | *Cobbanites* indet. sp. B  
Ashman Fm., GSC C-? (89 PLS-80), Loc. 60 - Upper Bathonian.  
Lateral view of latex cast of external mould. |
| 9, 10 | Ventral imprints (*Lilloettia*)?  
Ashman Fm., GSC C-201434i, j (91 GTN-29), Loc. 60 - Upper Bathonian.  
Lateral view of latex cast of external mould. |
| 11   | *Lilloettia* sp. indet.  
Ashman Fm., GSC C-201435 (91 GTN-2), Loc. 62 - Upper Bathonian.  
Lateral view of latex cast of external mould. |
Explanation of Plate XV
(all figures natural size unless otherwise indicated)

**Upper Bathonian**

Fig. 1, 2  :  *Cobbanites* indet. sp. C
Ashman Fm., GSC C-201434k, l (91 GTN-29),
Loc. 60 - Upper Bathonian.
Lateral view of latex cast of external mould.

Fig. 3, 4  :  *Iniskinites* indet. sp. A
Ashman Fm., GSC C-201434m, n (91 GTN-29),
Loc. 60 - Upper Bathonian.
Lateral view of latex cast of external mould.

Fig. 5  :  *Iniskinites*? sp. indet.
Ashman Fm., GSC C-201603 (90 AJM-205),
Loc. 60 - Upper Bathonian.
5a: ventral view of internal mould.
5b: lateral view of internal mould.
Explanation of Plate XVI
(all figures natural size unless otherwise indicated)

*Upper Bathonian/Lower Callovian*

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<td><em>Lilloettia indet. sp. A</em> Ashman Fm., GSC C-201416a, b, c (91 GTN30b), Loc. 61 - Upper Bathonian - Lower Callovian. 7a, 11a, 14b: lateral view of internal mould. 7b, 11b, 14a: ventral view of internal mould.</td>
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<td>8</td>
<td><em>Iniskinites indet. sp. B</em> Ashman Fm., GSC C-201602 (90 AJM-191), Loc. 57a - Upper Bathonian. Lateral view of internal mould.</td>
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Explanation of Plate XVII

Scanning electrom micrographs
(Bar scale = number of μm cited for each specimen illustrated)

_Aalenian, possibly Lower Bajocian_

Fig. 1 : _Emiluvia_ sp. B
Salmon River Fm., GSC C-201628 (89 PLS-76), Loc. 42
Scale Bar = 100 μm

Fig. 2 : _Emiluvia_ sp. A
Salmon River Fm., GSC C-201628 (89 PLS-76), Loc. 42
Scale Bar = 100 μm

Fig. 3, 4 : _Crucella_ sp. indet.
Salmon River Fm., GSC C-159453 (CA89-89.54.2), Loc. 46.
Scale Bar = 100 μm

Fig. 5 : _Spongostaurus_ sp. A
Salmon River Fm., GSC C-201628 (89 PLS-76), Loc. 42
Scale Bar = 100 μm

Fig. 6 : _Archaeohagiastrum longipes_ BAUMGARTNER
Salmon River Fm., GSC C-201628 (89 PLS-76), Loc. 42
Scale Bar = 100 μm

Fig. 7 : _Paronaella variabilis_ CARTER
Salmon River Fm., GSC C-201628 (89 PLS-76), Loc. 42
Scale Bar = 100 μm

Fig. 8 : Spumellaria indet. D
Salmon River Fm., GSC C-201418 (91 GTN-31c), Loc. 43.
Scale Bar = 60 μm

Fig. 9 : _Emiluvia_ (?) aff. _moresbyensis_ CARTER
Salmon River Fm., GSC C-201628 (89 PLS-76), Loc. 42
Scale Bar = 100 μm
Explanation of Plate XVIII
Scanning electron micrographs
(Bar scale = number of μm cited for each specimen illustrated)

*Aalenian, possibly Lower Bajocian*

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<td><em>Hsuum</em> sp. indet. Salmon River Fm., GSC C-159484 (CA89-426.40.7), Loc. 48. Scale Bar = 100 μm</td>
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<td><em>Pseudocrucella</em> sp. cf. <em>P. sanfilippoae</em> (PESSAGNO). Salmon River Fm., GSC C-159453 (CA89-89.54.2), Loc. 46. Scale Bar = 100 μm</td>
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**Explanation of Plate XIX**

Scanning electrom micrographs

(Bar scale = number of μm cited for each specimen illustrated)

*Aalenian, possibly Lower Bajocian*

Fig. 1, 2 : *Stichocapsa cf. convexa* YAO
Salmon River Fm., GSC C-159453 (CA89-89.54.2), Loc. 46.
Scale Bar = 50 and 80 μm respectively

Fig. 3 : *Archaeocenosphaera* sp. indet.
Salmon River Fm., GSC C-159453 (CA89-89.54.2), Loc. 46.
Scale Bar = 80 μm

Fig. 4 : *Stichocapsa* sp. indet.
Salmon River Fm., GSC C-159453 (CA89-89.54.2), Loc. 46.
Scale Bar = 100 μm

Fig. 5 : *Spumellaria* indet. A
Salmon River Fm., GSC C-201628 (89 PLS-76), Loc. 42
Scale Bar = 80 μm

Fig. 6 : *Praeconocaryomma* sp. indet.
Salmon River Fm., GSC C-159453 (CA89-89.54.2), Loc. 46.
Scale Bar = 100 μm

Fig. 7 : *Acaeniostyle (?)* sp. indet.
Salmon River Fm., GSC C-159453 (CA89-89.54.2), Loc. 46.
Scale Bar = 100 μm

Fig. 8 : *Pseudocrucella* sp. cf. *P. sanfilippoae* (PESSAGNO)
Salmon River Fm., GSC C-159453 (CA89-89.54.2), Loc. 46.
Scale Bar = 100 μm

Fig. 9 : *Napora* sp. indet.
Salmon River Fm., GSC C-159453 (CA89-89.54.2), Loc. 46.
Scale Bar = 100 μm

Fig. 10 : *Spumellaria* indet. B
Salmon River Fm., GSC C-201628 (89 PLS-76), Loc. 42
Scale Bar = 100 μm

Fig. 11 : *Spumellaria* indet. E
Salmon River Fm., GSC C-201628 (89 PLS-76), Loc. 42
Scale Bar = 100 μm