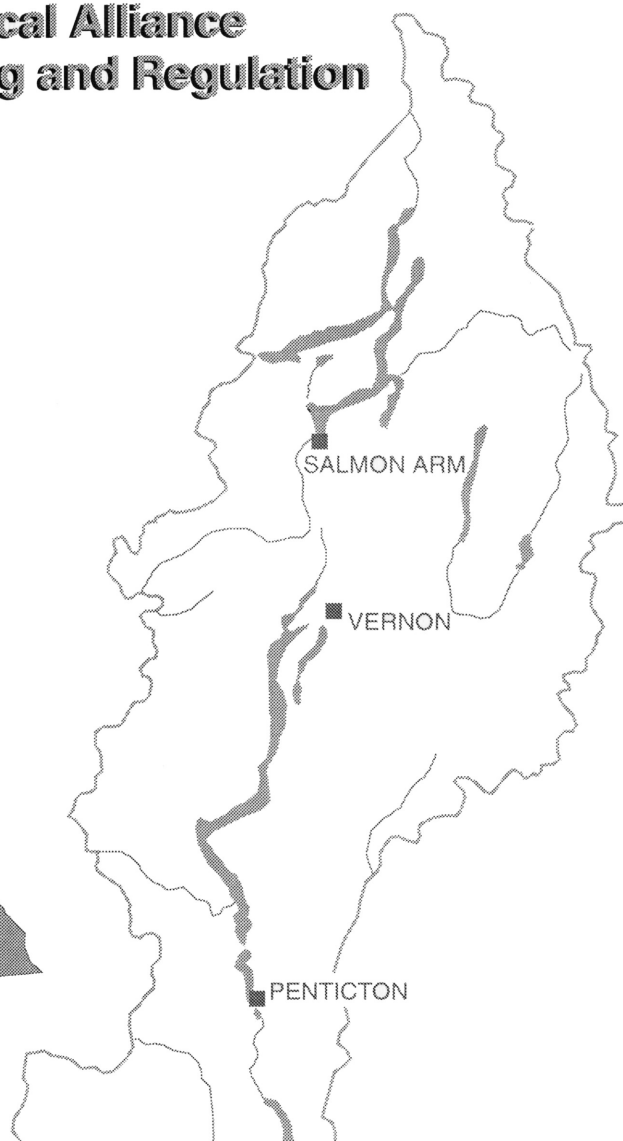


# Paleontological Resources of the Okanagan - Shuswap Land Resource Management Plan (LRMP) Area, British Columbia

Prepared by the  
**British Columbia Paleontological Alliance  
Committee on Fossil Collecting and Regulation**

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## SUMMARY

The British Columbia Paleontological Alliance (BCPA) is an organization of professional and amateur paleontologists of British Columbia, dedicated to advancing the science of paleontology in the province through education. The BCPA is a leading authority on paleontological resources in British Columbia, and includes representation from most of British Columbia's principal museums, universities, and government agencies that deal with paleontology. This report has been prepared by the BCPA for the Okanagan-Shuswap Land Resource Management Plan team, to enable them to make informed decisions about land designation issues relating to paleontological resources. The recommendations stated are those of the BCPA and are not those of the Geological Survey of Canada.

The Okanagan-Shuswap LRMP area comprises many different geologic units but fossils are distributed sparsely in most of these units. Microfossil assemblages are most common in the rocks, macrofossils less so. Fossil localities in the Okanagan-Shuswap LRMP area include fossil types and assemblages known from elsewhere in the LRMP area, in British Columbia, or in Canada, and are therefore considered as not especially unique or significant. On this basis, it is the opinion of the BCPA that no fossil localities within the Okanagan-Shuswap LRMP area merit special protection status.

It is the recommendation of the BCPA that all areas of the Okanagan-Shuswap LRMP area remain open to fossil collecting by the professional and amateur community, under the standards of the BCPA Code of Ethics. The BCPA recommends that no fossil sites presently known in the LRMP area be advertised in a manner which would promote overcollection or site destruction, but rather any collection should be done in a manner which is consistent with the BCPA Code of Ethics. Should new information come to light about fossil resources in the Okanagan-Shuswap LRMP area, local land-use planners are encouraged to consult with the BCPA to assess the scientific value of such sites and decide on appropriate action for special designation status.

## **PREFACE**

The British Columbia Paleontological Alliance (BCPA) is a union of professional and amateur paleontologists from across the province, dedicated to advancing the science of paleontology, chiefly through education. Amateurs and professionals have organized together in regional societies which hold regular meetings and field trips. The Board of Directors of the BCPA (see Appendix A) consists of 2 directors from each of the 5 regional societies presently active in the province, plus representatives from university, government, and museum organizations actively engaged in professional paleontological research or education in the province. As the largest organization of professional and amateur paleontologists in the province, the membership of the BCPA represents a wide spectrum of paleontological expertise, much broader than any single agency in the province.

The BCPA is working actively to provide needed information to land-use planners and other government officials to help them make decisions regarding paleontological resources in British Columbia. In addition, it is a goal of the Geological Survey of Canada (GSC) to catalog and inventory the paleontological resources of the Canadian Cordillera. This report is the fourth in a series resulting from this collaborative effort between the GSC and the BCPA. In order to disseminate the information widely, the reports have been published by the Geological Survey of Canada as Open File Reports. The recommendations made in the report are those of the BCPA and not the Geological Survey of Canada. The first report deals with paleontological resources of the Kamloops LRMP area and was produced in Fall, 1996 (Haggart et al., 1997a). The second covers paleontological resources of the Lakes District LRMP area and was produced in Winter, 1996/97 (Haggart et al., 1997b). The third report addresses paleontological resources of the Dawson Creek LRMP area and was produced in Spring, 1997 (Haggart et al., 1997c). The reports have been written in a format which assumes a limited but basic understanding of geology. Much of the summary information is similar in each of the reports; however, recommendations regarding paleontological resources are specific to each particular LRMP area. These recommendations reflect the views of the BCPA and not those of the Geological Survey of Canada.

This report has been prepared by the BCPA in response to a request from planners for needed information and advice on paleontological resources in the Okanagan-Shuswap LRMP area.

## THE NATURE OF PALEONTOLOGICAL RESOURCES

Fossils constitute the remains of plants and animals that lived in the distant past and which have been subsequently petrified and preserved in the rock record. ***Paleontology*** is the scientific study of these fossils. In this report, we refer to ***paleontological resources***, also known as ***fossil resources***, as all those fossil materials which are present in the area of the report.

### THE NATURE OF FOSSILS

One line of evidence that fossils represent ancient organisms is that they are usually found in hard rock, or lithified sediment, in contrast to human remains and artifacts, which are found in soft or unlithified sediments. However, not all rock types are fossiliferous. Fossils are most often found in a variety of sedimentary rocks, including sandstone, shale, conglomerate, and limestone. Fossils may also be preserved in metamorphic rocks, that is, those altered by the long-term effects of heat or pressure, but they are typically deformed and often unrecognizable. Fossils are not found in igneous rocks such as granite and volcanic rocks.

The fossil record shows that life on Earth has had a long and varied history. Life on our planet is considered to have evolved initially in the ocean environment, with the transition to land taking place much later in the Earth's history. The oldest direct evidence of biological organisms presently known consists of fossil bacteria, approximately 3 billion years in age. The first soft-bodied organisms, animals such as jellyfish and worms, probably evolved around 1 billion years ago. It was not until about 600 million years ago that the first shelled animals living in the oceans evolved, during the so-called "Cambrian Explosion." The first ancestors of ocean fishes subsequently evolved about 450 million years ago, and plants began to experiment with environments on the land at approximately the same time. All of this evolutionary history of life on the planet has been interpreted from analysis of the fossil record.

#### 1. Distinction Between Paleontological and Archeological Resources

*It is critical that resource planners understand that paleontological resources are distinct from archeological resources, and that different and unique criteria are used for determining where paleontological resources may occur in a region,*

*as well as their scientific importance.*

Confusion often exists among the lay public as to the precise nature of paleontological, anthropological, and archeological resources. Physical anthropology studies the evolutionary history of humans through analysis of their fossil remains and is thus a subdiscipline of paleontology. Such fossil resources generally range in age from approximately 250,000 to 1.75 million years old, the approximate length of time that direct human ancestors have been present on Earth. Such human remains predate the arrival of human cultures in North and South America and thus, research in physical anthropology is focused in Africa, the Middle East, and Asia.

In contrast, scientists consider paleontology to be distinct from archeology, or the branch of science that studies human cultures through excavation and recovery of relics left by them. Archeological resources, for example, are the criteria by which the presence and activities of native cultures in British Columbia over the past 10,000 years or so have been established.

## **2. Types of Fossils**

For the purposes of this report, we ascribe fossils to two basic types: microfossils and macrofossils. Microfossils are those fossil materials which are too small to be seen readily with the naked eye and which therefore require a microscope for detailed study. To study microfossils, the paleontologist collects bulk samples in the field and then uses physical or chemical methods to break down the rock enclosing the microfossils. The isolated microfossils are then mounted on a specimen slide for study under the microscope. Common types of microfossils include radiolarians, conodonts, foraminifers, ostracodes, ichthyoliths (fish teeth and bones), and pollen grains. Generally, microfossils are found in limestone and shale rocks and are usually abundant. They are, of course, not generally recognizable until extracted from the host rock.

Macrofossils, in contrast, are those fossil materials which can be seen readily and studied without a microscope. Examples of this group include bone and bone fragments, plant and leaf material, corals, and shells. Macrofossils can be found in all the sedimentary rock types listed above. They are located by the paleontologist principally by applying mechanical action, usually hammers, to break apart the rock at the outcrop, splitting it into smaller pieces until a specimen

is found. In some instances, the paleontologist may bring bulk samples to the laboratory to break them down.

### **3. Occurrence and Preservation of Fossils**

Macrofossils are generally less abundant than are microfossils. This is because of several factors, among them that microfossils are so much smaller than macrofossils, and many more of them can be preserved in the same area as a single macrofossil. In addition, the destructive forces which act to break down a formerly living animal or plant, such as biological decay, environmental weathering and chemical dissolution, work more effectively on larger objects.

Generally, macrofossils are found in rock outcrops where these destructive forces have been minimal since the death of the once-living organism. However, if a particular rock unit contains fossils at one locality, it is reasonable to conclude that the same unit will also contain fossils at other localities where such destructive factors have also been minimal. Any locality where the rock unit is exposed at the surface may potentially contain similar, or different, fossils. It is important, however, that the rock itself be exposed at the surface and not covered with soil or vegetation. For this reason, road-cuts from new road-building activity are a favorite study area for the paleontologist: they expose fresh rock which may contain fossils. In this way, new fossil localities are continually coming into existence in areas of development. Similarly, storms and heavy rain may erode rock in drainages and on cliffs, providing new exposures to survey for fossil materials. Most fossils therefore constitute a resource that is continually being recharged as erosion or development exposes new and different areas of fossiliferous rocks.

*In this manner, paleontological resources are not generally considered to be unique. This places them in direct contrast with archeological resources, which are considered unique for a specific time and place. Land managers and planners must keep this critical distinction in mind when assessing paleontological resources in their areas.*

### **USES AND VALUES OF FOSSILS**

Fossils are extremely valuable in a variety of ways. They are utilized by paleontologists and

geologists to date the age of the rocks containing them, and to help construct geological maps of the Earth's surface. They can be used to help interpret the environments of the rocks containing them. And of course, they are critical to unraveling the history of life on our planet and the processes that have shaped the evolutionary history of organisms.

## **1. Age Dating of Rocks**

It has been known for nearly two centuries that fossils are very useful for defining the age of geological rock units, and a basic background in geology is thus necessary to properly interpret fossils and their geologic context. Because the evolutionary history of life is irreversible, the succession of fossils in the rock record has been used by geologists as the basis of the geological time scale (Appendix C). Rocks that contain a particular fossil or fossil assemblage are thus considered to be *correlative*, or the same age as all other rocks around the globe that contain the same fossils. The value of most fossils as geological correlation tools is based on their relatively widespread distribution and their abundance. Correlation of rocks underpins the production of geologic maps and the elucidation of Earth history.

## **2. Paleogeography and Paleoenvironmental Reconstruction**

Interpreting the environment of deposition of ancient sedimentary rocks is a key role of fossils, and one for which they are highly valued. By studying assemblages of fossils preserved in a sedimentary rock, the paleontologist can ascertain whether the rock formed in the ocean, in a lake, or even in a desert environment. Knowing the depth in the ocean at which marine rocks accumulated is often crucial in the search for oil and natural gas, and such fossil information is highly prized by the petroleum exploration industry. Fossil assemblages can tell us whether the ocean or land temperatures were cold or hot in past times, whether land masses were covered by luxuriant forests or barren deserts, and which land areas were once connected but have been torn apart through the migration of the Earth's tectonic plates.

## **3. History of Life on Earth**

Of course, fossils are also of great value in deciphering the history of life on Earth. The development of life on our planet has often been characterized by great leaps in evolutionary



advancement, when many new life forms evolved over relatively rapid intervals of geologic time. Our understanding of the processes by which this evolutionary development has taken place is based primarily on analysis of the fossil record, as well as observation of biological processes active in the world today.

The history of life on Earth is also one of times of great crisis, when large-scale extinction events have decimated our biological world. The precise causes of many such extinctions in the geological past will perhaps never be fully known, but there is certainly no question that our planet has experienced many periods when great numbers of the plants and animals living have become extinct over very short periods of time, never to be seen again. Fossils play a critical role in helping paleontologists assess the extent and rapidity of these past extinction events. Through understanding the nature and pace of past extinction events, it is clear that our planet is currently experiencing a period of extinction equal to, and probably significantly greater than, any recorded in the fossil record.

## **THE ROLE OF AMATEUR COLLECTING**

Traditionally, scientific collecting of fossils has been undertaken primarily by professional paleontologists, those trained researchers pursuing the science as a full-time career. Professional paleontologists have great interest in adequately assessing each paleontological site and in collecting from the site in a rigorous scientific manner. Increasingly, however, the abilities of professionals to undertake field expeditions to collect fossils are being restricted as their employment and funding organizations cut back on the amount of monies allocated for paleontological research. This problem is particularly acute in Canada at the present time.

For this reason, many professional paleontologists rely increasingly on contributions from the amateur collecting community to supplement their field activities. In British Columbia, for example, amateur collectors have been responsible for locating the first Eocene bird fossil in the province, and probably from Canada, the first Eocene crayfish, many new Eocene insect finds, a Cretaceous elasmosaur, dinosaur and other vertebrate remains on Vancouver Island, and many new Jurassic and Cretaceous mollusk occurrences across the province. In addition, amateurs have located new localities for many known fossil types, greatly increasing the paleontologists' understanding of the geographic distribution of those fossils.

Most professional paleontologists in the province, including all professional members of the BCPA, encourage amateur collectors to make their finds known to the professional community. By doing so, professional paleontologists recognize that the maximum amount of information is made available for scientific study. Through the educational efforts of the BCPA, professionals work with the amateur community to ensure that amateur collecting is done in a rigorous and scientific manner. Professionals participate in field trips and demonstrations to show the amateur community how to collect fossils adequately, how to measure and describe the rocks containing the fossils, and how to curate their collections for long-term storage. In addition, the amateur collecting community follows a strict Code of Ethics (outlined in the BCPA Collecting Policy, Appendix B). The willingness of most collectors to provide their fossils for scientific study is to be commended.

Of course, not all amateur collectors will subscribe to the strict guidelines of the BCPA Collecting Policy. But this will be true whether such a policy exists or not. In fact, a very large number of amateurs *do* follow the guidelines and they *do* make their collections available for study. Most professionals are strongly concerned that, by restricting the access of amateurs to collect fossils, the free exchange of information that presently exists between the amateur and professional communities will evaporate. This is precisely the situation that has evolved in Alberta, where very restrictive legislation and a permit system have driven collecting underground. In spite of the existing legislation in Alberta, unmonitored fossil collecting continues in that province, but collaborative interactions with the scientific community have virtually ceased. For this reason, the BCPA strongly recommends that no limitations be placed on the rights of amateurs to collect fossils in all those areas not specifically designated in this report.

## **DESIGNATED FOSSIL SITES IN BRITISH COLUMBIA**

In spite of the fact that most fossiliferous rocks in British Columbia contain fossils at numerous localities over their outcrop area, some rock units are known to contain only one or, at best, several fossil localities. Given that such fossil localities can be "one-of-a-kind" in a national or global sense, specific protection of such localities is often desirable. Several such fossil localities are already known to exist in British Columbia and they have been recognized previously for their unique paleontological materials. Chief among these are the Burgess Shale, Wapiti Lake, Puntledge River and Driftwood Canyon localities.

### **1. Burgess Shale**

The Burgess Shale locality is found in Yoho National Park and is therefore administered federally through Parks Canada. This relatively small exposure of marine rocks is one of the few places in the world where soft-bodied Cambrian (530 million years old) fossil organisms have been preserved. It has been declared a World Heritage Site by UNESCO as a result of this uniqueness. The Burgess Shale locality is administered under National Park General Regulations with specific restrictions to access by a Superintendent's Order under Section 7. The order specifies two zones: Zone 1 allows access to researchers by permit only, with limited collecting allowed; Zone 2 allows licensed guided tours with no collecting allowed. A Mandate of Understanding places responsibility for research and management of the fossil beds with the Royal Ontario Museum, Toronto. Enforcement of regulations relies largely on National Park rangers and research staff (while on-site).

Contacts:        Brian MacDonald, Department of Canadian Heritage, Vancouver  
                     Paul Kutzer, Yoho National Park Administration, Field, B.C.

### **2. Wapiti Lake (Fossil Fish Lake)**

This site is located in the Peace/Liard District and contains 240 million year-old marine vertebrates, including armored fish and coelacanths, which are remarkably complete and well preserved. Fossil specimens from Wapiti Lake are found today in museums around the globe. The 127.5 hectare site was designated as Management Class 0 by the British Columbia Ministry

of Forests in 1990, which excludes timber supply activities and notes high sensitivity features. Specifically, the area was covered at that time under Land Act Map Reserve No. 908049, established by the Ministry of Crown Lands on behalf of the Ministry of Municipal Affairs, Recreation and Culture for a period of five years, renewable for subsequent 5-year periods. A renewal of map reserve status was approved in 1995. Scientific fossil collecting and commercial extracting activity have been undertaken at the site under this status and permits have been issued for these activities. Research permits have been issued through the BC Lands Office in Fort St. John, while at least some of the commercial ventures have been overseen by the Royal Tyrrell Museum. The Wapiti Lake site is in the Dawson Creek LRMP area and specific proposals for protection and management of the site were presented in the report prepared by the BCPA for that LRMP area (Haggart et al., 1997).

Contact: Jeff Beale, Ministry of Forests (Dawson Creek), Chair, Interagency Planning Team

### **3. Peace River Ichthyosaur Fossils**

This site is located in the Peace River District along the west bank of Peace River at the mouth of Nabesche River, presently flooded by Williston Lake. The ichthyosaur fossils were found in the early part of the century in Triassic strata. In order to preserve these and other vertebrate fossils found at the site, the area was designated an “Historic Object” under the Historic Objects Preservation Act by Order-in-Council (#1475), December 8, 1930. Subsequent flooding by Williston Lake precludes any further paleontological collecting at the site, although other collecting opportunities probably exist in the adjacent area.

### **4. Peace River Dinosaur Tracks**

The Dinosaur Tracks site is also located in the Peace River District, along the north bank of Peace River in Rocky Mountain Canyon, opposite the mouths of Johnson and Moose Bar creeks. This site has also been subsequently flooded. Extensive dinosaur tracks and some bones were found here in the 1920s, in Lower Cretaceous strata, and the area was designated an “Historic Object” under the Historic Objects Preservation Act by Order-in-Council (#637), May 16, 1930. An extensive salvage survey in the late 1970s, in advance of the rising waters behind Peace

Canyon Dam, located many hundreds of specimens, most of which are repositied at the Tyrrell Museum, Drumheller, Alberta. Subsequent flooding by Dinosaur Lake precludes any further paleontological collecting in the area.

## **5. Puntledge River Paleontological Site**

The Puntledge River shales, exposed on southeastern Vancouver Island, contain abundant, well preserved marine fossils, including some vertebrates, approximately 70 million years old. These shales crop out extensively on the east side of Vancouver Island and the adjacent Gulf Islands. In April, 1989, a small section of the river (10 x 30 meters) was designated, under the Heritage Conservation Act, as a BC Provincial Heritage Site by Order-in-Council (#547), in order to facilitate the excavation of the fossilized skeleton of an elasmosaur, an extinct marine reptile. More recently, additional significant elasmosaur and vertebrate remains have been found on other nearby rivers. In February, 1996, the Puntledge River site was proposed for Protected Area status, the extent of which will be dependent on negotiations with private landowners who hold a considerable portion of the property in question, and subject to the ability of funds to purchase lands at fair market value. Subsequent management strategies have not yet been determined.

Contact: Lyn Barnett, Land Use Coordination Office, Ministry of Environment, Lands and Parks, Victoria

## **6. Driftwood Canyon**

This site in the Skeena District consists of a small canyon containing well preserved, lacustrine plant, insect and fish fossils, approximately 40 million years old. Outcrops of similar Eocene strata are found extensively throughout the Smithers region, and also near Horsefly and throughout a large part of south-central British Columbia, in the Princeton/Kamloops region. Originally established as a Class A Provincial Park in 1967, Driftwood Canyon was recommended for reclassification as a Recreational Area in 1978 in order to allow public fossil collecting. The Driftwood Canyon locality was thus the first, and to date the only, site in the province with its special status conferred not due to the uniqueness of its fossils or their preservation, but rather to allow general collecting of fossils. Active promotion of the fossil beds as a local recreational attraction by the Smithers Chamber of Commerce has subsequently

generated extensive excavation of the site, resulting in serious undercutting of the cliff face forming the major outcrop. This safety hazard, coupled with a request for protection from the Royal British Columbia Museum, have resulted in a recent initiative to phase out public collecting through a campaign of education and information.

Contact: Ken Zimmer, Acting District Manager, BC Parks, Smithers, B.C.

## **GEOLOGY OF THE OKANAGAN-SHUSWAP LRMP AREA**

Gabrielse et al. (1991) noted that the geological architecture of the Canadian Cordillera can be described in terms of tectonic assemblages, terranes, and morphogeological belts. Each tectonic assemblage is unique, reflecting its own depositional history, place of origin and subsequent changes as it accreted to the continent of North America during the Mesozoic and Cenozoic time periods (see Appendix C). This accretion and subsequent disruption through plate tectonic processes led to the development of the five morphogeological belts of the province (Figure 1a). These belts are (from east to west): the Foreland Belt; the Omineca Belt; the Intermontane Belt; the Coast Belt; and the Insular Belt. The Okanagan-Shuswap LRMP area straddles two of these belts - the western half of the LRMP resides in the Intermontane Belt while the eastern half lies in the Omineca Belt (Figure 1b). Each of these two regions is particularly unique and as such they are discussed individually.

### **1. The Eastern LRMP Area**

The majority of the eastern half of the Okanagan-Shuswap LRMP area is part of the Omineca Belt. For the most part, the Omineca Belt is an uplifted region, extensively underlain by metamorphic and granitic rocks, and straddling the boundary between the accreted terranes on the west and ancestral North America on the east. The eastern boundary of the belt in British Columbia corresponds to the Rocky Mountain trenches while the western boundary includes the Shuswap Metamorphic Complex (Monashee Group as described by Jones, 1951) in the south, following the western slope of the Kaska Mountains in the rest of the province (Gabrielse et al., 1991).

The Omineca Belt regionally comprises an imbricated succession of folded thrust sheets of Mesozoic age. The structurally lowest of these thrust sheets is the Kootenay Terrane, composed of Proterozoic to Upper Triassic assemblages of siliceous clastic, felsic and mafic volcanic, and carbonate rocks (Gabrielse et al., 1991). Three other significant groups of rocks are found locally in the Omineca Belt: 1) plutonic rocks; 2) Tertiary interbedded lacustrine and tuff sequences; and 3) Quaternary glacial and fluvio-glacial deposits. The plutonic intrusions of the Omineca Belt are primarily Tertiary, and lesser volumes of Jurassic and older stocks and batholiths of granitic composition. They appear to have been emplaced after, or, in some cases, during the main

### **Igneous Rocks (No Fossils)**

Etn, EtgL: Early Tertiary plutonic rocks

LKg, mKd, mKg, mKgB: Cretaceous plutonic rocks

Jkg: Jurassic-Cretaceous plutonic rocks

Ejg, EJgG, EJyCM, MJg, MJgS, MjgO: Jurassic plutonic rocks

TrJd: Triassic-Jurassic plutonic rocks

Dg, DmgMF: Devonian-Mississippian plutonic and metamorphic rocks

### **Sedimentary and Volcanic Rocks (Locally with Fossils)**

Ntc: Late Tertiary Chilcotin Group volcanics

PTK, Pts: Early Tertiary Kamloops Group volcanics and Sifton Group non-marine clastic rocks

mKS: Cretaceous South Fork volcanics

TrJN: Triassic-Jurassic Nicola Group volcanics with minor marine to non-marine clastic and carbonate strata

CPA: Carboniferous-Permian Anarchist oceanic and volcanic rocks

DtrH: Devonian-Triassic Harper Ranch Group volcanoclastics

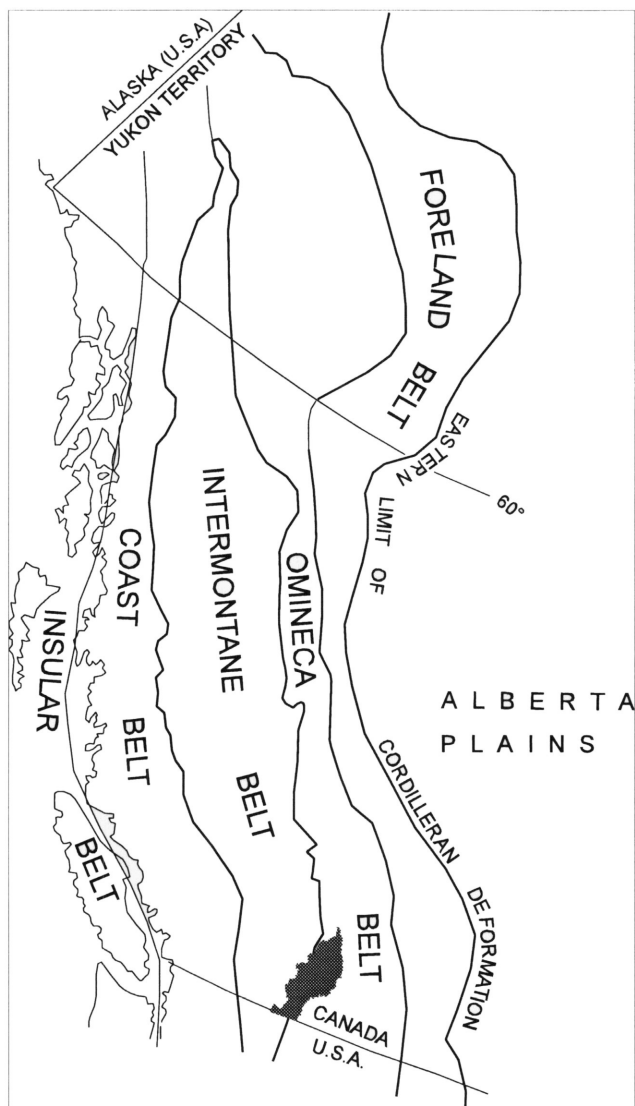
OtrS: Ordovician-Triassic Shoemaker Assemblage: oceanic tuffs and sediments

### **Metamorphic Rocks (No Fossils)**

OsnL: Ordovician-Silurian metamorphic rocks

PPEK: Upper Proterozoic-Paleozoic Eagle Bay Assemblage clastic and volcanic strata

IPM: Lower Proterozoic Monashee Complex metamorphic strata



*Figure 1a. Morphogeological belts of the Canadian Cordillera. Shading indicates area of Okanagan-Shuswap LRMP.*

*Figure 1b. (At right; caption above). Generalized geology of the Okanagan-Shuswap LRMP area (from Wheeler and McFeely, 1991).*

periods of metamorphism and deformation in the region.

Granitic rocks include no fossils and most metamorphic lack them as well. Thus, most rocks of





the Omineca Belt are barren of fossils. The Nicola Group volcanics, which include interstratified limestone, do contain local accumulations of microfossils and some macrofossils, including bivalves and ammonoids - however, the numbers of localities is small and the contained fossils are typically poorly-preserved

## **2. The Western LRMP Area**

The western half of the Okanagan-Shuswap LRMP area forms part of the Intermontane Belt, a topographically low and physiographically subdued region in comparison to the Omineca and Coast belts, which lie to its east and west respectively. The Intermontane Belt is composed primarily of the Quesnellia terrane. Flat-lying Tertiary volcanic rocks overlie the older, basinal terrane strata, producing the widespread uniformly low relief of the belt (Gabrielse et al., 1991).

The Quesnellia terrane consists of Upper Triassic and Lower Jurassic arc volcanics, volcanoclastics, and contemporaneous intrusive rocks overlain by Jurassic arc-derived clastics. This terrane makes up the bulk of the western portion of the Okanagan-Shuswap LRMP area and forms the basement complex for the widespread, overlying Tertiary lacustrine and tuff sequences. Of special significance is the Harper Ranch Group (Monger, 1975, 1977), containing rocks ranging in age from latest Devonian to Late Permian (Monger and McMillan, 1984). The most abundant rock types are thinly interbedded homogenous argillite, laminated argillite and siltstone, in places silicified. Turbiditic sandstones are common, as well as massive sandstones with rip-up clasts from volcanic sources. Fossils from interbedded carbonates include abundant crinoidal debris as well as conodonts, fusulinids and other foraminifers and local brachiopods and corals. Most of the fossils date the sequence from Late Devonian to Early Permian (Orchard, 1985).

Fault-controlled sedimentary basins of Late Cretaceous to early Tertiary age are found throughout the Intermontane and Omineca belts of British Columbia (Yorath, 1991) and overlie the older terrane rocks. Of greatest interest to this report are the Eocene freshwater lacustrine deposits (Wilson, 1977). The Eocene strata at all localities are only slightly deformed. Although the strata from the different basins are approximately contemporaneous, their nomenclature varies greatly (Wilson, 1977). Interbedded siltstones, shales, and tuffs are known from the southwestern part of the Okanagan-Shuswap LRMP area and locally contain plant fossils.

The younger, Chilcotin Group volcanics (Bevier, 1983) consists of thin, crudely columnar-jointed pahoehoe flows, some thick, tiered flows, pillow lava and pillow breccia, and rare silicic tephra layers. These are predominantly flat-lying and are inferred to form a series of low, coalesced shield volcanoes which erupted from central vents (Souther and Yorath, 1991). These volcanic rocks do not contain fossil materials.

Quaternary glacial deposits vary throughout the region and are confined primarily to valleys, where both glacial (ice-derived) and fluvial-glacial (water-derived) sediments are common. Deposits vary from sorted, very coarse gravels, sand and silts to unsorted tills. Due to the extent of coverage of Quaternary deposits, they have not been included on the map of Figure 1. Pleistocene fossils are known from several localities within the Quaternary deposits of the Okanagan-Shuswap LRMP area. These include vertebrates such as horses, bison and mammoths, as well as freshwater gastropods, bivalves and plants.

## **PALEONTOLOGICAL SITE ASSESSMENT PROCESS**

The BCPA's Committee on Fossil Collecting and Regulation Policy was asked by members of the Okanagan-Shuswap LRMP team to assess the paleontological importance of all known sites within the Plan study area. In discussions with Okanagan-Shuswap LRMP team personnel, the Committee stipulated that the BCPA would only deal with assessing which fossil sites in the study area are scientifically unique or of unusual value, such that special protection is merited in our view. The BCPA also agreed to suggest options for managing any sites it so proposed. Other multiple criteria upon which site management selection might be based, such as recreational potential, scenic attraction, commercial activity, etc., were specifically excluded from the BCPA assessment mandate. The BCPA is not prepared to assess such additional factors in total and, if such analysis is desired by the LRMP team, an independent agency should undertake this effort. The BCPA can provide a listing of consulting paleontologists who can be contacted for such services.

University and museum researchers who have undertaken studies of British Columbia fossils, particularly those of the Okanagan-Shuswap LRMP area, were solicited for their opinions on the quality and significance of paleontological sites in the LRMP area. These researchers include Drs. Jim Basinger and Elizabeth McIver (University of Saskatchewan, Saskatoon), Dr. Ruth Stockey (University of Alberta, Edmonton), Dr. L.V. Hills (University of Calgary), Dr. Steven R. Manchester (University of Florida, Gainesville), Dr. Terry Poulton (Chief Paleontologist, Geological Survey of Canada, Calgary), Drs. Michael J. Orchard, Howard Tipper, and Tim T. Tozer (Geological Survey of Canada, Vancouver), Wesley C. Wehr (University of Washington, Seattle) and Dr. Mark V.H. Wilson (University of Alberta, Edmonton).



## **RECOMMENDATIONS**

As discussed above, microfossil localities are widespread within the Okanagan-Shuswap LRMP area, macrofossil localities less so. Most of the Paleozoic and Mesozoic macrofossil localities in the LRMP area contain commonly occurring invertebrate fossil remains, including ammonoid cephalopods, bivalves, brachiopods, corals, plants, and echinoderms. Tertiary localities in the LRMP area are locally rich in plant fossils and several Pleistocene localities have produced limited vertebrate remains. All of these fossil types are often found by local collectors, and they provide the nucleus for recreational fossil collecting.

Professional paleontologists consulted in the preparation of this and other LRMP reports agree that, although all fossil sites in the Okanagan-Shuswap LRMP area provide useful information about the distribution of fossil species in the province, none of the localities in the LRMP area should be considered especially unique or significant. For this reason, the BCPA concludes that there are no known paleontological sites in the area of the Okanagan-Shuswap LRMP area for which special land-use designation should be provided at present. We reiterate our belief that scientific fossil collecting under the conditions of the BCPA Code of Ethics should continue at such localities in the Okanagan-Shuswap LRMP area.

It is our further recommendation that no fossil sites known in the Okanagan-Shuswap LRMP area be advertised to promote collecting by the general public in a manner which might lead to site destruction, or be contrary to the BCPA Code of Ethics. It is our view that fossil collecting should be undertaken by persons interested enough to seek out information on localities from established organizations. This approach should facilitate public education about fossil resources and encourage responsible collecting within the framework of the Collecting Policy established by the BCPA. It is possible that such collecting may generate new fossil discoveries that do merit special designation. Should the BCPA become aware of any specific information about fossils of significant scientific importance in the Okanagan-Shuswap LRMP area, it will immediately convey this information to local planners for special-status consideration. Such status might include various restrictions on collecting at the site(s), as outlined in the BCPA Policy on Fossil Collecting and Regulation (Appendix B).

The BCPA has prepared this report on a voluntary basis, in the interest of providing summary

information to local land-use planners. Should planners require more detailed study of specific fossil sites, they should contract for such assessment with a consulting paleontologist; the BCPA can provide a listing of consulting paleontologists in British Columbia, if requested.

## **ACKNOWLEDGMENTS**

We sincerely thank the Okanagan-Shuswap LRMP planning team, in particular John Meeson, for supporting this initiative and providing advice on land status designations.

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## APPENDIX A

### BRITISH COLUMBIA PALEONTOLOGICAL ALLIANCE

#### Board of Directors

November 30, 1997

Bruce Archibald	<i>Vancouver Paleontological Society, Vancouver</i>
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## **APPENDIX B**

### **BRITISH COLUMBIA PALEONTOLOGICAL ALLIANCE POLICY ON FOSSIL COLLECTING AND REGULATION**

Adopted February 24, 1996

The British Columbia Paleontological Alliance (BCPA) is a union of professional and amateur paleontologists working to advance the science of paleontology in the province through fostering public awareness, scientific collecting and education, and by promoting communication between all those interested in fossils. It is the position of the BCPA and its component regional societies that fossils comprise a critical record of past life forms and, therefore, fossils have important scientific, heritage and educational values. Any collecting of fossils must be made with due consideration of these factors.

#### **General Scientific Collecting**

Fossil collecting activities, by both professionals and amateurs, should be undertaken in a responsible manner, that is, suitable for subsequent scientific study and where collected materials receive proper curation, as described in the following BCPA Standards and Ethics for Scientific Collecting. Fossil collecting undertaken according to these standards provides a valuable record of British Columbia's paleontological resources and should be encouraged.

#### **Standards and Ethics for Scientific Collecting**

Determine the status of the land prior to collecting. Ensure that appropriate permission and permits have been obtained from landowners or governmental authorities before venturing to a fossil site. Leave each site as found with respect to gates, fences or constructions on the property.

Practice sound environmental etiquette. Ensure that the size of field groups, as well as collecting methods employed, minimize the impact of collection on the outcrop.

Take appropriate safety precautions while collecting and carry a first aid kit in each field group.

Collectors must record and maintain documentation of all relevant geographic and stratigraphic information for each fossil in their collections. Every effort should be made to ensure that this information is accessible to interested professional researchers.

Fossil collections must be properly curated. Each specimen should normally have a unique identifying number related to a documented fossil locality. Specimens should be stored in a

manner consistent with their long-term preservation. Important specimens should be housed in a recognized paleontological repository.

Sale of fossils for personal or corporate profit by any member of the Alliance is unacceptable.

Members who fail to adhere to these standards may have their membership in the Alliance revoked.

## **Paleontological Reserves**

A few fossil localities in British Columbia are of outstanding scientific importance (e.g. Burgess Shale and Wapiti Lake, both presently protected) and merit specific protection and regulation as Paleontological Reserves. Measures of the importance of a Paleontological Reserve include, but are not limited to: uniqueness of the fossils found there (either individual specimens or associations of fossil types); unusual preservation of fossils; large, moderately-complete vertebrate remains; etc. It is the opinion of the BCPA that recommendations proposing such a locality, and the nature and extent of management of such sites, should be made to legislators by the BCPA in consultation with other professionals having specific knowledge relevant to the proposed locality.

General scientific collecting is not permitted in Paleontological Reserves. Locality protection should be flexible, to allow for periodic revision of the status, and should be designed so as not to hinder valid scientific research at the locality.

The BCPA will seek to work directly with provincial ministries and legislators to help develop a process whereby Paleontological Reserves can be designated promptly and with the input of the BCPA.

## **Paleontological Research Sites**

The BCPA recognizes that valid scientific research may require that some fossil sites remain undisturbed for the duration of the study. Such sites are to be designated Paleontological Research Sites (PRS). Researchers may apply to the BCPA for PRS status. Research sites would be established typically for periods of six months to two or more years, depending on the nature of the research. Collecting by BCPA members will be prohibited for the duration of the Paleontological Research Site designation. At the conclusion of the assigned study period, the

site will revert to normal status unless the researcher demonstrates to the satisfaction of the BCPA that it should be further protected.

The BCPA will seek to work directly with provincial ministries and legislators to help develop a process whereby Paleontological Research Sites can be designated promptly and with the input of the BCPA.

### **Out-of-Province Paleontologists**

Out-of-province paleontologists should not be restricted or hindered from fossil collecting, provided they follow adequate collecting and curatorial procedures, as outlined in the above Standards and Ethics for Scientific Collecting. Out-of-province paleontologists should inform the BCPA of their research program prior to initiation of their collecting program. Type specimens and general collections of fossils must be housed in appropriate institutions designated for such storage. In particular instances, the BCPA may request out-of-province paleontologists to deposit a representative suite of specimens in a British Columbia museum, or recognized institutional collection.



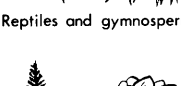

















### **Commercial Collecting**

The BCPA is opposed to commercial extraction of fossils by its member organizations or individuals. Any commercial fossil extraction activity should be regulated by the province and should require permits and/or licenses, with some sort of associated fee. The BCPA anticipates that its advice will be sought and followed by regulators in assessing each permit application for suitability.

The BCPA will seek to work directly with provincial ministries and legislators to help develop a method whereby guidelines for Commercial Fossil Collecting Standards and a Commercial Permit Application Process are established.

# APPENDIX C

## THE GEOLOGICAL TIME SCALE

ERA	PERIOD	CHARACTERISTIC LIFE	CANADIAN OROGENIES	TOTAL ESTIMATED TIME IN YEARS
CENOZOIC	TERTIARY	Man 		
		RECENT PLEISTOCENE		2,000,000
		Mammals and modern plants 		5,000,000
		PLIOCENE		25,000,000
		MIOCENE		38,000,000
		OLIGOCENE		55,000,000
		EOCENE		65,000,000
MESOZOIC	CRETACEOUS	Reptiles and gymnosperms 	Laramide 	
			Columbian 	140,000,000
		JURASSIC	Nassian Inklinian 	210,000,000
		TRIASSIC	Tahltanian Appalacian 	250,000,000
		Amphibians and lycopods 		
PALAEZOIC	CARBONIFEROUS	PERMIAN 		
		PENNSYLVANIAN		
		MISSISSIPPIAN		
		DEVONIAN	Caribooan Ellesmerian 	345,000,000
		SILURIAN	Acadian 	440,000,000
		Higher invertebrates 	Taconic 	
		ORDOVICIAN		
PRECAMBRIAN	ARCHAEO PROTEROZOIC	CAMBRIAN 		540,000,000
		Primitive invertebrates and algae		
		HADRYNIAN	Grenville 	945,000,000
		HELIKIAN 	Elsonian 	1,370,000,000
		APHEBIAN 	Hudsonian 	1,735,000,000
PRECAMBRIAN	ARCHAEO PROTEROZOIC	Algae and other?		
		?	Kenoran 	2,490,000,000
				3,900,000,000

## APPENDIX D

### PALEONTOLOGICAL RESOURCES OF THE OKANAGAN-SHUSWAP LRMP AREA

Library resources at the Vancouver office of the Geological Survey of Canada were utilized to compile a listing of all fossil localities in the Okanagan-Shuswap LRMP area discussed in the geological literature. Compilation data include locality, stratigraphic unit, fossils collected and identified, age of strata, and the source of the reference.

In addition, the database files of the Geological Survey of Canada office in Vancouver were searched for additional, unpublished fossil localities. A total of 130 microfossil collections were identified in the database, consisting of conodonts, radiolarians and other microfossils, of Ordovician, Devonian, Carboniferous, Permian and Triassic ages. Only two macrofossil localities were identified in the Vancouver database from within the LRMP area.

Given that microfossil resources are typically distributed widely, these localities are not listed here. The following is a summary listing of the macrofossil localities in the Okanagan-Shuswap LRMP and their fossils.

#### 1.

Location: NTS 82L (Vernon): Valley of Siwash [Naswhito] Creek (west of Okanagan Lake), 3.5 miles from mouth

Strat: Harper Ranch Group

Fossils: Coral: *Menophyllum* ? sp.

Brachiopods:

*Productus* sp.

*Athyris* sp.

*Spirifer* sp.

*Spiriferina* ? sp.

Bryozoa: *Fenestella* cf. *basleoensis* Bassler

Foraminifera, including:

*Schwagerina* sp.

*Parafusulina* sp.

Age: Probably late Carboniferous

Source: E.M. Kindle and P. Harker in Jones (1959: pp. 43-44).

**2.**

Location: NTS 82L (Vernon): Four miles west of Falkland near Salmon River at valley level

Strat: Harper Ranch Group

Fossils: Brachiopods:

*Chonetes* sp.

*Stropheodonta* ? sp.

Foraminifera

Age: Early Permian or Late Pennsylvanian

Source: E.M. Kindle and R.T.D. Wickenden in Jones (1959: p. 45).

**3.**

Location: NTS 82L (Vernon): On ridge north of Siwash [Naswhito] Creek, 1 mile north of preceding location

Strat: Harper Ranch Group

Fossils: Coral: *Duplophyllum* sp. cf. *D. septurugosum* Moore & Jeffords

Brachiopods:

*Derbyia* spp.

*Meekella* sp.

"*Productus*" sp.

*Productus* sp. cf. *P. artiensis* Tschernyschew

*Linoproductus* sp. cf. *L. aagardi* (Toula)

*Marginifera* sp.

*Stiatifera* sp. cf. *S. compressa* (Waagen)

*Rhynchopora* sp. cf. *R. nikitini* Tschernyschew

*Stenosisma* sp. cf. *S. venusta* (Girty)

*Spiriferella* sp. cf. *S. rajah* (Salter)

*Spiriferella* sp. cf. *S. saranae* (de Verneuil)

*Ambocoelia* sp.

Crinoids:

*Martinia* sp.

*Hemiptychina* ? sp.

Age: Early or Middle Permian

Source: P. Harker in Jones (1959: p. 44).



**4.**

Location: NTS 82L (Vernon): On east-flowing tributary of Equesis Creek (north of Siwash [Naswhito] Creek), 4.8 miles west of the confluence with Equesis Creek

Strat: Harper Ranch Group

Fossils: Brachiopods:  
*Meekella* sp.  
Small brachiopod fragments  
Foraminifera

Age: Middle Permian

Source: R.T.D. Wickenden and P. Harker in Jones (1959: p. 45).

**5.**

Location: NTS 82L (Vernon): Two miles southwest of Whiterocks Mountain

Strat: Harper Ranch Group

Fossils: Coral fragments  
Brachiopod: *Linoproductus* sp.  
Fragments of fenestellid bryozoa  
Crinoid stems

Age: Permian

Source: P. Harker in Jones (1959: p. 46).

**6.**

Location: NTS 82L (Vernon): Along Monashee Pass highway, 2.5 miles west of summit

Strat: Harper Ranch Group

Fossils: Brachiopods

Age: Permian

Source: P. Harker in Jones (1959: p. 46).

**7.**

Location: NTS 82L (Vernon): Low hills immediately north of Bluenose Mountain, 1.5 miles south of Lavington

Strat: Harper Ranch Group

Fossils: Corals:  
*Syringopora* sp.  
Fragments of species of *Clisiophyllum*  
Crinoid fragments  
Brachiopod: productid fragment - possibly *Linoproductus* sp.

Age: Permian  
Source: P. Harker in Jones (1959: p. 47).

**8.**

Location: NTS 82L (Vernon): North of Monashee Pass on Highway #1, northwest side of Kettle River, on crest of ridge, 3 miles due west of Keefer Lake  
Strat: Harper Ranch Group?  
Fossils: Brachiopod fragment, probably *Spiriferella* sp.  
Brachiopod fragments, indet.  
Fragmentary zaphrentid coral, indet.  
Age: Late Paleozoic  
Source: P. Harker in Jones (1959: p. 46).

**9.**

Location: NTS 82L (Vernon): Lat. 50° 28' 50"N, Long. 119° 41' 25"W  
Strat: Carbonate unit in Thompson Assemblage  
Fossils: Crinoids  
Rugose coral fragment  
Foraminifera  
Age: Late Paleozoic?  
Source: Okulitch (1979).

**10.**

Location: NTS 82L (Vernon): Lat. 50° 28' 00"N, Long. 119° 40' 20"W  
Strat: Carbonate unit in Thompson Assemblage  
Fossils: Crinoids  
Undetermined fossil fragments  
Foraminifera  
Age: Late Paleozoic?  
Source: Okulitch (1979).

**11.**

Location: NTS 82L (Vernon): Lat. 50° 17' 30"N, Long. 119° 28' 15"W  
Fossils: Not described  
Age: Carboniferous to Triassic  
Source: Rice (1946).

**12.**

Location: NTS 92H (Hope): Nickel Plate Mountain area, east of Hedley  
Strat: Nicola Group  
Fossils: Bivalves: *Daonella* cf. *Halobia*  
Ammonoid: '*Arcestes*' sp.  
Age: Late Triassic  
Source: F.H. McLearn in Rice (1947: pp. 14-15).

**13.**

Location: NTS 82E (Penticton): North of Peachland, Lat. 49° 51' 35"N, Long. 119° 38' 55"W and Lat. 49° 53' 17"N, Long. 119° 17' 55"W  
Strat: Kamloops Group?  
Fossils: Undescribed fossil plants  
Age: Paleocene or Eocene?  
Source: Little (1961).

**14.**

Location: NTS 82E (Penticton): North side of Yellow Lake, north of Highway 3A  
Strat: 'Kamloops Group'  
Fossils: Plant fossils, unidentified  
Age: Eocene  
Source: Tempelman-Kluit (1989: map).

**15.**

Location: NTS 92H (Hope): Head of Glacier Lake, Cathedral Provincial Park  
Strat: Princeton Sediments  
Fossils: Plants:  
*Equisetum similkameenense* Dawson  
*Sequoia langsdorfii* (Brongniart) Heer  
*Trochodendroides arctica* (Heer)  
Age: Eocene  
Source: W.A. Bell in Rice (1947: pp. 30).

**16.**

Location: NTS 82E (Penticton): 6 km south of highway 97 and 4 km southwest of Okanagan Falls, on east side of country road to radio telescope near White Lake. Fossils are sparsely distributed in the rocks exposed for about half a kilometer along the road.

Strat: Kamloops Group shales  
 Fossils: Compression plants, *Metasequoia* sp. and *Comptonia* sp.  
 Great variety of broad-leafed foliage  
 Legume pods  
 Other fruiting bodies  
 Age: Eocene  
 Sources: Church (1973: p.45); S.B. Archibald, personal communication (1997).

### 17.

Location: NTS 82L (Vernon): Westwold?  
 Strat: From a sand lens in the silt beneath Okanagan Centre Drift  
 Fossils: Vertebrate remains, including *Bison* sp.  
 Fragments of beetles  
 Fragments of fish and rodents  
 Thin-shelled mollusks  
 Age: Pleistocene  
 Source: C.R. Harington in Fulton (1975: p. 15).

### 18.

Location: NTS 82L (Vernon): Riggings Road, 13 km east of Lumby, and other localities  
 Strat: Bessette sediments  
 Fossils: Gastropoda:  
     *Fluminicola* sp.  
     *Lymnaea bulimoides*  
     *Lymnaea* sp.  
     *Discus cronkhitei*  
     *Valvata* sp.  
     *Gyraulus* sp.  
 Bivalvia:  
     *Margaritifera margaritifera*  
     *Anodonta nuttalliana*  
     *Anodonta* sp.  
     *Pisidium* sp.  
 Plantae (from leaf impressions)  
     *Corylus* sp.  
     *Populus tremuloides*  
     *Populus trichocarpa*

*Prunus virginiana*

Vertebrata

*Equus* sp. (?)

*Equus* cf. *conversidens*

*Bison* sp.

*Mammuthus* cf. *columbi*

*Mammuthus* sp.

Ostracods

Charophytes

Age: Late Pleistocene

Source: Fulton (1975: p. 16).

**19.**

Location: NTS 82L (Vernon): Lat. 50° 18' 00"N, Long. 119° 27' 50"W

Strat: Carbonate unit in Thompson Assemblage

Fossils: Brachiopod and undetermined fragments

Age: Undetermined

Source: Okulitch (1979).

**20.**

Location: NTS 82L (Vernon): Lat. 50° 28' 10"N, Long. 119° 26' 20"W

Strat: Slocan Group

Fossils: Fossil spines

Age: Undetermined

Source: B.E.B. Cameron in Okulitch (1979).

**21.**

Location: NTS 82L (Vernon): Lat. 50° 21' 05"N, Long. 119° 56' 10"W

Strat: Nicola Group

Fossils: Crinoid

Siliceous skeletal material

Age: Undetermined

Source: B.E.B. Cameron in Okulitch (1979).