WHC Nomination Documentation

File name: 304.pdf UNESCO Region EUROPE

SITE NAME ("TITLE") Canadian Rocky Mountain Parks

DATE OF INSCRIPTION ("SUBJECT") 2/11/1984; 1990

STATE PARTY ("AUTHOR") CANADA

CRITERIA ("KEY WORDS") N (i)(ii)(iii)

DECISION OF THE WORLD HERITAGE COMMITTEE:
8th Session
The Committee requested the Canadian authorities to consider adding the adjacent Provincial Parks of Mount Robson, Hamber, Mount Assiniboine and Kananskis to this property. Furthermore, the Committee agreed to incorporate the Burgess Shale site in this property, which henceforth would not be separately indicated on the World Heritage List. Finally, the Committee decided that the site be designated as the "Canadian Rocky Mountain Parks" to specify the precise boundary of the property within the entire chain of the Rocky Mountains.

BRIEF DESCRIPTION:
The contiguous National parks of Banff, Jasper, Kootenay and Yoho, as well as the Mount Robson, Mount Assiniboine and Hamber Provincial Parks, studded with mountain peaks, glaciers, lakes, waterfalls, canyons and limestone caves, form a striking mountain landscape. The Burgess Shale fossil site, well-known for its fossil remains of soft- bodied marine animals, can also be found there.

* The Burgess Shale Site, inscribed on the World Heritage List in 1980, is part of the Canadian Rocky Mountain Parks.

1.b. State, province or region: Province of British Columbia

1.d Exact location:

1. SPECIFIC LOCATION

a) COUNTRY

Canada

b) STATE, PROVINCE OR REGION

Provinces of Alberta and British Columbia

c) NAME OF PROPERTY

The Canadian Rockies comprising:

Banff National Park
Jasper National Park
Kootenay National Park
Yoho National Park

d) EXACT LOCATION ON MAP AND INDICATION OF GEOGRAPHICAL CO-ORDINATES

Refer to maps

WORLD SETTING

GEOGRAPHICAL CO-ORDINATES

2. JURIDICAL DATA

a) OWNER

Government of Canada – administered by Parks Canada under the authority of the *National Parks Act.*

b) LEGAL STATUS

The *National Parks Act* provides the Government of Canada with legal control over all lands contained within the parks. Under this legislation, *"The Parks are hereby dedicated to the people of Canada for their benefit, education and enjoyment… and the National Parks shall be maintained and made use of so as to leave them unimpaired for the enjoyment of future generations"* (Section 4). The Schedule of the *National Parks Act* describes the legislated boundaries of Banff, Jasper, Kootenay and Yoho national parks.

c) RESPONSIBLE ADMINISTRATION

Regional Director
Parks Canada, Western Region
520, 220 - 4th Avenue S.E.
Calgary, Alberta

Mailing Address:
P.O. Box 2989, Station M
Calgary, Alberta
T2P 3H8

3. IDENTIFICATION

a) DESCRIPTION AND INVENTORY

The Canadian Rockies are of outstanding universal value for their exceptional beauty combined with superlative natural resources of heritage and scientific interest. With an area of 20,160 km², the four contiguous national parks of Banff, Jasper, Yoho and Kootenay are included in this nomination. These parks comprise one of the largest and best known protected natural areas in the world.

Accessibility allows over nine million visitors annually to appreciate and experience this impressive mountain environment. There are still large areas where man has had little or no influence on the natural landscape. In fact much of the four parks' area is more than 10 km from a public road or park/provincial boundary.

THE CANADIAN ROCKIES

BANFF JASPER KOOTENAY YOHO

i) THE CANADIAN ROCKIES IN THE NEARCTIC BIOGEOGRAPHICAL REALM

The Canadian Rockies site lies in the northern half of the Rocky Mountains Biogeographical Province of the Nearctic Realm as defined by Udvardy (Udvardy, 1975). This province forms the backbone of North America and is comprised of young mountains with many peaks above 4270 m; great local relief (1525 m to 2135 m); extensive forests and a diverse wildlife population. It is in this province that the national parks systems of two countries – Canada and the United States – began a century ago.

The Rocky Mountain Biogeographical Province can be subdivided into four distinct ecoregions. These are, from north to south: (1) Northern Rocky Mountains; (2) Middle Rocky Mountains; (3) Wyoming Basin; and; (4) Southern Rocky Mountains. The distinguishing characteristics of each ecoregion are summarized in Table 1 along with a listing of those areas within them that have been dedicated as national parks and monuments.

ii) GEOLOGY

Geological formations in the parks of the nominated area are composed primarily of shale, dolomite, sandstone, limestone, quartzite and slate, spanning time periods from the pre-Cambrian to present. Continental tectonic forces have resulted in faulting, folding and uplifting of these sedimentary layers, to produce mountain ranges which form the continental spine.

The Canadian Rocky Mountains consist of four northwest-southeast trending geological subprovinces, all of which are represented in the parks. These subprovinces are the Western Ranges, the Main Ranges, the Front Ranges and the Foothills. Straddling the Continental Divide of western North America, the four ranges dramatically illustrate tectonic forces, characteristic geology, and erosion. Glacial and climatic processes have played a major role in the development of the area's varied environments. Together, these four mountain national parks provide exemplary representation of the Canadian Rocky Mountains.

TABLE 1: ECOREGIONS, CHARACTERISTICS AND NATIONAL PARK REPRESENTATION IN THE ROCKY MOUNTAIN BIOGEOGRAPHICAL PROVINCE

ECOREGION	CHARACTERISTICS	REPRESENTATION IN THE NATIONAL PARKS SYSTEM – UNITED STATES OF AMERICA AND CANADA
SOUTHERN ROCKY MOUNTAINS	A series of mountain ranges and intermontane basins, mostly trending north; high part of the continental divide; altitudes 1,525m to more than 4270m.	Florisant Fossil Beds National Monument (U.S.A.), Great Sand Dunes National Monument (U.S.A.), Rocky Mountains National Park (U.S.A.).
WYOMING BASIN	Elevated semiarid basins; isolated low mountains; altitudes mostly between 1,525m and 2135m.	No protected areas.
MIDDLE ROCKY MOUNTAINS	An assortment of different kinds of mountains with differing trends and semiarid intermontane basins; features here resemble those of the neighboring provinces; altitudes mostly 1525m to about 3660m.	Dinosaur National Monument (U.S.A.), Grand Teton National Park (U.S.A.), Timpanogos Cave National Monument (U.S.A.), *Yellowstone National Park (U.S.A.)
NORTHERN ROCKY MOUNTAINS	Linear blocky mountains with long, straight valleys, including the 800 km long Rocky Mountain trench. Altitudes mostly between 1220m and 3050m.	Glacier National Park (U.S.A.), Waterton Lakes National Park (Can.), °Banff National Park (Can.), °Jasper National Park (Can.), °Yoho National Park (Can.), °Kootenay National Park (Can.), Glacier National Park (Can.), Mount Revelstoke National Park (Can.)

* World Heritage Site

° World Heritage Site Nomination

The Western Ranges, found in the southern part of Kootenay National Park, are composed of relatively soft shales that folded intricately during the mountain building process.

The Main Ranges occur in all four of the parks. In Kootenay and Yoho, two distinct subprovinces of these ranges are represented: eastern and western. In Banff and Jasper, only the eastern sub-province of the Main Ranges occurs. The eastern main Ranges, underlain by the strong quartzite of the Gog Group and bordered by faults, uplifted as rigid blocks, forming mountains with sharp shoulders and great, banded cliffs. The Main Ranges contain the highest mountains in the four parks and form the Continental Divide. Castle Mountain and Mount Edith Cavell are among the most dramatic examples of the many Main Range peaks.

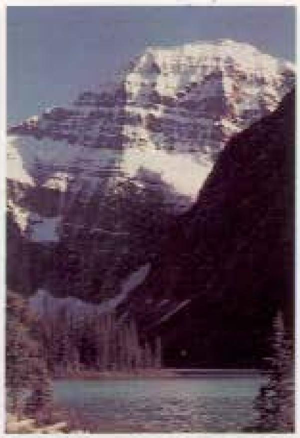
The Front Ranges, found in Banff and Jasper, are composed of thick layers of limestone and shale. They are separated from the Main Ranges by a zone of faults which runs the length of Banff and Jasper. These mountains often have a tilted, tooth-like appearance and in places the rock layers have been folded. Mountains such as Mount Rundle and Roche Miette characterize these ranges.

The Foothills are the easternmost extension of the Rockies. A small area in the southeastern portion of Jasper, along the Southesk River, provides the only representation of the rounded rolling hills of the Foothills in the four parks.

The sedimentary Rocky Mountains contain an extensive fossil record dating from Precambrian to Recent. Of particular note in the Main Ranges are the exquisitely preserved soft-bodied fossils found in the Burgess Shale layer of the Stephen Formation in the Cathedral Escarpment. This discontinuous layer of highly fossiliferous shales, extends about 20 km southeast of Mount Field in Yoho National Park.

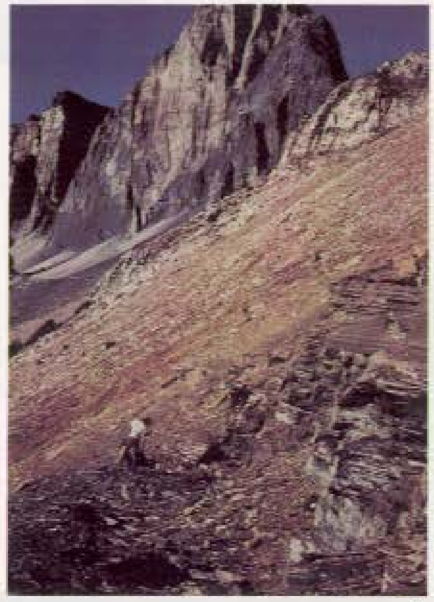
Since 1981, when the Burgess Shale was declared a World Heritage Site, several new fossil locations have been discovered, revealing a distribution pattern for fossils far more varied and complex than previously realized (Collins, 1982). As one of the most significant fossil sites in the world, the Burgess Shale portrays a view of evolution in action during the Middle Cambrian times (Morris and Whittington, 1979).

1.



2.

3.



4.

5.

6.

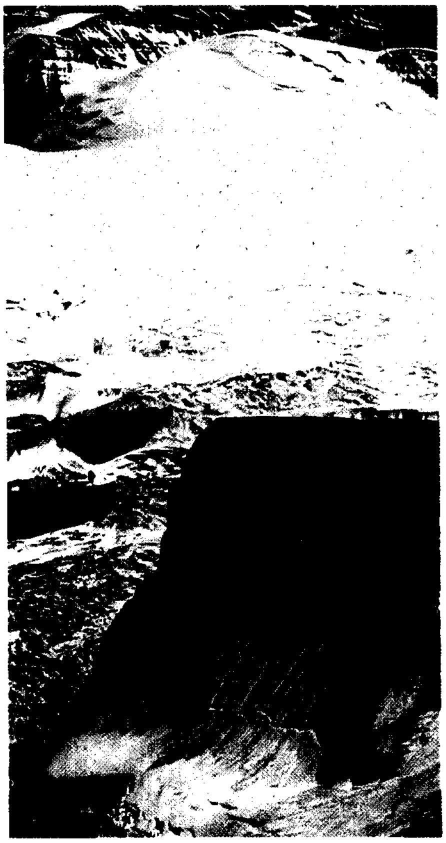
1. *Burgess Shale – fossils*
2. *Mount Edith Cavell – Main Range – Uplifted mountain with banded cliffs.*
3. *Mount Rundle – mountain of Front Range*
4. *Burgess Shale quarry – slope of Stephen Formation*
5. *Roche Miette – Front Ranges in Jasper*
6. *Hoodoos in Yoho National Park – effects of erosion*

iii) THE LANDFORMS

Since the folding and uplifting that raised the Rocky Mountain region above sea-level, mountains have been carved in the sedimentary layers; first by rivers, later by glaciers. As the Rockies uplifted, rivers cut a trellis-like pattern which during the recent geological past has been remoulded by major glacial advances and retreats.

Although the last major glacial advance ended about 10,000 years ago, there are still active glaciers throughout the region, particularly in the Main Ranges along the Continental Divide. The most significant area portraying glacial action is the Columbia Icefield. The icefield complex is important due to its combination of beauty and scientific importance in the study of glaciation and karst systems. As one early observer wrote:

> *"The peaks and glaciers around the great Columbia Icefield, the scene of our wanderings in 1898, are entirely new ground; and placed as they are at the sources of three of the largest rivers in the Dominion, they probably constitute the culminating point of the Canadian Rocky Mountain System."*
> H. Stutfield, 1903.



1.

This was an astute observation, since today the Columbia Icefield is recognized as the largest icefield in the Rocky Mountains and the largest in North America's subarctic interior. Covering approximately 325 km^2 (Boranowski and Henoch, 1978), it exhibits many classical glacial features, processes and phenomena.

The Columbia Icefield spans the Continental Divide and the boundary between Jasper and Banff national parks. The area serves as headwaters and contributes significant flow volumes to three major river systems: the North Saskatchewan, the Athabasca and the Columbia. Respectively, these rivers flow to the Hudson Bay, the Arctic Ocean and the Pacific Ocean.

The icefield complex is composed of the Columbia Icefield and six major valley glacier basins, each displaying a great diversity of glacial and periglacial landforms. The Athabasca Glacier, part of this complex, is the most accessible glacier ice in North America. Located adjacent to the Icefield Parkway linking Banff and Jasper national parks, it provides unequalled opportunities for visitors to view ongoing glacial processes.

An outstanding natural resource associated with the Columbia Icefield is the Castleguard Cave system. This karst system is internationally significant. Its far-reaching extension below the glaciers of the icefield, and its related karst features, are the foremost examples of a modern subglacial karst system in the world. Although the cave system is located in a remote area of the icefield complex, it is noted as being among the world's finest and most scenic examples of alpine karst topography (Ford, 1983). Part of this significance can be attributed to its value as a model to assess the conditions which existed in temperate caves during past periods of glaciation.

A great variety of small karren (water-dissolved cracks and grooves in limestone) occur at the surface. Subglacial stalagmite precipitates (deposited beneath glaciers) that occur in this area are the best known world examples. There is a greater density of sinkholes in this region than anywhere else in the Canadian Rockies (Ford, 1969; 1979; Ford and Smart, 1979).

The nationally and internationally significant phenomena and features associated with the Columbia Icefield are placed in a setting of exceptional natural beauty, surrounded by 11 of the Canadian Rockies' 22 highest peaks, including the second and third highest peaks in the Main Ranges.

The Maligne Valley complex is also extraordinary in its representation of mountain systems since it contains natural resources characteristic of the region as well as ones of high scientific interest and importance. Almost all the typical mountain landforms are common in the valley, including castellate and sawtooth mountains, cirques and hanging valleys, canyons, talus, avalanche slopes, rock slides and rock glaciers, kames, kettles, and moraines. These representative resources are side by side with resources of exceptional significance from both a scientific and aesthetic perspective.

For example, Maligne Lake at the head of the valley was described by one of its first visitors in 1908:

> *"There burst upon us that which all in our little company agreed was the finest view any of us had ever beheld in the Rockies"*
> Schäeffer, 1911.

A view of Spirit Island backed by the lake's deep blue waters and by snow-capped mountains has helped make the beauty of Maligne Lake legendary.

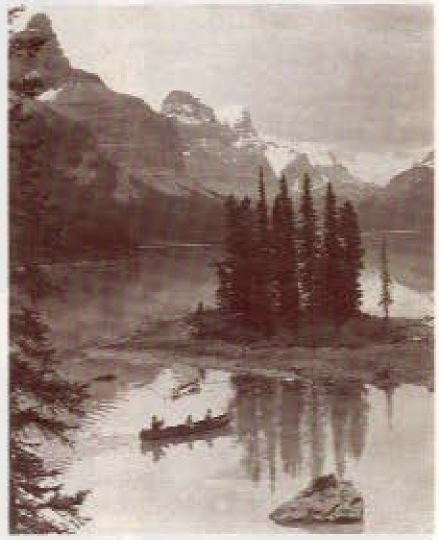
Moving downstream from the lake, the Maligne River enters Medicine Lake. Medicine Lake is drained by one of the largest underground river systems in North America through what may be one of the largest inaccessible cave systems in the world (Brown, 1970; Kruse, 1980). The water from Medicine Lake rises to the surface again in springs in the floor of Maligne Canyon and at lakes 16 km down the valley.

Maligne Canyon, near the bottom of the valley, is a fascinating example of the sculpturing effects of flowing water. For over 10,000 years water has etched a deep, jagged cut into the limestone rock, until today the canyon is over 60 m deep.

2.

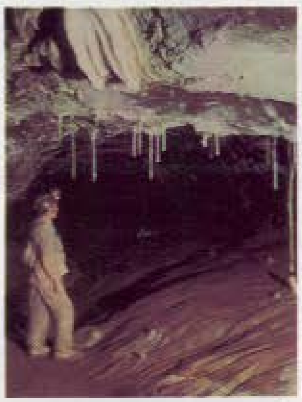
3.

4.



5.

6.



7.

8.

1. *Columbia Icefield – headwaters of three major river systems*
2. *Icefield Parkway – a scenic route linking Banff and Jasper national parks.*
3. *Glacier Ice – a place of recreation*
4. *Saskatchewan Glacier – easily accessible glacier ice*
5. *Maligne Lake – historic view of Spirit Island*
6. *Maligne Canyon – sculpturing effect of water*
7. *Castleguard Cave – grotto*
8. *Talus slopes – Front Ranges*

iv) HYDROLOGY

The mountain parks lie at the head of major Canadian watersheds. Within the parks, the Continental Divide is formed by the Main Ranges. Waters in Yoho and Kootenay on the west side of the Divide flow to the Pacific; those in Jasper and Banff flow east and north into the Hudson Bay and the Arctic Ocean. Easterly flowing waters supply a significant portion of the Saskatchewan River system, the primary water source for the Great Plains region of Canada (Hansen, no date).

Spectacular waterfalls plummet and cascade over the sharp cliffs of the typically high and rugged ranges, and in particular the rugged eastern Main Ranges. Takakkaw Falls and Twin Falls in Yoho National Park are breath-taking examples of such mountain waterfalls.

The interface of water and mountains in the Canadian Rockies is evident in other ways as well. Hundreds of lakes act as settling basins for the many streams and rivers. The suspended material selectively reflects parts of the light spectrum, resulting in a beautiful blue-green color. Lakes with this characteristic color, surrounded by rugged mountains, the slopes of which are covered with fallen rock, coniferous trees and remnants of the glacial age are unforgettable highlights of many mountain visits. Lake Louise, Peyto Lake and Emerald Lake are but a few of the easily accessible lakes of unsurpassed beauty.

1.

River and stream systems of the Canadian Rockies are also numerous and extremely varied in character. For example, the deeply incised walls of Johnston Canyon in Banff, and the power of Athabasca Falls in Jasper, each portray the force of moving water in their own way. Some rivers are navigable by canoe or kayak, but the majority are strewn with rocks and impassable falls and rapids. The Athabasca River is navigable for much of its length as it braids its way through the landscape of Jasper National Park. Over one of its reaches, post-glacial wind-formed sand and silt deposits are up to 25 metres thick. This is the only location in the four parks that dune formations of this type and magnitude occurs.

Underground springs are common in the parks. During the early stages of settling the Canadian west, the construction of the transcontinental railway through the Front Ranges led to the discovery of hot springs, now known as the Cave and Basin Springs, and later to designation of Canada's first national park in 1885. Other major hot springs occur in the Miette area of Jasper, and the Radium area of Kootenay national parks. These developed springs continue to be major visitor attractions.

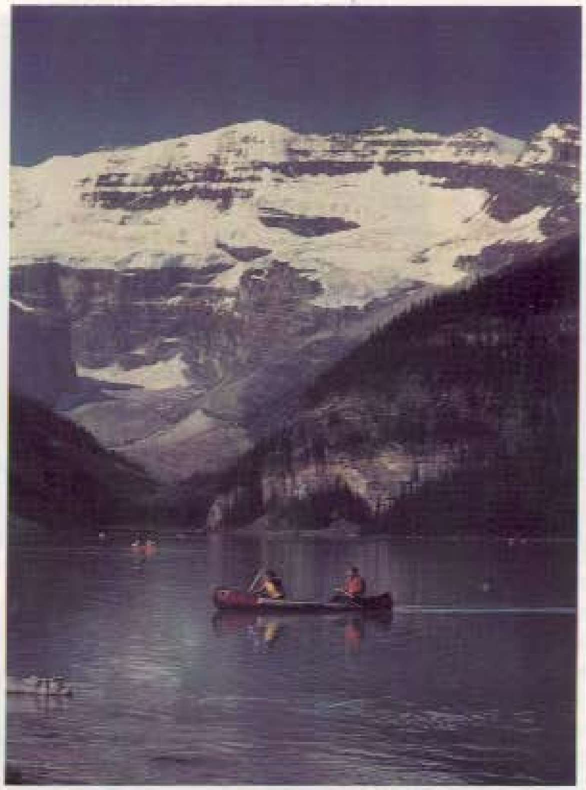
v) CLIMATE

A continental climate prevails in all the parks, with great seasonal and annual variation in precipitation and temperature. Generally winters are long and the summers cool and short, with occasional hot spells. Macro and microclimatic differences are pronounced both within and between the parks.

The Front Ranges and Foothills help to block the flow of cold Arctic air from the prairies into Banff and Jasper national parks. Outbreaks of cold in these parks are not usually as severe or prolonged as on the prairies to the east. In the same way, the Main ranges along the Continental Divide generally prevent Arctic air from entering Kootenay and Yoho national parks; consequently, they are not as cold on average as Banff and Jasper. Although several mountain ranges intercept Pacific moisture carried by the prevailing westerly winds, the climate of the western side of the Continental Divide is influenced by the milder maritime climate of the Pacific. The mountains act as a barrier causing Pacific air masses to rise which results in heavier precipitation on the west slopes. In some locations in Kootenay and Yoho parks, vegetation species such as western hemlock, western cedar and devil's club are found at the eastern limit of their ranges, reflecting the moister conditions of these locations. Annual precipitation in the parks ranges from less than 380 mm at lower elevations to greater than 1250 mm in regions along the Continental Divide (Janz and Storr, 1977.)

Mountain topography has a strong effect on climate. The northwest-southeast orientation of the mountains and main valleys is almost at right angles to the prevailing winds aloft, causing rain shadows (dry areas) in main valleys. Air masses rise as they move eastward, losing their moisture, resulting in greater precipitation on higher, west-facing slopes than on lower areas of east-facing slopes.

2.



3.

4.

6.

5.

1. *Takakkaw Falls – Canada's highest falls, with a drop of 380 m*

2. *Johnston Canyon – an easily accessible canyon in Banff National Park*

3. *Lake Louise – a resource with unsurpassed beauty in Banff National Park*

4. *Twin Falls – an impressive falls in the Main Ranges*

5. *Radium Hot Springs Pool – a popular visitor attraction in Kootenay National Park*

6. *Devil's club – at its eastern extremity in the Canadian Rockies*

7. *Athabasca River valley – sand dune*

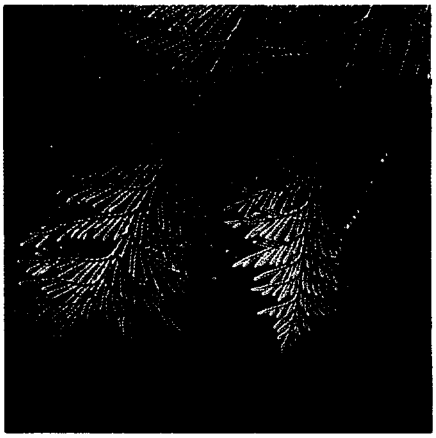
7.

vi) VEGETATION

Vegetation in Banff, Jasper, Kootenay and Yoho national parks is an obvious indicator of many environmental factors. It strongly reflects climatic conditions both on a geographic and topographic basis. In addition, vegetation is intimately linked to soil development and stability, and to wildlife habitat.

The vegetation of the four Canadian Rockies parks is typically Cordilleran, with the three major ecoregions (montane, subalpine, and alpine) identified largely by differences in vegetation. The elevations characteristic of each ecoregion are influenced by factors incuding latitude and slope aspect.

The montane ecoregion is lowest. Examples of montane vegetation uncommon in the context of the parks occur in the extensive wetland areas of Vermilion Lakes near Banff Townsite. In Jasper National Park, the sand and silt dune area of the Athabasca River also harbours montane plants not commonly found elsewhere in these parks. Otherwise the montane areas generally contain characteristic flora such as lodgepole pine, white spruce and Douglas fir. The montane ecoregion also includes much of the grassland in the park, as well as the major land uses by humans.



1.

The subalpine ecoregion occurs above the montane. The lower subalpine areas support closed coniferous forests dominated by Engelmann spruce, subalpine fir and, in its younger successional stages,lodgepole pine. Open meadows are found where environmental conditions have not favoured the development of forests. A location of interest is the Vermilion Pass area which was burned by a fire in 1968. It is a convenient and useful scientific benchmark for the study of the effects of fire on vegetation and wildlife. The upper subalpine ecoregion has greater snowfall and a shorter growing season and is characterized by open forests with stunted trees (krummholz). Engelmann spruce and subalpine fir are common, but lodgepole pine is not.

The alpine ecoregion is devoid of trees, reflecting the cold harsh climate of the higher elevations. Alpine meadow areas such as those near the Sunshine Meadows area in Banff and above Lake O'Hara in Yoho, display a complex fine-scale mosaic typical of high country vegetation. About one-third of the mountain park land area is unvegetated exposed rock, colluvial material, or glacial and permanent snowfields (Holland and Coen, 1982).

vii) WILDLIFE

The four contiguous national parks possess an interesting and varied wildlife population (Holroyd and Van Tighem, 1982). Fifty-six species of mammals are represented, ranging in size from the impressive moose to the tiny pigmy shrew. The ungulates (moose, wapiti, mountain goat, bighorn sheep, woodland caribou, white-tailed deer and mule deer), are often seen in their natural habitat by visitors. A population of about 200 grizzly bear (Parks Canada Warden Service, 1983) inhabits the parks.

Two species noted as being vulnerable in the IUCN Red Book, bighorn sheep and grey wolf, are found in the parks. A population of approximately 2500 bighorn sheep (Parks Canada Warden Service, 1983) resides in the parks and grey wolves are resident, particularly in the large tracts of undisturbed land in Jasper.

Over 280 species of birds have been identified in the parks. Many different habitats exist in these parks because of the great range of elevation and landforms. Tracts of grassland, deciduous and mixed forests, wetlands, alpine meadows, bare rock, and snowfields provide a diversity of environments, each populated or visited in season by characteristic birds.

Relatively few are year-round residents, with most species present only during the summer months. Some bird species occurring in these parks are of particular interest. Two of the parks' raptors, golden eagle and bald eagle, occur high in the food chain and because of their sensitivity have undergone serious population declines across the continent.

Amphibians and reptiles are limited in their distribution and abundance in the parks because of the relatively severe climate. One species of toad, three frog species, one salamander species and three species of snakes have been recorded.

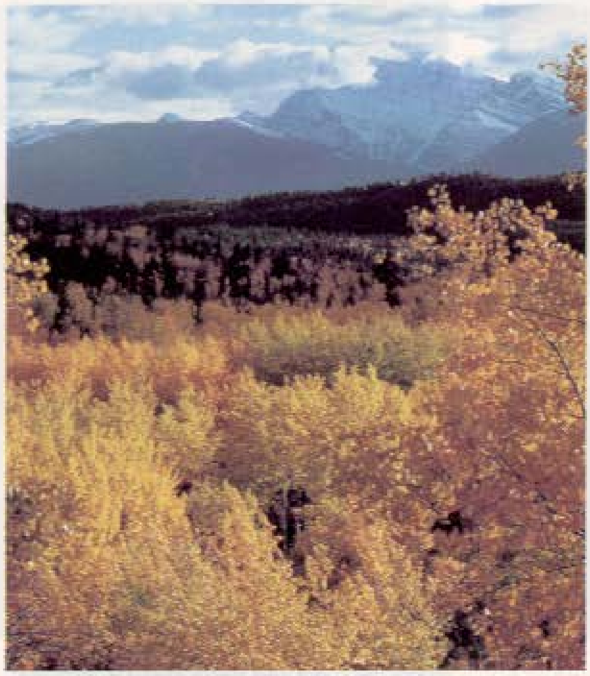
Fish occur in all major watersheds in the four parks. In general, the lakes and rivers of the parks are relatively cold, have low nutrient supply and are not highly productive. In fact, many water-bodies were originally fishless until fish stocking was initiated in the early 1900s to improve sport fishing (Ward 1974).

1. *Western Red Cedar – found in areas of milder climate*
2. *Moose – the parks' largest ungulate*
3. *Wood Lily – 8 cm wide blossoms*

2.

3.

4.



5.

6.

7.

8.

Grizzly Bear – good habitat exists in large tracts of the parks

Aspen – in autumn colours

Pileated Woodpecker – the parks' largest woodpecker

Alpine meadow – a spectacular display of nature's colour

Pika – rock-pile resident

1.

b) MAPS AND/OR PLANS

Maps and plans are included in the text of the nomination form as appropriate.

c) PHOTOGRAPHIC AND/OR CINEMATOGRAPHIC DOCUMENTATION

Photographs are included in the text of the nomination form as appropriate.

d) HISTORY

Although only limited archaeological investigations have been conducted to date, the artifact evidence indicates that the Canadian Rockies have been occupied by man for about 10,000 years (Christensen, 1971). For most of this period, native groups entered into the Rockies in search of sources of food and clothing. In certain places in the parks, natives quarried for tool materials. In others, they collected ochre or iron oxide for decorative use. There is also some evidence of native use in the vicinity of the parks' hot springs.

European exploration, exploitation and settlement in the eighteenth and nineteenth centuries brought a new importance to the mountains. The Rockies were viewed by early explorers as a major obstacle in the effort to find a western route to the Pacific Ocean. With the assistance of native guides familiar with passes through the mountains, early explorers such as Mackenzie, Thompson, McGillivray and Simpson overcame this obstacle. Later the Fur Trade era of the mid 1800's brought traders and merchants to the area in search of new sources of furs and new markets for their European goods. Traders also sought a transmountain fur trade link to reap the harvest of Pacific furs.

Transcontinental transportation, however, has had the most significant influence on these four Rocky Mountain parks. In order to ensure that Canada stretched from the Atlantic to the Pacific, and as a condition for British Columbia's entry into Confederation, the Government of Canada sponsored construction of a transcontinental railway. By 1883 the Canadian Pacific Railway (CPR) extended to Lake Louise, Alberta.

The coming of the railway also marked the beginning of the National Parks System of Canada. In that same year (1883) three CPR employees chanced upon the Cave and Basin Springs. For the enjoyment and healthful benefits of all Canadians, the hot springs and an area around them were set aside by the Canadian Government in 1885 as a park reserve. Two years later, the federal government formally established "Rocky Mountains Park" as Canada's first national park (later to become known as Banff National Park). Now a national historic site, the Cave and Basin Springs area will provide a major focus for the National Parks Centennial in 1985.

Yoho and Jasper national parks have also been closely associated with railway construction. A small reserve around Mount Stephen, British Columbia, was set aside near the CPR railway line in 1886, marking the beginnings of Yoho National Park. The construction of the Spiral Tunnels in Yoho was undertaken in 1908-1909 to reduce the steep grade resulting from the rapid drop in elevation from the Continental Divide to Field. Two spiral tunnels resembling a stretched-out figure eight reach about a kilometre each inside a mountain. They represent a remarkable engineering feat and a masterpiece of railway construction. As well, they are the only spiral railway tunnels in North America. Jasper became a national park in 1907 in association with the construction of Canada's second and more northerly transcontinental railway.

Transportation was also the spark leading to the establishment of Kootenay National Park in 1920. The Province of British Columbia began construction of the Banff-Windermere Road in 1910 but ran out funds before its completion. To obtain the federal government funds to finish it the province agreed to the establishment of this park in 1920.

The transportation theme dominated the history of the parks, and continues to play an important role. There are now two transcontinental highways and two major parkways passing through the parks, as well as the two railway routes. Banff and Jasper townsites were allowed to develop in the early days to service the railway, and to provide essential services to the many park visitors. These transportation routes and townsites and other visitor facility and service centres, continue to play an important role in serving the national interest and Canadian and international visitors to these parks.

Some mineral and forest exploitation was allowed in the parks until about the turn of the century. Since then the parks have been virtually free from resource extraction.

e) BIBLIOGRAPHY

A list of principal references used in this nomination is set out in Appendix One. This appendix also includes references to other bibliographies including works on the four Canadian Rockies national parks.

2.

3.

1. *Town of Banff – bridge and park administration building*

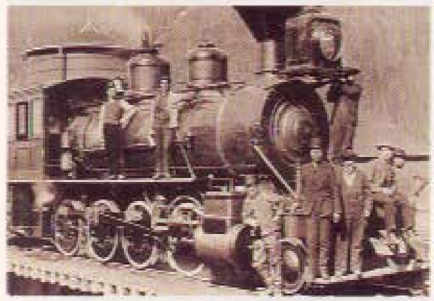
2. *North American Indians – early residents*

3. *Railway construction camp bake oven – Kicking Horse Valley*

4. *1907 Alpine Club of Canada campers – above Paradise Valley, Banff National Park*

5. *Canadian Pacific Railway locomotive – Yoho National Park*

4.



5.

6.

6. *Car caravan – the opening of the Banff – Windermere Parkway, 1920*

7. *Modern-day Banff Avenue – Town of Banff*

8. *Early days of the spiral tunnels. – Yoho National Park*

7.

8.

1.

4. STATE OF PRESERVATION/ CONSERVATION

a) DIAGNOSIS

All lands nominated are under the control of the Government of Canada and protected under the *National Parks Act* and Regulations.

Most of this extensive area is in its natural state. Exceptions are due primarily to facilities and services provided to allow visitors to enjoy the natural environment, or to the existence of national transportation corridors which traverse the parks.

All new proposed activities are subject to the Federal Environmental Assessment and Review Process which ensures that all environmental impacts are evaluated and that development proceeds only when suitable mitigation measures are employed.

b) AGENT RESPONSIBLE FOR PRESERVATION/ CONSERVATION

Parks Canada, Western Regional Office,
520, 220 - 4th Avenue S.E.
P.O. Box 2989, Station M
Calgary, Alberta
T2P 3H8

through Park Superintendents at
(1) Box 900, Banff, Alberta TOL OCO
(2) Box 10, Jasper, Alberta TOE 1EO
(3) Box 220, Radium Hotsprings, British Columbia, VOA 1MO
(4) Box 99, Field, British Columbia VOA 1GO

c) HISTORY OF PRESERVATION/ CONSERVATION

The national parks system of Canada began in the Canadian Rockies almost a century ago. In many ways, the history of conservation in the four contiguous parks making up this nomination reflects the history of conservation in Canada. Much progress has been made, and today there are 29 national parks in Canada with a combined area of about 130,000 km^2, and parks in every province and territory.

BANFF NATIONAL PARK

The Cave and Basin mineral hot springs and a 26 km^2 area around them were set aside in 1885 for their advantage to the public. This reserve was the birthplace of Canada's system of national parks, and was the third such area to be set aside in the world. In 1887, the reserve was enlarged to 673 km^2 through passage of the *Rocky Mountains Park Act* which set apart the land *"as a public park and pleasure ground for the benefit, advantage and enjoyment of the people of Canada..."*
(Lothian, 1981).

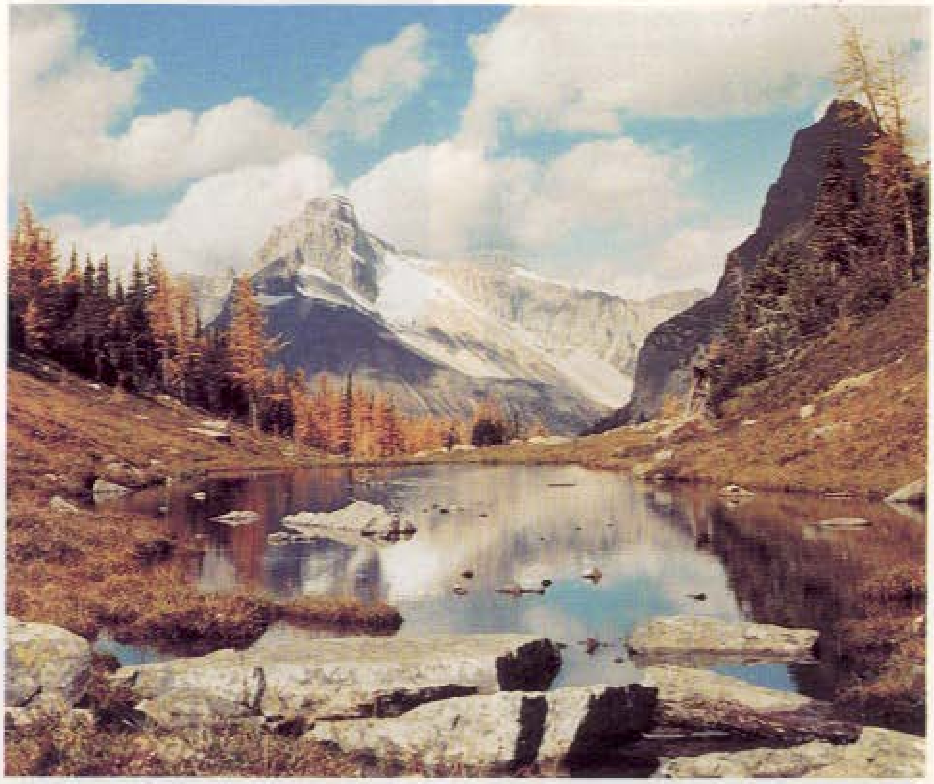
The Canadian Pacific Railway (CPR) Company was one of the strongest supporters of parks, and assisted in getting areas set aside. They saw the tourism benefits of parks along the CPR line and lobbied actively for their protection. Landmarks such as the Banff Springs Hotel and Chateau Lake Louise in Banff National Park are testaments of the CPR's close links with the conservation, and tourism movement in the Rockies.

Lake Louise and an area of 130 km^2 around it were set aside in 1892 to preserve its alpine splendour. Then, in 1902 the *Rocky Mountains Park Act* was amended to allow the addition of Lake Louise and other areas to the park. The park's area changed four times until passage of the *National Parks Act* in 1930. With this act, this park became known as Banff National Park and contained 6,695 km^2. The deletion of 54 km^2 in 1949 left a total of 6,641 km^2, the present size of the park.

YOHO NATIONAL PARK

Interest was aroused in other park proposals due to the Cave and Basin Springs reservation. As was the case with the Cave and Basin reserve, the CPR played an important role in setting aside other reserves along their line.

In 1886, a reserve of 26 km^2 surrounding the base of Mount Stephen was set aside. This area was enlarged in 1901 to 2,153 km^2 when Yoho Park Reserve was established. Part of the reason for its establishment was that the scenic wonders of the area were viewed by the CPR as a tourist attraction. From 1901 to passage of the *National Parks Act*, the park area was reduced to its current size of 1313 km^2.



2.

3.

1. *Cave and Basin Springs – being restored to this 1930's period for the National Parks Centennial of 1985.*
2. *Opabin Plateau – Yoho National Park*
3. *Kayaking – a popular white water sport*
4. *Banff Springs Hotel – present building completed in 1928.*
5. *A fisherman – enjoying the solitude of a mountain lake.*
6. *A cycling excursion – growing numbers travel along the Icefields Parkway.*

4.

5.

6.

JASPER NATIONAL PARK

Plans for construction of a second transcontinental railway across the Canadian Rockies led to the establishment of Jasper Forest Park in 1907. Jasper was set aside initially for the preservation of forest trees on the crests and slopes of the Rocky Mountains and for the proper maintenance of the volume of water in the rivers and streams. The park originally had an area of 12,950 km^2, but in 1930, the area became 10,878 km^2. The parks area has not changed since then.

KOOTENAY NATIONAL PARK

The construction of the Banff-Windermere Road provided the impetus for establishment of Kootenay National Park. A road linking the attractions of Banff to those in the Windermere area was seen as a valuable commercial link and a spectacular tourist route. Because the road could not be completed by the Province of British Columbia, the federal government agreed to complete it in exchange for establishment of Kootenay Dominion Park, an area eight kilometres in width along each side of the road. In 1930 the park's area became 1,520 km^2. The area was subsequently reduced to its present size of 1,378 km^2.

LEGISLATION

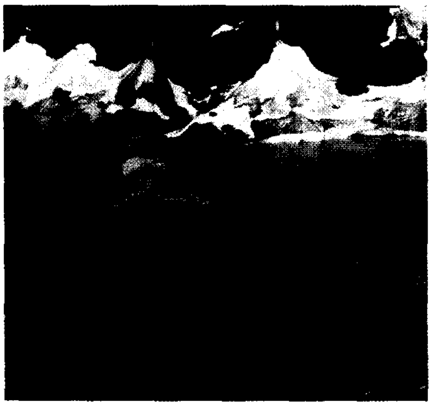
When originally established, these parks were to be preserved as public parks and pleasure grounds and were designed to become the focus of a tourist industry. This was the goal even though lumbering and mining had modified the landscape of accessible portions of the parks. In 1911 the *Dominion Forest Reserves and Parks Act* was passed to differentiate between the many types of parks and reserves established in the Rockies and elsewhere in Canada. The primary objective became one of conserving the sources of water supply by the protection of timber. When the *National Parks Act* was passed in 1930, the term national park came into offical use, and the protection mandate of national parks was stated. The act confirmed the parks as game sanctuaries, made no provision for mineral exploration or development, and limited the use of green timber to that essential for park management purposes.

Policies for national parks were first approved in 1964 and then revised in 1979 when the Parks Canada Policy was approved by the federal Cabinet.

Regulations to ensure the effective protection and management of the national parks have been in effect since those first approved under the *Rocky Mountains Park Act* in 1889. There are now general regulations, and ones specific to each national park in Canada.

d) MEANS FOR PRESERVATION/ CONSERVATION

Enforcement of the *National Parks Act* and Regulations is by national parks' staff who operate throughout the parks. Each park is managed by a Superintendent who is assisted by both full-time and seasonal staff. In total, the four parks have approximately 750 person years assigned to them. The staff work with an annual operating budget of over $21 million. A regional office located in Calgary, Alberta, provides specialized management, direction and assistance.



1.

e) MANAGEMENT PLANS

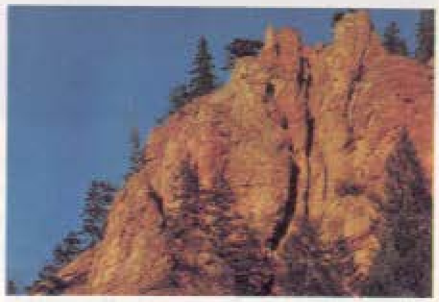
The direction for long term management for resource conservation and visitor use is developed in park management plans. Management plans are presently being prepared for each of the four parks covered in the nomination. These are scheduled for completion by 1985. The plans will reflect the direction given by the National Park Policy and the Park Purpose and Objective Statements (Refer to Appendix Two for the Park Purpose and Objective Statements).

Certain areas of these parks which are subject to high levels of visitor use or contain resources with particular sensitivity have been subject to specific land use and resource management plans. Conservation plans for the parks and specific resource management plans have been completed or are currently underway.

2.

3.

4.



5.

1. *Floe Lake – Warden on duty*
2. *Tenting – a welcomed activity*
3. *Spruce forest – dappled with sunlight*
4. *Medicine Lake – known for its karst features*
5. *Red Wall Fault – Kootenay National Park*
6. *Meisner Ridge – high above the Athabasca River*

6.

BANFF JASPER KOOTENAY YOHO

5. JUSTIFICATION FOR INCLUSION IN THE WORLD HERITAGE LIST

a) CULTURAL PROPERTY

Not applicable

b) NATURAL PROPERTY

The Canadian Rockies being nominated to the World Heritage List include portions of all four of the geological sub-provinces of the Rocky Mountains in an outstanding natural setting of exceptional beauty. This, coupled with the internationally significant Burgess Shale complex, and the scientific and educational importance of both the Columbia Icefield complex and the Maligne Valley, give this area substantial world value as a natural property. With an annual visitation of over 9.2 million, the area offers unparalleled opportunities for experiencing nature and for communicating the message of conservation and protection of Canada's natural heritage.

This area meets all four criteria required for designation as a World Heritage Site natural property.

i) EARTH'S EVOLUTIONARY HISTORY

The area contains the Burgess Shale, an outstanding site containing fossils representing a major stage in the earth's evolutionary history.

THE BURGESS SHALE:

- was declared a World Heritage Site in 1981;
- contains one of the world's finest deposits of soft-bodied fossils of the Middle Cambrian times;
- has been found to contain a far more varied and complex distribution pattern for fossils than previously realized; and
- is considered to be one of the world's most significant fossil sites, even without reference to recent discoveries in the area.

It is proposed that the Burgess Shale World Heritage Site be incorporated into this nomination as a major feature of the Canadian Rockies site.

ii) ON-GOING GEOLOGICAL PROCESSES

The Canadian Rockies site includes the Columbia Icefield complex and Maligne Valley, outstanding examples of combinations of features which represent significant geological processes.

THE COLUMBIA ICEFIELD COMPLEX:

- is the largest icefield in the Rocky Mountains and the largest in North America's subarctic interior, covering a total of 325 km^2;
- is composed of the Columbia Icefield and six valley glacier basins with a diversity of glacial and periglacial landforms;
- includes the Athabasca Glacier, the most accessible glacier ice in North America;
- is important as a source of water for river systems on both sides of the Continental Divide;
- includes the internationally significant Castleguard Cave system which extends below the glaciers of the icefield and includes subglacial karst features – the finest examples in the world;
- contains some of the most scenic alpine karst topography known anywhere; and
- is located in a broader setting of exceptional natural beauty.

THE MALIGNE VALLEY

- includes beautiful Maligne Lake which at 27.5 km long, is the largest glacier-fed lake in the Canadian Rockies;
- includes almost all the common mountain landforms found in the Rocky Mountains;
- contains the Maligne River/Medicine Lake karst phenomena, with Medicine Lake draining through one of the world's largest sinking rivers and inaccessible karst systems; and
- ends in Maligne Canyon, a spectacular narrow canyon cut over 60 m deep into limestone rock.

iii) EXCEPTIONAL NATURAL BEAUTY

The Canadian Rockies landscape is one of exceptional natural beauty, as is exemplified by the number and diversity of different environments and scenic places dispersed throughout the four parks making up this nomination. Protection of the varied natural resources and processes in this large area is assured for this and future generations.

iv) HABITATS

Vegetation in this Canadian Rockies site displays an impressive variation due to the area's large size and diversity of altitudinal, geographic and topographic influences. Undisturbed habitats of many species of wildlife typical of the Rocky Mountains are wholly contained in the parks. Wildlife populations are a noted and popular attraction. As well there are species which are considered as vulnerable species in the IUCN Red Book. These include the grey wolf and bighorn sheep. Other species of note due to threats to their habitat are the grizzly bear and woodland caribou.

Each of these criteria in isolation has a significant natural resource value. Combined, their significance is greatly enhanced, giving the area global significance.

The Canadian Rockies nomination meets the conditions of integrity required of a World Heritage Site. All key interrelated and interdependent elements of a Rocky Mountain ecosystem are included. Examples of the major processes which formed the landscape (glacial, hydrological, colluvial and eolian) and the vegetation and wildlife which inhabit it, are found in the Canadian Rockies. The nominated area is of sufficient size and diversity to contain self-perpetuating ecosystems where human impact is limited.

Beginning in 1885 with the establishment of Banff National Park, the Canadian Rockies formed the backbone of Canada's conservation system. Areas of outstanding beauty such as Maligne and Peyto lakes are protected along with areas of scientific interest such as the Castleguard Caves and the karst features of Medicine Lake. This extensive area with its large tracts of wilderness is dedicated as a World Heritage Site for the benefit and enjoyment of all nations.

Signed (on behalf of State Party) ____________________

Full name A. T. Davidson

Title Assistant Deputy Minister, Parks Canada

Date November 23, 1983

APPENDIX ONE

SELECTED REFERENCES

The bibliographic references below are but a small portion of over 1000 documents which make up the reference collection for Banff, Jasper, Kootenay and Yoho national parks. Most of these references are contained in an annotated bibliography by Scace, 1973, noted below. Approximately 150 references have been added since the bibliography by Scace was completed.

Baranowski, S. and Wes Henoch,
"Supplementary Report" to *Glacier and Landform Features in the Columbia Icefield Area, Banff and Jasper National Parks,* Glaciology Division of Inland Waters Directorate, Environment Canada, 1978.

Brown, M.C.,
"Hydrology of a Large Karst Lake in Western Alberta: Medicine Lake, Jasper", in E.R. Reinett, R.H. Laycock and W.M. Schultz (eds.), *Proceedings of the Symposium on the Lakes of Western Canada,* University of Alberta, Water Resources Centre, Edmonton, Alberta, 1973, pp. 190-195.

Brown, M.C.,
Karst Geomorphology and Hydrology of the Lower Maligne Basin, Jasper, Alberta, Unpubl. PhD thesis, Department of Geography, McMaster University; Hamilton, Ontario, 1970.

Brown, M.C.,
"Hydrology of the Lower Maligne Basin, Jasper, Alberta," *Cave Studies,* No. 13, Cave Research Associates, Dept. of Geography, University of Alberta, Edmonton, Alberta, May, 1970.

Collins, D.H.,
"Final Report on the 1981 Reconnaissance of Soft-Bodied Fossil Localities of the Burgess Shale Type in Yoho National Park", Report to the Director, Western Region, Parks Canada, Calgary, Alberta, 1982.

Christensen, Ole,
Prehistoric Settlement and Subsistence in Banff National Park, Manuscript Report Series No. 67, Parks Canada, Ottawa, Ontario, 1971.

Ford, D.C.,
"Castleguard caves and Karst, Columbia Icefield Area, Rocky Mountains of Canada, a Symposium," *Arctic and Alpine Research,* Vol. 15, No. 4, Nov., 1983, Boulder, Colorado, pp. 425-554.

Ford, D.C.,
Full Report to the National and Historic Parks Branch (Contract 69075), Department of Indian Affairs and Northern Development, unpubl., Ottawa, Ontario, 1969.

Ford, D.C.,
"Final Report Upon the 1979 Winter Expedition to Castleguard Cave", Department of Geography, McMaster University: Hamilton, Ontario, 1979.

Ford, D.C.,
"New Discoveries in Our Greatest Cave," *Canadian Geographic,* Vol. 100, No. 4, Aug./Sept., 1980, Ottawa, Ontario, pp. 12-23.

Ford, Derek C., and James F. Quinlan,
Theme and Resource Inventory Study of the Karst Regions of Canada. – Final Report (Contract 72-32), National and Historic Parks Branch: Ottawa, Ontario, 1973.

Ford, D.C. and C.C. Smart,
The Castleguard Karst, Main Ranges, Rocky Mountains, unpubl. Interim Report, Department of Geography, McMaster University: Hamilton, Ontario, 1979.

Forster, Merna M.,
"Maligne: Valley of the Wicked River", Parks Canada: Calgary, Alberta, 1979.

Government of Canada,
Office Consolidation, National Parks Act, Supply and Services Canada, Hull, Quebec, 1978.

Hanson, W.R.,
Conserving a Watershed, Eastern Rockies Conservation Board, Edmonton, Alberta, no date.

Holland, W.D., and G.M. Coen (eds.),
Ecological (Biophysical) Land Classification of Banff and Jasper National Parks, Vol II: Soil and Vegetation Resources, Environment Canada, Edmonton, Alberta? 1982.

Holroyd, Geoffrey L., and Kevin J. Van Tighem,
Ecological (Biophysical) Land Classification of Banff and Jasper National Parks, Vol. III: The Wildlife Inventory, Environment Canada, Edmonton, Alberta? 1982.

Janz, B., and D. Storr,
The Climate of the Contiguous Mountain Parks, Atmospheric Environment Service, Department of the Environment, Toronto, Ontario, 1977.

Kruse, P.B.,
Karst Investigations of Maligne Basin, Jasper National Park, Alberta, Dept. of Geography, University of Alberta, Edmonton, Alberta, 1980.

Kucera, R.E., and Wes Henoch,
Glacier and Land Form Features in the Columbia Icefield Area, Banff and Jasper National Parks, Canada, Glaciology Division of Inland Waters Directorate, Environment Canada, n.p., March, 1978.

Lothian, W.F.,
A History of Canada's National Parks, Parks Canada, Environment Canada, Ottawa, Ontario, 1981, 4 Vol.

McIlreath, Ian A.,
Stratigraphic and Sedimentary Relationships at the Western Edge of the Middle Cambrian Carbonate Facies Belt, Field, British Columbia, unpubl. PhD thesis, Department of Geology, University of Calgary, Calgary, Alberta, 1977.

Morris, Simon Conway and H.B. Whittington,
"The Animals of Burgess Shale," *Scientific American,* July, 1979, Vol. 241 No. 1, New York, New York, pp. 122-133.

Nelson, Samuel J.,
The Face of Time, Alberta Society of Petroleum Geologists, Edmonton, Alberta, 1970.

North, F.K. and A.A.L. Henderson,
"Summary of the Geology of the Southern Rocky Mountains of Canada", in *Proceedings of the Fourth Annual Field Conference of the Alberta Society of Petroleum Geologists,* Calgary, Alberta, 1954, pp. 15-81 and map.

Parks Canada,
Columbia Icefield Interpretive Management Unit Information Package, unpubl. Jasper National Park, Alberta, 1981, 191 pp.

Parks Canada,
Background information: Four Mountain Parks Planning Program, Western Regional Office: Calgary, Alberta, 1983, 2 Vol.

Parks Canada,
An Overview of the Natural Resources of the Four Mountain Parks, Four Mountain Parks Planning Program, Western Regional Office: Calgary, Alberta, 1983.

Scace, Robert C.,
Banff, Jasper, Kootenay and Yoho – An Initial Bibliography of the Contiguous Canadian Rocky Mountain National Parks, Calgary, Alberta, 1973, 3 Vol.

Schäffer, T.S.,
Old Indian Trails of the Canadian Rockies, Putnam's Sons, New York, London, 1911.

TERA Environmental Consultants Ltd.,
Regional Analysis Study of Natural Region 5, The Rocky Mountains. Stages 2 and 3, prepared for Parks Canada: Calgary, Alberta, 1982.

Udvardy, Miklos D.F.,
"A Classification of the Biogeographical Provinces of the World," IUCN Occasional Paper No. 18, IUCN, Morges, Switzerland, 1975.

Ward, J.C.,
Fishes and Their Distribution in the Mountain National Parks of Canada, prepared for Parks Canada by Canadian Wildlife Service, Edmonton, Alberta, 1974.

ADDITIONAL REFERENCES

NOMINATION OF THE CANADIAN ROCKIES FOR INCLUSION IN THE WORLD HERITAGE LIST

Appendix One provides only a brief listing of general information sources and papers referenced in the document. This addition provides an expanded list.

Achuff, P.L. and G.M. Coen. 1980. Subalpine Cryosolic soils in Banff and Jasper National Parks. Canadian J. of Soil Science. 60:579-581.

Aitken, James D. and M.E. Taylor (eds.). 1981. The Cambrian system in the southern Canadian Rocky Mountains, Alberta and British Columbia. 2nd International Symposium on the Cambrian System. Guidebook for Field Trip #2. International Geological Congress, Montreal, Quebec. 61 pp.

Allan, John A. 1954. Ice River igneous intrusion in Guidebook of the 4th Annual Field Conference, Society of Petroleum Geologists. Edmonton, Alberta pp. 141-145.

Anderson, R.M. 1938. Investigation into wildlife conditions *in* national parks (Waterton Lakes, Banff and Jasper) in the province of Alberta, 1938. Canadian Wildlife Service. 17 pp.

Anderson, R.S. and D.B. Donald and others. 1977-1981. Limnological studies in Jasper National Park. Parts 1-VIII. Canadian Wildlife Service. Edmonton, Alberta.

Baig, M.N. 1972. Ecology of timberline vegetation in the Rocky Mountains of Alberta. PhD thesis, University of Calgary. Calgary, Alberta. 444 pp.

Baird, D.M. 1963. Jasper National Park. Behind the mountains and glaciers. Geological Survey of Canada Miscellaneous Report. Ottawa. 6:184.

Banfield, A.W.F. 1958. The mammals of Banff National Park, Alberta. National Museums of Canada, Bulletin No. 159. Ottawa.

Belyea, H.R. 1964. The story of the mountains in Banff National Park. Geological Survey of Canada 42 pp.

Bostock, H.S. 1970. Physiographic Regions of Canada. Geologic Survey of Canada. Map 1254A.

Bowman, T.E. 1975. Three new troglobitic asellids from Western North America (Crustacea: Isopoda: Asellidae). International J. of Speology. 7: 339-356.

Byrne, A.R. 1968. Man and landscape change in the Banff National Park area before 1911. Parks Canada, National Park Series No. 1. Ottawa. 173 pp.

Carbyn, L.N. 1974. Wolf population fluctuations in Jasper National Park, Alberta, Canada. Biological Conservation. 6(2):94-101.

Carbyn, L.N. 1974. Wolf predation and behavioural interactions with elk and other ungulates in an area of high prey diversity. Canadian Wildlife Service. Edmonton, Alberta.

Carl, G. Clifford, W.A. Clemens, and C.C. Lindsey. 1977. The fresh-water fishes of British Columbia. British Columbia Provincial Museum. Handbook #5. Victoria, British Columbia. 192 pp.

Charlesworth, H.A.K., J.L. Weiner, A.J. Akehurst, H.U. Bielenstein, C.R. Evans, R.E. Griffiths, D.B. Remington, M.R. Stauffer and J. Steiner. 1967. Precambrian geology of the Jasper region, Alberta. Research Council of Alberta Bulletin. 23: 74 pp.

Clarke, Arthur H. 1976. The endangered mollusks of Canada *in* Theodore Mosquin and Cecile Suchal (eds.) Canada's threatened species and habitats. Proceedings of the Symposium on Canada's threatened species and habitats. Canadian Wildlife Federation and World Wildlife Fund, Ottawa. pp. 148-152.

Clarke, Arthur H. 1981. The freshwater mollusks of Canada. National Museum of Natural Sciences, National Museum of Canada, Ottawa.

Clarke, C.H.D. and I. Mctaggert Cowan. 1945. Birds of Banff National Park, Alberta. Canadian Field-Naturalist. 49:83-103.

Clifford, Hugh F., and Glen Bergstrom. 1976. The blind aquatic isopod *Salmasellus* from a cave spring of the Rocky Mountain's eastern slopes, with comments on a Wisconsin refugium. Canadian J. of Zoology. 54:2028-2032.

Coen. Gerald M., Philip F. Epp. Joseph Tojak, and Leonard Knapik. 1977. Soil survey of Yoho National Park, Canada. Alberta Institute of Pedology #5-77-37; Land Resources Research Institute Publication #1. 208 pp and maps.

Collins, D.H. 1982. Final Report on the 1981 Reconnaissance of Soft-Bodied Fossil Localities of the Burgess Shale Type in Yoho National Park, Report to the Director, Western Region, Parks Canada. Calgary, Alberta.

Cook, D.C. 1975. Structural style influenced by lithofacies in the Rocky Mountain Main Ranges, Alberta-British Columbia. Geological Survey of Canada Bulletin, 233.

Cruden, D.M. 1976. Major rock slides in the Rockies. Canadian Geotechnical Journal. 13:8-20.

Currie, K.L. 1975. The geology and petrology of the Ice River alkaline complex, British Columbia. Geological Survey Bulletin 245. Energy, Mines and Resources, Canada, Ottawa. 68 pp.

Falconer, G., W.E.S. Henoch and G.M. Ostrem. 1966. A glacier map of southern British Columbia and Alberta. Geographic Bulletin. 8:108-112.

Fenton, M.B., H.G. Merriam, and G.L. Holroyd. 1983. Bats of Kootenay, Glacier, and Mount Revelstoke national parks in Canada: identification by echolocation calls, distribution, and biology. Canadian J. of Zoology 61(11):2503-2508.

Gardner, J. 1972. Recent glacial activity and some associated landforms in the Canadian Rocky Mountains, *In* H.O. Slaymaker and H.J. McPherson (eds.), Mountain geomorphology. Geomorphological processes in the Canadian Corillera. British Columbia Geographic Series No. 14. Tantalus Research Ltd., Vancouver, British Columbia. pp. 55-62.

Hall, W.K. 1977. Status and management of the Rocky Mountain goat, *Oreamnos americanus*, in the province of Alberta. pp. 8-14 *in* W. Samuel, and W.G. MacGregor, (eds.), Proceedings of the First International Mountain Goat Symposium. 243 pp.

Hamer D. and S. Herrero, (eds.) 1983. Ecological study of grizzly bear of Banff National Park. University of Calgary, Alberta.

Herrero, S. 1976. Conflicts between man and grizzly bears in the national parks in North America pp. 121-145 *In* M.R. Pelton, J.W. Lentfer, and G.E. Folk Jr., (eds.). Bears – their biology and management. IUCN Publication. Series 40.

Heusswer, C.J. 1956. Post-glacial environments in the Canadian Rocky Mountains. Ecological Monographs. 26(4):263-302.

Hitchcock, C.L. and A. Cronquist. 1973. Flora of the Pacific Northwest. University of Washington Press. Seattle, Washington, U.S.A. 730 pp.

Holsinger, John R. 1980. *Stygobromus canadensis*, a new subterranean amphipod crustacean (Crangonycitidae) from Canada, with remarks on Wisconsin refugia. Canadian J. of Zoology. 58:290-297.

Hrapko, J.O. and G.H. La Roi. 1978. The alpine tundra vegetation of Signal Mountain, Jasper National Park. Canadian J. of Botany. 56:309-332.

Jackson, P.C. 1975. Geological highway map of Alberta. Canadian Society of Petroleum Geologists. Calgary, Alberta.

King, R.H. and G.R. Brewster. 1976. Characteristics and genesis of some subalpine Podzols (spodsols), Banff National Park, Alberta, Arctic Alpine Research 8:91-104.

Knapik, L.J., G.W. Scotter and W.W. Pettapiece. 1973. Alpine soil and plant community relationships of the Sunshine area, Banff National Park. Arctic Alpine Research. 5:A161-A170.

Kuchar, P. 1978. The vegetation of Yoho National Park. Report to Parks Canada. Calgary, Alberta. 382 pp.

LaRoi, G.H. and R.J. Hnatiuk. 1980. The *Pinus contorta* forests of Banff and Jasper National Parks: a study in comparative synecology and syntaxonomy. Ecological monographs. 50: 1-29.

Luckman, B.H. and K.J. Crockett. 1978. Distribution and characteristics of rock glaciers in the southern part of Jasper National Park, Alberta. Canadian J. of Earth Sciences, 15:540-550.

Mackenzie, W.W. 1969. Stratigraphy of the Devonian Southesk Cairn carbonate complex and associated strata, eastern Jasper National Park, Alberta. Geological Survey of Canada Bulletin. 184:77 pp.

Marsh, A.H. 1976. The botany and natural history of Middle Springs Swamp, Banff, Alberta. The Canadian Field-Naturalist 88(2):129-140.

Mayhood, D.W. and R.S. Anderson. 1976. Limnological survey of the Lake Louise area, Banff national Park. Parts I-IV. Canadian Wildlife Service. Edmonton, Alberta.

McCrory, W.P., D.A. Blood. 1978. Mammals of Yoho National Park, B.C. (2 Vols.) Prepared for Parks Canada, Western Region. Calgary, Alberta.

McIlreath, Ian A. 1977. Stratigraphic and sedimentary relationships at the western edge of the Middle Cambrian carbonate facies belt, Field, British Columbia. PhD thesis, Department of Geology, University of Calgary, Calgary, Alberta.

McPherson, J.J. 1970. Landforms and glacial history of the Upper North Saskatchewan Valley, Alberta, Canada. Canadian Geographic. 14:10-25.

McTaggart-Cowan, I. 1947. The timber wolf of the Rocky Mountain National Parks of Canada. Canadian Journal of Research, Section D. 25:139-174.

McTaggart-Cowan, I. 1969. The role of ecology in the national parks. pp. 931-939 *in* Nelson, J.G. and R.C. Scace, (eds.). The Canadian National Parks: today and tommorrow. Proceedings of 1968 conference. Vol. II. University of Calgary, Calgary, Alberta.

Moss, E.H. 1959. Flora of Alberta. University of Toronto Press. Toronto, Ontario. 546 pp.

Mudry, Dwight R. and R. Stewart Anderson. 1975. Aquatic resources inventory. Yoho National Park. 3 Vols. Canadian Wildlife Service. Edmonton, Alberta.

Nelson, J.G. 1970. Canadian parks in perspective. Harvest House Ltd., Montreal Quebec. 343 pp.

Nelson, Samuel J. 1970. The face of time. Alberta Society of Petroleum Geologists. Edmonton, Alberta. 133 pp.

Norris, D.K. 1965. Stratigraphy of the Rocky Mountain Group in the southeastern cordillera of Canada. Geological Survey of Canada Bulletin. 125:82 pp.

Ogilvie, R.T. 1976. The alpine in the Rocky Mountains of Alberta. *In* H.A. Luttmerding and J.A. Shields (eds.), Proceedings, Workshop on alpine and subalpine environments. Victoria, B.C. Province of British Columbia. Ministry of Environment, Resource Analysis Branch. Victoria, British Columbia. pp. 34-36.

Porsild, A.E., and Dagny Tande Lid. 1974. Rocky Mountain wild flowers. National Museums of Canada. Ottawa. 454 pp.

Reynolds, David M. 1977. Water (hydrology) resources inventory. Yoho National Park, 1975-1976. 2 vols. Report to Parks Canada, Calgary. 240 pp. and maps.

Russell, R.H., J.W. Nolan, N.G. Woody and G.H. Anderson. 1979. A study of the grizzly bear in Jasper National Park, 1975 to 1978. Canadian Wildlife Service. Edmonton, Alberta 136 pp.

Soper, J.D. 1970. The mammals of Jasper National Park, Alberta. Canadian Wildlife Service, Ottawa. Report Series No. 10. 80 pp.

Sproule and Associates Ltd. 1975. Report on geology and landforms emphasizing surficial geology, Yoho National Park, British Columbia. Report to Parks Canada, Calgary, Alberta. 97 pp. and maps.

Stelfox, J.G. 1971. Bighorn sheep in the Canadian Rockies; a history 1800 - 1970. Canadian Field Naturalist. 84:102-122.

Stelfox, John. 1976. Range ecology of Rocky Mountain Bighorn Sheep. Canadian Wildlife Service. Report Series Number 39. Edmonton, Alberta. 50 pp.

Stelfox, J.G., P. Kuchar and J.A. Bindernagel. 1978. Range ecology of mountain caribou *(Rangifer tarandus caribou)*, Jasper National Park, 1971 - 1974. Canadian Wildlife Service. Edmonton, Alberta. 121 pp.

Stringer, P.W. 1973. An ecological study of grasslands in Banff, Jasper and Waterton Lakes National Parks. Canadian J. of Botany. 51:383-411.

Stringer P.O. and G.H. La Roi. 1970. The Douglas-fir forests of Banff and Jasper National Parks, Canada. Canadian J. of Botany. 48:1703-1726.

Strong, W.L. and K.R. Leggat. 1981. Ecoregions of Alberta. Alberta Energy and Natural Resources Report. Edmonton, Alberta. 143:64 pp.

Theberge, J.B. 1979. The role of ecology in national parks *In* J.G. Nelson, R.D. Needham, S.H. Nelson and R.S. Scace, (eds.). The Canadian National Parks today and tomorrow, Conference II: Ten years later. Vol 2. University of Waterloo, Ontario. pp. 673-686.

Van Tighem, K. 1977. The avifauna of Kootenay National Park. Parks Canada. Calgary, Alberta. 71 pp.

Van Tighem, K.J. and G.L. Holroyd. 1982. Checklist of the birds of Banff and Jasper National Parks. Parks Canada, Ottawa. 27 pp.

Vroom, G.W., S. Herrero and R.T. Ogilvie. 1977. The ecology of winter den sites of grizzly bears in Banff National Park, Alberta *In* C.J. Martinka, and K.L McArthur, (eds.) 1980. Bears and their biology. Bear Biology Association Conference Series, No. 3. pp. 321-330.

Wade, Carson. 1977. Avifauna inventory of Yoho National Park. 2 vols. Report to Parks Canada. Calgary, Alberta. 799 pp.

Walker, B.D., P.L. Achuff, D.T. Allan, W.S. Taylor, J.R. Dyck, and H. Dudynsky. 1982. Ecological (biophysical) land classification of Kootenay National park, interim report, 1982 - 83. Northern Forest Research Center, Environment Canada. Edmonton, Alberta. 88 pp. and app.

Theberge, J.B. 1979. The role of ecology in national parks *In* J.G. Nelson, R.D. Needham, S.H. Nelson and R.S. Scace, (eds.). The

APPENDIX TWO

PURPOSE AND OBJECTIVES STATEMENT

1. PURPOSE FOR THE FOUR MOUNTAIN PARKS

Banff, Jasper, Kootenay, and Yoho national parks contain and protect a representative cross-section of the eastern system of the Canadian Cordillera – the Rocky Mountain natural region – for the appreciation, understanding, and enjoyment of present and future generations of Canadians and other visitors.

2. PARKS OBJECTIVES

2.1 PROTECTION AND PRESERVATION OF HERITAGE RESOURCES AND PROCESSES

NATURAL HERITAGE RESOURCES AND PROCESSES

a) To protect and preserve the natural resources and processes of Banff, Jasper, Kootenay, and Yoho national parks associated with the Rocky Mountains Natural Region.

b) To provide the highest level of protection or, where appropriate, preservation to resources and processes which are:

i) nationally or internationally significant;
ii) unique, rare, or endangered;
iii) good examples of the natural resources and processes of the Canadian Rocky Mountains; and
iv) important for the retention of the parks' wildland character.

HUMAN HERITAGE RESOURCES

a) To protect, preserve, recognize, or restore, in an appropriate manner,human heritage resources of Banff, Jasper, Kootenay, and Yoho national parks.

b) To give the highest level of attention to those resources which are:

i) nationally significant;
ii) good examples of man's interaction with the landscape of the Canadian Rocky Mountains.

2.2 PARKS USE, FACILITIES AND SERVICES (APPRECIATION, UNDERSTANDING, AND ENJOYMENT)

a) To provide year-round opportunities for the appreciation, understanding, and enjoyment of the parks' natural and human heritage resources while maintaining the wildland character of Banff, Jasper, Kootenay, and Yoho national parks.

b) To provide a range of facilities and services for day-use and extended stays in the parks for persons of varying skills, knowledge, economic means, and interests.

c) To provide a range of information, orientation and interpretative services and facilities to enable the parks' users to better understand, protect and enjoy safely the parks' resources.

d) To continue to provide visitors with the essential facilities and services required to meet their needs and to meet park operational requirements through the towns of Banff and Jasper, the visitor service centre at Lake Louise, and the community of Field.

e) To allow for the provision of services and facilities to meet normal community requirements of the residents of the towns of Banff and Jasper.

2.3 REGIONAL INTEGRATION AND CONSIDERATIONS

a) To coordinate the protection and management of Banff, Jasper, Kootenay, and Yoho national parks with those of provincial governments and agencies and private interests having control over lands and resources and their use in areas adjacent to the parks.

b) To coordinate the social and economic activities of the parks where feasible with programs in the adjacent regions.

c) To coordinate the parks' roles in recreation and tourism in a manner complementary to programs in adjacent regions and to national programs.

d) To coordinate the management of existing developments associated with transportation and utility corridors and scientific and educational facilities in a manner that minimizes their impact on the natural and human heritage resources of Banff, Jasper, Kootenay, and Yoho national parks.

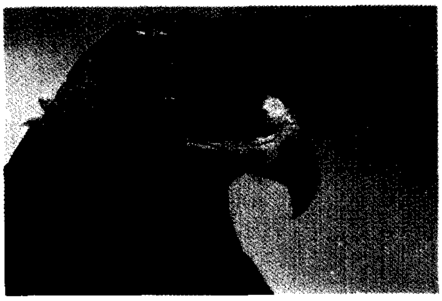
e) To provide opportunities for the public of adjacent regions to become involved in the planning and on-going plan implementation for these parks.

APPENDIX THREE

COMMON AND SCIENTIFIC NAMES OF VEGETATION AND WILDLIFE REFERENCED IN THE TEXT

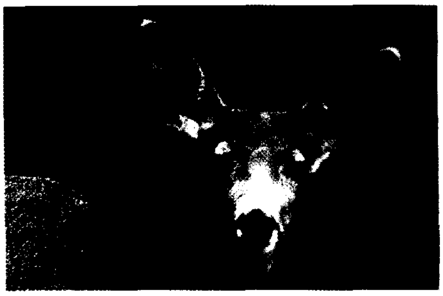
VEGETATION

Douglas fir	Pseudotsuga menziesii var. glauca
Subalpine fir	Abies lasiocarpa
Lodgepole pine	Pinus contorta var. latifolia
Englemann spruce	Picea engelmannii
White spruce	Picea glauca



BIRDS

Bald eagle	Haliaeetus leucocephalus
Golden eagle	Aquila chrysaëtos



MAMMALS

Grizzly bear	Ursus arctos
Woodland caribou	Rangifer tarandus var. caribou
Mule deer	Odocoileus hemionus
White-tailed deer	Odocoileus virginianus
Mountain goat	Oreamnos americanus
Moose	Alces alces
Bighorn Sheep	Ovis canadensis
Pigmy shrew	Microsorex hoyi
Wapiti	Cervus elaphus
Grey Wolf	Canis lupus

NOMINATION OF MOUNT ROBSON, MOUNT ASSINIBOINE, AND HAMBER PROVINCIAL PARKS FOR INCLUSION IN THE WORLD HERITAGE LIST

1. <u>Specific Location</u>	
a) Country	Canada
b) State, Province or Region	Province of British Columbia
c) Name of property	Addendum to Canadian Rocky Mountain Parks (Site 304)
d) Exact location on map and indication of geographical coordinates	Exact location on map and indication of geographical coordinates Mount Robson Provincial Park, Hamber Provincial Park, and Mount Assiniboine Provincial Park. Refer to maps in Appendix 1.
e) Maps and/or Plans	Topographic maps are included in Appendix 1.
2. <u>Juridical Data</u>	
a) Owner	Crown, Province of British Columbia
b) Legal Status	The areas being nominated are under direct ownership of the Crown, Province of British Columbia, and administered by the Ministry of Parks under the authority of the provincial Park Act. The boundaries of the parks are established by legislation, and their legal descriptions are included in the Park Amendment Act, 1990 (See Appendix 2).
c) Responsible agency	Ministry of Parks, Parliament Buildings, Victoria, British Columbia, V8V1X4
d) Collaborating national agencies and organizations	Federal Department of the Environment, Canadian Parks Service

3. Identification

a) History

Mount Robson Provincial Park was established in 1913 and encompassed 218,795 hectares (ha). A small addition of 739 ha in 1967 brought Mount Robson Park to its present size of 219,534 ha. Protective status was given to Mount Assiniboine in 1922, when a 5,200 ha provincial park was established. In 1973, the park was enlarged to 39,052 ha to protect the alpine areas and watershed and to link the park to Banff and Kootenay National Parks. Hamber Provincial Park was established in 1941 and was 1,009,112 ha in size. Significant boundary modifications in 1961 and 1962 reduced the park to its present size of 24,518 ha. The boundaries are now established by legislation.

b) Description and Inventory

The areas being nominated represent a significant addition to the Rocky Mountain World Heritage Site for they protect examples of the Rocky Mountains western slopes.

Geology - Underlain by Palaeozoic and Proterozoic sediments, the parks are mainly composed of limestone or limestone related rocks with some sandstones and shales. The have been subjected to much thrust faulting and general folding. There is considerable exposure of bedrock, even at low elevations, due to steep cliff faces. Many northeast scarp slopes are very steep while southwest dip slopes are comparatively gentle (30-45 degrees).

Landforms - All three parks are situated in the Southern Rocky Mountain Ecoregion. The general character of the region is mountainous. Summits are typically serrated and castellated and long continuous ridges are common. Ruggedness tends to increase eastward. Relief ranges from 1,000 to 3,500 metres above sea level (a.s.l.) in the north and between 1,000 to 3,000 metres a.s.l. in the south. Valleys are relatively wide and mountain sides are often concave in profile, due to heavy valley glaciation.

Mount Robson Provincial Park encompasses a variety of natural features including the headwaters of the Fraser River; Mt Robson, which at 3,954 metres is the highest peak in the Canadian Rockies; Berg, Kinney, Moose and Yellowhead Lakes; and Yellowhead Pass, the lowest pass through the Canadian Rockies south of the 54th parallel (1,131 metres).

Mount Assiniboine Provincial Park, a mountainous, triangular shaped park, is dominated by Mount Assiniboine (3,618 metres). Mt. Magog, Mt. Sturdee, Marshall and Lunett peaks all reach or exceed 3,100 metres, while a score of other peaks in the park exceed 2,700 metres. No point in the park is below 1,500 metres. Icefields are situated near the higher peaks, and lakes are found in the southeastern and northern areas of the park. Other visual highlights include alpine and subalpine meadows in the Magog - Rock Isle corridor and Wonder Pass.

Hamber Provincial Park encompasses the watershed of Fortress Lake. Lying at an elevation of 1,336 metres, the lake is surrounded by peaks reaching over 3,000 metres. Fortress and Chisel peaks are the dominant peaks on the northern and southern sides of the lake. Mt. Quincy in Jasper Park provides a dramatic backdrop of turreted peaks and hanging glaciers. Glaciers are also dominant features within Hamber Park.

Hydrology - Lakes, rivers, and streams and alpine glaciers are numerous in the Southern Rocky Mountain Ecoregion. Small icefields and glaciers are common throughout the area, with many streams and lake being glacially fed. Drainage has a distinct trellis pattern and waterfalls and cascades are common at all elevations.

Mount Robson's Moose and Yellowhead lakes are found near the headwaters of the Fraser River and are easily accessible from the highway crossing through the park. Berg and Kinney Lakes are accessible by trail only and provide settings for wilderness experiences. Glaciers are found in the northwestern and southeastern regions of the park.

Just west of Mount Robson Park on the Fraser River is Rearguard Falls. The protection of the Fraser River headwaters is important because these falls mark the furthest migration of sockeye salmon *(Oncorhynchus nerka)* which travel over 1000 kilometres from the Pacific Ocean to spawn.

There are numerous lakes in Mount Assiniboine Park, which is situated near the continental divide. Almost all of the lakes are located in broad alpine valleys and plateaus where they typically occupy glacially scoured depressions in the limestone bedrock. Lake Magog and Og Lake are unusual in that there are no outlets but they show considerable fluctuation in their water levels. The presence of a large areas of possible karst topography in the Valley of the Rocks north of Og Lake indicates that both lakes probably drain underground into the Simpson River Drainage. Icefields are situated in the southeastern area of the park.

Hamber Park features the watershed of Fortress Lake. There are three main streams feeding the lake and twelve minor ones. Fortress and Chisel creeks are the main drainages leading into the lake. Fortress Lake is approximately 11 km long and 1-1.5 km wide. At an elevation of 1,336 metres, less than 7 metres separate the lake from the top of the continental divide. Alnus Creek near the west end of the lake is the major valley which runs south to join the Wood River below the main outlet of the lake. There is intermittent flow into the Athabaska River system, which is fed by the Columbia icefield. Glaciers are common in the alpine basins above the lake.

Climate - The climate type in the parks is interior montane. Summers are moderately warm while winters are cold with heavy snow accumulation. In the Northern Continental Ranges ecosection of the Southern Rocky Mountain Ecoregion, summers are somewhat moist, while in the Southern Continental Ranges where Mount Assiniboine is situated, summers are fairly dry. The climate of the Rocky Mountains is dominated by Pacific air masses moving from the west across British Columbia, although Arctic air masses moving from the north and east also influence the climate. The moist Pacific air masses are forced to rise over the western flanks of the Rocky Mountains producing a zone of relatively high precipitation. As a result, weather conditions can be highly variable.

In general, precipitation increases and temperature decreases with increasing elevation, and the highest precipitation occurs in the vicinity of the highest mountains. In the winter, the weather is controlled by moist, relatively mild Pacific air masses which alternate with cold, dry Arctic air masses.

Vegetation - The three provincial parks are generally characterized by two biogeoclimatic zones: Alpine Tundra and Engelmann Spruce -Subalpine Fir. The zones are named after the climatic climax trees found in the area, which are the dominant member of the mature plant community. Alpine Tundra includes areas above the tree line at high elevations. The short, cool growing season creates conditions too severe for the growth of most woody plants except in dwarf form. Alpine Tundra is dominated by dwarf shrubs, mountain heather, herbs, mosses and lichens. The Engelmann Spruce - Subalpine Fir zone has a cool, short growing season and long cold winters. Engelmann Spruce *(Picea engelmannii)*, Subalpine fir *(Abies lasiocarpa)*, Lodgepole pine *(Pinus contorta)*, and Mountain Hemlock *(Tsuga mertensiana)* are common, with understories that are usually shrub dominated.

In Mount Robson Park, spruce, fir, cedar, balsam, and alder grow in most areas below the treeline, with lodgepole pine and birch prevalent in the eastern portion of the park. Along the Fraser River, near Yellowhead Pass, Lodgepole pine, hybrid and white spruce *(Picea glauce)* and Subalpine fir are the dominant tree species.

Of the two climatic climax species found in Mount Assiniboine Park, Engelmann Spruce tends to dominate rich valley bottom and valley side sites, while Subalpine fir is the dominant species near the treeline. Alpine Larch *(Larix lyallii)*, Whitebark Pine *(Pinus albicaulis)*, Lodgepole pine, Douglas Fir *(Pseudotsuga menziesii)*, and Mountain Hemlock are also found at the higher elevations. Shrubs in the park include: False Azalea *(Menziesia ferruginea)*, Grouseberry *(Vaccinium scoparium)*, White Mountain Rhododendron, White Moss Heather, Red Mountain Heather and Black Mountain Huckleberry *(Vaccinium membranaceum)*.

In Hamber Park, the dense forests covering the slope north of Fortress Lake, and south along the Wood River are composed of Engelmann Spruce, Mountain Hemlock and Alpine Fir. Tree heights reach 50 metres. Heavy windfall and thick False Azalea characterize the understorey. Marshy areas extend down the Wood River from the outlet of the lake. The large burn covering the slope northeast of Fortress Lake from the shore to the treeline dates back to 1960. Pine, spruce and pioneer deciduous tree and shrub species have taken a firm hold in regenerating the area. The alpine tundra contains large open basins with extensive meadows. Krummholz on the ridgelines and willow-alder thickets along seepage areas form a common vegetation pattern on the lower alpine fringe. Slide paths ranging from 100-500 metres in width prevalent along the slopes of the lake and tributary valleys. Slide areas have dense thickets of alder and willow at lower elevations and give way to forbs and grasses on the higher slopes.

Fish and Wildlife - The diverse landforms found within the three parks provide excellent habitat for the variety of animals associated with the western slopes of the Rocky Mountains. There are some limitations to the area's ability to support fish and wildlife populations, including the low water temperatures and high sediment loads characteristic of the parks' glacial lakes. In addition, the high amount of snowfall limits the number of ungulates that winter in the parks.

A diversity of wildlife species can be found in Mount Robson Park. Moose *(Alces alces)* may be seen in the marshes at the east end of Moose Lake, while mountain goats *(Oreamnos americanus)* and grizzly bears *(Ursus arctos)* frequent the rock slide on the north side of the highway and Yellowhead Lake. Caribou *(Rangifer tarandus)* range in the high basins. Mule deer *(Odocoileus hemionus)* and black bear *(Ursus americanus)* are found throughout the park while

	elk *(Cervus elaphus)* roam in the eastern region. Pikas and marmots may be observed on rocky terrain and squirrels and chipmunks can be found at lower elevations. Beaver *(Castor canadensis)* and muskrat *(Ondatra zibethicus)* inhabit the marshlands. More than 170 species of birds have been reliably reported in the park. Members of the grouse family and jays are the most common. Yellowhead and Moose lakes are known to support Dolly Varden char *(Salvelinus malma)*, lake char, and rainbow trout *(Salmo gairdneri)*. Rocky Mountain elk, mule deer, moose, mountain goats, bighorn sheep *(Ovis canadensis)*, and grizzly bears can be found in Mount Assiniboine Park. Squirrels, chipmunks, hoary marmots *(Marmota caligata)*, and pikas are often heard. Ninety-three species of birds have been sighted in the park. Marsh hawk, Gray Jay *(Perisoreus canadensis)*, Clark's nutcracker *(Nucifraga columbiana)*, White-tailed Ptarmigan *(Lagopus leucurus)*, Pine Grosbeak *(Pinicola enucleator)*, gray crowned Rosy Finch *(Leucosticte arctoa)*, Pine Siskin *(Carduelis pinus)*, and Boreal Chickadees *(Parus hudsonicus)* are common. Dolly Varden char occur in four lakes in the northern end of the park, while Yellowstone cutthroat trout *(Salmo clarki)* and rainbow trout are found in lakes in the southeastern part of the park. Hamber Park protects important habitat for moose, mountain goats, grizzly and black bears. Eastern Brook trout *(Salvelinus fontinalis)* is the only recorded fish species in the park. The large size and number fish in Fortress Lake are an attraction for park visitors.
c) Photographic and/or cinematographic documentation	Photographic documentation is enclosed in Appendix 3.
d) Public Awareness	The parks of the Rocky Mountains are popular with Canadian and foreign visitors. In 1989, over 500,000 visits were made to the parks. The two tables below outline the level of campground and day use visits in the three parks during 1989.

1989 CAMPGROUND USE

	Parties	Visits
Mt. Robson	14,398	46,073
Mt. Assiniboine	2,262	7,238
Hamber	334	1,069
Total	16,994	54,380

1989 DAY USE

	Parties	Visits
Mt. Robson	120,308	421,078
Mt. Assiniboine	12,398	43,393
Hamber	*	*
Total	132,706	464,471

* Access into Hamber Park limits day use opportunities.

e) Bibliography

Farley, A.L., Atlas of British Columbia, Vancouver: The University of British Columbia Press, 1979.

Paquet, M., The BC Parks Explorer, Vancouver: Whitecap Books, 1986.

Ministry of Environment, Wildlife Branch, Province of British Columbia, BC Wildlife Habitat Maps, Omenica South, March 1989, East Kootenay, July 1989.

Ministry of Environment and Parks, Province of British Columbia, Mount Assiniboine Provincial Park Background Report, May 1987.

Ministry of Environment and Parks, Province of British Columbia, Hamber Provincial Park Master Plan, December 1986.

Ministry of Parks, Province of British Columbia, Annual Report 1988-1989, March 1990.

Ministry of Parks, Province of British Columbia, Park Data Handbook, 1989, March 1990.

Ministry of Parks, Province of British Columbia, Striking the Balance, British Columbia Parks Policy, June 1990.

Ministry of Parks, Province of British Columbia, Mount Assiniboine Provincial Park Master Plan, October 1989.

Ministry of Recreation and Culture, Province of British Columbia, Mount Robson Park Master Plan, November 1978.

Straley, G., Taylor, R., and Douglas G., The Rare Vascular Plants of British Columbia, National Museums of Canada, Syllogeus No.59, Ottawa, 1985.

Youds, Ken, Regional Landscapes for the British Columbia Parks System, prepared for Ministry of Parks, Province of British Columbia, Victoria, June 1989.

4. State of Preservation/ Conservation

a) Diagnosis

The nominated parks are under the control of the government of British Columbia and protected under the provincial Park Act. The majority of these areas are in their natural state, with exceptions for transportation and energy transmission corridors and visitor facilities. All new proposed developments and activities within the parks must be compatible with the park master plan.

b) History of Preservation/ Conservation

In 75 years, British Columbia's parks have evolved into a system of 390 parks and recreation areas, encompassing 5.4 million hectares. The original provincial parks were created to encourage tourism. Strathcona, the first provincial park, established in 1911, was quickly followed by other pioneer parks such as Mount Robson and Garibaldi. They were vast, spectacular and wild lands selected with the hope of starting a tourist boom in the western reaches of the continent.

In later eras, provincial parklands were meant to fill public demands for recreation and tourism. Many parks were developed along new highways to meet a spiralling need for roadside stops, campgrounds and holiday destinations during the auto-touring years of the 1950s and 60s. While conservation of natural resources has always been a concern, it was not until the Park Act was passed in 1965 that provincial parks gained a strong conservation mandate. The purpose of parks is to set aside common lands "for preservation of their natural environments for the

	inspiration, use and enjoyment of the public". This mandate became further refined as it became clear that the park system could not grow indefinitely, due to competition for natural resources. So the selection of new parks focused on areas that represent the best features and diversity of British Columbia. The provincial parks of British Columbia are set aside for recreational use and for conservation. They have a role in both attracting tourists and in preserving wilderness.
c) Means for Preservation/ Conservation	The Park Act is enforced by contractors within the parks, and staff in 12 district offices, 3 regional offices, and headquarters in Victoria. The Ministry of Parks firmly retains management control of the provincial park system. It sets standards of performance, campground fees, and retains ownership of land and facilities while contractors provide services.
d) Management Plans	The direction for long term management of the parks is developed in park master plans, which are reviewed every five years. Resources within a park are inventoried, assessed, and actions identified for balancing recreation and conservation within the park over the long-term. Within each master plan, the park is divided into zones. Zones describe access, facilities, and recreation activities compatible with the natural resources found in a specific area. Zones in a park may range from Intensive Recreation where the objective is to provide for a variety of high-use, readily accessible, facility-oriented outdoor recreation activities to Wilderness Conservation where a remote, undisturbed natural landscape is protected and backcountry experiences are provided in a pristine environment where no motorized activities are allowed. An updated master plan for Mount Robson Park will be completed in 1991. The Mount Assiniboine and Hamber park master plans were completed in 1989, and 1986 respectively.
5. <u>Justification of the inclusion in the World Heritage List</u>	
a) Cultural Property	Not applicable
b) Natural Property	The areas nominated for addition to the Rocky Mountain World Heritage Site are known for their outstanding natural beauty. The three provincial parks, situated on the western

slopes of the Rocky Mountains, are characterized by mountain scenery, numerous lakes, rivers, and waterfalls, and a diversity of wildlife and habitats.

The nominated areas meet the criteria for inclusion within a World Heritage Site.

Ongoing Geological Processes

Hamber Park incorporates the height of land separating the Athabaska and Columbia river systems. Fortress Lake, at an elevation of 1336 metres, is separated by less than 7 metres from the top of the continental divide. The main flow from the lake is westward into the Wood river, and there is intermittent flow into the Athabaska river system, which is fed by the Columbia icefield.

Berg Glacier, in the northwest section of Mount Robson Park, is one of the few advancing glaciers in the Canadian Rockies. The glacier 'calves' huge chunks of ice into Berg Lake.

Superlative Natural Phenomena, Formations or Features

The headwaters of British Columbia's longest river, the Fraser, are protected within Mount Robson Park. The park also contains the highest peak in the Canadian Rockies and the lowest pass south of the 54th parallel. Mount Robson reaches 3,954 meters and Yellowhead Pass is situated at 1,131 meters.

The drainage of Magog and Og Lakes in Mount Assiniboine Park are associated with scenic alpine karst topography. The presence of a large area of possible karst topography in the Valley of the Rocks north of Og Lake indicates that both lakes probably drain underground into the Simpson River Drainage.

Important Natural Habitats

The nominated sites contain large areas of undisturbed vegetation and wildlife habitats. The Rocky Mountain World Heritage Site and the nominated provincial parks substantially contribute to the protection of ecosystems typical in the region.

Sensitive wildlife species are found in all of the nominated parks. These include the Bald Eagle *(Haliaeetus leucocephalus)*, Grizzly Bear *(Ursus arctos)*, and Rocky Mountain Big Horn Sheep *(Ovis canadensis)*. Caribou *(Rangifer tarandus)* and Western Bluebird *(Sialia mexicana)* are also found in Mt. Robson and Hamber parks.

Rare vascular plants found in Mt. Assiniboine park include: American Alpine Smelowskia *(Smelowskia calycina)*, Raynold's Sedge *(Carex raynoldsii)*, Cusick's Indian Paintbrush *(Castilleja cusickii)*, Stalked-pod Locoweed

(Oxytropis podocarpa), Dwarf Saw-wort *(Saussurea nuda)*, and Apetalous Campion *(Silene uralensis, subsp. attenuata)*, Dwarf Poppy *(Papaver pygmaeum)* and Wooly Fleabane *(Erigeron lanatus)*.

Rare vascular plants found in Mount Robson park include: Low Sandwort *(Arenaria longipedunculata)*, Slender Indian Paintbrush *(Castilleja gracillima)*, Western Indian Paintbrush *(Castilleja occidentalis)*, Sulphur Indian Paintbrush *(Castilleja sulphurea)*, Blue Hackelia *(Hackelia micrantha)*, Bluefly Honeysuckle *(Lonicera dioica)*, Arctic Cinquefoil *(Potentilla hyparctica)*, Apetalous Campion *(Silene uralensis subsp. attenuata)*, Blunt-sepaled Starwort *(Stellaria obtusa)*.

Conclusion

As a part of the Rocky Mountain World Heritage Site, the nominated areas will contribute to the protection of the natural resources found in the Canadian Rockies. The areas include superlative natural phenomena, important vegetation and wildlife habitats, and ongoing geological processes. Additionally, the conditions of integrity required for a World Heritage Site are met by this proposal. In conclusion, this addition to the Rocky Mountain World Heritage Site justifies recognition as an area of global significance.

Signed (on behalf of the State Party)

[signature]

Full Name J.D. Collinson

Title Assistant Deputy Minister
Canadian Parks Service

Date October 2, 1990

UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION

For WHC Use Only

Date received: 28.12.79
Identification No.: 133

Convention concerning the protection of the world cultural and natural heritage

World Heritage List

Nomination Form

Under the terms of the Convention concerning the Protection of the World Cultural and Natural Heritage, adopted by the General Conference of Unesco in 1972, the Intergovernmental Committee for the Protection of the World Cultural and Natural Heritage, called "the World Heritage Committee" shall establish, under the title of "World Heritage List", a list of properties forming part of the cultural and natural heritage which it considers as having outstanding universal value in terms of such criteria it shall have established.

The purpose of this form is to enable States Parties to submit to the World Heritage Committee nominations of properties situated in their territory and suitable for inclusion in the World Heritage List.

Notes to assist in completing each page of the form are provided opposite the page to be completed. Please type entries in the spaces available. Additional information may be provided on pages attached to the form.

It should be noted that the World Heritage Committee will retain all supporting documentation (maps, plans, photographic material, etc.) submitted with the nomination form.

The form completed in English or French should be sent in three copies to:

The Secretariat
World Heritage Committee
Division of Cultural Heritage
Unesco
7, place de Fontenoy
75700 Paris

CC 77 WS.64
Paris, January 1978
Original: English

1. Specific location

a) *Country* | Canada

b) *State, Province or Region* | British Columbia

c) *Name of property* | Burgess Shale Site.
The Property is located on land known as Yoho National Park

d) *Exact location on map and indication of geographical co-ordinates* | See attached copy of relevant portion of E.M.R. map Lake Louise (west half), sheet 82N/8 west, Scale 1:50,000, 1959. Fossil Beds are circled in red, co-ordinates are 51° 25' 29"N, 116° 28' 47"W.

2. Juridical data

a) *Owner* | Government of Canada - Administered by Department of Environment, Parks Canada, under authority of the National Parks Act.

b) *Legal status* | Attached is a photocopy of National Parks Act, Chapter N-13, page 27, describing the boundaries of the park as established under the National Parks Act of the Government of Canada.

c) *Responsible administration* |
Director,
Parks Canada,
Western Region,
134-11th Avenue S.E.,
Calgary, Alberta T2G OX5

3. Identification

a) Description and inventory

Stephen Formation of Middle Cambrian age, that is characterized by its profuse and unique fossil fauna. It is located in Yoho National Park, British Columbia, on the west side of the ridge connecting Mount Field to Wapta Mountain, at 51°26'29"N, 116°28'47"W, two miles (3.2 km) in a direct line from the Trans-Canada Highway. The floor of the fossil quarry is at about 7500 feet (2286 m), or some 3400 feet (1036 m) above the nearby village of Field. The site is named from the nearby Mount Burgess and Burgess Pass.

The west side of the Mount Field-Wapta Mountain ridge is a rather uniform, steep, largely unvegetated slope largely covered by talus deposits. The talus cover is interrupted by scattered outcrops of n great relief, one of which is the Burgess Shale. Another significa outcrop is that of dolomite of the Cathedral Formation, a few hundred feet north of the fossil quarry. The shale beds of the Stephen Formation abut the dolomite mass, which is an exposure of the ancient reef-front that provided the environment in which the Burgess fauna thrived and was preserved after death.

The general vicinity of the site is little disturbed by man. A well-maintained trail crosses the mountainside about 800 feet (245 m) below the quarry. From this, two faint branch trails rise to the quarry proper. The quarry itself forms a step in the slope about 100 feet (30 m) long and 10 feet (3 m) wide, partly back-filled by natural talus accumulations and quarry debris. The waste cone below the quarry is scarcely distinguishable from the natural talus. The moraine and meadow below the trail are somewhat scarred by the camp used by the recent investigators in 1966, 1967 and 1975.

The vantage point of the quarry provides a magnificent alpine view to the south, west and north.

b) Maps and/or plans

("F" denotes maps on which the fossil quarry is identified)

(F) Lake Louise (west half), scale 1:50,000, Sheet 82N/8 West, Canada, Dept. of Mines and Technical Surveys (now Energy, Mines and Resources), 1959.

(F) Fig. 1 of Fritz (1971) (see Bibliography)
- this is a geological map of the immediate area, scale 1:100,000.

(F) Yoho (National) Park, scale 1:126, 720, Sheet MCR 213, Canada, Dept. of Mines and Technical Surveys (now Energy, Mines and Resources), 1961.

Map 1368A, in Cook, 1975 (see Bibliography)
- a geological map of the region, scale 1:75,000.

(continued on attached sheet)

3. Identification (cont'd)

(b) Maps and/or plans

The following are referenced only. Maps not included.

Fig. 2-1 of McIlreath, 1977 (see Bibliography)
- an updated geological map, scale 1:50,000.

Airphoto Pair - for stereoscopic coverage
National Air Photo Library, Ottawa
Flight A13253, no's. 96,97.

3. Identification (cont'd)

c) Photographic and/or cinematographic documentation

#1 North end of the Burgess Shale quarry, 1966. Workmen are removing layers of barren shale that overlie the celebrated "Phyllopod bed", while the paleontologists split shale in search of fossils.

#2 South end of the Burgess Shale quarry at "2" (1966). Figures at "1" are at a small quarry opened by P.E. Raymond in 1930.

#3 West flank of the ridge connecting Mount Field (right) to Wapta Mountain (out of view, left). Quarry camp area is at "1". Burgess Shale Quarry, largely filled with snow, is at "2". Dashed line is a well-maintained foot-and-horse-trail.

#4 View northwest from the trail between the camp and the quarry. President Range in background. Emerald Lake occupies the deep valley at centre and left.

d) History

Charles D. Walcott, the famous American paleontologist and stratigrapher, discovered the outcrop of the Burgess Shale in 1910, by deliberate search following the finding of one of the unique fossils in a talus fragment in 1909. His party quarried the site during parts of the field seasons of 1910 through 1913, removing, in all, about 150 cubic yards of the shale. He returned to the quarry again in 1917, spent fifty days there, and later stated that the "Phyllopod bed" was practically exhausted (i.e., that few fossils remained in place).

P.E. Raymond of Harvard University worked at the site in 1930 and made a small collection at Walcott's quarry, and another small quarry about 70 feet higher.

The quarry lay dormant, protected by the regulations of Yoho National Park, until 1966, when permission was granted by the park management for a party under Geological Survey of Canada auspices to reopen the quarry, with possible extensions for two further years. This party, under the general direction of H.B. Whittington of Cambridge University soon established that contrary to wide-spread belief, the rich fossil beds were not exhausted. Quarrying in 1966 and 1967 removed some ninety cubic yards of shale. The main object of the work was to determine precisely the spatial relationships among the fossils, because this could not be established by re-examination of the earlier collections. Work was not continued in 1968, because the cover above the "Phyllopod bed" was now so thick that further quarrying would be much larger-scale operation than any carried out to this date. The quarry has remained dormant since 1967.

e) Bibliography

See attached pages

Identification (cont'd)

(e) Bibliography

Aitken, J.D., and Fritz, W.H. 1968. Burgess Shale project, British Columbia [82 H/8 (West Half)]. Canada Geol. Survey Pap. 68-1A: 190-192.

_____, ___, and Whittington, H.B. 1967. Stratigraphy, paleontology and palaeoecology of the Burgess Shale. Canada Geol. Survey Pap. 67-1A: 52.

Conway Morris, S. 1976a. A new Cambrian lophophorate from the Burgess Shale of British Columbia. Palaeontology 19: 199-222.

_____. 1976b. Worms of the Burgess Shale, middle Cambrian, Canada. Unpubl. Ph.D. thesis, Cambridge University.

_____. 1977. A new metazoan from the Cambrian Burgess Shale of British Columbia. Palaeontology 20: 623-640.

_____. in press. The Burgess Shale. In: R.W. Fairbridge and D. Jablonski (Editors), Encyclopedia of Paleontology, Dowden, Hutchinson and Ross, Stroudsburg, Pa.

_____ and Whittington, H.B. 1979. The animals of the Burgess Shale. Scientific American 241: 122-133.

Cook, D.G. 1975. Structural Style Influenced by Lithofacies, Rocky Mountain Main Ranges, Alberta - British Columbia. Canada Geol. Survey Bull. 233.

Fritz, W.H. 1967. Cambrian biostratigraphic studies in the Canadian Cordillera. Canada Geol. Survey Pap. 67-1A: 58.

_____. 1968. Middle Cambrian trilobite studies near Field, British Columbia. Canada Geol. Survey Pap. 68-1A: 102.

_____. 1971. Geological setting of the Burgess Shale. In: Extraordinary fossils. Symp. North America Paleontology Conv. 1969, Pt. I: 1155-1170.

Hughes, C.P. 1975. Redescription of Burgessia bella from Middle Cambrian Burgess Shale, British Columbia. Fossils Strata 4: 415-435.

Hutchinson, G.E. 1930. Restudy of some Burgess Shale Fossils. Proc. U.S. Natl. Museum 78: 1-24.

Lohmann, N.H. 1922. Oesia disjuncta Walcott, eine Appendicularie aus dem Kambrium. Mitt. Zool. St. Inst. Hamburg 38: 69-75.

Madsen, F.J. 1956. Eldonia a Cambrian siphonophore - formerly interpreted as a holothurian. Vidensk. Meddel. Dansk. Naturh. Foren. 118: 7-14.

_____. 1957. On Walcott's supposed Cambrian holothurians. Jour. Pal. 31: 281-282.

McIlreath, I.A. 1977. Stratigraphic and sedimentary relationships at the western edge of the Middle Cambrian carbonate facies belt, British Columbia. Ph.D. thesis (unpubl.), University of Calgary.

Owre, H.B., and Bayer, F.M. 1962. The systematic position of the Middle Cambrian fossil Amiskwia Walcott. Jour. Pal. 36: 1361-1363.

Rasetti, F. 1951. Middle Cambrian stratigraphy and faunas of the Canadian Rocky Mountains. Smithsonian Misc. Coll. 116: 1-277.

Raymond, P.E. 1935. Leanchoilia and other Mid-Cambrian Arthropoda. Harvard Univ. Museum Comp. Zool. Bull. 76: 205-230.

Resser, C.E. 1938. Fourth contribution to nomenclature of Cambrian fossils. Smithsonian Misc. Coll. 97: 1-43.

Rolfe, W.D.I. 1962. Two new arthropod carapaces from the Burgess Shale (Middle Cambrian) of Canada. Breviora 160: 1-9.

Ruedemann, R. 1931. Some new Middle Cambrian fossils from British Columbia. Proc. U.S. Nat. Museum 79: 1-18.

Simonetta, A.M. 1962. Note sugli artropodi non trilobiti della burgess shale, cambriano medio della Columbia Britannica (Canada). I. Monit. Zool. Ital. 69: 175-185.

_____. 1963. Osservazioni sugli artropodi non trilobiti della "Burgess Shale" (Cambriano Medio), II. Monit. Zool. Ital. 70-71: 97-108.

_____. 1964. Osservazioni sugli artropodi non trilobiti della "Burgess Shale" (Cambriano Medio), III. Monit. Zool. Ital. 72: 215-231.

Valentine, J.W. 1977. General patterns of metazoan evolution. In: A. Hallam (Editor), Patterns of evolution. Elsevier, New York, 1977: 27-58.

Walcott, C.D. 1911a. Middle Cambrian Merosfomata. Cambrian Geol. and Paleont. II. Smithsonian Misc. Coll. 57: 17-40.

_____. 1911b. A Geologist's paradise. Nat. Geog. Mag. 22: 509-521.

_____. 1911c. Middle Cambrian Holothurians and Medusae. Cambrian Geol. and Paleont. II. Smithsonian Misc. Coll. 57: 41-68.

_____. 1911d. Middle Cambrian Annelids. Cambrian Geol. and Paleont. II. Smithsonian Misc. Coll. 57: 109-144.

_____. 1912a. Middle Cambrian Branchiopoda, Malacostraca, Trilobita and Merostamata. Cambrian Geol. and Paleont. II. Smithsonian Misc. Coll. 57: 145-228.

______. 1912b. Cambrian of the Kicking Horse Valley, British Columbia. Summary Rep. Geol. Survey Branch Dept. of Mines 1911, Sessional Pap. 26: 188-191.

______. 1912c. Studies in Cambrian geology and paleontology in the Canadian Rockies. In: Expeditions organized or participated in by the Smithsonian Institution in 1910 and 1911. Smithsonian Misc. Coll. 59: 39-45.

______. 1912d. Cambrian Brachiopoda. U.S. Geol. Survey Monograph 51, pt.1: 1-872;pt. 2: 1-363.

Walcott, C.D. 1913. Geological explorations in the Canadian Rockies. In: Explorations and fieldwork of the Smithsonian Institution in 1912. Smithsonian Misc. Coll. 60: 24-31.

______. 1914. Geological explorations in the Canadian Rockies. In: Explorations and fieldwork of the Smithsonian Institution in 1913. Smithsonian Misc. Coll. 63: 2-12.

______. 1918a. Geological explorations in the Canadian Rockies. In: Explorations and fieldwork of the Smithsonian Institution in 1917. Smithsonian Misc. Coll. 68: 4-20.

______. 1918b. Appendages of trilobites. Cambrian Geol. and Paleont. IV. Smithsonian Misc. Coll. 67: 115-216.

______. 1919. Middle Cambrian Algae. Cambrian Geol. and Paleont. IV. Smithsonian Misc. Coll. 67: 217-260.

______. 1920. Middle Cambrian Spongiae. Cambrian Geol. and Paleont. IV. Smithsonian Misc. Coll. 67: 261-364.

______. 1921. Notes on structure of Neolenus. Cambrian Geol. and Paleont. IV. Smithsonian Misc. Coll. 67: 365-456.

______. 1924. Cambrian and Ozarkian Brachiopoda. Cambrian Geol. and Paleont. IV. Smithsonian Misc. Coll. 67: 477-554.

______. 1931. Addenda to descriptions of Burgess shale fossils. Smithsonian Misc. Coll. 85: 1-46. (With explanatory notes by Charles E. Resser).

Walton, J. 1923. On the structure of a Middle Cambrian alga from British Columbia (Marpolia spissa Walcott). Proc. Cambridge Phil. Soc. Biol. Sci. 1: 59-62.

Whittington, H.B. 1971a. The Burgess Shale: History of research and preservation of fossils. In: Extraordinary fossils. Symp. North Amer. Paleont. Conv. 1969, pt. 1: 1170-1201.

______. 1971b. Redescription of Marella splendens (Trilobitoidea) from the Burgess Shale, Middle Cambrian, British Columbia. Bull Geol. Surv. Can. 209: 1-24.

_____. 1974. Yohoia Walcott and Plenocaris n.gen., arthropods from the Burgess Shale, Middle Cambrian, British Columbia. Bull. Geol. Surv. Can. 231: 1-27.

_____. 1975a. The enigmatic animal Opabinia regalis, Middle Cambrian, Burgess Shale, British Columbia. Philos. Trans. R. Soc. B271: 1-43.

_____. 1975b. Trilobites with appendages from the Middle Cambrian, Burgess Shale, British Columbia. Fossils Strata 4: 97-136.

Yochelson, E.L. 1961. The operculum and mode of life of Hyolithes. Jour. Pal. 35: 152-161.

4. State of preservation/ conservation

a) Diagnosis

Except for the quarry excavation itself, the immediate area of the Burgess Shale is very nearly in its natural state. Inconspicuous foot trails provide access, and the campsite 800 feet (245 m) below bears some scars of occupation [see 3 (a)].

When the quarry is not being exploited, there is little for non-specialists to see. The quarry, partly backfilled by waste rock and natural talus, is about 100 feet long and 10 feet wide, with a back wall (the working face) nearly 20 feet high. The presence of fossils is not evident; they must be brought to light by splitting the dark grey shale on planes parallel to the bedding. This is only possible after the shale has been broken into flat slabs, by quarrying from the top downward. Because the richly fossiliferous material (the "Phyllopod bed", 5 1/2 feet thick) now lies beneath at least ten feet of rock in place, the fossils

(continued on attached sheet)

b) Agent responsible for preservation/ conservation

Parks Canada, Western Region Office, 134-11th Avenue S.E., Calgary, Alberta, through the Superintendent, Yoho National Park, Field, British Columbia.

c) History of preservation/ conservation

The site has been under the control and supervision of the federal government since 1901 and has also been under the protection provi by the National Parks Act of 1930. In 1971, a Provisional Master Plan for all four Mountain Parks was established, with a Revised Edition specific to Yoho in 1975. In it, the Burgess Shale is specifically classed as Zone I - Special Preservation Areas, areas which contain fragile, unique or representative examples of flora, fauna or landscape. These Class I areas will be left virtually untouched by man and will be designated, where possible, on the basis of natural features. The Burgess Shale and Mt. Stephen Fossil Beds are recognized by geologists throughout the world as unique phenomena. The Class I boundaries were defined on the mapped boundaries of the fossil beds.

d) Means for preservation/ conservation

Legislative protection is provided under the National Parks Act and Regulations which are enforced by Yoho Park staff who operate out of Field, British Columbia. Planning for the park is done by the Programming and Development Division, Parks Canada, Western Region, Calgary, Alberta, Canada. The park, of which the Burgess Shale site is a part, is managed by a Superintendent who resides in Field, B.C., and is assisted by both full-time and seasonal staff.

e) Management plans

Attached is a copy of part 4, "The Resource Management Statement" from Resource Management Planning - Yoho National Park. Note in particular p. 128 and p. 133.

4. State of Preservation/ Conservation

a) Diagnosis (cont'd)

are inaccessible to anything but a serious quarrying operation. Casual, unauthorized attempts at collection or vandalism could deface the site but could do no serious damage to the remaining fossils.

In the opinion of those who have worked the quarry most recently, the richly fossiliferous beds are not mined-out, but probably continue some distance into the mountainside from the present quarry face. The fossils are now much less accessible than they were to earlier workers.

5. Justification for inclusion in the World Heritage List (cont'd)

b) *Natural property*

The Burgess Shale merits inclusion on the World Heritage List on two counts. First, under criterion "i", it is a unique and superlative natural phenomenon, certainly one of the three most significant fossil localities in the world, and in some opinions, the most significant. These other significant fossil sites, the Olduvai Gorge in Tanzania and Dinosaur Provincial Park in Canada, embody fossils from a different geological age and fossil group. Second, under criterion "ii", it is a unique sample of a major stage in the earth's evolutionary history.

The Burgess Shale has yielded to date more than 150 species of fossils assigned to some 120 genera. Of these, the majority are unique to the Burgess Shale and are not present elsewhere in the fossil record.

Of greater significance, perhaps is the fact that the majority of the exquisitely preserved fossil taxa are animals lacking hard parts, that is, animals that do not normally appear in the fossil record. Discovery of the Burgess Shale therefore provided a glimpse of the previously unimagined abundance and variety of soft-bodied marine forms of life early in the history of multicellular animal life on earth, that is, less than fifty million years after the great evolutionary "explosion" that took place at the beginning of the Cambrian Period. Thus, the import of the site to evolutionary biology exceeds that to geology.

Finally, the abundance of the fossils is remarkable. Charles D. Walcott, the discoverer, collected many tens of thousands of specimens from 150 cubic yards of the shale. These specimens are very carefully curated at the United States National Museum, in Washington.

Although a voluminous literature on the paleontology of the Burgess Shale already exists, work continues. Re-study of Walcott's collections, augmented by study of the new material collected by the Geological Survey of Canada in 1966 and 1967, and employing methods of examining and figuring the fossils not available to past generations of investigators, is being actively carried out by a group based on Cambridge University under the general direction of Harry B. Whittington.

The enclosed article by S. Conway Morris and H.B. Whittington (1979) describes in greater detail the universal importance of the Burgess Shale.

Signed (on behalf of State Party) [signature]

Full name Peter H. Bennett

Title Special Adviser to the Assistant Deputy Minister, Parks Canada, on UNESCO World Heritage Convention

Date December 20, 1979

PART II

NATIONAL PARKS IN THE PROVINCE OF BRITISH COLUMBIA

(1) Yoho National Park

All and singular that certain parcel or tract of land situate lying and being in the Province of British Columbia, designated Yoho Park and shown bordered in yellow on the map of Yoho Park which was reprinted with corrections in the office of the Surveyor General and Chief of the Hydrographic Service, Department of Mines and Resources, Ottawa, in 1939, and of record in the Legal Surveys and Aeronautical Charts Division of the Department of Energy, Mines and Resources under number 39587, which said parcel may be more particularly described as follows:

Commencing at a point on the easterly boundary of the Province of British Columbia, said point being south of the main line of the Canadian Pacific Railway and ten miles perpendicularly distant therefrom; thence in a southwesterly direction along a line parallel to and ten miles perpendicularly distant from the main line of the Canadian Pacific Railway as constructed to the intersection of said line with the height of land which divides the watershed area of Kicking Horse River from that of Vermilion River in approximate latitude 51° 12′ N. and approximate longitude 116° 21′; thence in a general southwesterly direction and following the crest of the spur ridge which divides the watershed of Moose Creek from that of Ice River throughout all its sinuosities to the summit of a peak marked 9687 on said map; thence in a straight line to a point on the right bank of Ice River opposite the point at which the most southerly tributary shown on said map enters Ice River from the east side; thence following said right bank of Ice River downstream to its confluence with Beaverfoot River; thence following the right bank of said Beaverfoot River downstream to its intersection with the north boundary of Township twenty-five, Range nineteen, West of the fifth Meridian, or said north boundary produced easterly; thence west along said north boundary and the production thereof to the southeast corner of Section four in Township twenty-six, Range nineteen; thence north along the east boundary of said Section four to its intersection with the left bank of Kicking Horse River; thence in a general northwesterly direction and following throughout the left bank of Kicking Horse River to its intersection with the east boundary of Township twenty-six, Range twenty, West of the fifth Meridian; thence north along said east boundary of Township twenty-six to its intersection with the summit of a well defined ridge dividing the watershed of Porcupine Creek from that part of Kicking Horse River which lies west of said east boundary; thence in a general northerly direction along the summit of the height of land which forms the westerly boundary of the watershed area of that part of Kicking Horse River which lies upstream from the east boundary of said Township twenty-six, and following all the sinuosities of said height of land to its intersection with the summit of Mount Rhondda which mountain is also a point on the summit of the Rocky Mountains forming the easterly boundary of the Province of British Columbia; thence in a general southeasterly direction and following the said summit of the Rocky Mountains throughout all its sinuosities to the point of commencement; said parcel containing an area of approximately 507 square miles.

PARTIE II

PARCS NATIONAUX SITUÉS DANS LA PROVINCE DE LA COLOMBIE-BRITANNIQUE

(1) Parc national Yoho

L'ensemble et chaque partie d'un certain lopin ou d'une certaine étendue de terre située dans la province de la Colombie-Britannique, désignée parc Yoho et indiquée par une bordure jaune sur la carte du parc Yoho qui fut réimprimée avec corrections au bureau de l'arpenteur en chef et chef du service hydrographique, ministère des Mines et des Ressources, Ottawa, en 1939, et dont une copie est déposée au Service des levés officiels et des cartes aéronautiques du ministère de l'Énergie, des Mines et des Ressources, sous le numéro 39587, lequel lopin de terre peut être décrit plus particulièrement comme il suit:

Commençant à un point sur la limite orientale de la province de la Colombie-Britannique, ledit point étant situé à une distance perpendiculaire de dix (10) milles au sud de la ligne principale du chemin de fer Pacifique-Canadien; de là dans la direction sud-ouest le long d'une ligne parallèle à la ligne principale du chemin de fer Pacifique-Canadien et à une distance perpendiculaire de dix (10) milles de celle-ci ainsi qu'elle est établie, jusqu'à l'intersection de ladite ligne avec la ligne de faîte qui divise le bassin de la rivière Kicking Horse de celui de la rivière Vermilion, à la latitude approximative de 51° 12′ N. et à la longitude approximative de 116° 21′; de là dans une direction en général sud-ouest suivant la crête de l'élévation qui divise le bassin du creek Moose de celui de la rivière Ice et épousant toutes ses sinuosités jusqu'au sommet d'un pic marqué 9687 sur ladite carte; de là en ligne directe jusqu'à un point sur la rive droite de la rivière Ice vis-à-vis l'endroit où l'affluent le plus au sud, indiqué sur ladite carte, se jette dans la rivière Ice venant du côté est; de là suivant ladite rive droite de la rivière Ice, en aval jusqu'à son confluent avec la rivière Beaverfoot; de là suivant la rive droite de ladite rivière Beaverfoot en aval jusqu'à son intersection avec la limite septentrionale du township 25, rang 19, à l'ouest du 5e méridien, ou du prolongement de ladite limite septentrionale vers l'est; de là vers l'ouest le long de ladite limite septentrionale et de son prolongement jusqu'à l'angle sud-est de la section quatre (4) dans le township 26, rang 19; de là vers le nord le long de la limite orientale de ladite section quatre (4) jusqu'à son intersection avec la rive gauche de la rivière Kicking Horse; de là dans une direction en général nord-ouest et suivant partout la rive gauche de la rivière Kicking Horse jusqu'à son intersection avec la limite orientale du township 26, rang 20, à l'ouest du 5e méridien; de là vers le nord le long de ladite limite orientale du township 26 jusqu'à son intersection avec le sommet d'une élévation bien définie qui divise le bassin du creek Porcupine de la partie de la rivière Kicking Horse sise à l'ouest de ladite limite orientale; de là dans une direction en général nord le long de la ligne de faîte de l'élévation qui forme la limite occidentale du bassin de la partie de la rivière Kicking Horse sise en amont à partir de ladite limite dudit township 26, et suivant toutes les sinuosités de ladite ligne de faîte jusqu'à son intersection avec le sommet du mont Rhondda, lequel constitue aussi un point sur le sommet des Montagnes Rocheuses qui forme la limite orientale de la province de la Colombie-Britannique; de là dans une direction en général sud-est et suivant ledit sommet des Montagnes Rocheuses dans toutes ses sinuosités jusqu'au point de départ; ledit lopin renfermant une superficie d'environ 507 milles carrés.

1969

Symposium
North American
Paleontological Convention
Part I

EXTRAORDINARY FOSSILS

Geological Setting of the Burgess Shale

W. H. Fritz

Geological Survey of Canada, Ottawa 4, Ontario

INTRODUCTION AND ACKNOWLEDGMENTS

In 1966 the Geological Survey of Canada began a comprehensive study of the geology of the famous Burgess Shale. The present report attempts to consolidate some of the data gained from 1966 to 1969, a three-year period at the beginning of the Burgess Project. The report is based mainly on the writer's biostratigraphic studies, but includes other field observations and selected data from the literature. These ingredients are combined to highlight past concepts that are consistent with present findings. These concepts may be subject to future modification since some of the Project's major programs, such as detailed aerial mapping and geochemical analysis, are still in their early phases. Helpful comments on this report were given by Christina Balk, D. L. Bruton, B. S. Norford, R. A. Price, Franco Rasetti, H. B. Whittington, and J. D. Aitken. Aitken's assistance was particularly useful, as his knowledge of the described rocks far exceeds that of the writer. The data on Fig. 1 were provided by D. G. Cook, who graciously permitted the use of part of his thesis map. Some changes need to be made on the map, but this was not done because it would introduce confusion as to authorship. Aitken's new map of the area should be available soon.

Permission for field work was granted by the National and Historic Parks Branch, Department of Indian Affairs and Northern Development, and amiable co-operation was given by the personnel of Yoho National Park.

LOCATION AND GENERAL STATEMENT

Walcott's Burgess Quarry containing the "Phyllopod bed" is located three miles north of the town of Field, British Columbia, and two miles northwest of the Trans-Canada Highway between Mt. Field and Wapta Mtn. (see Fig. 1). The quarry cannot be seen from the highway, but equivalent Middle Cambrian strata, together with thousands of feet of older and younger Cambrian strata, are visible to the northwest on Mt. Field, and to the southeast on Mt. Stephen. Also apparent is a lithologic and physiographic change that takes place within a narrow zone trending northwestward along the southwest flank of Mt. Field and Mt. Stephen. To the northeast of this zone the mountains are composed of resistant carbonate and quartzite, the strata are nearly horizontal, and they are magnificently exposed along steep, nearly vertical cliffs. These mountains belong to the eastern sector of the Main Ranges Subprovince of the Rocky Mountains (North and Henderson, 1954, p. 29–37). Southwest of this zone the moun-

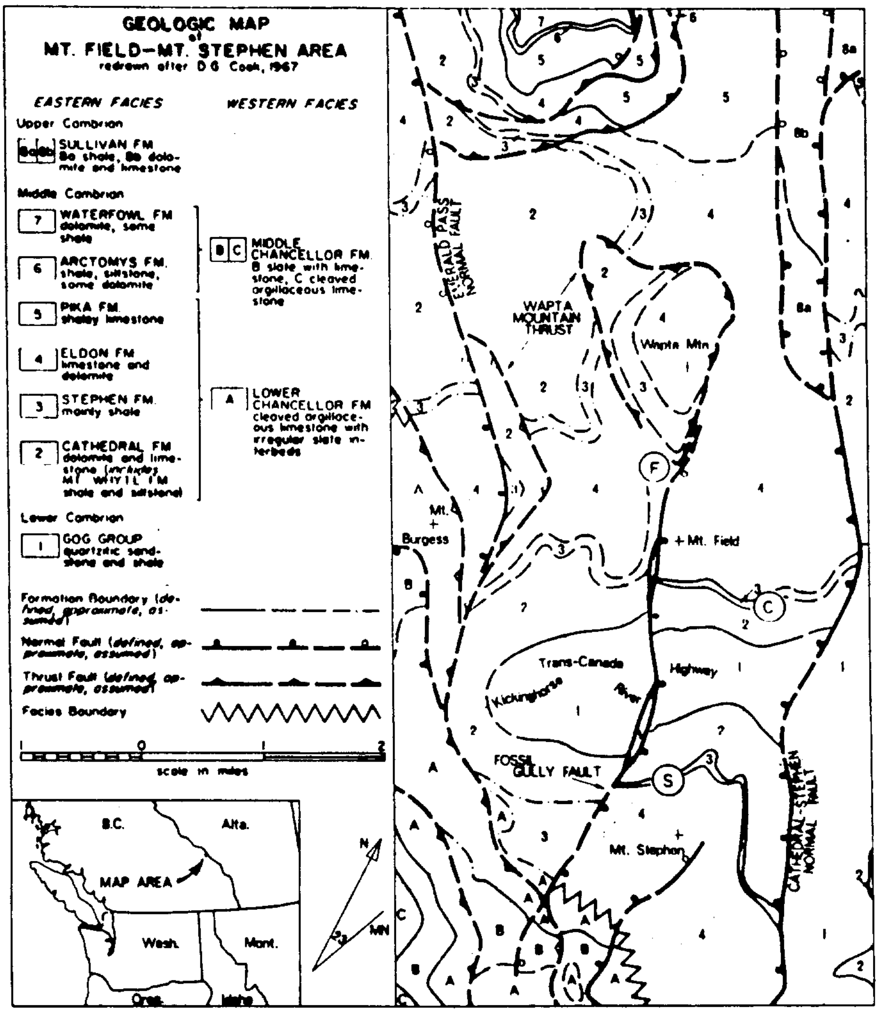


FIG. 1. Geologic map showing the Mt. Field-Mt. Stephen area. The Burgess Quarry is located at "F." Also at "F" are the Burgess Shale section (Fig. 5), which passes through the quarry, and the Paradox section (Fig. 4), located just north of the quarry. The Chalet section (Fig. 4) is located at "C" and the Stephen section (Fig. 6) at "S."

tains are composed of slate and thin-bedded limestone, the strata are steeply tilted and folded. The mountains are tree covered and lower than those to the northeast; they belong to the western sector of the Main Ranges. The narrow zone marks a major Middle Cambrian facies change between an outer detrital belt to the southwest and a middle carbonate belt to the northeast. A description of similar Cambrian belts in Utah and Nevada has been given by Robison (1960) and by Palmer (1960).

STRUCTURE

Although there was early and continued recognition (McConnell, 1887, p. 250; Deiss, 1940, p. 779; Rasetti, 1951, p. 43–45, 68, 69; Ney, 1954, p. 123, 124; North and Henderson, 1954, p. 48, 49) of the rapid facies change along the above mentioned zone, other writers have attributed this change to a fault that had brought together two unlike facies (Allan, 1912, p. 79, 181; 1914, p. 64; Raymond and Willard, 1931, p. 115; Wheeler, 1963, p. 8). Recently, Cook (1967) demonstrated that no major fault exists in this zone by locally tracing individual beds from one facies to the other.

Part of Cook's geologic map (Fig. 1) shows the area surrounding the Burgess Quarry. On it the quarry, Mt. Field and Mt. Stephen are shown to belong to the same, elongate, north-northwest trending structural unit. This unit is truncated to the east by the Cathedral-Stephen normal fault, and to the west by the Emerald Pass normal fault. Locally, the unit is overlain by the Wapta Mtn. thrust fault along which fossils in quarry-equivalent shales to the north and west have been tectonically destroyed. The Fossil Gully fault enters the structural unit from the south where it has a stratigraphic displacement of 500 feet on the west face of Mt. Stephen (Rasetti, 1951, p. 42). Cook traced this fault northward and shows it passing just east of the Burgess Quarry (Fig. 1).

The structural unit containing the Burgess fossils, together with adjacent units, is underlain by a regional décollement thrust. The unit has been transported 100 miles to the east relative to the crystalline basement (Bally, Gordy and Stewart, 1966, p. 359) along this thrust plane. Transport took place in Mesozoic time when metamorphic activity was starting to the west. This metamorphism might well have destroyed the Burgess fossils if they had remained in their original area of deposition.

Within the structural unit, small faults have been observed that do not pose a major problem in the tracing of beds. The "much deformed and faulted" beds mentioned by Deiss (1940, p. 779) on Mt. Stephen were not seen. Depositional slumping and compaction faulting are present and could be mistaken for evidence of tectonic activity.

STRATIGRAPHY

Walcott (1928, pp. 320–322) pointed out that the celebrated fossils from the Burgess Quarry come from a 7-foot, 7-inch thick interval near the base of a 410-foot shale section. He referred to this section as the Burgess Shale Member of the Stephen Formation. Present correlations (Figs. 5, 6) indicate that Walcott's Burgess Shale Member is equivalent to most of the type Stephen Formation on Mt. Stephen. The term "member" will therefore be dropped here, as its definition by Walcott is too broad to be useful. A more

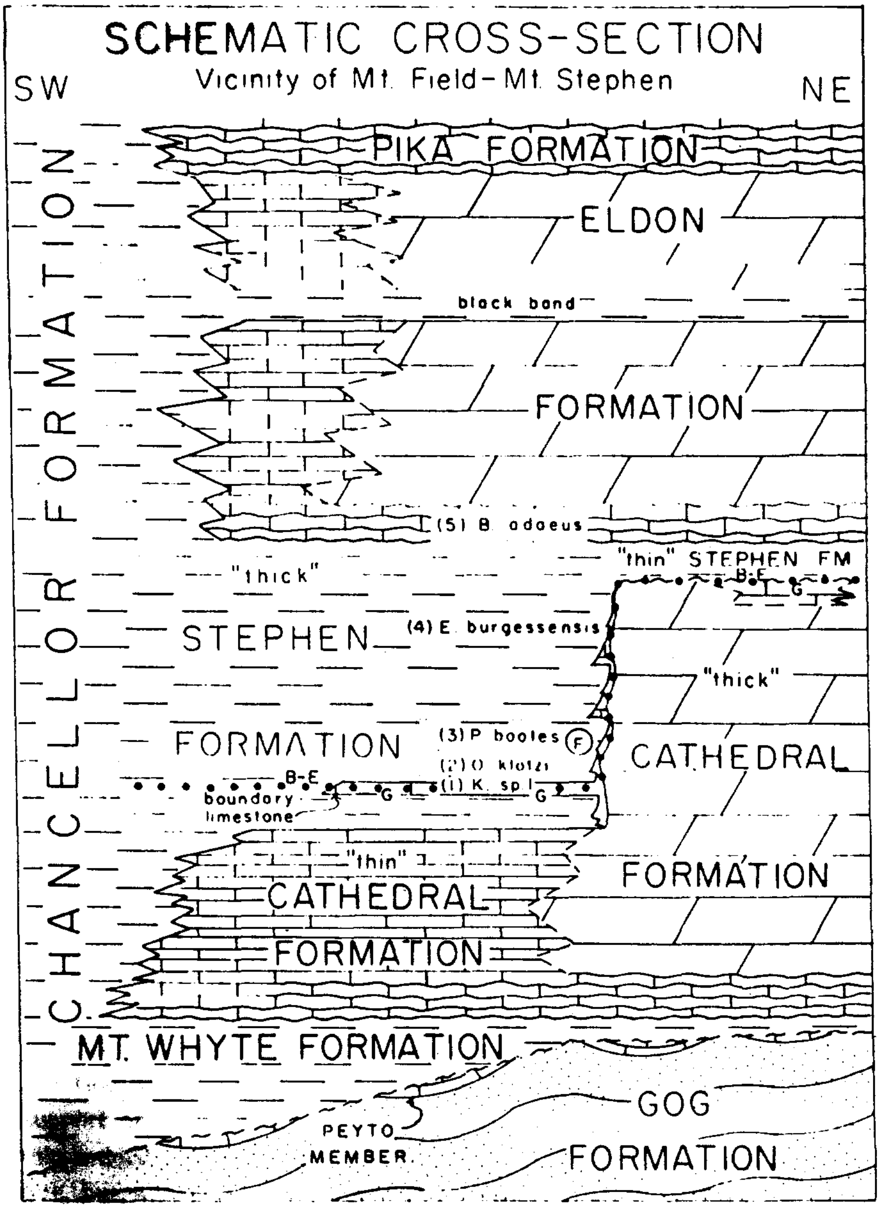


FIG. 2. Schematic cross-section showing formations exposed along the Trans-Canada Highway between Mt. Field and Mt. Stephen. Thicknesses are greatly exaggerated relative to horizontal distance. The approximate position of the Burgess Quarry is located at "F." A heavy dotted line marks the boundary between the *Glossopleura* Zone (G) and the *Bathyuriscus-Elrathina* Zone (B-E).

meaningful designation of members within the Stephen undoubtedly will come from those who do the future detailed mapping of the Stephen Formation. Here the Burgess Shale will be considered as an outcrop of the Stephen Formation best exposed along a line of section that passes through the Burgess Quarry.

Since the soft-bodied fossils of the Burgess Quarry are from the Stephen Formation, this formation will be emphasized in the discussion below. The relationship between the Stephen and underlying Cathedral Formation is also believed to be highly significant, and therefore the Cathedral will be given equal weight. Three additional formations will be briefly described as they complete the stratigraphic succession that is well exposed above the Trans-Canada Highway on Mt. Field and Mt. Stephen. A schematic cross-section showing these formations is presented in Fig. 2. For a more detailed description of these five formations, the reader is referred to papers by Deiss (1940) and Rasetti (1951). No reference will be made to older or younger formations except to state here that a thick stratigraphic succession is present in the surrounding Rocky Mountains that ranges in age from the Late Precambrian into the Mesozoic.

Gog Formation

The oldest strata visible from the highway consist of several hundred feet of barren, light brown quartzite overlain by 30–40 feet of fossiliferous limestone (Rasetti, 1951, p. 55). This is the Gog Formation with the Peyto Limestone Member at the top. The Peyto contains a late Lower Cambrian *Bonnia-Olenellus* faunule (Rasetti, 1951, p. 83).

Mt. Whyte Formation

Above the Gog is the Mt. Whyte Formation, composed of light greenish-gray weathering shale. This shale unit is 80 feet thick on Cathedral Mountain (Rasetti, 1951, p. 23) two miles east of the Cathedral Stephen fault, and 580 feet thick on the southwest shoulder of Mt. Field, a mile and a half west of the fault. The faunal break between the Gog and Mt. Whyte is sharp, a fact which, together with a variable regional thickness of the Mt. Whyte, led Rasetti (1951, p. 86) to suggest that an unconformity exists at the Gog–Mt. Whyte contact. No subsequent evidence has been found to support or refute this suggestion. Overlying the shale mentioned above is thin-bedded limestone which Rasetti (1951, p. 62) included in the Mt. Whyte, but which is here considered part of the Cathedral Formation. All of the fossils from the Mt. Whyte, and from the basal Cathedral above, have been placed in the Early Middle Cambrian *Wenkchemnia-Stephenaspis* and *Plagiura-Kochaspis* Zones (*Plagiura-Poliella* Zone of Lochman-Balk, 1956, p. 536) by Rasetti (1951; 1957).

Cathedral Formation

On the northeast shoulder of Mt. Stephen, the Cathedral Formation is approximately 1,900 feet thick (Ney, 1954, p. 123), and consists predominantly of massive, light-gray dolomite. Directly across (one mile to the north) from this corner of Mt. Stephen, the Cathedral on Mt. Field is of the same lithology and probably of the same thickness. On Mt. Field, *Glossopleura*? sp. was found at the top of the Cathedral, and three miles to the east a *Glossopleura* faunule was found 30 feet from the top. Thus, the strata in the Cathedral outcrops mentioned above belong to the *Plagiura-Poliella* (Rasetti, 1951, p. 36, 37; 1957, p. 955–957), *Albertella* (reported by Burling, 1916, six miles to the northeast), and *Glossopleura* Zones. For reasons soon to become evident, the exposures described above will be referred to as being outcrops of the "thick" Cathedral.

The contact between the "thick" Cathedral Formation and the underlying Mt. Whyte is a narrow zone in which the shale below grades into carbonates above. The writer favours placing the base of the Cathedral at the top of the highest shale, despite Rasetti's (1951, p. 62) selection of a higher and somewhat irregular contact with limestone below and dolomite above.

In the course of investigating lead-zinc mines near the base of the "thick" Cathedral, Ney (1954, p. 123–4) made an important observation as he traced the "thick" Cathedral southwestward from the northeast corner of Mt. Stephen. He noted that the massive upper Cathedral dolomites extend only a short distance southwestward before "A striking change occurs at the top of the Cathedral Formation. Here there is a steep west-facing precipice of dolomite nearly 400 feet high, against which shales on the west terminate abruptly. This feature occurs on both sides of the Kicking Horse Valley, the brow of the precipice having a trend slightly more northerly than the [northwest trending] line joining the two mines. The change is apparent on Plate 17 [see Fig. 3], but to appreciate the structure fully, one must stand at the brink of the precipice and look down to the west on the stratigraphically equivalent shales.

"Strata are continuous above and below the precipice, so there is no possibility of it being a fault feature. Nor is it probable that dolomite could replace a thick band of shales. It seems to be an original feature of deposition, originally built between ["thick" Cathedral] limestone and [Stephen] shale, the limestones having been altered to dolomite. The structure resembles that of a reef. To the writer's knowledge, however, no organic remains have been found in this part of the Cathedral Formation."

Ney's "reef" concept proved to be correct when the strata involved were dated by fossils (Aitken and Fritz, 1968). At Ney's writing, however, there was an unstated alternative that the carbonate "reef" grew at only a slight elevation above adjacent mud to the southwest. Perhaps Ney did not attempt to date the "reef" and "off-reef" beds from Rasetti's work in this

FIG. 3. Southeast face of Mt. Field. Formations are Cathedral (C), Stephen (S), and Eldon (E). Fault at the left is the Fossil Gully Fault.

area because Rasetti (1951, p. 100) had encountered problems in correlating faunules from Mt. Stephen and Mt. Field eastward. Walcott's biostratigraphy may not have been used to date the "off-reef" shale for, as Deiss (1940, p. 779) had pointed out, Walcott had inadvertently reversed the position of the *Ogygopsis* faunule from its true position near the base of the Stephen Formation to the top of this formation.

The *Plagiura-Poliella* through *Glossopleura* age of the Cathedral Formation applies to the core of the "thick" Cathedral bank and probably to strata within a few feet of the nearly vertical front. This age might not apply, however, to a thin veneer on the steep reef front that may have accumulated from sediments passing over the reef edge. The age of these sediments, hundreds of feet down the front, could be the same as those on top. Moreover, if sedimentation had stopped above the "thick" Cathedral bank due to bypassing, the coating on the face could be younger than the strata at the top. This latter possibility may explain the presence of the oldest post-*Glossopleura* faunule in limestone tongues attached to the front of the "thick" Cathedral bank. The tongues are present at the Paradox section (Fig. 4) located just north of the Burgess Shale section at stratigraphic horizons that are 590, 650, and 680 feet below the top of the bank. This

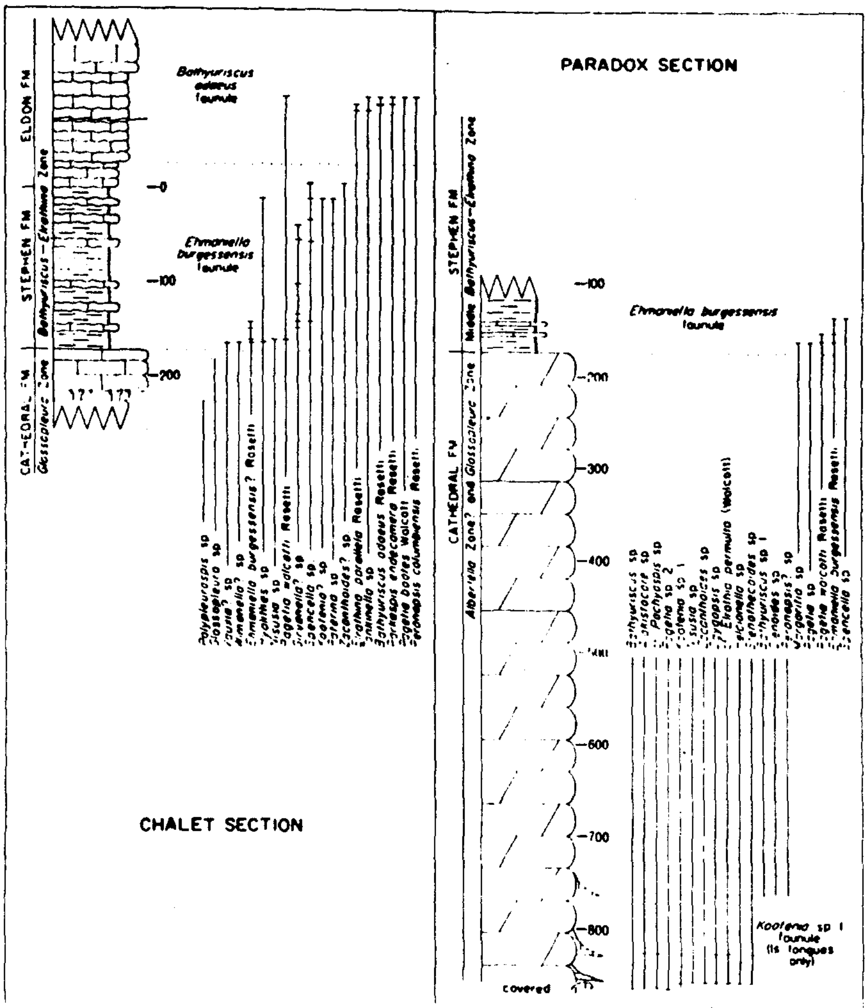


FIG. 4. On the left is the Chalet section, located on the southeast face of Mt. Field (see "C" on Fig. 1) and immediately to the right (NE) of the exposure shown in Figure 3. On the right is the Paradox section, located just to the north of the Burgess Quarry (see "F" on Fig. 1). Fossil occurrences indicated by short, horizontal lines opposite sections. Stratigraphic distance is measured in feet downward from Stephen-Eldon contact.

post-*Glossopleura* faunule is here tentatively called the *Kootenia* sp. 1 faunule.

If the bottom surface at the end of *Glossopleura* time is drawn using data from the site of the Paradox section (data projected to Fig. 2, heavy dotted line), then it can be shown that the minimum depth of water at the end of *Glossopleura* time was 680 feet. In explaining this figure, the age of strata at two points on the Paradox section is critical. First, the barren dolomite at the top of the bank (upper Cathedral) must be dated. This can be done with near certainty, as these strata correlate with the uppermost Cathedral containing a *Glossopleura* faunule both at the Chalet section (Fig. 4) one and a half miles to the east, and at an outcrop on the Trans-Canada Highway four miles to the east. Second, it must be demonstrated that the *Kootenia* sp. 1 faunule occupies a position above the top of the *Glossopleura* Zone. This relationship can be demonstrated from localities on the southeast face of Mt. Field and on the northwest face of Mt. Stephen (Fig. 6). In the Paradox section, the 680-foot stratigraphic interval between the top of the bank and the lowest occurrence of *Kootenia* sp. 1 contains only relatively pure carbonate. Therefore, no adjustment for compaction need be made before accepting 'λ's figure as representing minimum depth at the front of the reef.

Southwest of the "thick" Cathedral bank, the Cathedral Formation abruptly thins (see Figs. 2, 3) and is referred to there as the "thin" Cathedral. The "thin" Cathedral consists mainly of very dark gray limestone that weathers to thin, light gray plates. West of the Fossil Gully fault on the southwest shoulder of Mt. Field, the "thin" Cathedral is 815 feet thick.

The transition from "thin" to "thick" Cathedral is mainly one of change from thin-bedded limestone on the southwest to thick-bedded dolomite to the northeast (Figs. 2, 3). Rasetti believes that during the deposition of the "thin" Cathedral, local relief existed at the edge of the "thick" Cathedral. In Rasetti's (1951, p. 45) description of beds here designated as "thin" Cathedral he states, "These units also include gigantic boulders of dolomite or massive limestone, sometimes up to 30 feet in diameter. . . . These boulders indicate that a portion of Cathedral limestone or dolomite of normal lithology had been sedimented at the northeast prior to deposition of shales and thin-bedded limestones at the southwest. Probably the massive carbonates represent reefs of algal origin. . . . These reefs appear to have formed a steep submarine slope along which large boulders, possibly incompletely consolidated, could slide and become embedded in the argillaceous sediments being deposited southwest of the margin of the reef." As part of his stratigraphic studies, J. D. Aitken (oral communication) is studying the boulders described by Rasetti to ascertain whether they were transported or are algal mounds which grew in place. No similar structures were seen by the writer in other stratigraphic units, except for numerous local limestone masses at the top of a limestone unit (Fig. 6, 820 to 880-foot interval) within the lower portion of the "thick" Stephen Formation.

Rasetti (1951, p. 49–53) reported on faunules found low in the "thin" Cathedral at two sections located on the northwest face of Mt. Stephen. These faunules belong to the *Plagiura-Poliella* Zone and to the *Albertella* Zone(?). The writer has made float collections of fossils from the *Glosso-*

pleura Zone that probably came from the "thin" Cathedral on Mt. Stephen and Mt. Field. It is known that the "thin" Cathedral cannot be younger than the *Glossopleura* Zone, as a *Glossopleura* faunule was collected in place 155 feet above the Cathedral–Stephen boundary on Mt. Stephen (Fig. 6).

Stephen Formation

The type locality of the Stephen Formation is on the northwest face of Mt. Stephen where Walcott (1908, p. 3, 4) reported a thickness of "562 feet with 150 feet of local development of *Ogygopsis* shale at the summit." Walcott (1928, p. 247) later affirmed the location as being the type locality, and again gave the thickness (totaled) as 712 feet. Rasetti (1951, p. 49) found the Stephen (as here defined) to be 1,063 feet thick on the northwest face of Mt. Stephen near the Fossil Gully fault. The writer and J. D. Aitken measured 1,030 feet on the same face at a section (Figs. 1, 6) located midway between the outer edge of the "thick" Cathedral carbonate bank and the Fossil Gully fault. The formation consists mainly of light brown weathering, slightly calcareous shale. Most of the shale is siliceous and non-fissile, and might be classified as an argillite by those using a more restricted nomenclature.

The base of the Stephen was placed at the horizon where the thin-bedded limestone of the "thin" Cathedral abruptly gives way to the shale of the overlying Stephen Formation. The upper formational contact is at the top of the highest shale. In this paper, the type Stephen and other Stephen outcrops southwest of the upper Cathedral carbonate bank will be referred to as the "thick" Stephen.

Rasetti (1951, p. 102–105) worked out the faunal succession within the "thick" Stephen. This was done mainly at the Burgess Shale section that passes through Walcott's quarry. Collections by the writer from the Burgess Shale section (Fig. 5), the Mt. Stephen section (Fig. 6), and an undescribed section on the southwest face of Mt. Field confirm Rasetti's work and add two faunules thus far unreported from the "thick" Stephen.

The lowest faunule found in the "thick" Stephen is at the base of a limestone unit occupying the interval 150 to 210 feet above the basal contact of the formation on Mt. Stephen. *Glossopleura?* sp., *Polypleuraspis* sp., and *Oryctocephalus* cf. *O. reynoldsi* are present. This locality, plus a similar locality at the base of the same unit on Mt. Field, has provided the first record of "thick" Stephen fossils that can definitely be assigned to the *Glossopleura* Zone.

At the top of the same limestone unit on Mt. Stephen is the lowest faunule of the *Bathyuriscus-Elrathina* Zone. This faunule is referred to in this paper as the *Kootenia* sp. 1 faunule. On Mt. Stephen it consists of *Kootenia* sp. 1 and *Stenothecoides* sp. On Mt. Field *Kootenia* sp. 1, *Olenoides* sp., *Steno-*

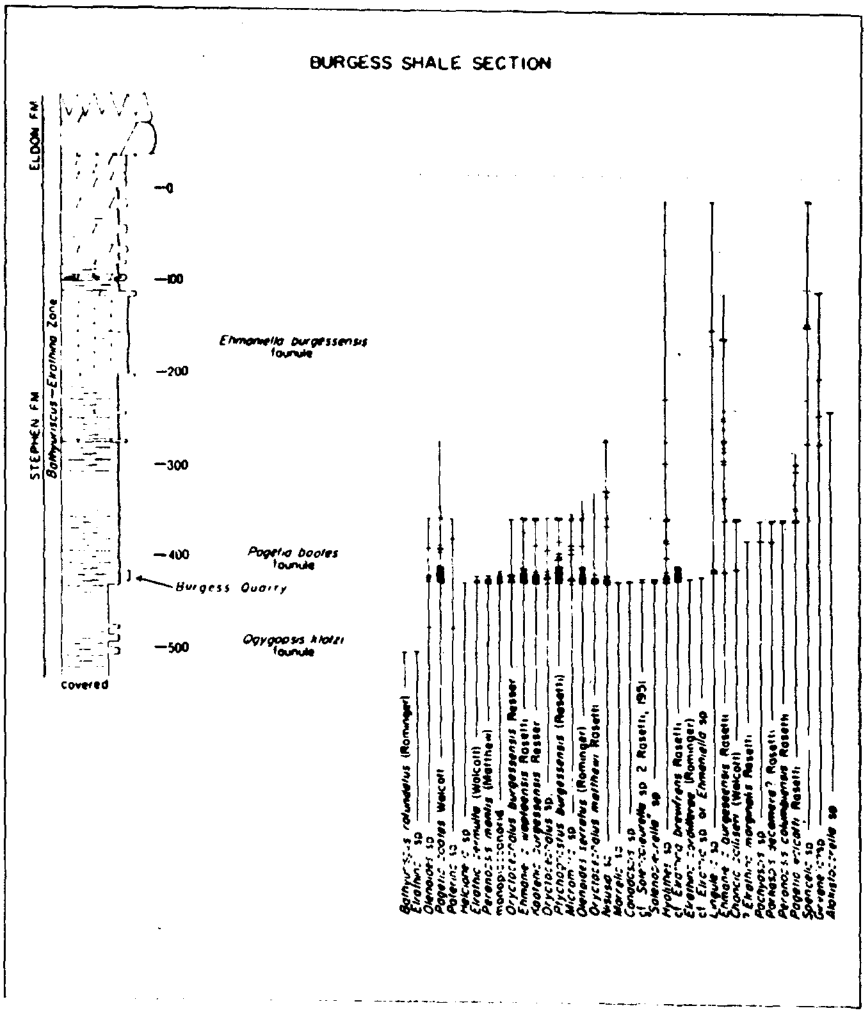


Fig. 5. Burgess Shale section, located at "F" on Figure 1. Fossil occurrences indicated by short, horizontal lines opposite section. Stratigraphic distance is measured in feet downward from Stephen-Eldon contact.

thecoides sp., and *Paterina* sp. are present at the top of the same limestone unit. The *Kootenia* sp. 1 faunule was also found in the offbank tongues attached to the "thick" Cathedral near the Burgess Quarry (Fig. 4).

Because faunules of the *Glossopleura* and *Bathyuriscus-Elrathina* Zones are present at the base and top, respectively, of the above mentioned limestone unit, it was informally called the "boundary limestone" in the field. This limestone is one of the few easily traced units within the "thick" Stephen, and is, therefore, an important stratigraphic marker.

The second faunule recognized in the *Bathyuriscus-Elrathina* Zone is the *Ogygopsis klotzi* faunule. Deiss (1940, p. 779) and Rasetti (1951, p. 104) noted the low position of this faunule within the Stephen Formation, but neither was able to trace it from the "fossil beds" on Mt. Stephen northeastward on this mountain across the Fossil Gully fault and into the continuous stratigraphic section on the northwest face. Rasetti (1951, p. 102–104) was reasonably sure that the faunule predated the *Pagetia bootes* faunule, and that it was closely related to his *Olenoides serratus* and *Alokistocarella fieldensis* faunules. In this paper the latter two faunules are grouped with the *Ogygopsis klotzi* faunule, as they have thus far proved too similar to be differentiated. The stratigraphic interval in which the *Ogygopsis klotzi* faunule occurs on the northwest face of Mt. Stephen is less than 100 feet thick (Fig. 6).

The next overlying faunule (third in *Bathyuriscus-Elrathina* Zone), the *Pagetia bootes* faunule, is of special interest as it is the one containing the celebrated soft-bodied forms from the Burgess Quarry. Field observations suggest that this faunule at the quarry is in a more siliceous shale matrix than farther south. At the quarry, the most abundant fossils are *Pagetia bootes*, *Ptychagnostus burgessensis*, *Hyolithes* sp., and a monoplacophorid. To the south, *Ptychagnostus burgessensis* and the monoplacophorid become rare. Some genera not found at the quarry, such as *Bathyuriscus*, are present at the quarry level to the south. Only a few, poorly preserved, soft-bodied forms were found to the south. It is not known whether the dramatic drop in the number of soft-bodied fossils is controlled by actual faunal distribution or by lack of preservation. In the Burgess Shale section, the *Pagetia bootes* faunule occupies an interval approximately 70 feet thick. The base of this interval is slightly below the Burgess Quarry, and the top is within a small fossil quarry worked by P. E. Raymond (1935, p. 205) in 1930.

The youngest Stephen faunule (fourth in the *Bathyuriscus-Elrathina* Zone), the *Ehmaniella burgessensis* faunule, was collected mainly in thin layers between relatively barren intervals. *Ehmaniella burgessensis* is the most abundant and intermittently persistent species. In the upper portion of the Stephen, *Spencella* sp. predominates in some of the limestone interbeds. *Girvanella?* sp. was noted 158, 187, 228, and 320 feet above the base of the quarry in the Burgess Shale section (Fig. 5).

The lower portion of the "thick" Stephen terminates to the northeast against the steep carbonate front of the upper Cathedral Formation (Figs. 2, 3). Northeast of this interface, only the upper, or "thin" Stephen is present. The relationship between the "thin" Stephen and the underlying "thick" Cathedral has been described by Deiss (1940, p. 779), who states, " . . . the ["thick"] Stephen in the type locality is partly different lithologically and in age than the rocks assigned to the Stephen Formation in the sections to the northeast and southeast, and a hiatus is present at the base

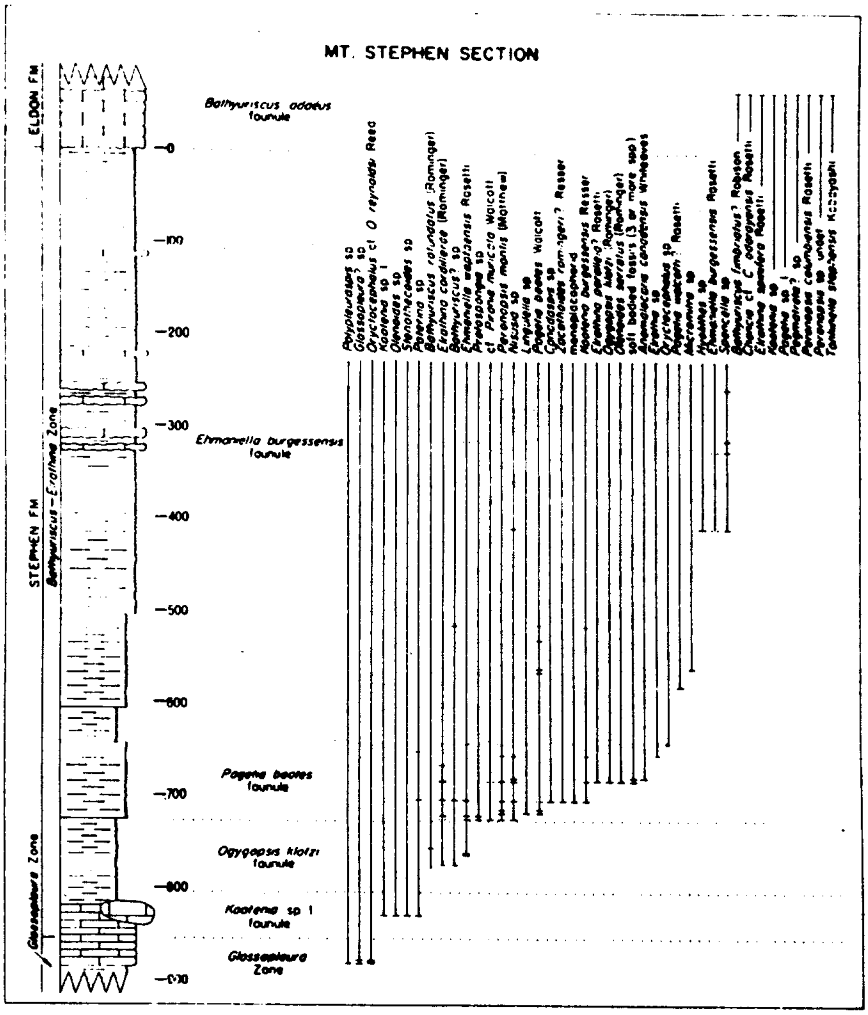


Fig. 6. Mt. Stephen section, located at "S" on Fig. 1. Fossil occurrences indicated by short, horizontal lines opposite section. Stratigraphic distance is measured in feet downward from Stephen-Eldon contact.

of the formation which is equivalent to at least the time required for the deposition of [illegible] all of the beds containing *Ogygopsis* on Mount Stephen." At [illegible] writing the *Ogygopsis* faunule was the one faunule known from the lower part of the "thick" Stephen, and the absence of this faunule to the east, plus the thinner Stephen there probably prompted his suggestion that a "hiatus" (unconformity) existed to the east at what here is considered to be the Stephen-Cathedral boundary.

The "thin" Stephen at the Paradox and Chalet sections (Fig. 4) consists

Whyte Formations. The thickness appears to be constant as it is traced over the "thick" and "thin" Stephen, and the enclosed faunule is also persistent, as was revealed from studies of collections made above the "thick" Stephen on Mt. Stephen and above the "thin" Stephen on Mt. Field (Fig. 4). The most conspicuous change in the lower Eldon is the "erratic dolomitization of the limestone" noted by Rasetti (1951, p. 75). This dolomitization is well exposed along the Fossil Gully fault on Mt. Field.

SUMMARY

The abrupt change in the Stephen Formation at the Burgess Quarry is mainly a depositional change, with faulting playing only a minor role. The change is best exposed on Mt. Field and Mt. Stephen where Ney focused attention on the near-vertical contact between the shale of the Stephen Formation and carbonate of the upper Cathedral Formation. The steep Cathedral front was correctly identified by Ney as a submarine escarpment which existed at a time when lower Stephen shales were being deposited immediately to the southwest. Ney's interpretation agrees with local observations made earlier by Deiss, who stated that lower Stephen shales were deposited to the southwest while no equivalent strata were being deposited to the northeast. Deiss correctly pointed to the resulting unconformity to the northeast. The above conclusions were tested using Rasetti's biostratigraphy and new data. The results show that three ***Bathyuriscus-Elrathina*** faunules were deposited along with lower Stephen shales before younger Stephen shales containing a fourth faunule covered the carbonate bank to the northeast. Since the celebrated fossils from the Burgess Quarry belong to the third (offbank) faunule, it is concluded that the quarry fossils were deposited in relatively deep water near the edge of a steep submarine escarpment.

LITERATURE CITED

AITKEN, J. D., and FRITZ, W. H. 1968. Burgess Shale Project, British Columbia. Canada Geol. Survey Pap. 68–1, A, 190–192.

ALLAN, J. A. 1912. Geology of Field map-area, Yoho Park, B. C. Canada Geol. Survey Summary Report (1911), 175–187.

1914. Geology of Field Map area, B. C. and Alberta. Canada Geol. Survey Mem. 55, 312 p.

BALLY, A. W., GORDY, P. L., and STEWART, G. A. 1966. Structure, seismic data, and orogenic evolution of southern Canadian Rocky Mountains. Canadian Petrol. Geol. Bull. 14: 337–[illegible].

BURLING, L. D. [illegible]. The *Albertella* fauna located in the Middle Cambrian of British Columbia and Alberta. Am. Jour. Sci., 4th ser., 42: 469–472.

COOK, D. G. 1967. Structural style influenced by a Cambrian regional facies change in the Mount Stephen-Mount Dennis area, Alberta-British Columbia. Queen's Univ. unpublished Ph.D. thesis.

DEISS, C. 1940. Lower and Middle Cambrian stratigraphy of southwestern Alberta and southeastern British Columbia. Geol. Soc. America Bull. 51: 731–794.

FRITZ, W. H., and AITKEN, J. D. 1969. Geological setting of the Burgess Shale. Jour. Pal. 43: 887–888 (abstr.).

LOCHMAN-BALK, C. 1956. The Cambrian of the Rocky Mountains and southwest deserts of the United States and adjoining Sonora Province, Mexico. *In* El Sistema Cambrico, su paleogeografia y el problema de su base, 20th Intern. Geol. Congress (Mexico) 2, pt. 2: 529–653.

MCCONNELL, R. G. 1887. Report on the geological structure of a portion of the Rocky Mountains accompanied by a section measured near the 51st parallel. Canada Geol. and Natural Hist. Surv. Ann. Report 2: 5D–41D.

NEY, C. S. 1954. Monarch and Kicking Horse Mines, Field, British Columbia. Alberta Soc. Petrol. Geol. 4th Ann. Field Conf. Guidebook, 119–136.

NORTH, F. K., and HENDERSON, G. G. L. 1954. Summary of the geology of the southern Rocky Mountains of Canada. Alberta Soc. Petrol. Geol. 4th Ann. Field Conf. Guidebook, 15–81.

PALMER, A. R. 1960. Some aspects of the early Upper Cambrian stratigraphy of White Pine County, Nevada and vicinity. Intermountain Assoc. Petrol. Geol. Guidebook, 11th Ann. Field Conf., 53–58.

RASETTI, F. 1951. Middle Cambrian stratigraphy and faunas of the Canadian Rocky Mountains. Smithsonian Misc. Colln. 116, no. 5, 277 p.

——. 1957. Additional fossils from the Middle Cambrian Mt. Whyte Formation of the Canadian Rocky Mountains. Jour. Pal. 31: 955–972.

RAYMOND, P. E. 1935. *Leanchoilia* and other Mid Cambrian Arthropoda. Harvard Univ. Mus. Comp. Zool. Bull. 76: 205–230.

——, and WILLARD, B. 1931. A structure section across the Canadian Rockies. Jour. Geol. 39: 97–116.

ROBISON, R. A. 1960. Lower and Middle Cambrian stratigraphy of the eastern Great Basin. Intermountain Assoc. Petrol. Geol. Guidebook, 11th Ann. Field Conf. 43–52.

WALCOTT, C. D. 1908. Nomenclature of some Cambrian Cordilleran formations. Smithsonian Misc. Coll. 53: 1–12.

——. 1928. Pre-Devonian Paleozoic formations of the Cordilleran provinces of Canada. Smithsonian Misc. Coll. 75, no. 5: 175–368.

WHEELER, J. O. 1963. Rogers Pass map-area, British Columbia and Alberta. Canada Geol. Survey Pap. 62-32, 32 p.

The Burgess Shale: History of Research and Preservation of Fossils

HARRY B. WHITTINGTON

Sedgwick Museum, Cambridge, England

INTRODUCTION

Since their discovery by Charles D. Walcott, the Burgess Shale fossils have attracted the attention of palaeontologists and biologists everywhere. This is because they include not only animals with a mineralised exo- or endoskeleton found widely in Cambrian rocks (trilobites, brachiopods, echinoderms and primitive molluscs), but also an astonishing variety of animals without mineralised hard parts. These fossils include species referred to as a medusa, an actinarian, problematical holothurians, a variety of "worms" (annelid and nemertine) and arthropods. Two of the trilobite species have the appendages preserved. There are also many kinds of

Proc. North American Paleontological Convention: 1170-1201. 1969

of siliceous shale with some interbeds of limestone, and is therefore similar in composition to the upper portion of the "thick" Stephen. The base of the "thin" Stephen is placed at the horizon where the upper Cathedral carbonate ends and is overlain by a nearly continuous section of Stephen Shale. This contact is higher than that used by Deiss (1940, p. 745) and Rasetti (1951, p. 69), who chose a limestone-dolomite contact that is known to transgress bedding planes. By using the lower contact, they included *Glossopleura*-bearing limestone beds in the Stephen.

The upper contact of the "thin" Stephen, and of the "thick" Stephen as well, is placed at the top of the highest shale bed. This contact is lower than that picked by Deiss and Rasetti, who again chose a limestone-dolomite contact. Rasetti (1951, p. 74, 75) rightly acknowledges the problem of tracing the limestone-dolomite contact, for he states, "A better-defined Stephen-Eldon contact would result if the uppermost unit of the Stephen were included in the Eldon. Then the boundary, placed at the contact of an underlying shaly unit and an overlying limestone, would become fairly sharp and independent of the erratic dolomitization of the limestone."

Eldon Formation

On Wapta Mtn., Mt. Stephen, and Mt. Field the Eldon Formation consists predominantly of light gray weathering, thick-bedded to massive dolomite. Near the middle of the formation is a black weathering shale unit that is 150 feet thick on Mt. Stephen (North and Henderson, 1954, p. 60). At the base of the formation is a unit of dark gray, thin-bedded limestone that is 185 feet thick on the northwest shoulder of Mt. Stephen. At various localities, this basal unit is altered to light gray weathering dolomite.

Three *Bathyuriscus-Elrathina* Zone faunules were identified by Rasetti (1951, p. 106, 107) from the lower unit. In ascending order, these are the *Bathyuriscus adaeus*, *Tonkinella stephenensis*, and *Parkaspis endecamera* faunules. The three faunules have three species in common, are similar in gross aspect, and in this paper are considered as one faunule (fifth *Bathyuriscus-Elrathina* Zone faunule), the *Bathyuriscus adaeus* faunule. The most abundant forms in this faunule belong to the trilobite genera *Pagetia* and *Peronopsis*.

The *Bathyuriscus adaeus* faunule bears little resemblance to the immediately underlying *Ehmaniella burgessensis* faunule, but it is quite similar to the next underlying *Pagetia bootes* faunule. Both the *Bathyuriscus adaeus* and *Pagetia bootes* faunules are dominated by agnostids and species of *Pagetia*. It is tentatively suggested that relatively deep water conditions, as has been postulated for the *Pagetia bootes* faunule, existed during the deposition of the *Bathyuriscus adaeus* faunule.

The basal limestone of the Eldon Formation does not undergo the rapid local change that was noted in the underlying Stephen, Cathedral, and Mt.

PART 4

THE RESOURCE

MANAGEMENT STATEMENT

INTRODUCTION

This statement is intended to facilitate the overall Park Management Planning process by outlining the Resource Management Objectives for the rational preservation and/or use of the known physical resources at this point in time. Modification of the following objectives will be necessary when additional resource inventory information becomes available.

Meanwhile, the objectives will serve as broad conceptual guidelines for ongoing park programs and park management proposals. It must be noted that any operational application of such programs or proposals will require a stricter and more detailed review of the resource maps extrapolated from the existing biophysical resource inventory data. In addition, development plans prepared by disciplines other than Resource Conservation must consider the biophysical inventory data as well, to minimize or eliminate any projected impact the application of their plans may have to modify the park's natural state.

GLOSSARY

AFFINITY	- casual connection or relationship, kinship, possession of common features.
FRAGILE	- frail, easily broken or destroyed; of delicate frame or constitution.
GAME	- all wild animals, amphibians, reptiles and wild birds within any park, and the heads, skins and any or every part of such mammals, amphibians, reptiles and wild birds (N.P. Game Reg., P.C. 1954-1431).
INTEGRITY	- an unimpared or unmarred condition; the quality or state of being complete undivided.
MONITORING	- to watch, observe or check especially for a special purpose.
NATURAL	- determined by nature.
PERPETUITY	- the quality or state of being perpetual; duration without limitations as to time.
REPRESENTATIVE	- one that represents another <u>or</u> others in a special capacity or quality.
UNIQUE	- the only one, specimen, thing, circumstance, of its kind.
VALUE	- the monetary or other worth of something; relative worth, utility, or importance; degree of excellence.

Resource Management Objectives

Yoho National Park

OBJECTIVE 1 - LANDSCAPE

1.1 All landscapes and soils will be afforded the protection measures required to retain their natural state.

1.2 Where projected land use has the potential to modify the natural state adversely, use and development proposals must not exceed known, inherent limitations. This can be accomplished by:

- 1.2.1 - Utilization of land units with fewer resource limitations, or . . .
- 1.2.2 - Where this is not possible, by modifying such land use and/or development to incorporate the said limitations.

1.3 Operational Resource Management Plans[1] will be formulated by the park's Resource Conservation Section which incorporate monitoring techniques to assess environmental trends.

1.4 Site-specific studies and/or Environmental Impact Assessments[2] will be initiated by the park's Resource Conservation Section prior to approval in principle of any development plans for land-use and facility development.

1.5 Research for any purpose must be designed to avoid any alteration of any aspect of the environment. Furthermore, this research will be permitted only when approved by Park Management and will be under the scrutiny and guidance of the Parks Resource Management Section.

---

1 Operational Resource Management Plan: is an official document which provides a course of action by directing activities toward the maintenance or modification of the biotic and abiotic resources of an area within the park to achieve a [illegible] objective of protection and/or use, supported by existing laws, regulations, policies, etc. - to be valid, it must be approved by park management.

2 Environment Impact Assessment: is an official document prepared for park management's consideration which defines and evaluates the effects on the environment of a proposed project or action and its alternatives. It further attempts to determine the possibility of ameliorating negative impacts, considering trade-offs, and clearly stating residual impacts requiring special consideration.

Resource Management Objectives (cont'd)

OBJECTIVE 2 - FLORA/PHYSIOGNOMY

2.1 The special status of representatives or uniqueness of certain species, vegetation associations and habitat types within the flora require predetermined protection measures to assure their integrity and perpetuity.

2.2 Where visitor use and/or facility development may have adverse impact on both representative or outstanding (unique) associations or species of the flora, such activity will be redirected to vegetations and habitat types:

2.2.1 - less susceptable to such impact, or . . .

2.2.2 - those more commonly found in the park, region and park's system.

2.3 Where existing resource base information allows the development of specific management criteria, Operational Resource Management Plans will be formulated by the Resource Conservation Section which incorporate monitoring techniques to assess environmental trends.

2.4 Where such resource base information is currently unavailable, but required for management purposes, specific recommendations and substantiations will be formulated by the park's Resource Conservation Section to facilitate the process of completing the resource inventory sought.

2.5 Research for any purpose must be designed to avoid any alteration of any aspect of the biology of flora. Furthermore, this research will be permitted only when approved by Park Management and will be under the scrutiny and guidance of the Parks Resource Management Section.

Resource Management Objectives (cont'd)

OBJECTIVE 3 - FAUNA

3.1 All wildlife will be afforded the protection possible under existing international, federal and/or provincial legislation.

3.2 Wildlife habitat identified as essential to the survival of an endangered or threatened species, will be afforded the highest degree of protection.

3.3 Where projected land use and development has the potential to affect any one or more aspects of the fauna adversely, use and development proposals must not exceed known, inherent wildlife limitations. This can be accomplished by:

3.3.1 - Utilization of land units with fewer resource limitations, or . . .

3.3.2 - Where this is not possible, by modifying such land use and/or development to incorporate the said limitation.

3.4 Where existing resource base information allows the development of specific management criteria, Operational Resource Management Plans will be formulated by the park's Resource Conservation Section which incorporate monitoring techniques to assess environmental trends.

3.5 Where such resource base information is currently unavailable, but required for management purposes, specific recommendations and substantiations will be formulated to facilitate the process of completing the resource inventory sought.

3.6 Research for any purpose must be designed to avoid any alteration of any aspect of the biology of any species. Furthermore, this research will be permitted only when approved by Park Management and will be under the scrutiny and guidance of the Parks Resource Management Section.

Resource Management Objectives (cont'd)

OBJECTIVE 4 - CLIMATE & HYDROLOGY

In the absence of a long-term climatical and hydrological information base, only tentative sub-objectives can be established at this time:

4.1 All hydrological resources will be protected from impairment and will be managed in the natural state until the resource base information has been sufficiently broadened to allow rational diversification of management and/or manipulation, when and where required.

4.2 Where existing resource base information allows the development of specific management criteria, Operational Resource Management Plans will be formulated by the park's Resource Conservation Section.

4.3 Where such resource base information is currently unavailable, specific recommendations and substantiations will be formulated to facilitate the process of completing the resource inventory sought.

4.4 In the interim period, monitoring techniques must be developed (including their respective instrumentations), as a vital part of Operational Resource Management Plans, in order to assess and document climatical and hydrological trends.

4.5 Research for any purpose must be designed to avoid any alteration of any aspect of climate or hydrology. Furthermore, this research will be permitted only when approved by Park Management and will be under the scrutiny and guidance of the Parks Resource Management Section.

Resource Management Objectives (cont'd)

OBJECTIVE 5 - HUMAN HISTORY

5.1 All archaeological and historical sites, artifacts, records and similar resources will receive total protection from development and exploitation, until their cultural importance has been firmly established by competent researchers.

5.2 Upon the completion of the cultural evaluation, site-specific Operational Resource Management Plans will be prepared by the park's Resource Conservation Section where required, to provide for the degree of protection and/or use necessary to fulfill the park's mandate.

5.3 Such plans will incorporate monitoring techniques designed to keep management options current in the light of changing socio-cultural and recreational trends.

5.4 Research for any purpose must be designed to avoid any alteration of any aspect of human history. Furthermore, this research will be permitted only when approved by Park Management and will be under the scrutiny and guidance of the Parks Resource Management Section.

Resource Management Objectives (cont'd)

OBJECTIVE 6 - RESOURCE UTILIZATION

6.1 Operational Resource Management Plans will be formulated by the park's Resource Conservation Section in consultation with other sections to accommodate acceptable forms of recreational use, while assuring that such use does not exceed known, inherent resource Limitations, nor public safety standards.

6.2 Such plans will incorporate monitoring techniques designed to keep management options current in the light of changing recreation trends.

6.3 Consumptive resource uses and resource extractions will be minimized wherever possible. Appropriate management plans will be formulated by the park's Resource Conservation Section to eliminate, restrict or guide such activities in accordance with known and inherent resource Limitations and Capabilities.

6.4 Any Development Plans[1] with potential to affect the park's natural environment must obtain an Environmental Impact Assessment from Resource Conservation Section prior to it being forwarded to management for approval in principle.

6.5 Various forms of air, water, soil, etc. pollution arising from resource utilization are incompatible with resource management aims and will be radically reduced, controlled and/or eliminated wherever possible.

6.6 Research for any purpose must be designed to avoid any alteration of any aspect of the environment. Furthermore, this research will be permitted only when approved by Park Management and will be under the scrutiny and guidance of the Parks Resource Management Section.

---

[1] Development Plan: is a statement of a proposed course of action of land-use of facility development; as such it would include the site, place, area to be developed, the extent, methods to be used and time frames, as well as rehabilitation methods to be employed.

Scientific American, Vol. 241, No. 1. July 1979 - pp. 122-133

The Animals of the Burgess Shale

The fossils of a rock formation in western Canada are a rich sample of an animal community in the mid-Cambrian. Some of the animals are ancestors of those living today; others are unique and bizarre

by Simon Conway Morris and H. B. Whittington

By far the most numerous fossils representing the first abundant life on the earth are the hard parts of various marine animals without backbones: shells and similar fragments of external skeleton. This makes for a lopsided fossil record. For example, of the 30 or so phyla of animals living today more than half are made up of species with few hard parts or none. As a result the descent of these phyla remains largely undocumented by fossil evidence.

Fortunately the situation is not completely lopsided. A few geological deposits have been discovered that as a result of exceptional circumstances contain exquisitely preserved fossils of animals that are partly or entirely soft-bodied. Here we shall describe one such deposit: the Burgess Shale of western Canada. The great age and the rich variety of the marine invertebrates in the Burgess Shale make it perhaps the best-known of all such deposits. In addition to describing the Burgess Shale fauna we shall attempt to reconstruct the kind of underwater environment these organisms inhabited early in Paleozoic times: some 530 million years ago.

In the fall of 1909 the Secretary of the Smithsonian Institution, Charles Doolittle Walcott, was searching for fossil-bearing rock formations in British Columbia. Following a footpath that ran across the western slope between Wapta Mountain and Mount Field in the southern part of the province, Walcott literally stumbled over a block of shale that had fallen onto the path from the slope above. Examining the easily split rock, he was astonished to find the fossil impressions of a number of soft-bodied organisms preserved in its layers. In a letter to a colleague in Toronto dated November 27, 1909, he dryly reported that he had spent "a few days collecting ... in the vicinity of Field and found some very interesting things."

Walcott returned to the spot the following year to search upslope for the shale stratum that had been the source of his fallen rock. His search was successful: he found two fossil-bearing shale exposures separated by a vertical distance of some 70 feet. He did shallow quarrying in both; the lower exposure proved to be the richer of the two. He shipped back to the District of Columbia thousands of fossil specimens that he removed from what he called his Phyllopod Bed. (The term, little used by paleontologists today, refers to certain fossil arthropods, or joint-legged animals, that are probably ancestral to living crustaceans.)

As Walcott's own work and decades of study by others have shown, the fossils of the Burgess Shale include a great abundance of marine invertebrates: more than 120 species. Some of them belong to the Phylum Porifera: the sponges. This phylum of primitive animals is the only one in the subkingdom of parazoans, a category higher than the subkingdom of the one-celled protozoans but lower than the subkingdom of the many-celled metazoans. Perhaps 10 other species represent metazoan phyla that were unknown before they were found in the Burgess Shale; they are not present elsewhere in the fossil record. The scores of other species that lack hard parts can be assigned to one or another phylum of metazoans with living relatives as follows:

Coelenterates: the phylum that includes such living marine animals as jellyfishes, sea pens and corals. The Burgess Shale coelenterate species number perhaps four.

Echinoderms: the phylum that includes, among others, starfishes, sea cucumbers and crinoids, or sea lilies. At least four species of Burgess Shale echinoderms are recognized.

Mollusks: the phylum that includes, among others, oysters and clams, squids and octopuses and the primitive chitons (of the Class Amphineura). Three Burgess Shale molluscan species are recognized.

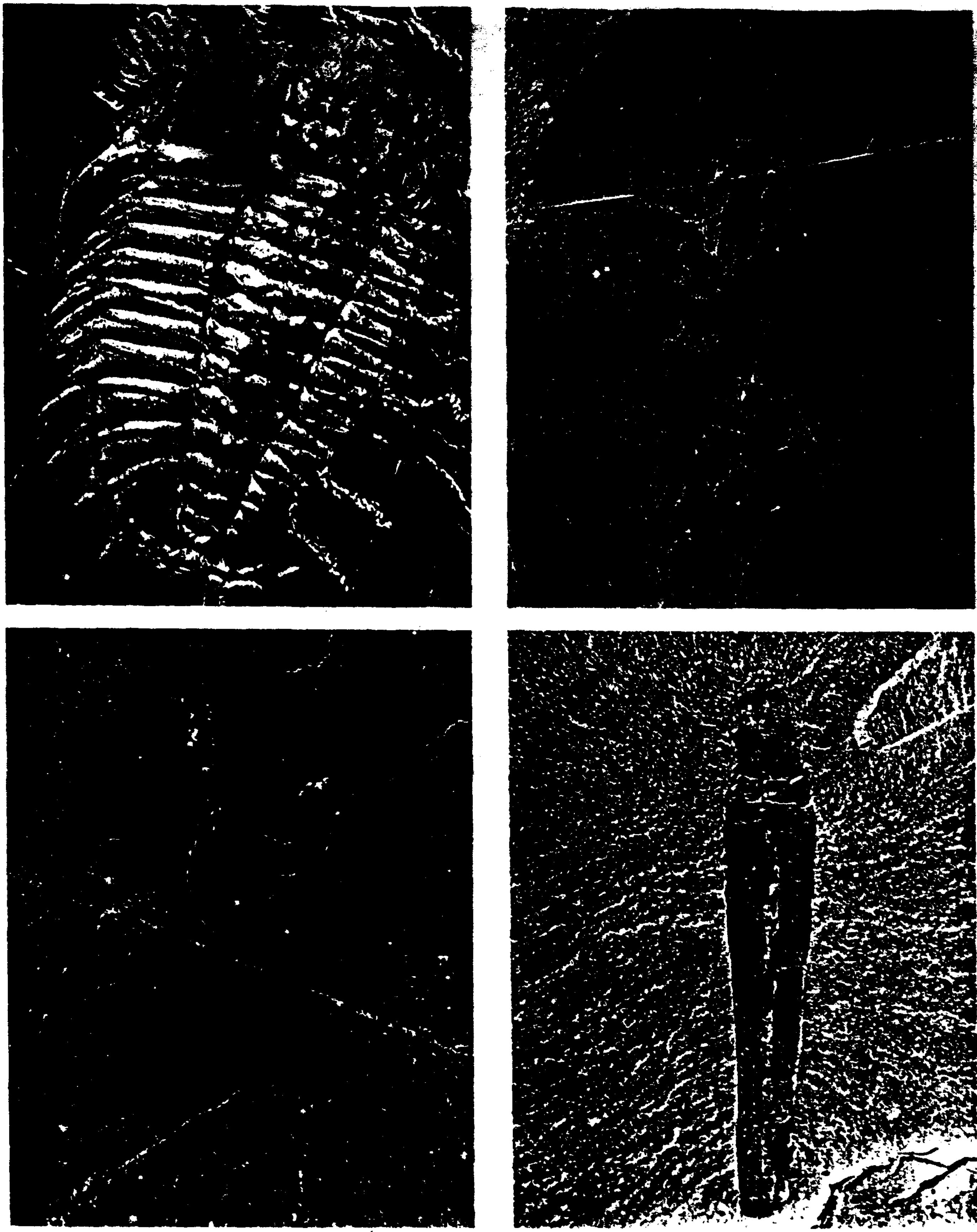
Arthropods: the phylum that includes, among a great many others, lobsters, shrimps, crabs and barnacles (all of the Class Crustacea) and the less familiar terrestrial animal *Peripatus* (a member of the Class Onychophora). The Burgess Shale arthropods include several representatives of the long extinct trilobite class, a peripatus-like animal that was aquatic rather than terrestrial, and about 30 other species of arthropods.

Priapulids: a minor phylum of unsegmented marine worms. The living genus, *Priapulus*, gives the phylum its name. Seven species of these now obscure bottom burrowers flourished in the Burgess Shale muds.

Annelids: the phylum that includes earthworms, leeches and a less familiar but very large class of marine worms, the polychaetes. The annelid phylum is represented in the Burgess Shale by six species.

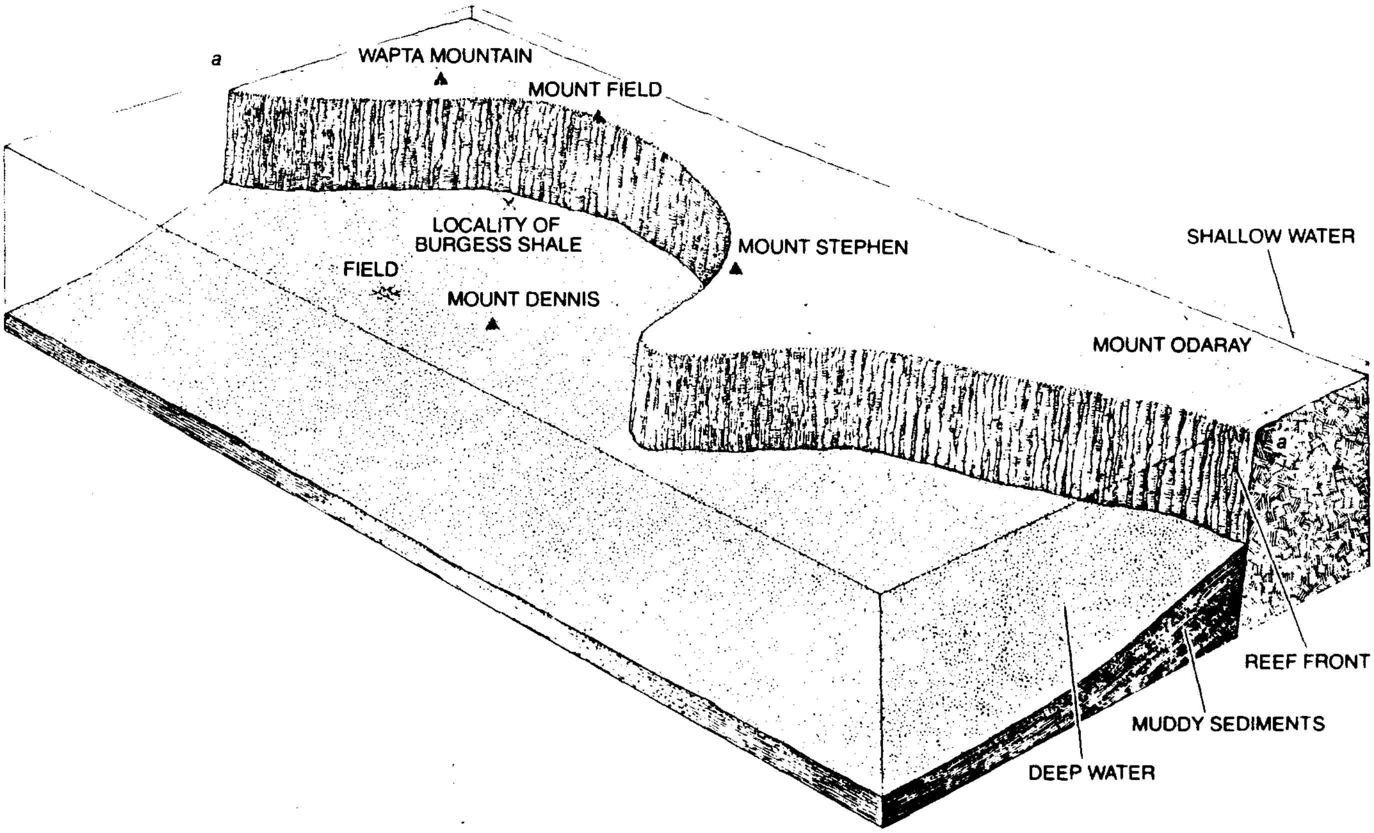
Finally, we find among the Burgess Shale fauna one of the earliest-known invertebrate representatives of our own conspicuous corner of the animal kingdom: the chordate phylum. Among its living representatives (other than vertebrates) are the sea squirts and the peculiar marine animal *Amphioxus*. The chordates are represented in the Burgess Shale by the genus *Pikaia* and the single species *P. gracilens*.

Such a remarkably preserved soft-bodied fauna, representing eight known and 10 or more previously unknown phyla that flourished in the Middle Cambrian, is by itself of great interest to students of the fossil record. In addition to this intrinsic interest, however, the Burgess Shale invertebrates, with their specialized adaptations, have an even wider importance in clarifying the early evolution of the animal kingdom. The only earlier-known soft-bodied animals are representative of late Precambrian time, 700 to 600 million years ago and therefore at least 70 million years earlier than Middle Cambrian times. These are the Ediacara animals, first discovered some 30 years ago in the Ediacara Hills of southern Australia and recognized since then in a number of other places throughout the world. The Ediacara



FOUR ANIMALS that lived in the ocean in Middle Cambrian times, some 530 million years ago, are seen in these fossils. At the top left is a trilobite, *Olenoides*, one of the many animals whose anatomy has been preserved in remarkable detail in the silts that solidified to form the Burgess Shale of British Columbia. The specimen is 5.5 centimeters long. Unlike most arthropods, or joint-legged animals, *Olenoides* had unspecialized limbs. At the top right is another Burgess Shale arthropod, *Waptia*. When this bottom-feeding animal was extended, it was four centimeters long. At the bottom left is *Opabinia*, one of about 10 animal species found in the shale that belong to previously unknown phyla. It had five eyes and steered its seven-centimeter body with a vertical tail fin as it swam close to the sea floor in search of food. At the bottom right is one of the many unsegmented marine worms that inhabited the sea floor. It is *Selkirkia*, one of the priapulid phylum. With its projecting proboscis it measured five centimeters. A successful group in the Cambrian, priapulid worms are now rare.

LOWER QUARRY, named the Phyllopod Bed by Charles Doolittle Walcott of the Smithsonian Institution, who first sampled the Burgess Shale, shows patches of winter snow. The view looks south. This and a higher shale exposure were requarried for fossils in 1966–67.

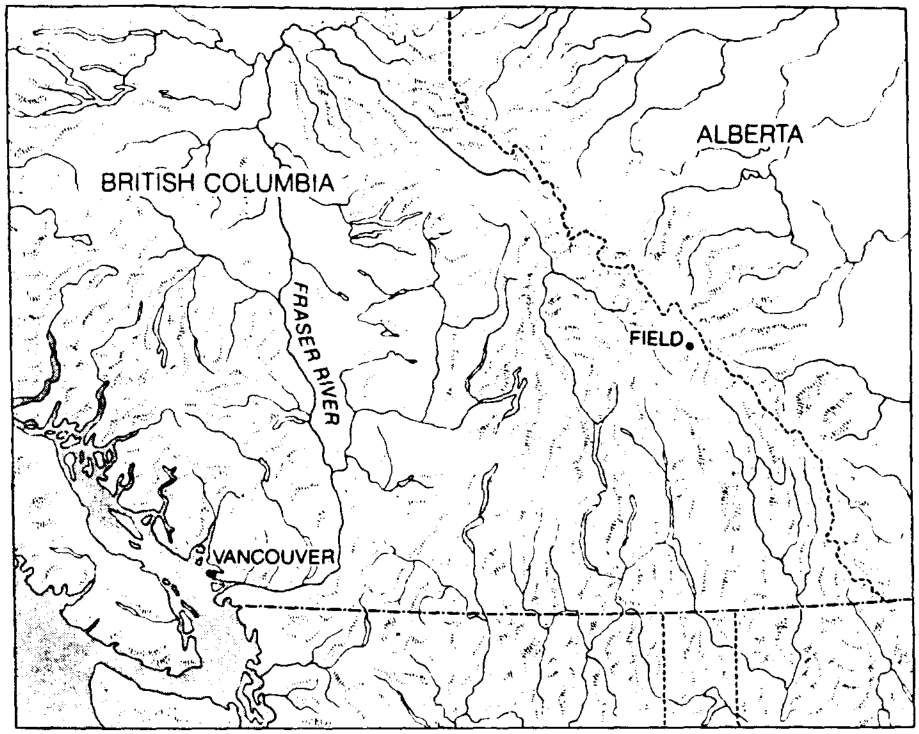


BURGESS SHALE OUTCROP, marked by the colored *X* in this block diagram of the Middle Cambrian seascape, is a small portion of an extended sea-bottom deposit of silts accumulated at the foot of a deeply embayed algal reef that rose vertically some 530 feet above the shallowest silts. The reef did not rise above sea level but was covered by shallow water. The vertical scale in the block diagram is exaggerated by a factor of five, and the distance (*a–a'*) from north to south along the reef is some nine miles. Later uplift and dissection gave rise to the peaks of the Rockies along the border of Alberta and British Columbia, indicated by colored triangles. The reconstruction of the sea floor and the reef is based on the work of I. A. McIlreath of Petro-Canada, one recent investigator of the unique formation.

fauna stands in marked contrast to the Burgess Shale fauna both in the kinds of animals represented (chiefly coelenterates) and in these earlier animals' limited range of specialization.

The event that separates the impoverished Ediacara fauna from the Burgess Shale fauna is an explosive evolutionary diversification of multicelled animals that took place near the beginning of Cambrian time. The fossils of the Burgess Shale thus give us a unique glimpse into the results of this sudden metazoan adaptation relatively soon after it occurred.

In spite of the work done by Walcott and others significant gaps remain in what is known about the Burgess Shale paleoenvironment and how its fauna was preserved. A fuller appreciation of these gaps stimulated a reinvestigation of the site by the Geological Survey of Canada, beginning more than a decade ago. The authorities of the Yoho National Park in British Columbia and the Parks Canada administration in Ottawa granted special permission to collect material from the shale outcroppings. Walcott's quarries were reopened in 1966 and 1967 under the direction of J. D. Aitken of the Geological Survey of Canada. Both the new material collected during these two seasons and a part of the great Burgess Shale collection amassed by Walcott some 60 years earlier then came to us at the University of Cambridge for analysis.



BURGESS SHALE FORMATION is situated some 350 miles northeast of Vancouver near the town of Field, B.C. The fossil-rich formation was found accidentally by Walcott in 1909.

What kind of environment did the Burgess Shale fauna inhabit? Studies done by I. A. McIlreath of Petro-Canada and W. H. Fritz of the Geological Survey of Canada show that the animals lived on or in a muddy bottom where sediments had accumulated at the base of a gigantic reef. This structure, made up of material secreted by algae, rose vertically for hundreds of feet from a deep-water basin that was gradually being filled with sediments. Scattered outcrops of the reef front can still be traced for miles across British Columbia. The bottom waters of the basin were apparently limited in circulation, rich in hydrogen sulfide and poor in oxygen. The various invertebrates flourished where the muddy sediments were banked high enough against the reef to be clear of the stagnant bottom waters, about 530 feet below sea level.

The reef-front sediments were not stable. Studies of the shale by D. J. W. Piper of Dalhousie University show that periodic slumping resulted in the flow of mud into the deeper anaerobic waters of the basin. These flows wiped away all the surface tracks and subsurface burrows made by the Burgess Shale fauna. Because the animals trapped in the torrents of mud died during or shortly after their burial they could not leave new traces. This means that the way of life of each species must be deduced from a study of their organs of locomotion and from comparisons with living invertebrates of the same kind.

At the same time the catastrophic burials, in anaerobic deposits of fine silt where scavengers could not survive, greatly favored the preservation of the animals' soft parts. As the mud gradually compacted and became hard rock the buried carcasses were flattened and the soft parts were transformed into thin films of calcium aluminosilicate. In general the films are rather dark, but certain parts of most specimens are preserved as highly reflective areas.

Paradoxically, although the animals' soft parts are wonderfully preserved, signs of rotting after burial can often be detected. Many specimens are associated with a black-stained area, a result of the body contents of the carcass seeping out into the surrounding mud. In extreme cases the fossil of a worm consists only of a hollow bag of cuticle because practically all the animal's internal organs have been destroyed by decay. In some worms a subtler indication of decay is the pulling away of body-wall muscles from the cuticle.

Burial in a mud flow has other important effects. For one thing, many of the animals came to be buried at all angles; the shale bedding has therefore preserved them in a variety of orientations that reveal much more of the animals' anatomy than simple horizontal burial does. For another, the fluid sediments that penetrated between the appendages of animals such as arthropods and polychaetes during the turbulent flow of silt were eventually reduced to thin layers of shale. Judicious work with a microchisel enables one to remove these fine layers, thereby revealing further details of a specimen's anatomy that would otherwise remain hidden.

The composition of the Burgess Shale fauna upsets the conventional notion of what makes up a typical assemblage of Cambrian animals. The fossils found at most Cambrian localities are the exoskeletons of such arthropods as trilobites, the shells of various members of the brachiopod phylum and of such echinoderms as the extinct plate-shelled Eucrinoid class. Animals such as these account for barely 20 percent of the invertebrate genera in the Burgess Shale. Is it justified, then, to regard the Burgess Shale assemblage as the Cambrian norm, at least with respect to the fauna of deeper waters, and to view the other Cambrian faunas as being skewed by the selective fossilization of animals with hard parts?

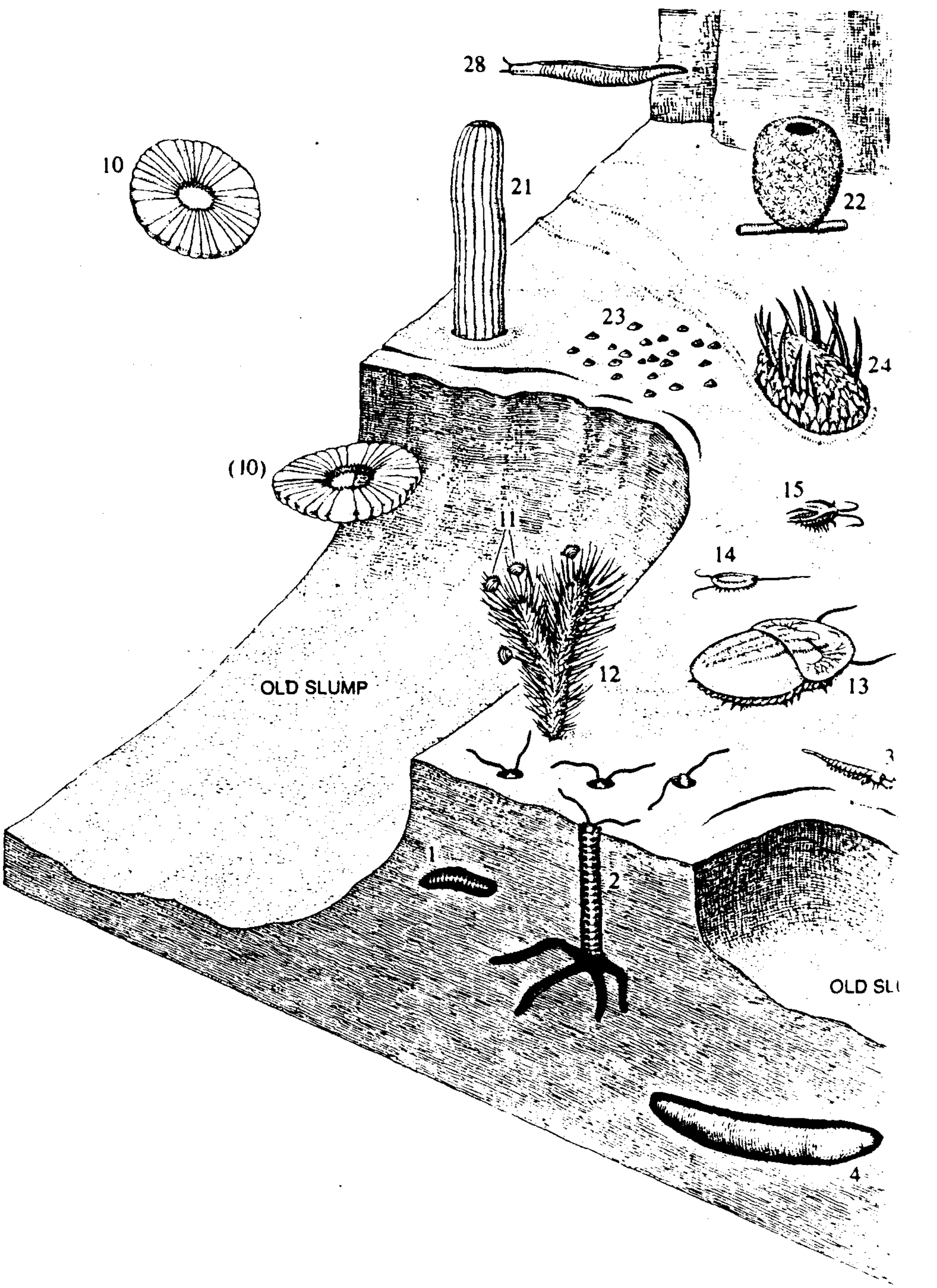
Since the Burgess Shale represents a single environment that has been frozen for a split second of geologic time, no firm answer can be given to the question. Several factors nonetheless suggest that the Burgess Shale fauna was not untypical of Middle Cambrian times. The scattered occurrence of species similar to those from the Burgess Shale in other Cambrian rocks hints at the existence in this period of a widespread soft-bodied fauna. Furthermore, in some Cambrian fossil assemblages certain rather peculiar species were able to flourish because access by sea to the area of deposition was limited. The Burgess Shale, on the other hand, lay at the edge of the open sea and would have been exposed to colonization by marine larvae floating in from other areas. This circumstance adds weight to the hypothesis that the Burgess Shale fauna approaches the Cambrian norm.

In this connection it should be noted that representatives of certain modern invertebrates that have almost certainly had a long geological history are absent from the Burgess Shale. No species of the platyhelminth phylum, the flatworms whose living members include flukes, tapeworms and planarians, are present. There are also no species of another worm phylum, the Nemertea, which includes the modern proboscis worm, and none of still another, the sipunculid phylum. It may be that such worms are not represented because the reef-front environment was not suitable for them.

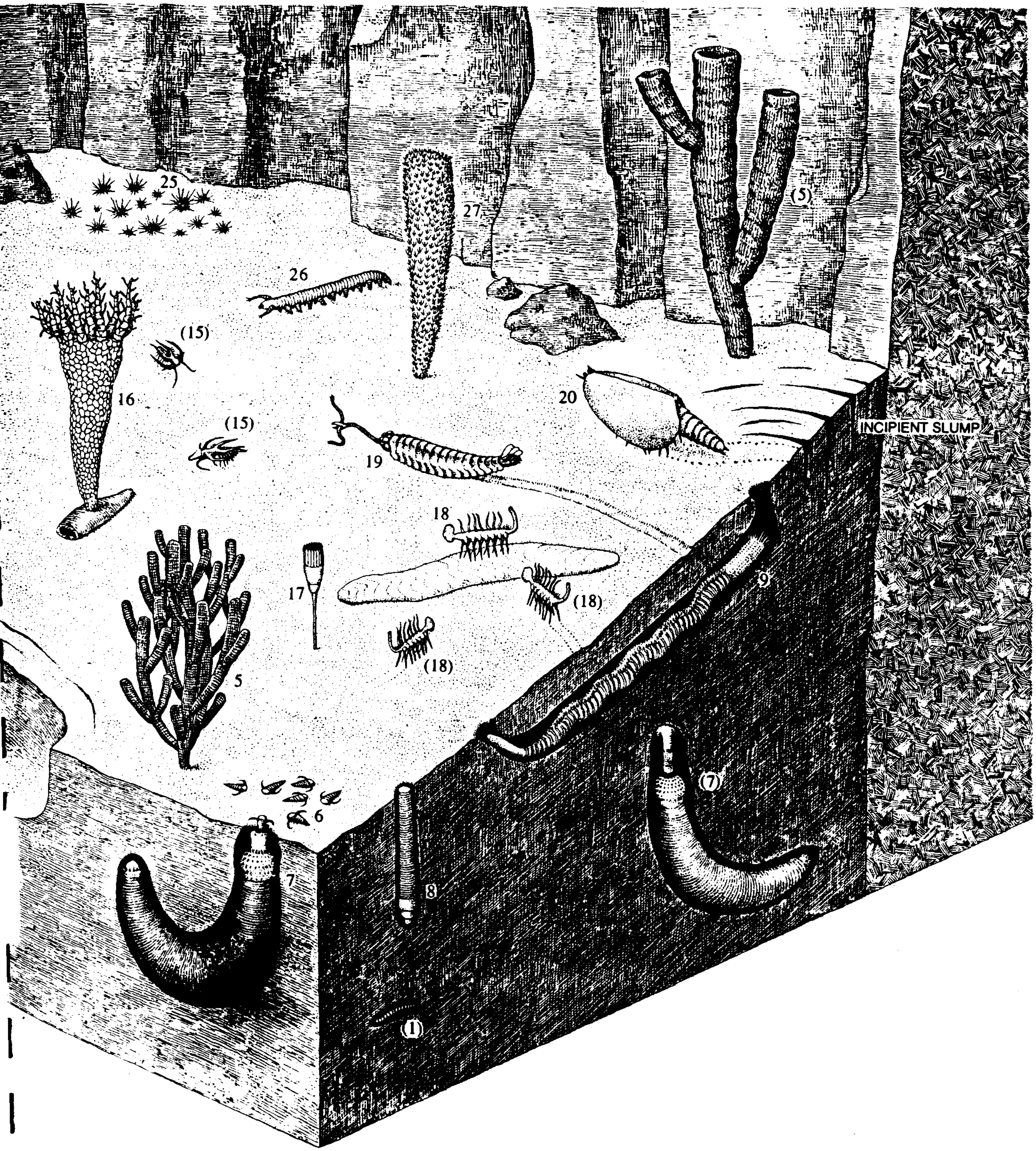
Most of the species found in the Burgess Shale can be placed in the ecological framework of a bottom-dwelling marine community that thrived on the muddy sea floor between intervals of slumping. The mud supported an active group of burrowing invertebrates, with priapulid worms predominant. Attached to the sea floor and growing to various heights were a variety of sponges representing at least 15 genera; they fed on food particles suspended in the water. Actively patrolling the sea-floor surface or plowing through the mud in search of food were many species of arthropods. Certain brachiopods occupied a peculiar niche: they attached themselves to the elongated spicules of one of the sponges, *Pirania*. For the brachiopods the advantages are obvious: they lived somewhat above the turbid waters of the sea floor and could capture food particles such as the sponges fed on at these higher levels.

In addition to this community of fixed and mobile surface dwellers and burrowers a number of free-swimming species inhabited the waters along the reef front. Of these animals there are only tantalizing glimpses, in the form of rare specimens buried by chance in the slumped sediments. The different members of this pelagic fauna probably lived at different depths; some among them may have been species swept into the reef-front area from the open sea.

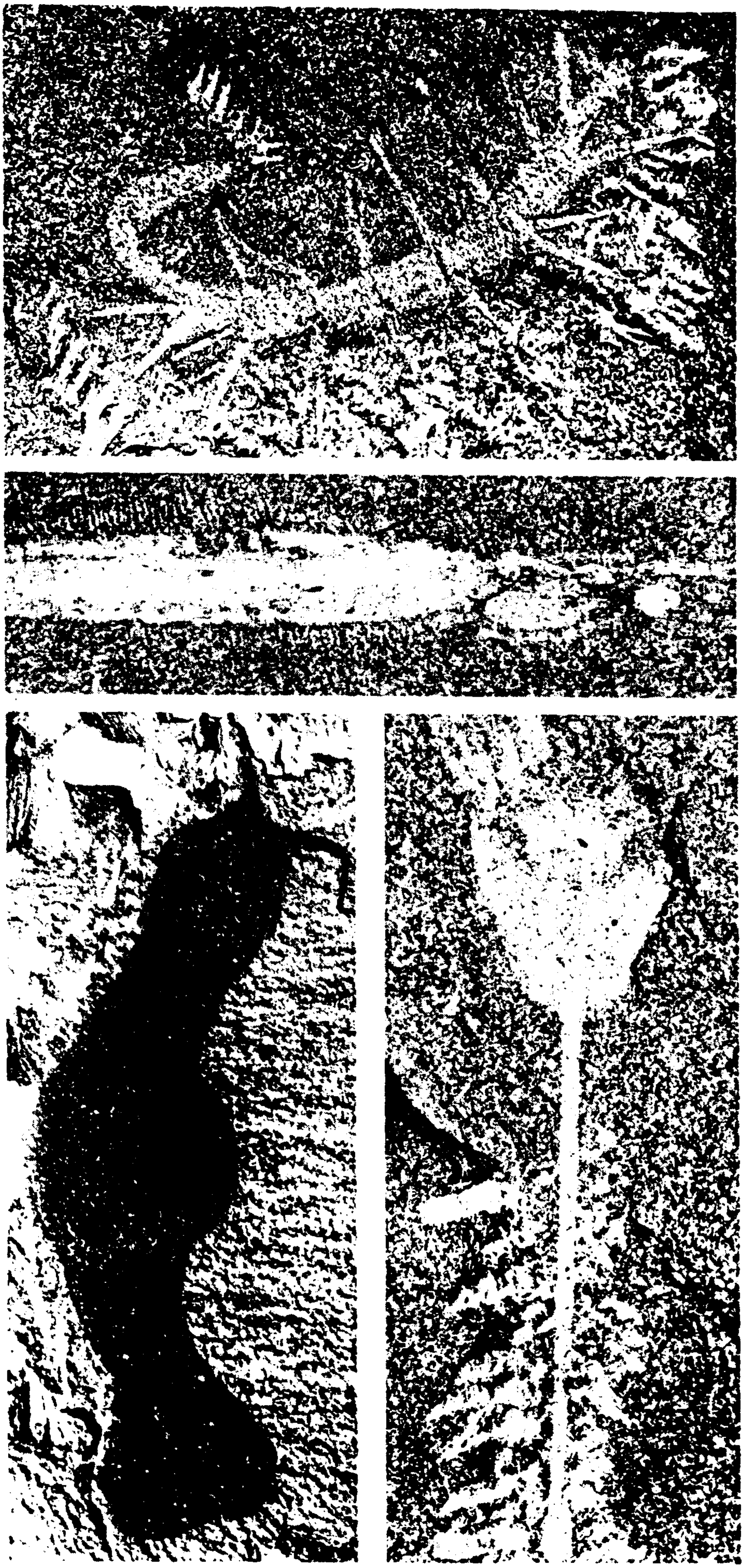
At most Cambrian fossil localities the mineralized exoskeletons of trilobites, the most familiar of all Paleozoic arthropods, are in the majority. In the Burgess Shale, however, trilobites—with one exception—are comparatively unimportant. The exception is *Olenoides*, which is of great significance because in several specimens the appendages have



UNDERWATER SCENE where silts slope down from the face of the great reef and the Burgess Shale fauna lived is shown in an idealized reconstruction. No attempt has been made to show the animals in numbers proportional to their fossil abundance. The fauna are identified by number, starting at the bottom left; only about a fifth of the species fossilized in the shale are shown. Most of the immobile animals of the sea floor are sponges: *Pirania* (*12*), seen with brachiopods attached to its spicules; *Eiffelia* (*22*); the gregarious *Choia* (*25*); a gracile species of *Vauxia* (*5*), with a more robust species at the top right, and *Chancelloria* (*27*). Three other immobile animals are *Mackenzia* (*21*), a coelenterate; *Echmatocrinus* (*16*), a primitive crinoid, seen attached to an empty worm tube, and *Dinomischus* (*17*), one of the Burgess Shale species that represent hitherto unknown invertebrate phyla. The burrow-dwelling animals are *Peronochaeta* (*1*), a polychaete worm that fed on food particles in the silt; *Burgessochaeta* (*2*), a second polychaete that captured food with its long tentacles; *Ancalagon* (*4*), a priapulid worm pos-



sibly ancestral to some modern parasites; *Ottoia* (*7*), another priapulid, seen at the center feeding on the mollusk *Hyolithes* (*6*) and at the right burrowing; *Selkirkia* (*8*), a third priapulid, seen here in a burrow front end down, and *Louisella* (*9*), a fourth priapulid that inhabited a double-ended burrow and undulated its body to drive oxygenated water over its gills. *Peytoia* (*10*) is a free-swimming coelenterate shaped like a pineapple ring. The sea-floor-dwelling mollusks in addition to *Hyolithes* are *Scenella* (*23*), its soft parts hidden under "Chinese hat" shells, and *Wiwaxia* (*24*), with its covering scales and defensive spines, seen here plowing a trail through the silt. Among the many arthropod genera of the sea floor are *Yohoia* (*3*), with its distinctive grasping appendages; *Naraoia* (*13*), an atypical trilobite that retained some larval characteristics; *Burgessia* (*14*), with its long tail spine; *Marrella* (*15*), which may have swum just above the sea floor; *Canadaspis* (*20*), an early crustacean, and *Aysheaia* (*26*), a stubby-legged animal suggestive of the living land dweller *Peripatus*. Other representatives of new phyla seen in addition to *Dinomischus* are *Hallucigenia* (*18*), one preparing to feed on a dead worm and two others approaching it, and *Opabinia* (*19*), seen here grasping a small worm with its single bifurcated appendage. Finally, seen swimming alone at the top left, is *Pikaia* (*28*), the sole representative of the chordate phylum in this Middle Cambrian fauna. *Pikaia* probably used its zigzag array of muscles to propel itself above the sea floor. The phylum of chordates includes the subphylum of vertebrates, which evolved later.



been preserved in detail. *Olenoides* had a pair of slender antennae in front and a pair of cerci, or antennalike structures, in back. The limbs along the length of the animal, up to 16 of them, were all similar in construction. The coxa, a large unit closest to the body, carried a battery of ferocious-looking spines. Attached to the coxa were two appendages; one was a filamentous gill and the other was a walking leg. *Olenoides* could seize and shred soft food, such as small worms, and pass the fragments along to its mouth. The forward antennae and the rear cerci no doubt supplied the animal with information about both food and potential predators. The fact that the primitive limbs of this trilobite are all similar is in marked contrast to the arrangement in many fossil and living arthropods whose limbs are variously modified and specialized.

About 40 percent of the Burgess Shale fauna consists of arthropods. Both in the number of species and the number of individual specimens the soft-bodied representatives of the phylum outrank the hard-shelled trilobites. Many of these "nontrilobites" have had their appendages preserved in remarkable detail; some of them must have been effective predators and scavengers. The most abundant is *Marrella*, an arthropod with a wedge-shaped head that bore two pairs of long hornlike spines curving to the rear. *Marrella* sensed the sea-floor environment with a pair of antennae and swept food particles toward its mouth with adjacent feathery appendages. Its score or more of side limbs were jointed, and a filamentous gill branched from each limb.

The next most abundant of the nontrilobites is *Canadaspis*. All but the hind part of its body was concealed by a double shell. Careful removal of this covering reveals the underlying appendages, which are remarkably like those of certain living crustaceans. Still another arthropod was one of the larger predators of the sea floor. This is *Sidneyia*, an animal whose distinctive limbs recall those of the living horseshoe crab, *Limulus*. It has been possible to identify some of the gut contents of *Sidneyia* as being fragments of brachiopod shells, evidence

UNIQUE ANIMALS of the Burgess fauna include the four seen in the photographs at the left. At the top is *Hallucigenia*, shown in the illustration on the preceding two pages. Second from the top is *Nectocaris*, a streamlined animal with conspicuous fin rays. At the bottom left is *Amiskwia*, a gelatinous worm with prominent fins. At the bottom right is *Dinomischus*, the stalked animal also shown reconstructed on the preceding two pages. Each of these species and six or more others represent hitherto unknown phyla of invertebrates.

that this arthropod was able to crush hard-bodied prey.

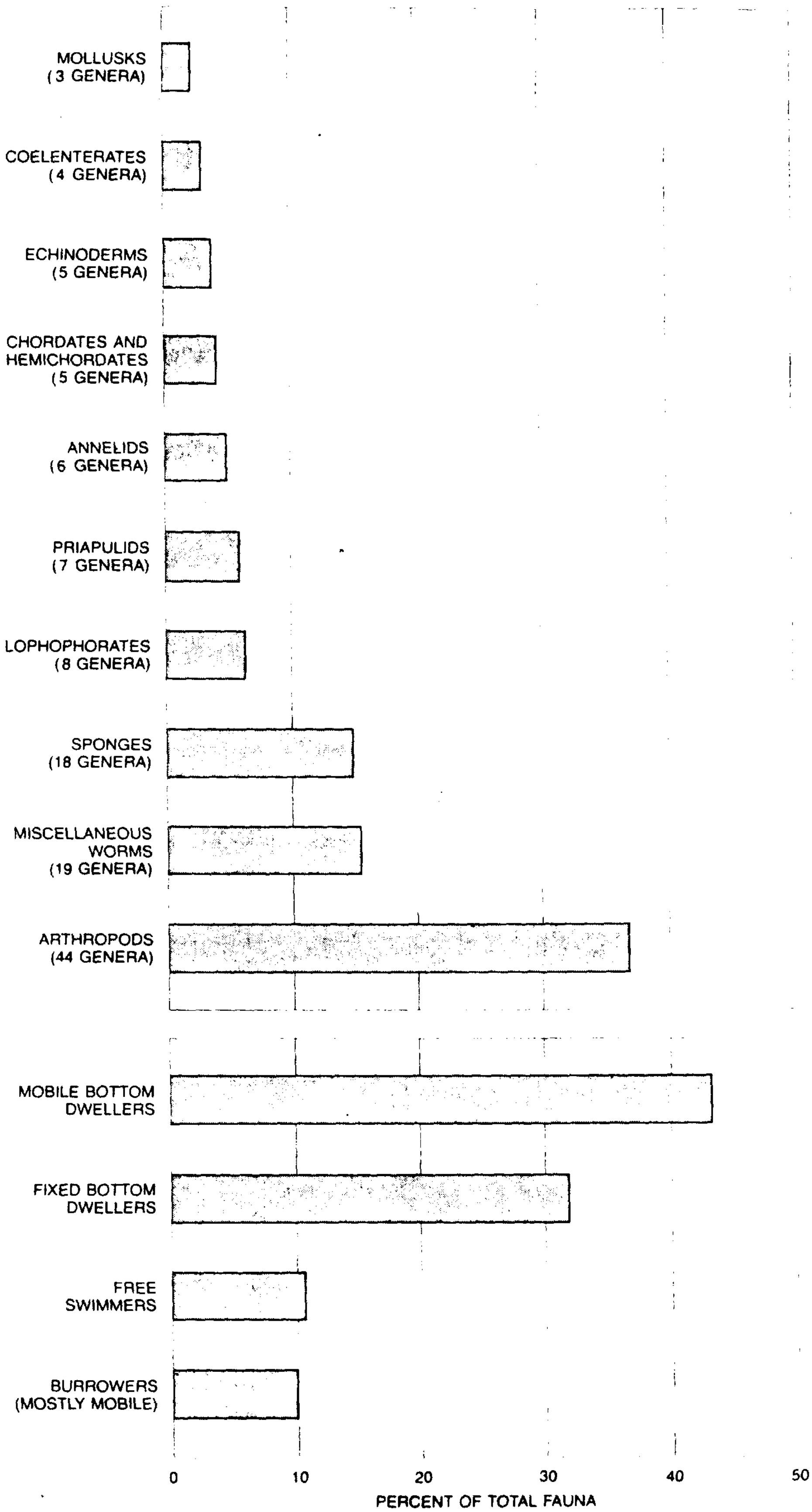
Sidneyia was not the largest of the Burgess Shale arthropods. The shale contains the impressions of isolated large limbs; if they are in proportion, they may have belonged to an animal as much as a meter long. The name *Anomalocaris* has been assigned to these fossils, which possibly represent one of the largest of all Cambrian invertebrates.

The most interesting of all the Burgess arthropods is *Aysheaia*, an animal with a pudgy body and stubby limbs. When Walcott first published a photograph of this fossil half a century ago, a number of zoologists wrote to him to point out how much this Middle Cambrian invertebrate resembled *Peripatus*, an animal with eight genera of relatives (comprising two families) in the small class of onychophores within the arthropod phylum. *Peripatus* was a land animal and *Aysheaia* was a marine form; nevertheless, *Aysheaia* surely represents the kind of ancestor that could have given rise to such living arthropods as myriapods and insects.

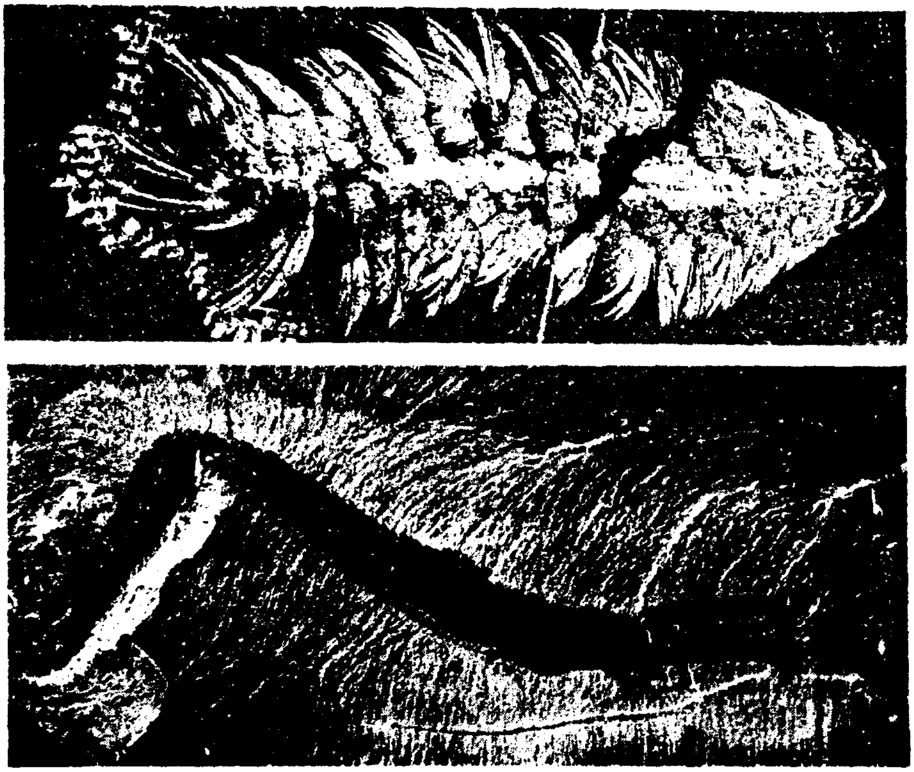
Although some of the nontrilobite arthropods in the Burgess shale, such as *Aysheaia*, are reminiscent of later forms, most of them cannot be placed in any recognized group. They have no obvious relatives either among the other Burgess Shale species or among the arthropods of later times. Because they exhibit a surprisingly wide array of anatomical features, indicating a high degree of specialization, they are evidence of a hitherto unsuspected adaptive radiation of arthropods in Cambrian times. It appears that the numerous stocks that arose during this period of rapid evolution were mostly unsuccessful. It is interesting to note that the animals that were to become dominant in later geological history generally have only a minor position in the various Cambrian faunas; a hypothetical observer would have been hard-pressed to predict just which groups had the flexibility necessary for long-term biological success.

Of the Burgess Shale animals other than arthropods the representatives of six phyla are particularly noteworthy. Among the echinoderms the class of holothurians, the group that includes the sea cucumbers, was once thought to be widely represented. Now only one animal, *Eldonia*, is so classified. Unlike the great majority of the species in its class, *Eldonia* had a jellyfishlike body and a pair of oral tentacles. These animals probably swam through the water in shoals, using their tentacles to capture food. Another Burgess Shale echinoderm, the sea lily *Echmatocrinus*, is the earliest crinoid in the fossil record; as might be expected, it shows a number of primitive features.

The species of the coelenterate phy-



BURGESS SHALE GENERA currently number 119. The percent of the total assigned to various phyla is indicated in the upper part of this bar chart. Nearly 40 percent of the total are arthropods; only 14 of the 44 arthropod genera are trilobites. Worms other than priapulids and annelids (19 genera) and sponges (18 genera) make up another 30 percent of the total; mollusks are the most poorly represented. In terms of habitat, as the lower set of bars indicates, more than 40 percent of the Burgess Shale animals wandered the sea floor and more than 30 percent were rooted in the silt. Most of the burrowing animals also moved freely, although some remained fixed. Burrowers were slightly outnumbered by animals that swam above the sea floor.



TWO PHYLA OF WORMS in the Burgess Shale fauna are the familiar annelids and the less common priapulids. A typical Burgess Shale annelid is *Canadia*, a polychaete worm (*top*); its setae, bundles of fine bristles that were organs of locomotion, are preserved in detail. A typical priapulid worm (*bottom*) is *Louisella*, also reconstructed in illustration on pages 126 and 127.

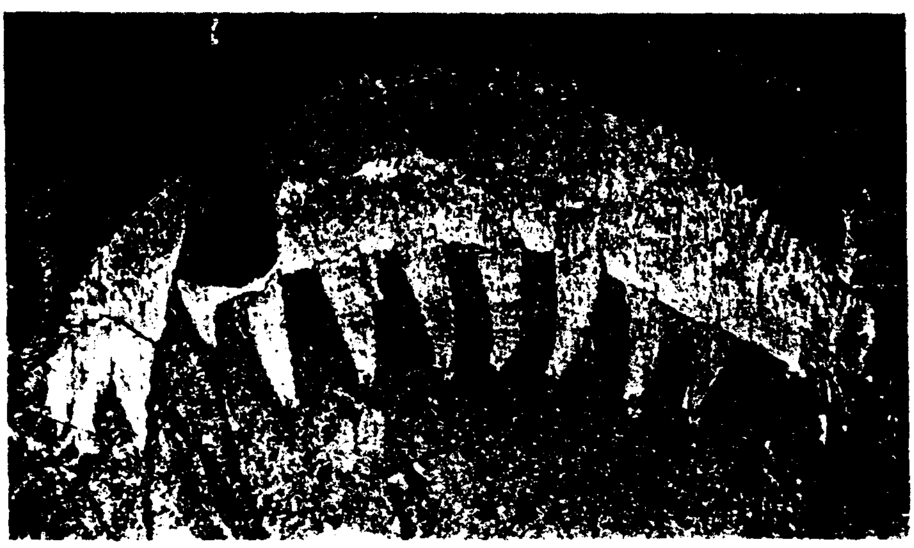
lum are among the most primitive of the metazoans. For example, in the late Precambrian fossil assemblage from the Ediacara Hills the coelenterates predominate. In contrast, the several Burgess Shale coelenterates, some resembling jellyfishes and others resembling sea pens, seem to have played a rather limited role in the community. On the other hand, the Burgess Shale sponges, the most primitive of all the animals present, were prominent members of the community. They were abundant and varied in form; some species grew on the sea floor in thickets.

The various Burgess Shale "worms" were mainly assigned by Walcott to the annelid phylum in general and to the class of polychaetes in particular. It is now realized that many of them belong to other phyla. Nevertheless, it is among the polychaete worms that some of the most spectacular examples of soft-body preservation are to be found: the setae, or bundles of fine bristles, that were these animals' organs of locomotion have been particularly well preserved as bright, reflective films in the shale. One of the polychaetes, *Canadia*, apparently did not live in a burrow but spent much of its time swimming close to the sea floor. Another, *Burgessochaeta*, was probably a more typical burrower, taking refuge in the muddy bottom and searching for food around the burrow entrance with its long tentacles.

Today the priapulid phylum is of interest only to a handful of specialists. These worms, however, were an important group in Cambrian times, and two priapulids present in the Burgess Shale are particularly noteworthy. One of them, *Ottoia*, is the most abundant of the group. It has been preserved in such detail that muscles are clearly visible and the gut content of some specimens can be analyzed. *Ottoia* fed on two kinds of shellfishes: brachiopods and hyolithids. The hyolithids, possibly members of the mollusk phylum, had a conical shell that was capped by a protective operculum, or lid, when the animal was fully withdrawn. The teeth of *Ottoia* were not strong enough to break open the shell, and so the hyolithids were swallowed whole and their soft parts were digested as the shells passed through the priapulid's gut unscathed. These shellfishes were not *Ottoia*'s only food. A unique specimen contains within its gut the remnants of another worm of the same species, showing that (as with some living priapulid worms) *Ottoia* could be cannibalistic.

Parasitologists take considerable interest in another Burgess Shale priapulid. It is *Ancalagon*, which may be ancestral to the living group of spiny-headed worms, the Acanthocephala, that seem to have been parasites for millions of years. These parasitic worms have no gut and absorb nourishment through their body wall while they are lodged in the intestine of their host. If evolution is hypothetically reversed and the worms are reendowed with the organs necessary for a free-living existence, the reconstructed animal is remarkably like *Ancalagon*.

Two other supposed worms, once considered to be polychaetes, are *Wiwaxia* and *Pikaia*. The body of *Wiwaxia* was covered with large scales. Long spines that curved upward and outward along the animal's back evidently were protection against predators. That the spines actually were protective is indicated by the fact that in some specimens of *Wiwaxia* they have been snapped off. An inhabitant of the sea floor, *Wiwaxia* nourished itself by scraping off fragments of food with a rasping organ. The rasp resembles the radula, or horny



ANCESTRAL ARTHROPOD with a striking resemblance to the living onychophore *Peripatus* is this remarkably preserved invertebrate, *Aysheaia*. Cambrian arthropods such as *Aysheaia* could have been ancestral to such living members of that phylum as the myriapods and insects.

toothed tongue, of certain living mollusks. Is *Wiwaxia* a primitive mollusk? If it is, the details of its remarkably preserved anatomy will throw new light on the early evolution of this highly successful phylum of invertebrates.

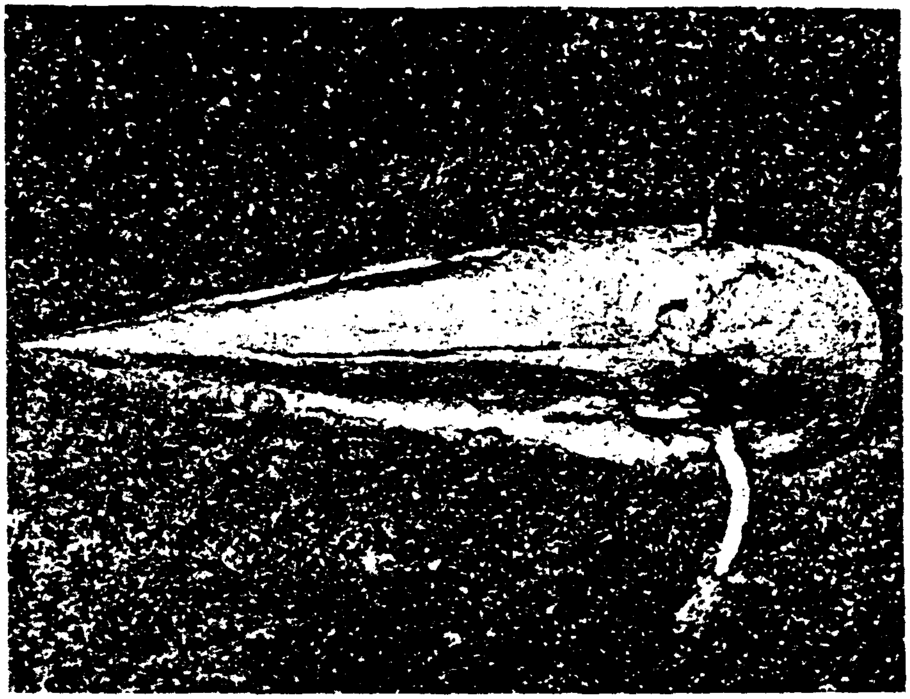
What about *Pikaia*, formerly considered a polychaete worm? Some 30 well-preserved specimens show a prominent rod along the animal's back that appears to be a notochord, the cartilagelike stiffening organ that gives the chordate phylum its name. In addition to this key anatomical feature the blocks of muscle in *Pikaia* form a zigzag pattern that is comparable to the musculature of the primitive living chordate *Amphioxus* and of fishes. Although *Pikaia* differs from *Amphioxus* in several important respects, the conclusion that it is not a worm but a chordate appears inescapable. The superb preservation of this Middle Cambrian organism makes it a landmark in the history of the phylum to which all vertebrates, including man, belong. There are possible instances of even earlier chordates from Lower Cambrian formations in California and Vermont but none is as rich in detail.

Perhaps the most intriguing problem presented by the Burgess Shale fauna is the 10 or more invertebrate genera that so far have defied all efforts to link them with known phyla. They appear to be the only known representatives of phyla whose existence had not even been suspected. Their origins must lie in Precambrian obscurity, where the initial metazoan diversification began. The peculiarity of these novel animals is exemplified by the aptly named *Hallucigenia*.

This animal propelled itself across the sea floor by means of seven pairs of sharply pointed stiltlike spines. Seven tentacles arose from the upper surface of the animal's body; at the end of each tentacle was a pair of strengthened tips. Did the tentacles gather food? If they did, did each tentacle act as an individual mouth with a direct connection to the animal's alimentary canal? There are more questions than answers, but a valuable clue to the animal's behavior is preserved in a specimen from a Harvard University collection. There one can see more than 15 individual *Hallucigenia* associated with a large worm. There seems little doubt that, having detected the carcass of the worm, these odd animals had congregated to scavenge it.

Compared with *Hallucigenia* a second unique animal, *Opabinia*, seems almost orthodox. Its five eyes were arranged across its head, so that it was probably able to avoid predators with ease as it swam close to the sea floor, steering itself with a vertical tail fin. *Opabinia* fed by capturing prey with a grasping organ that projected forward.

Alternative approaches to problems



MOLLUSK REPRESENTATIVE, ***Hyolithes*****, had a cone-shaped shell that was capped by a protective lid. One of the burrowing worms,** ***Ottoia*****, preyed on these mollusks but was not able to break the shell open. The worm digested** ***Hyolithes'*** **soft parts and excreted its shell.**

PROBABLE MOLLUSK, ***Wiwaxia*****, with its cover of large scales and array of long protective spines, was first placed among the polychaete worms of the Burgess Shale. Its rasplike feeding organ, similar to a mollusk's radula, suggests that it belongs to the molluscan phylum instead.**

of functional design are evident among these unusual invertebrates. For example, for a worm with a fluid-filled body cavity one problem is that muscular contraction in one part of the body will distort the shape of the rest of the body. In annelid worms the problem has been solved by dividing the body cavity into a series of watertight compartments. *Banffia*, a unique Burgess Shale worm, developed an alternative solution. The stiffened front half of its body was separated from the more saclike back half by a prominent constriction at the midpoint. The constriction appears to have damped the hydrostatic fluctuations set up by the locomotor muscles of the animal's front half, thereby minimizing the distortion of its unstiffened back half.

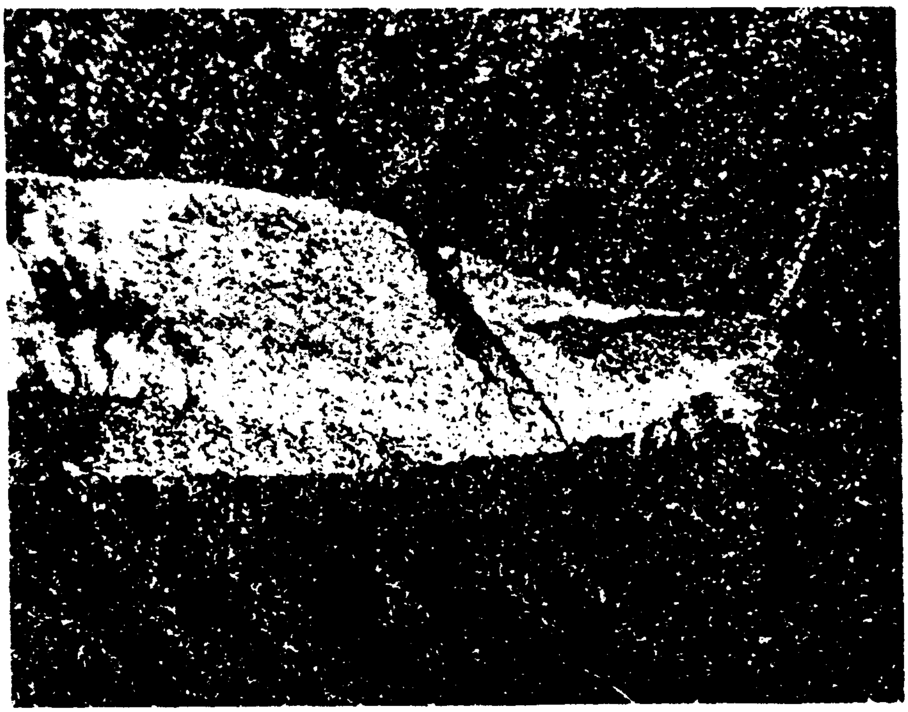
Some representatives of new phyla have been preserved by the dozen. Others, particularly the free-swimming inhabitants of the higher water levels that would seldom be trapped by slumping mud, are quite rare. One such animal is the worm *Amiskwia*; judging by its prominent fins, it was probably quite an active swimmer. Another animal, *Nectocaris*, a fast-swimming predator, had enormous eyes and evidently propelled its streamlined body by rapid lateral flicks of its body. Prominent dorsal and ventral fins, stiffened by numerous fin rays, helped to keep the animal stable as it was swimming.

Conodonts, or "cone teeth," are enigmatic fossils that resemble tiny teeth; they are found in formations ranging in age from the latest Precambrian to the Triassic, a span of almost 400 million years. Although they look like teeth, they cannot have acted as such because they show no signs of wear. What soft-bodied animal had conodonts and for what purpose has long been an unanswered question. Another rare pelagic invertebrate preserved in the Burgess Shale, *Odontogriphus*, may be that animal. The tentacular feeding apparatus of the animal, another unique representative of a hitherto unknown phylum, incorporates a set of minute conical objects that appear to be conodonts. Since conodonts cannot have acted as teeth, the hypothesis has been advanced that they were some kind of support for the feeding tentacles. Was the feeding apparatus of *Odontogriphus* and of animals like it the source of the conodonts so copiously distributed throughout the Paleozoic and the earliest Mesozoic fossil record? Possibly so.

As more is learned about the Burgess Shale fauna the picture of Cambrian life will gain a new perspective, particularly with respect to the explosive evolution of the metazoans. For example, the wide range of arthropods, with their distinctive and different groupings of anatomical characteristics, is already such that a single phylum seems too small to hold them all. The adaptive radiation of the Cambrian invertebrates can be seen as the initial response to the availability of a very wide variety of marine ecological niches. Hence many Cambrian animals seem to be pioneering experiments by various metazoan groups, destined to be supplanted in due course by organisms that are better adapted. The trend after the Cambrian radiation appears to be the success and the enrichment in the numbers of species of a relatively few groups at the expense of the extinction of many other groups.

An additional possibility is suggested by the Burgess Shale fauna itself. Some groups of major stature in Cambrian times, such as the priapulid worms, may have fared badly against later competitors and only escaped extinction by migrating into marginal niches that were either unattractive or unavailable to other metazoans. One such manifestation of movement into a marginal niche is the scaling down of body size. This miniaturization may well be how some priapulids managed to survive. An alternative escape route is to become parasitic; the priapulids that appear to have given rise to the parasitic spiny-headed worms could be an example of the alternative. In any event the Burgess Shale fauna affords both a marvelous glimpse of evolution in action during this brief interval of Middle Cambrian times and a stern reminder of how impoverished and distorted the fossil record is. The study of these soft-bodied animals illuminates many hitherto unsuspected aspects of the history of life.

STIFFENING ROD, or notochord, runs partway along the back of the early chordate *Pikaia*. The animal's head, seen in more detail in the illustration below, is at the right. The pattern of its musculature resembles that of fishes and of the living primitive chordate *Amphioxus*. A reconstruction of this free-swimming chordate appears in the illustration on pages 126 and 127.



FRONT END of *Pikaia* is seen enlarged in this photograph, making visible the animal's pair of sensory tentacles and behind them a short row of small appendages. Earlier Cambrian formations preserve the remains of possible chordates, but none compare with *Pikaia* in detail.

ORGANISATION DES NATIONS UNIES
POUR L'EDUCATION, LA SCIENCE
ET LA CULTURE

Date de réception : 28.12.79
N° d'ordre : 133
Original : Anglais

Convention concernant la protection du patrimoine
mondial, culturel et naturel

LISTE DU PATRIMOINE MONDIAL

Proposition d'inscription présentée par le Canada

Site des Schistes de Burgess

1. Localisation précise

(a) Pays	Canada.
(b) Etat, province ou région	Colombie britannique.
(c) Nom du bien	Site des schistes de Burgess, dans le Parc national de Yoho.
(d) Localisation exacte sur les cartes avec indication des coordonnées géographiques	Les coordonnées sont les suivantes : 51°25'29" de latitude nord et 116°28'47" de longitude ouest.
2. Données juridiques (a) Propriété	Gouvernement du Canada - géré par le Département de l'environnement, Parks Canada, en vertu de la Loi relative aux parcs nationaux.
(b) Statut juridique	Parc national du gouvernement du Canada (voir à l'annexe la Loi relative aux parcs nationaux).
(c) Administration responsable	Director, Parks Canada, Western Region, 134-11th Avenue S.E., Calgary, Alberta T2G OX5

3. Identification

(a) Description et inventaire

Constitués par une masse rocheuse affleurante, partie de la formation Stephen du Cambrien moyen, les Schistes de Burgess sont caractérisés par une abondante et exceptionnelle faune fossile. Le site se trouve dans le Parc national de Yoho, en Colombie britannique, sur le versant occidental de la crête qui relie le mont Field au mont Wapta, par 51°26'29" de latitude nord et 116°28'47" de longitude ouest, à 3,2 kilomètres à vol d'oiseau de la route transcanadienne. L'assise du gisement fossilifère est à environ 2.286 mètres d'altitude, ou à quelque 1.036 mètres au-dessus du village voisin de Field. Le site tire son nom du mont Burgess et du col Burgess situés à proximité.

Assez raide et régulier, le versant occidental de la crête qui relie le mont Field au mont Wapta est dans sa majeure partie dépourvu de végétation et recouvert de dépôts rocailleux. La couverture d'éboulis est interrompue de loin en loin par des affleurements de grandes dimensions ; le site des schistes de Burgess est l'un d'entre eux. A quelques dizaines de mètres de là, on trouve un autre affleurement dolomitique de la formation Cathédrale, lui aussi digne d'intérêt.

Les couches schisteuses de la formation Stephen s'appuient sur la masse dolomitique, qui est le résultat de la mise à nu de l'ancien front corallien qui a fourni le cadre dans lequel la faune de Burgess s'est développée et a été conservée, après sa disparition, sous forme de fossiles.

Le voisinage du site n'a guère été endommagé par l'homme. Une piste bien entretenue sillonne le versant environ 245 mètres en contre-bas. Il donne naissance à deux sentiers qui conduisent à la carrière proprement dite. Cette dernière forme elle-même un replat dans le versant de 30 mètres de long et de 3 mètres de large, dont le fond est en partie comblé par des accumulations d'éboulis naturels et des débris de carrière. Le cône de débris situé au-dessous de la carrière se distingue à peine de l'accumulation d'éboulis naturels. La moraine et le pré que l'on trouve en contre-bas de la piste portent quelques traces du campement utilisé récemment par des chercheurs en 1966, 1967 et 1975.

De la carrière, on a une magnifique vue alpestre vers le sud, l'ouest et le nord.

(b) Cartes et/ou plans

("F" indique les cartes sur lesquelles est indiqué l'emplacement du champ fossilifère) (voir annexe)

(F) Lac Louise (moitié ouest), échelle de 1/50.000, feuille 82N/8 ouest, Canada, Département des mines et des études techniques (actuellement Département de l'énergie, des mines et des ressources), 1959.

(F) Figure 1 de Fritz (1971) (<u>voir</u> Bibliographie)
- il s'agit d'une carte géologique de la zone avoisinante, au 100.000ème.

(F) Parc (national) de Yoho, échelle de 1/126.720, feuille MCR 213, Canada, Département des mines et des études techniques (actuellement Département de l'énergie, des mines et des ressources), 1961.

Carte 1368A, dans Cook, 1975 (<u>voir</u> Bibliographie)
- Carte géologique de la région au 75.000ème.

<u>Les cartes ci-après sont indiquées uniquement à titre de référence</u>.

Fig. 2-1 de McIlreath, 1977 (<u>voir</u> Bibliographie)
- carte géologique mise à jour au 50.000ème.

	Airphoto Pair - pour travaux stéréoscopiques Bibliothèque nationale de la photographie aérienne, Ottawa Vol A13253, n° 96 et 97.
(c) Documentation photographique et/ou cinématographique.	Quatre photographies noir et blanc sont jointes à la proposition d'inscription (voir annexe)
(d) Historique	C'est après avoir trouvé, en 1909, un fossile exceptionnel dans un fragment de roche d'éboulis que Charles D. Walcott, le célèbre paléontologue et spécialiste américain de la stratigraphie, découvrit, l'année suivante, le site des Schistes de Burgess. De 1910 à fin 1913, son équipe procéda à des fouilles pendant certaines parties de la saison, et dégagea en tout 115 m^3 de roches. D. Walcott reprit ses travaux en 1917 ; après avoir passé 50 jours sur place, il déclara que le "gisement de Phyllopodes" était pratiquement épuisé (c'est-à-dire qu'il ne renfermait plus que quelques fossiles). P.E. Raymond, de l'Université Harvard, trouva en 1930 un petit nombre de fossiles à l'emplacement de Walcott et dans une autre petite carrière située une vingtaine de mètres en contre-haut.

Protégé par les règlements du Park national de Yoho, le site de Burgess demeura inexploité jusqu'en 1966, date à laquelle l'administration du Park autorisa une équipe patronnée par le Geological Survey of Canada à reprendre les fouilles, cette autorisation pouvant être prorogée de deux années. Dirigée par H.B. Whittington de l'Université de Cambridge, l'équipe ne tarda pas à établir que contrairement à l'idée reçue, les riches gisements de fossiles n'étaient pas épuisés. Les travaux effectués en 1966 et 1967 permirent de dégager 70 m^3 de schistes. Leur principal objet était de déterminer avec précision les corrélations spatiales entre les fossiles, ce que ne pouvait permettre le réexamen des spécimens exhumés antérieurement. Les travaux n'ont pas été poursuivis en 1968 ; en effet, l'épaisseur de la couche au-dessus du "gisement de Phyllopodes" était telle qu'il aurait fallu des moyens beaucoup plus grands que tous ceux qui avaient été mis en oeuvre jusqu'alors. Le champ fossilifère est inexploité depuis 1967.

Identification (cont'd)

(e) Bibliography

Aitken, J.D., and Fritz, W.H. 1968. Burgess Shale project, British Columbia [82 H/8 (West Half)]. Canada Geol. Survey Pap. 68-1A: 190-192.

_____, ___, and Whittington, H.B. 1967. Stratigraphy, paleontology and palaeoecology of the Burgess Shale. Canada Geol. Survey Pap. 67-1A: 52.

Conway Morris, S. 1976a. A new Cambrian lophophorate from the Burgess Shale of British Columbia. Palaeontology 19: 199-222.

_____. 1976b. Worms of the Burgess Shale, middle Cambrian, Canada. Unpubl. Ph.D. thesis, Cambridge University.

_____. 1977. A new metazoan from the Cambrian Burgess Shale of British Columbia. Palaeontology 20: 623-640.

_____. in press. The Burgess Shale. In: R.W. Fairbridge and D. Jablonski (Editors), Encyclopedia of Paleontology, Dowden, Hutchinson and Ross, Stroudsburg, Pa.

_____ and Whittington, H.B. 1979. The animals of the Burgess Shale. Scientific American 241: 122-133.

Cook, D.G. 1975. Structural Style Influenced by Lithofacies, Rocky Mountain Main Ranges, Alberta - British Columbia. Canada Geol. Survey Bull. 233.

Fritz, W.H. 1967. Cambrian biostratigraphic studies in the Canadian Cordillera. Canada Geol. Survey Pap. 67-1A: 58.

_____. 1968. Middle Cambrian trilobite studies near Field, British Columbia. Canada Geol. Survey Pap. 68-1A: 102.

_____. 1971. Geological setting of the Burgess Shale. In: Extraordinary fossils. Symp. North America Paleontology Conv. 1969, Pt. I: 1155-1170.

Hughes, C.P. 1975. Redescription of Burgessia bella from Middle Cambrian Burgess Shale, British Columbia. Fossils Strata 4: 415-435.

Hutchinson, G.E. 1930. Restudy of some Burgess Shale Fossils. Proc. U.S. Natl. Museum 78: 1-24.

Lohmann, N.H. 1922. Oesia disjuncta Walcott, eine Appendicularie aus dem Kambrium. Mitt. Zool. St. Inst. Hamburg 38: 69-75.

Madsen, F.J. 1956. Eldonia a Cambrian siphonophore - formerly interpreted as a holothurian. Vidensk. Meddel. Dansk. Naturh. Foren. 118: 7-14.

_____. 1957. On Walcott's supposed Cambrian holothurians. Jour. Pal. 31: 281-282.

McIlreath, I.A. 1977. Stratigraphic and sedimentary relationships at the western edge of the Middle Cambrian carbonate facies belt, British Columbia. Ph.D. thesis (unpubl.), University of Calgary.

Owre, H.B., and Bayer, F.M. 1962. The systematic position of the Middle Cambrian fossil Amiskwia Walcott. Jour. Pal. 36: 1361-1363.

Rasetti, F. 1951. Middle Cambrian stratigraphy and faunas of the Canadian Rocky Mountains. Smithsonian Misc. Coll. 116: 1-277.

Raymond, P.E. 1935. Leanchoilia and other Mid-Cambrian Arthropoda. Harvard Univ. Museum Comp. Zool. Bull. 76: 205-230.

Resser, C.E. 1938. Fourth contribution to nomenclature of Cambrian fossils. Smithsonian Misc. Coll. 97: 1-43.

Rolfe, W.D.I. 1962. Two new arthropod carapaces from the Burgess Shale (Middle Cambrian) of Canada. Breviora 160: 1-9.

Ruedemann, R. 1931. Some new Middle Cambrian fossils from British Columbia. Proc. U.S. Nat. Museum 79: 1-18.

Simonetta, A.M. 1962. Note sugli artropodi non trilobiti della burgess shale, cambriano medio della Columbia Britannica (Canada). I. Monit. Zool. Ital. 69: 175-185.

_____. 1963. Osservazioni sugli artropodi non trilobiti della "Burgess Shale" (Cambriano Medio), II. Monit. Zool. Ital. 70-71: 97-108.

_____. 1964. Osservazioni sugli artropodi non trilobiti della "Burgess Shale" (Cambriano Medio), III. Monit. Zool. Ital. 72: 215-231.

Valentine, J.W. 1977. General patterns of metazoan evolution. In: A. Hallam (Editor), Patterns of evolution. Elsevier, New York, 1977: 27-58.

Walcott, C.D. 1911a. Middle Cambrian Merosfomata. Cambrian Geol. and Paleont. II. Smithsonian Misc. Coll. 57: 17-40.

_____. 1911b. A Geologist's paradise. Nat. Geog. Mag. 22: 509-521.

_____. 1911c. Middle Cambrian Holothurians and Medusae. Cambrian Geol. and Paleont. II. Smithsonian Misc. Coll. 57: 41-68.

_____. 1911d. Middle Cambrian Annelids. Cambrian Geol. and Paleont. II. Smithsonian Misc. Coll. 57: 109-144.

_____. 1912a. Middle Cambrian Branchiopoda, Malacostraca, Trilobita and Merostamata. Cambrian Geol. and Paleont. II. Smithsonian Misc. Coll. 57: 145-228.

_____. 1912b. Cambrian of the Kicking Horse Valley, British Columbia. Summary Rep. Geol. Survey Branch Dept. of Mines 1911, Sessional Pap. 26: 188-191.

_____. 1912c. Studies in Cambrian geology and paleontology in the Canadian Rockies. In: Expeditions organized or participated in by the Smithsonian Institution in 1910 and 1911. Smithsonian Misc. Coll. 59: 39-45.

_____. 1912d. Cambrian Brachiopoda. U.S. Geol. Survey Monograph 51, pt.1: 1-872;pt. 2: 1-363.

Walcott, C.D. 1913. Geological explorations in the Canadian Rockies. In: Explorations and fieldwork of the Smithsonian Institution in 1912. Smithsonian Misc. Coll. 60: 24-31.

_____. 1914. Geological explorations in the Canadian Rockies. In: Explorations and fieldwork of the Smithsonian Institution in 1913. Smithsonian Misc. Coll. 63: 2-12.

_____. 1918a. Geological explorations in the Canadian Rockies. In: Explorations and fieldwork of the Smithsonian Institution in 1917. Smithsonian Misc. Coll. 68: 4-20.

_____. 1918b. Appendages of trilobites. Cambrian Geol. and Paleont. IV. Smithsonian Misc. Coll. 67: 115-216.

_____. 1919. Middle Cambrian Algae. Cambrian Geol. and Paleont. IV. Smithsonian Misc. Coll. 67: 217-260.

_____. 1920. Middle Cambrian Spongiae. Cambrian Geol. and Paleont. IV. Smithsonian Misc. Coll. 67: 261-364.

_____. 1921. Notes on structure of Neolenus. Cambrian Geol. and Paleont. IV. Smithsonian Misc. Coll. 67: 365-456.

_____. 1924. Cambrian and Ozarkian Brachiopoda. Cambrian Geol. and Paleont. IV. Smithsonian Misc. Coll. 67: 477-554.

_____. 1931. Addenda to descriptions of Burgess shale fossils. Smithsonian Misc. Coll. 85: 1-46. (With explanatory notes by Charles E. Resser).

Walton, J. 1923. On the structure of a Middle Cambrian alga from British Columbia (Marpolia spissa Walcott). Proc. Cambridge Phil. Soc. Biol. Sci. 1: 59-62.

Whittington, H.B. 1971a. The Burgess Shale: History of research and preservation of fossils. In: Extraordinary fossils. Symp. North Amer. Paleont. Conv. 1969, pt. 1: 1170-1201.

_____. 1971b. Redescription of Marella splendens (Trilobitoidea) from the Burgess Shale, Middle Cambrian, British Columbia. Bull Geol. Surv. Can. 209: 1-24.

_____. 1974. Yohoia Walcott and Plenocaris n.gen., arthropods from the Burgess Shale, Middle Cambrian, British Columbia. Bull. Geol. Surv. Can. 231: 1-27.

_____. 1975a. The enigmatic animal Opabinia regalis, Middle Cambrian, Burgess Shale, British Columbia. Philos. Trans. R. Soc. B271: 1-43.

_____. 1975b. Trilobites with appendages from the Middle Cambrian, Burgess Shale, British Columbia. Fossils Strata 4; 97-136.

Yochelson, E.L. 1961. The operculum and mode of life of Hyolithes. Jour. Pal. 35: 152-161.

4. <u>Etat de préservation/de conservation</u>

(a) Diagnostic

A l'exception de la zone d'excavation proprement dite, le voisinage immédiat du site de Burgess a presque conservé son état naturel. De discrets sentiers pédestres y assurent l'accès, et le campement situé 245 m en contre-bas porte quelques marques d'occupation /voir 3 (a)/

Quand elle n'est pas exploitée, la carrière ne présente guère d'intérêt pour le profane. En partie comblée dans son fond par des débris de roche et des éboulis naturels, la carrière mesure 30 m de long X 3 m de large, et sa paroi postérieure - qui constitue le champ de fouille - est haute de près de 6 m. La présence de fossiles n'est pas évidente ; pour les mettre au jour, il faut cliver le schiste gris sombre selon des plans parallèles aux strates.
On ne peut le faire qu'après avoir délité le schiste de haut en bas. Du fait que les riches matériaux fossilifères (le "gisement de Phyllopodes" a une épaisseur de 1,6 m) se trouvent maintenant au-dessous d'une couche de roche d'au moins 3 m d'épaisseur, les fossiles ne sont accessibles qu'au prix d'importants travaux d'excavation. Des prélèvements fortuits ou clandestins ou encore des actes de vandalisme pourraient défigurer le site, mais ne risquent guère d'endommager les fossiles restants.

	De l'avis de ceux qui ont travaillé sur le site tout récemment, les riches filons fossilifères ne sont pas épuisés ; ils s'enfoncent sans doute sur une certaine distance dans le flanc de la montagne à partir de la face d'excavation actuelle. Lesfossiles sont maintenant beaucoup moins accessibles qu'ils ne l'étaient aux premiers chercheurs.
(b) Agent responsable de la préservation ou de la conservation	Parks Canada, Bureau de la région occidentale, 134-11th Avenue S.E., Calgary, Alberta, par l'intermédiaire du Directeur du Park national de Yoho, Field (Colombie britannique).
(c) Historique de la préservation ou de la conservation	Le site est placé depuis 1901 sous la surveillance et la protection du Gouvernement fédéral; il est également protégé par la Loi de 1930 relative aux parcs nationaux. Un Plan directeur provisoire pour les quatre parcs de montagne a été élaboré en 1971. Dans le Plan révisé propre au Park de Yoho établi en 1975, les Schistes de Burgess sont classés zone I (zones spéciales de conservation, où se trouvent des exemples fragiles, uniques ou représentatifs de la flore, de la faune ou du paysage). Ces zones qui seront classées dans la mesure du possible en fonction de leurs traits naturels, demeureront pratiquement vierges.

	Les Schistes de Burgess et les gisements fossilifères du Mont Stephen sont considérés par les géologues de tous les pays comme des phénomènes uniques au monde. Les limites des zones I ont été définies d'après les limites des gisements fossilifères figurant sur les cartes.
(d) Moyens de préservation ou de conservation	La protection législative est assurée par la Loi et les Règlements relatifs aux parcs nationaux, qui sont appliqués par le personnel du Park de Yoho en poste à Field, en Colombie britannique. Les travaux de planification intéressant le Park sont effectués par la Division de la programmation et du développement de Parks Canada, région occidentale, Calgary, Alberta (Canada). Le parc, dans lequel se trouve le site des Schistes de Burgess, est géré par un directeur qui réside à Field, B.C., et qui est assisté d'un personnel permanent et saisonnier.
(e) Plans de gestion	Un plan de gestion a été établi sous le titre "Réserve Management Planning - Yoho National Park". (voir Annexe).

5. Justification de l'inscription sur la liste du patrimoine mondial
(b) Bien naturel

Les Schistes de Burgess méritent de figurer sur la Liste du patrimoine mondial à deux titres : premièrement, pour ce qui est du critère "i", il s'agit d'un phénomène naturel tout à fait exceptionnel, qui compte certainement parmi les trois plus grands sites fossilifères du monde et qui est, de l'avis de certains, le plus important. Ces autres sites, la gorge d'Olduvai en Tanzanie et le Parc provincial des dinosaures au Canada, renferment des fossiles d'un groupe et d'un âge géologique différents. Deuxièmement, s'agissant du critère "ii", le site de Burgess est un témoignage unique d'une grande étape de l'histoire de l'évolution terrestre.

Les Schistes de Burgess ont produit jusqu'ici plus de 150 espèces de fossiles attribués à quelque 120 genres. Pour la plupart, ces fossiles ne se rencontrent nulle part ailleurs.

Peut-être encore plus important est le fait que la majorité des empreintes admirablement conservées sont celles d'animaux dépourvus de parties dures, c'est-à-dire d'animaux dont on ne trouve généralement pas de fossiles. La découverte des Schistes de Burgess a donc donné une idée de l'abondance et de la variété insoupçonnées des animaux marins à corps mous au début de l'histoire de la vie animale multicellulaire sur terre, c'est-à-dire moins de 50 millions d'années après le grand bouleversement évolutionnaire qui marqua le début du Cambrien. C'est pourquoi l'exploitation du site a contribué davantage à la biologie de l'évolution qu'à la géologie.

Enfin, l'abondance des fossiles est remarquable. Charles D. Walcott, qui a découvert le site, a dégagé des dizaines et des dizaines de milliers de spécimens de 114 m^3 de schistes. Ces spécimens sont précieusement conservés au Musée national des Etats-Unis de Washington.

Bien qu'il existe déjà de nombreux ouvrages sur la paléontologie des Schistes de Burgess, les travaux se poursuivent en la matière. A l'aide de moyens d'investigation dont ne disposaient pas les premiers chercheurs, une nouvelle étude de la collection de Walcott et des autres fossiles recueillis par le Geological Survey of Canada en 1966 et 1967 est menée activement par un groupe de l'Université de Cambridge, dirigé par Harry B. Whittington.

ANNEXE

Documents joints à la proposition d'inscription du site des Schistes de Burgess.

Les documents énumérés ci-après ont été présentés par le Canada à l'appui de la proposition d'inscription mentionnée ci-dessus ; ils peuvent être consultés à la Division des sciences écologiques de l'Unesco et seront disponibles pour examen lors des réunions du Bureau du Comité du patrimoine mondial et du Comité lui-même :

1. Documents relatifs au statut juridique et à la gestion du bien

   Loi relative aux parcs nationaux, chapitre N-13, p. 27 indiquant les limites du Parc national de Yoho dans lequel se trouve le site des Schistes de Burgess.
   "The Resource Management Statement" de "Resources Management Planning - Yoho National Park".

2. Photographies noir et blanc

   1. Extrémité nord du champ fossilifère des Schistes de Burgess, 1966. Des terrassiers retirent les couches de schiste qui recouvrent le célèbre "gisement de Phyllopodes", tandis que les paléontologues clivent le schiste à la recherche de fossiles.

   2. Extrémité sud du champ fossilifère à "2" (1966). Les chiffres à "1" indiquent une petite carrière ouverte par P.E. Raymond en 1930.

   3. Versant occidental de la crête reliant le mont Field (à droite) au mont Wapta (nom visible sur la photo, à gauche). Le campement se situe à "1". Le champ fossilifère des Schistes de Burgess, en grande partie comblé par la neige, se trouve à "2".

Le pointillé indique un sentier pédestre et équestre bien entretenu.

4. Vue nord-ouest prise du sentier entre le campement et la carrière. La President Range est à l'arrière-plan. Le lac Emeraude occupe la profonde vallée au centre et à gauche.

3. Cartes

Lac Louise (moitié ouest), échelle de 1:50.000, feuille 82N/8 ouest, Canada, Département des mines et des études techniques (actuellement Département de l'énergie, des mines et des ressources).

Parc (national) de Yoho, échelle de 1:126.720, feuille MCR 213, Canada, Département des mines et des études techniques (actuellement Département de l'énergie, des mines et des ressources), 1961.

Carte 1368A, dans Cook, 1975 (voir Bibliographie) - carte géologique de la région au 75.000ème.

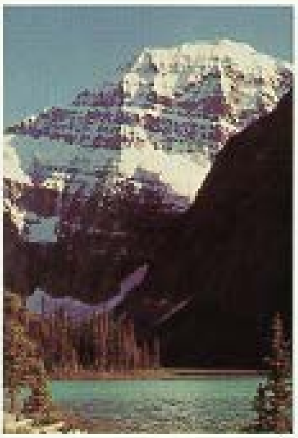
4. Photocopies d'articles décrivant le site

Fritz, W.H., 1969. Geological setting of the Burgess Shale. Proc. N. Amer. Paleon. Conv., p. 1155-1170.

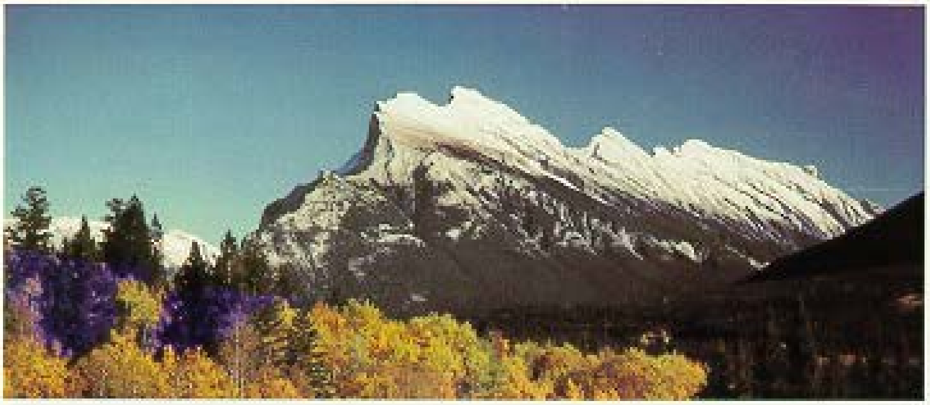
Conway Morris, S. ; Whittington, H.B., 1979. The animals of the Burgess Shale. Sci. Amer., vol. 241, n° 1, p. 122-133.

THE CANADIAN ROCKIES

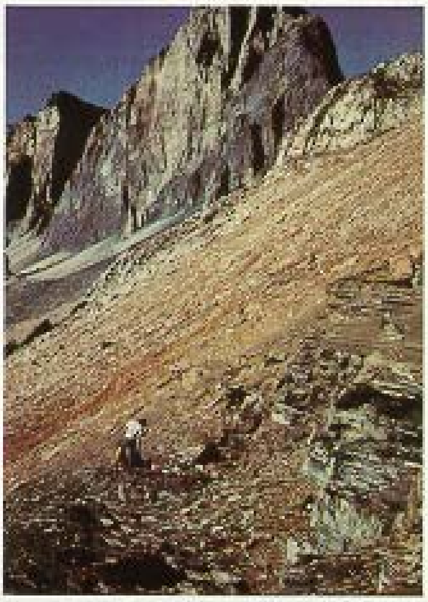
1.



2.



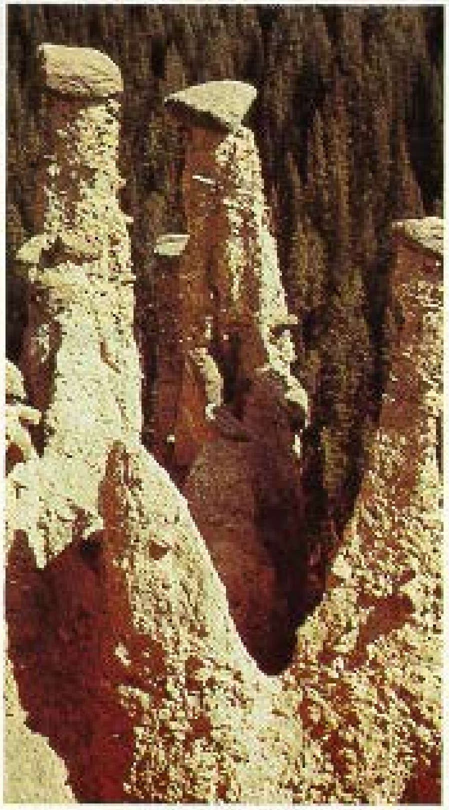
3.



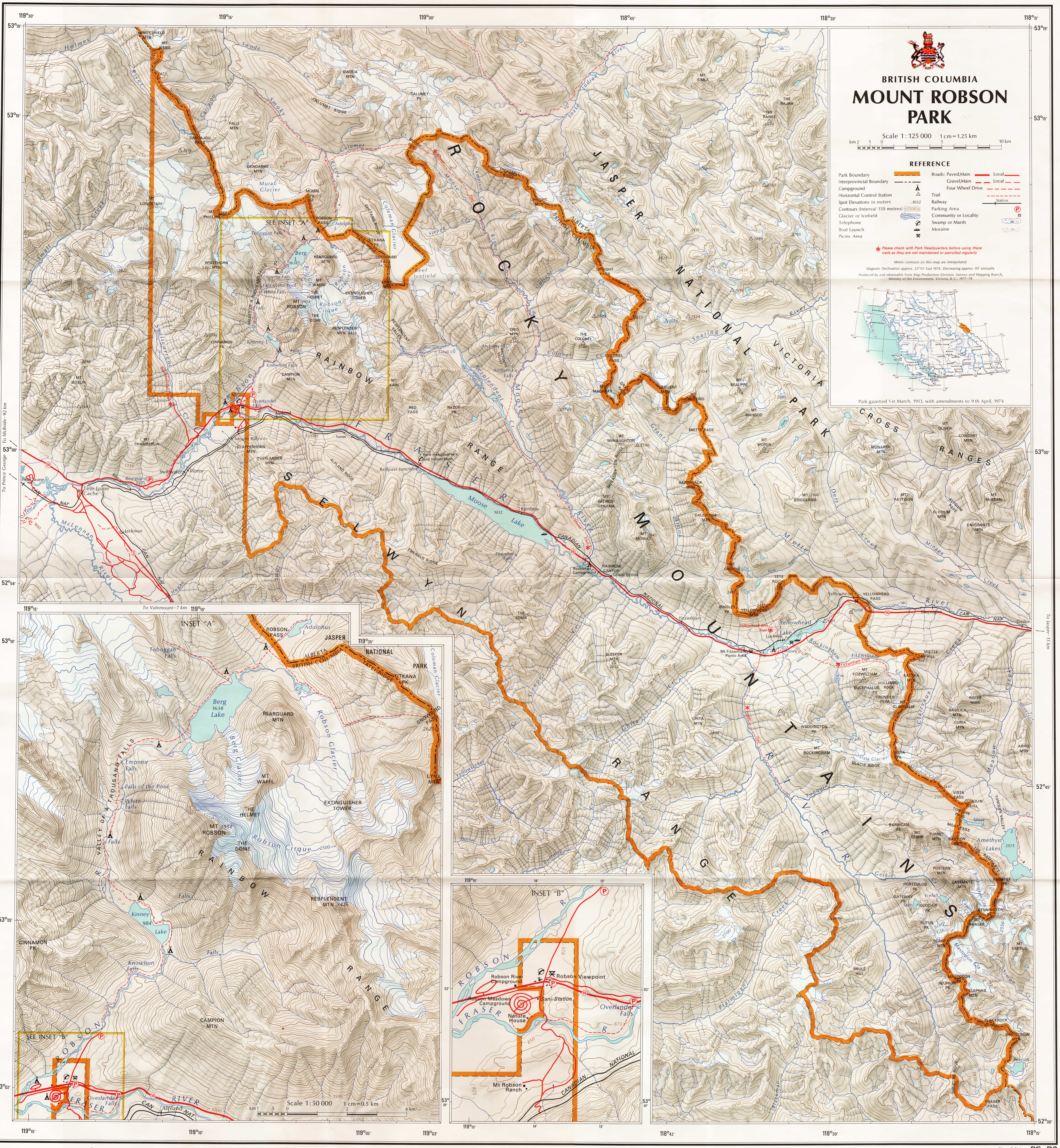
4.

1. *Burgess Shale – fossils*
2. *Mount Edith Cavell – Main Range – Uplifted mountain with banded cliffs.*
3. *Mount Rundle – mountain of Front Range*
4. *Burgess Shale quarry – slope of Stephen Formation*
5. *Roche Miette – Front Ranges in Jasper*
6. *Hoodoos in Yoho National Park – effects of erosion*

5.



6.



First Edition PS–R2


JASPER NATIONAL PARK
PARC NATIONAL JASPER
WHITE GOAT WILDERNESS AREA
FIRST RANGE
RAM RANGE
KOOTENAY PLAINS NATURAL AREA
SIFFLEUR WILDERNESS AREA
BANFF
ROCKY MONTAGNES
NATIONAL
A L B E R T A
ROCKY
MOUNTAIN
FOOTHILLS
PARK
MOUNTAINS
ROCHEUSES
PARC
NATIONAL
BANFF
YOHO NATIONAL PARK
PARC NATIONAL YOHO
BRITISH
COLUMBIA
COLOMBIE
BRITANNIQUE
GLACIER NATIONAL PARK
PARC NATIONAL GLACIER
KOOTENAY NATIONAL PARK
PARC NATIONAL KOOTENAY
MOUNT ASSINIBOINE PROVINCIAL PARK
GHOST RIVER WILDERNESS AREA
KANANASKIS COUNTRY
KANANASKIS PROVINCIAL PARK
COLUMBIA MOUNTAINS
BUGABOO ALPINE PROVINCIAL RECREATIONAL AREA
SPILLIMACHEEN RANGE
BEAVERFOOT RANGE
VERMILION RANGE
SAWBACK RANGE
SUNDANCE RANGE
FISHER RANGE
CANMORE
TINDA RANCH
WAPTIK MOUNTAINS
OTTERTAIL RANGE
BOW RANGE
ALBERTA
COLOMBIE BRITANNIQUE

NOMINATION TO THE WORLD HERITAGE LIST

Convention concerning the Protection of the World Cultural and Natural Heritage

Name: CANADIAN ROCKIES

Identification No: 304 Date received by WH Secretariat: 23.12.83

Contracting State Party having submitted the nomination of the property in accordance with the Convention: CANADA

Summary prepared by IUCN (March 1984) based on the original nomination submitted by Canada. This original and all documents presented in support of this nomination will be available for consultation at the meetings of the Bureau and the Committee.

---

1. LOCATION: Provinces of Alberta and British Columbia, Canada.

2. JURIDICAL DATA:

Owned by Government of Canada; legally administered by Parks Canada under the National Parks Act. A small area of what was to become Banff national park was established in 1885. To this reserve of 26 sq km around the Hot Springs at Banff additional lands were added to give its present size of 6641 sq km. Yoho National Park was added in 1886 and is now 1313 sq km in size. Park initiatives in Jasper began in 1907 and today the park is 10,878 sq km. Kootenay Park was added in 1930 and its present size is 1378 sq km.

3. IDENTIFICATION:

The property consists of four contiguous national parks -- Banff, Jasper, Kootenay and Yoho. Total size is 20,210 sq km. Together, these four parks comprise within their boundaries the most outstanding natural features of the Rocky Mountain Biogeographical Province of North America. The area is extremely rugged, largely unmodified by man and mountainous with many peaks above 4000 m and local relief up to 2135 m. Geological formations are composed of highly faulted, folded and uplifted sedimentary rocks. All four geological divisions of the Rocky Mountain chain are represented in the parks. There are several icefields and hundreds of remnant valley glaciers. Glacial lakes, numerous waterfalls, extensive limestone cave systems, fossil beds, deeply incised canyons, hot springs, and underground rivers are other physical features. The four parks are aligned along the continental divide which marks the hydrographic apex of North America separating the drainage basins of the Arctic, Pacific, and Atlantic oceans.

The area has a continental climate of the western interior of North America with long, cold winters and short, cool summers. Major air masses affecting the area originate in the Pacific and in the Arctic. Mountain topography has strong effects on microclimate. January and July mean daily temperatures are -12·7°C and 15·6°C respectively. Mean annual total precipitation varies from 380 mm at lower elevations to 1250 mm in areas along the continental divide.

Three vegetation zones occur depending on altitude -- montane, subalpine, and alpine. Included are wetlands, dune areas, extensive coniferous forests and alpine meadows. About one third of the total area is unvegetated exposed rock, colluvial material, glaciers and permanent snowfields.

Wildlife resources are typical of the Rocky Mountains and include 56 species of mammals, 280 species of birds and 8 species of amphibians and reptiles. A population estimate of 200 grizzly bears still remain. One species is listed as "vulnerable" in the IUCN Red Data Book, the grey wolf.

Historical use by North American indians occurred in isolated locations from 10,000 B.C. European exploration began with the fur trade era in the 1800s and rapidly expanded during construction of intercontinental transportation through the area. In 1885 a park reserve was established near the Hot Springs in Banff which became Rocky Mountains Park in 1887.

Access and facility development in the form of railways, transcontinental 4-lane highways, townsites, and alpine ski areas allow some 9 million visitors annually to use the area. Some 10,000 people reside permanently in the two townsites of Banff and Jasper. Eight provincial parks and wilderness areas act as buffer zones to the Federal lands.

4. STATE OF PRESERVATION/CONSERVATION:

Mineral and forest exploitation and hunting was allowed in the area prior to World War I and one hydro development thereafter. Resource extraction since then has been limited to occasional culling of excess herbivore populations and removal of some timber.

Although tourism and transportation facilities are well developed, some 90% of the total property remains as undisturbed wildland with access only by foot or by horseback. Development projects are subject to the Federal Environmental Review Assessment Process which has conducted impact statements of road and railway construction projects.

The four parks together comprise a contiguous unit and although each has a separate administration they are coordinated through a regional office. A management plan for each park is in preparation and will be completed in 1985. In total the four parks have 750 man-years of personnel and US $17 million allocated to them.

5. JUSTIFICATION FOR INCLUSION ON THE WORLD HERITAGE LIST:

The Canadian Rockies nomination, as presented by the Government of Canada, provides the following justification for designation as a World Heritage property:

a) Cultural property -- not applicable

b) Natural property

(i) Earth's evolutionary history. The area incorporates the Burgess Shale which was declared a World Heritage Site in 1981 and is considered as one of the world's most significant fossil sites.

(ii) On-going geological processes. The site includes the full range of features and processes relating to glaciation -- icefields, cirque glaciers, moraines, hanging valleys, striations, and pioneer stages of plant succession.

(iii) Exceptional natural beauty. The Canadian Rockies landscape is known for its scenic values and attracts millions of visitors for this reason.

(iv) Habitats of rare and endangered species. Diverse vegetation and undisturbed habitats support wildlife typical to the region. One vulnerable species occurs.

WORLD HERITAGE NOMINATION -- IUCN TECHNICAL EVALUATION

304 CANADIAN ROCKIES (CANADA)

1. DOCUMENTATION

i) Nomination form and map
ii) IUCN Data Sheets for Banff, Jasper, Kootenay and Yoho National Parks
iii) Consultations: Dr. V. Geist, Dr. J. Marsh
iv) Literature Consulted: numerous references as cited in data sheets.

2. COMPARISON WITH OTHER AREAS

The property includes the largest complex of national parks in any one area of the Rocky Mountains Biogeographical Province of North America. The combination of natural features and superlative scenery that are contained within this complex are unsurpassed anywhere in the Province. Several features of particular significance are found nowhere else (the Burgess Shales, Castleguard Caves, Columbia Icefield, and the Maligne Valley). Historically, the site includes the area at Banff that was Canada's first national park. The area differs greatly from the other World Heritage Site in the Rocky Mountain region, Yellowstone National Park, which is basically a volcanic plateau containing many thermal features. Other comparable areas are found in the mountain blocks of the northern interior of British Columbia but none have the collection of values found within the nominated site and none have the measure of protection afforded by national park status.

3. INTEGRITY

The area contains the headwaters of major river systems and, combined with its large size, associated provincial park buffer zones, and diversity of habitats, maintains a high measure of ecological integrity. The political boundaries are firm and unlikely to be modified.

Some winter range grazing land outside the eastern margin of the area is used by ungulate populations in the park. Although sport hunting of these animals on their winter range takes place, this is not a serious depleting factor. More serious are periodic poisoning programmes carried out by local ranchers which have reduced wolf populations as well as other non-target species. Adjacent to the western margins of the area major forestry and hydro-developments are in process which are providing increased human access to some of the wilderness zones of the parks.

Inside the boundary of the parks there are a number of localized sites that have been significantly modified for tourism or transportation purposes. These are contained within defined intensive use development zones and are subject to elaborate environmental assessments. Over 90 percent of the site remains as undisturbed natural wildland.

4. ADDITIONAL COMMENTS

a) Inclusion of Burgess Shale Site. This small specific feature is included within the nominated area although it was included on the World Heritage List in 1980. The site itself is a very limited area within Yoho National Park and is only one of many natural features of the Canadian Rockies nomination.

b) Comprehensiveness of nomination. Although the nominated site is of substantial size (only four existing World Heritage Sites are larger), it should be noted that only Federal national park land is included. Several of the most outstanding features of the Canadian Rockies (e.g., Mt. Robson, Mt. Assiniboine, Kananaskis, Fortress and Cummins Lakes, and a large portion of the Columbia Icefield), lie in provincial lands immediately adjacent to the national parks.

Although Parks Canada contacted the Provincial authorities, no consideration of these additional inclusions was made. Consequently several of the most outstanding features of the Canadian Rockies are missing in the nomination.

5. EVALUATION

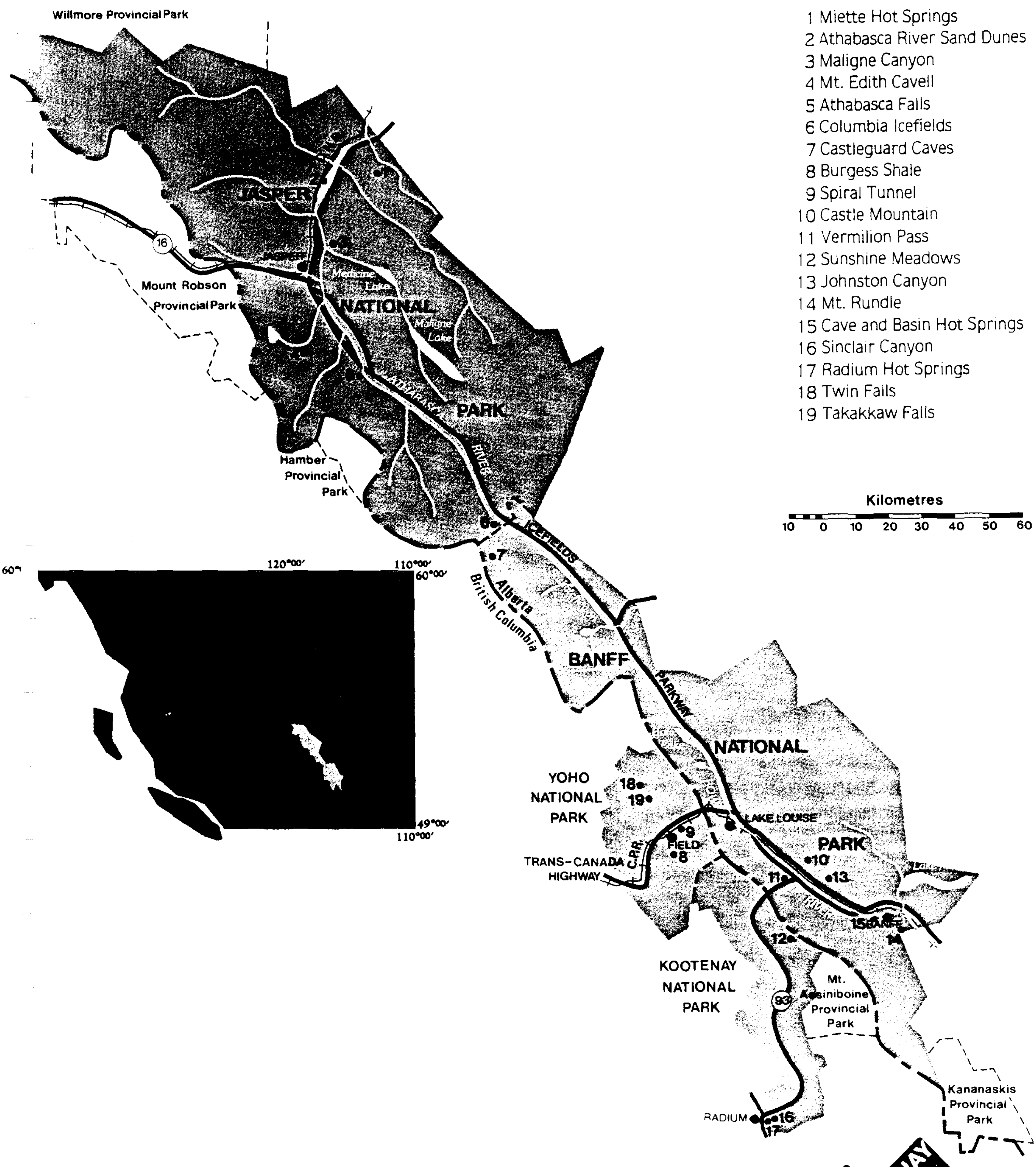
The Canadian Rockies nomination, including the four contiguous national parks, contains the majority of the outstanding physical and biological features of the Rocky Mountain Biogeographical Province. Classic illustrations of glacial geological processes (criteria ii) are found here as well as exceptional natural beauty (criteria iii). As the Burgess Shale fossil site is part of the area it also meets criteria (i). Management plans for each park are now being drafted and the total area is under an effective management regime.

6. RECOMMENDATION

The site meets three criteria for World Heritage recognition and should be added to the List. The Committee may wish to urge the Canadian authorities to consider adding several of the adjacent outstanding provincial lands to the site, such as those mentioned in 4(b) above. IUCN further recommends that, if the nomination is approved, the Burgess Shale Site be incorporated as part of the Canadian Rockies property. This will require an agreement with the Government of Canada on the name of this property, which could read "The Canadian Rockies including the Burgess Shale Site".

UNION FOR CONSERVATION OF NATURE AND NATURAL RESOURCES - INTERNATIONAL

THE CANADIAN ROCKIES



BANFF JASPER KOOTENAY YOHO

CANADA - Alberta

NAME Jasper National Park

MANAGEMENT CATEGORY II (National Park)

Part of the Canadian Rockies World Heritage Site

BIOGEOGRAPHICAL PROVINCE 1.19.12 (Rocky Mountains)

GEOGRAPHICAL LOCATION In Alberta on the eastern edge of the Rocky Mountains, centred around Jasper township. 52°05'-53°28'N, 116°50'-119°32'W

DATE AND HISTORY OF ESTABLISHMENT Created a national park in 1930. First protected as Jasper Forest Park (1,295,000ha) in 1907. Accepted as a World Heritage Site (in combination with Kootenay, Banff and Yoho national parks) in 1984.

AREA 1,087,800ha; contiguous to Banff National Park (664,076ha) to the south-east, and two British Columbian provincial parks to the west. Component of the Canadian Rockies World Heritage Site.

LAND TENURE Federal Government

ALTITUDE 1,058-3,747m (Mount Columbia)

PHYSICAL FEATURES The park stretches from the Continental Divide to the eastern Front Ranges of the Rocky Mountains, which were formed 75 million years ago. Some of the exposed rocks in the park date back over 500 million years. Major peaks include, Columbia (3,747m), the Twins (3,684 and 3,559m), Alberta (3,619m), King Edward (3,475m), Fryatt (3,361m), Brazeau (3,470m), Poboktan (3,323m) and Sunwapta (3,315m). A small area in the south-eastern portion of the park along the Southesk River is the only protected example of the rounded rolling hills of the Foothills, the easternmost extension of the Rockies. Beds of Palliser limestone form the great cliffs at Roche Miette and the Palisades. Some spectacular peaks have been carved by glaciation and several active glaciers (Angel, Dome, Athabasca and Saskatchewan) continue to create new land forms. The Columbia ice field, covering 37,500ha, is the most spectacular of its kind in Canada. Alpine and rock barrens cover some 10,400ha at higher altitudes. The Athabasca River is the major waterway flowing south-north along the central broad, flat valley which runs the length of the park. It originates in the Columbia Icefield and is fed by numerous tributaries draining the surrounding mountains. There are also numerous lakes filled by glacial meltwater collecting in the valleys gouged out by the glaciers. They include Maligne, Amethyst and Brazeau. Other notable features are the mineral hot springs of Sulphur Creek (Miette Hot Springs); Medicine Lake, which drains via an underground river into the spectacular Maligne Canyon; Maligne Lake, which is the largest glacier-fed lake in the Canadian Rockies; and Angel Glacier on the slopes of Mount Edith Cavell (3,363m).

CANADA - British Columbia

NAME Yoho National Park

MANAGEMENT CATEGORY II (National Park)

Part of the Canadian Rockies World Heritage Site

BIOGEOGRAPHICAL PROVINCE 1.19.12 (Rocky Mountains)

GEOGRAPHICAL LOCATION Rocky Mountains in British Columbia, adjoining Kootenay and Banff National Parks. 51°06'-51°39'N, 116°13'-116°45'W

DATE AND HISTORY OF ESTABLISHMENT 1886. Accepted as a World Heritage Site (in combination with Jasper, Kootenay and Banff national parks) in 1984.

AREA 131,313ha

LAND TENURE Government of Canada

ALTITUDE 1,036-3,562m

PHYSICAL FEATURES Representative of both the western and eastern Main Ranges of the Rocky Mountains; heavily faulted, rigid uplifted blocks underlain by quartzite. Many of the older rocks are rich in fossils, including those of the Burgess Shale (Cathedral Formation); an exquisite assemblage of soft-bodied fossils, some remarkably preserved. Fossils are significant in that they portray a view of Middle Cambrian evolution.

There is a notable laccolith at the south end of the park and a natural bridge spanning the waters of the Kicking Horse River. Kicking Horse River has been designated a Canadian Heritage River, recognising the significance of physical processes, cultural and recreational importance. Other features include the 380m Takakkaw Falls, Laughing Falls and Twin Falls.

CLIMATE January and July mean daily temperatures are -10.7°C and 13.6°C respectively. Mean annual precipitation is 690mm.

EGETATION There is a rich and varied plant life. Middle and lower altitude communities are representative of the montane ecoregion, with Douglas fir Pseudotsuga menziesii and white spruce Picea glauca the dominant species. Higher elevations are characteristic of the sub-alpine and alpine ecoregions, forested with Engelmann's spruce P. engelmannii, alpine fir Abies lasiocarpa, larch L. lyallii and limber pine Pinus flexilis. Alpine meadows have a variety of heaths, grasses, sedges and forbs. Species of interest include Rhododendron spp., dwarf birch Betula glandulosa and alpine bearberry Arctostaphylos rubra.

Areas of special interest include Emerald Lake, with species typical of the Pacific floristic element; western red cedar Thule plicata, western hemlock Tsuga heterophylla and western yew Taxus brevifolia, all of which are at the extreme easternmost extent of their range. Lower Ice River and Kicking

Horse valleys have extensive wetland areas.

FAUNA Characteristic mammals of the alpine tundra include pika Ochotona princeps, hoary marmot Marmota caligata and **mountain** goat Oreamnos americanus. Mammals of the forest include hare Lepus canadensis, red squirrel Tamiasciurus hudsonicus, porcupine Erethizon dorsatum, black bear Ursus americanus, grizzly bear Ursus arctos horribilis, wolverine Gulo gulo luscus, cougar Felis concolor, lynx F. lynx canadensis. Ungulates include moose Alces alces, elk Cervus elaphus, mule deer Odocoileus hemionus and white-tailed deer Odocoileus virginianus. Recent increases in the sighting of timber wolf Canis lupus. Some 145 recorded bird species including white-tailed ptarmigan Lagopus leucurus, northern three-toed woodpecker Picoides tridactylus, grey jay Perisoreus canadensis, Bohemian waxwing Bombycilla garrulus and **mountain** bluebird Sialia currucoides.

CULTURAL HERITAGE No information

LOCAL HUMAN POPULATION

VISITORS AND VISITOR FACILITIES Approximately 1.1 million visitors per year, five campgrounds, three for tents/RVs - 262 sites; two for tents - 65 sites; also one group tenting area and one winter camping area. Visitor services are available at Field, BC, a community of 250 residents inside the park. Three roadside commercial accommodation facilities - 152 units and two backcountry lodges accommodating 74 people, considerable backcountry overnight use (19,200 visitor nights in 1984-85) and day use, particularly in the popular Lake O'Hara and Yoho Valley areas.

SCIENTIFIC RESEARCH AND FACILITIES Ecological land classification studies and studies of internationally significant Burgess Shale soft-bodied fossils

CONSERVATION MANAGEMENT Guided by the 1988 Yoho National Park Management Plan, which places a priority on the protection of heritage resources.

MANAGEMENT PROBLEMS Trans-Canada Highway CP Railway with Spiral Tunnels and yarding facilities at Field

STAFF 96.77 man-years - 65 full-time employees.

BUDGET US$718.5 O&M (G&S); $2,422.9 O&M (Salary)

LOCAL ADMINISTRATION Superindendent, Yoho National Park, Box 99, Field, BC VOA 1GO

REFERENCES

Canadian Parks Service (1988). Yoho National Park Management Plan. Western Region, Calgary.

Coen, G.M. and Kuchar, P. (1982). Biophysical (Ecological) Inventory of Yoho National Park, British Columbia, Canada. Alberta Soil Survey Unit, Agriculture Canada, Edmonton.

Infobase produced by WCMC, January 1992

CLIMATE Mean monthly temperatures are -12.2°C in January and 15.6°C in July. Mean annual precipitation is 508mm.

VEGETATION A series of vegetation zones occur at different altitudes. Valleys are heavily forested with conifers, the main communities being dominated by lodgepole pine Pinus contorta (which invades after fire), occupying some 168,000ha, and white spruce Picea glauca covering 27,500ha. Along the rivers, forest communities of aspen Populus tremuloides (700ha) and poplar Populus balsamifera occur. Some lower and drier slopes support Douglas fir Pseudotsuga menziesii forest (500 ha), while spruce-fir Picea engelmanii-Abies lasiocarpa forest occupies 232,500ha near the timberline. Small areas of black spruce Picea mariana cover about 120ha. Above the timberline open alpine meadows cover 50,000ha and support communities dominated by arctic species such as heath Cassiope tetragona, **mountain** avens Dryas integrifolia and willow Salix arctica. Noteworthy herbaceous species include Heuchera glabra, Lupinus nootkatensis, Galium palustre and Dryopteris phegopteris.

FAUNA Marmot Marmota caligata, bighorn sheep Ovis canadensis and pika Ochotona princeps are typical of higher elevations and moose Alces alces, mule deer Odocoileus hemionus, caribou Rangifer tarandus (woodland form) and beaver Castor canadensis occur in the valleys. Carnivores include timber wolf Canis lupus (V), grizzly bear Ursus arctos horribilis, wolverine Gulo gulo luscus, badger Taxidea taxus, lynx Lynx lynx canadensis and cougar Felis concolor. About 200 species of birds have been identified in the park, including Clark's nutcracker Nucifraga columbiana.

CULTURAL HERITAGE Several transient Indian campsites and workshops, dating back some 3,000 years, have been excavated within the park and an ancient quarry just outside the boundaries was the source of flint-like quartz used for tools and arrow-heads. The first Europeans reached the area in the early 1800s and the trading post established by Jasper Hawse has been restored as an historical monument near Jasper township.

LOCAL HUMAN POPULATION Jasper town, with a population of 3,732, lies at the junction Highway 16 and 93 in the centre of the park.

VISITORS AND VISITOR FACILITIES 1,937,436 visitors were recorded in .981-82. The park contains 1,752 campsites (of varying standards) in 12 front-country campgrounds and 200 sites reserved for group tenting. In addition, there are over 100 designated back-country campsites. There is accommodation for about 4,500 visitors in the town of Jasper, and a well-developed network of marked hiking trails and cross-country skiing routes (some 1,000km). Permits must be obtained for overnight stays along trails. There are information centres in Jasper town and the Columbian Icefield.

SCIENTIFIC RESEARCH AND FACILITIES Studies of fire ecology, grizzly bear biology and ecology, insect taxonomy, glaciology, alpine flora, fossils and stratigraphy, wildlife diseases and hydrology and an aquatic resources survey.

Infobase produced by WCMC, January 1992

CONSERVATION MANAGEMENT Resource protection takes precedence over visitor use and facility development where conflicts occur. Park resources are managed on an ecological basis; coordinating management efforts with the other **parks** in the four-park block and with adjacent lands. There are warden stations at the Sixth Bridge on the Maligne Road (headquarters), Poboktan (winter) and various locations in the backcountry. Sport fishing is considered compatible with the proper management of natural zones. Zoning is as follows: Zone I: Special preservation <1%; Zone II; Wilderness 98% (wilderness area boundaries and acceptable levels of use and development are designated by legislation); Zone III: Natural Environment <1%; Zone IV: Outdoor Recreation <1%; Zone V: park services <1%.

MANAGEMENT PROBLEMS Some disturbance inevitably results from the high level of tourism in the park, with the permanent townsite of Jasper, skiing facilities and use of fishing powerboats on designated lakes. Littering by hikers and the problems of garbage disposal at the major campsites attracts the wildlife and is known to have changed the feeding patterns of bears. Tourism and transportation usage is confined to the Intensive Use (Park Services) zone and is subject to elaborate environmental assessments. The Yellowhead Highway, other main roads and a major railway cross the park. Sport hunting of ungulate populations on adjacent provincial lands is not a serious depleting factor.

STAFF 222 man-years - 137 full time employees

BUDGET US$9,901,000 for operation and maintenance 1982-83

LOCAL ADMINISTRATION Superintendent, Jasper National Park, **Parks** Canada, Box 10, Jasper, Alberta J0E 1E0

REFERENCES

Canadian Parks Service (1988). Jasper Park Management Plan. **Canadian Parks** Service, Western Region, Calgary, Alberta.

Holland, W.D. and Coen, G.M. (eds) (1982). Ecological (Biophysical) Land Classification of Banff and Jasper National **Parks**. Vol I: summary and Vol. II: soil and vegetation resources. Alberta Institute of Pedology Publication SS-82-44. Edmonton.

Laidlaw, T.F. (1971). The black spruce (Picea mariana) vegetation of Banff and Jasper National **Parks**. MSc Thesis, University of Alberta, Edmonton.

Northern Forest Research Centre (1980). Biophysical land classification studies of Jasper National Park.

Parks Canada tourist information leaflets

Porsild, A.E. (1959). Botanical excursions to Jasper and Banff National **Parks**, Alberta. Publ. Nat. Mus. Can.

Scace, Robert (1973). Banff, Jasper, Kootenay and Yoho: an initial bibliography of the contiguous **Canadian Rocky Mountain** National **Parks**.

Stringer, P.W. (1973). An ecological study of grasslands in Banff, Jasper and
Waterton Lakes National **Parks**. Can. J. Bot. 51: 383-411.

Stringer, P.W. and La Roi, G.H. (1970). The Douglas Fir Forests of Banff and

Infobase produced by WCMC, January 1992

Jasper National **Parks**, Canada. Can. J. Bot. 48: 1703-1726.
World Heritage nomination submitted to Unesco

DATE 1983, updated October 1989
0246U

CANADA - Alberta

NAME Banff National Park

MANAGEMENT CATEGORY II (National Park)

Part of a World Heritage Site (Criteria i, ii, iii)

BIOGEOGRAPHICAL PROVINCE 1.19.12 (Rocky Mountains)

GEOGRAPHICAL LOCATION Alberta. 50°42'-51°55'N, 115°10'-117°18'W

DATE AND HISTORY OF ESTABLISHMENT 1885 as a park reserve (2,600ha) around the Cave and Basin mineral hot springs. Formally established in 1887 as Rocky Mountains Park (67,300ha), Canada's first national park, under the Rocky Mountains Park Act. Named as Banff National Park (669,500ha) in 1930 under the National Parks Act. Deletion of 5,400ha in 1949. Accepted as part of the World Heritage Site, Canadian Rockies, in 1984.

AREA 664,109ha. Contiguous to Jasper National Park (1,087,800ha) to the north-west. Stretches 240km along the eastern slope of the Continental Divide.

LAND TENURE Government of Canada

ALTITUDE 1,383-3,628m

PHYSICAL FEATURES The Main and Front Ranges of the Rocky Mountain landscape were formed 75 million years ago and modified by folding, faulting and glaciation. Essentially, there are three parallel ranges. Features include several still active glaciers, mineral hot springs of Sulphur Mountain and Johnston Canyon, and the so-called hoodoos or erosion-carved pinnacles. Alpine and rock barrens cover 113,000ha. The Columbia Icefield (37,500ha), the largest icefield in the North American sub-arctic interior, spans the Continental Divide and the boundary between Banff and Jasper national parks. The area serves as headwaters and contributes significant flow volumes to three major river systems: North Saskatchewan, Athabasca and Columbia. Associated with the icefield is the Castleguard Cave System which is a modern sub-glacial karst system and there is also a great density of sinkholes.

CLIMATE Mean temperatures are -12.2°C in January and 15.6°C in July. Mean annual precipitation is 508mm.

VEGETATION Plant life in the park reflects the wide range of climatic conditions found at different altitudes. Valleys are dominated by dense lodgepole pine *Pinus contorta* forest occupying 192,000ha and further up the slopes stands of Douglas fir *Pseudotsuga menziesii* forest cover some 500ha. The principal sub-alpine forest community is Engelmann spruce *Picea engelmanii*, covering 162,000ha. Alpine meadows occupy 25,000ha above 2,000m consisting of a wide diversity of alpine species including *Dryas* hookeriania, Kobresia bellardii, Phyllodoce glandulifolia, Antennaria lanata, Salix arctica and Carex nigricans. Less extensive forest types include aspen forest Populus tremuloides, white spruce forest Picea glauca and willow scrub Salix spp.

FAUNA **Rocky Mountain** goat Oreamnos americanus and bighorn sheep Ovis canadensis are typical of the higher alpine pastures; elk Cervus elaphus, white-tailed deer Odocoileus virginianus and mule deer O. hemionus are typical of meadows in the forest zone; and moose Alces alces occur in valley bottoms.

Predators include timber wolf Canis lupus (V), grizzly bear Ursus arctos horribilis and cougar Felis concolor. The area has a wide variety of bird species but distribution is thin except in favoured areas such as the Vermilion Lakes. Lakes and streams contain 6 salmonid species including eastern brook trout, cut-throat, rainbow and brown trout.

CULTURAL HERITAGE No information

LOCAL HUMAN POPULATION No information

VISITORS AND VISITOR FACILITIES Approximately 8 million people pass through the park each year. About 3.3 million stop to use the park. There is one town (Banff) and one visitor centre (Lake Louise) with a total capacity of about 8,000 overnight visitors and almost 2,500 campsites within the park, and 1,575km of hiking trails.

SCIENTIFIC RESEARCH AND FACILITIES Research includes a comprehensive wildlife monitoring programme, water quality monitoring, as well as fire and vegetation management pgorammes. In addition to these ongoing programmes, research projects include an assessment of the twinning of the Trans-Canada Highway on wildlife, black bear research, Sunshine summer use monitoring and glaciology by other agencies.

CONSERVATION MANAGEMENT The recently approved Banff Park Management Plan (1988) guides the protection, use, development and management of the park. An emphasis is placed on protecting natural and cultural resources. Zoning is as follows: Zone 1 (Special preservation) covers approximately 4% of the park area; Zone 2 (Wilderness) approximately 93%; Zone 3 (Natural Environment); Zone 4 (Outdoor Recreation) approximately 1% and Zone 5 (Park Services) <1%. Sport fishing is permitted.

MANAGEMENT PROBLEMS The Trans-Canada highway, other main roads and a major railway pass through the park. There is a permanent town with associated facilities (population 8,000) and a service centre at Lake Louise (population 1,000). There are high rates of visitation and backcountry use. Bear-proof containers in campgrounds and subsequent haulage of garbage to dumps outside the park effectively limits bear-garbage problems. Stocking of fish species continues on a limited scale in a few front-country lakes. Poaching of trophy animals, and to some extent as a source of food, continues to be a minor problem. Boundaries are being defined by law to control expansion of the three downhill ski areas and the

Banff townsite. Zoning limits most tourist facility development to a small area of the park.

STAFF 335 total man-years - 218 full-time employees.

BUDGET US$ 9,989,792 for operation and maintenance in 1987-88.

LOCAL ADMINISTRATION Superintendent, Banff National Park, Parks Canada, Box 900, Banff, Alberta T0L 0C0.

REFERENCES

Achuff, P.L. et al. (1986). Special Resources of Banff National Park. Warden Service, Banff National Park.

Banfield, A.W.F. (1958). Mammals of Banff National Park. Bulletin of the National Museum of Canada 159.

Byrne, A.R. (1968). Man and landscape change in the Banff National Park area before 1911. Studies in Land Use History and Landscape change in National Parks, Series 1. University of Calgary, Calgary, Alberta.

Canadian Parks Service (1988). Banff National Park Management Plan. Western Region, Calgary.

Clarke, C.H.D. (1940). Wildlife investigations in Banff National Park, 1939. Canadian National Parks. Bur. MS Rep. (mimeo).

Clarke, C.H.D. and Cowan, I. McT. (1945). Birds of Banff National Park. Canadian Field Naturalist 59: 83-103.

Gadd, B. (1986). Handbook of the Canadian Rockies. Corax Press, Box 1577, Jasper T0E 1E0.

Holland, W.D. and Coen, G.M. (eds) (1982). Ecological (biophysical) Land Classification of Banff and Jasper national parks. Vol I: summary and Vol. II: soil and vegetation resources. Alberta, Institute of Pedology Publication SS-82-44.

Holroyd, G.L. and Van T. ghem, K.J. (1983). Ecological (biophysical) Land Classification of Banff and Jasper National Parks. Vol. III: The Wildlife Inventory. Canadian Wildlife Service, Edmonton.

Price, M.F. (1983). Parks 7(4)

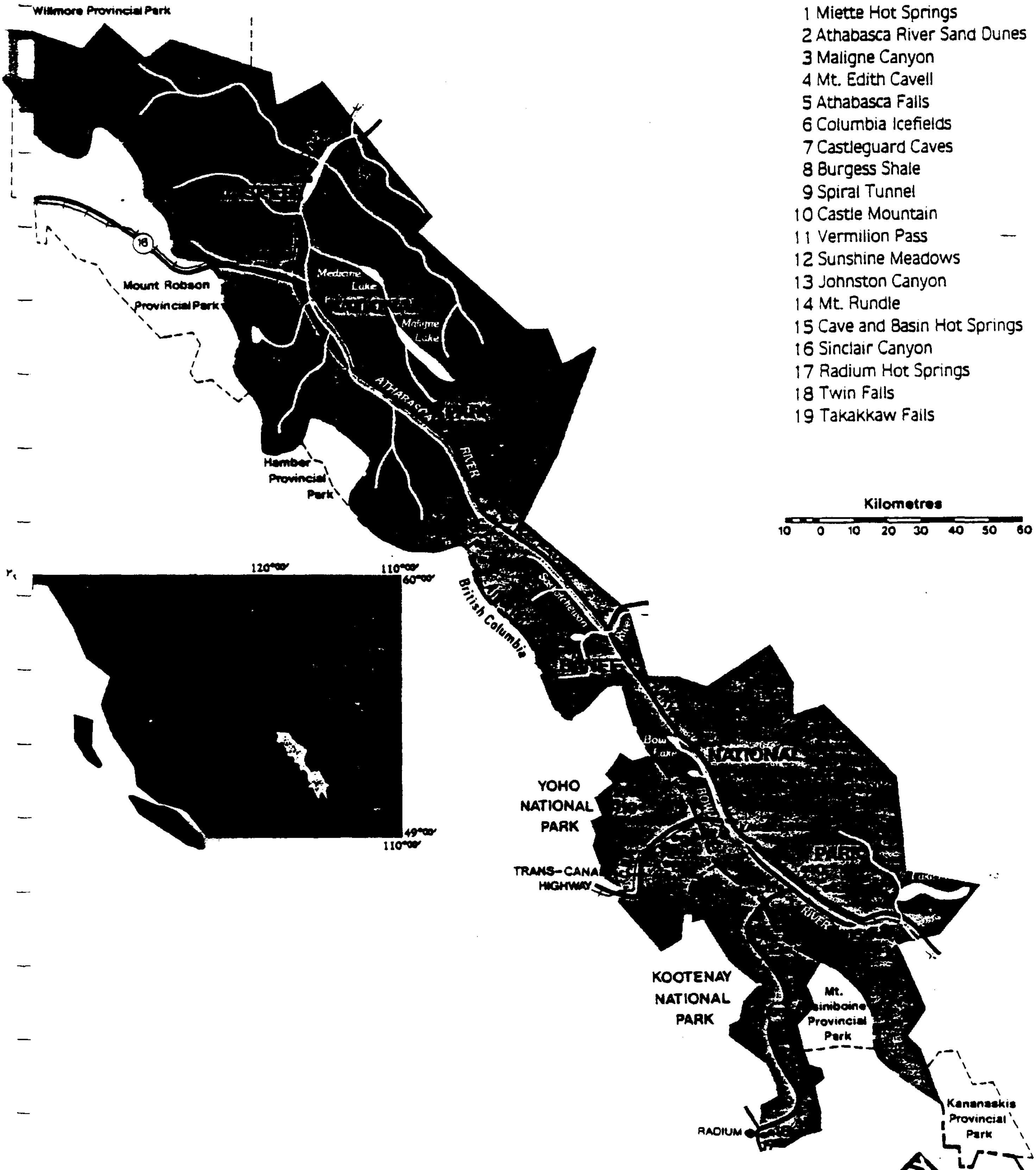
Rutter, P.W. and La Roi, G.H. (1970). The Douglas fir forests of Banff and Jasper National Parks, Canada. Canadian Journal of Botany 48: 1703-1726.

Scace, Robert (1973). Banff, Jasper, Kootenay and Yoho: an initial bibliography of the contiguous Canadian Rocky Mountain National Parks.

DATE Revised 1987, updated October 1989

0248U

THE CANADIAN ROCKIES



BANFF JASPER KOOTENAY YOHO

Convention concernant la protection du Patrimoine mondial, culturel et naturel

PROPOSITION D'INSCRIPTION SUR LA LISTE DU PATRIMOINE MONDIAL

Nom : LES ROCHEUSES CANADIENNES

N° d'ordre : 304 Date de réception par le Secrétariat : 23.12.83

Etat partie ayant présenté la proposition d'inscription du bien conformément à la Convention : CANADA

Résumé établi par l'UICN (mars 1984) à partir de la proposition d'inscription présentée par le Canada. Le document original et toutes les informations communiquées à l'appui de cette proposition d'inscription pourront être consultés aux réunions du Bureau et du Comité.

---

1. LOCALISATION : Provinces de l'Alberta et de la Colombie britannique (Canada).

2. DONNEES JURIDIQUES :

Propriété du Gouvernement canadien, ce bien est officiellement administré par Parcs Canada en vertu de la loi sur les parcs nationaux. Une réserve, embryon de ce qui allait devenir le Parc national de Banff, a été créé en 1885. Elle couvrait 26 km2 autour des sources thermales de Banff ; avec les terres qui lui ont été ajoutées, le parc atteint actuellement la superficie de 6.641 km2. Le Parc national de Yoho a été créé en 1886 et représente maintenant une superficie de 1.313 km2. A Jasper, les premières mesures ont été prises en 1907 et le parc atteint aujourd'hui 10.878 km2 Le Parc de Kootenay, qui a été créé en 1930, couvre actuellement 1.378 km2.

3. IDENTIFICATION :

Il s'agit de quatre parcs nationaux contigus - Banff, Jasper, Kootenay et Yoho - d'une superficie totale de 20.210 km2. Considérés globalement, ces quatre parcs présentent les caractéristiques naturelles les plus exceptionnelles de la Province biogéographique "Montagnes Rocheuses". Cette région est extrêmement accidentée, en grande partie intacte et montagneuse avec de nombreux pics dépassant 4.000 mètres et un relief atteignant en moyenne 2.135 m. Les formations géologiques se composent de roches sédimentaires extrêmement faillées, plissées et soulevées. Les quatre divisions géologiques de la chaîne des montagnes Rocheuses sont représentées dans ces parcs. On trouve plusieurs champs de glace et des centaines de vestiges de glaciers de vallée. Lacs glaciaires, nombreuses chutes d'eau, systèmes complexes de grottes calcaires, gisements de fossiles, canyons profondément encaissés, sources thermales et rivières souterraines sont autant d'autres caractéristiques physiques. Les quatre parcs longent la ligne de partage des eaux qui marque le point hydrographique culminant de l'Amérique du Nord séparant les bassins versants drainant respectivement les eaux vers les océans Arctique, Pacifique et Atlantique.

La zone a le climat continental de la partie ouest de l'intérieur de l'Amérique du Nord, avec des hivers longs et froids et des étés courts et frais. Elle subit l'influence de grandes masses d'air formées dans le Pacifique et dans l'Arctique. Le relief montagneux a une forte incidence sur le microclimat. Les températures diurnes moyennes de janvier et de juillet sont respectivement de -12,7°C et 15,6°C. La moyenne annuelle de précipitations totales varie de 380 mm à basse altitude à 1.250 mm le long de la ligne de partage des eaux.

L'altitude détermine trois zones de végétation : montagneuse, sub-alpine et alpine. Ces zones comportent des marécages, des dunes, de grandes forêts de conifères et des prairies alpines. A peu près le tiers de l'ensemble de la zone se compose de roche nue sans végétation, de matériau colluvial, de glaciers et de champs de neige permanents.

La faune typique des montagnes Rocheuses comporte 56 espèces de mammifères, 280 espèces d'oiseaux et 8 espèces d'amphibiens et de reptiles. Il existe encore une population d'environ 200 grizzlis. Une espèce est classée comme vulnérable dans le "Red Data Book" de l'UICN : le loup gris.

Des lieux isolés témoignent de la présence d'Indiens d'Amérique du nord à partir de 20.000 av. J.C. L'exploration européenne commença avec le commerce des fourrures dès les années 1800 et s'est rapidement développée avec la construction des voies de transport intercontinentales qui ont traversé cette zone. En 1885 fut créée, près des sources thermales de Banff, une réserve qui est devenue le Parc des montagnes Rocheuses en 1887.

Le développement des moyens d'accès et des équipements - chemins de fer, routes transcontinentales à quatre voies, agglomérations urbaines et aires de ski alpin - permet à quelque neuf millions de visiteurs par an de profiter du site. Les deux agglomérations de Banff et de Jasper comptent environ dix mille résidents permanents Huit parcs provinciaux et zones de nature protégée ("wilderness") jouent le rôle de zones tampons protégeant les terres fédérales.

4. <u>ETAT DE PRESERVATION OU DE CONSERVATION</u> :

L'exploitation minière et forestière et la chasse étaient autorisées dans la zone avant la Première Guerre mondiale et un projet de production d'hydro-électricité a été réalisé après la guerre. Depuis, l'exploitation des ressources s'est limitée à l'élimination occasionnelle des excédents de populations d'herbivores et à la coupe de bois d'oeuvre.

Si le tourisme et les moyens de transport sont bien développés, environ 90 % de l'ensemble du bien demeure à l'état sauvage, intact, accessible seulement à pied ou à cheval. Les projets de mise en valeur sont soumis au Federal Environment Review Assessment Process, qui a étudié les incidences des projets de construction routière et ferroviaire.

Les quatre parcs constituent globalement une unité et, s'ils relèvent chacun d'un service administratif distinct, ils sont coordonnés par un bureau régional. Un plan de gestion est en préparation pour chaque parc et sera achevé en 1985. Au total, les quatre parcs disposent de 750 années-hommes de personnel et de 17 millions de dollars des Etats-Unis.

5. <u>JUSTIFICATION DE L'INSCRIPTION SUR LA LISTE DU PATRIMOINE MONDIAL</u> :

La proposition présentée par le Gouvernement canadien, visant à l'inscription des Rocheuses canadiennes sur la Liste du Patrimoine mondial invoque les critères suivants
<u>Bien naturel</u>

(i) Histoire de l'évolution de la terre. La zone englobe le site de Burgess Shal qui a été inscrit sur la Liste du Patrimoine mondial en 1981 et est considéré comme l'un des gisements de fossiles les plus importants du monde.

(ii) Processus géologique en cours. Le site illustre la gamme complète des caractéristiques et processus relatifs à la glaciation : champs de glace, cirques glaciaires, moraines, vallées suspendues, stries et stades pionniers de la succession végétale.

(iii) Beauté naturelle exceptionnelle. Les Rocheuses canadiennes sont réputées pour la beauté spectaculaire de leurs paysages et attirent des millions de visiteurs

(iv) Habitats d'espèces rares ou menacées d'extinction. Une végétation variée et des habitats intacts abritent une faune et une flore sauvages typiques. Une espèce est classée comme vulnérable.

PROPOSITION D'INSCRIPTION SUR LA LISTE DU PATRIMOINE MONDIAL

EVALUATION TECHNIQUE PAR L'UICN

304 ROCHEUSES CANADIENNES (CANADA)

1. DOCUMENTATION

i) Formulaire de proposition d'inscription et carte
ii) Fiches signalétiques de l'UICN pour les parcs nationaux de Banff, Jasper, Kootenay et Yoho
iii) Consultants : M. V. Geist, M. J. Marsh
iv) Documents consultés : nombreuses références citées dans les fiches signalétiques

2. COMPARAISON AVEC D'AUTRES REGIONS

Il s'agit du plus grand ensemble de parcs nationaux situés dans la province biogéographique "Montagnes rocheuses" d'Amérique du Nord. La combinaison des phénomènes naturels et du paysage exceptionnel qui y sont contenus est inégalée dans la province. Plusieurs éléments d'une importance particulière ne se retrouvent nulle part ailleurs (Burgess Shales, Castleguard Caves, Columbia Icefield et Maligne Valley). Historiquement, le site contient la zone de Banff qui a été le premier parc national du Canada. La zone diffère considérablement de l'autre site de la région des Montagnes rocheuses inscrit sur la Liste du Patrimoine mondial, le Parc national de Yellowstone, qui est essentiellement un plateau volcanique présentant de nombreux phénomènes thermaux. On trouve d'autres zones comparables dans les blocs montagneux du nord de l'intérieur de la Colombie britannique, mais aucune ne présente l'ensemble de caractéristiques que comporte le site proposé, ni ne bénéficie du degré de protection associé au statut de parc national.

3. INTEGRITE

Le site est traversé par d'importantes rivières qui y prennent leur source et, grâce à son immense superficie, aux zones tampons qui constituent les parcs provinciaux et à la diversité de ses habitats, il présente un haut degré d'intégrité écologique. Les limites politiques sont stables et peu susceptibles d'être modifiées.

Des pâturages d'hiver situés à l'extérieur de la limite orientale de la zone sont utilisés par les populations d'ongulés du parc. Si la chasse, en tant que sport, de ces animaux sur leurs parcours d'hiver est pratiquée, elle ne constitue pas un facteur de raréfaction grave. Plus dangereux sont les programmes d'empoisonnement périodiques appliqués par les éleveurs locaux, qui ont réduit les populations de loups, ainsi que d'autres espèces non visées par l'opération. En bordure des limites occidentales du bien, de grands projets d'exploitation forestière et de construction d'ouvrages hydrauliques sont en cours d'exécution, ce qui facilite l'accès à certaines zones de nature protégée des parcs.

Les parcs comptent un certain nombre de sites qui ont été considérablement modifiés à des fins de tourisme ou de transport. Ces sites se trouvent dans des zones d'exploitation intensive et font l'objet de procédures complexes d'évaluation de l'environnement. Le bien demeure constitué, à plus de 90 %, de terres sauvages naturelles intactes.

4. OBSERVATIONS SUPPLEMENTAIRES

(a) Inclusion du site des schistes de Burgess. Ce phénomène naturel peu étendu fait partie de la zone considérée, bien qu'il figure sur la Liste du Patrimoine mondial depuis 1978. Le site lui-même est une zone très limitée du Parc national de Yoho et constitue un des phénomènes naturels uniques parmi les nombreuses caractéristiques invoquées dans la proposition d'inscription des Rocheuses canadiennes.

(b) Portée de la proposition d'inscription. Si le site proposé est d'une superficie considérable (quatre sites seulement de la Liste du Patrimoine mondial sont plus grands), il faut noter qu'il ne comprend que les terres des parcs nationaux fédé ıL Plusieurs des caractéristiques les plus exceptionnelles des Rocheuses canadiennes (par exemple le Mont Robson, le Mont Assiniboine, les lacs Kananaskis, Fortress et Cummins, et une grande partie de Columbia Icefield) se trouvent dans des terres provinciales contiguës aux parcs nationaux.

Si Parcs Canada s'est mis en contact avec les autorités provinciales, l'inclusio de ces zones supplémentaires n'a pas été prise en considération. En conséquence, plusieurs des éléments les plus caractéristiques des montagnes Rocheuses canadiennes ne figurent pas dans la proposition d'inscription.

5. EVALUATION

La proposition d'inscription des Rocheuses canadiennes, y compris les quatre parcs nationaux contigus, signale la majorité des principales caractéristiques physiques et biologiques de la province biogéographique "Montagnes rocheuses". On y trouve des exemples typiques des processus géologiques glaciaires (critère ii), ainsi que des paysages d'une beauté naturelle exceptionnelle (critère iii). Par l'inclusion du site des fossiles des schistes de Burgess dans le bien, celui-ci répond aussi au critère (i). Des plans de gestion pour chaque parc sont actuellement en cours d'élaboration et l'ensemble de la zone fait l'objet d'une politique de gestion efficace.

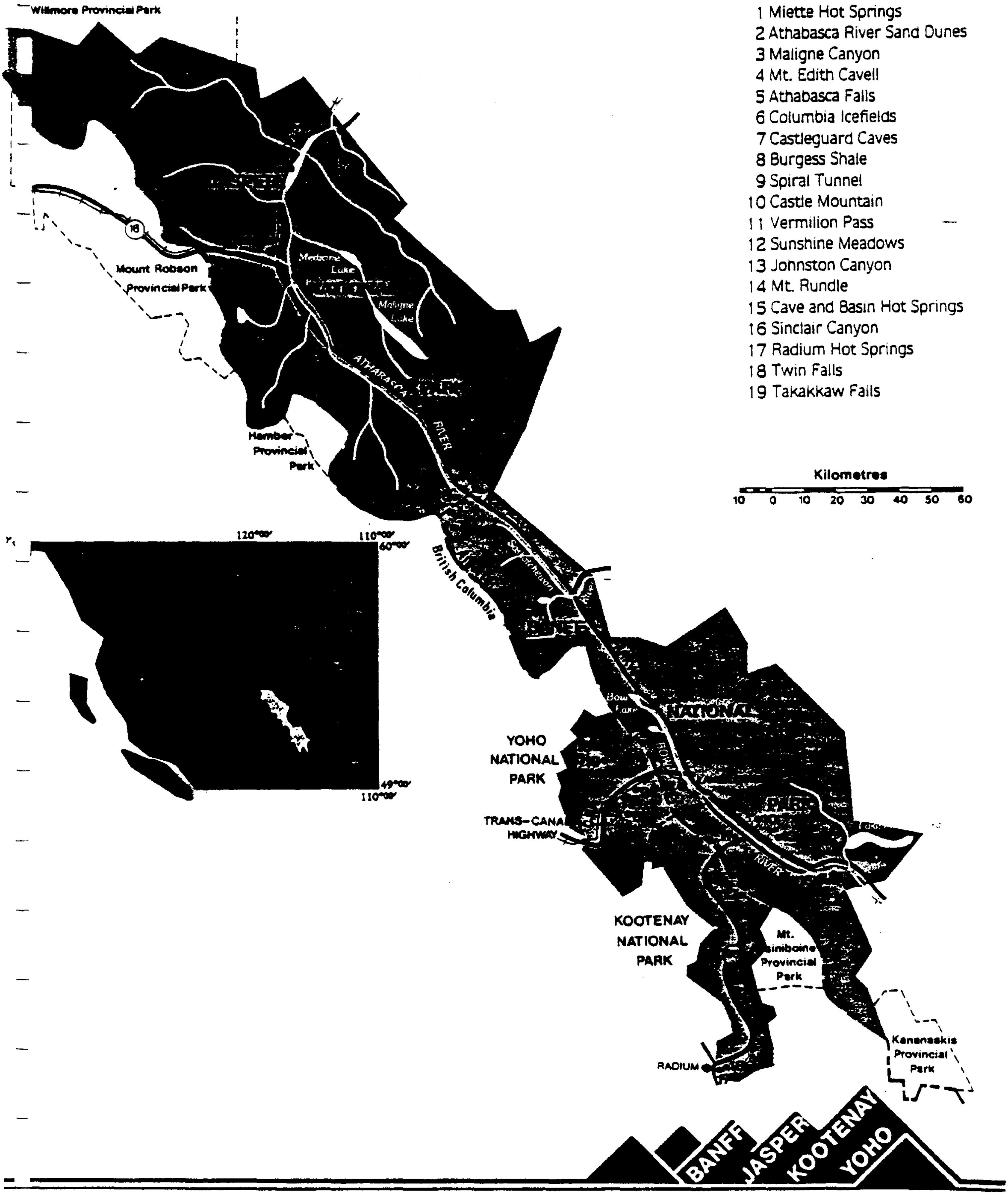
6. RECOMMANDATION

Le site répondant à trois critères justifiant son inscription sur la Liste du Patrim mondial, il doit y être inscrit. Le Comité souhaitera peut-être inviter les autorité canadiennes à envisager d'ajouter au site plusieurs des terres provinciales adjacentes particulièrement remarquables, telles qu'elles sont décrites au 4(b) ci-dessus. L'UI recommande en plus que, dans le cas où la proposition d'inscription serait acceptée, le site de Burgess Shale soit incorporé au bien des Montagnes rocheuses. Il faudra, pour ceci, avoir l'accord du Gouvernement Canadien sur le nom du bien, lequel pourra se lire: "Les Rocheuses Canadiennes, comprenant le site de Burgess Shale".
/Parcs montagneux des]

UNION INTERNATIONALE POUR LA CONSERVATION DE LA NATURE ET DE SES RESSOURCES — UICN

J Thorsell

THE CANADIAN ROCKIES



1 Miette Hot Springs
2 Athabasca River Sand Dunes
3 Maligne Canyon
4 Mt. Edith Cavell
5 Athabasca Falls
6 Columbia Icefields
7 Castleguard Caves
8 Burgess Shale
9 Spiral Tunnel
10 Castle Mountain
11 Vermilion Pass
12 Sunshine Meadows
13 Johnston Canyon
14 Mt. Rundle
15 Cave and Basin Hot Springs
16 Sinclair Canyon
17 Radium Hot Springs
18 Twin Falls
19 Takakkaw Falls

Kilometres
10 0 10 20 30 40 50 60