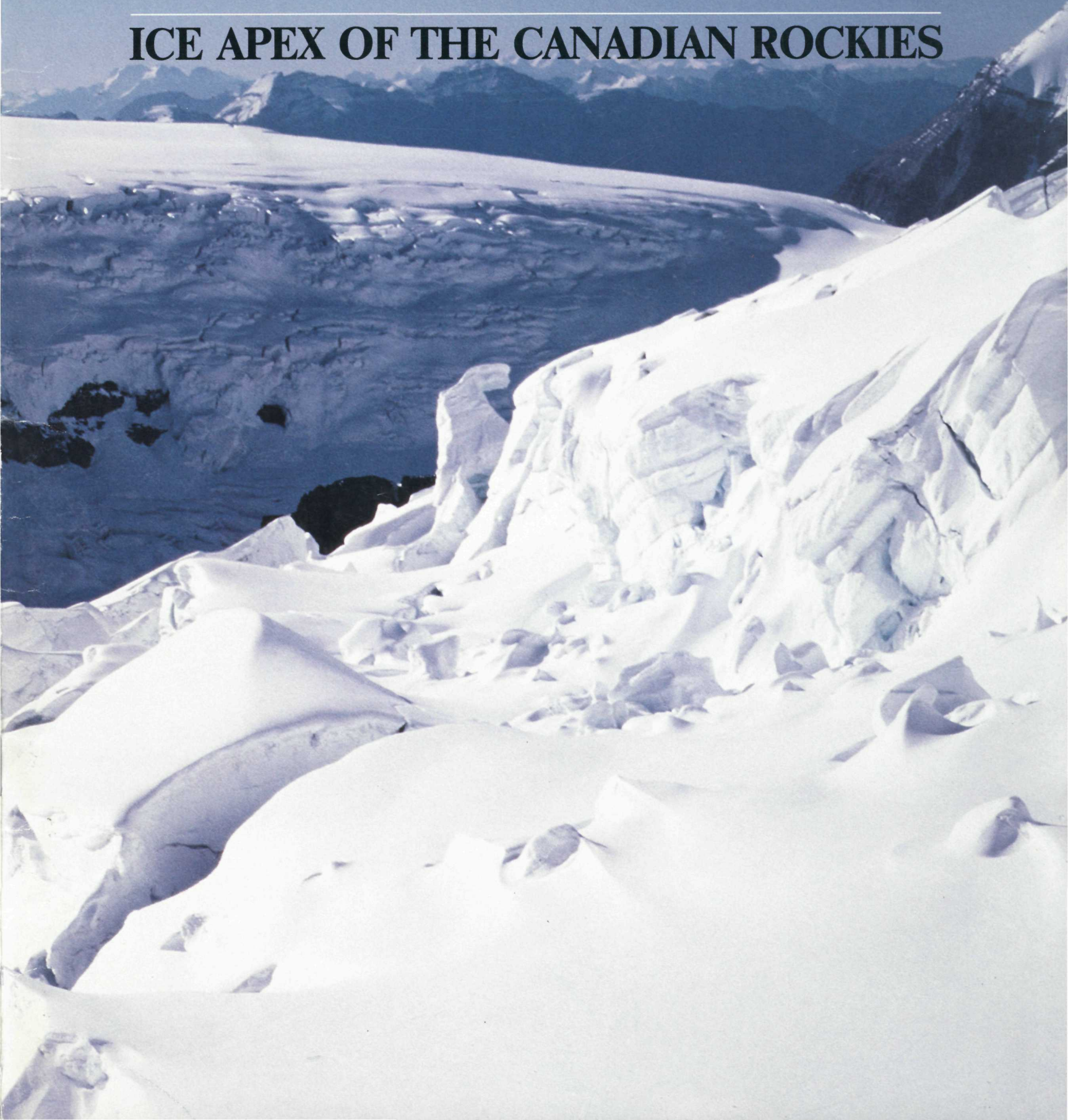

COLUMBIA ICEFIELD

ICE APEX OF THE CANADIAN ROCKIES





PREFACE

In the hour before a midsummer dawn, a light snowfall settles on the Columbia Icefield and its glaciers. The valleys below – the Sunwapta, North Saskatchewan, Castleguard, Athabasca, Alexandra and Bush – are silvered by moonlight, while the icefield above is covered in cloud. Bighorn sheep doze on the slopes of Wilcox Peak.

The pre-dawn stillness is broken by the groaning and pinging of moving ice at the edge of the Athabasca Glacier and by the shattering crash of a collapsing ice slab. Rocks and ice clatter across the moraine below until the frosty stillness settles once more on this land of ice and rock. Save for the slow trickling of the last of yesterday's meltwater, all is silent.

As the sky lightens and pink alpenglow catches the summit of Mount Athabasca, a cold breeze blows from the icefield, over the glaciers and down the valleys, hissing in the branches of stunted spruce and fir.

By noon, as the sun's warmth becomes noticeable in the valleys below the Columbia Icefield, another change is afoot. At dawn, the small creeks barely gurgled with run-off; now they flow with gathering strength. The snow on the surface of the

icefield and its glaciers has begun to melt and the glacier ice itself releases more water. Even high on the icefield, the sun is at work and the sound of running water is heard. Cracks and millwells swallow the icy streams. Through turquoise channels, water plunges into the depths of the glaciers and finds its way to hidden rivers beneath.

Slowly at first, then building through the afternoon, the headwaters of the Athabasca and North Saskatchewan rivers swell with silt-laden meltwater. Water thunders, silt hisses, and gravel and boulders clatter along the stream beds. Snow avalanches, chunks of ice and slabs of stone crash regularly to the surface of the icefield and its glaciers.

For another brief day, in another brief summer, the Sunwapta Valley fills with the din and clamor of glaciers at work.

Evening comes, the temperature drops and the roar of melting water lessens. Beneath the rising moon the ancient ice is barely touched by the passing of a day. Time in the ice is different from the time we know. Glaciers have flowed from the Columbia Icefield for three million years. A day, a year, even a century is barely a single chapter in the age-old story of ice and rock.

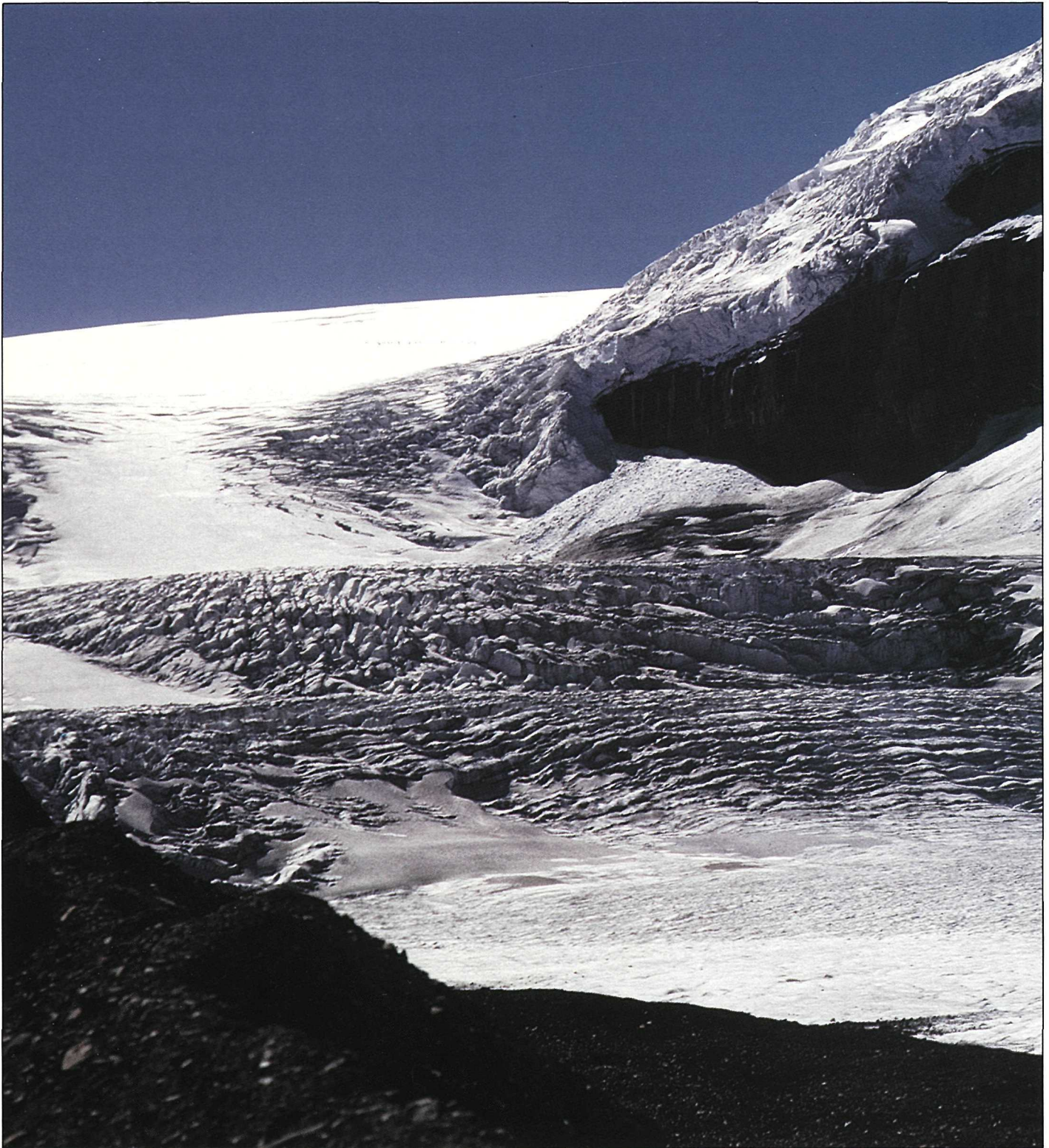
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TIME IN THE ICE

1



THE PAST

The Columbia Icefield and the glaciers it feeds, massive and awe-inspiring as they are, are mere remnants of what they were 40,000 years ago at the peak of the Wisconsin glaciation. Then, the Rocky Mountains were blanketed by moving ice. Only the highest peaks protruded like rocky islands in a sea of snow and ice. The valleys through which we travel today were filled with massive glaciers, flowing eastward to join continental ice sheets that covered most of Canada and the northern United States.

The Wisconsin glaciation was only one of several major ice advances during the Pleistocene epoch, which began two million years ago and continues today. Indeed, the ice may advance again, as it did 500 years ago with the onset of the Little Ice Age. The peak of the Little Ice Age occurred around

1750, about the time Anthony Henday of the Hudson's Bay Company first saw the shining mountains along the western horizon. The glaciers have since slowly retreated to the positions they now occupy.

The retreat of the Athabasca Glacier, one of the largest and most accessible glaciers to visitors in Banff and Jasper national parks, is marked by moraines and trimlines in the Sunwapta River Valley. Its toe has retreated almost two kilometres (1.2 miles) since 1750.

Including the Pleistocene epoch, there have been at least seven ice ages during the earth's history. Each time, the climate cooled and precipitation increased, snowfields grew to become icefields and glaciers advanced across the landscape. Each time, too, the ice has retreated in the face of a warming climate, leaving the earth raw and re-arranged.

THE PRESENT

Today, glacier ice remains only in the highest mountains and polar ice cap regions. Most of the icefields and glaciers in the Rocky Mountains linger among the peaks of the Continental Divide. More snow falls each year along the divide than in the lower mountains to the east

and west. In these high mountains the air is cool, and snow and ice melt slowly.

Many of the glaciers in Banff and Jasper are retreating. A few, such as the Columbia Glacier, which flows from the northwest corner of the Columbia Icefield, are advancing.

THE FUTURE

Whether the Columbia Icefield will one day disappear altogether in the face of a warming climate, or whether the glaciers will again advance to cover the landscape with ice hundreds of metres thick, is a mystery. Scientists studying glaciers agree that the factors that cause the ice to come and go are too complex to allow them to predict the future.

There is growing speculation, however, that the future of the earth's climate – and thus, the future of the great glaciers of the world – will be influenced by

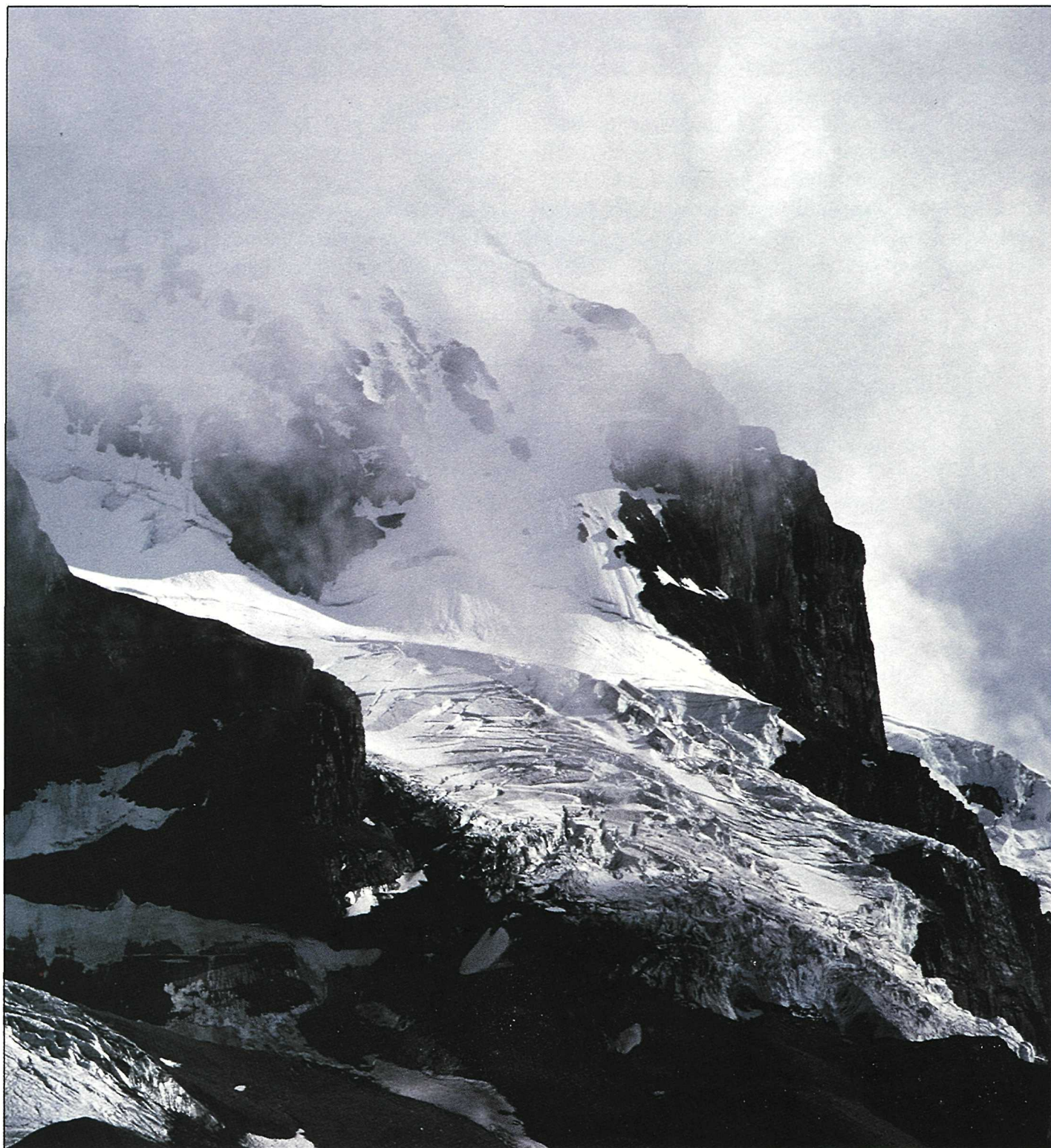
man's activities. As fossil fuels are burned and tropical forests cut down, a greenhouse effect may result, filling the atmosphere with carbon dioxide and other gases which hold the sun's heat and warm the atmosphere. On the other hand, increased cloud and haze may reflect the sun's heat and cool the atmosphere, spawning a new ice age. Man's use of the earth and its resources will doubtless effect the climate of the future, but exactly how is impossible to predict.



Largest of all icefields in the Canadian Rockies, the Columbia Icefield is guarded by 11 of the Rockies' 22 highest peaks. Here, perennial snows accumulate and turn to ice which flows to feed six major outlet glaciers, three of Canada's largest rivers and, eventually, three oceans. The ice straddles the Continental Divide, two provinces, and two national parks.

THE DYNAMICS OF ICE

2



THE WEATHER

THeavy-laden with moisture from its long sweep across the Pacific Ocean, the wind flows inland and rises to cross the mountain chains of Western Canada. Each time the wind lifts, it cools and clouds form, shedding rain and snow.

The Columbia Icefield receives more snow than most parts of the Rocky Mountains because it is surrounded by the highest collection of peaks on the Continental Divide. A high plateau enclosed by some of the tallest mountains in the Rockies and covering more than 300 square kilometres cradles the icefield, blocking the moist air systems from the west. As storm clouds rise to cross this barrier, they release more snow than falls anywhere for hundreds of kilometres to the north and south – at least 10 metres of snow each year.



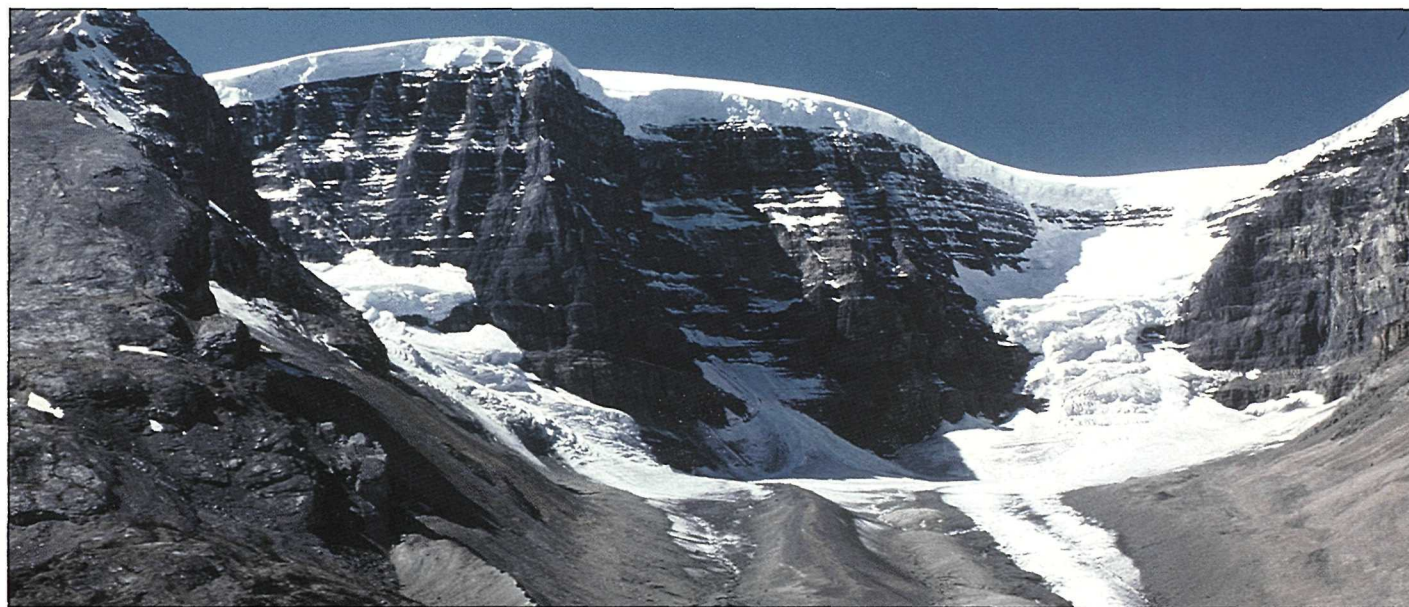
Snow may fall any time of the year in the icefield area.

ICE CRADLE

In most parts of the Rockies, steep slopes shed snow before it becomes deep enough to turn into ice. There are few places where snow does not fall away in avalanches or melt each spring; these are the places where glaciers grow.

For glacier ice to form there must be a ledge or relatively flat place where snow can accumulate. It must be a cold place where snow can build faster than it melts. The plateau that supports the Columbia Icefield is such a place.

The icefield rests on a massive mountain block about 20 kilometres square, eroded at the edges into deeply-incised valleys separated by mountains. The edges of this block can be seen in the cliffs that overshadow the Icefields Parkway from the Big Bend to Beauty Creek Flats. Unseen by the traveller on the Icefields Parkway, hidden by the massive walls of Mounts Athabasca, Kitchener, Stutfield, The Twins, Columbia and Snow Dome, the Columbia Icefield is cradled upon a high, frozen plateau.



Only the edge of the icefield is visible from the Icefields Parkway.

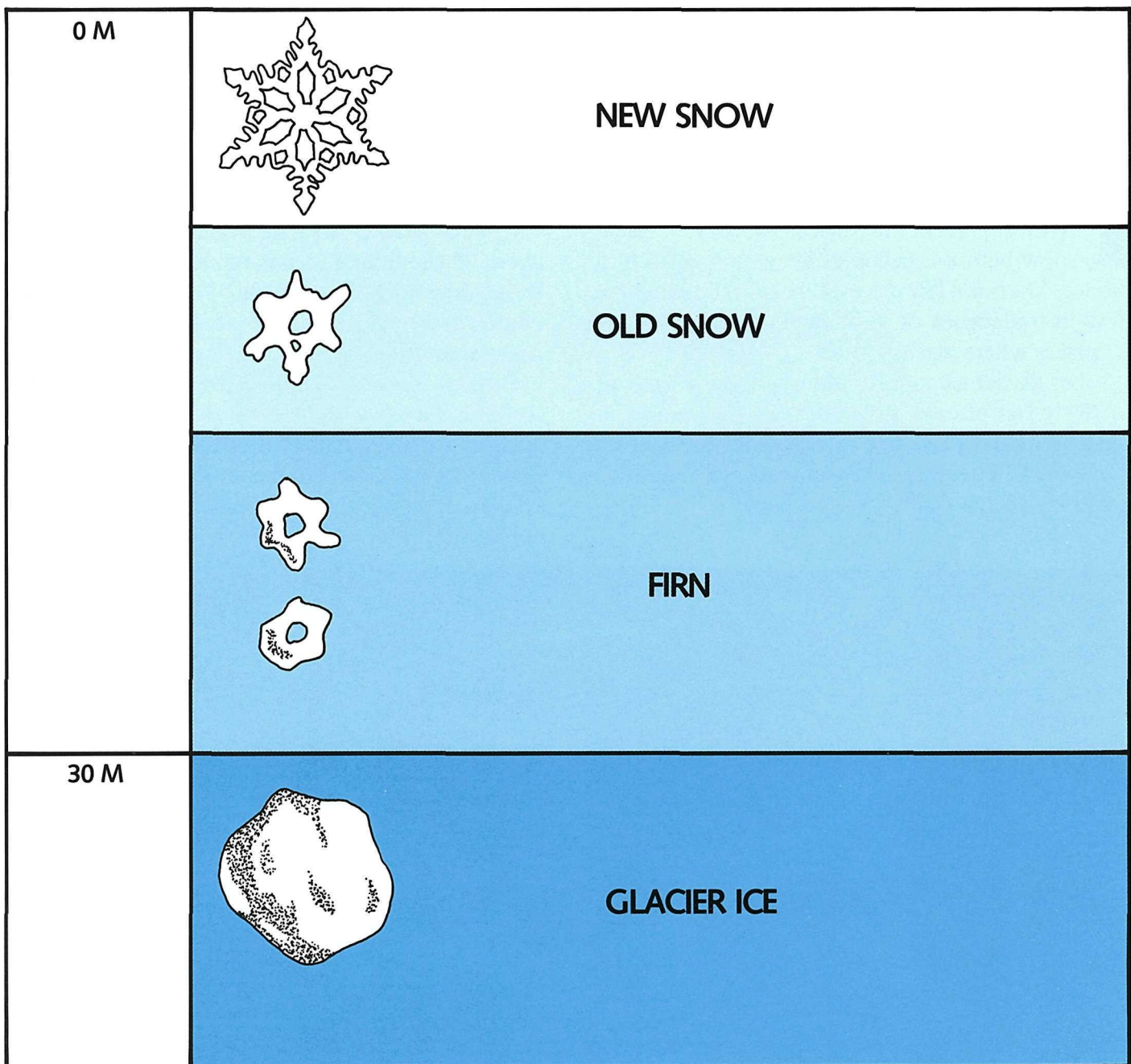
ICE FROM SNOW

All glaciers begin as snow. Snowflakes accumulate and gradually become grains, then ice crystals and finally ice.

As snow particles age, they change from flakes to grains because of the natural tendency of crystals to rearrange themselves into a more circular form. As the grains are compacted by the weight of more layers of snow, as meltwater trickles down and refreezes between the crystals, and as air is slowly squeezed out of the snow mass, it gradually becomes ice. This process is not unique to glaciers. Snow on city

sidewalks becomes ice by a similar process, under the constant trampling of feet.

For pressure to turn snow to glacier ice in the mountains, at least 30 metres of snow must accumulate in one place. It takes many years for so much snow to build up in the Canadian Rockies. Only in places that are high and level enough to catch and keep snow year after year will glacier ice form. The only other requirement is that there be somewhere for the ice to flow, for it is not a glacier unless the ice moves.



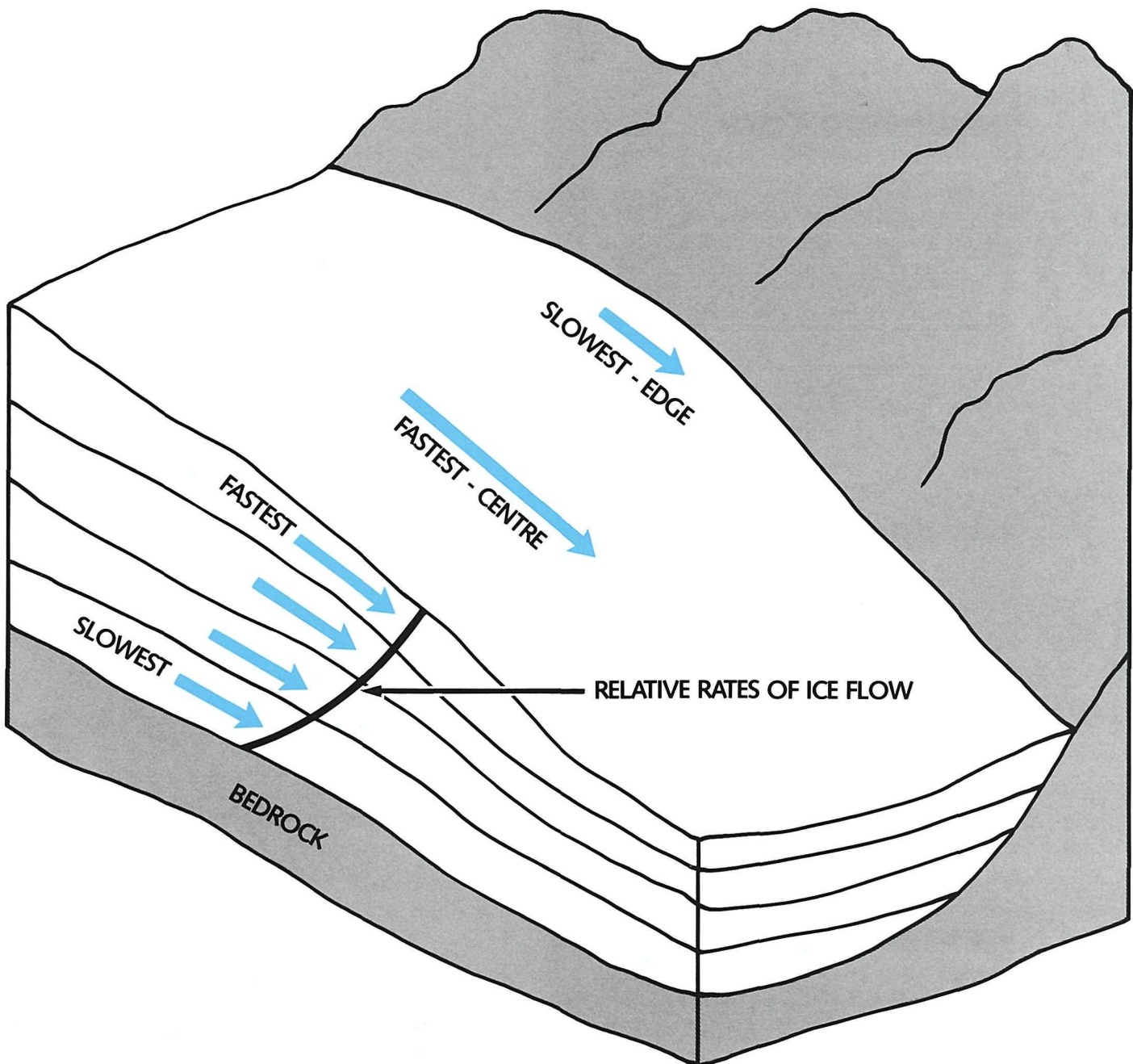
HOW GLACIERS MOVE

Because of the crushing weight of the layers above, the ice deep in a glacier is flexible enough to bend, stretch and flow. This plasticity allows the ice to flow away from areas of accumulation, and to mold itself to the shape of the rock over which it flows.

A glacier, like a river, is contained by banks higher than its own surface. It flows generally downhill, spreading and thinning in wide areas and squeezing and deepening in narrow areas. Most glaciers, such as the Athabasca, are lobe-shaped

because of this tendency to spread at the toe where the ice thins and is released from confinement.

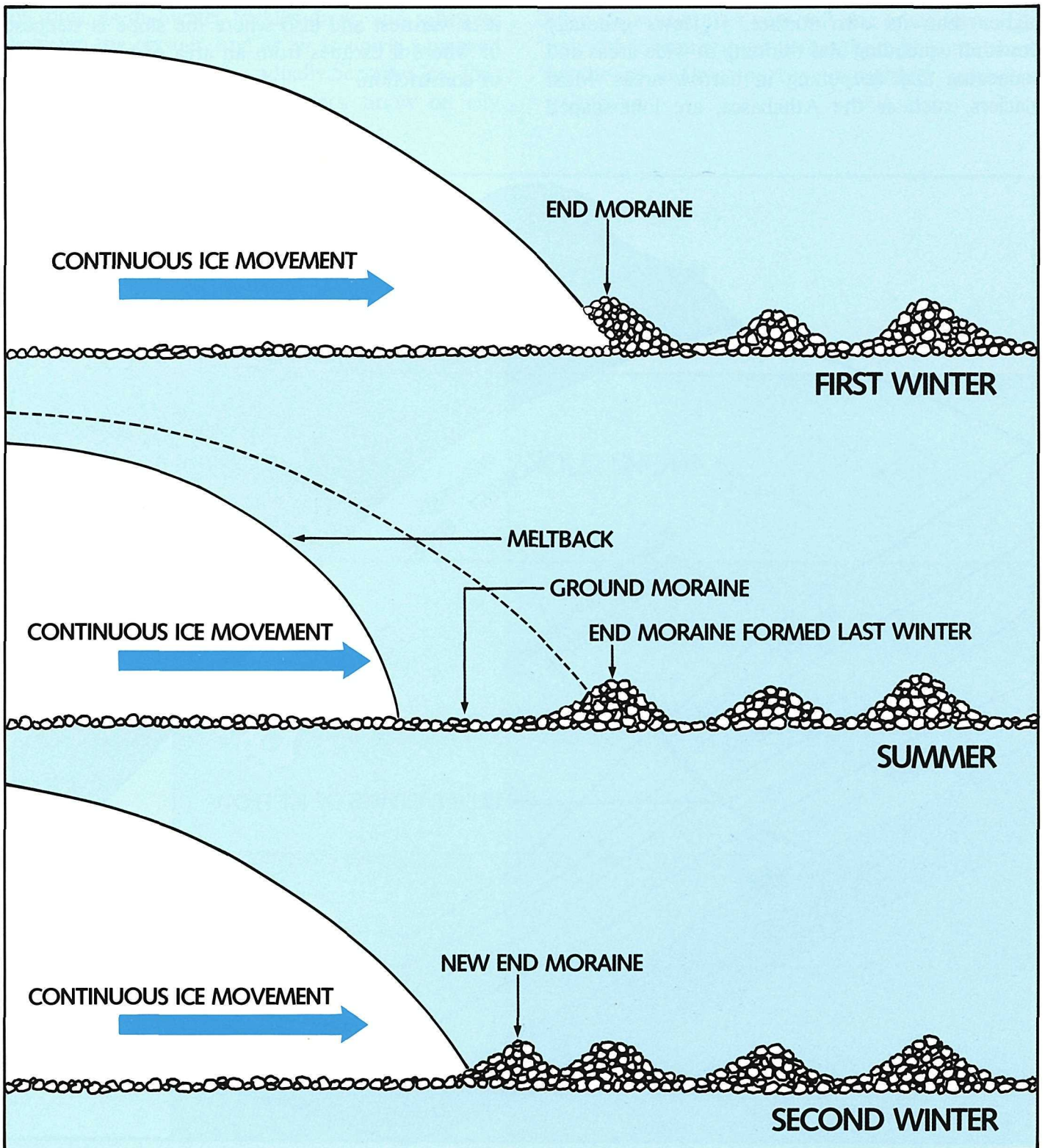
Friction with rock causes the ice at the sides and bottom of a glacier to flow more slowly than ice in the middle. The middle of the Athabasca Glacier flows at an average speed of 80 metres a year, or about one centimetre an hour. It flows faster in summer when it is warmest and also where the slope is steepest or where it escapes from an area of high pressure or constriction.



ADVANCES AND RETREAT

A If ice melts out of a glacier faster than it is replaced by new ice, the glacier shortens and thins. If, on the other hand, ice builds more quickly than it melts, the glacier gradually lengthens and thickens. However, whether the toe of a glacier is retreating or advancing during a period of time, the

glacier as a whole is always moving downhill and forwards. The Athabasca Glacier is an example of how a glacier can retreat even as its ice flows downhill. In 1976, the ice in the middle of the glacier flowed forward at least 35 metres, yet the glacier toe receded three metres.



THE FACE OF THE ICE

3

Rock and ice, wind and snow: at the Columbia Icefield the marks of the glaciers are freshly etched into the landscape. Only a few thousand years ago most of Canada was under ice, but in the years since the retreat of the great glaciers their marks have been

smoothed by erosion and covered by forests, fields and the works of man. Here, at the ice apex of the Canadian Rockies, the story of the Ice Age is still being written.



TYPES OF GLACIERS

Of the 10 major types of glacier in the world, classified by shape and position, five are visible at the Columbia Icefield.

MOUNTAIN ICE CAP

This type of glacier, of which the Columbia Icefield itself is a classic example, is a flat or gently sloping upland covered in ice; it may feed one or several outlet glaciers.

OUTLET VALLEY GLACIER

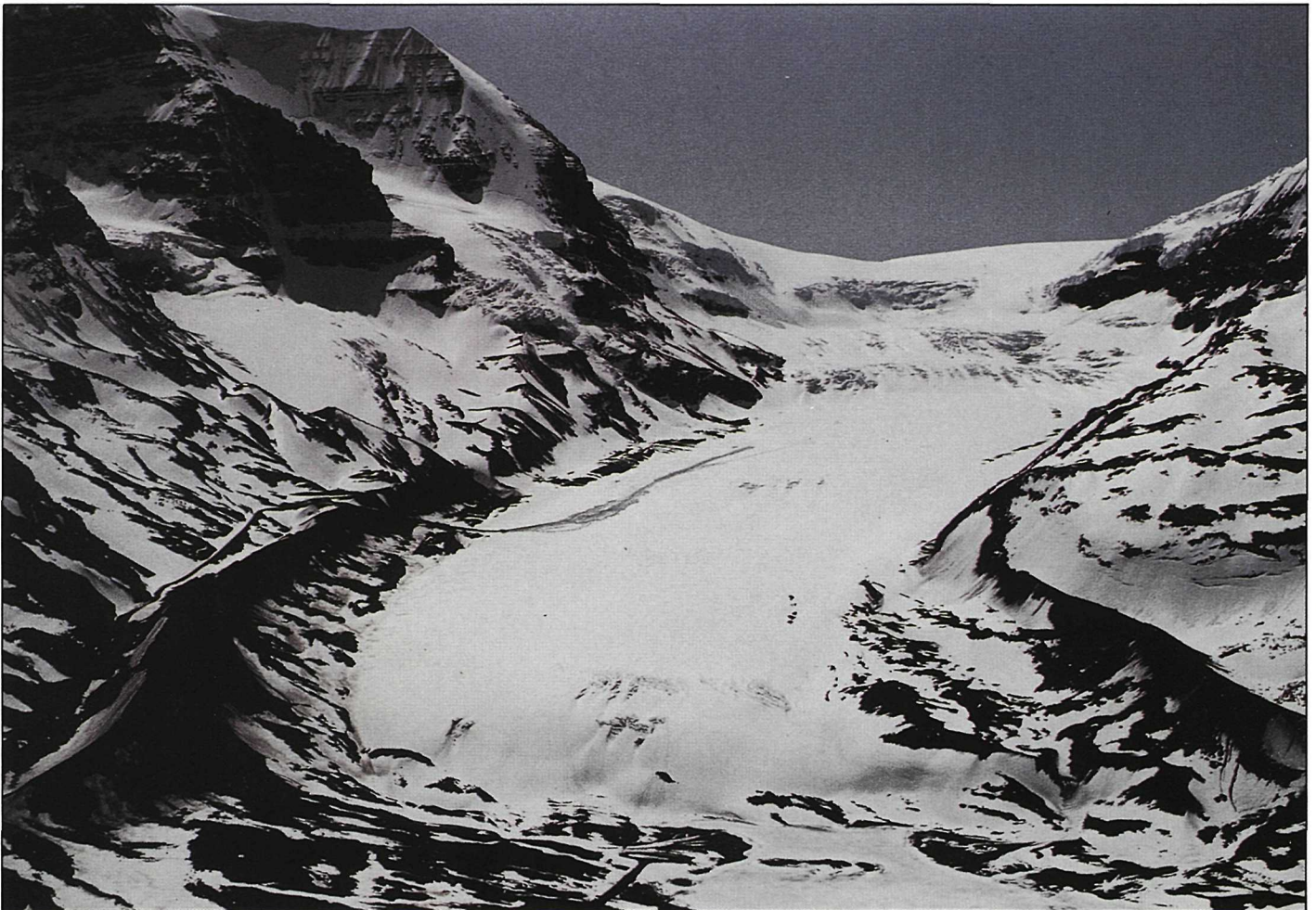
The glacial arms that radiate from the icefields along the Continental Divide are typical outlet glaciers, flowing down broad valleys.

CIRQUE GLACIER

These small, bowl-like glaciers occupy flat shelves on mountainsides and gradually shape an amphitheatre by carving back into the surrounding bedrock. Where several cirque glaciers encircle a mountain peak, they may chisel it into a tooth-like “matterhorn.”



The Columbia Icefield: a mountain ice cap.



The Athabasca Glacier: an outlet valley glacier.



A cirque glacier rests in the bowl it has carved.

ALPINE VALLEY GLACIER

Looking much like outlet glaciers, these small glaciers are not fed by icefields. They occupy high valleys where the ice accumulates in the same trough down which it flows.



Alpine glacier on Mount Athabasca.

NICHE GLACIER

Also called wall-sided or cliff glaciers, these are small glaciers that cling to gullies and niches on mountain faces. Because they conform closely to the shape of the rock they often have distinctive shapes.



Niche glaciers seem almost to hang from mountainsides.

GLACIAL FEATURES

Ice is neither fluid, like water, nor solid, like stone. The patterns and shapes that develop in flowing ice are unique to glaciers.

CREVASSES

Glacier ice can stretch, but only to a certain point. Beyond that limit it cracks and crevasses form. The lower layers of a glacier's ice are more plastic than the surface, so most crevasses on the Athabasca Glacier are less than 30 metres deep, confined to the brittle upper ice. Crevasses may be caused by ice flowing over bedrock irregularities, dragging against the rock walls of the adjacent mountains, or flowing at different rates in some parts of the glacier than in others.

Transverse Crevasses: these run across the glacier from one side to the other. They occur most often where the ice drops over a step or cliff of bedrock. Since ice flows fastest at the centre of the glacier, transverse crevasses often curve toward the toe of the glacier.

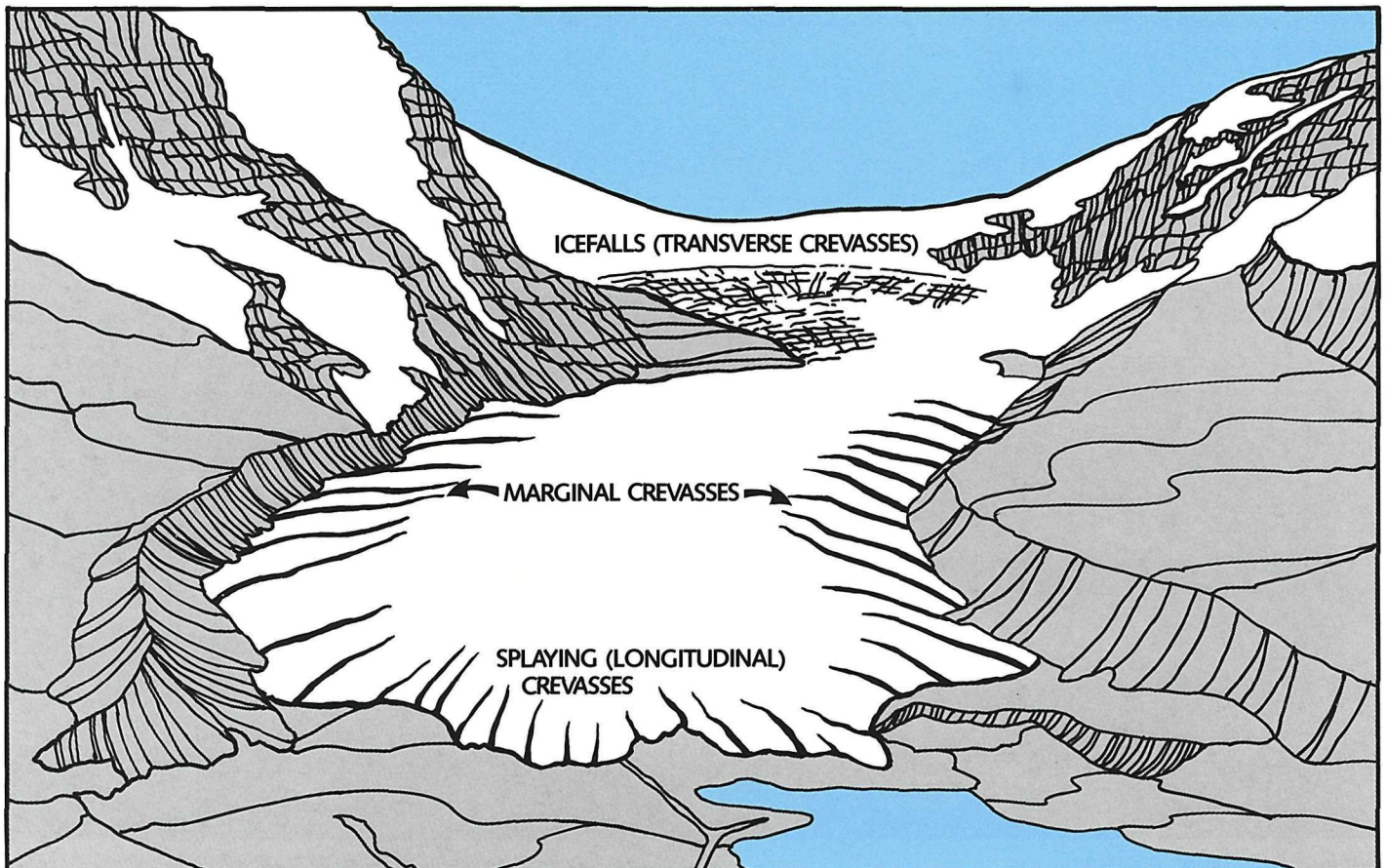
Chevron (or Marginal) Crevasses: at the edges of the glacier, friction with adjacent rock creates crevasses at regular intervals that trend up-glacier

without meeting at the middle.

Radial (or Splaying) Crevasses: glacier ice spreads out at the toe of the glacier, creating crevasses that slice back into the glacier; these expose more ice surface to the air and hasten melting.

ICEFALLS

Glaciers mold themselves to the underlying bedrock. Where a glacier flows over a cliff, distinct bands of crevasses across the face of the glacier mark



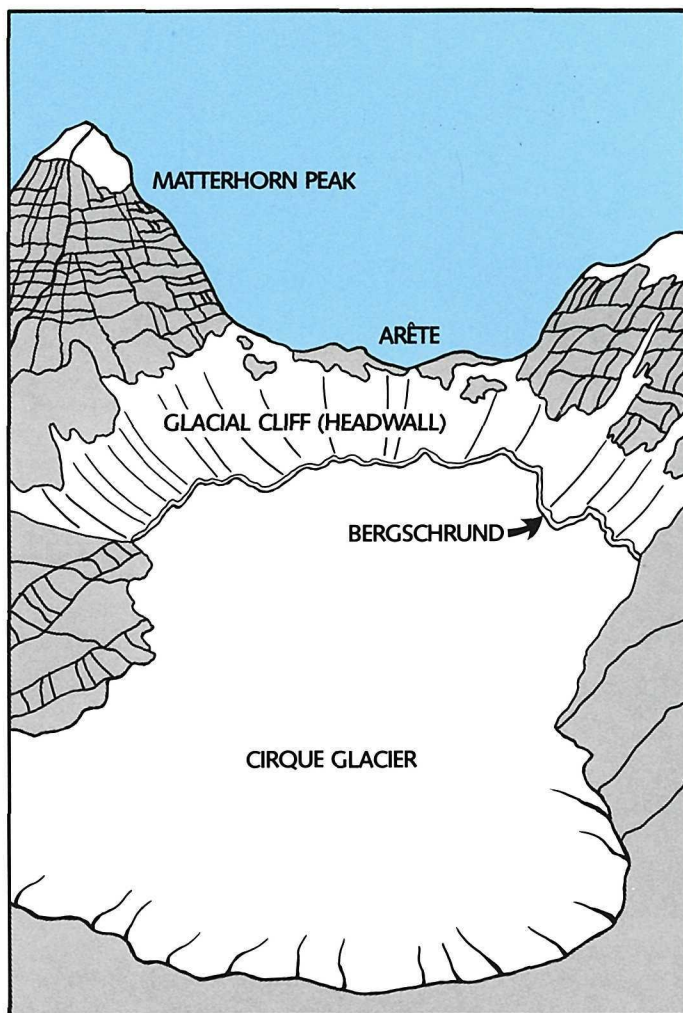
the icefall. As the glacier ice flows, the old crevasses close up and new ones form above, so that the icefall remains in the same location.

OGIVES

As crevasses in an icefall open in the summer, the ice is exposed to the sun and the air trapped in the ice is released at the same time as dust and silt become imbedded in the ice. Crevasses that open in the winter become filled with snow which is full of air bubbles. The result is that ice flowing out of icefalls and other active crevasse areas has alternating dark and light bands. Since the dark ice melts faster than the light, ogives may develop into a washboard surface lower down the glacier.



Ogives in the Columbia Glacier, seen from the air.

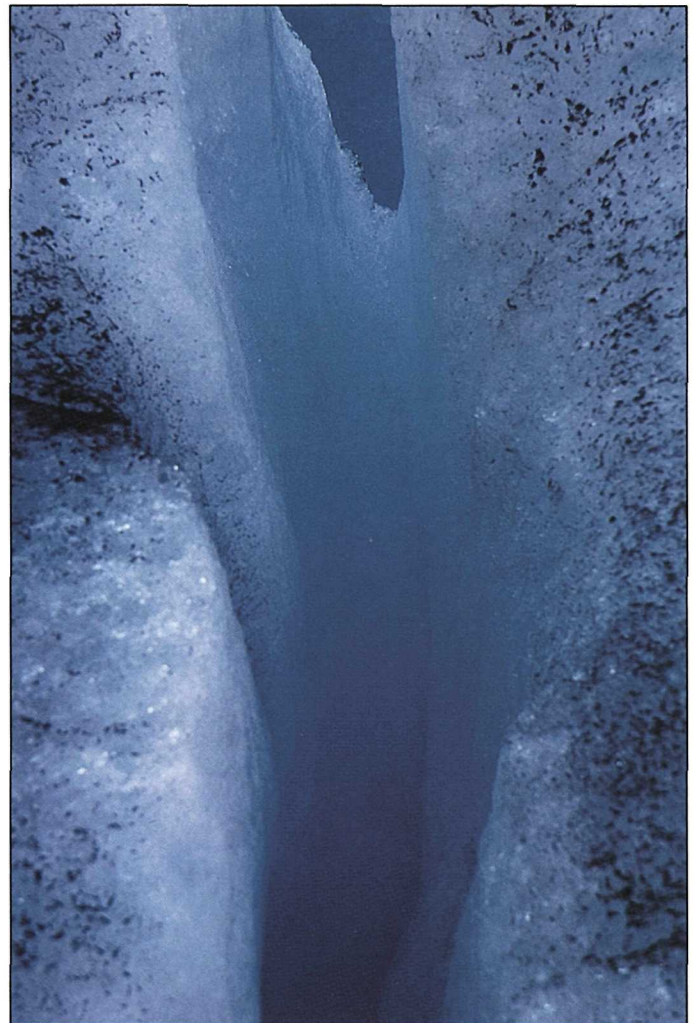


Blue Ice

Unlike clear lake ice or white snow, the ice inside a glacier is a deep turquoise blue. Since it is formed under pressure, much of the air that would otherwise be trapped in the ice is squeezed out. Light that would normally be reflected by air bubbles can penetrate deep into the ice, which absorbs most of the colors of the spectrum. The remaining blue light waves are scattered inside the ice and refracted back to the surface.

BERGSCHRUNDS

Where the upper end of a glacier (its accumulation zone) lies against a rock wall, the glacier may pull away from some of the ice that abuts the wall. The ragged crevasse that results is a bergschrund; much of the most active erosion by a cirque glacier takes place here.

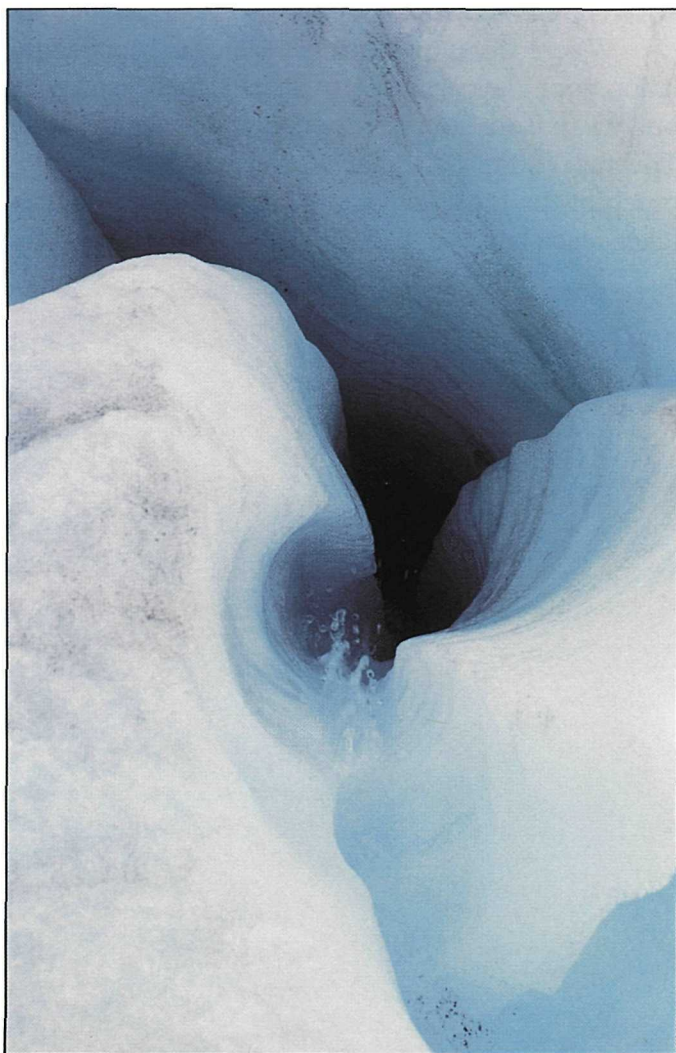


MELTWATER FEATURES

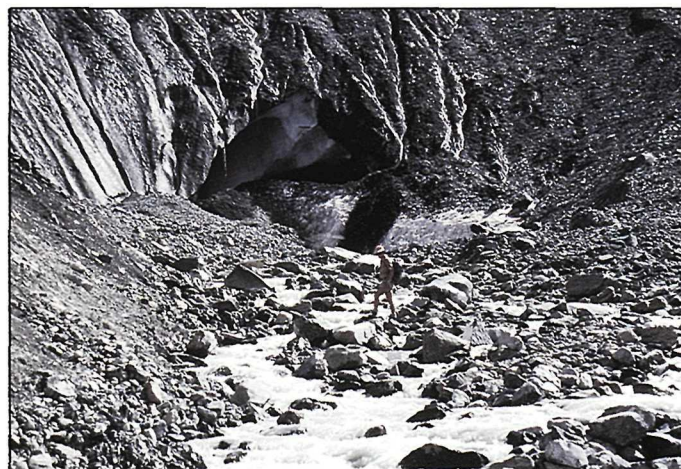
Summer meltwater streams carve channels in and through glaciers. Some streams flow on the surface of the ice for a considerable distance before disappearing into the maze-like network of subglacial streams that gather into larger streams and emerge at length from the toe of the glacier.

Millwells: meltwater streams on the glacier surface form rounded drains where they plunge into the ice.

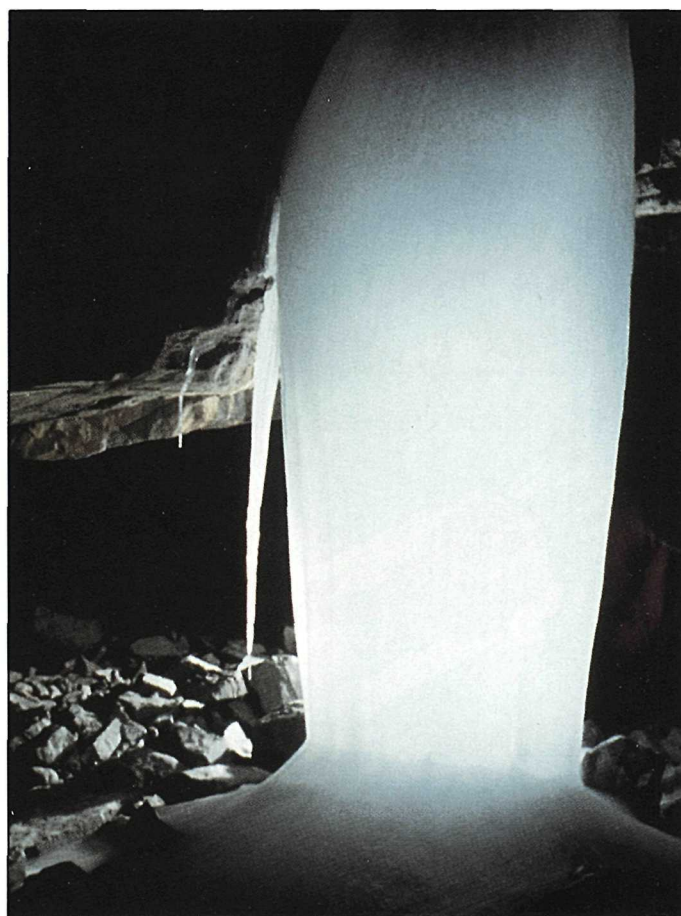
Glacial river gates: after travelling through and under the glacier, meltwaters emerge as large streams from tunnels at the toe of the glacier.



Millwell.



The Sunwapta River emerging from the ice.



Castleguard Cave

A mystery hidden beneath the Columbia Icefield, the Castleguard Cave is the longest known cave system in Canada. A network of underground passages dissolved by meltwaters seeping through limestone, the cave extends from unknown sources beneath the icefield to an outlet below the Castleguard Meadows, south of the icefield. As access is remote and dangerous, only part of the cave system has been mapped and scientists can only speculate about its origin. It may be that these passages, which are more than half a million years old, once drained the plateau now occupied by the Columbia Icefield.

GLACIAL EROSION FEATURES

Glaciers and their meltwaters have changed the face of the Rockies dramatically and continue to rearrange the landscape today. Glacier ice carves and plucks at the rock around it. Rock fragments imbedded in the ice grind at the bedrock below. Glacial meltwaters sweep away the rock and silt fragments eroded by the ice. Even as the glaciers of the Columbia Icefield continue to chisel their signatures into stone, the marks of glacial erosion are exposed on the mountain slopes and valley floors nearby.

GLACIAL CLIFFS

At its sides, a glacier gradually pulls loose enough stone to undercut the rock walls which may then become unstable and collapse on the glacier below, leaving sheer cliffs towering above.

TROUGHS

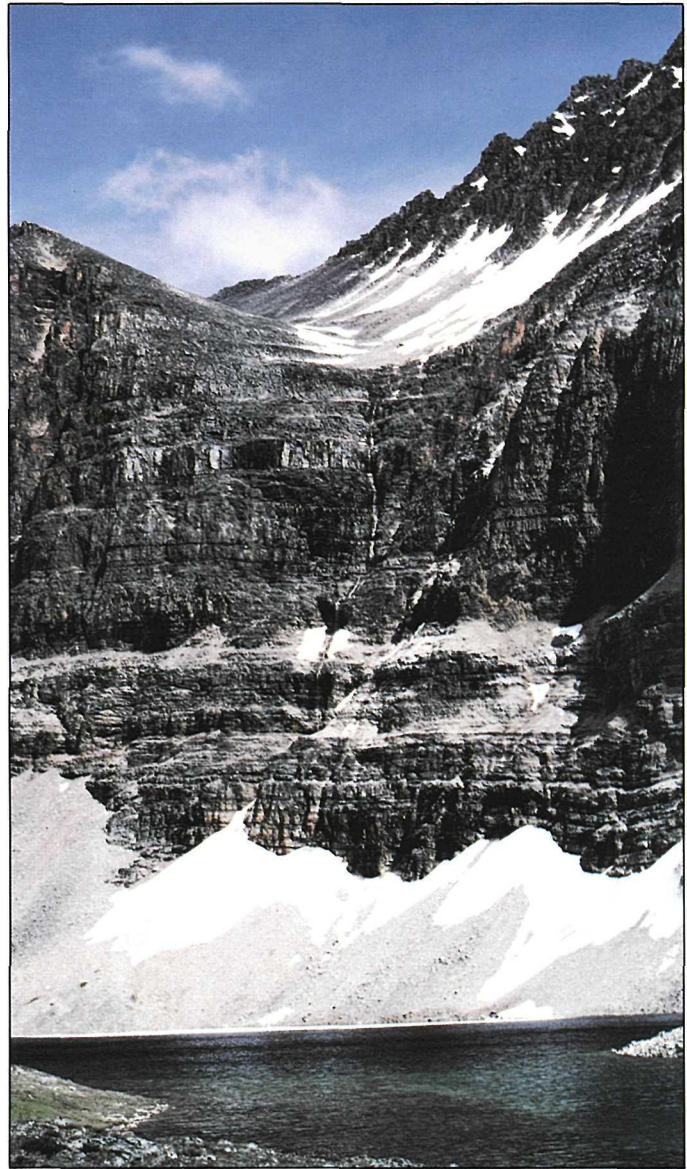
Glaciers erode the rock along their sides almost as much as the rock beneath them, unlike water which cuts mostly downward. Most of the valleys in the Canadian Rockies are glacial troughs; they have been widened and their walls have been steepened by the action of massive glaciers.

HANGING VALLEYS

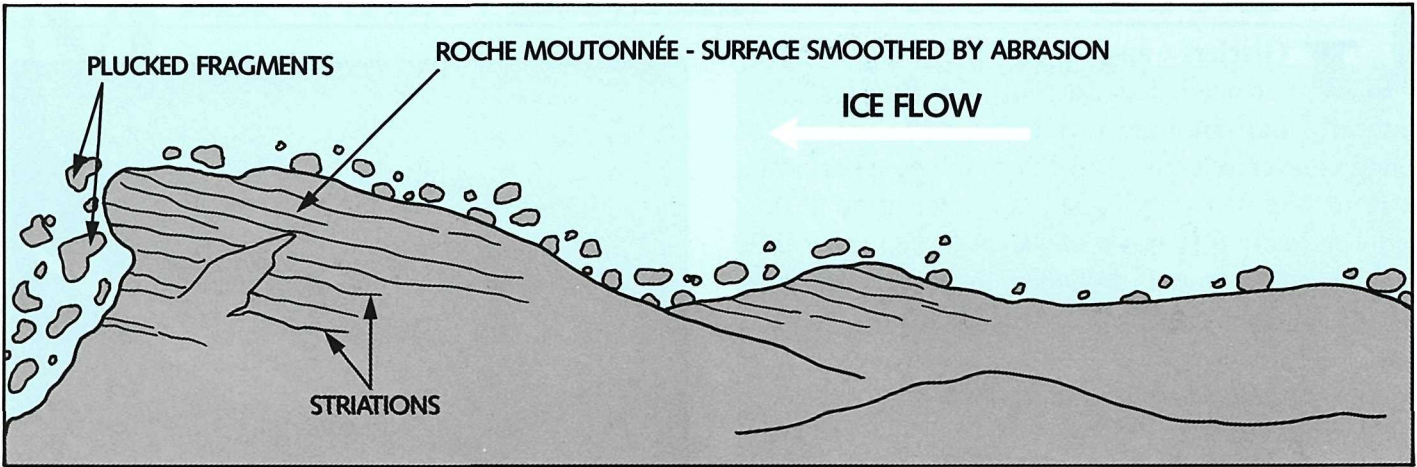
A big glacier carves a larger valley than a small glacier. Where a small tributary glacier flows into a larger glacier, its floor is much higher than the floor of the large glacier. When the glaciers recede, the small valley appears to be hanging above the side of the larger one.

CIRQUES

A cirque glacier plucks rock from the mountain against which the glacier rests, gradually eroding an amphitheatre-like depression in the mountain. Where two cirques form back-to-back, a knife-edge ridge called an *arête* forms between them. Where a mountain peak is eroded on several sides by cirque glaciers, a pyramid or Matterhorn-type peak results.



Glacial cliffs tower above a tarn, or glacial lake, cupped in a cirque in Jasper National Park.



The Athabasca River flows through a U-shaped glacial trough with hanging valleys along its edges.

ROCHES MOUTONNÉES

Also called hogbacks, roches moutonnées are small knolls carved out of bedrock by the moving glacier. The ice presses against the uphill side of the knoll, smoothing and planing it, while roughly plucking stone from the downhill end.

STRIATIONS

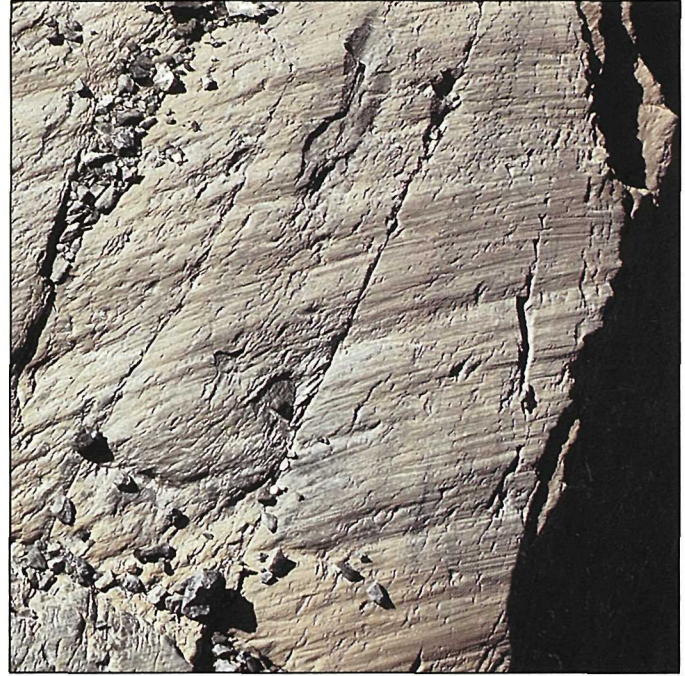
Besides leaving chatter marks, rock debris caught in the underside of a glacier may leave scratches and gouges up to a few metres long on the bedrock. If the debris in the ice is fine enough and the bedrock soft enough, it can actually polish the bedrock beneath.

TRIMLINE

Where a glacier has advanced down forested valleys and retreated again, there is a distinct boundary between the old forest and the area where the glacier scraped away all the vegetation and left raw gravel and silt to be colonized anew by plants. It takes many decades for forest to cover glacial deposits; thus the trimline marks the limits of a glacier's advance for many years after the ice has retreated.

CHATTER MARKS

Where boulders imbedded in glacier ice grind against bedrock, crescent-shaped chunks may crack out of the bedrock.



A triangular patch of trees between the Athabasca and Dome Glaciers was trimmed to its present shape during the Little Ice Age, which ended less than 150 years ago. Some of the trees are more than 300 years old.

GLACIAL DEPOSITION FEATURES

G Just as glacier ice has its own unique patterns and formations, so do the landscapes that are exposed after glaciers retreat. At the Columbia Icefield many of these features are freshly revealed.

All the rubble and debris dislodged, ground up and transported by the glaciers eventually gets dumped somewhere. Some large boulders from the Rocky Mountains were carried far out onto the foothills and plains of Alberta by glaciers during the last ice age. These rocks are called erratics, since they are often found in places where they do not seem to belong.

The smallest form of glacial debris is rock flour, a



Laden with glacial silt, or rock flour, the Sunwapta River carries meltwaters from the Athabasca Glacier.

fine powder which glaciers grind out of bedrock. Rock flour stays suspended in water for long periods, giving glacial streams a grey color and mountain lakes a distinctive turquoise hue.

Most glacial deposits are a mixture of clay, silt, sand, gravel and large rocks which are collectively known as till. Glacial till may be deposited in distinctive shapes or it may be strewn many metres thick over the entire landscape. Much of Canada's landscape is blanketed by glacial deposits from the last ice age, but the shapes are hidden by forests, fields, lakes and cities. At the Columbia Icefield the glacial landscape is still new and still evolving, and the deposits of retreating glaciers are plain to see.



Glacial deposits exposed by road construction; much of Canada is covered by till similar to what the Athabasca Glacier is depositing today.

MORAINES

Both within their ice and on top of it, glaciers carry the debris that will become glacial till. As the ice flows and melts, the glaciers deposit their debris in distinctive shapes.

End Moraines: As ice melts at the glacier's toe, the rock debris in and on the ice is deposited as piles of till in front of the glacier, called end moraines. There are several kinds of end moraines. When the glacier stops advancing and its toe remains almost stationary for a number of years before beginning to retreat, the till accumulates into a large, distinctive mound known as a terminal moraine. A retreating glacier melts most rapidly in summer, spreading till below its toe. In the

winter it may advance a little, pushing the till up into a low ridge that marks the position of the toe each year; these ridges are called recessional, push or annual moraines. Several end moraines and their dates of formation are marked on the trail to the toe of the Athabasca Glacier.

Lateral Moraines: Rock and debris falling from surrounding cliffs form large piles on the edge of the glacier. As the glacier shrinks, the debris is left on the valley walls as a knife-edged ridge of debris. These ridges often have a core of blue glacier ice that melts more slowly than the rest of the glacier because of the insulating cover of rock debris.

Dead Ice Moraine: As a glacier retreats, large areas of ice may become isolated from the glacier and gradually melt in one place. Since the amount of rock debris in and on the ice usually varies from one part to

the other, the end result when the ice has finally melted, is a landscape full of small hills and depressions, filled with varying amounts of glacial till.



Dead ice moraine.



End moraines below the toe of the Athabasca Glacier.



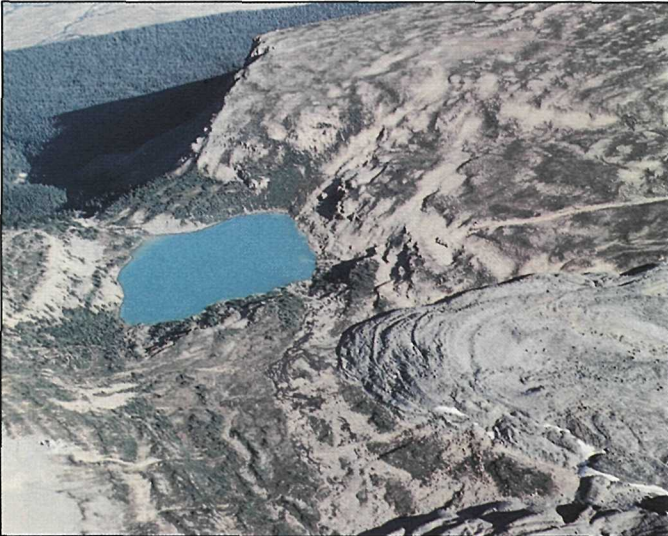
Lateral moraine of the Dome Glacier.

OUTWASH PLAINS

Meltwater streams carry massive amounts of silt, sand and rock debris. Rounded by constant pounding, the gravel and larger rubble settles out wherever the current slows a little, while sand and silt are dropped in calm backwaters and overflow ponds. Constantly changing course as it deposits more outwash material, a glacial stream weaves a braided pattern across its ever-thickening floodplain.

ROCK GLACIERS

Neither glaciers, nor piles of rock, these are unique landforms common in the high mountain areas where true glaciers develop. These large lobed-shaped piles of rock covering a core of ice, or with the rocks held together by ice, flow downhill in a similar manner to true glaciers.



Rock glacier.



The braided floodplain of the upper Athabasca River viewed from the air.

DWELLERS AT THE ICE

4

To those of us who live in places where summers are long, warm and green, the Columbia Icefield area may seem too cold and hard for living things to survive. Not so; for the surprising diversity of plants and animals that dwell within sight of the Columbia Icefield and its glaciers, this is home. The environment – even with its deep snow, frequent

winds and short cool summers – is perfectly suited to their needs.

Bighorn sheep, rosy finches, snow algae and rock lichens; each animal and plant has its own role to play in the living communities that have developed around the glaciers in the few thousand years since the ice retreated to this cold mountain refuge.



LIFE ON THE ICE

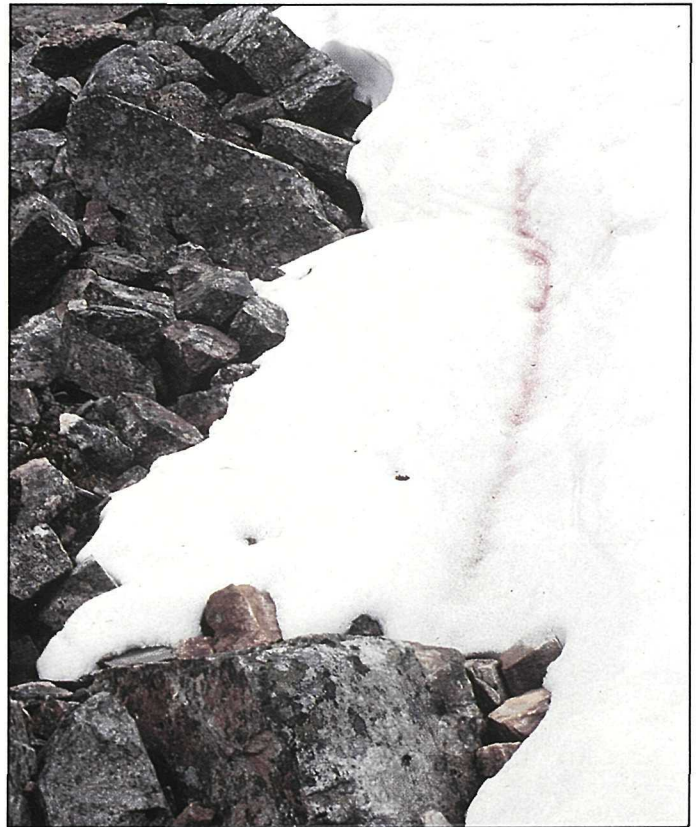
One of the early explorers of the Columbia Icefield, J. Monroe Thorington, found life thriving even high on the seemingly barren icefield in 1923:

“Air currents from the British Columbia side, are quite constant, and carry thousands of insects up on the ice; at 10,000 feet and above, we found many varieties of moth, bugs and beetle, most of them alive but torpid from cold. These insects serve as the principal food supply of a large number of snow-finches which are seen darting about on the snowfield.”

Rosy finches can still be seen today, feeding on dead insects on the ice or flying to their nests in the broken rock faces surrounding the glaciers.

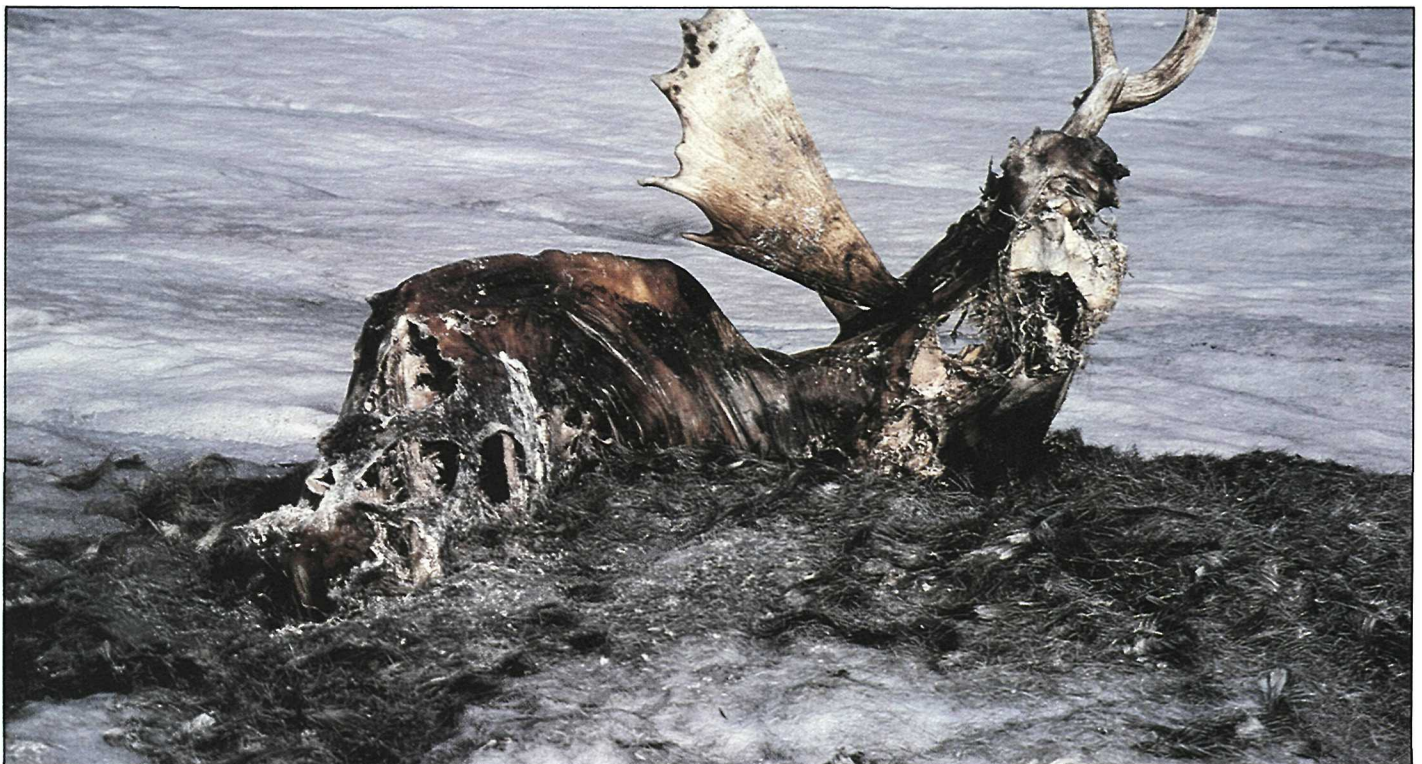
Other animals, too, are seen on the ice at times. Tracks of mountain goats and caribou sometimes appear at the edges of glaciers. In the late 1970s, a dead moose was discovered in the Saskatchewan Glacier; no one will ever know where it had come from or where it was going when it slipped into a crevasse.

Among the very few organisms that actually make their home on the ice is a primitive form of plant known as snow algae. Red snow, looking like spilled watermelon juice, marks patches of the algae, which grows on old snow rich with dust particles.



*Red snow caused by the algae **Chlamydomonas nivalis**.*

Dead moose melting out of the Saskatchewan Glacier.



PLANTS NEAR THE ICE

There are few places in the world where the ability of life to thrive under adverse conditions is more apparent than at the Columbia Icefield. Even on the raw debris newly exposed by retreating glaciers, grasses, sedges and flowers take root and flourish.

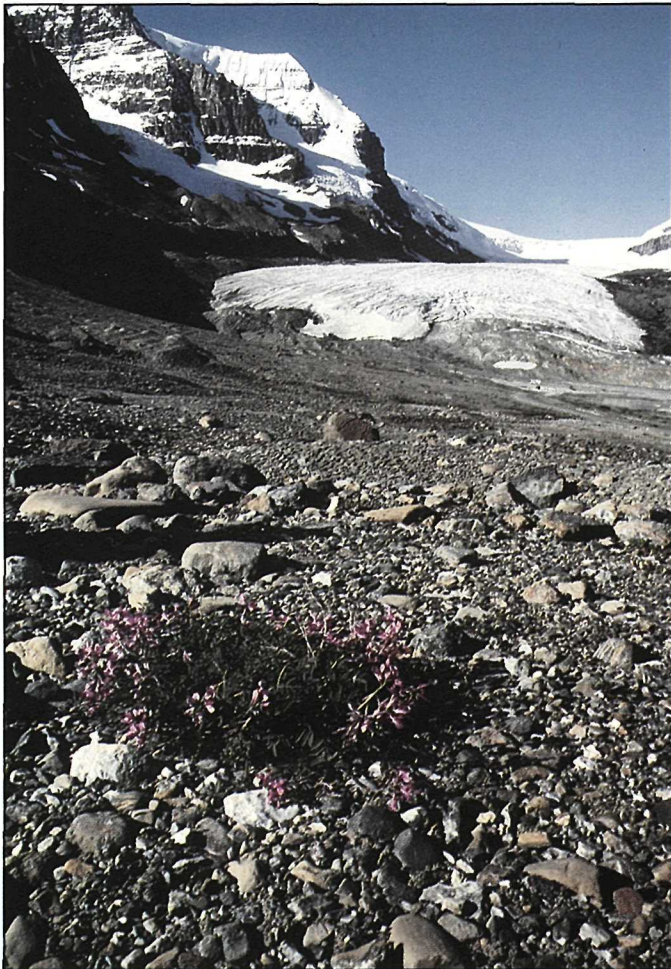
The plants that grow near the ice are those that specialize in survival. Many cling close to the ground where they are sheltered from drying winds and insulated by winter snows. Some have special pigments that screen their cells from intense ultraviolet light, common at this high elevation. All must be able to grow and reproduce in a land of shallow soils, constant winds, frigid winters and a growing season of about three months.

On the most recent moraines and outwash deposits, pioneer plants such as yellow dryas and river beauty cover the coarse gravel and begin the centuries-long process of building soil. The coarsest

rock deposits resist colonization by all but the most specialized rock lichens.

Where the glacial debris has been exposed longer, other plants such as spruce, shrubby cinquefoil, hedsarum and willow have taken root and the young soil supports a denser growth of sedges, grasses and flowers.

Patches of subalpine fir forest, dense willow stands and heather meadows are found only where the ice retreated hundreds of years ago. They mark the final stages of the long, slow processes of plant succession and soil formation. At lower elevations where the climate is less severe, the mosaic of mature vegetation found near the Columbia Icefield is replaced by a carpet of dense coniferous forest that smooths the scars left by the glaciers when they retreated to the high Rockies 10 to 15 thousand years ago.



Vegetation colonizes newly exposed glacial till.



A century or more after the ice has retreated, willows and other plants form lush meadows.



It takes several centuries for forests to cover the tracks of retreating glaciers.



Shrubby Cinquefoil: A rugged shrub which thrives in dry conditions, shrubby cinquefoil is ideally suited to glacial outwash deposits. It contributes to soil development, but is not eaten by sheep or other animals because it is too woody.



Rock Lichens: Several kinds of rock lichen grow on bare rock, even on the peaks high above the icefield. A lichen is two plants in one: an alga produces food from sunlight, and a fungus protects and shares the energy of the alga.



River Beauty: Another pioneer plant, related to the common fireweed, river beauty is spread by wind-blown seeds and forms colorful mats on well-watered silt and sand deposits along glacial outwash streams.



Yellow Dryas: Spread by creeping stems which sprout new roots at intervals, yellow dryas soon carpets moraine and outwash deposits. It builds soil where none existed before, by trapping wind-blown dust in its foliage and by fixing soil nitrogen in its roots.



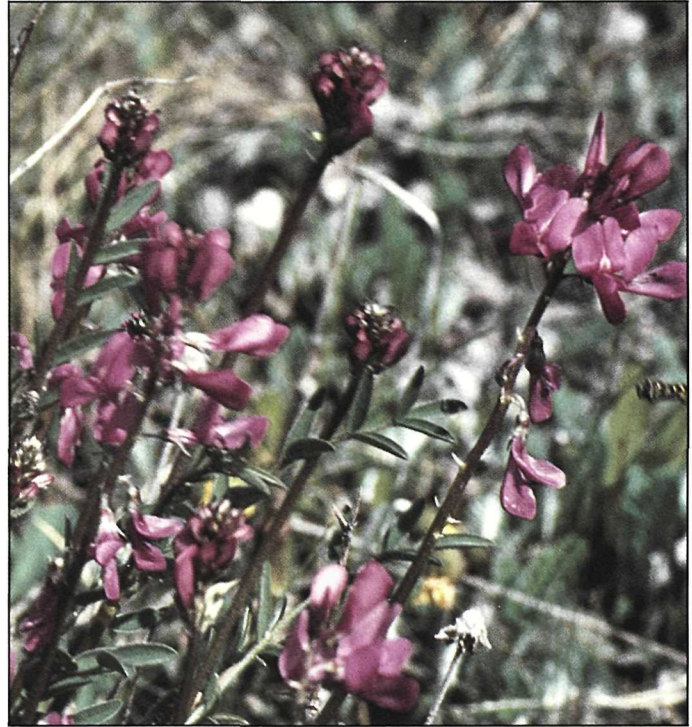
Engelmann Spruce: The first tree to sprout on raw gravel, the Engelmann spruce is common on old glacial moraines. Some trees in the Athabasca Glacier area are more than 700 years old.

White Mountain Heather: Low-growing and sprinkled liberally with delicate bell-like flowers, white mountain heather forms springy mats on timberline and alpine slopes long abandoned by the retreating glaciers.





Barratt's Willow: Valley bottoms that trap pools of icy air draining from the glacier surface are too cold to sustain trees. Dense willow thickets here provide food for moose and nesting shelter for birds.



Hedysarum: Related to the common garden pea, hedysarum is found frequently in the open vegetation of areas recently exposed by retreating glaciers. Its starch-rich roots are essential grizzly bear food in spring and fall.

Subalpine Fir: The oldest forests in the Columbia Icefield area, and those at the highest elevations, contain more subalpine fir than spruce. At timberline, this tree becomes a wind-twisted shrub that huddles against the ground where there is shelter from the drying, abrasive winds of the icefields area.



A NIMALS NEAR THE ICE

Winter – the season of scarce food, difficult travel and severe cold – lasts for almost nine months in the valleys below the Columbia Icefield. On the ice itself, winter has lasted for centuries.

The animals that live in sight of the icefield are limited by their abilities to cope with long winters. Many species, including most of the birds, raise their young here in summer and then migrate to other areas where winter is less harsh. Elk and mule deer, for example, migrate down to the windswept lower Athabasca and North Saskatchewan valleys.

Other animals fatten on the summer's green wealth and then sleep away the winter while blizzards whip the peaks above. Grizzly bears, hoary marmots and Columbian ground squirrels are among the animals that hibernate through the winter.

The few animals that remain active in the icefield area in winter are able to take advantage of the winter environment to survive. Mice and voles, for

example, feed on buds and seeds in runways beneath the snow, relying on the thick snow cover to protect them from predators and insulate them from severe cold. Ptarmigan and other grouse grow scaly snowshoes to walk on the snow surface. While grouse take shelter in spruce and fir forests, ptarmigan remain in the open but turn white so that they are less visible to predators.

Bighorn sheep are particularly well-suited to life near the Columbia Icefield. The young vegetation around the glaciers is rich in the grasses and sedges upon which sheep feed. The winds produced by cold air draining off the icefield whip snow off the exposed ridges where the sheep survive the winter.

Most other large animals leave the icefield area in winter. Only the moose, with its long legs, and the caribou, with its wide feet that support it in deep snow, can travel and feed in deep snow.



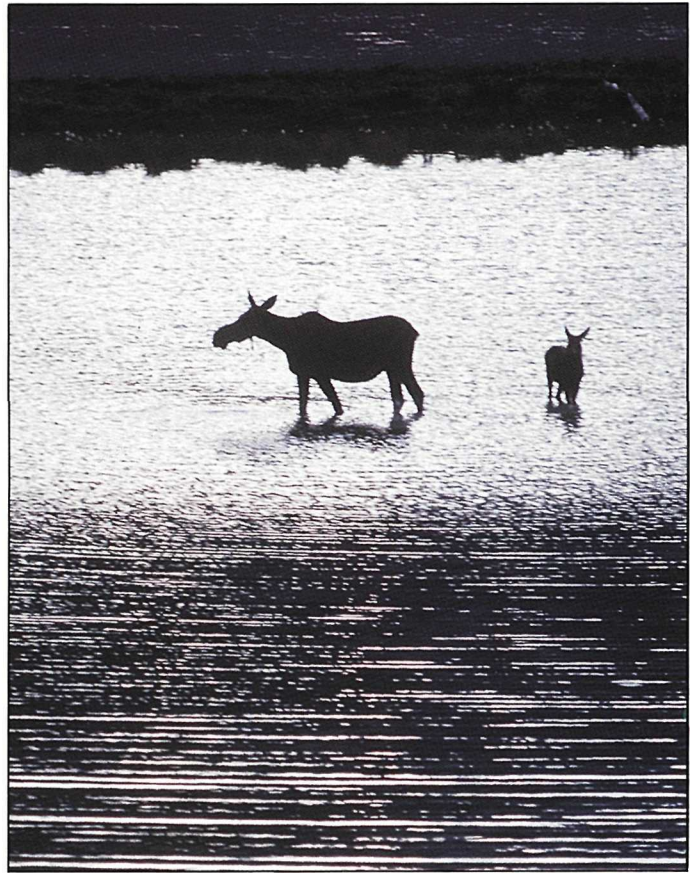
Ptarmigan remain year-round in the icefield area.



The bighorn sheep is one of many animals that live in sight of glaciers.



Bighorn Sheep: Year-round residents of Mount Wilcox and Tangle Ridge, bighorn sheep rely on the frequent winds off the Athabasca Glacier to clear winter snows from the ridges where they feed.



Moose: Long legs allow the moose to survive the deep snow that drives deer and elk out of the Icefield area each winter. The willow tangles that fill the high valleys below the icefield provide abundant forage.



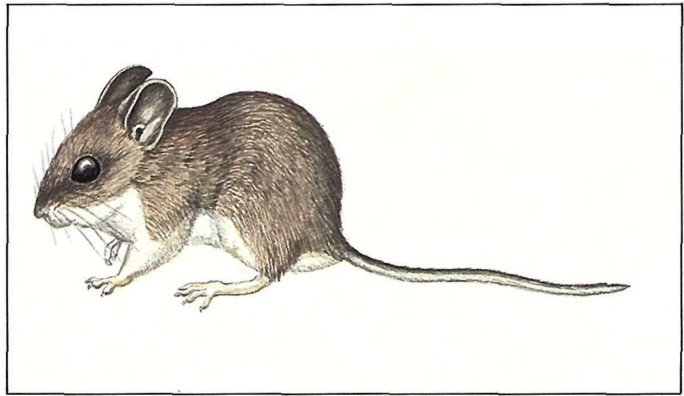
Hoary Marmot: A piercing alarm whistle is usually the first sign of a hoary marmot. Sheltering in boulder piles or under glacial erratics, this large rodent feeds in lush timberline meadows.



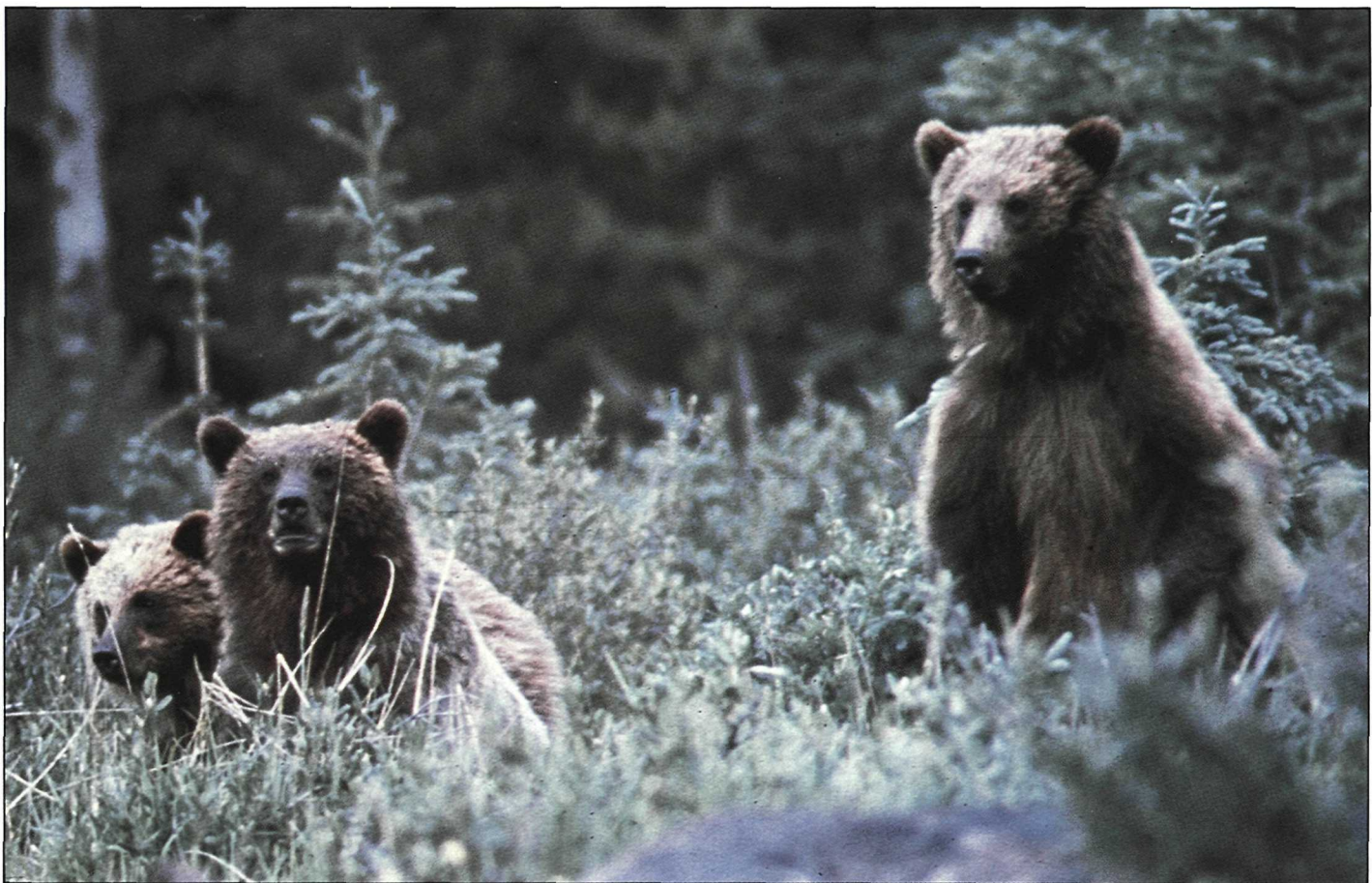
Woodland Caribou: Little larger than a deer, the woodland caribou has no difficulty travelling in deep snow, thanks to its over-size feet. Caribou eat tree lichens in winter and are occasionally seen in spring along the Icefields Parkway, feeding on sedges and dryas.



American Pika: Unlike the marmot, which hibernates, the pika stores hay and remains well-fed and active all winter under the insulating snow. A nasal “beep” betrays the presence of this little rabbit in talus piles and boulder-filled moraines.



Deer Mouse: Any open areas with abundant grasses, berries and other plant foods support large numbers of deer mice. Breeding two or three times a year, deer mice soon colonize newly-vegetated areas near the toes of glaciers.



Grizzly Bear: Feeding on hedysarum roots and other plant material, as well as marmots, ground squirrels and the occasional carcass of a dead moose or sheep, the grizzly bear is well suited to life near the

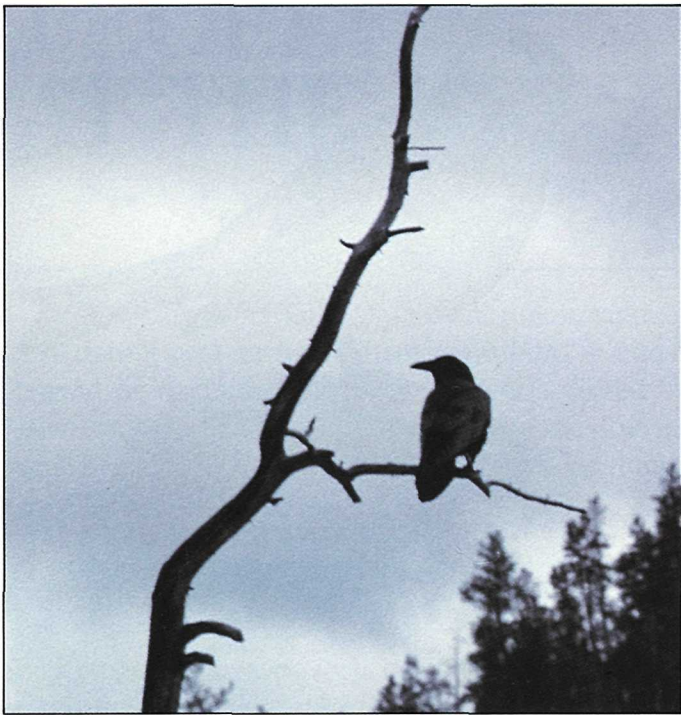
ice. Wandering over a home range of many square kilometres each summer, the grizzly survives the glacial winters by digging a den and going to sleep.



Golden Eagle: Nowhere common, the golden eagle needs a large hunting area to provide enough ground squirrels, marmots and other small animals to feed its nestlings each year. One pair nests each year on cliffs near the Athabasca Glacier.



Columbian Ground Squirrel: Colonies of Columbian ground squirrels dig dens in meadows and forest edges wherever the soil is well enough developed to support them. Active all day, this rodent is an important food source for eagles and hawks.



Common Raven: Another cliff-nester, the raven is a scavenger found throughout the Rocky Mountains, including the icefield area. Few animals die in the Rockies without being found and fed on by ravens.



Blue Grouse: A large grouse that favors semi-open forest, the blue grouse moves up to timberline in winter and survives by eating the buds and needles of subalpine fir and spruce.

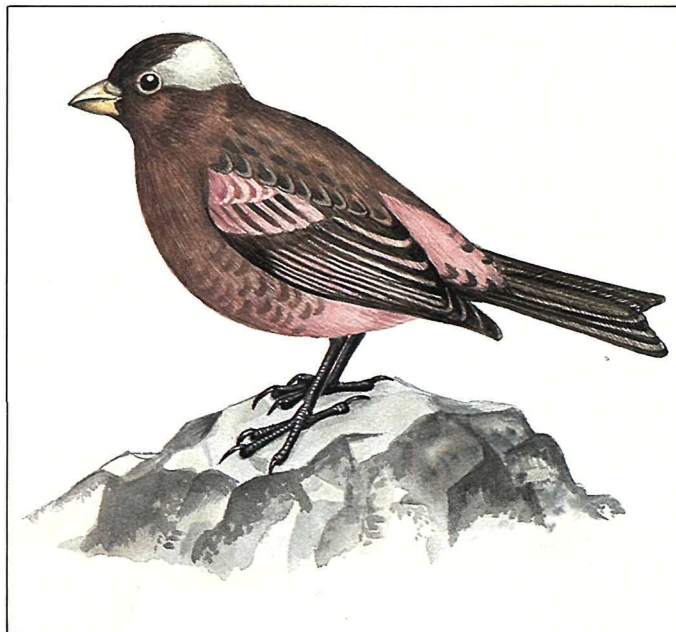


White-tailed Ptarmigan: Mostly brown in summer and pure white in winter, the white-tailed ptarmigan lives year-round in the icefield area. In

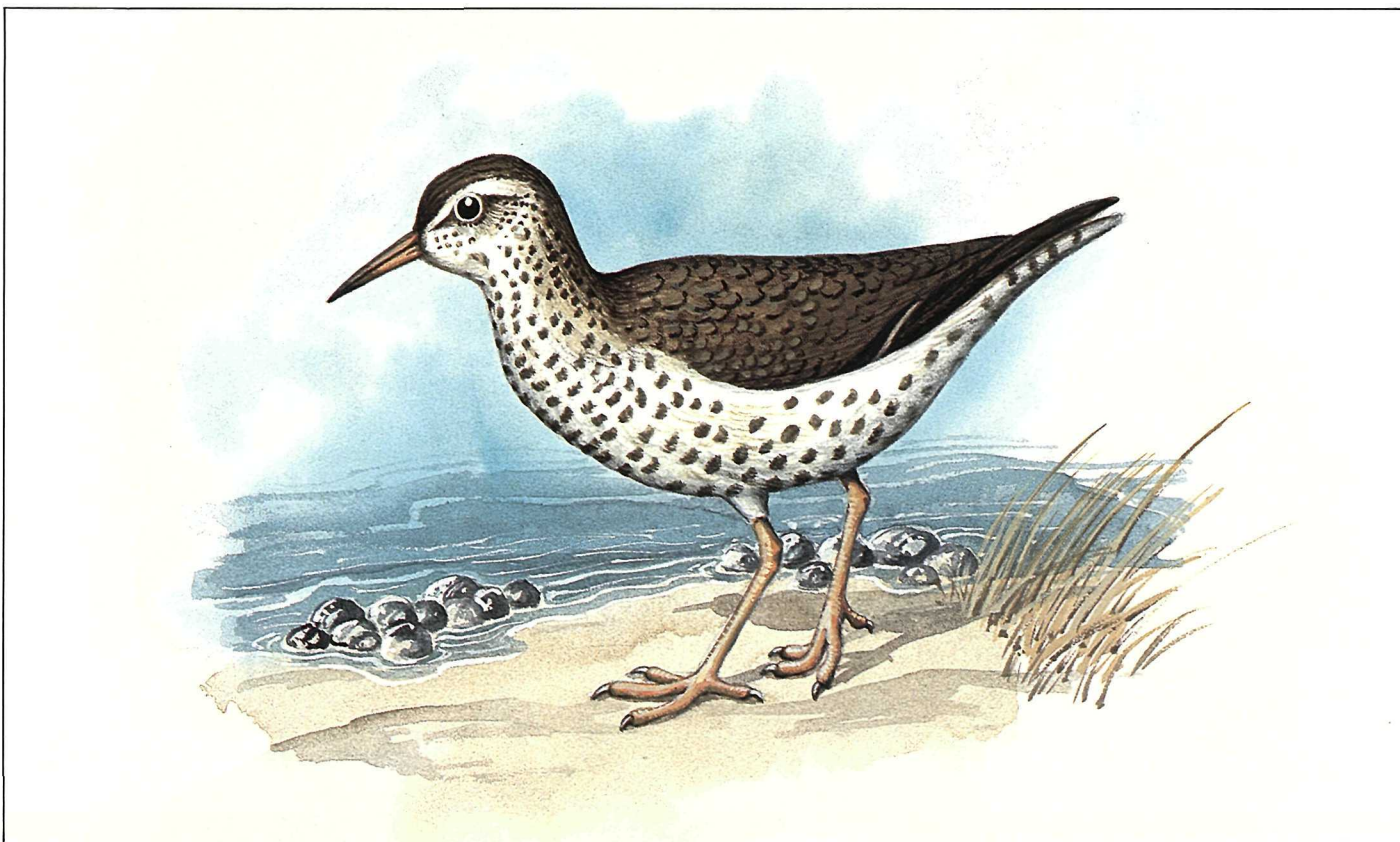
winter it eats willow buds in the meadows along outwash streams.



Water Pipit: During June and July the song of the water pipit is heard in alpine meadows around the icefield. The male sings in flight while the female incubates eggs in a patch of sedge or heather below.



Rosy Finch: Rosy finches nest in crevices in cliffs and rock debris and feed on insects and seeds in alpine meadows and on the surface of glaciers and snowfields. In winter they migrate to open areas at lower elevations.



Spotted Sandpiper: Along the edges of glacial outwash streams and small kettle ponds, the tracks of

this small sandpiper can be seen all summer on silt and sand flats.

PEOPLE AT THE ICE

5

The Columbia Icefield area was unknown until less than a century ago. There is no hint, in either legend or rumour, that the icefield was visited by native people. The earliest human use of the Rockies was by natives who hunted the accessible lower

valleys where game was abundant, and by white explorers looking for ways through the mountain barrier. It is little wonder, then, that the men who first saw the Columbia Icefield were looking for something else.



DISCOVERY

DA Scottish botanist, David Douglas, journeyed through the Athabasca Pass, 70 kilometres north of the Icefield, in 1827. The Rocky Mountains were largely unexplored at that time and only fur traders regularly traversed the easiest passes. Douglas was so impressed with the mountains on either side of Athabasca Pass that he concluded that they must be more than 5,000 metres (17,000 feet) above sea level. He named them after two other noted botanists - Brown and Hooker - and published his accounts of the discovery some time later.

The reputed heights of Mounts Hooker and Brown, more than 1,000 metres higher than any other

mountain in Western Canada, inspired mountaineers to search for and climb them. Arthur Coleman, a Canadian geologist and mountaineer, explored the area east and north of the Columbia Icefield in 1892 and 1893 without success, and concluded that he had been "humbled" by Douglas' claims.

Walter Wilcox, a young American mountaineer who explored much of the area between Lake Louise and Jasper, narrowly missed the icefield in 1896 when he detoured through what is now called Wilcox Pass, to avoid the Athabasca Glacier and Sunwapta Canyon.



Mount Columbia.

Two years after Wilcox's visit, three other climbers arrived at Sunwapta Pass in search of the fabled Mounts Hooker and Brown. Norman Collie and Hermann Woolley climbed Mount Athabasca to get a better view of the surrounding area, while their companion Hugh Stutfield went hunting for bighorn sheep with their guide, Bill Peyto and packer Nigel Vavasour.

From the summit of Mount Athabasca, the two climbers became the first people ever to see the Columbia Icefield. It was August 18, 1898. Norman Collie later described their discovery:

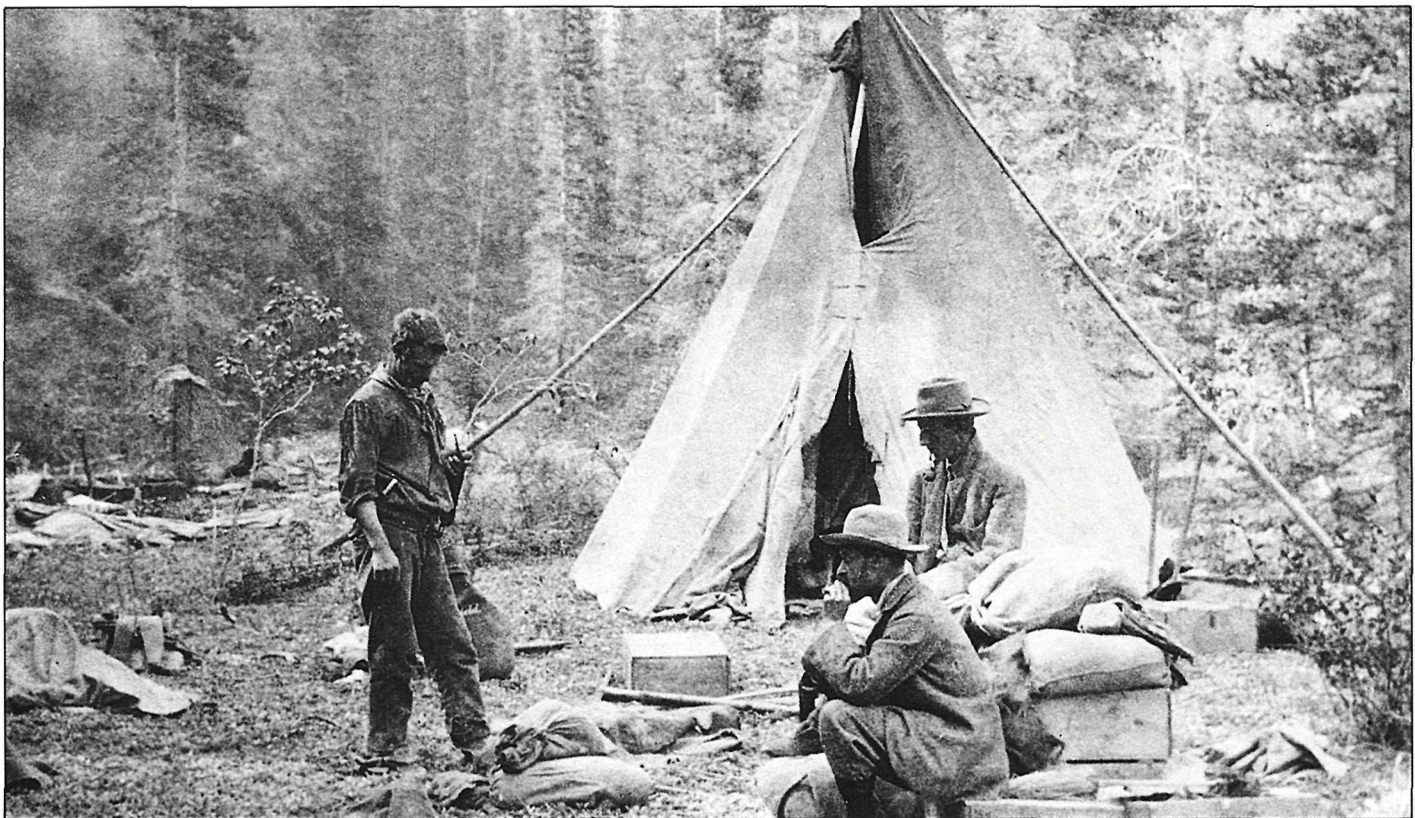
"We were looking on a country probably never before seen by human eye. A vast snow-field, feeding many glaciers, lay at our feet, rock-peaks and snow-covered mountains were ranged around it, whilst, far away to the westward we could just see through the haze of the valley of the Columbia River. This great snowfield, from which the Saskatchewan Glacier takes its rise, also supplied the ice for another glacier at the headwaters of the Athabasca; whilst to the west we saw the level snows bending over to flow down more than one channel, feeding, when

melted, the rivers that empty themselves into the Pacific Ocean."

Still hopeful that their quest for the fabled heights of Mounts Brown and Hooker might be nearly over, the climbers studied the mountains that ringed the Columbia Icefield:

"... on the opposite side of the snow-field in a north-westerly direction, the biggest peak of all was seen. Chisel-shaped at the head, covered with glaciers and ice, it also stood alone, and I at once recognised the great peak I was in search of; moreover, a short distance to the northeast of this peak another, almost as high, also flat-topped, but ringed round with sheer black precipices, reared its head above all its fellows to the sky. Here, then, we thought were Brown and Hooker."

In fact, these were two of the highest mountains in the Rockies - Mounts Columbia and Alberta - and both were higher than Mounts Brown and Hooker, which had been much over-rated by David Douglas. The search by mountaineers for ever higher and more remote mountain peaks to conquer had finally brought man to the Columbia Icefield.



Bill Peyto, Norman Collie and Hugh Stutfield - 1898 Icefield Expedition.

THE GLACIER TRAIL

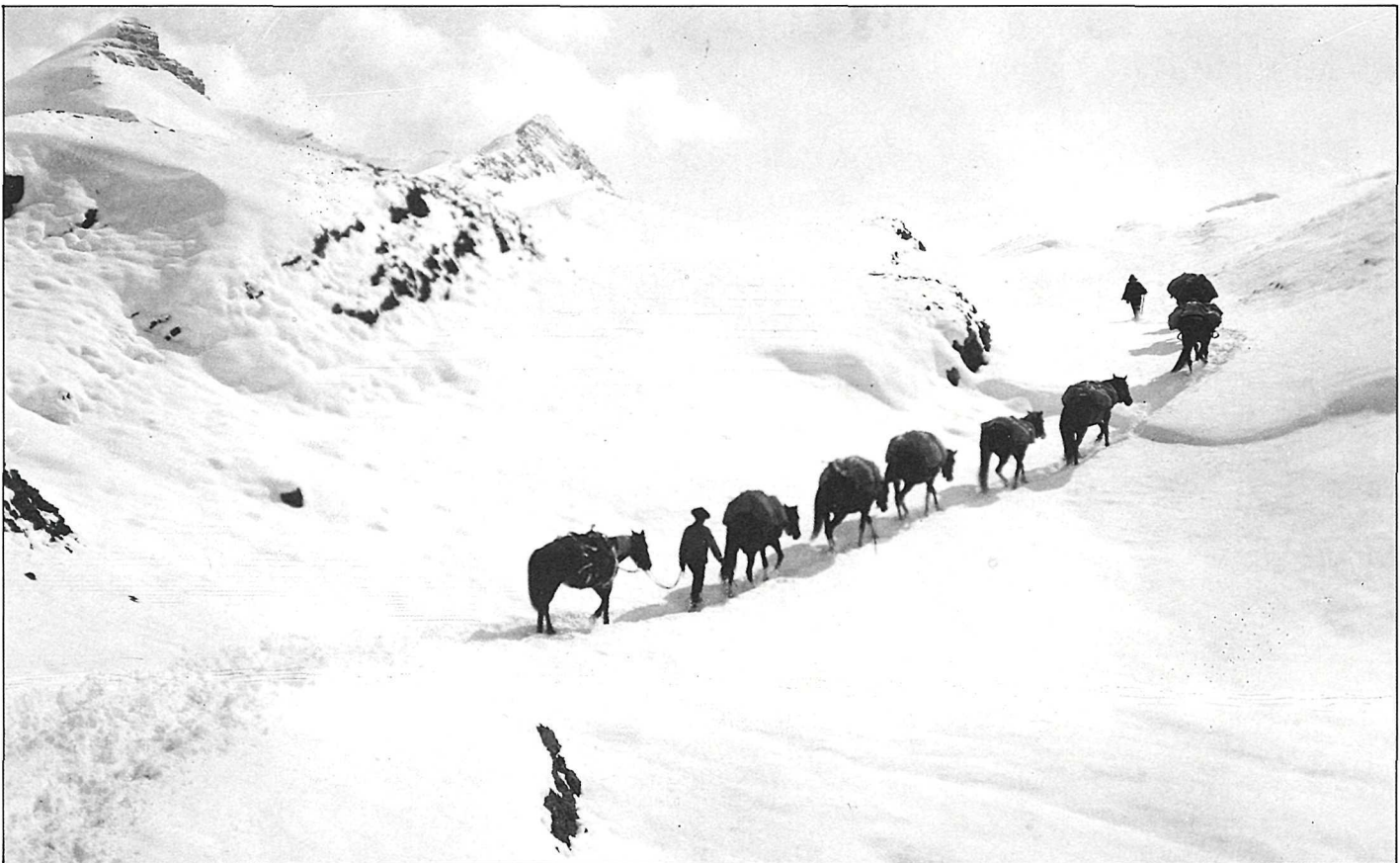
The discovery of the Columbia Icefield, its glaciers and surrounding peaks awakened interest among mountaineers and travellers who wished to explore the remote parts of the Rocky Mountains. The icefield area became a popular destination for pack trips north from the Canadian Pacific Railway at Lake Louise. One of the early outfitters of Banff and Jasper national parks, Jack Brewster, offered a regular Glacier Trail tour that included a three-day camp at Castleguard Meadows while climbing and horseback excursions were taken into the surrounding area. These outings even included a horse trip over the Saskatchewan Glacier to the icefield itself.

Many of the earliest visitors were mountaineers, attracted by published accounts of the massive peaks surrounding the icefield. In 1923 J. Monroe Thorington, an American climber, made six ascents of peaks at the icefield. Returning from the first

ascent of North Twin, he described the journey across the ice:

“No one who does not follow our track will quite understand that journey back across the endless icefield. We were too tired to appreciate it, plodding on and on in deep insufficiently-crusted snow, over plateau and ridge and dip, until darkness came. The field is so huge. In one corner the stars were out; in another, beyond Mount Athabasca, dark clouds hung and lightning flashed. We lit our lantern and went on through the night . . .”

Another early explorer was Mary Schäffer, an American woman who explored many of the little-known valleys of Jasper National Park. In 1909 she journeyed far up the Athabasca River to the Columbia Glacier.



A 1911 packtrip through Wilcox Pass.



Mary Schäffer.



THE PARK ERA

The reign of the horse outfitted pack train in the Columbia Icefield ended in the 1930s. The icefield area had been brought into Jasper National Park in 1927, at a time when plans were already afoot to replace the pack trail between Lake Louise and Jasper with a motor road. In the mid-1930s, partly to create employment during the Depression, the federal government began work on the new road.

When the new motor road from Lake Louise to Jasper was finally opened in 1940, there was also a hotel in Sunwapta Pass, one of several lodgings built along the road to serve visitors to the area. Even though the road and facilities allowed motorists to

visit what had been remote wilderness only a few years previously, the new road was almost as much of an adventure for travellers as the pack trail had been. It was narrow and winding, and crept chillingly close to many sheer drops.

Because of its new accessibility, the American, British and Canadian armies practised mountain warfare on the icefield and the glaciers around it in the early 1940s. Armored vehicles and undetonated shells, and personal belongings such as cigarette lighters, jewelry and clothing that were lost or abandoned during the training exercises still appear occasionally at the toes of the area's glaciers.



A Bombardier tour of the Athabasca Glacier, 1952.

THE ICEFIELD TODAY

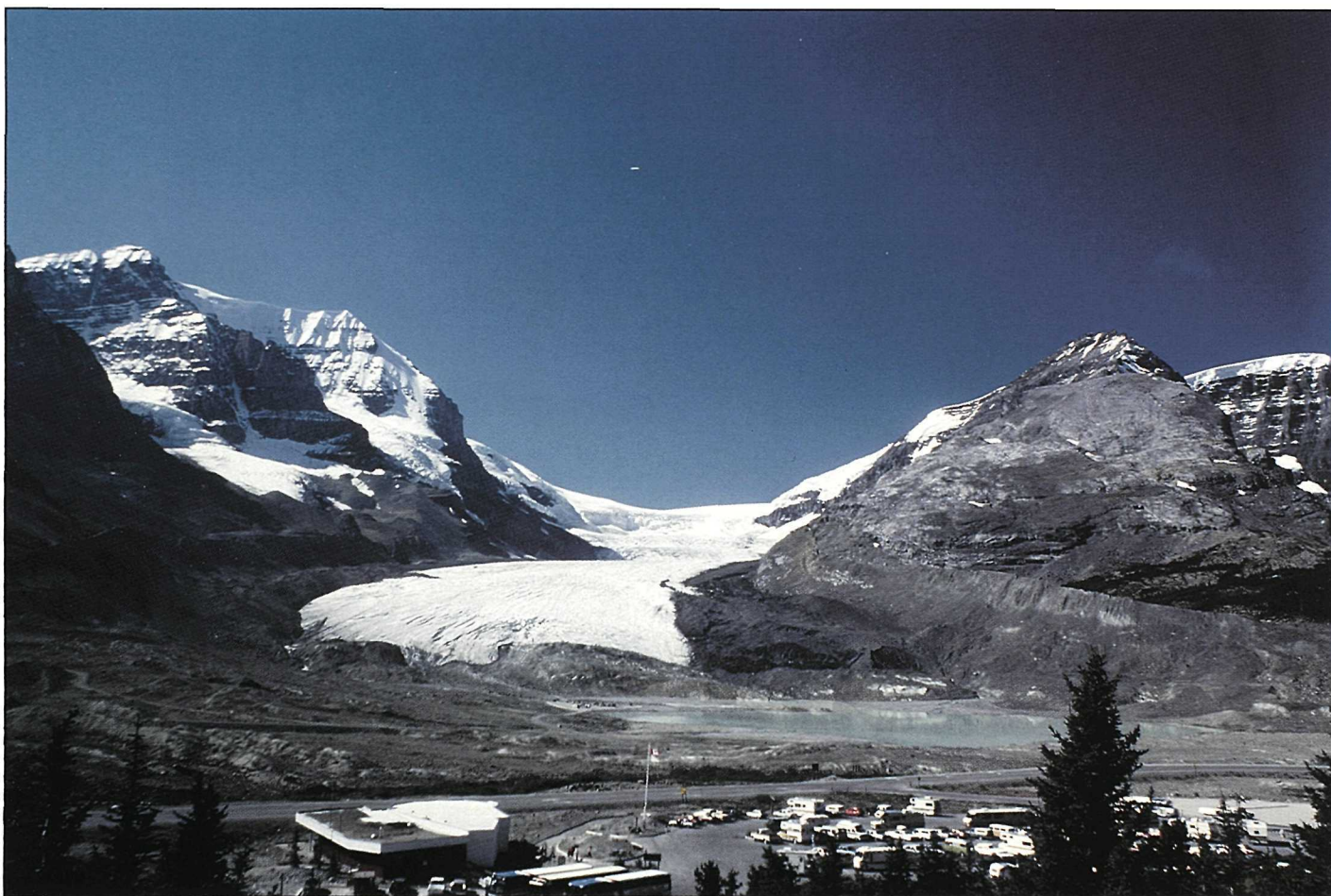
T On August 3, 1961, a cairn was unveiled to officially open the paved and realigned Icefields Parkway.

The Icefields Parkway opened the icefield and its glaciers not only to park visitors, but also to scientific study. The Athabasca and Saskatchewan glaciers have been monitored and the icefield itself has been probed for clues to the secrets of alpine and continental glaciation. Research continues today, revealing a wealth of information on climatic change and glacial processes.

In 1973 the new Icefield Centre was opened. Commanding a fine view of the Athabasca Glacier, it has become the major staging point for the visitors to the south end of Jasper National Park. It contains displays and exhibits and information staff to help visitors to understand the story of alpine glaciation and to learn more about the Columbia Icefield area.

Hundred of thousands of vehicles now use the Icefields Parkway each year, where only 50 years ago the only access was a week-long journey by horse through valleys barely known to man. Four national park campgrounds and two hostels accommodate visitors to the Columbia Icefield area, in addition to the expanded Icefield Chalet, a privately operated hotel. Visitors camp, hike, climb and explore self-guiding trails and exhibits in the area. Snowcoach tours and commercial tour guides allow visitors to travel safely onto the surface of the Athabasca Glacier.

For eons the ruling forces at the Columbia Icefield have been rock, ice, weather and time. In less than a century, man has joined these ancient forces as a formidable influence on the landscape. At the same time that we enjoy and admire the glaciers, peaks and wildlife, we have changed them with our facilities and continue to change them through our very presence.



Today thousands of visitors admire the Athabasca Glacier each year.

THE ICE AND US

6

A visitor to the Columbia Icefield today travels through broad valleys that were carved by glaciers centuries ago. The roads and railroads upon which the visitor travels were built with gravel and fill from

glacial deposits. The rivers and streams along the way carry water that was glacier ice only a day or two earlier.



Most of Canada was carved and shaped by glaciers; today the Columbia Icefield survives to remind us of our country's icy past.

ICE RESERVOIRS

Icefields, glaciers and the perennial snows of the high Rockies act as natural reservoirs which collect snow throughout the fall, winter and spring, and gradually release it as meltwater in summer. Long after the spring runoff is past, glaciers along the Great Divide feed a constant supply of

meltwater into the river systems of the Prairies. Water from the Columbia Icefield crosses all three prairie provinces, helping to turn hydro-electric generators, irrigate crops, water cattle and quench thirsts from Rocky Mountain House to York Factory.

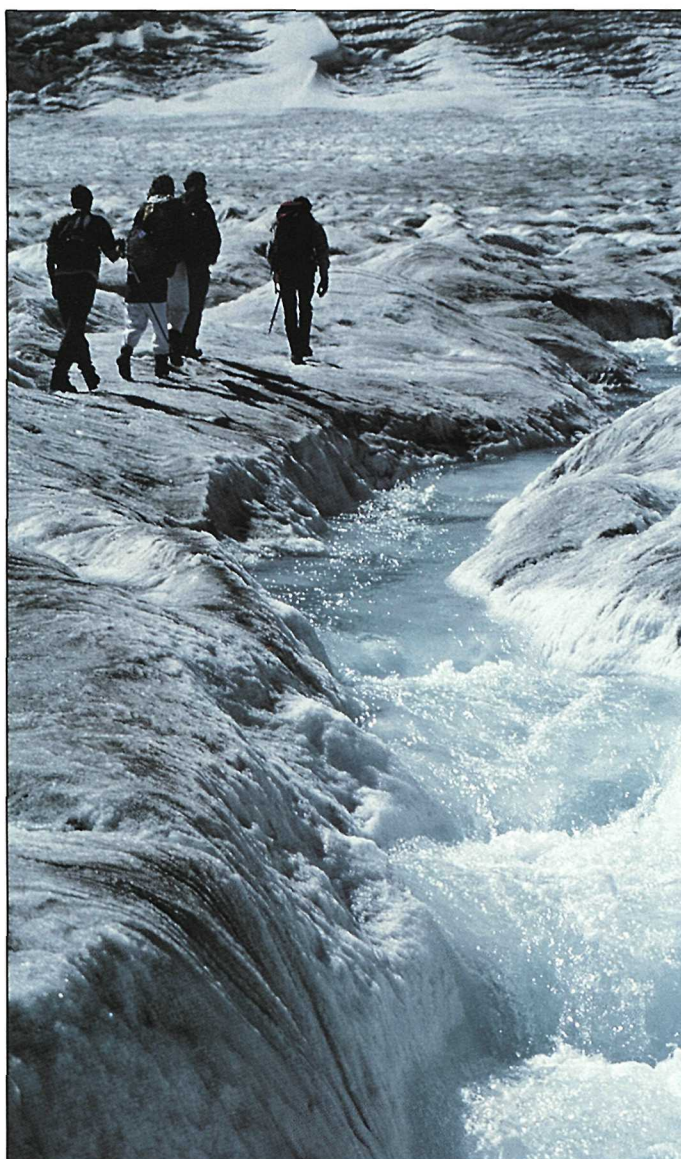


There is no denying the effects glaciers have upon our lives. As the mountains see time, it was only yesterday when the great glaciers covered most of Canada. Today we grow wheat on silt left at the bottoms of glacial lakes. We quarry gravel from old moraines, and take hydro-electric power and drinking water from glacier-fed rivers. The hills and valleys that describe our landscapes and confine our travels were carved and shaped by flowing ice. In ways we can scarcely imagine, the great glaciers of the past rule our present existence.

At the Columbia Icefield the past and present come together in a spectacular array of mountain peaks, glacier ice and meltwater torrents.

Here, cupped among the highest of the Rocky Mountains, snow falls and becomes ice, ice flows and grinds rock, and plants and animals struggle to colonize ground that has been covered by glacier ice for thousands of years.

Visitors to the Columbia Icefield pause awhile, dressed warmly against the cold glacier winds, and try to decipher the centuries-old story of the encounter between rock and ice. It is an encounter seemingly as alien to us as it is spectacular, but in the story of flowing ice, eroding rock and running water we read the story of the land in which we live.



EXPLORING JASPER NATIONAL PARK

E If you have enjoyed finding out about alpine glaciation in the Columbia Icefield area, you might be interested in some of Jasper National Park's other stories. Three other publications in this series deal with other aspects of the park's natural history:

Maligne: Valley of the Wicked River - describes the geology, natural history and underground drainage systems of the Maligne Valley, with numerous illustrations.

Mount Edith Cavell: In the Heart of the Subalpine - an illustrated guide to life in the subalpine life zone, which includes much information that also applies to the Columbia Icefield area.

The Whistlers: Upper Limits of Life - an illustrated guide to life in the alpine zone, which

includes much information that also applies to the Columbia Icefield area.

Exhibits, signs and self-guiding trails are available in several parts of Jasper National Park. Among the areas where park interpretive media are available are:

Icefields Parkway - land, life and man in the shadow of the Great Divide

The Whistlers - the alpine life zone

Mount Edith Cavell - the subalpine life zone

Maligne Valley - landscape sculpturing

Fiddle Valley - geology of the Rocky Mountain Front Ranges



FURTHER READING

F Canadian Parks Service. **The Columbia Icefield/The Athabasca Glacier.**

Environment Canada, Calgary. 1983.

– a brochure which summarizes the features of the Athabasca Glacier area.

Canadian Parks Service/Inland Waters Directorate. **Columbia Icefield.** Environment Canada, Ottawa. 1980.

– a 1:50,000 map with full color display of vegetation and landform features and shaded topographical relief. The reverse side of the sheet contains natural history and visitor information.

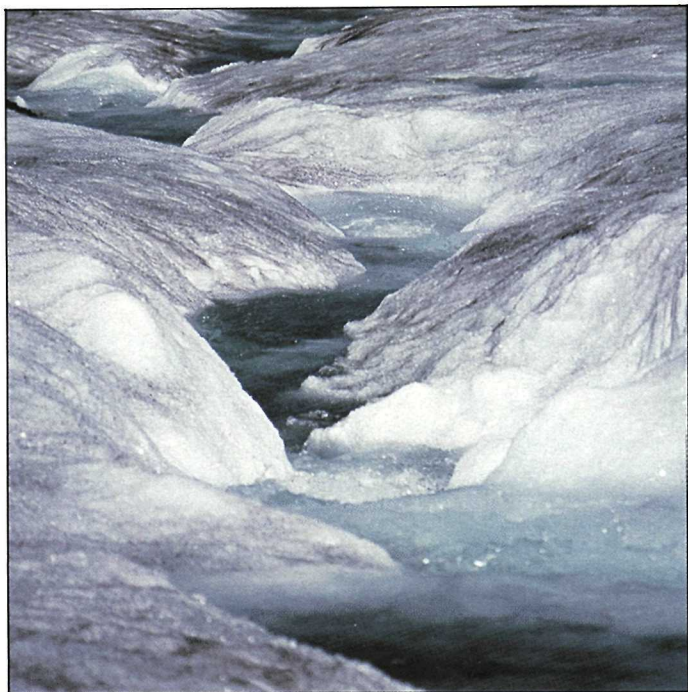
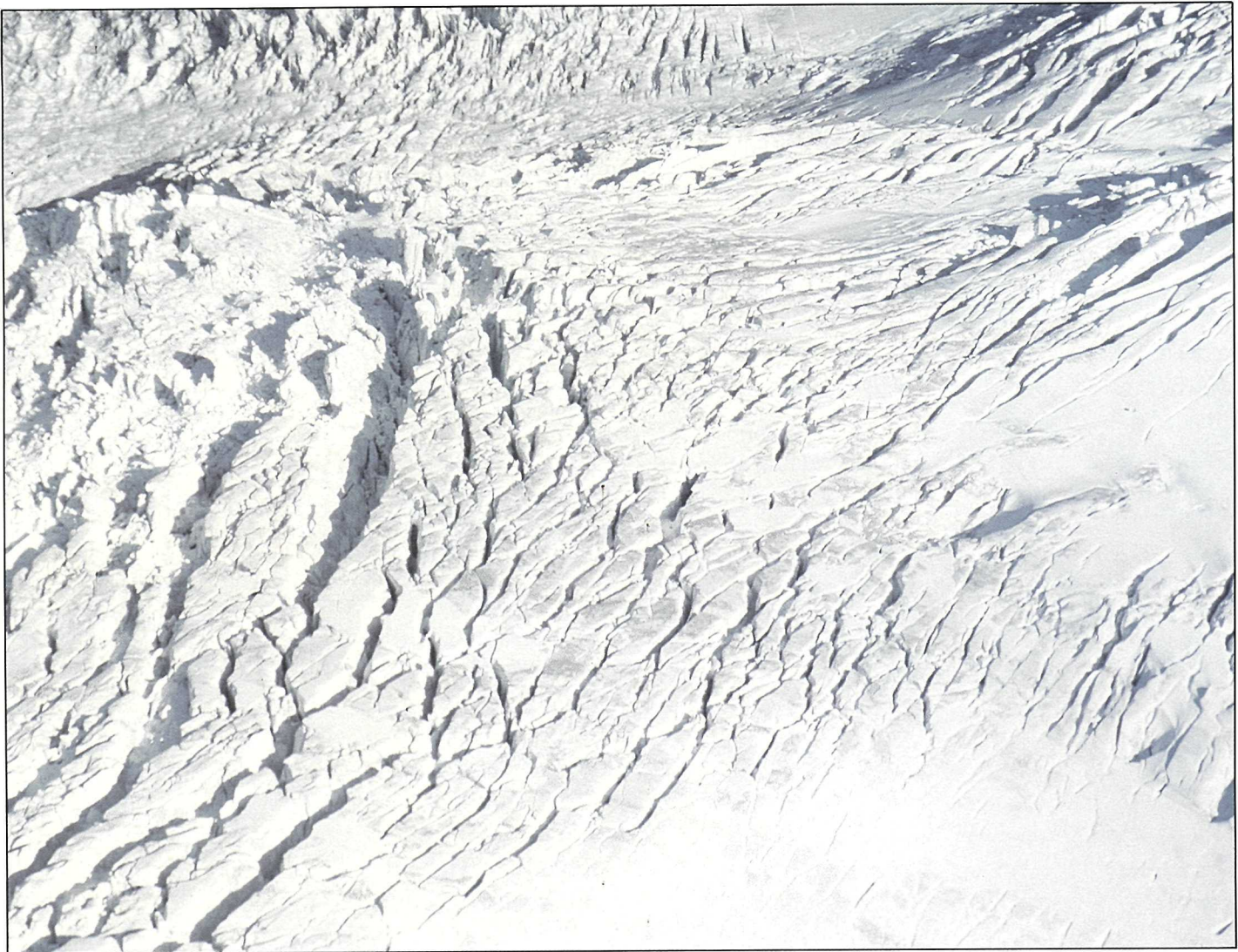
Kucera, Richard E. **Exploring the Columbia Icefield.** Richard E. Kucera, Vancouver. 1976.

– a detailed and scientific guide to the dynamics and features of the Athabasca Glacier, written by a scientist who has done several years of research in the area.

Robinson, Bart. **Columbia Icefield: A Solitude of Ice.** Altitude Publishing, Banff. 1981.

– an assemblage of original photography and text in coffee-table book format.





Finding More Information:

For additional information about the Columbia Icefield area and other aspects of Jasper National Park, please write to:

Superintendent
Jasper National Park
P.O. Box 10,
Jasper, Alberta T0E 1E0

Cette publication est aussi disponible en français

Published by the authority of the
Minister of the Environment in cooperation with
Parks and People, Jasper.

© Minister of Supply and Services Canada, 1987
En Publication No. QS W211 - 000 - EE - A1
Cat. No. R63-170/1987E
ISBN 0-660-12194-8

Additional copies of this and the three other
publications in this series are available from:

Parks and People, Jasper
P.O. Box 992
Jasper, Alberta
T0E 1E0

Text:

Eric Bailey, and Kevin Van Tighem,
Interpretive Service, Jasper National Park

Design and Illustrations:

One Plus One Art Studios Ltd.

Editing and Printing Coordination:

Information Services, Parks,
Western Regional Office, Calgary

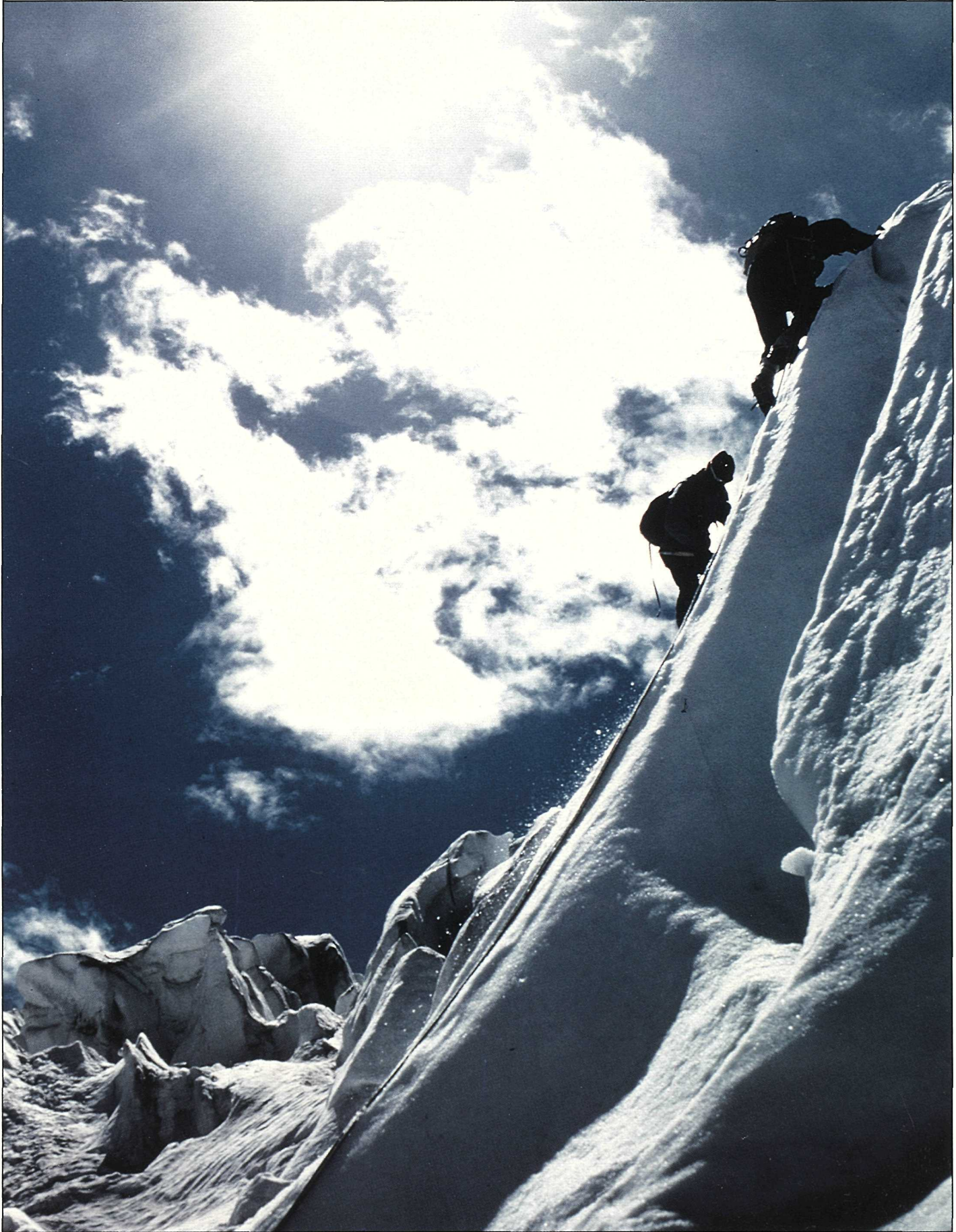
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Caution on Glaciers!

Glaciers are dangerous. You could slip on the ice, or fall onto a deep crevasse.

Never venture onto a glacier unless you have experience and knowledge about glacier travel, or are with a certified guide. Do not put yourself or your party at serious risk.





Parks and People



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COLUMBIA ICEFIELD

ICE APEX OF THE CANADIAN ROCKIES



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