Tuktut Nogait: Rivers and Rocks

Robert Rainbird

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Dedication

This book is dedicated to the people of Paulatuk, Northwest Territories, and in particular, to our memories of Frances Wolki and Jonah Nakimayak, who worked as part of our field research team in 2015, and who both sadly passed away the following year. Thank you Frances and Jonah.

Frances Wolki and Jonah Nakimayak.

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Foreword

Tuktut Nogait National Park is one of those places that is at the same time endlessly fascinating, very beautiful and ultimately unfathomable. It's a place we can glimpse only through its many complementary dimensions and perspectives. This book is an opportunity for those who will never be able to visit this place to appreciate at least some of its beauty and to understand its purposes and what it protects.

The primary purpose of the park is to protect the Bluenose-West caribou herd and its calving grounds, and the calving grounds remain relatively remote from the community and undisturbed by the Inuvialuit.

Several years ago, Dr. Robert Rainbird and his colleagues at the Geological Survey of Canada (GSC) at Natural Resources Canada, informed the Tuktut Nogait National Park Management Board and Parks Canada of the GSC's interest in conducting geological research into the ancient origins of Tuktut Nogait and its surrounding geology. We supported and approved this research.

This book presents us with the oldest perspective of all: it is a glimpse into one of the early chapters of the history of Earth itself. Through their research, and the canyons formed by the relentless erosion of the Hornaday, Brock and Roscoe rivers, Rob Rainbird and his colleagues allow us to look back hundreds of millions — even billions — of years. When we consider that the human species has inhabited the Earth for only a few tens of thousands of years, these time periods strain the limits of our comprehension. They help liberate us from self-centredness.

Rob Rainbird's research, and the photographs in this book that follow, stir the imagination and our sense of the endless possibilities that emerge each moment, when we open our minds.

Tom Nesbitt
Chair of the Tuktut Nogait National Park Management Board

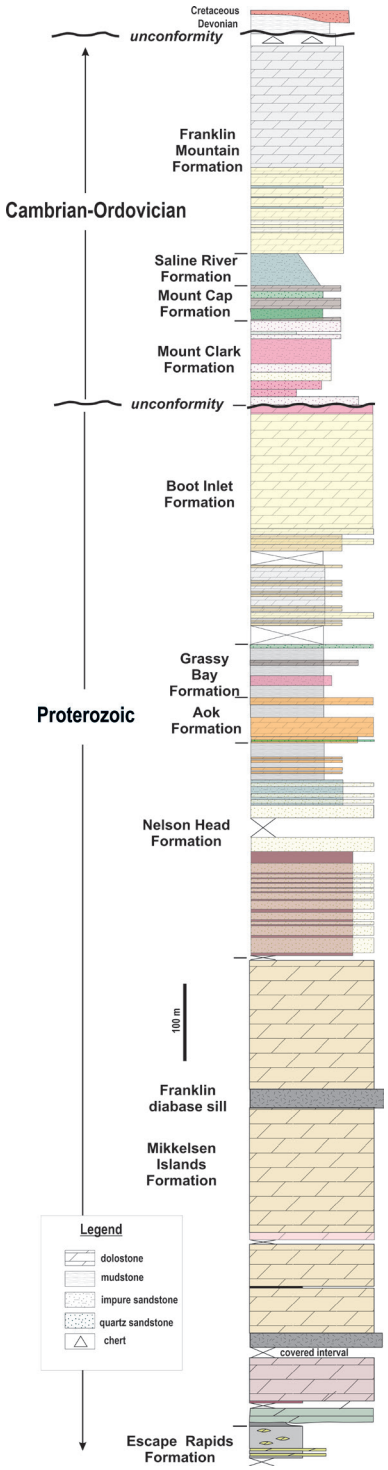
Introduction

Tuktut Nogait is a national park located near the western Arctic coast, just east of the hamlet of Paulatuk in the Northwest Territories. Meaning “young caribou” in Inuvialuktun, Tuktut Nogait is the main calving grounds of the Bluenose-West caribou herd. The park encompasses more than 18,000 square kilometres and is located 170 kilometres north of the Arctic Circle.

The upland region of the park, mostly composed of ancient Precambrian bedrock, is known in geological terms as the Brock Inlier – an inlier is an area of older rocks that’s surrounded by younger ones. The bedrock is variably covered by surficial sand and gravel, mostly deposited during the Wisconsinan continental glaciation, approximately 10,000 years ago.

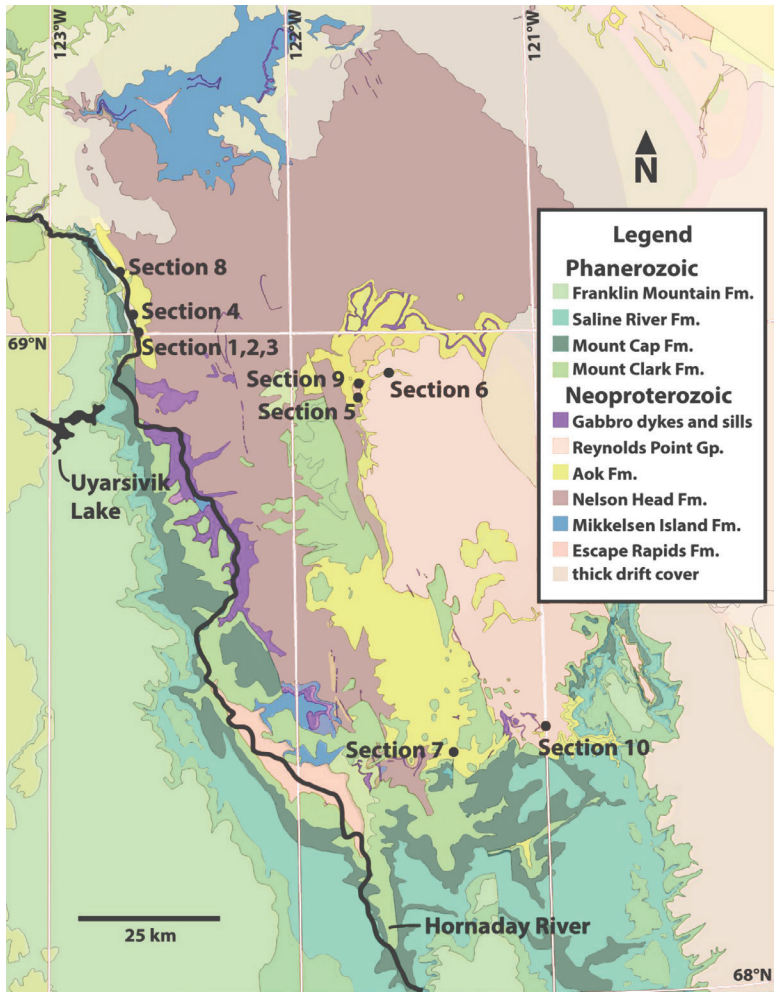
The region is drained by three main rivers: the Hornaday River, the Brock River and the Roscoe River. All follow the northwesterly slope of the land, leading into the Amundsen Gulf (Arctic Ocean) at Darnley Bay. Where they leave the uplands, the three rivers have carved deep and precipitous canyons. These canyons offer spectacular views of sedimentary rocks (limestone, dolostone, sandstone and shale) whose layers represent the deposits of ancient seas and rivers that occupied this region around 1 billion years ago. Dark layers represent magma that intruded the sedimentary rock layers about 700 million years ago. Younger sedimentary rocks occur on top of the older layers, representing deposition after prolonged periods of erosion.

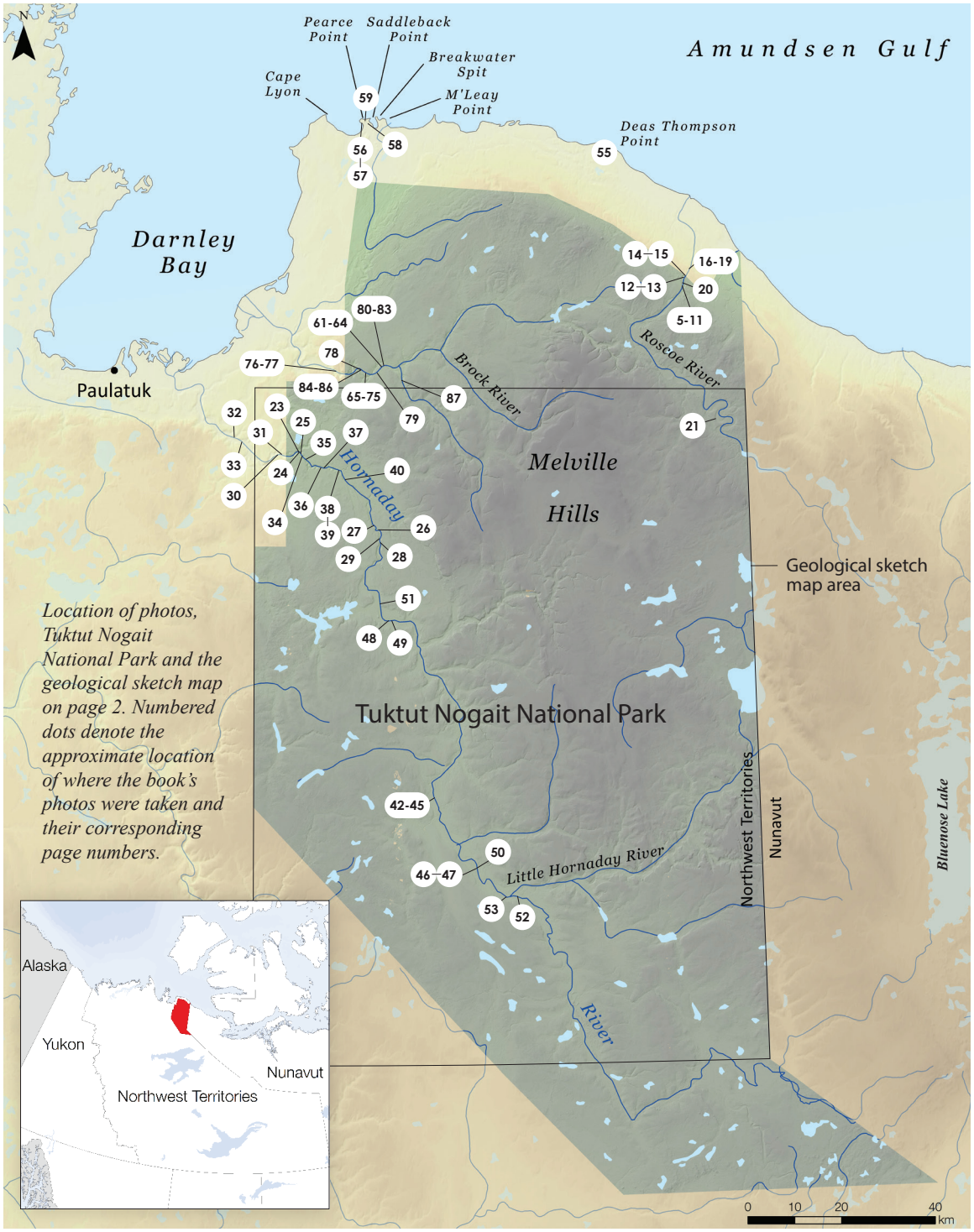
This book features photographs taken mainly from a helicopter during the summers of 2014 and 2015, when a GSC field mapping party, led by Robert Rainbird, was conducting a project to map the geology of the Brock Inlier.



The composite stratigraphic column on the left depicts the type and thickness of the various sedimentary rocks found in Tuktut Nogait. The column is derived from smaller (thinner) sections that were measured at various locations shown on the geological sketch map below. The width of the column varies according to how resistant the different rock types are to weathering – rocks such as dolostone are more resistant to weathering and are therefore shown as being wider.

Below is a bedrock geological sketch map that is representative of the geology of Tuktut Nogait National Park. Formations referred to in the photograph captions are listed in the geological sketch map's legend and the stratigraphic section.




N
Amundsen Gulf
Pearce Point
Saddleback Point
Breakwater Spit
M'Leay Point
Cape Lyon
Deas Thompson Point
Darnley Bay
Paulatuk
Brock River
Roscoe River
Hornaday
Melville Hills
Geological sketch map area
Location of photos, Tuktut Nogait National Park and the geological sketch map on page 2. Numbered dots denote the approximate location of where the book's photos were taken and their corresponding page numbers.
Tuktut Nogait National Park
Little Hornaday River
River
Northwest Territories
Nunavut
Bluenose Lake
Alaska
Yukon
Nunavut
Northwest Territories
0 10 20 40
km

Roscoe River

The Roscoe River flows northwestward for approximately 100 kilometres from its headwaters at Bluenose Lake in western Nunavut (see map on p.3). Like the Brock River, this section of the river follows an old meandering meltwater channel carved into glacial till and morainal deposits.

This channel used to follow the Brock River but was captured and diverted northward into the Roscoe River as its headwaters migrated southward because of post-glacial uplift. At the point of capture, the river takes a 90 degree turn and continues northward for another 35 kilometres to its confluence with the Amundsen Gulf. Similarly to the Hornaday River, this part of the river cuts down through Paleozoic limestone and sandstone into more resistant Proterozoic dolostone, forming a narrow, steep-walled slot canyon for an approximately 10 kilometre-long stretch. The final section of the river forms a small braided channel across marine sediments associated with a postglacial sea.

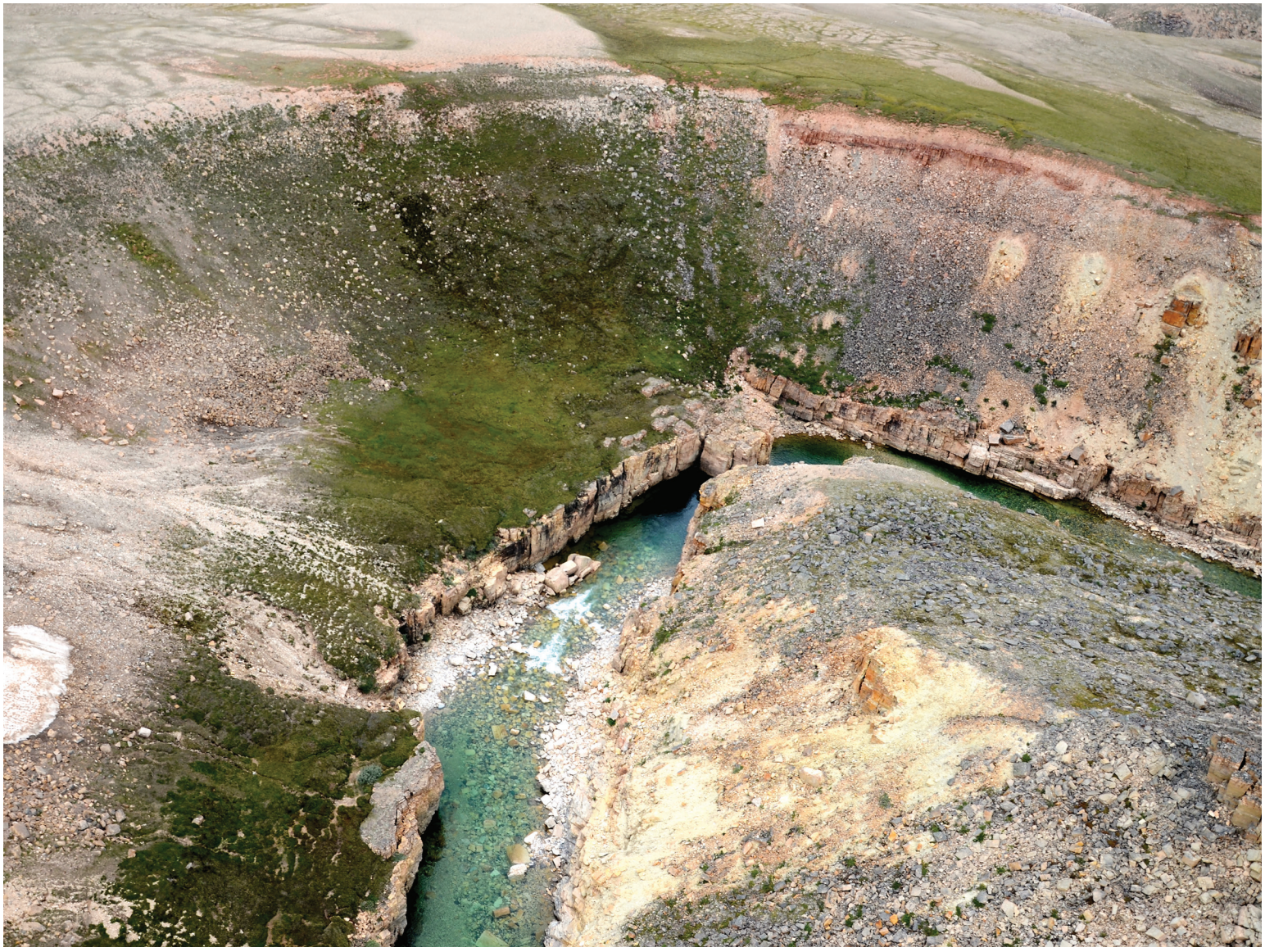
A short, approximately 150-metre long, slot canyon on the Roscoe River's northern segment offers a spectacular exposure of tabular-bedded dolostones from the Proterozoic-age Boot Inlet Formation. These rocks are the remnants of a huge, shallow-water reef structure that extended for more than 1,000 kilometres, from western Victoria Island to the Mackenzie Mountains, on the Northwest Territories-Yukon border. Unlike modern-day reefs, composed of coral and other macroscopic animals, Proterozoic reefs are composed of microbially constructed structures called stromatolites.

ROSCOE RIVER

ROSCOE RIVER

Water draining the lower reaches of the Roscoe River cascades down through a series of waterfalls in a canyon that exposes sandstone and shale of the Cambrian-age Mount Cap and Mount Clark formations. In the walls of the canyon, one can also see dark limestone and dolostone of the underlying, Proterozoic-age, Boot Inlet Formation.

ROSCOE RIVER



ROSCOE RIVER

ROSCOE RIVER

ROSCOE RIVER

ROSCOE RIVER

ROSCOE RIVER

ROSCOE RIVER

ROSCOE RIVER

A high-resolution satellite image mosaic showing an old meandering channel along the upper reaches of the Roscoe River. Vegetation along the current channel suggests that water flow along this part of the river has diminished significantly. Image source: Digital Globe.

Hornaday River

The Hornaday River originates from a high plateau along the Northwest Territories-Nunavut border, approximately 200 kilometres southeast of the hamlet of Paulatuk, which is approximately 5 kilometres west of where it empties into Darnley Bay and the Amundsen Gulf (see map on p.3).

The upper reaches of the river were discovered in 1868 by Émile Petitot, a French Missionary Oblate and notable cartographer and ethnologist. He named it Rivière La Roncière-Le Noury in honour of Admiral Clément La Roncière-Le Noury, commander of the Mediterranean Squadron and president of the Société de Géographie de France. The lower reaches of the river were discovered in 1899 and named the Hornaday River after American zoologist William Temple Hornaday. It wasn't until decades later that the La Roncière and the Hornaday were ascertained to be the same river.

In its upper reaches, and along its main tributary — the Little Hornaday River — the channel is very sandy and winds through low hills composed of sedimentary rock that are partly covered by glacial till. During spring meltwater flooding, the sand is sculpted into large dunes, which later become exposed along the river shore when water levels drop in the summer. The lower reaches of the river cut through thick layers of sandstone, shale and carbonate rocks of Proterozoic and Paleozoic age. Canyon walls become progressively higher, eventually attaining a maximum height of approximately 150 metres below La Roncière Falls, a spectacular 25-metre waterfall. Near the end of the river, the surrounding topography flattens, and the river widens into a broad delta, which fans out into Darnley Bay.

Alternating layers of sandstone, shale and limestone composing the Cambrian-age Mount Cap Formation are exposed at La Roncière Falls, considered to be one of the visual centrepieces of Tuktut Nogait National Park. An approximately 20-metre thick sandstone layer, in the centre of the image, is more resistant to erosion and forms the cliff over which the water falls.

HORNADAY RIVER

HORNADAY RIVER

HORNADAY RIVER

HORNADAY RIVER

Beautiful section exposing interbedded sandstone and shale of the uppermost Nelson Head Formation and its abrupt contact with orange-weathering stromatolitic dolostone of the Aok Formation (cliff at top).

HORNADAY RIVER

Dolostone cliffs of the Ordovician-age Franklin Mountain Formation.

Distinctly layered red and grey siltstone and sandstone of the Devonian-age Bear Rock Formation draping and infilling an ancient valley developed on tan-coloured limestones of the underlying Ordovician-age Franklin Mountain Formation along the lower reaches of the Hornaday River. The canyon wall is approximately 150 metres high. Another "paleovalley" is evident in the image on the right. Note how the layers are more curved at the base but flatten out upward indicating that the paleovalley was gradually infilled.

HORNADAY RIVER

Cambrian-age Mount Cap Formation, south of La Roncière Falls.

View looking north toward La Roncière Falls.

HORNADAY RIVER

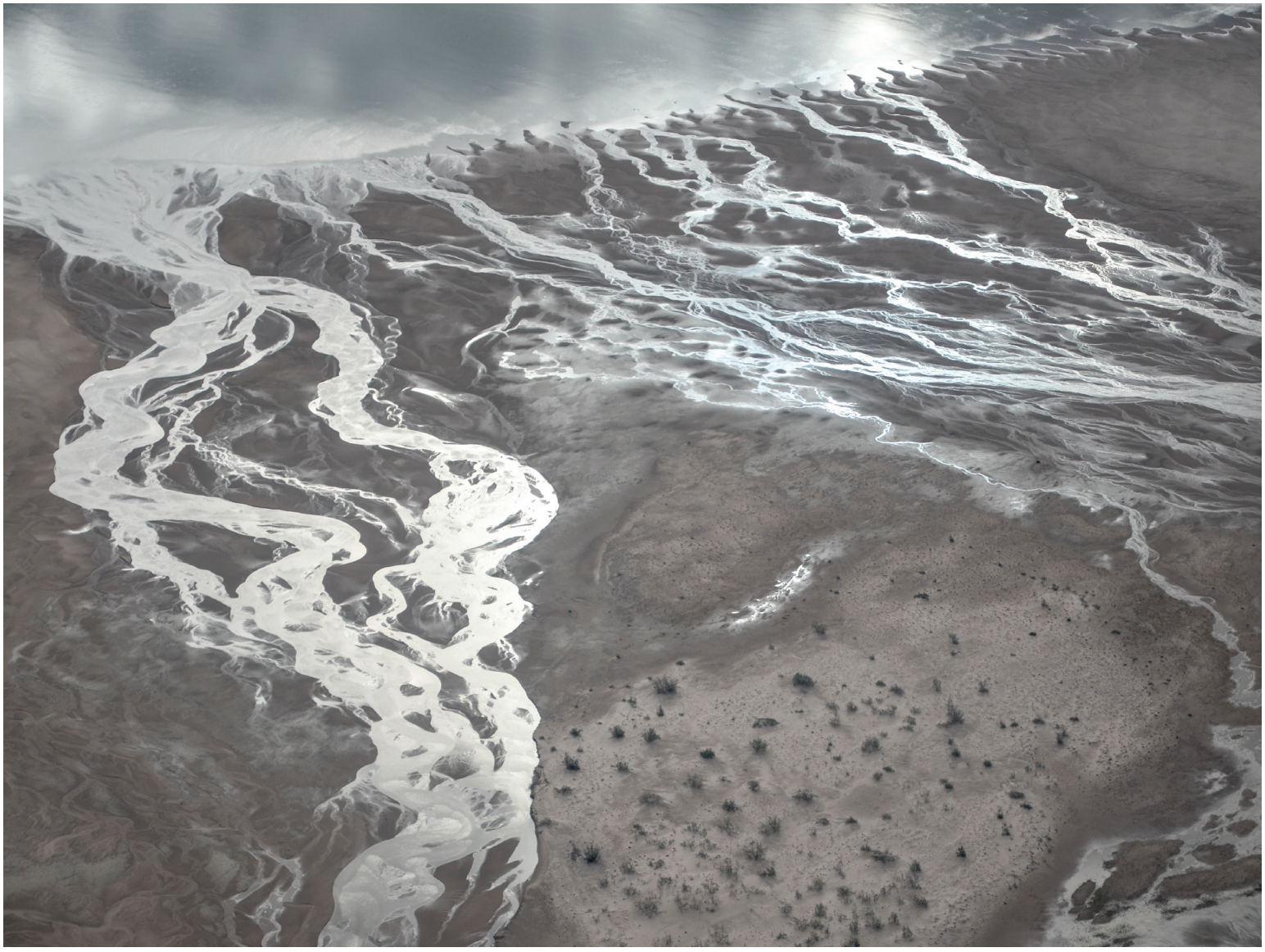
In this image, reddened, pancake-like outcrops of Proterozoic-age dolostone in the foreground (Boot Inlet Formation) are overlain by rust-coloured, Cambrian-age sandstone and shale (Mount Clark Formation). The contact between those formations, shown in more detail in the image on the right, is at the base of the cliff and is called an unconformity because it represents a discontinuity in sedimentation; a gap in time of approximately 400 million years. The underlying Boot Inlet Formation rocks are normally tan to buff-coloured but have been reddened by oxidation during the time gap, when the rocks were exposed to surface weathering processes.

HORNADAY RIVER

Rusty weathered dolostone of the Boot Inlet Formation cut by a small fault. This is represented by a crack in the shadowy gully on the cliff side of the river.

Along the channel margins of the upper reaches on the Hornaday River, one can find deposits of sand mixed with loess – silt that has been winnowed (separated) out of glacial till by wind and redeposited. These deposits offer a stable substrate for establishment of small shrubs, such as Arctic willow.

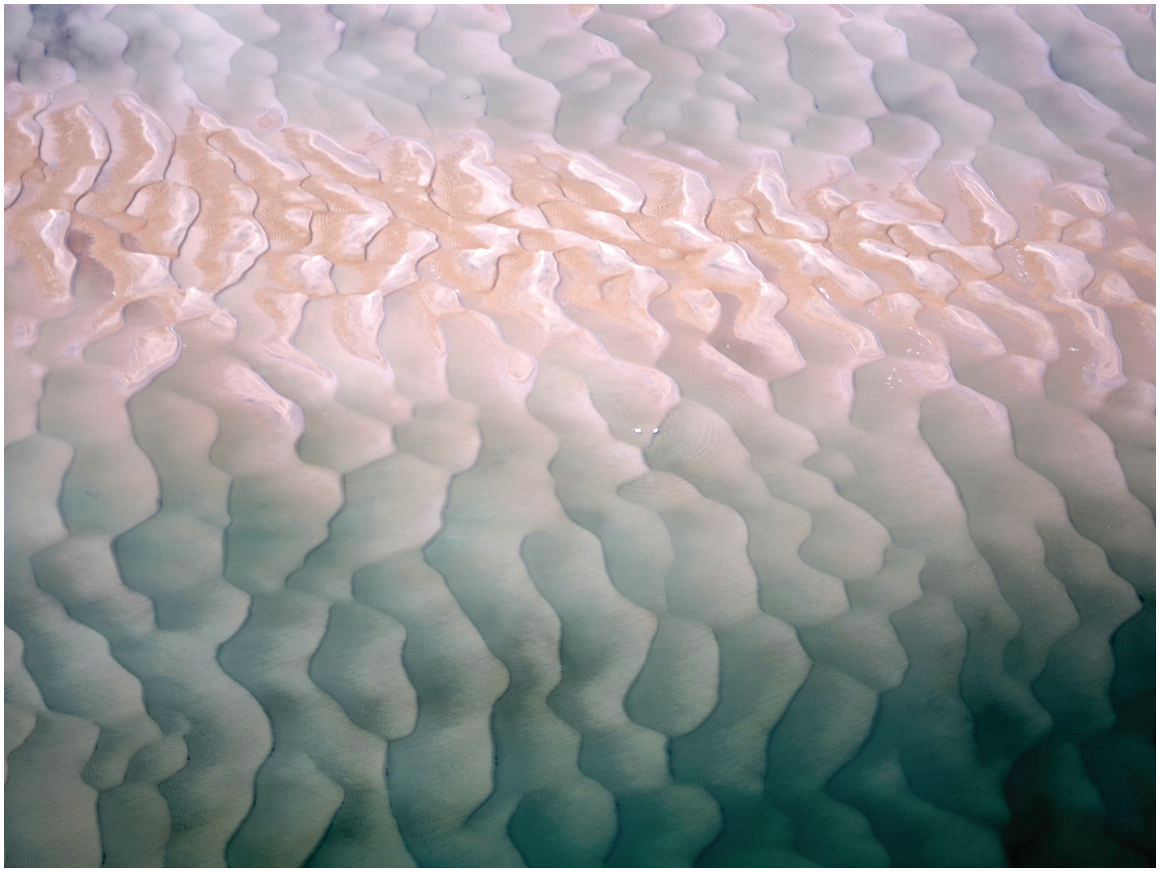
HORNADAY RIVER



Sand and loess deposits along the edge of the Hornaday River.

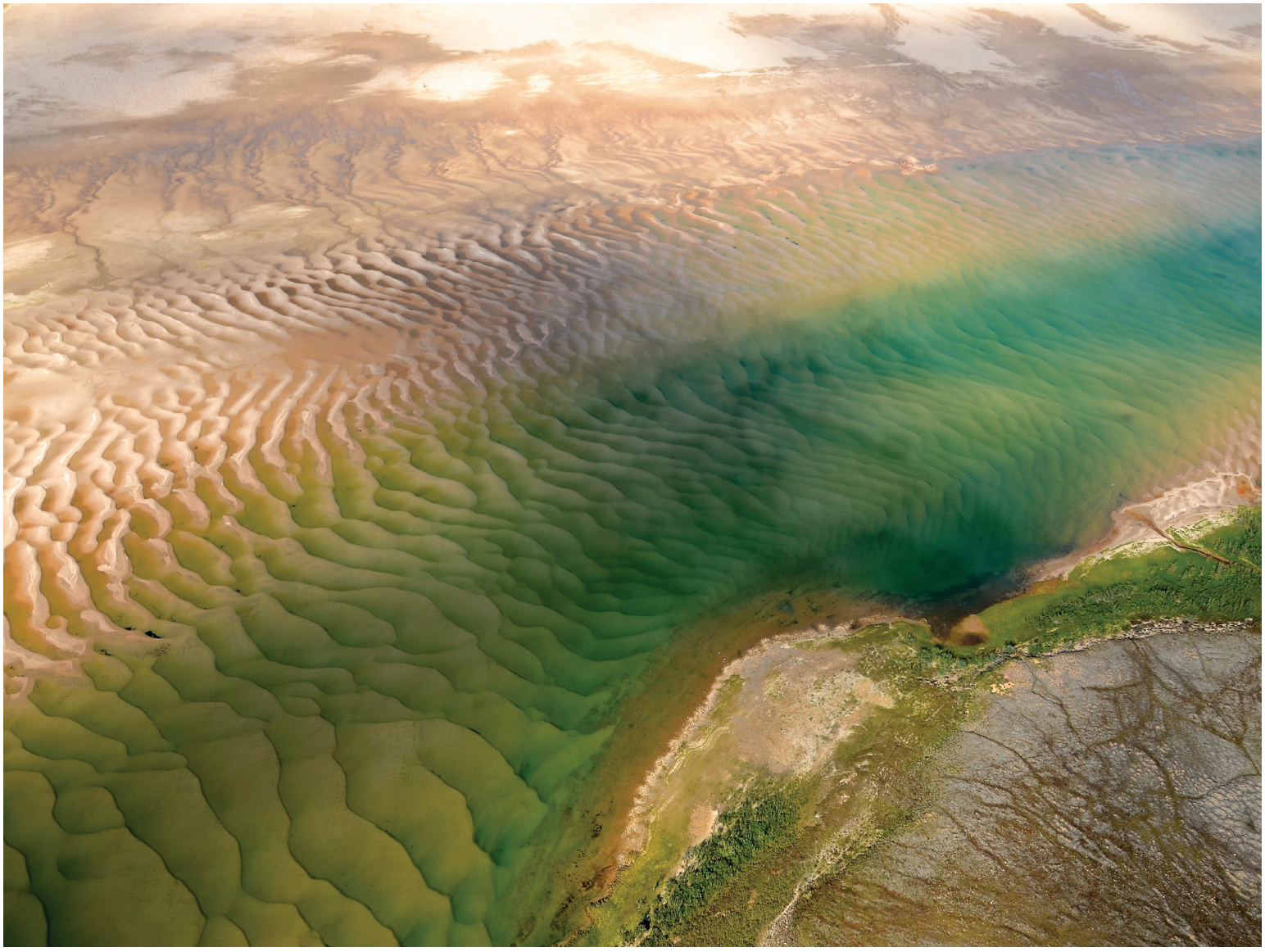
A series of images showing the development of spectacular subaqueous sand dunes. These form in the spring when the water is deeper and flow in the river (from left to right) is much stronger. As the water levels drop throughout the short summer, the dunes emerge at the shallower edges of the channel. The deepest part of the channel is marked by the darkest hues of green.

The streaks or striations in the center of the image were probably formed by ice as it was dragged along the river bottom during spring break-up.



Current-formed dunes in the main channel. Note the pair of swans in the middle of the image, which gives one a sense of the scale of these sedimentary structures. The crests of the dunes in the upper part of the image are emergent (above water) and have been flattened slightly by wind action.

A close-up of subaqueous dunes, which migrate slowly from left to right as sand is moved downstream by the river's current. Current-formed dunes are asymmetrical, being shallow on the upstream side and steep on the downstream side.



A small meandering stream entering the Hornaday River. The end of the channel has been captured by the bigger channel of the Hornaday. Note the development of pattern ground (ice-wedge polygons), formed by the freezing and thawing of ground ice (permafrost), along the river's flood plain.

The confluence of the Little Hornaday (top of the image) and Hornaday rivers. This image was taken in mid-August when water levels in the rivers are generally quite low. Note that the Little Hornaday's channel is being cut off by a large mid-channel bar in the Hornaday – flow in the Hornaday River is from right to left.

Amundsen Gulf

The Amundsen Gulf coastal region in the Arctic is part of the northern border of Canada's mainland (see map on p.3). The photographs from this region include coastal scenes from eastern Darnley Bay, Cape Lyon, and Pearce Point, stretching as far southeast as Clinton Point, near the Northwest Territories-Nunavut border.

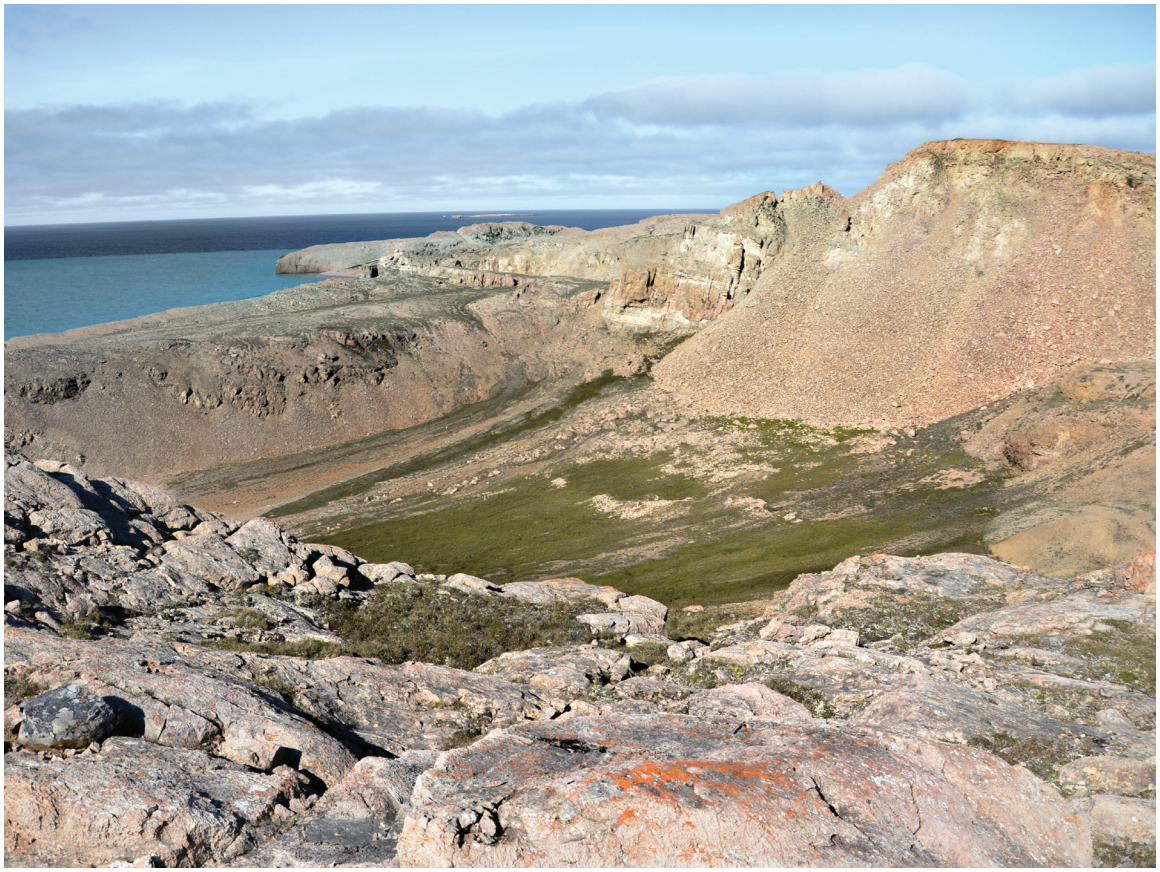
The region is characterized by barren plains composed of glacial till and outwash that gently slope toward the ocean and muddy marine sediments now exposed because of post-glacial uplift. Sections of the coastline are marked by rocky headlands of Proterozoic-age dolostone, such as Pearce Point and Deas Thompson Point – they appear as low cliffs and near-shore islands that have been sculpted and undercut by the ocean's waves. Between the rocky headlands are broad crescentic bays with pebble beaches that accentuate the azure blue waters of the gulf region.

A cave, formed by wave erosion, in Proterozoic dolostone (Boot Inlet Formation) near Deas Thompson Point.

A peninsula composed of a dark igneous rock layer called a diabase sill, which has intruded tan-coloured dolostone (in the foreground), located south of Pearce Point. Photo looking westward to Cape Lyon, in the distance.

Looking east at the tip of the peninsula shown on the opposite page (the dark cliff on the right).

Tilted layers of the Mikkelsen Islands Formation, looking east from Saddleback Point to the Breakwater Spit and M'Leay Point, in the distance.

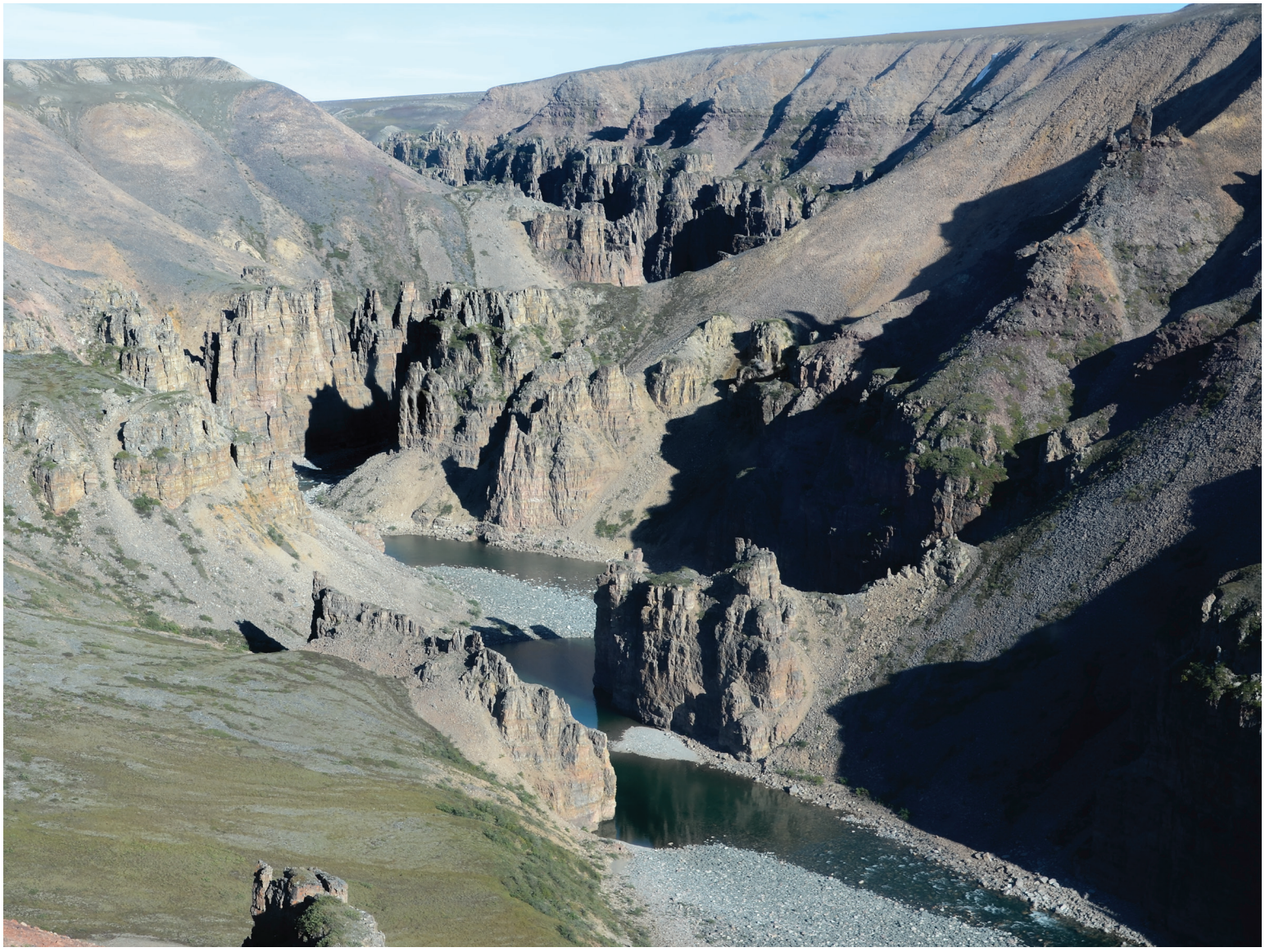


Dolostone cliffs of the Proterozoic-age Mikkelsen Islands Formation at Pearce Point.

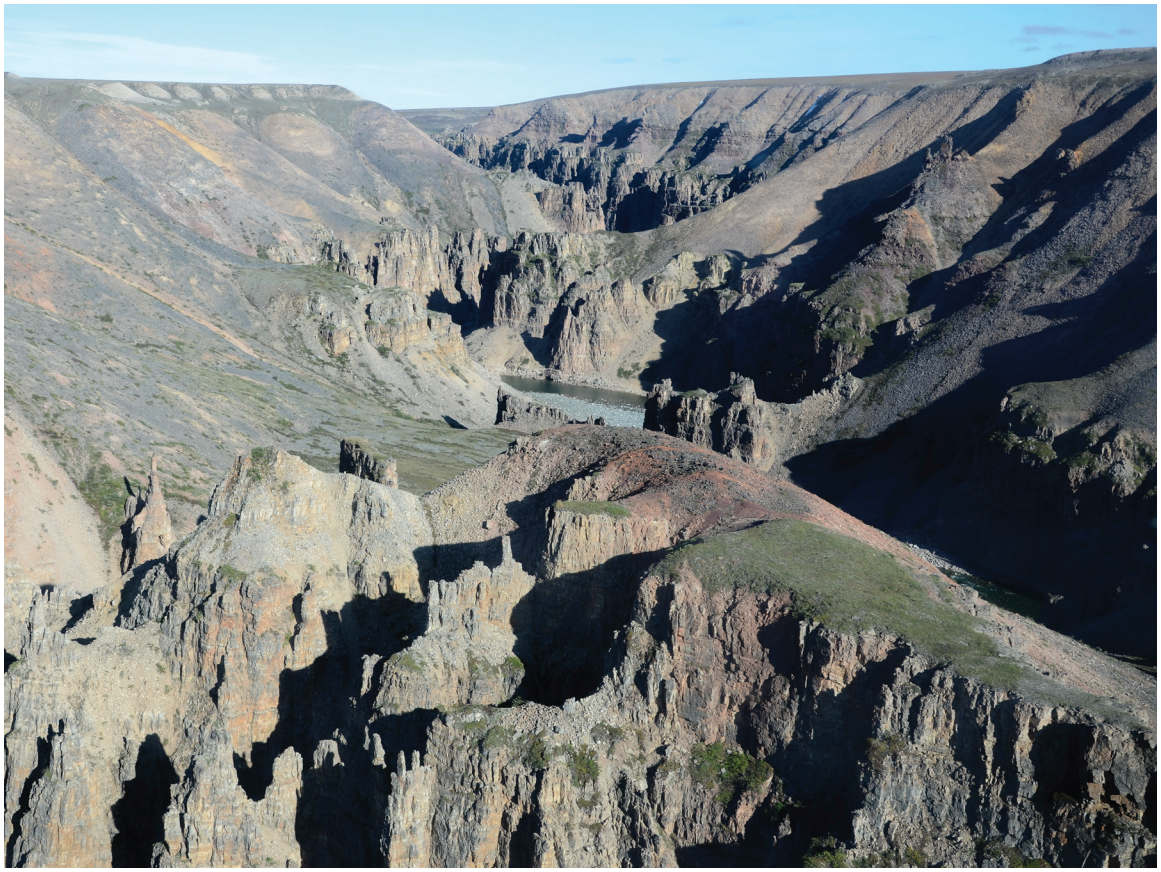
Brock River

The Brock River originates from the northern end of the Melville Hills, approximately 100 kilometres east of the hamlet of Paulatuk, which is roughly 30 kilometres southwest of where the river empties into Darnley Bay on the Amundsen Gulf (see map on p.3).

The upper reaches of the river meander through soft glacial till and sandy outwash deposits, following the path of meltwaters from glaciers that retreated from the area nearly 10,000 years ago. Flowing westward, it starts to carve down into Precambrian bedrock composed of rhythmically layered dolostone intruded by black igneous layers called diabase. The river then narrows into a winding, steep-walled canyon with pinnacles of the weathered dolostone on either side. Further downstream, the bedrock changes to sandstone, and the river widens into a sandy, braided channel, which cuts down through broad terraces deposited by the earlier glacial rivers.



BROCK RIVER



The main canyon of the Brock River features craggy pinnacles of resistant, Proterozoic-age dolostone, which are overlain by rubbly weathering sandstone of the Nelson Head Formation, also of Proterozoic age. Unconsolidated, Quaternary-age, glacial till and gravel outwash deposits compose the uppermost terrace on the left (see the image on page 82 for an aerial view).

BROCK RIVER

BROCK RIVER

BROCK RIVER

BROCK RIVER

Pinnacled cliffs composed of resistant carbonate rock (dolostone), part of the Proterozoic-age Mikkelsen Islands Formation. The rock is rythmically layered, consisting of alternating pale grey-weathering and medium brown weathering dolostone in cycles that are typically 1 to 2 metres thick. The cyclicity is caused by alternating environmental conditions in the shallow marine waters from which the carbonate was deposited, but the origin of that alternation is unknown.

A fault, running down the gully on the left side of the image, is identified by the change in tilt of dolostone layers on either side of it. The dark rock near the water is diabase sill (see p.80 for explanation).

BROCK RIVER

A hole in the wall: an unusual natural opening in a relatively thin cliff wall composed of layered dolostone near the lower end of the Brock River canyon. The hole is at the top of a long fracture, indicating that this is probably a zone of weakness, which likely opened up as water gradually began flowing through it.

BROCK RIVER

Sand and gravel (glacial outwash) deposits along the lower reaches of the Brock River.

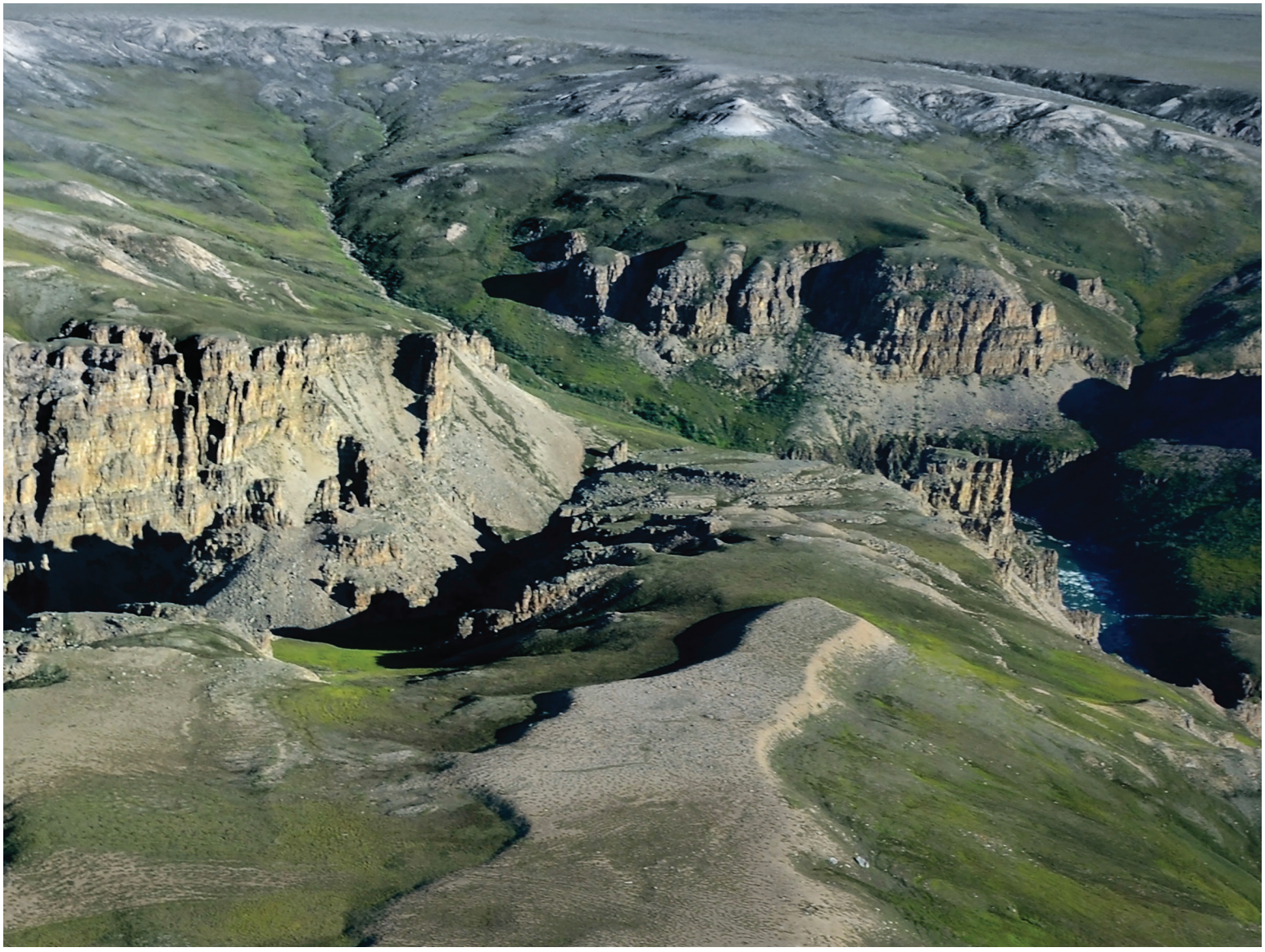
BROCK RIVER

BROCK RIVER

Layered dolostone of the Mikkelsen Islands Formation overlain by a dark igneous rock called diabase. The diabase represents hot magma that was intruded into the limestone approximately 720 million years ago. These rocks are evidence of an extensive magmatic episode, known as the Franklin Event, that occurs all across the northern mainland and the Arctic islands of the Northwest Territories, northern Yukon, and Nunavut.

BROCK RIVER

A view looking down on weathered pinnacles of Proterozoic-age dolostone.



An aerial view of a Quaternary-age glacial outwash terrace on top of Proterozoic dolostone and sandstone deposits exposed in the Brock River canyon below.

A Geological Survey of Canada campsite on an old, uplifted river terrace. The western terminus of the river's main canyon is in the background.

An aerial view, looking west, of the Geological Survey of Canada's campsite with cliffs of the Nelson Head Formation sandstone in the background. The camp is on the lower of two old river terraces.

These flat, tabular-bedded, sandstone deposits of the Proterozoic-age Nelson Head Formation are the remnants of a transcontinental river system that originated from the Laurentian Mountains in eastern Canada, nearly 1 billion years ago.

Blue-weathering shale (interlayered mudstone and siltstone) of the Escape Rapids Formation exposed along a southern tributary to the Brock River. The shale is considered to represent sediments from a river delta that were deposited into a large lake or interior sea basin. It is the oldest formation in the region and was recently determined to be 1,070 million years old.

Acknowledgements

I would like to thank people of the hamlet of Paulatuk for access to their land and for their guidance, hospitality and gracious spirit. I would also like to thank Maya March and Renee Wissink of Parks Canada for their help with logistics and encouragement to move forward with this project. Funding was provided by the Geo-mapping for Energy and Minerals program of the Geological Survey of Canada (Natural Resources Canada) and by the Northwest Territories Geological Survey.

Maps and Technical Reports on the Geology of Tuktut Nogait

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This book is a tribute to the northern mainland coast of Canada's western Arctic: a rolling, barren plateau overlooking the Arctic Ocean, dissected by streams and rivers that have carved spectacular, rocky canyons into the landscape. Via compelling photographs and geological interpretations, the reader is transported to this vast and unforgiving wilderness, presenting a rare opportunity to tour this scenic area.

Inside you'll visit Tuktut Nogait, a national park that's also the calving ground of the Bluenose West caribou herd, whose name means "young caribou" in Inuvialuktun. You'll explore the landscape along the Hornaday, Brock and Roscoe rivers and the coast of the Amundsen Gulf, offering spectacular exposures of ancient sedimentary rocks (limestone, dolostone, sandstone and shale). These rocks represent the deposits of seas, rivers and glaciers that occupied this region thousands, millions, and even billions, of years ago.

This book of photographs is intended for readers who want to learn more about the geology and natural history of Tuktut Nogait, along with those who enjoy the pristine scenery and unique beauty of the Arctic. As a geologist with considerable experience in the region, Dr. Robert Rainbird expertly ties the striking patterns in the landscape with his knowledge of how these patterns were generated by the great forces of nature.

Dr. Robert Rainbird has explored Canada's Arctic since 1986, first as a graduate student at Western University, then as a research scientist with the Geological Survey of Canada, based in Ottawa. He is a field geologist specializing in sedimentology and stratigraphy of Precambrian sedimentary basins, of which the mountains and river valleys of the Northwest Territories and Nunavut hold some of the world's best preserved examples.

Rainbird's interest in photography stems from his work as a geologist, through which he is continually exposed to the striking beauty of natural patterns in the landscape. His appreciation comes from an understanding of how these patterns were generated by forces of nature that occurred hundreds to millions, and even billions, of years ago. It is with this deep appreciation that Rainbird offers this book, so that you, too, may share in the wonder and experience these rarely seen landscapes.

Photo by Galen Halverson