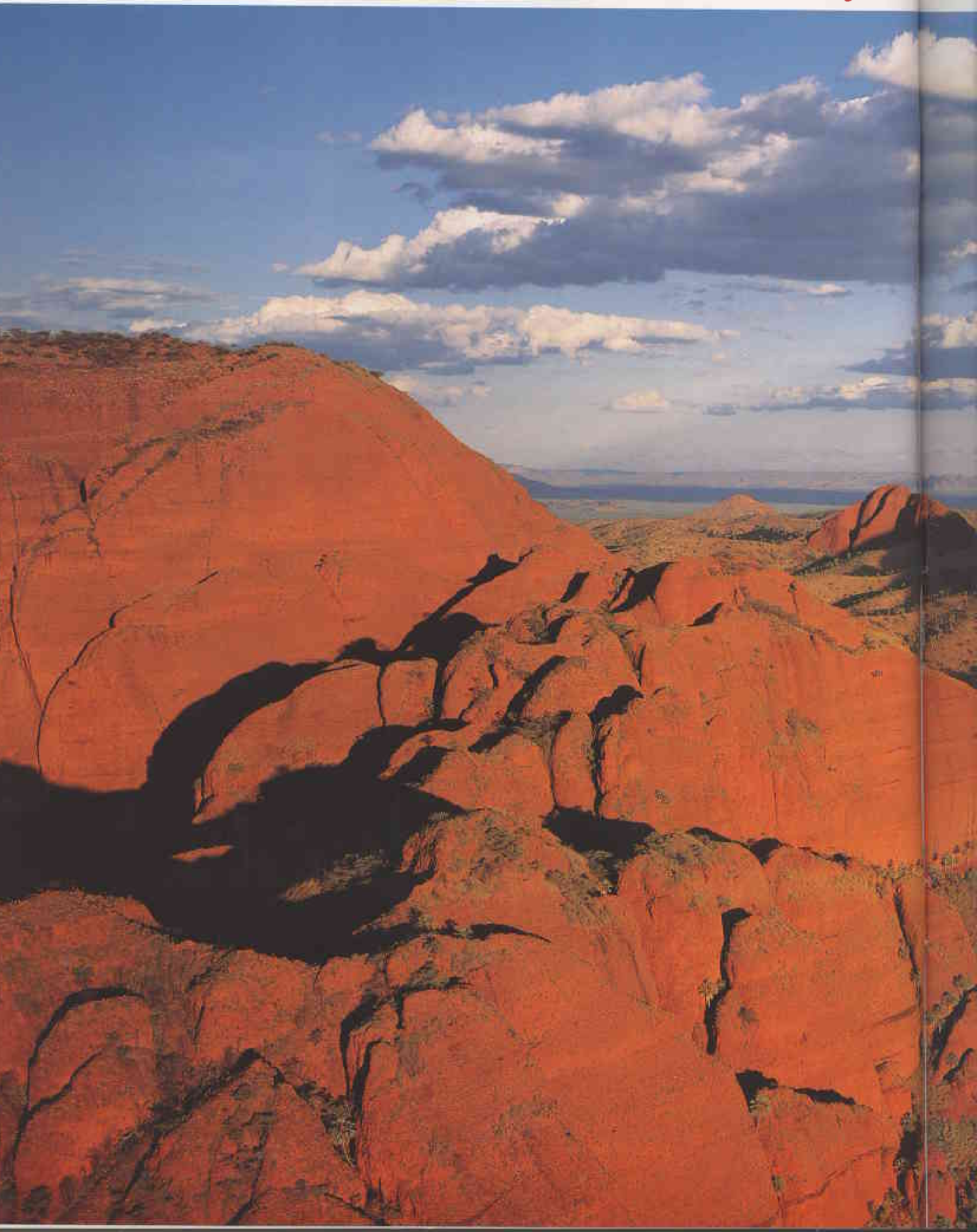
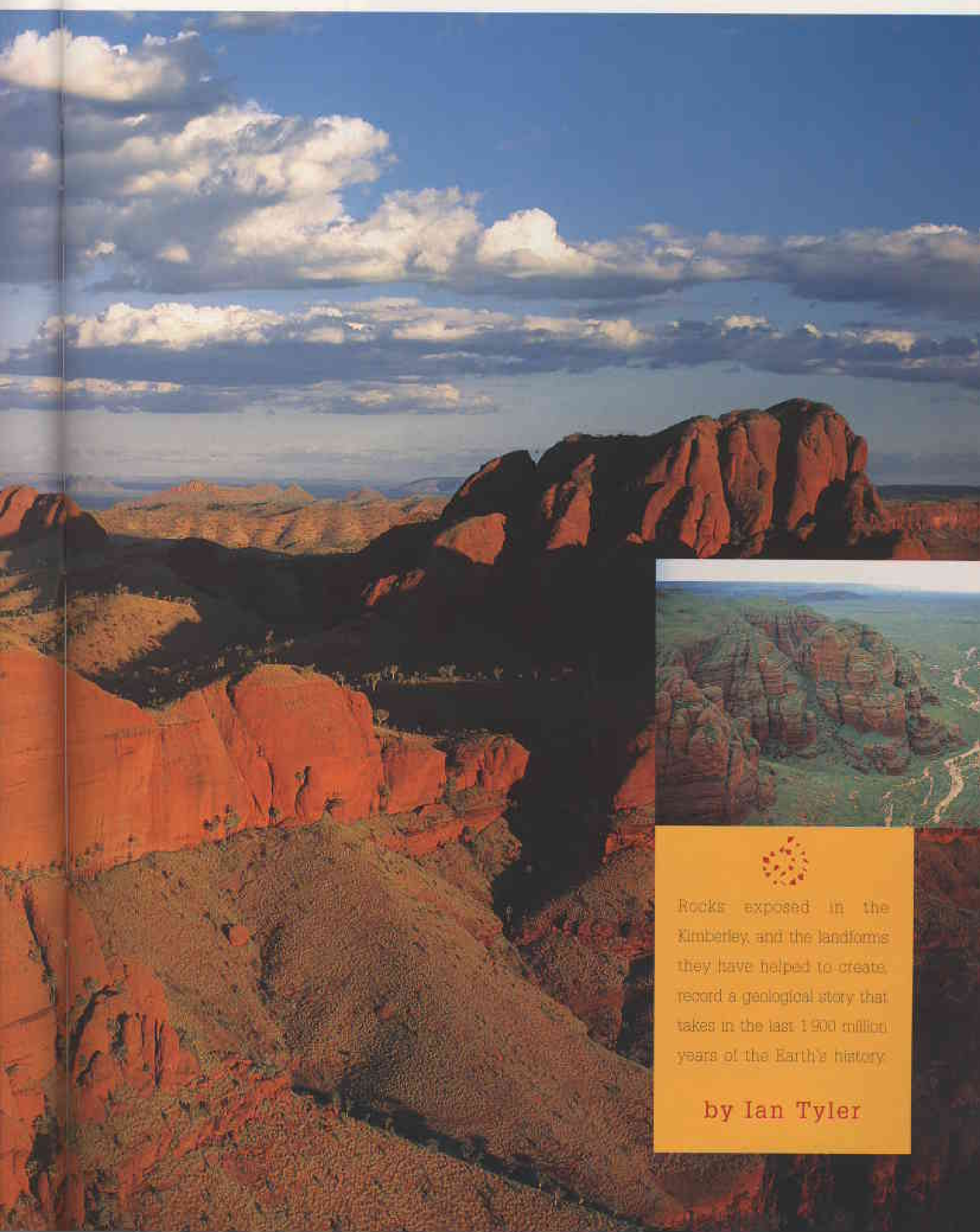
Geology and Landforms
of the Kimberley

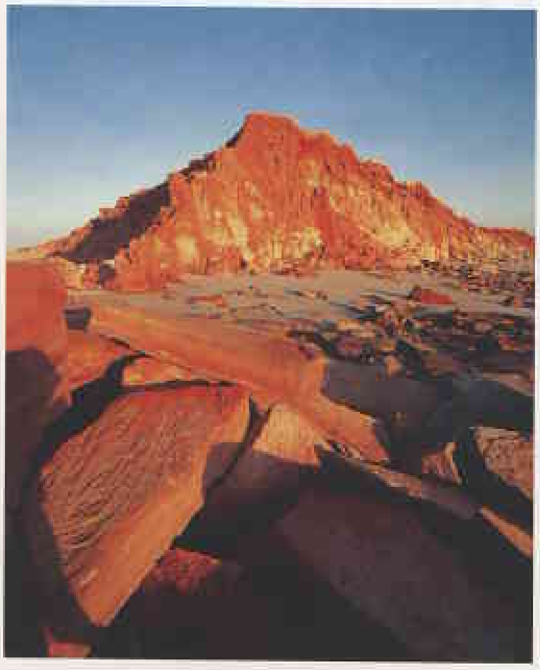




Rocks exposed in the Kimberley, and the landforms they have helped to create, record a geological story that takes in the last 1 900 million years of the Earth's history.

by Ian Tyler

When we look at the Kimberley landscape today, it is hard to imagine that the region was once adrift from the rest of Australia. In fact, more than 1 900 million years ago, the Kimberley was part of a larger continent, most of which lay farther to the north. However, it was on a collision course with a continent that made up the rest of northern Australia. The region's oldest rocks were deposited in an ancient ocean 1 920 to 1 790 million years ago. This lay between the two converging land masses and was gradually being closed.



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Main: The Ragged Ranges, north of the Argyle Mine.
Photo – Col Roberts/Lochman Transparencies
Inset: The Bungle Bungle Range.
Photo – Pamela Butt

Left: Sandstones, deposited in shallow seas 135 million years ago, can be seen along the coast at Cape Leveque.
Photo – Michael James

Below: The remains of a 70–50 million-year-old landscape can be seen in the Tanami Desert. The breakaway has formed where erosion has cut into this ancient surface.
Photo – Bill Bachman

MELTING MOMENTS

When the Kimberley collided and amalgamated with the rest of northern Australia about 1 830 million years ago, there were major upheavals in the Earth's crust. Huge volumes of molten rock (magma) were produced. This either erupted from volcanoes as lava, or intruded into pre-existing rocks below the Earth's surface and solidified to form granite and gabbro. The tremendous forces at work buckled rocks into folds, or broke them along faults, burying some rocks deep in the crust, where they were greatly altered by the action of pressure and heat. In the most extreme conditions, the rocks began to melt.

A mountain range is thought to have formed along the southern and eastern margins of the Kimberley 'continent' between 1 865 and 1 850 million years ago, similar to the Andes along the Pacific coast of South America today. The collision uplifted the continental margin, and sediment was eroded and deposited in a nearby basin, known as the Kimberley Basin, until about 1 800 million years ago. This sediment can be seen today in the King Leopold and Durack Ranges. At that time, sediment deposited by a major river system flowing from the north covered the whole region.

WHEN THE EARTH MOVED

For the last 1 790 million years, the Kimberley region has remained within a larger continent. However, the area has become geologically active from time to time, usually in response to events occurring at the margins of the continent.

Between 1 600 and 1 500 million years ago, sedimentary rocks were deposited in the Birrindudu Basin, forming rocks that now underlie the Tanami Desert. Fossil stromatolites are found in magnesium-rich limestones, known as dolomites, of this age in the Osmond Range, north of the Bungle Bungle Range. More sediments were deposited in the eastern Kimberley about 1 200 million years ago and soon after were intruded by the Argyle diamond pipe.

About 1 000 million years ago, tremendous earth movements folded, faulted and metamorphosed the rocks. For example, rocks now exposed on the Yampi Peninsula were buckled into massive folds. During this period, the Halls Creek Fault system formed. This system of wrench faults can be traced from the edge of the Great Sandy Desert all the way to Darwin. Movement is

horizontal, similar to the San Andreas Fault in California—the rocks on the western side of the fault have moved to the left (south-west) relative to those on the eastern side.

Between 700 and 600 million years ago, much of the Earth was caught in the grip of an ice age. Glaciers once descended from either side of a range of ice-capped mountains that stretched across the Kimberley at this time. Glaciers are an amazing force in sculpting the landscape. They are constantly moving, and the enormous weight and force of the moving ice tears away rocks of varying sizes and may redeposit them kilometres away from their source. The glacial deposits from the eastern side of this ancient range can be seen along the last part of the Spring Creek Track, west of the Purnululu Ranger station, and along the Duncan Highway, east of Palm Spring. The western deposits are exposed around Louisa Downs Station, between Halls Creek and Fitzroy Crossing, and on Mount House Station, east of the Gibb River Road.

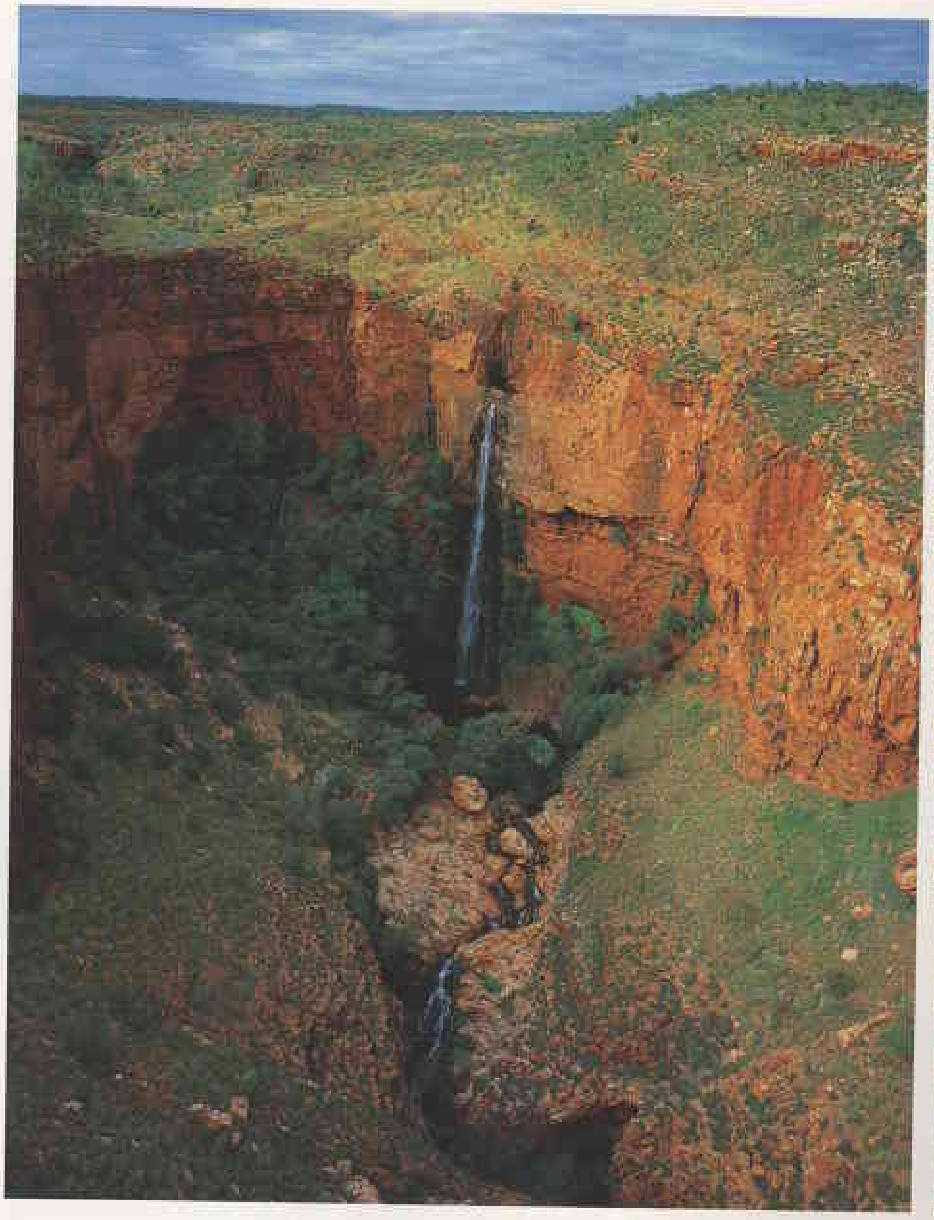
About 550 million years ago, the Halls Creek Fault system was again on the move, crumpling the margin of the Kimberley Basin and causing spectacular folding in the King Leopold Range.

The best cattle-grazing country in the eastern Kimberley forms part of the Ord Plains and lies to the south and east of Lake Argyle and to the south-east of Purnululu National Park. Between 560 and 530 million years ago, these areas were awash with flows of molten lava that erupted from fissures and spread out for several tens of kilometres. Individual lava flows can be seen as benches on hillsides and scarps. From 540 to 500 million years ago, in Cambrian times, they were covered in shallow seas, during a time when the diversity of life on Earth exploded. Fossils in the limestone rocks laid down in these seas include stromatolites, trilobites and brachiopods.

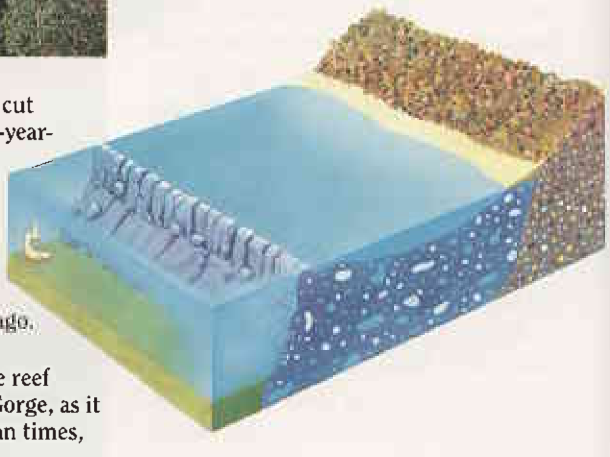
DEVONIAN REEF

Sedimentary rocks began to be deposited in a former sea within the Canning Basin, from about 500 million years ago. About 375 million years ago, in Devonian times, the sea deepened and a remarkable system of barrier reefs began to form. The reefs were built by lime-secreting organisms, mainly calcareous algae and extinct organisms called stromatoporoids. Though corals were present, they were much less important in reef-building than the corals of modern times. Gastropods, brachiopods, bivalves and stromatolites were also found. The reefs fringed three sides of a land mass, formed by what is now the Kimberley plateau, extending into the Bonaparte Basin. This Devonian reef now forms a chain of often steep-sided, low ranges, up to 300 metres above sea level, that include the Napier, Oscar, Pillara and Emanual Ranges.

On the fourth side of the land mass, the Halls Creek Fault system again became active, and sediment that was eroded from active fault scarps accumulated as sandstones and conglomerate deposits. These now form the Ragged Ranges, the Bungle Bungle Range and Hidden Valley at Kununurra. For example, faulting uplifted the Osmond Range to the north of the present-day Bungle Bungle Range. Streams and rivers eroded this ancient highland. At its edges, slopes were steep and the energy in the streams and rivers was high, allowing them to carry large boulders. The walls of Echidna Chasm were formed from these boulder conglomerates. Some of the boulders at Echidna Chasm show scratches and grooves typical of erosion by ice and were eroded from glacial rocks exposed in the Osmond Range, only to be redeposited a few kilometres further south. However, most of the rocks in the Bungle Bungle Range are sandstones deposited farther from the highlands by lower-energy, braided rivers flowing across broad plains in open valleys.



The Osmond Range was formed by movement along major faults, including the Halls Creek Fault.
Photo – Col Roberts/Lochman Transparencies



Above: The Fitzroy River has cut through the 370–350 million-year-old Devonian barrier reef to form Geikie Gorge.
Photo – Michael James

Above right: Ice-capped mountains spanned the Kimberley 600 million years ago.

Right: A reconstruction of the reef that, today, forms Windjana Gorge, as it would have looked in Devonian times, 350 million years ago.

Between 310 and 270 million years ago, an ice age again affected much of Australia and the sedimentary rocks that formed during this time buried the Devonian reef. Deposition of sedimentary rocks in shallow seas and by rivers has continued in the Canning and Bonaparte Basins ever since.

EVOLUTION OF THE KIMBERLEY LANDSCAPE

The story of the geology, however, is only half the story. The landscape that we see in the Kimberley today has been evolving for the last 250 million years and was shaped by powerful external forces acting on the underlying geology.

The evolution of the landscape is cyclical. Over long periods of time, the effects of climate and erosion by water, wind and ice wears away hills and valleys, and a nearly flat 'planation' surface is produced, on which only isolated hills remain. If the surface is subsequently uplifted by earth movements, the landscape will be rejuvenated, as rivers and streams cut down into the old surface, forming a new system of hills and valleys. The presence of a former planation surface can usually be seen in the similar heights of hill tops.

At least two planation surfaces have been formed in the Kimberley region, only to be eroded as the landscape was uplifted. Due to repeated uplifts, the oldest planation surface is now the highest, and is referred to as the High Kimberley surface. It was formed about 200 million years ago and is preserved only as remnants, which now make up the highest points of the main Kimberley plateau. The tops of tablelands and mesas reach up to 776 metres above sea level at Mount Hann, before falling away to between 200 and 300 metres along the coastline. The higher summits within the King Leopold and Durack Ranges (up to 937 metres at Mount Ord) form remnant hills rising above this earliest surface.

Uplift and erosion of the High Kimberley surface took place between 200 and 100 million years ago and a new, lower planation surface, the Low Kimberley surface, formed around the main plateau and originally extended over much of central and western Australia. Laterite formed a hard capping on the surface 70 to 50 million years ago. At that time, Australia was in tropical latitudes, and the high rainfall caused deep weathering and the leaching of elements such as potassium, sodium, magnesium and calcium from the surface rocks, concentrating iron and aluminium in the capping.

The present Kimberley landscape of hills, valleys and gorges was produced by erosion that resulted from uplift of the Low Kimberley surface 20 million years ago. The relief is still considerable and the surface is a long way from the establishment of a new planation surface. The Low Kimberley surface is preserved around Halls Creek where, at between 500 and 600 metres above sea level, it divides the Ord River and the Fitzroy River drainage areas. The lower hill country (Bow River hills, Halls Creek ridges, Lennard hills, and Napier hills) around the edge of the Kimberley Plateau has been eroded from this surface, and this is reflected in the locally uniform level of the hill and ridge tops, which become progressively lower towards the coast. To the east and south-east of Halls Creek, the Duncan Highway and Tanami Road both climb out of the hill country onto plateau country covered by sandplains, which form the Great Sandy and Tanami Deserts.

Rivers that originally meandered

across the Low Kimberley surface have cut directly down into it as the surface was uplifted. As a result, the rivers' courses were not influenced by local geology, cutting directly through ridges of more resistant rocks, such as at Carlton Gorge, where the Ord River has cut through the Carr Boyd Ranges, rather than taking an easier course around the north-eastern end of the range.

When the last ice age ended, between 20 000 and 6000 years ago, water released from the melting ice caps caused a substantial rise in the sea level. The Kimberley coastline was subsequently drowned, with the sea now filling what were once river valleys.

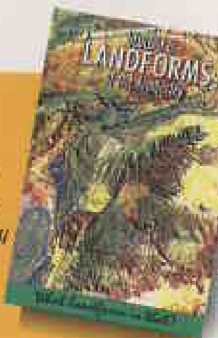
RIVERS AND MUDFLATS

Today, two major river systems dominate the drainage of the Kimberley region. The Fitzroy River enters the sea at King Sound near Derby, and the Ord River flows into Cambridge Gulf near Wyndham. Both river systems form wide floodplains, and their mouths are a complex system of tidal channels, mangrove swamps, and mud and samphire flats. The river mouths and floodplains represent areas where present day deposition of sediment is taking place. The rivers only flow after periods of prolonged heavy rain, usually associated with major tropical cyclones, which hit the area every few years. Extensive flooding occurs, which dumps large volumes of sediment into the sea and along the rivers' wide floodplains. The channels, mudflats and mangrove swamps forming the rivers' mouths also reflect the influence of the large tidal ranges (up to 11 metres) that affect the Kimberley coastline.

The mudflats are an example of sedimentary rock formation in action. The river mouths and floodplains are made up of muds, silts and sands, eroded from across the Kimberley. Over the next few thousands to millions of years, these sediments, together with the remains of plants and animals living on or within them, will be buried by more sediment. The weight of overlying sediments, and the action of fluids, rich in silica and/or calcium carbonate, flowing through them and cementing the mud particles and sand grains together, will one day turn the unconsolidated sediment into solid rock.

Above: Tunnel Creek is part of WA's oldest cave system, some 250 million years old.
Photo – Michael James

Below: The Packsaddle Plains form part of the current floodplain of the Ord River.
Photo – Col Roberts/Lochman Transparencies



Ian Tyler, a project leader with the Geological Survey of Western Australia, is the author of *Geology and Landforms of the Kimberley*, a recent **Bush Book** published by CALM. Packed with colour photographs and illustrations, it provides a fascinating insight into the geological processes that shaped the stunning scenery that attracts visitors to this region.

This book is the first of its kind that presents technically accurate geological information that anyone can understand. It is available from CALM offices, tourist bureaus and bookshops for just $5.95. Ian can be contacted on (08) 9222 3605.

Noisy scrub-birds are rare in museum collections. This one, from a Dutch Museum, was probably collected by John Gilbert. See page 36.

LANDSCOPE

VOLUME TWELVE NUMBER ~~3~~ 4, WINTER 1997

This year, The Hills Forest celebrates its fifth birthday. Find out what's been happening there in our story on page 10.

The Kimberley region of Western Australia has some weird and wonderful landforms. Read all about them on page 16.

Mount Bakewell looms over the old town of York, but it is more than just a prominent landmark. Find out why on page 42.

The northern quoll is just one of WA's marsupials that have been part of a recent conservation status review. See page 22.

FEATURES

REGULARS

COVER

Get down on the ground, scramble through the leaf litter and compost in your garden, and discover the fascinating world of insects. 'Insects in the Garden', on page 28, shows how these seemingly insignificant creatures help keep the ecosystem running smoothly and how they are a vital part of nature's life-cycle.

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Colour Separation by Prepress Services
Printed in Western Australia by Lamb Print

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Published by Dr S Shea, Executive Director
Department of Conservation and Land Management,
50 Hayman Road, Como, Western Australia