Geology of Windjana Gorge, Geikie Gorge and Tunnel Creek National Parks

by
Phillip Playford

Geological Survey of Western Australia

Geikie Gorge, on the Fitzroy River. Note flood level.

Acknowledgement

The National Parks Authority wishes to thank Dr. Phillip Playford, Deputy Director of the Geological Survey of Western Australia, for providing the research, text and photographs in this publication. Also thanks to the drafting office of the Mines Department for the provision of illustrations.

Issued by:
The Director of National Parks, Colin C. Sanders,
National Parks Authority,
Hackett Drive,
Nedlands Western Australia 6009

Geology of Windjana Gorge, Geikie Gorge and Tunnel Creek National Parks

Introduction

Windjana Gorge, Geikie Gorge and Tunnel Creek cut through rugged limestone ranges that form part of Western Australia's famous Devonian "Great Barrier Reef" (Figures 1 and 2). These three areas have been declared national parks because of their scientific importance and scenic beauty.

The barrier reef belt grew some 350 million years ago during the Devonian Period, when the Canning Basin south-east of Derby was covered by a tropical sea. The reefs are now exposed in a series of limestone ranges extending for 300 km along the northern margin of the basin, but they once probably continued for some 1 000 km around the present Kimberley region, to join with similar reefs that are exposed in the Kununurra area of the Bonaparte Basin (Figure 1).

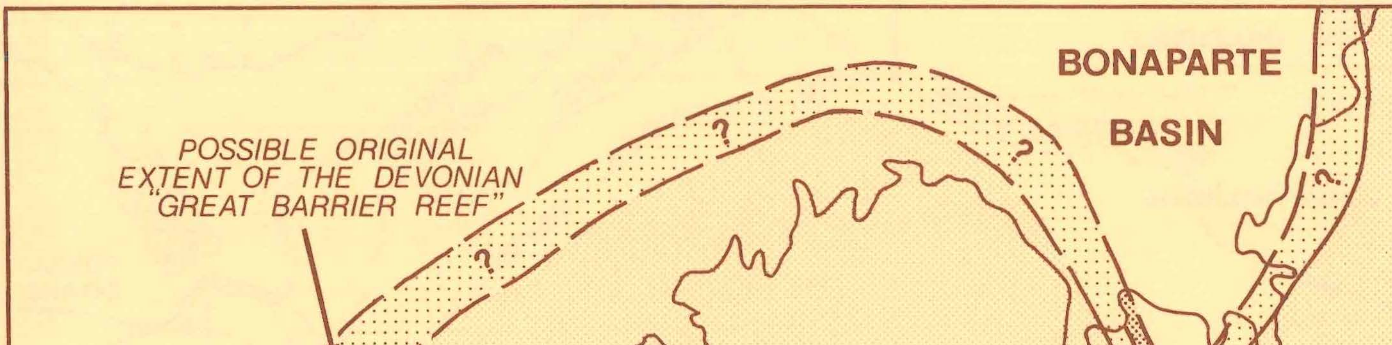

Figure 1: *Map of the Kimberley district showing the outcrop area of Devonian reefs in the Canning and Bonaparte Basins, and the possible original extent of the Devonian "Great Barrier Reef".*

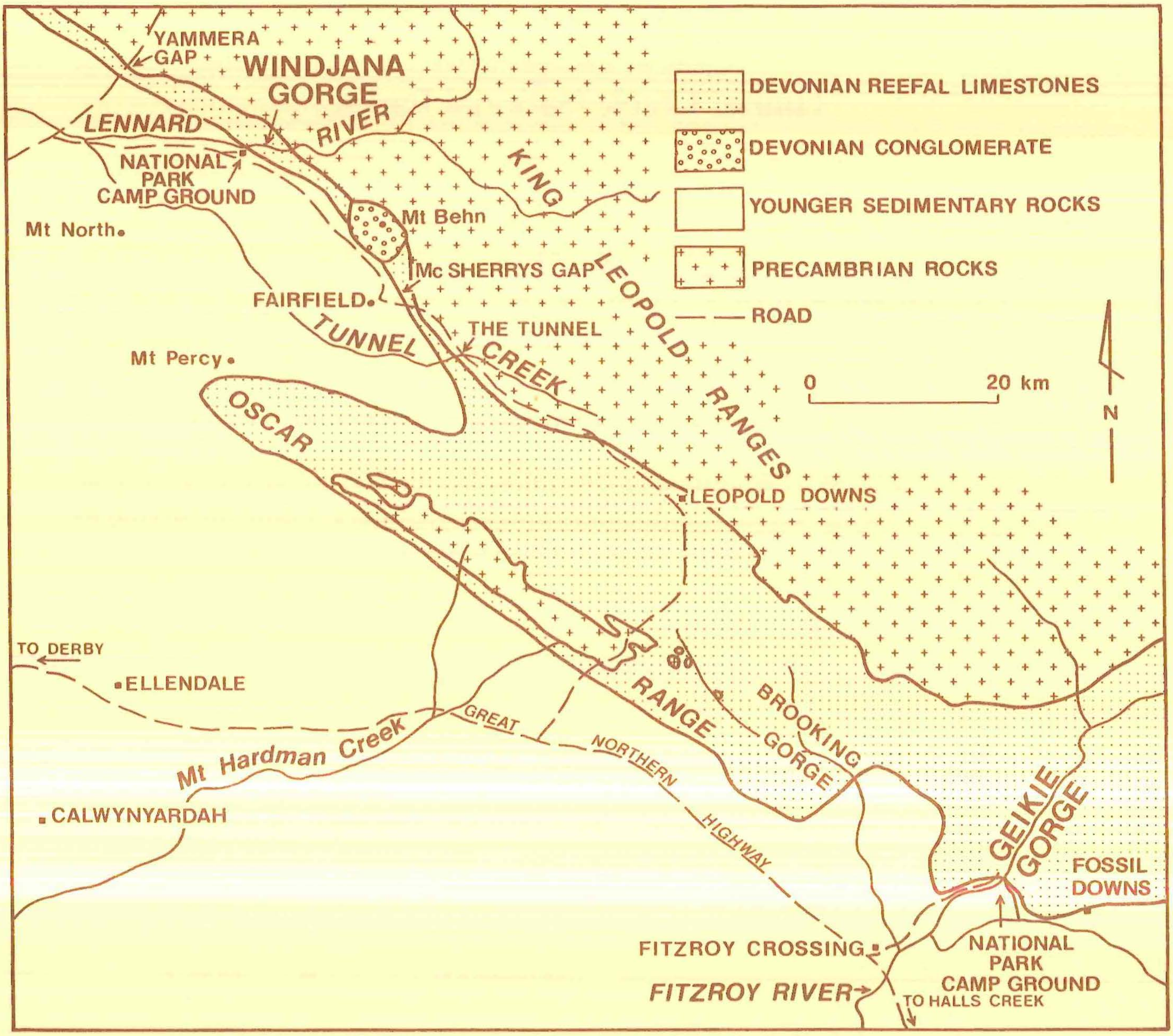

Figure 2: Geological map of the Windjana Gorge-Geikie Gorge area.

The limestone reefs and their associated deposits wind across the countryside, reaching some 50 to 100 m above the adjoining plains, in much the same way that they stood above the ancient sea floor. From the air (Figure 3) it appears as though the sea has only recently withdrawn from the area, leaving the reefs in their original form. In fact, since the Devonian the area has gone through a complex history of sedimentation, uplift, and erosion over many millions of years. The reason for the clear topographic expression of the reefs today is that the shales and other soft sediments laid down in the ocean basin in front of the reefs are readily eroded to form valleys, whereas the resistant limestone reefs are "exhumed" as ranges.

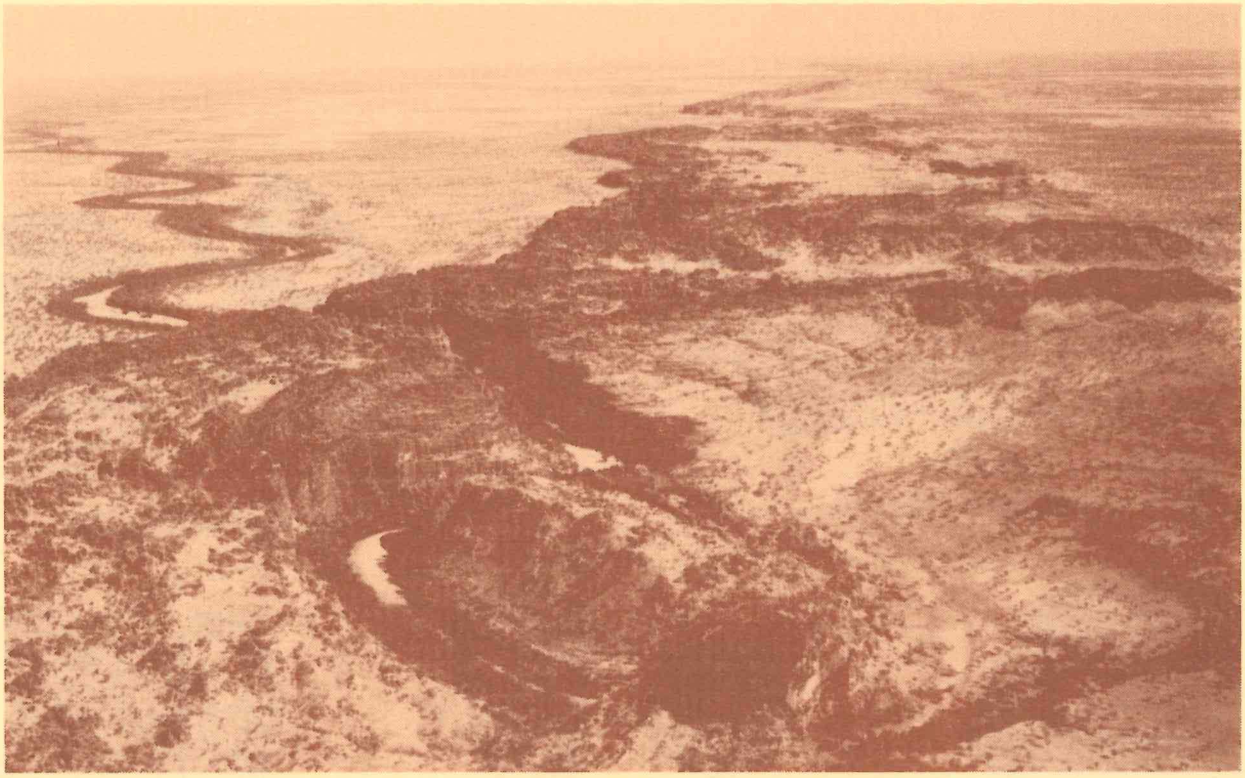

Figure 3: Aerial view looking northwest over Windjana Gorge and the Napier Range.

It is possible for geologists to obtain a clear picture of the environments in which these ancient reefs formed by studying the rock outcrops in detail. Some of the limestones are rich in well-preserved fossils, which testify to the types of animal and plant life that lived in and around the reefs some 350 million years ago. Typical fossils found in the area are illustrated in Figures 4 and 5.

The reefs themselves were built by various lime-secreting organisms that had the ability to erect wave-resistant frameworks close to sea level. The main contributors were calcareous algae, stromatoporoids, and corals, in that order of importance. Modern reefs, by comparison, are constructed mainly by corals and calcareous algae, but in these Devonian reefs the corals were less important than the stromatoporoids, a group of extinct organisms which resemble corals in their growth forms, but differ in their internal structure.

The wave-resistant reefs themselves formed a small part of the total volume of the barrier-reef complex (Figure 6). Back-reef deposits make up the major part of the reef-fringed limestone platforms. The reefs were commonly fronted by reef scarps, against which inclined layers of limestone accumulated on marginal slopes that descended to depths of as much as several hundred metres in the adjoining basins. The basin deposits consist largely of shale, sandstone, and thin beds of limestone. Each of these major deposits have their own characteristic fossil assemblages. Thus the reefs and back-reef deposits are dominated by specific algae, stromatoporoids, and corals, the marginal-slope deposits by sponges, brachiopods, nautiloids, and some algal stromatolites, and the basin deposits by fish, goniatites, and nautiloids.

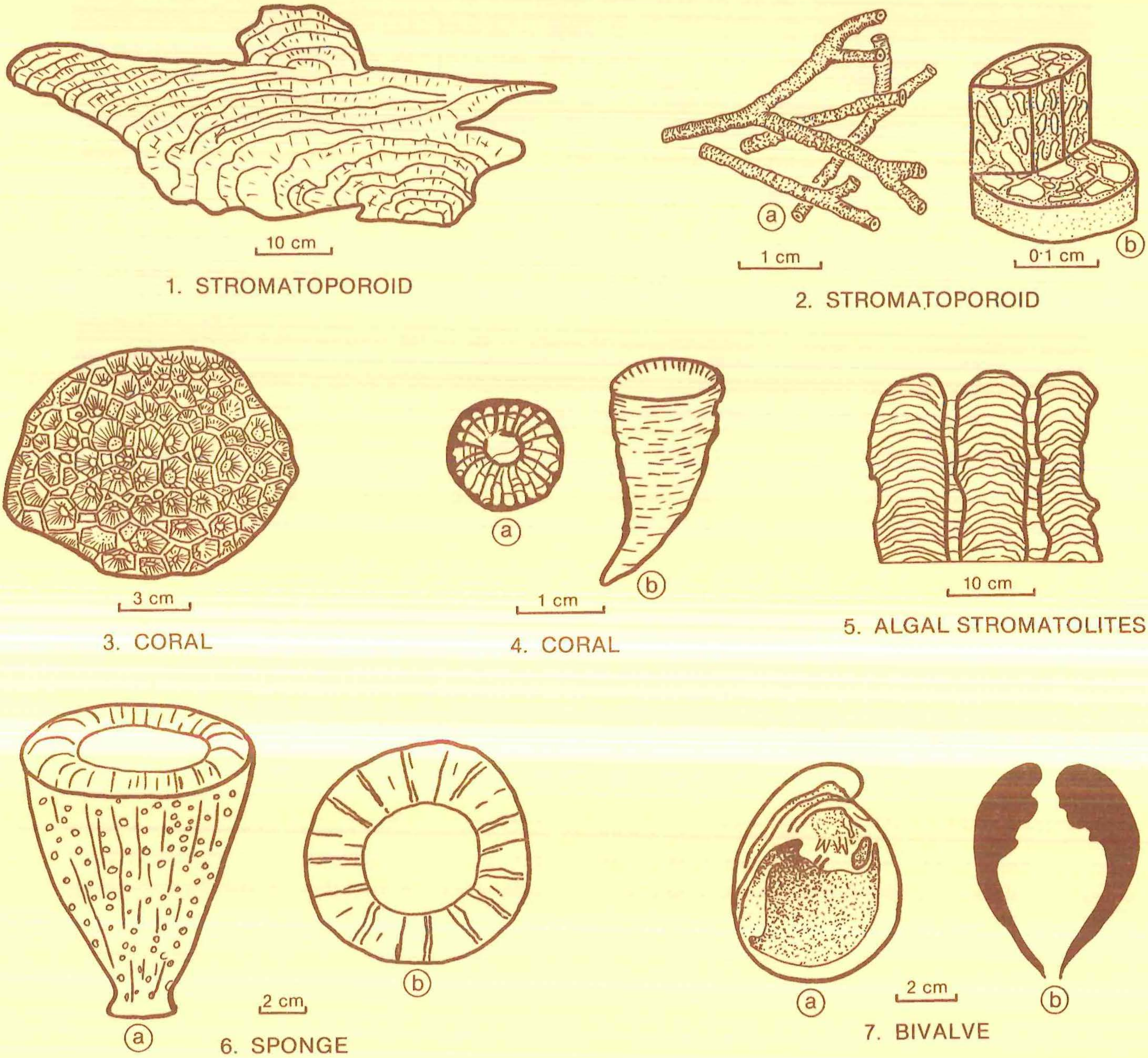

Figure 4: *Typical fossils of the Devonian reefs and their associated deposits. 1: The reef-building stromatoporoid* ***Actinostroma*** *(sectional view). 2: The back-reef stromatoporoid* ***Amphipora;*** *2a — external view, 2b — sectional view. 3: The reef-building coral* ***Argutastrea.*** *4: The horn coral* ***Catactotoechus*** *(found in reef, back-reef, and marginal-slope deposits); 5: Algal stromatolites (found in reef, back-reef, and marginal-slope deposits). 6: A sponge (found mainly in marginal-slope deposits). 7: The bivalve* ***Megalodon*** *(found mainly in reef and back-reef deposits); 7a — inside of shell, 7b — section through two shells.*

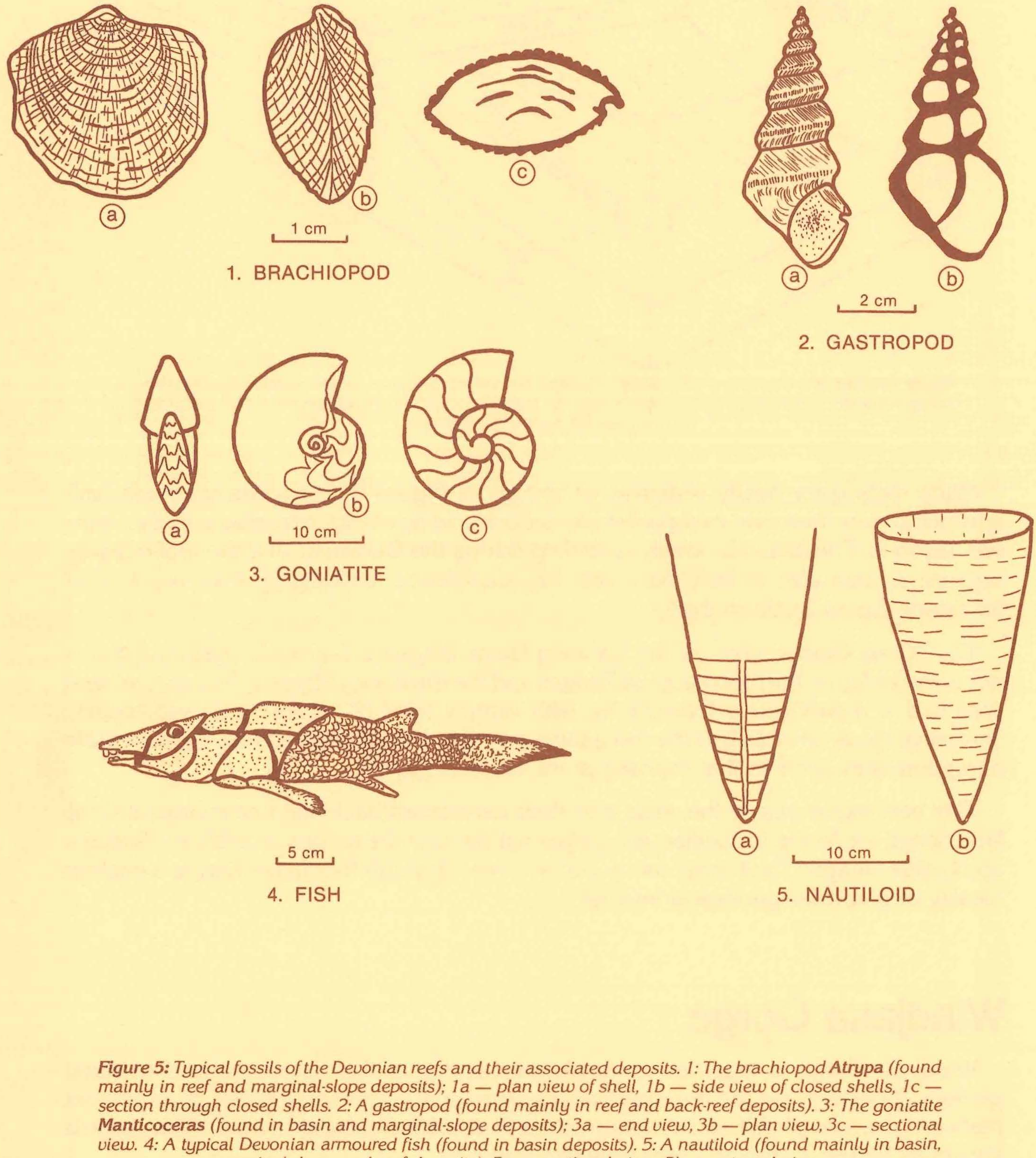

Figure 5: *Typical fossils of the Devonian reefs and their associated deposits. 1: The brachiopod* ***Atrypa*** *(found mainly in reef and marginal-slope deposits); 1a — plan view of shell, 1b — side view of closed shells, 1c — section through closed shells. 2: A gastropod (found mainly in reef and back-reef deposits). 3: The goniatite* ***Manticoceras*** *(found in basin and marginal-slope deposits); 3a — end view, 3b — plan view, 3c — sectional view. 4: A typical Devonian armoured fish (found in basin deposits). 5: A nautiloid (found mainly in basin, marginal-slope, and reef deposits); 5a — sectional view, 5b — external view.*

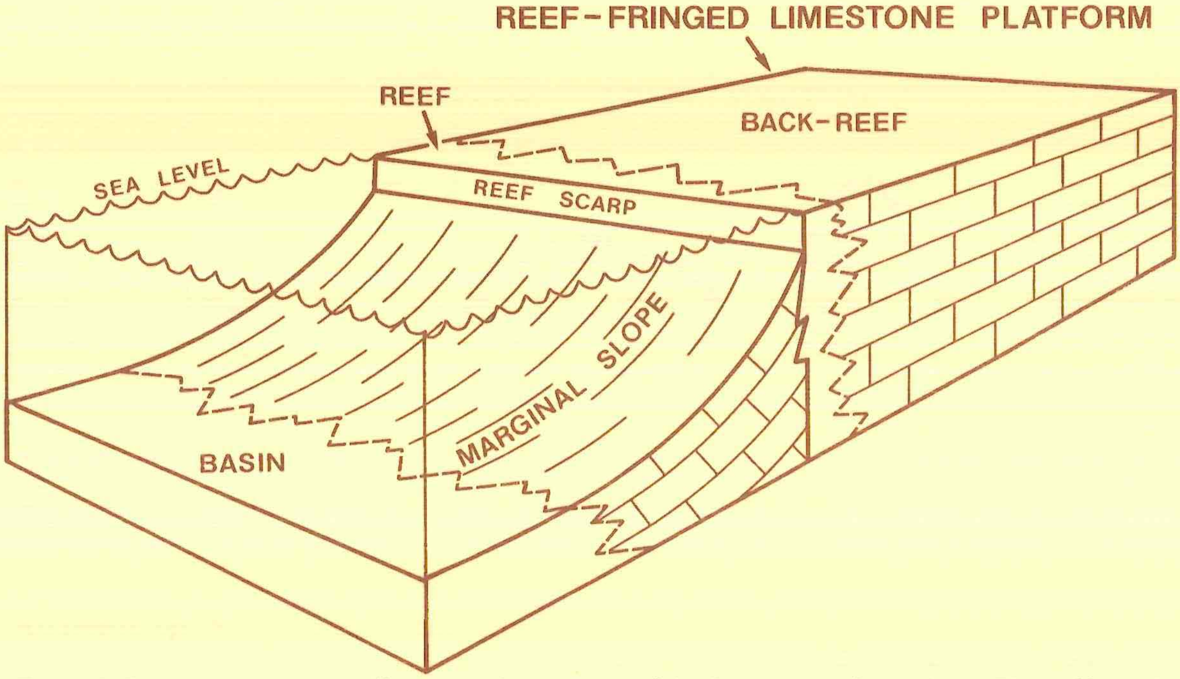

Figure 6: Diagrammatic section illustrating the structure of the Devonian reef complexes. The reef-fringed limestone platforms stood up to several hundred metres above the adjoining basins and were fronted by steeply inclined marginal-slope deposits.

Many reefs grew nearly vertically, as shown in Figure 6, but some grew outward, advancing over their own marginal-slope deposits, while others retreated over the back-reef lagoons. The area was slowly subsiding during the Devonian, and the reef-building organisms were able to keep pace with this subsidence, building up thick deposits of limestone (up to 2 000 m thick).

The "Great Barrier Reef" of the Canning Basin fringed a Devonian mainland that is occupied today by the King Leopold Ranges and the Kimberley Plateau. This ancient land area had a mountainous topography, with vertical relief of several thousand metres. Torrential rivers flowed from the mountains, carrying boulders which now form massive conglomerates such as that exposed at Mt. Behn (Figure 2).

The best exposures of the reefs and their associated back-reef and marginal-slope limestones are found in spectacular gorges cut through the ranges, notably at Windjana and Geikie Gorges. The tunnel cut by Tunnel Creek through the Napier Range is another locality of particular geological interest.

Windjana Gorge

Windjana Gorge is regarded by geologists as one of the classic features of world geology. Nowhere else are the relationships between the various deposits of an ancient reef complex so well exposed as they are here. A simplified geological map of the gorge is shown as Figure 7, and an aerial view as Figure 3.

The gorge is a picturesque narrow canyon cut by the Lennard River through the Napier Range. It is about 3.5 km long, up to 100 m deep, and has near-vertical walls for most of its length. The river flows for only short periods in the wet season, and during most of the year water only occurs as isolated pools in the main channel. These pools contain a fauna of fish and fresh-water crocodiles.

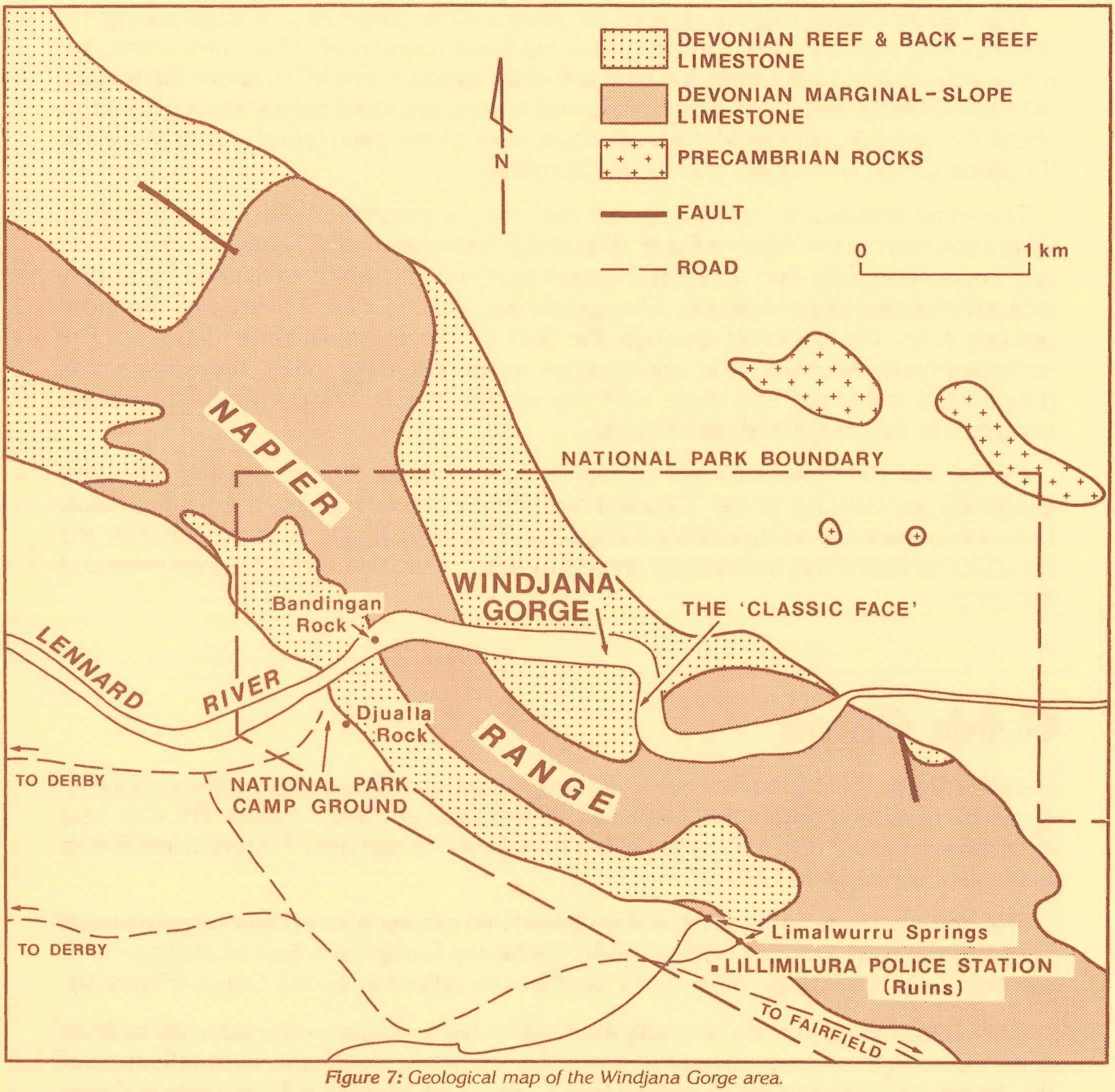

Figure 7: *Geological map of the Windjana Gorge area.*

Figure 8: *Panoramic view of the "Classic Face" at Windjana Gorge (for location see Figure 7). Flat-bedded back-reef and reef limestones (on the right) grade into the massive reef margin, which is fronted by steeply inclined marginal-slope limestones.*

The river has taken millions of years to erode out the gorge. At one stage during the down-cutting process a river gravel containing fossil remains of extinct crocodiles and turtles accumulated in a small cave on a wall of the gorge, some 40 m above the present river level. One of the crocodiles represented among the fossil bones was a giant form about 7 m long. Another extinct animal whose bones have been found in river gravels at Windjana Gorge is the giant marsupial *Diprotodon.*

The most impressive exposure of the reef and its associated deposits in Windjana Gorge is known as the "Classic Face" (Figure 8). At this locality flat-bedded back-reef and reef limestone grade into a narrow massive reef margin, which is fronted by steeply inclined marginal-slope deposits. Changes in the fossil faunas are very well displayed passing from the back-reef through the reef to the marginal-slope deposits. The stromatoporoid *Amphipora* is conspicuous in the back-reef, other stromatoporoids (largely *Actinostroma*) and algae were the dominant reef builders, and sponges are common in the marginal-slope deposits.

During the early phase of reef growth in the Windjana Gorge area the reef grew essentially vertically (as in the "Classic Face"), but in the later phase it extended nearly horizontally over the marginal-slope deposits. This later phase is represented by the massive reef limestone, built almost entirely by algae, which is exposed at the west end of the gorge.

Geikie Gorge

Geikie Gorge, cut by the Fitzroy River through the Geikie Range, also exposes another excellent section through the Devonian "Great Barrier Reef" (Figure 9). It is very appropriate that in 1883 the gorge should have been named after the renowned British geologist Sir Archibald Geikie.

The gorge is some 14 km long, and is divided into two sections of approximately equal length by the eastern end of Copley Valley near Sheep Camp Yard. Several atoll-type reefs are present in the Copley Valley and Fossil Downs adjoining Geikie Gorge (Figure 9).

The walls of the gorge are generally about 30 m high. They are cleaned white by flood action to a height of about 10 to 12 m above the normal river level, and internal features of the limestone, including the contained fossils, are clearly visible on these clean surfaces.

The gorge contains permanent fresh water throughout its length, and the abundant fish fauna includes sawfish and stingrays, whose ancestors migrated progressively up the Fitzroy River for some 300 km from their more normal habitat in the sea. The fresh-water Johnston crocodile is also common.

Most of Geikie Gorge in the southern part of the National Park is cut through back-reef deposits, which together with the narrow reef were constructed almost entirely by algae, with only minor contributions by stromatoporoids. The contact between steeply inclined marginal-slope deposits and horizontally bedded reef and back-reef deposits is well seen 2 km south of the Sheep Camp Yard (Figure 10). The marginal-slope deposits in this area contain some conspicuous bivalve shells.

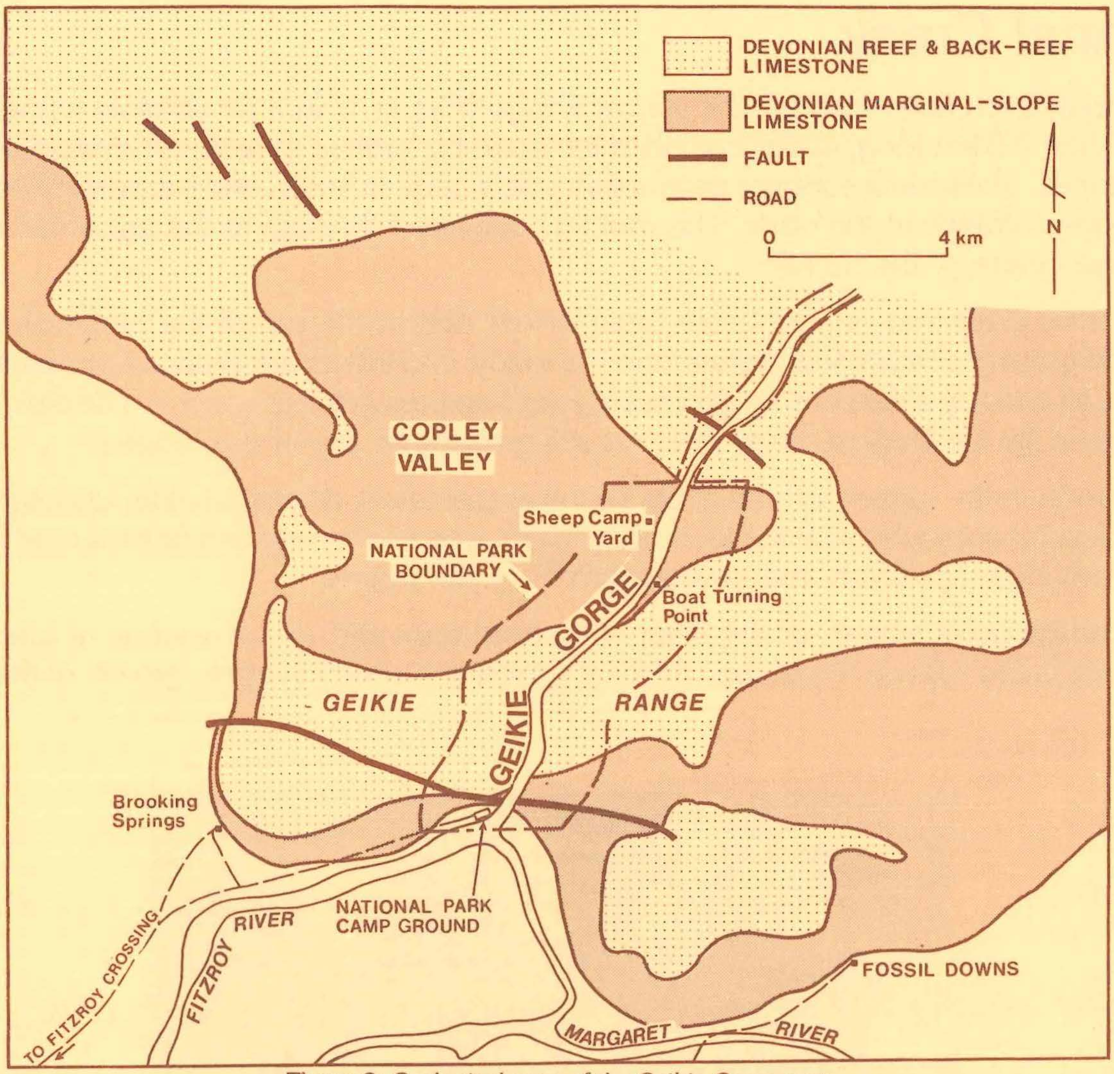

Figure 9: *Geological map of the Geikie Gorge area.*

Figure 10: *Aerial view looking northeast along Geikie Gorge, about 3 km south of Sheep Camp Yard. The wall of the gorge shows flat-bedded back-reef limestones (on the right), grading into a narrow reef margin, which is fronted by steeply inclined marginal-slope limestones (left centre).*

Tunnel Creek

Tunnel Creek flows through the Napier Range (Figure 1) in a remarkable tunnel cave more than 0.5 km long, which has been localised by jointing in reef and marginal-slope limestones. The tunnel contains permanent pools of fresh water, and it is possible to walk from one entrance to the other. The roof has collapsed through to the top of the range near the centre of the tunnel.

It seems likely that Tunnel Creek once flowed across the top of the range when the general ground surface was higher than it is today, and it later adopted the underground course formed by solution enlargement of joint fractures in the limestone. The old course is marked by the shallow valley which is still present on top of the range.

A bench in the tunnel some 8 m above the present floor marks an older underground creek level. It coincides with the level of the plain, which is incised in a narrow channel by the creek both upstream and downstream from the tunnel.

A conspicuous feature of the algal and stromatoporoid reef limestone at the north entrance is the intense fracturing which occurred at an early stage in growth of the reef.

Stalactites on the roof of Tunnel Creek Cave. Photo B. Muir.