NORTHERN BARRIER RANGES REGION, NEW SOUTH WALES

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INTRODUCTION

This case study encompasses the area of the northern Barrier Ranges between latitude 30°45’ and 31°5’S, and longitude 141°35’ and 141°55’E, and is based on the investigations of Gibson (1997, 1998, 1999, 2000). The area falls within the COBHAM LAKE (SH54-11) and BROKEN HILL (SH54-15) 1:250 000 map sheets, immediately north of the Fowlers Gap Arid Zone Research Station (Macdonald, 2000) and about 100 km north of Broken Hill in northwestern NSW (Figure 1). A northerly trending range dominates the central part of the area, with depositional plains to the east, and undulating rises and low hills to the west.

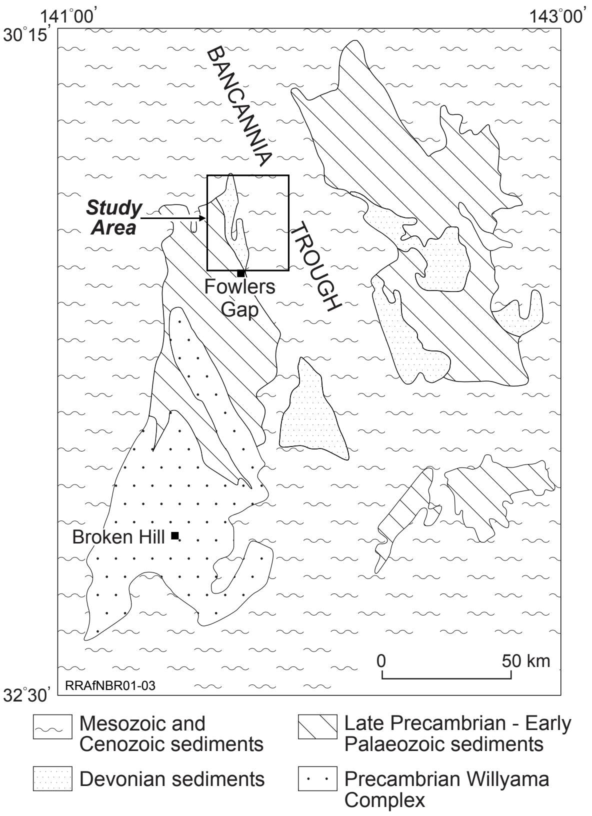

Figure 1. Location of study area and regional geology.

PHYSICAL SETTING

Geology

Ward *et al*. (1969), Cooper *et al*. (1978), Beavis and Beavis (1984), and Neef *et al*. (1995) have described the bedrock geology of the area. Dipping Neoproterozoic low-grade metasediments (shale, quartzite and dolomite) with open fold structures are present in the west of the area, and are unconformably overlain by, and faulted against, easterly dipping Devonian sandstones (Figures 2, 3). The dip of the Devonian sandstones increases towards the east (Figure 3). Middle and Late Devonian sequences are separated by the major north-trending Nundooka Fault (Figure 2). Sediments of the Telephone Creek Formation, traditionally thought to be Tertiary but more recently determined to be of Early Cretaceous or possibly Late Jurassic age on the basis of plant macrofossil and microfossil evidence (Gibson, 2000), unconformably overlie the Neoproterozoic and Devonian rocks (Figure 3). The Mesozoic sediments are flat-lying in the east and west of the area, but have an easterly dip of up to 30° close to the eastern margin of the ranges. A small area of strongly silicified sediment containing Tertiary plant fossils is present in the southwest of the area. Quaternary sediments in the form of a depositional plain characterise the eastern part of the area (Figure 2). The Quaternary sediments are underlain by the NNW-trending Bancannia Trough; a graben containing more than 5 km of Devonian sediments and overlain by a thin cover of Mesozoic and younger sediments. Minor aeolian sand is locally present.

Geomorphology

Mabbutt (1973) described the geomorphology of part of the area, and Mabbutt *et al*. (1973) produced a map of the geomorphic units. The Neoproterozoic rocks form an undulating topography, with persistent strike ridges underlain by the more resistant rock

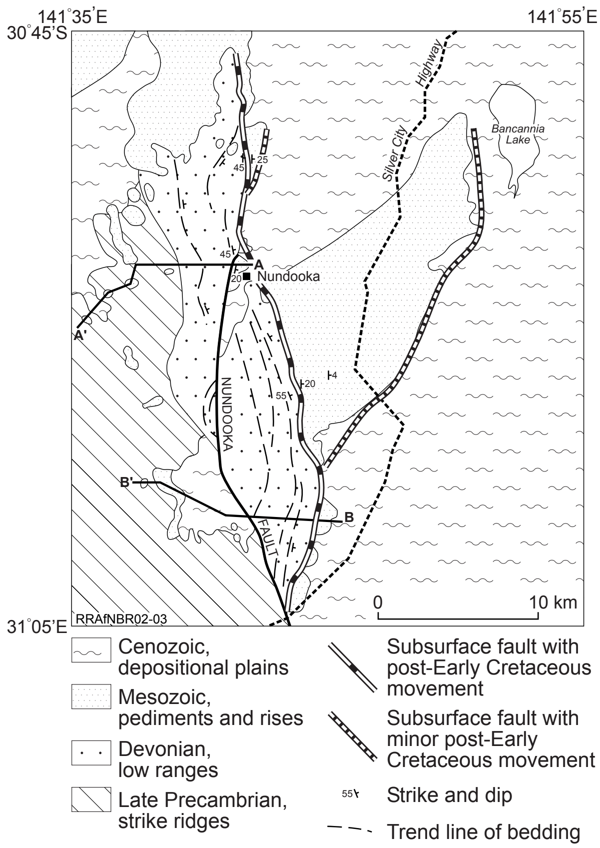

Figure 2. Generalised geology of study area. Sections A–A’ and B–B’ are shown in Figure 3.

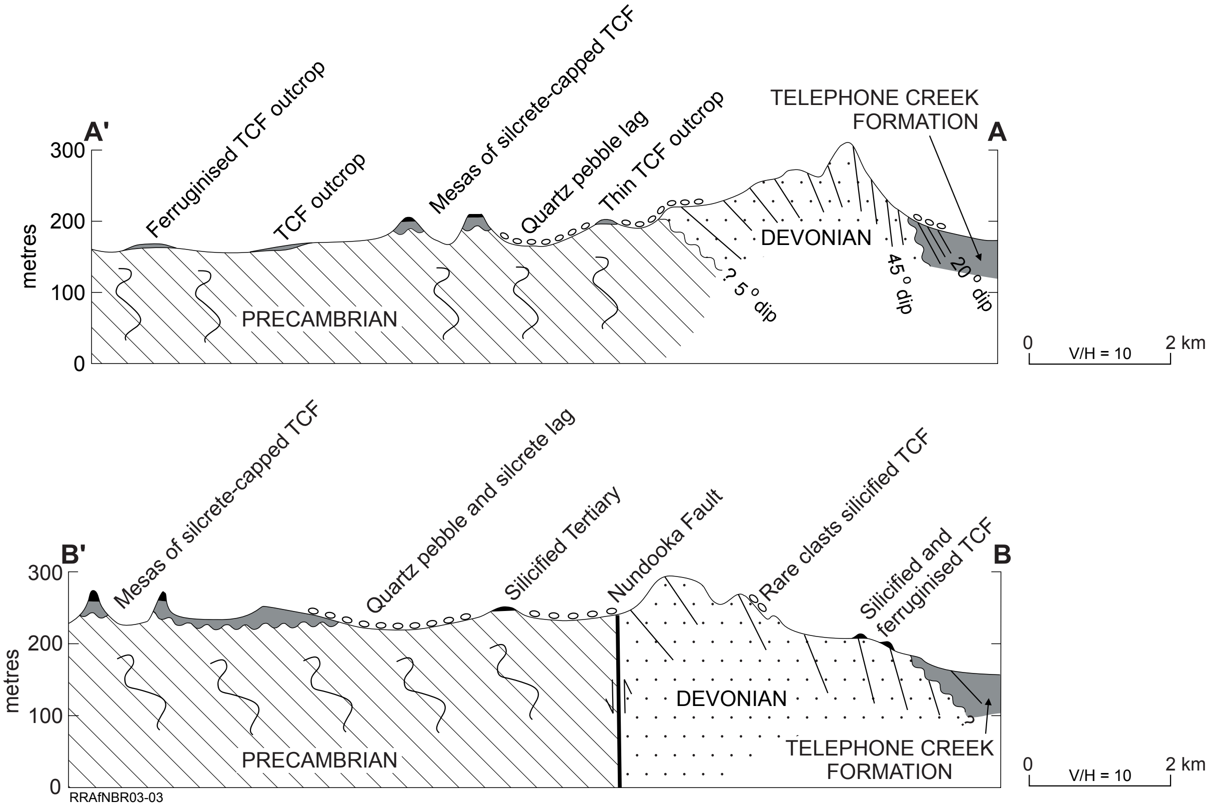

Figure 3. Sections across the ranges with geological data. Locations are shown in Figure 2. TCF = Telephone Creek Formation.

types. The Devonian sandstones form low ranges with asymmetric strike ridges (cuestas) producing a sawtooth topography. Stony pediments and rises underlain by Mesozoic sediments fringe the east and north margins of the ranges (Figure 2), and there is a distinct break of slope at the range/pediment boundary which coincides with the surface trace of the Palaeozoic–Mesozoic unconformity (Figure 3). Low relief strike-parallel ridges of silicified[1] and more rarely ferruginised Mesozoic sediment are locally present on the pediments. The pediments merge downslope with depositional plains associated with the modern drainage. Scattered silcrete-capped mesas and undulating areas of Mesozoic sediments are present in the west of the area (Figure 3).

Climate and vegetation

The climate is hot and dry, with much of the highly variable rainfall falling during summer and winter storms (Bell, 1972; Macdonald, 2000). Vegetation (Milthorpe, 1972a,b; Walker, 1991) consists mainly of saltbush and bluebush with grasses, forbs and copperburrs. Some mulga (*Acacia aneura)* and other small trees occur on the erosional plains and rises, and Mitchell Grass, saltbush and bluebush occur on the depositional plains. River gums (*Eucalyptus camaldulensis*) are locally present along larger drainage lines. All of the area is used for low intensity grazing on pastoral leases. The natural vegetation has been significantly affected by the introduction of domestic animals and rabbits (Bailey, 1972).

[1] Silicification of the Mesozoic sediments has been intense leading to the formation of silcrete.

REGOLITH–LANDFORM RELATIONSHIPS

The Neoproterozoic rocks are variably weathered, depending on lithology. There is minor weathering of resistant quartzite, which forms steep strike ridges. Dolomite, which has undergone some weathering, forms lower strike ridges. Shales have been deeply weathered possibly to 100 m (Beavis and Beavis, 1984), and form strike valleys. Loamy calcareous soils predominate, except on the quartzite ridges. A colluvial mantle of locally-derived rock fragments dominated by angular fragments of quartz vein and locally quartzite occurs on lower relief areas (Figure 3). Locally, the mantle includes, or is dominated by, fragments of silicified sediments and rounded quartz clasts. These materials are interpreted to be the remnants of a former cover of Mesozoic sediment (Telephone Creek Formation).

The Devonian sandstones are mostly fairly fresh, with a few weathered interbeds. They form low ranges with cuestas of more resistant beds. Soils are mostly skeletal, with abundant fragments of Devonian sandstone. Pockets of aeolian sand are locally present at the foot of west-facing bluffs. A stony mantle over the Devonian sandstones locally includes fragments of silicified sediment and rounded quartz clasts that are also interpreted to be the remnants of a former cover of the Telephone Creek Formation (Figure 3).

The Mesozoic sediments of the Telephone Creek Formation are highly weathered forming pediments and erosional rises in the east of the study area (Figure 3). Relatively fresh exposures of the Mesozoic sediments, with preserved easterly dips, occur in

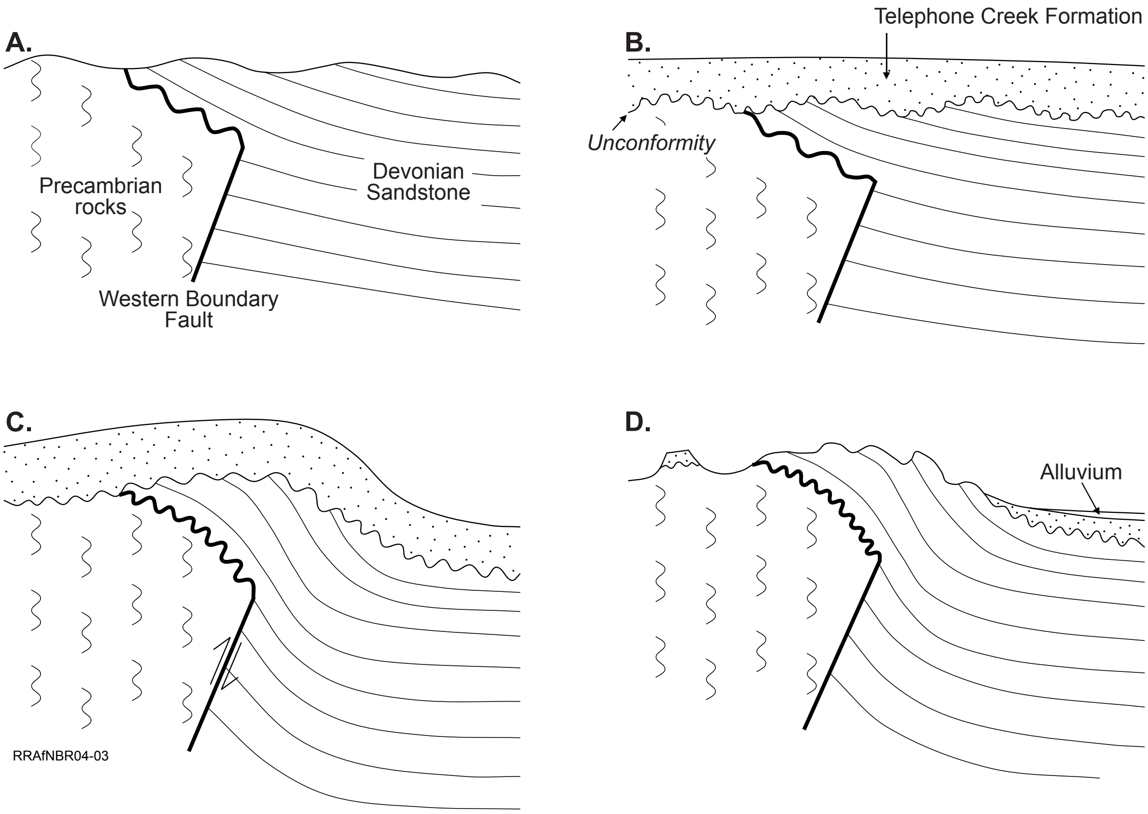

Figure 4. Interpreted stages of development of ranges north of Fowlers Gap by post-Early Cretaceous deformation and erosion. **A** Relatively uniformly dipping Devonian sandstone with little relief. **B** Deposition of Telephone Creek Formation during shallow marine incursion. **C** Monoclinal folding and uplift due to reverse faulting at depth. **D** Differential erosion of the uplifted areas imparts present day features to the ranges.

eroded gullies. Resistant beds cemented by silica (silcrete) and/or iron oxides form low strike ridges on the pediments. In the west of the study area, the sediments are flat lying and form mesas capped by discontinuous *in situ* silicified beds of sediment and ubiquitous loose silcrete fragments (Figure 3). Undulating areas with a mantle of silcrete fragments, ferruginised sediment, and rounded quartz clasts from eroded conglomerates are also present.

The Tertiary sediment with plant fossils in the southwestern part of the area has been silicified and has a mantle of silcrete fragments. Unsilicified Tertiary sediment is not exposed. Alluvium is locally present along watercourses. The alluvial tracts widen in the east of the area to form a broad alluvial plain dominated by coalescing low angle fans. Some of the plain is subject to severe wind erosion, and the lower lying part of the Bancannia Trough to the east of the area is dominated by sand dunes derived from sediment deposited over the trough. Many soils in the area are carbonate-rich, and soil on lower slope erosional areas display a contour-parallel banding of micro-topography, vegetation and soil properties (Mabbutt, 1972, 1977; Macdonald 2000; Macdonald and Melville 1999, 2000; Macdonald *et al*., 1999). The finer material in many soils is interpreted to be at least in part aeolian-derived (Macdonald, 2000). Gypsum is locally abundant in soils and near-surface deposits.

Some scree slopes beneath silcrete outcrops have been partly cemented to form a hardpan with a red earthy matrix enclosing clasts. The hardpan protects the slope from erosion. However, where it has been breached, the underlying highly weathered materials are easily eroded.

REGOLITH AND LANDSCAPE EVOLUTION

Along the eastern margin of the ranges, the Mesozoic sediments of the Telephone Creek Formation typically dip to the east at about 20°–30°, but further to the east and in the west of the area the Mesozoic sediments are near flat-lying. The base of the Mesozoic sediments lies at a higher elevation in the west of the area than in the east (Figure 3). The easterly dip of the Devonian rocks increases to the east, reaching a maximum of about 50°–70° at the eastern margin of the ranges. The eastern slope of much of the ranges approximates the dipping Palaeozoic–Mesozoic unconformity, and lags interpreted to have been derived from the Mesozoic sediments overlie the more steeply dipping Devonian sandstone at varying elevations on the eastern slope of the ranges (Figure 3).

Reconstruction of the palaeogeology of the area immediately before deposition of the Telephone Creek Formation suggests that the Devonian sandstones dipped towards the east at up to about 30° and formed an undulating area (Figure 4a). The Mesozoic sediments were subsequently deposited, burying the older Precambrian and Devonian rocks (Figure 4b). Studies of cross-bedding show that palaeocurrents were from the south (Neef *et al*., 1995), indicating a north-flowing drainage.

At some time after Mesozoic sedimentation, reverse movements along the northwest-dipping fault system at the northwest margin of the Bancannia Trough resulted in monoclinal folding of the Devonian and Mesozoic rocks (Figure 4c). This steepened dips in the Devonian sediments nearby to the fault system, and deformed the previously flat lying Mesozoic sediments to form a topographic high west of the fault. The presence of dipping silcrete beds within the Mesozoic sediment, some with inclined columnar structures oriented normal to bedding, suggest that some beds in the sediment had been silicified at depth prior to deformation. A new drainage system developed normal to the uplifted zone, and differential erosion of the mostly poorly cemented Mesozoic sediment resulted in exhumation of the Devonian rocks along the uplifted area, forming the modern range (Figure 4d). Further erosion of less well-cemented rocks in the Devonian sequence has resulted in the present day cuesta strike ridges of the range. Minor movements along north- to northeast-trending faults emanating from bends in the main fault planes appear to have influenced the distribution of alluvial plains over part of the Bancannia Trough (Figure 2).

During erosion of the Mesozoic sediments in the early Tertiary, the valley of a palaeodrainage line eroded down onto Neoproterozoic bedrock and was then partially filled with sediment, which included leaves of the local flora. This sediment was subsequently silicified, and is now preserved as a single silcrete body with plant fossils, west of the ranges. More recent development of regolith includes the deposition of coalescing low-angle alluvial fans over the Bancannia Trough, the formation of the hardpans on slopes below silcrete, limited deposition of aeolian sand, widespread deposition of aeolian dust, and the development of partitioned soils with regolith carbonate, which may be in part aeolian-derived. The top silty layer of alluvium exposed in gully banks, sometimes attributed to deposition since European settlement, has been shown to be up to 5 000 years old (Wakelin-King, 2000).

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