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GEOLOGY OF TELOWIE GORGE CONSERVATION PARK

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W M Cowley

The geology of the Telowie Gorge Conservation Park is dominated by uniform, pink to white, fine to medium grained feldspathic sandstone and quartzite of the Neoproterozoic Emeroo Subgroup, folded into a shallow-plunging anticline whose western limb is truncated by a major fault which forms the margin of the uplifted Flinders Ranges here. The resistant nature of this rocktype is the main reason for the ruggedness of the landforms. Minor exposures of probable Tertiary clayey sand are known in the vicinity and underlie the coastal plain to the west. Quaternary alluvial fans, comprising pebbly and cobbly sand, silt and clay, are represented in the park's western extremities. Soils are shallow and uniform on the quartzite, but deep and with duplex structure on the alluvial sediments. Groundwater is extracted from the sediments of the plains west of the ranges.

INTRODUCTION

In November, 1994, the Department of Environment and Natural Resources (DENR) requested a geological description for the Telowie Gorge Conservation Park in the southern Flinders Ranges northeast of Port Pirie for their draft management plan. The area was part of a current mapping project (BURRA 1:250 000 sheet) and had just been mapped by the author, with the assistance of G F Nichols, contract geologist. Initially the southern (Napperby) section of the park was not included as it was gazetted as part of the Mount Remarkable National Park but, upon advice from DENR that it would become part of Telowie Gorge Conservation Park, was described as well. The text, map and cross section were supplied in February 1995.

REGIONAL SETTING

During the Neoproterozoic Era, about 800 million years ago, major crustal changes saw the breakup of very large, ancient continental landmasses, similar to the more recent (100 million years ago) events which gave rise to the present continents. In the region which was to become South Australia, the earth's crust was thinned and pulled apart by tectonic forces, forming an extensive, elongated sedimentary basin which the sea invaded. This basin, the Adelaide Geosyncline, stretched from near Oodnadatta to Kangaroo Island (Callen and Reid, 1994). For the next 300 million years, sandstone, mudstone, limestone and dolomite were deposited in this basin, reaching over 10 kilometres in thickness as subsidence continued. The sandstone and mudstone were mostly brought to the basin by rivers but, at times, glaciers added mud, sand, pebbles and boulders torn from adjacent land areas. Limestone and dolomite beds commonly resulted from the activities of primitive organisms such as algae and sponge-like creatures.

Sedimentation was brought to a close about 500 million years ago, near the boundary of the Cambrian and Ordovician Periods, by a major episode of crustal compression and heating, the Delamerian Orogeny. The compacted and cemented sediments were buckled and uplifted by the approach of the ancient land masses on either side of the Geosyncline. The strata, compressed by predominantly east-west forces in the southern Flinders Ranges region, folded into north-south-trending structures. In northern parts of the fold belt, folds formed in more variable orientations. Uplift was accompanied by movements on the major faults which bound the present day Mount Lofty and Flinders Ranges. As these ancient mountains were periodically uplifted, weathering and erosion acted to reduce them as fast as they rose; this process has continued to the present day, where, in some places, much of the stratigraphic sequence has been removed, exposing strata deposited during the early history of the Geosyncline.

By about 100 million years ago, the mountain belt had probably been reduced to a near-flat peneplain. Earth movements related to the separation of Australia from Antarctica at this time caused renewed uplift along the faults bounding the mountain belt, and for the last 50 million years or so, the Flinders Ranges have been rising steadily. The majority of the topographic and erosional features of the Mount Lofty and Flinders Ranges can be related to this latest phase of uplift. Persistent small earth tremors indicate that this activity is continuing today.

LOCAL GEOLOGY

The first recorded geological observations in the Telowie Gorge Conservation Park are by Walter Howchin in May 1904 (Howchin, 1928). He reported that Telowie Gorge "shows a great exposure of thin- and thick-bedded sandstones and quartzites, sometimes false bedded, which were followed up for about a mile and a half. Dip WNW at 65°. No other kind of rock was seen *in situ* or recognised among the gravel of the creek. In some places the stone contains nodular structures of the same kind of rock". Howchin (1928) also examined the well-exposed rocks of the Back Creek (Port Germein) Gorge to the north of the park, as did Binks (1971), for mapping of the ORROROO sheet. Jack (undated) visited Telowie Gorge, probably very early in 1927, to investigate possible sites for a weir. He recommended one site just below a major creek junction about 1km above Telowie Springs and another on the northern branch about 400m further upstream.

A brief examination was made of some mine workings near the eastern boundary of the Nelshaby water reserve which were purported to contain silver mineralisation (Anonymous, 1935). Sampling of the workings, however, showed no silver or gold was present. Tarvydas (1969) carried out a search for road metal on the plains immediately west of the ranges.

Regional mapping for the BURRA 1:250 000 geology map (Mirams, 1964) involved limited observations in the park region. However, no other geological work in the park is known prior to the 1994 mapping of Wayne Cowley (Regional Geology Branch, Mines and Energy South Australia) as part of remapping of the BURRA map. The following description is derived largely from field notes for this project.

The western part of the southern Flinders Ranges from Crystal Brook north to Back Creek Gorge is predominantly composed of sediments of the Neoproterozoic Burra Group. From oldest to youngest the group comprises Emeroo Subgroup (mainly sandstone, quartzite, siltstone and conglomerate), Skillogalee Dolomite (grey dolomite, siltstone and sandstone), Undalya Quartzite, and a succession of siltstone, dolomite, and minor limestone and quartzite, mostly belonging to the Saddleworth Formation and equivalent units. Further to the east, towards Wirrabara, the overlying Umberatana Group comprises basal Appila Tillite of glacial origin, Tapley Hill Formation siltstone and Angepena Formation, consisting mainly of siltstone and shale (Binks, 1971).

In the vicinity of the Telowie Gorge Conservation Park the ranges are composed predominantly of uniform, pink, pale pink and off-white, orange-weathering, fine to medium-grained feldspathic sandstone to feldspathic quartzite of the Emeroo Subgroup (see map). On the eastern slopes in the Wirrabara Forest Reserve, it can be divided into a lower, pink unit with occasional dark mineral bedding (Rhynie Sandstone equivalent) and an upper, white unit (Bungaree Quartzite equivalent), separated by a thin unit of greenish siltstone, reddish thin-bedded sandstone and rare dolomite (River Wakefield Subgroup equivalent).

In the northern section of the Conservation Park, only the lowermost pink unit is present, and is characterised here by moderate to large scale planar bedding and cross bedding, the latter being particularly well-displayed in Telowie Gorge. The cross bedding, because of its very large size, is interpreted as being possibly of aeolian origin. The prevailing wind direction is inferred to have been from the east, but there is evidence for other directions. This differs from other regions, where the Emeroo Subgroup is interpreted to have a fluvial and deltaic origin, with currents inferred to be generally from the west (Preiss, 1987). Minor interbeds of pale green-white silty sandstone are present; these locally have dispersed dark mineral grains. Ripple-marked bedding surfaces are very rare.

The Emeroo Subgroup in the southern section of the Conservation Park is similar but does not display the large scale cross bedding of the northern part. Instead, the quartzite is mostly planar bedded, with small to moderate scale cross bedding and may be fluvial-deltaic in origin as interpreted for other regions. Current directions are mainly northerly to northeasterly or westerly, the two directions perhaps reflecting a tidal influence. Good exposures are found in disused quarries along Nelshaby Creek and in Napperby Gorge; purple, green and grey interbeds of micaceous silty sandstone are more common here than in the northern section of the park.

Bedding in the Emeroo Subgroup dips westerly near the margin of the ranges and easterly on the upper western and eastern slopes, defining a Delamerian anticlinal fold whose axis is parallel to, and about 0.5-1.5 km east of, the range margin (see map and section). The fold axis plunges about 20° to the north near Telowie Gorge but to the south it flattens and is plunging shallowly about 15° southward at Napperby

Gorge. The base of the Emeroo Subgroup is not exposed; the lowest stratigraphic level is found adjacent to the near-horizontal fold axis near Nelshaby Creek. A good exposure of the anticline axis can be seen in the easternmost quarries in Napperby Gorge. At the eastern end the quartzite dips 21° east. In the main part of the quarry bedding undulates, with easterly and southwesterly dips. Heading west, on the northern side of the gorge, the bedding again shallows before curving over the anticlinal core to dip 32° west. Quartz-haematite veinlets are also common in the main quarry.

Crushed rock products are obtained from Emeroo Subgroup quartzite by Cunningham Quarries Pty Ltd from quarries north of the mouth of Napperby Gorge close to the park boundary. Some road metal is also obtained from this unit as well as from calcreted alluvium (see below) by local councils.

The western scarp is interpreted to be due to a major fault responsible for uplifting the ranges during the Cainozoic. This fault is hidden, however, beneath the aprons of alluvium eroded from the ranges as a result of this uplift. Some bedding is overturned immediately east of the scarp and may indicate proximity to a fault zone. A weak foliation is evident in places, generally dipping steeply west on the eastern side of the fold axis and steeply to moderately east on the western side. A major fault is interpreted to cross the southeastern corner of the northern section of the park; both the anticline axis and the eastern limit of the quartzite unit are offset. A fault can be seen in the easternmost old quarry on the southern side of Nelshaby Creek; in the southwestern corner hard quartzite is in contact along an east-dipping fault with strongly crushed and weathered quartzite.

The Conservation Park incorporates some very small areas of the coastal plain on its western edge. These are underlain by Pleistocene to Holocene (1.6 million years to present) red-orange pebbly and cobbly alluvial sand, silt and clay at the proximal edge of a series of coalesced alluvial fans fronting the ranges. Some horizons of Pleistocene (1.6 million to 10 000 years ago) calcrete palaeosol are present; calcrete of presumably similar age has developed on some west-facing slopes of quartzite which have undergone little erosion. Exposure of the alluvial sediments is confined largely to creek banks and gravel quarries. Up to 5 metres of bouldery and pebbly brown and red sand and red to pale grey clay can be seen in quarries where Nelshaby and Napperby Creeks emerge from the ranges. Well-rounded boulders up to 1 metre in size indicate very vigorous floods at times during the deposition of these sediments.

High on the southeastern face of the easternmost quarry in Napperby Gorge there is a wedge of gravelly alluvium marking an excavated creek valley. It is likely that much of the ranges, although appearing like quartzite outcrop, is mantled, at least on steeper slopes, by gravelly debris such as this.

Rare exposures of white to orange clayey sand occur outside the park boundaries and are believed to represent an older, Tertiary (65 million to 1.6 million years ago) alluvial unit; this may be present in the subsurface within the park as it is much thicker under the plains to the west (Shepherd, 1978). Both this unit and the more widespread younger alluvium can be related to erosion of the Neoproterozoic sediments in response to Tertiary to present-day uplift of the ranges.

Telowie Creek carries pebbly and bouldery sand as its present day alluvium; the large size of some of the boulders indicates that vigorous flow during periods of high rainfall continues.

Tertiary and Quaternary sediments up to 170m thick (minimum) in water bores which were put down quite close to the western scarp of the ranges (Chebotarev, 1958) are further evidence for major faulting along the scarp.

GEOMORPHOLOGY

The present landforms have resulted from the interaction between weathering and erosion, and the gradual uplift of the Flinders and Mount Lofty Ranges since reactivation of faulting in the Tertiary Period. Because the Emeroo Subgroup is composed predominantly of sandstone and quartzite resistant to chemical and mechanical attack, it has remained as topographically elevated areas while adjacent softer rocks have been worn away. In the part of the ranges that stretch southward from Telowie Gorge Conservation Park, the effective increase in thickness of these resistant rocks due to anticlinal folding undoubtedly has helped in the formation of a ridge considerably higher than surrounding regions.

Drainage patterns in the park areas show only poor control by northwesterly bedding trends in the Emeroo Subgroup, probably because the rocktype, and hence its resistance to erosion, shows little variation. Aerial photographs show only a few stream segments in the centre and southeastern corner of the northern section of the park which parallel bedding for any distance. The most elevated parts of the park are along the Go-Cart Track on the eastern boundary, culminating in The Bluff at 738m above sea level; this ridge forms the drainage divide between creeks which drain directly onto the plains to the west and those which drain into the upper reaches of Telowie Creek above Telowie Gorge or into the headwaters of Ippinitchie Creek or Crystal Brook (via Beetaloo Reservoir).

Telowie Creek has cut a tightly sinuous gorge right through the range and thus has its headwaters east of the Park in the Wirrabara Forest Reserve. Through the park, however, the gorge follows a northeast-southwest trend, possibly exploiting a fault or major fracture, although no direct evidence for a fault is known in the gorge. By comparison, Nelshaby and Napperby Creeks and numerous other creeks have been unable to cut through the range and their headwaters lie west of the main ridge.

SOILS

Soils developed on the quartzite ridges of the Telowie Gorge Conservation Park region are described by Laut et al. (1977a) as uniform reddish dense loams which are shallow, well drained and alkaline. They are sandy and gravelly and interspersed with outcrops of sandstone and quartzite. The alluvial fans at the western extremity of the park are characterised by hard red gravelly duplex soils, which are deep, well drained and alkaline (Laut et al., 1977b).

GROUNDWATER

Although no bores or wells are known within the Telowie Gorge Conservation Park, the southern Flinders Ranges in this area, with a maximum annual rainfall of over

700mm near The Bluff (Laut et al., 1977a), act as an effective catchment for groundwater recharge to the sediments underlying the plains to the west. Stock water is obtained from both the unconfined aquifer in Quaternary sediments as well as from the confined aquifer in the Tertiary sediments beneath. Less saline water for irrigation, including for market gardens near Napperby and Nelshaby, is obtained from the Tertiary aquifer (Shepherd, 1978). A similar situation exists close to the ranges near Telowie Gorge, where Telowie Creek could be expected to provide a concentrated source of fresh recharge to the underground supplies on the nearby plain. Mines and Energy Department records show several bores very close to the mouth of the gorge supplying good quality water (less than 1500 mg/l salts) from up to 115m of alluvial sediments.

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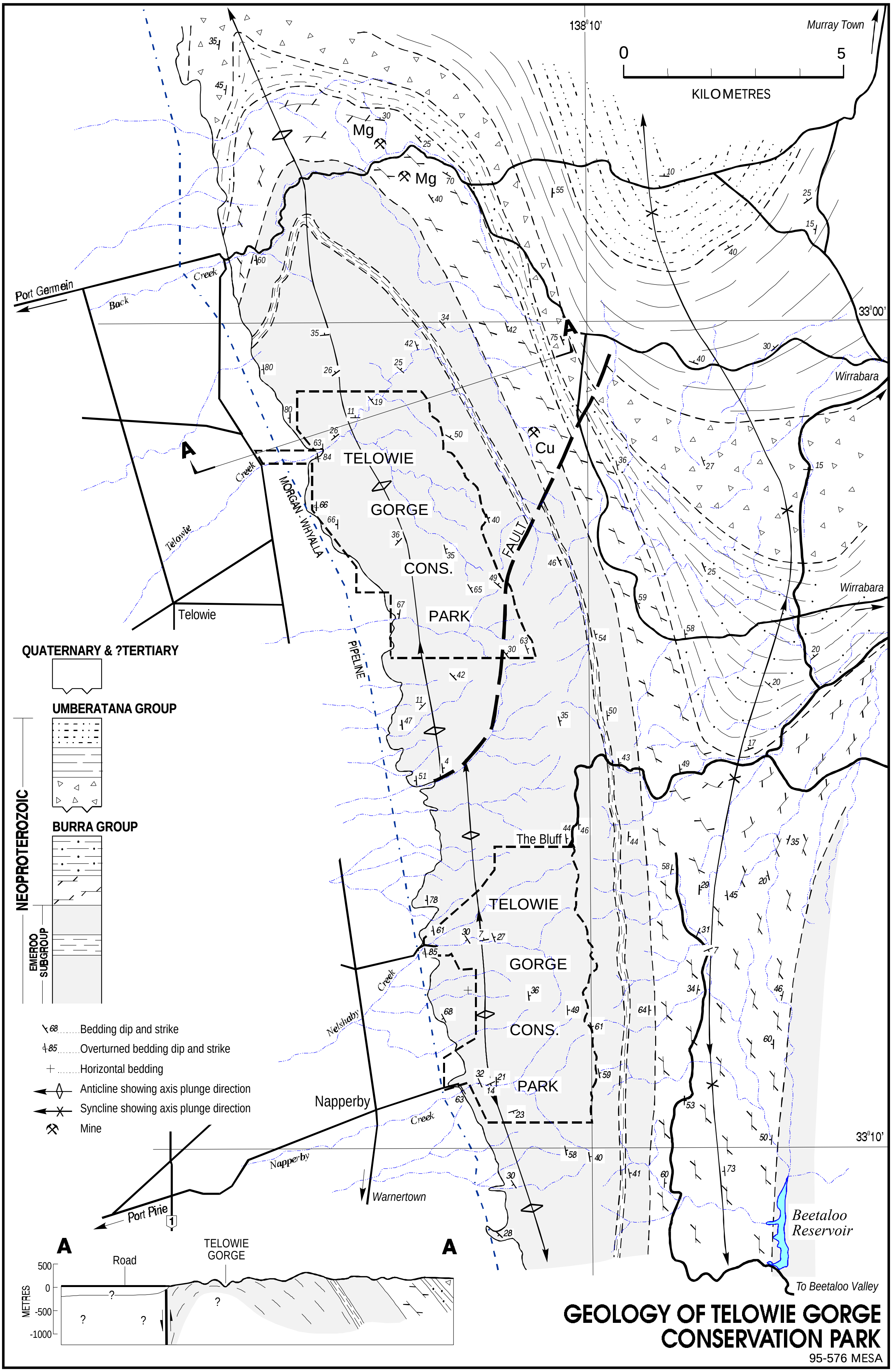

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