SECTION

DEPARTMENT OF MINES
SOUTH AUSTRALIA

GEOLOGICAL SURVEY
MINERAL RESOURCES DIVISION

RECONNAISSANCE SURVEY OF BALLAST SOURCES.
TARCOOLA - ALICE SPRINGS STANDARD GAUGE RAILWAY

MT. WILLOUGHBY - NORTHERN TERRITORY BORDER

- Commonwealth Railways -

by

J.B. FIRMAN
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NON-METALLICS SECTION

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DEPARTMENT OF MINES
SOUTH AUSTRALIA

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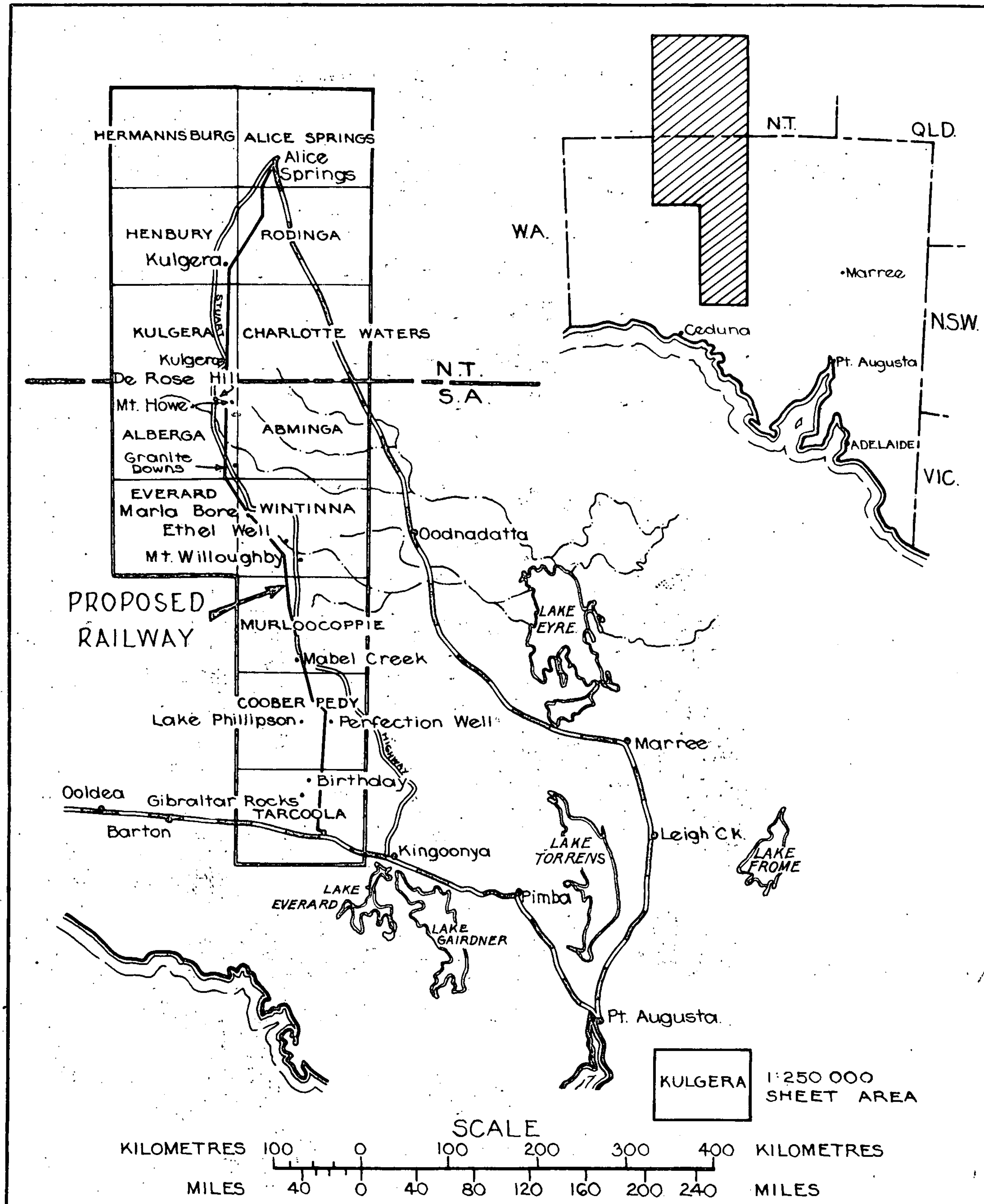

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MT. WILLOUGHBY - NORTHERN TERRITORY BORDER

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ABSTRACT

This report describes potential ballast sites on the Mt. Willoughby - Northern Territory Border section of the proposed Tarcoola - Alice Springs standard gauge railway.

Sedimentary rocks of Mesozoic and Tertiary age south of Marla Bore do not provide suitably large amounts of rock which could be classified as ballast. Crystalline rocks and sedimentary rocks of Precambrian and Palaeozoic age provide a number of potential ballast sites north of Marla Bore. Of these, the deposits at Mt. Chandler, Granite Downs, Olgas Bore, Eagle Hawk Dam and Calamity Bore have the greatest potential for a suitable quantity of hard rock.

Los Angeles Abrasion and Sodium Sulphate Soundress tests are included in support of geological opinion regarding the suitability of materials. A report on petrography of selected material is also provided.

INTRODUCTION

The existing narrow gauge track between Marree and Alice Springs is to be replaced by a standard gauge track between Tarcoola and Alice Springs. Both routes connect at the southern end at Port Augusta, a major rail junction and Headquarters in South Australia for the Commonwealth Railways (see Locality Map).

This report describes ballast sources along the Mt. Willoughby - Northern Territory border section of the route. About 2 000 cubic metres of ballast per kilometre are required. Sites should be at intervals of approximately 80km and the minimum amount of material at each site should be about 160 000 cubic metres (say 150 000 cubic metres of suitable rock).* Because the final selection of sites will be determined by the position and distance apart of sites elsewhere in South Australia and the Northern Territory, all potentially usable sites in the section have been described.

A detailed reconnaissance between Mt. Willoughby in South Australia and Kulgera in the Northern Territory was made by the writer between 7.7.71 and 22.7.71. The Mt. Willoughby - Northern Territory border section described herein ends at the State border about 23km (14 miles) south of Kulgera. An aerial reconnaissance of the entire route Tarcoola - Alice Springs was made on 3rd August, 1971, and a ground reconnaissance from Alice Springs to Mabel Creek was made between 5th August, 1971 and 10th August, 1971. These surveys - made in company with Mr. D. Smith, Maintenance Engineer, Trans Australian Railways - also provided useful information on the Mt. Willoughby - Northern Territory Border section. An earlier reconnaissance to examine potential ballast sites along the South Australian portion of the route was carried out in October, 1970 (Hiern, M.N., 1970).

GEOLOGICAL SETTING

The principal rock types cropping out along the route are

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*The ballast requirement was originally stated at 4 000 cubic yards per mile and 200 000 cubic yards per 50 mile interval.

crystalline rocks of Precambrian age and sedimentary rocks of Precambrian and Palaeozoic age - all north of Marla Bore - and sedimentary rocks of Mesozoic and Tertiary age south of Marla Bore. (see accompanying geological maps - Pocket). Younger sediments and soils veneer these deposits in many places.

Precambrian

Crystalline Rocks.

The crystalline rocks are part of ".....an immense crystalline basement terrain" (Thomson, 1969, p.34) which forms the Musgrave Block, and records a complicated sequence of tectonic, metamorphic and igneous events. [illegible]

Gneissic granite and granitic gneiss form low outcrops or are thinly veneered by younger surficial deposits near Granite Downs and De Rose Hill. Granite (including "adamellite" of Sprigg et al., 1959) and granodiorite intrusives crop out throughout the area. Younger dolerite intrusions occur as thin northwest - southeast trending dykes near Granite Downs, near Eagle Hawk Dam and Olgas Bore in the De Rose Hill area, and in the Calamity Bore area north and east of Sundown Homestead.

Basement Cover

The Precambrian cover rocks are part of a great belt of sediments which extends northwest from the Mt. Lofty Ranges to the Musgrave Block. They include minor volcanics and are structurally deformed, but otherwise relatively unaltered (Thomson, 1969, pp.49-83). Krieg, G.W. (1971) has mapped Proterozoic and younger Palaeozoic sequences on the EVERARD 1:250 000 sheet area.

From oldest to youngest the rock units or sequences are: Chambers Bluff Tillite south of Wantapella Swamp and east of the route; undifferentiated shale, siltstone, tillite and limestone with some vesicular basalt between Wantapella Swamp and De Rose Hill; and Rodda Beds and undifferentiated siltstone and sandstone of the Mt. Johns area south of Wantapella Swamp and west of the route (see Sheet 2). The Rodda Beds are a sequence of calcareous siltstone and sandstone with conglomerate bands, siltstone, dolomite and limestone.

Palaeozoic

Palaeozoic sedimentary rocks occur adjacent to the route between Marla Bore and Mt. Johns, where they overlie older sediments of the Precambrian basement cover with a strong unconformity. The oldest rocks are the Cambrian Observatory Hill Beds, which consist of brown and pink micaceous laminated siltstone and silty shales typically with chert nodules and bands. These are overlain by the Trainor Hills Sandstone and the Mt. Johns Conglomerate, also of Cambrian age, and the Ordovician Mt. Chandler Sandstone.

Mesozoic

The older rocks already described do not crop out south of Marla Bore. Instead, the landscape is dominated by sedimentary rocks of the Great Artesian Basin. These are of Mesozoic age and are covered by Tertiary and younger deposits in many places. No detailed mapping has been carried out, but much of the sequence exposed is thought to be Cretaceous Bulldog Shale. The Mesozoic rocks have been extensively altered by later weathering and diagenesis.

Cainozoic

Thin Tertiary and Quaternary deposits occur throughout the route. The deposits include weathered rocks of various ages; sediments; siliceous, ferruginous and calcareous duricrusts; and younger soils. Although important from an engineering construction point of view, most of these materials are not suitable as ballast.

BALLAST SOURCES

The materials investigated as a source of ballast in the northwest part of the Great Artesian Basin include sandstones in the Guldburra area which are possibly of Mesozoic or Tertiary age, beds in this same sequence which were silcreted during the Tertiary and other silcretes such as those at England Hill and Sarda Bluff, and the ?Pleistocene Mt. Willoughby Limestone. These deposits have been mentioned by Hiern (1970) and Nichol (1971a), and the Mt. Willoughby Limestone itself has been defined and also described as a source of ballast by Nichol (1971b) and c).

The deposits now discussed are of Precambrian to Cambrian age and either form part of the Musgrave Block or rest upon it. Petrographic descriptions of rocks from the various deposits are set out in Appendix 2 (AMDEL, 1971). Possible ballast sources are described beginning on the south side of the Block near Marla Bore and proceeding north to the Northern Territory Border. The deposits, which are all shown on Sheet 2 (Pocket), are named for convenience according to a nearby locality.

Marla Bore Deposit

The Trainor Hills Sandstone is part of a flat-lying sequence of Cambrian age which forms prominent low hills about 6 kilometres (4 miles) west of the proposed route and adjacent to the Stuart Highway 5 kilometres (3 miles) north of Marla Bore (<u>see</u> Figs.2 and 3).

The rock is a fine - medium grained sandstone finely cross-bedded in some places and flaggy in others. The sandstone cropping out is weathered with an oxidised outer surface somewhat hardened by secondary silica. Material at the hilltop appears to be harder than that on the lower slopes.

A very large tonnage is available in the hills which extend towards Mt. Johns about 18 kilometres (11 miles) to the north.

The results of Los Angeles abrasion tests and sulphate soundness tests (<u>see</u> Appendix 1) show that the material sampled is weathered and that it is suitable for use only as a very low-grade ballast (<u>see</u> Appendix 2 where rigorous criteria applied by the petrographer exclude the sandstone from classification as ballast).

The following steps are required to test the deposit:

1. Detailed reconnaissance to locate the hardest material in this vicinity.
2. Detailed mapping of the selected site.
3. Drilling of three holes to test continuity of suitable material (The rock may be less weathered at depth), and to prove a minimum quantity of 150 000 cubic metres.
4. Further abrasion and soundness testing if required, followed by a trial crushing if drilling shows that the quality of the material is not maintained below ground surface.

Fig. 2: Marla Bore Deposit. Distant view of outcrop of Trainor Hills Sandstone.

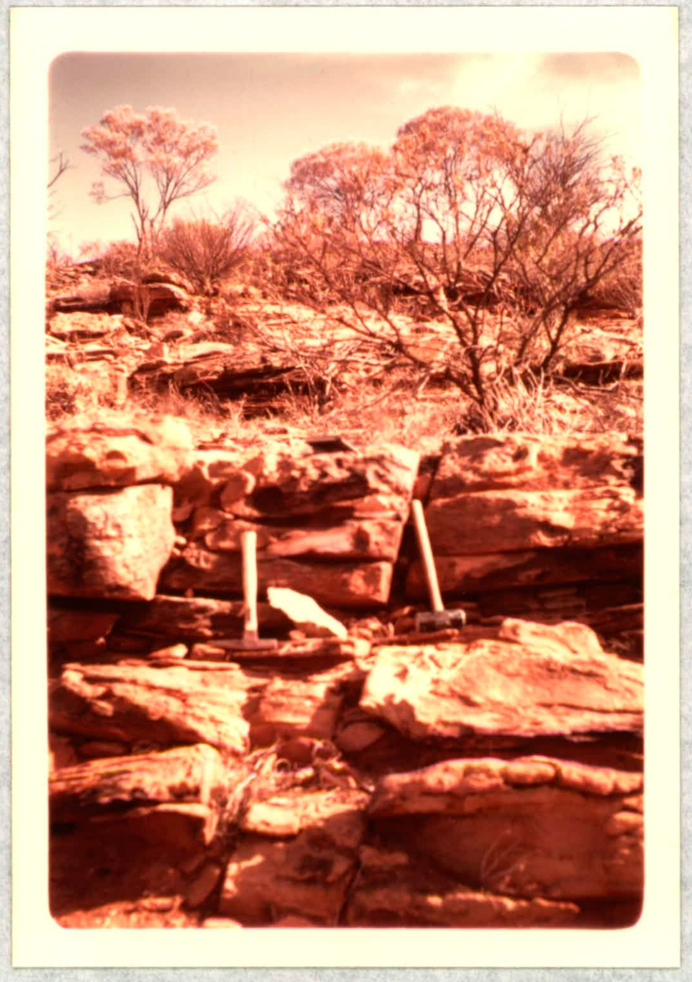

Fig. 3: Marla Bore Deposit, Trainor Hills Sandstone. Cross-bedded and flaggy units.

Mount Chandler Deposit

A low ridge of silicified sandstone (quartzite) occurs a short distance west of the Stuart Highway 3 kilometres (2 miles) south of the turn-off to Granite Downs and about 37 kilometres (23 miles) north of Marla Bore. The quartzite dips vertically and is contained within a strongly weathered siltstone which is part of a tillite sequence of Proterozoic (Sturtian) age. Light grey and red colours in the outcrop suggest that the material near ground surface has been silcreted in Tertiary time. The quartzite is strongly jointed. Larger ridges of the same rock are reported to the west by geologist R. Major (pers. com.).

The average height of the ridge is about 6 metres (20 feet) above the surrounding slopes. Average width of separate outcrops is about 18 metres (60 feet) (see Figs.4 and 5). Allowing for erosion, there is at least 10 000 cubic metres (13 000 cubic yards) in the outcrop. If the bed maintains its quality, length and thickness below ground surface, it should yield at least 6 500 cubic metres per metre of depth. (or about 3 000 cubic yards per vertical foot).

Abrasion and soundness tests (see Appendix 2) show that the material should make good ballast.

The following investigations are required to test the deposit:

1. Detailed mapping.

2. Drilling. At least 2 inclined diamond drill holes should be put down from the north side. These should be evenly spaced along the ridge and should be aimed to intersect the quartzite bed at its centre about 15 metres (50 feet) below the base of

the outcrop. Drill inclination and total footage can be calculated when ridge slope and true dimensions have been established by detailed mapping.

Fig.4: Mount Chandler Deposit. View of quartzite ridge looking southwest from the Stuart Highway about 350 metres (400 yards) distant.

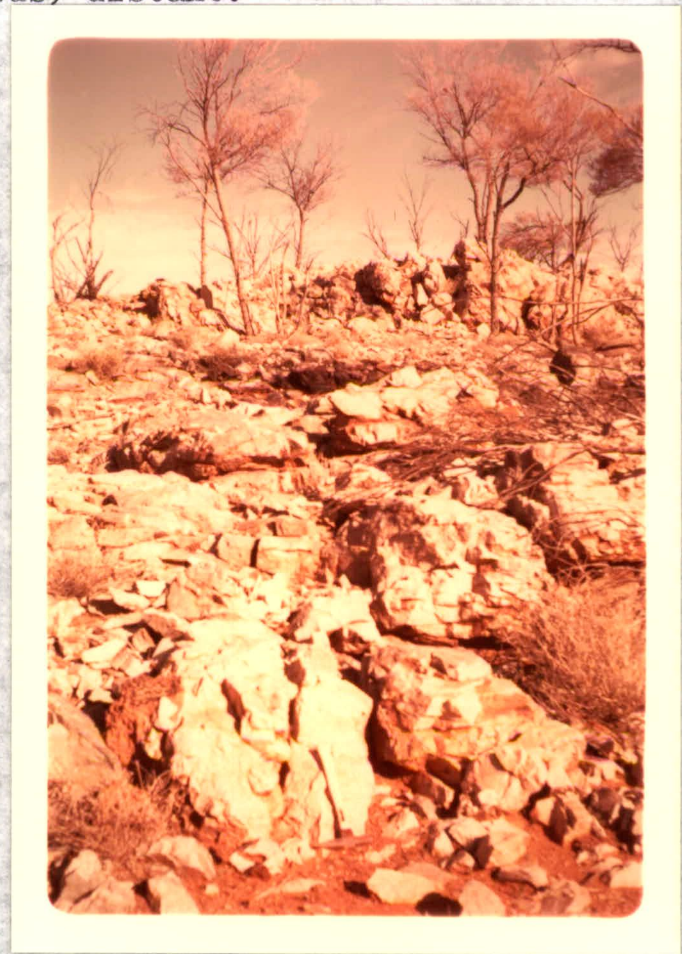

Fig.5: Mount Chandler Deposit. Close-up from north side. Ridge is about 35 metres (40 yards) wide at this point.

Granite Downs Deposits

Large dolerite dykes are numerous about 10 kilometres (6 miles) north of Mt. Chandler and east and west of the suggested route. Inspection of some of these dykes along the northern turn-off to Granite Downs Homestead shows that dense hard rock suitable for ballast occurs in many places. The number and wide-spread occurrence of the dykes suggests that site selection be deferred until the position of the route is better known. No difficulty will be found in selecting suitable deposits. The area could provide a much larger amount of rock than is required from local quarry sites.

The following programme is suggested:

1. Detailed reconnaissance of deposits adjacent to the route.
2. Mapping and drilling. Three holes are suggested to prove a suitable tonnage and test for continuation of sound rock at depth.

Dust Bowl Deposit

A low rise of thin-bedded siltstone and greywacke occurs about 2 kilometres (1 mile) east of the Stuart Highbury and 32 kilometres (20 miles) north of the turn-off to Granite Downs. The rise is about 3 kilometres (2 miles) across, but the main area of outcrop is about 350 metres (400 yards) across. The beds trend north-south and dip vertically. Although the greywacke might be suitable as ballast, the beds are only about 6 metres (20 feet) thick and for this reason the deposit could not be worked economically.

Olgas Bore Deposits

Dolerite dykes crop out about 5 kilometres (3 miles) east of Olgas Bore and 10 kilometres (6 miles) south-east of Eagle Hawk Dam. One of the dykes in this swarm is shown on the ALBERGA 1:250 000 sheet. The individual outcrops trend east-west and northwest. Most outcrops are only about 6 metres (20 feet) wide, are low and are soil covered in many places, but one outcrop a few hundred metres east of the track along the Tieyon boundary fence stands about 3 metres (10 feet) above the plain. The length of the dykes is not obvious because of poor outcrop, but one dyke in this area could be seen to extend over a distance of several hundred metres.

The rock is suitable for ballast and it is possible that a large tonnage of dolerite, perhaps mixed with other basement rock, could be won from the area. The extent of the dykes, continuity, jointing, weathering and nature of the adjoining basement can only be determined by a programme of detailed mapping over a wide area, followed by drilling of selected sites.

Eagle Hawk Deposit

Dolerite ("microgabbro") dykes are shown on the ALBERGA 1:250 000 sheet immediately north of Eagle Hawk Dam and about 6 kilometres (4 miles) east of De Rose Hill. The complete pattern of dykes shown on the map could not be seen during aerial reconnaissance and ground inspection. However, the most extensive outcrop is exposed about 45 metres (50 yards) west of a track running north from Eagle Hawk Dam and distant about 3 kilometres (2 miles) from that feature. The dyke consists of 3 in-line or slightly en-echelon outcrops, each about 90 metres (100 yards) long, extending northwest over a distance of about 2 kilometres (1.3 miles measured). At its southern end, the dyke is about 35 metres (40 yards) wide (see Fig.6).

The rock is suitable for ballast. The nature of the jointing and the continuity between outcrops can only be determined when the deposit is drilled and opened up. From the few indications available on the ground, it appears that the deposit may yield the required tonnage if soil covered dolerite has similar dimensions to surface outcrop.

Fig.6: Eagle Hawk Deposit. Main outcrop at the Southeast end.

The detailed examination of this deposit should be carried out as follows:

1. Reconnaissance of the dyke swarm shown on the ALBERGA 1:250 000 map sheet.
2. Detailed mapping of the main dyke.
3. Drilling to establish continuity between outcrops and to establish dyke widths.

Mt. Howe Deposits

Low rounded hills of granite are a feature of the gently undulating terrain about 26 kilometres (16 miles) east of Sundown Homestead and a few kilometres south of Mother Well. The most prominent hill is Mt. Howe.

The rocks in this area are coarse-grained and somewhat weathered near surface (see Appendixes 1 and 2). Joints are strong but wide-spaced (see Fig.7).

A large tonnage of material would be available but quarrying would be costly because of lack of joints to facilitate breakage.

It is suggested that the absence of close-spaced joints and the possibility of weathering on grain boundaries in this material may be a disadvantage. If possible, dense fine-grained rock should be used instead.

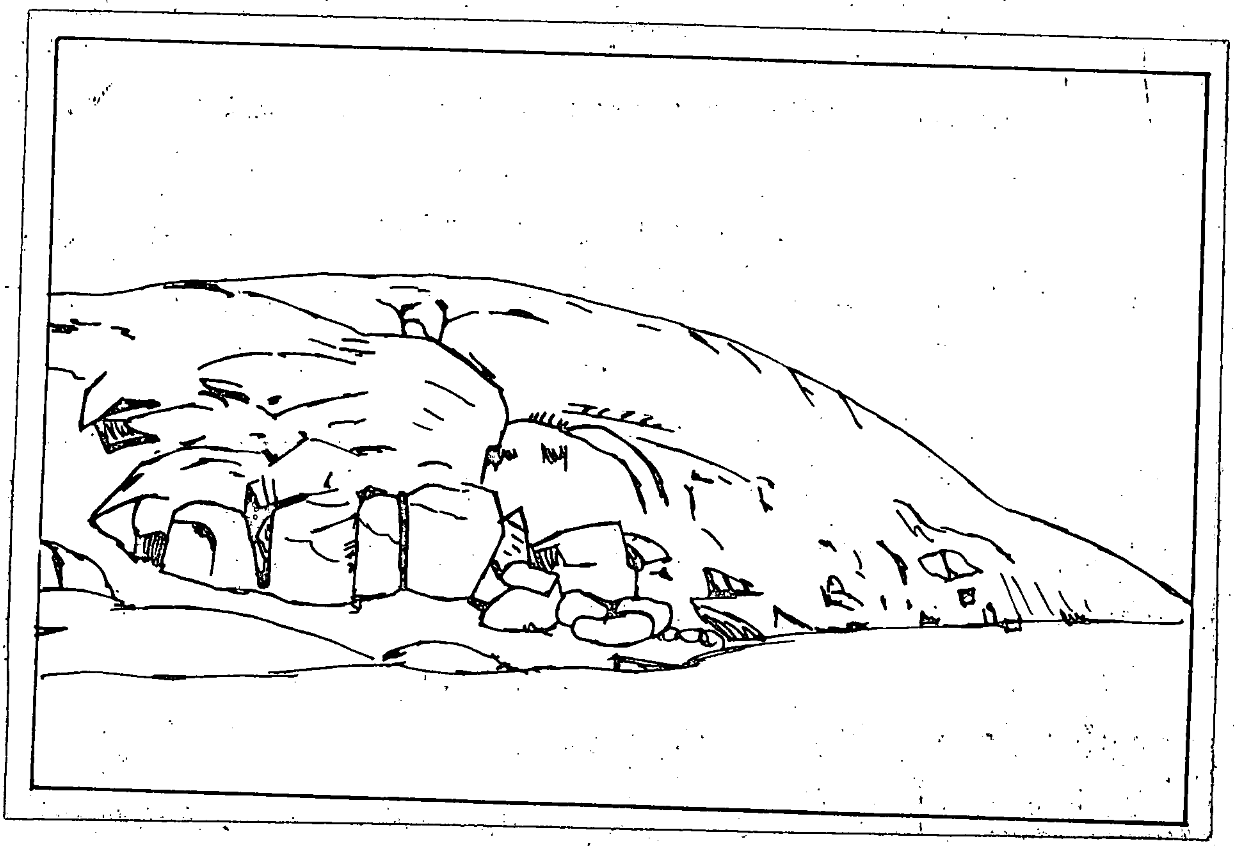

Fig. 7: Mt. Hows Deposit. Coarse-grained granite with wide-spaced joints.

Coultys Bore Deposits

Outcrops of granite gneiss are found about 10 kilometres (6 miles) west of Mt. Howe and a few kilometres northeast of Coulty's Hole Bore. These rocks are much the same as those at and near Mt. Howe.

The southern outcrops in this area are coarse-grained and weathered. The central outcrops marked by the most prominent hill in the area (see Fig.8) contain fine-grained rock suitable for ballast, but the hill itself is capped with coarse-grained gneiss which would prove an obstacle to efficient quarrying of the underlying material. The most northern outcrops are fine-grained and generally speaking appear to be the most suitable for ballast. An exception is the most western of the northern outcrops which is interbanded with softer and more weathered gneiss. This material would not be suitable ballast.

The northern outcrops are small and some distance apart (see Fig.9) but there is little doubt that they are connected beneath the blanket of coarse sandy soil and that they would yield the required amount of ballast.

The testing programme in this area should include:

1. Detailed mapping of the northern deposits.
2. Extensive shallow drilling between selected outcrops to prove continuity and quality.
3. Further petrological, abrasion and soundness testing.

Fig. 8: Coulty's Bore Deposit: Prominent Hill of fine-grained granite capped by coarse-grained gneiss in the central outcrop area.

Fig. 9: Coulty's Bore Deposit: Small outcrops of granite-gneiss in the northern area recommended for detailed mapping and drilling.

East Bore Deposit

A small hill of adamellite occurs 6 kilometres (4 miles) east-northeast of East Bore which is 6 kilometres (4 miles) east of Dougs Well. Dougs Well is about 14 kilometres (9 miles) south of the Northern Territory Border in the Stuart Highway. The unweathered material is quite strong, but the quantity above plain level is insufficient for requirements. Figure 10 shows most of the western side of the deposit.

Calamity Bore Deposits

A swarm of dolerite dykes - "microgabbro" of the ALBERGA 1:250 000 sheet - lies about 3 kilometres (2 miles) south of the South Australian - Northern Territory Border and about 14 kilometres (9 miles) east of Brunsons Well and Yard and 23 kilometres (14 miles) east of the Stuart Highway.

The rock is dense, hard and fine-grained. Abrasion and soundness tests show that it is well-suited for use as ballast. Although massive in some places it is quite strongly jointed in others. In some places joints are so close-spaced that crushing would produce cubical fragments with a length somewhat greater than 2 centimetres (1 inch) on the side.

A reconnaissance of the numerous outcrops shows that many of the dykes are narrow and their outcrop length is short. A promising site occurs 2 kilometres (1 mile) east of the north-south trending station boundary fence. Here the main dyke is about 30 metres (35 yards) wide and invades a fine-grained granite gneiss. The fine-grained granite gneiss is itself useful as ballast, and it is suggested that it could be worked together with the dolerite. The accompanying north-south sketch section (Fig.11) shows rock relations in the most promising area.

Testing of this deposit will probably require at least two shallow drill holes; one to prove that the dolerite is not weathered at depth, the other to test the suitability of adjoining granite gneiss.

Extensive outcrops of dolerite occur about 13 kilometres (8 miles) east of Kulgera in the Northern Territory. These deposits may provide a permanent ballast site suitably placed with regard to other sites in the Northern Territory, and this will influence site selection in South Australia.

Fig. 10: East Bore Deposit.

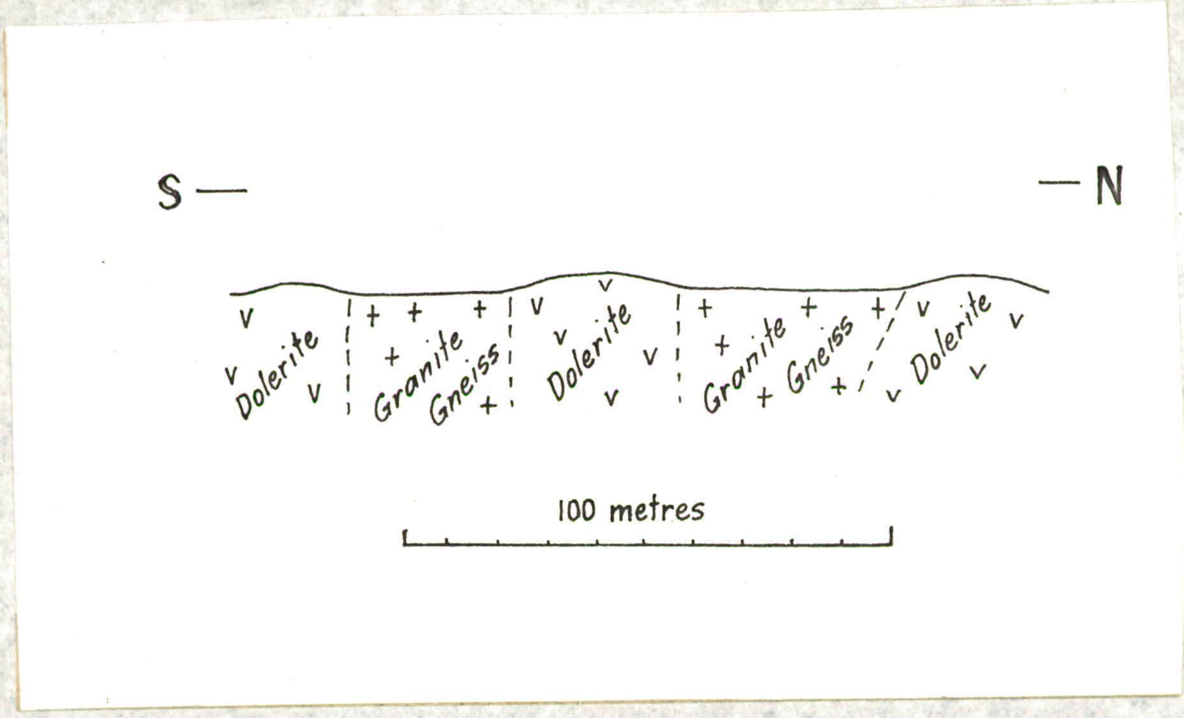

Fig. 11: Calamity Bore Deposit. N.S. sketch section at east end of promising area 2 kilometres (1 mile) east of station boundary fence.

SUMMARY AND CONCLUSIONS

Ten potential ballast sites have been examined between Mt. Willoughby and the Northern Territory Border. The Dust Bowl (greywacke) Deposit and the East Bore (adamellite) Deposit are too small to warrant further investigation. The Trainor Hill Sandstone near Marla Bore could provide a large quantity of rock, but further testing will be required to prove its suitability. The Mt. Howe (granite) Deposits are coarse-grained and poorly jointed, and the adjoining Coultys Bore (granite gneiss) Deposits should be considered instead if ballast is required in this area. The remaining deposits - quartzite near Mt. Chandler and dolerite near Granite Downs, Olgas Bore, Eagle Hawk Dam and Calamity Bore - all contain suitable material. Detailed mapping and drilling may prove them to be useful local ballast deposits. A permanent ballast site may be proven among the Granite Downs Deposits.

Before selected ballast deposits are opened up, it is recommended that detailed mapping and drilling should be carried out as previously outlined for individual deposits.

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*Title changed to Petrography of Seven Samples from the Musgrave Block Area in Appendix 2.

APPENDIX I

Los Angeles Abrasion Value and Sodium Sulphate Soundness Tests.

"S.A. Highways and Local Government Department" Materials and Research Laboratories (12th Nov., 1971).

Field Sample Number	Locality	Rock Type	Los Angeles Abrasion Value **		Sodium Sulphate Soundness* (Loss)	
			Size Fraction Tested	%	Size Fraction Tested	%
12269	Marla Bore Deposit	Sandstone	-¾" + ½"	56	-¾" + 3/8"	29.5 *
-	" " "	"Hard" Sandstone	-1½" + ¾"	53	-1½" + ¾"	11.0
12651	Mt. Chandler Deposit	Quartzite	-¾" + ½"	17	-¾" + 3/8"	0.4
12712.9	Eagle Hawk Deposit	Dolerite	-1½" + ¾"	15	-1½" + ¾"	0.7
12763.8	Mt. Howe Deposits	Granite	-¾" + ½"	53	-¾" + 3/8"	6.0
12832	Coultys Bore Deposit	Granite gneiss	-1½" + ¾"	66	-1½" + ¾"	7.6
12935	Calamity Bore Deposits	Dolerite	-1½" + ¾"	21	-¾" + 3/8"	3.0

S.A. Highways and Local Government Department. Materials and Research Laboratories. (12th November, 1971).

* A high sulphate loss is usually indicative of the material being subject to degradation by weathering.

** 1 inch x 2.54 = centimetres or 1 inch = 254 millimetres.

APPENDIX II

Petrography

The Australian Mineral Development Laboratories, Adelaide, South Australia. Report MP.657/72, September, 1971.

PETROGRAPHY OF SEVEN SAMPLES
FROM THE MUSGRAVE BLOCK AREA

Sample: P 463/71: TS 27320

Location:

Marla Bore Deposit (Collectors No. 12629)

Rock Name:

Argillaceous sandstone. (Trainor Hills Sandstone)

Hand Specimen:

The rock is buff to pale tan in colour and possesses a weak foliation. The grain size is uniform and the rock is quite porous.

Thin Section:

An optical estimate of the constituents gives the following:

	%
Quartz	60-70
Clay	10-20
(Voids)	10-20
Accessories	5

The texture of this rock is at first sight enigmatical. The quartz grains, which are irregular in shape but rather uniform in size, about 0.1-0.2 mm, are tightly welded. However, there are numerous voids and patches of clay which are several times as large as the quartz grains. Except for the voids and clay the rock would be a well-sorted welded quartz sandstone or orthoquartzite. It is difficult to see, however, how detrital clay could occur with such well sorted quartz and how the voids could persist during welding. There is no doubt that the rock is a sediment, as it contains a variety of rounded accessory heavy minerals. It is probable therefore that the voids and clay patches were not present as such during the welding of the quartz but have developed from something else since that time.

No feldspar has been observed in the rock, which is somewhat surprising as there are occasional flakes of muscovite. It is highly likely that some feldspar was present when the sand was deposited and it is suggested that the clay is the product of post-depositional alteration of feldspar and possibly of lithic fragments. The voids have probably formed by subsequent leaching of part of this clay.

There is a variety of heavy minerals present in minor amounts. These include tourmaline, leucoxene, zircon, sphene, rutile and epidote. Some of the leucoxene occurs as tiny grains (0.01 mm) within clay patches and these grains are probably secondary, in common with the clay. Because of the significant proportion of clay and high porosity of the rock, it does not have sufficient tenacity to be suitable for use as ballast.

Sample: P 464/71: TS 27321

Location:

Mount Chandler Deposit (Collectors No. 12651)

Rock Name:

Quartzite.

Hand Specimen:

This quartzite is pale-grey in colour and contains thin dark veins. One surface carries dark spots (?manganese oxide/hydroxide) and apart from this the weathered surfaces are stained red.

Thin Section:

An optical estimate of the constituents gives the following:

	%
Quartz	100
Sericite	Rare
Tourmaline	Rare

As the proportions indicate, this is a specimen of a pure quartzite. The rock's texture is indicative of considerable grain boundary activity under stress. Zones of granulated, sheared material are present. The quartz crystals are characterised by the presence of sutured and irregular boundaries, commonly containing smaller quartz crystals in bands or thin strings of single crystals. In many cases it is clear that previously highly strained crystals have recrystallised, forming several sub-crystals of differing orientations. A typical zone of fine-grained quartz is about 0.05 mm wide and contains crystals about 0.01 mm in diameter. Such a zone generally occupies grain boundary areas but in a few places occurs in the middle of quartz crystals. These shear zones form an unoriented, open network. Some parts of the thin section contain quartz grains of a wide range of sizes with small grains intergranular to the normal quartz grains which occupy most of the rock. Such an area as this is probably partially recrystallised towards a sheared type of texture.

Sericite and tourmaline are exceedingly rare components of the rock.

The sample was probably a pure quartz sandstone but has been deformed (sheared) and partially recrystallised to form a compact, massive rock. This is excellent material for ballast.

Sample: P 465/71: TS 27322

Location:

Dust Bowl Deposit (Collector's No. 12683.8)

Rock Name:

Greywacke

Hand Specimen:

This is a massive green rock, completely aphanitic in nature.

Thin Section:

An optical estimate of the constituents gives the following:

	%
Quartz grains	25
K-feldspar grains	5
Plagioclase grains	2
Rock fragments	Trace
Matrix	60
Calcite	2

Opaques	Trace
Epidote	2
Clinozoisite	1-2
Muscovite	1
Sphene	Trace
Chlorite	1

Detrital grains, apparently of granitic or metamorphic origin, occur in a matrix of fine-grained clayey material. There is a wide range in the size of detrital grains from 0.025 mm to 1 mm; most are sub-angular and have low sphericity values.

The great majority of quartz grains are single, mildly strained crystals but some composites of granoblastic quartz or strained, recrystallised quartz are also present. Of the feldspars, microcline is the most common type, together with lesser amounts of perthite and plagioclase. One grain of myrmekite (plagioclase and quartz) was noted. A small number of extensively sericitised grains are probably derived from feldspar. Apart from the types of rocks noted above, some fine-grained rock fragments consist of opaques and chlorite grains. No textures are preserved. Epidote and clinozoisite and unusually abundant detrital minerals, though their grain size rarely exceeds 0.1 mm. Some flakes of chlorite, similar in size to the epidote, probably are secondary in origin.

The matrix is too fine-grained for a precise determination of its mineralogical composition. Minute flakes with low birefringence and refractive index are probably clays and some quartz may also be present.

In summary: this sample consists of an unsorted collection of quartz, feldspar and rock fragments and abundant heavy minerals (principally epidote) in an argillaceous matrix. Some calcite probably represents a late-stage carbonatisation process.

Because of the argillaceous matrix the rock may not be suitable for use as ballast.

<u>Sample: P 466/71: TS 27323</u>

Location:

Eagle Hawk Deposit (Collectors No. 12710.7)

Rock Name:

<u>Altered dolerite</u>

Hand Specimen:

A compact, massive rock, grey-green in colour. Areas of milky white can be seen in the cut surface.

Thin Section:

An optical estimate of the constituents gives the following:

	%
Altered plagioclase	45
Tremolite-actinolite	45
Chlorite	3-5
Epidote	3-5
Opaques	1-2
Sphene	Trace
Quartz	Trace

This sample consists predominantly of pale-green amphibole and turbid, altered plagioclase laths; the rock clearly had an ophitic texture.

The amphibole is a pale-green pleochroic variety probably actinolite. It has developed from pyroxene and forms mats pseudomorphing the original crystals (uralite texture). The largest such area of actinolite is about 2 mm across and it is embayed and has its shape controlled entirely by adjacent plagioclase laths. Grey turbid areas with distinctive elongate shapes are clearly pseudomorphs of plagioclase. The laths had a decussate arrangement and an ophitic relationship with the pyroxene (now uralitised). In some cases the plagioclase has been partially replaced by very fine ?clay and the extinction position and twinning of the feldspar can still be seen. More commonly white mica and clays, chlorite and epidote obscure the feldspar and only its shape is visible.

Epidote and clinozoisite, as well as occurring in plagioclase, form anhedra (up to 0.7 mm in diameter) densely scattered in the rock. Some monomineralic patches of epidote can also be seen.

The opaque grains are clearly ilmenite since many have a skeletal shape and are associated with sphene. Crystals 0.5 mm across are not uncommon.

Quartz (?and K-feldspar) occur in little patches of partially resorbed material. This is probably a relict of the original dolerite's mesostasis.

Texturally, this rock is a typical dolerite. It has, however, suffered extensive alteration, probably as a result of low grade metamorphism. The rock seems to be fairly compact and should not degrade too quickly; it may thus be a satisfactory ballast material.

Sample: P467/71: TS 27324

Location:

Mt. Howe Deposits. Two kilometres (one mile) S.E. of Mt. Howe (Collectors No. 12762.7)

Rock Name:

Granite

Hand Specimen:

The rock is a massive pink granite containing large biotite flakes. The weathered surface is a distinct red colour.

Thin Section:

An optical estimate of the constituents gives the following:

	%
Quartz	25
Plagioclase	25
K-feldspar	45
Epidote	Trace
Biotite	3
Opaques	2
Amphibole	1-2
Sphene	1-2
Zircon	Trace
Apatite	Trace

This is a coarse granite with an allotriomorphic granular texture. Quartz and feldspar mostly form large anhedra several millimetres in diameter. Crystals less than 0.7 mm across constitute only a small proportion of the rock. The K-feldspar crystals are microcline and microcline perthites; the latter has only small quantities of exsolved albite. Much of the biotite in the rock is corroded by this microcline. The plagioclase is an albite showing primary albite twinning. A myrekitic relationship between albite and quartz is evident in a few places. Quartz occurs as very large crystals with curved grain boundaries showing lobed, interlocking forms. Biotite and, to a lesser extent, amphibole form large anhedra which have been extensively replaced by tectosilicates. The opaque grains rimming biotite probably result from this replacement reaction.

Sphene, epidote, zircon and opaque grains generally occur in loose clots or euhedral to subhedral crystals.

The coarseness of the grain size in this rock may allow too rapid a breakdown for it to be well-suited for ballast use.

<u>Sample: P 468/71: TS 27325</u>

Location:

Mt. Howe (Collectors No. 12763.8)

Rock Name:

<u>Granite</u>

Hand Specimen:

The hand specimen is similar in all respects to P 467/71.

Thin Section:

An optical estimate of the constituents gives the following:

	%
Quartz	25-30
K-feldspar	45-50
Plagioclase	15
Biotite	5
Opaques	1-2
Amphibole	1
Sphene	1
Rutile	1
Epidote	Trace
Zircon	Trace
Apatite	Trace

This is a coarse, granitic rock with an allotriomorphic granular texture. As the proportions given above indicate, there is a wide range of accessory minerals. Quartz, feldspars and biotite occur as large crystals several millimetres across. Some crystals, particularly of very small proportion of the rock. The K-feldspar is a microcline or microcline-perthite and the plagioclase is albitic in composition; much of the latter is midly sericitised.

There is some development of myrmekite and evidence that quartz has replaced some feldspar, which is suggested by the lobed boundaries between large quartz crystals and perthites. Except for biotite and amphibole, which tend to occur as large isolated crystals, the accessory minerals form loose clots generally with a large proportion of a reddish opaque phase and altered rutile (leucoxene).

This sample is similar to P 467/71. It is a granite which may have suffered some post-crystallisation heating and/or deformation leading to minor redistribution of elements among the tectosilicates. Apart from this grain boundary activity the rock retains its igneous character. As in the previous case, this rock is not well suited for use as ballast, since solution of alteration along only a few grain boundaries would allow disaggregation of the rock, due to its coarse grain size.

Sample: P 469/71: TS 27326

Location:

Goulty's Bore Deposit (Collectors No. 12832)

Rock Name:

Gneiss

Hand Specimen:

A friable bluff-coloured rock with a grain size of about 1 mm. A rather indefinite broad foliation can be recognised.

Thin Section:

An optical estimate of the constituents gives the following:

	%
Quartz	35
Perthite	60

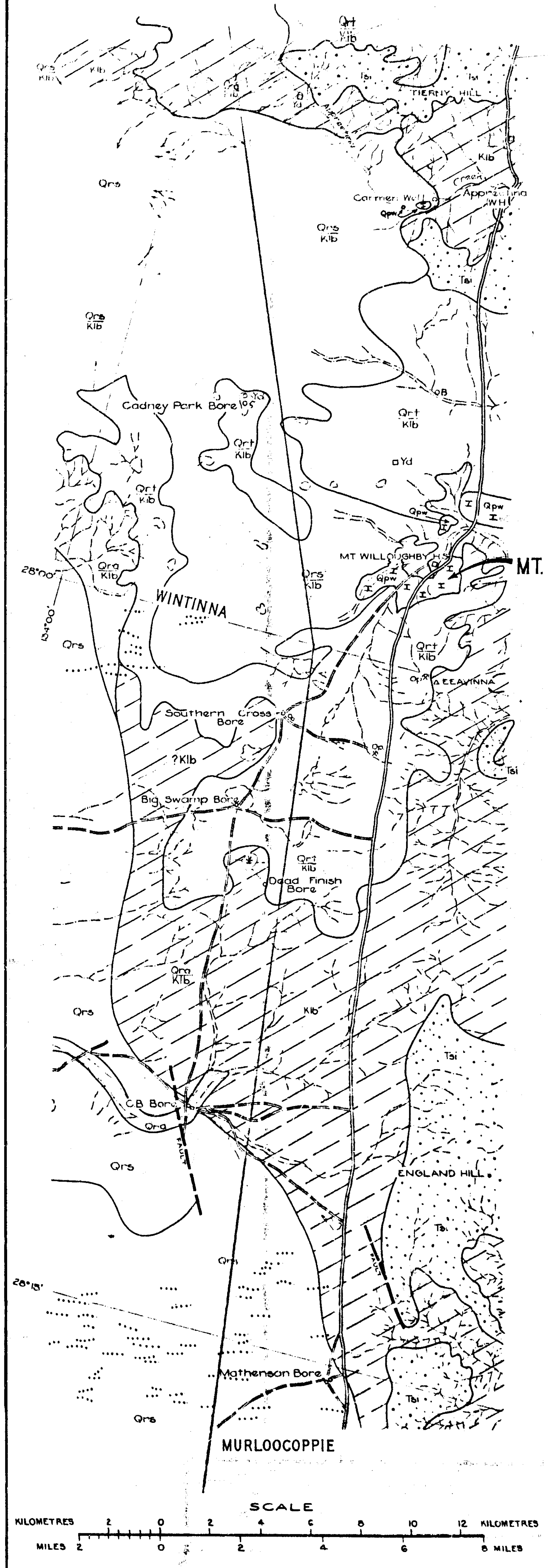
Plagioclase	2-3
Biotite	1-2
Garnet	1-2
Opaques	1
Zircon	Trace

Although a broad gneissic foliation can be seen in the hand specimen, no preferred orientation is apparent in thin section. The rock has a granoblastic texture and contains some garnet.

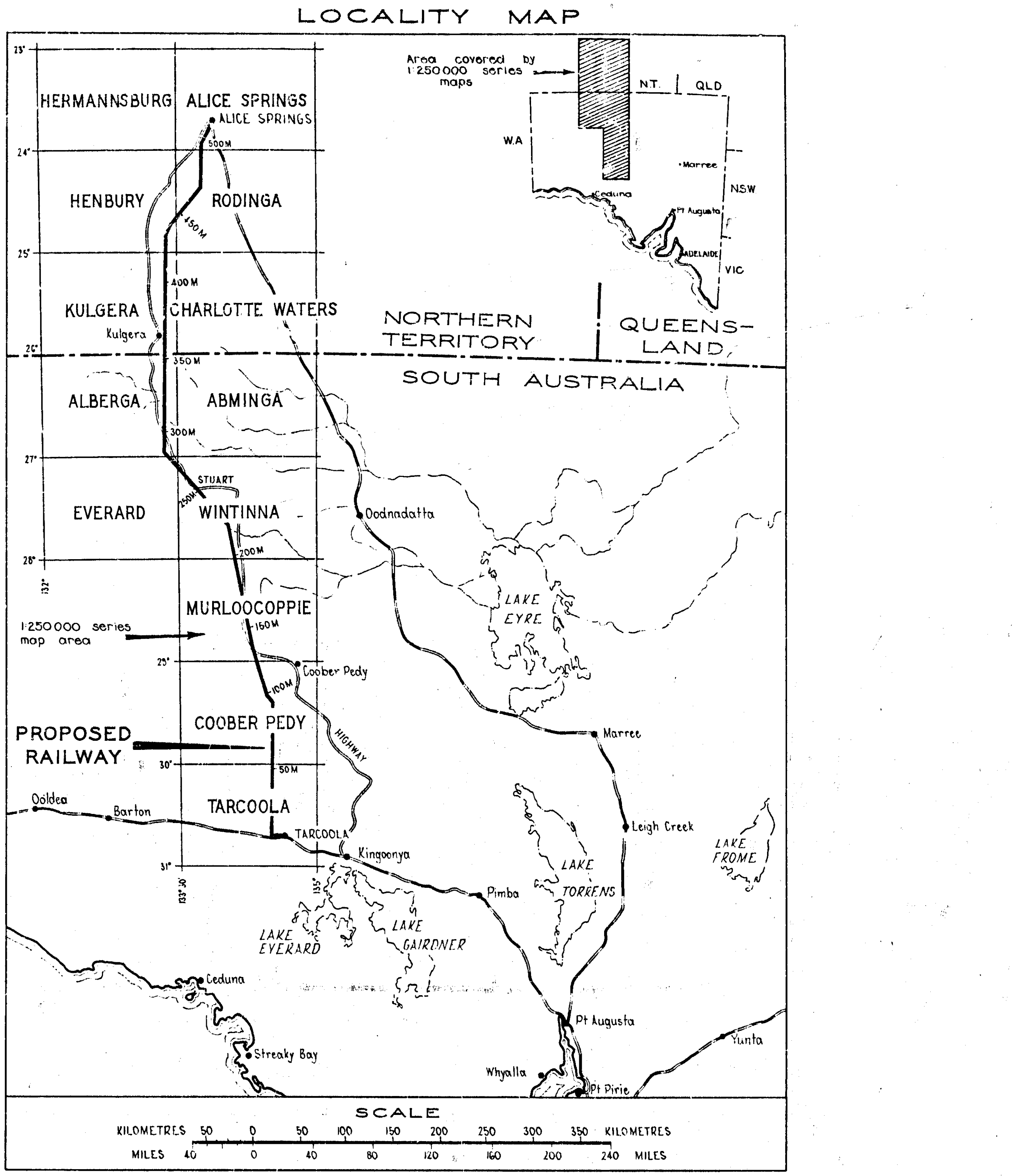
The tectosilicate minerals form interlocking random textures with a grain size of about 0.5 mm. Grain boundaries are irregular and between perthite grains there are small quartz crystals. It is possible that quartz has replaced some K-feldspar but the evidence of the textures is not conclusive. The K-feldspar itself is a ribbon perthite containing an unusually large proportion of the albite component. In some cases albite constitutes more than 50% of the perthite crystal and forms a solid mass of albite in the outer parts of perthite crystals.

Biotite occurs as flakes and anhedra widely scattered throughout the thin section. Garnet, similarly, is dispersed among the quartz and feldspar. Typically, the garnet forms almost spherical crystals about 0.25 mm in diameter. The presence of garnet suggests that this gneiss is derived from a sediment.

As material for ballast this gneiss is probably serviceable although the feldspars may deteriorate and the rock may have a tendency to fracture along the foliation.



LOCALITY MAP



LEGEND

CAINOZOIC

RECENT

- Qra — Alluvium of the stream courses and gibber gravel over Pleistocene soil.
- Qrs — Sand of the Recent dunes.
- Qrt — Talus, including silcrete gravel in places. Pleistocene talus not differentiated.

PLEISTOCENE

- Qpr — Gypsum crust.
- Qpw — Mt Willoughby Limestone

TERTIARY

- Tsi — Silcrete rubble marking former position of silcrete pan.

MESOZOIC

- Klb — Lower Cretaceous sediments including Bulldog Shale. Capped by silcreted Tertiary sediments in some places.

PALAEOZOIC

ORDOVICIAN

- Omc — Mt Chandler Sandstone

CAMBRIAN MIDDLE TO UPPER

- Єmt — Trainor Hills Sandstone (Mt Johns Conglomerate not differentiated)
- Є — Observatory Hill Beds.

PROTEROZOIC

PRECAMBRIAN COVER ROCKS

UPPER — ADELAIDEAN MARINOAN

- Єft — Siltstone and sandstone.
- Єfo — Rodda Beds: Calcareous siltstone and sandstone with conglomerate bands: in places, siltstone, dolomite and limestone.

STURTIAN

- Єu — Shale, siltstone, sandstone, greywacke and limestone. Vesicular basalt. Undifferentiated.
- Єyc — Chambers Bluff Tillite.
- Єbv — Siltstone, shale, and quartzite.

PRECAMBRIAN CRYSTALLINE BASEMENT: MUSGRAVE BLOCK

? LOWER ADELAIDEAN

- Dolerite dykes
- \+ Granite, 'adamellite', granite gneiss and granodiorite.

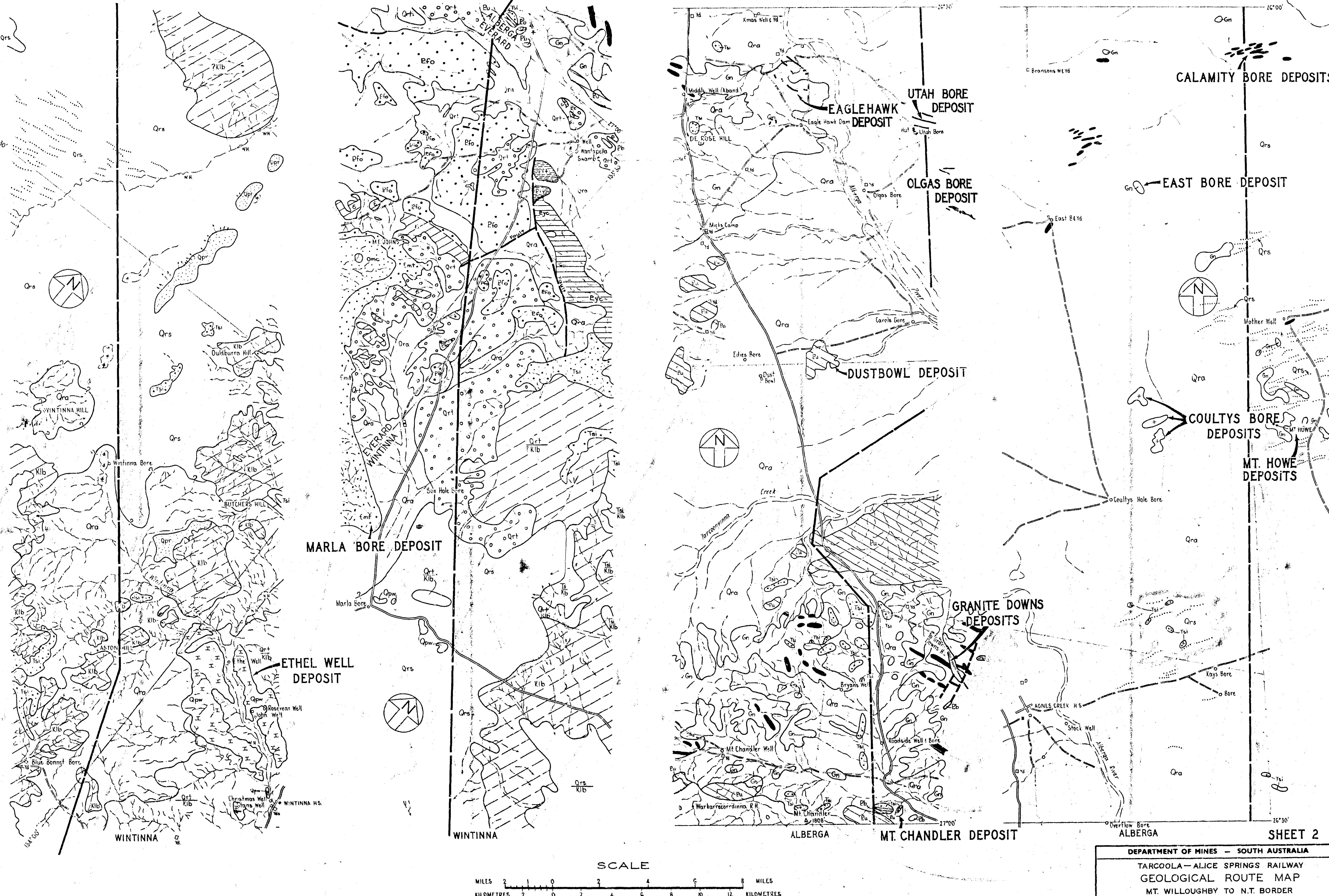
? LOWER

- Gn — Gneissic granite and granitic gneiss.

- Geological boundary (definite)
- Geological boundary (approx)
- Route of proposed railway
- Existing railway
- Stuart highway
- Secondary road or track
- Fence
- Watercourse
- Swamp
- Bore or well
- Tank or dam
- Stockyard

SHEET 1

DEPARTMENT OF MINES — SOUTH AUSTRALIA			
TARCOOLA — ALICE SPRINGS RAILWAY GEOLOGICAL ROUTE MAP MT. WILLOUGHBY TO N.T. BORDER			
MINERAL RESOURCES DIVISION	GEOLOGIST	Compiled J.B Firman	Scale: As shown
			Date 25 June 1971
		Drn. R.H.	Drg. No. 72-4 Ba
Director of Mines		Ckd.	



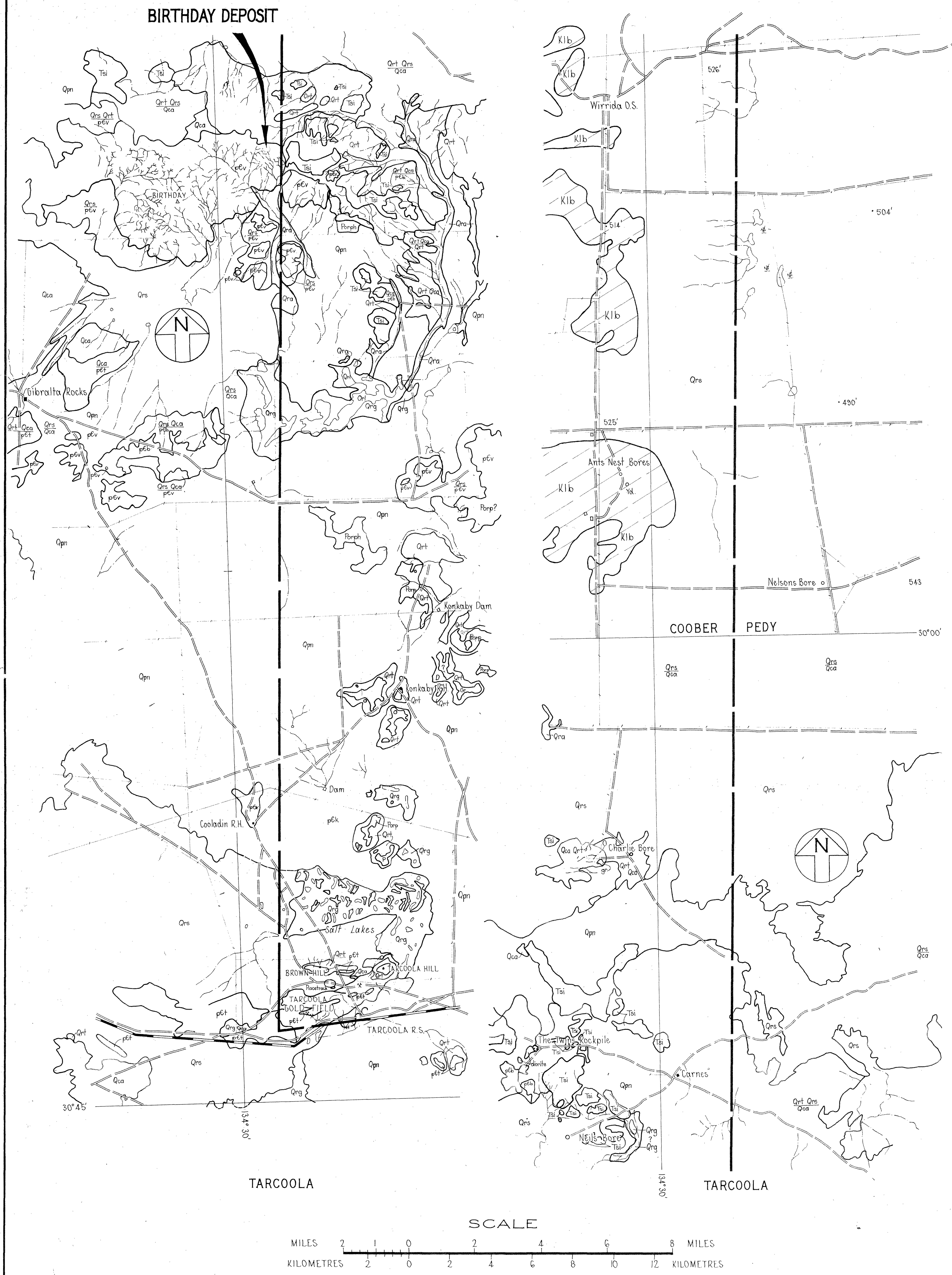
DEPARTMENT OF MINES – SOUTH AUSTRALIA

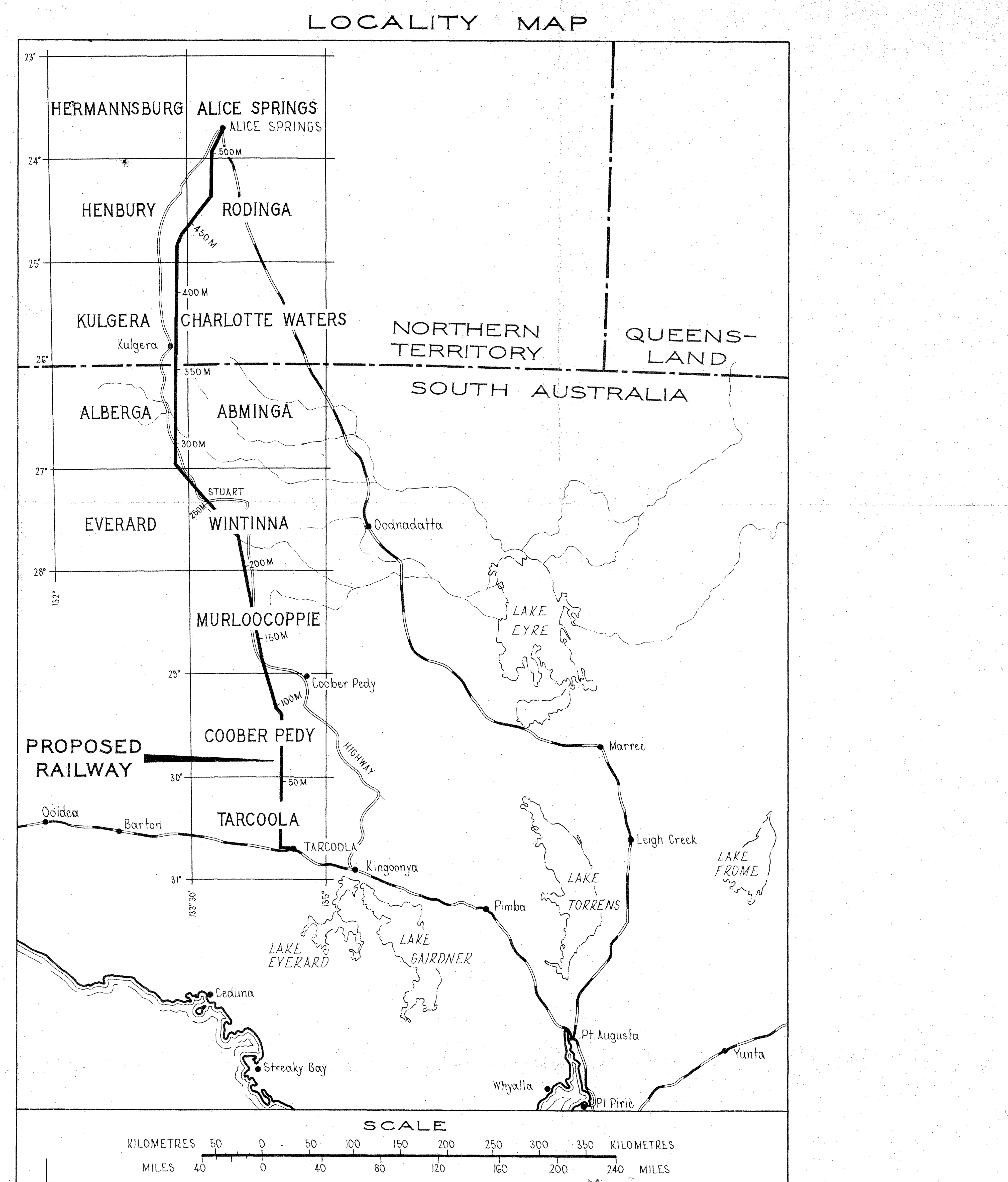
TARCOOLA – ALICE SPRINGS RAILWAY

GEOLOGICAL ROUTE MAP

MT. WILLOUGHBY TO N.T. BORDER

MINERAL RESOURCES DIVISION	GEOLOGIST	Compiled J B Firman	Scale: As shown
		Drn. R.H.	Date: 25 June 1971
Director of Mines		Ckd.	Drg. No. 72-4a 8a





LEGEND

CAINOZOIC – RECENT	Qra	Alluvium of the stream courses and gibber gravel over Pleistocene soil.
	Qrt	Talus, including silcrete gravel in places. Pleistocene talus not differentiated.
	Qrs	Sand of the Recent dunes.
	Qpr	Gypsite as off-white 'flour' gypsum or gypsum crust outside the limits of the salt lakes.
	Qrg	Sand of the gypsum dunes mapped with Yamba Formation.
	Qrl	YAMBA FORMATION: Gypsiferous muds of the salt lakes, flour gypsum of the bordering samphire flats
CAINOZOIC – PLEISTOCENE	Qpn	Soil mantles including CALLABONNA SOIL, and LOVEDAY SOIL with characteristic soft platy and nodular carbonates.
	Qca	Calcrete in BAKARA SOIL with RIPON CALCRETE at the base in some places.
	Qpw	Mt. Willoughby Limestone.
TERTIARY	Tsi	Silcrete rubble marking former position of silcrete pan.
MESOZOIC	Klb	Lower Cretaceous sediments including Bulldog shale and Cadna-owie in the Tarcoola areas.
PALAEOZOIC – ORDOVICIAN	Omc	Mt. Chandler Sandstone
PALAEOZOIC – MIDDLE TO UPPER CAMBRIAN	Ɛmt	Trainor Hills Sandstone (Mt. Johns conglomerate not differentiated.)
	Ɛ	Observatory Hill Beds.

PRECAMBRIAN COVER ROCKS.

PROTEROZOIC – UPPER – ADELAIDEAN – MARINOAN	Pft	Siltstone and sandstone.
	Pfo	Rodda Beds: Calcareous siltstones and sandstone with conglomerate bands in places, siltstone, dolomite and limestone.
STURTIAN	Pu	Shale, siltstone, sandstone, greywacke and limestone. Vesicular basalt. Undifferentiated.
	Pyc	Chambers Bluff Tillite.
TORRENSIAN	Pb	Siltstone, shale and quartzite.

PRECAMBRIAN CRYSTALLINE BASEMENT

GAWLER PLATFORM

MUSGRAVE BLOCK

PRE-STURTIAN	(line)	Dolerite dykes.
	Gn	Granite, adamellite, gneissic granite and granodiorite.
CARPENTARIAN	pƐk	Kokatha Granite equivalents.
	pƐv	Gawler Range Volcanics, including diorite in some places.
	pƐt	Tarcoola Beds.
	pƐb	Granite of the Tarcoola area. Possible Burkitt Granite equivalents.
LOWER – CLEVE METAMORPHICS		Metajaspilite (Commonwealth Hill)

- Geological boundary.
- Route of proposed railway.
- Existing railway.
- Stuart Highway.
- Secondary road or track.
- Fence.
- Watercoarse.
- Swamp.
- Bore or well.
- Tank or dam.
- Yd. Stockyard.

DEPARTMENT OF MINES — SOUTH AUSTRALIA			
TARCOOLA—ALICE SPRINGS RAILWAY GEOLOGICAL ROUTE MAP TARCOOLA TO PERFECTION WELL			
MINERAL RESOURCES DIVISION	GEOLOGIST	Compiled J.B.Firman	Scale: As shown
			Date 25 June 1971
Director of Mines		Drn. R.H.	Drg. No. 72-759 Ba
		Ckd.	

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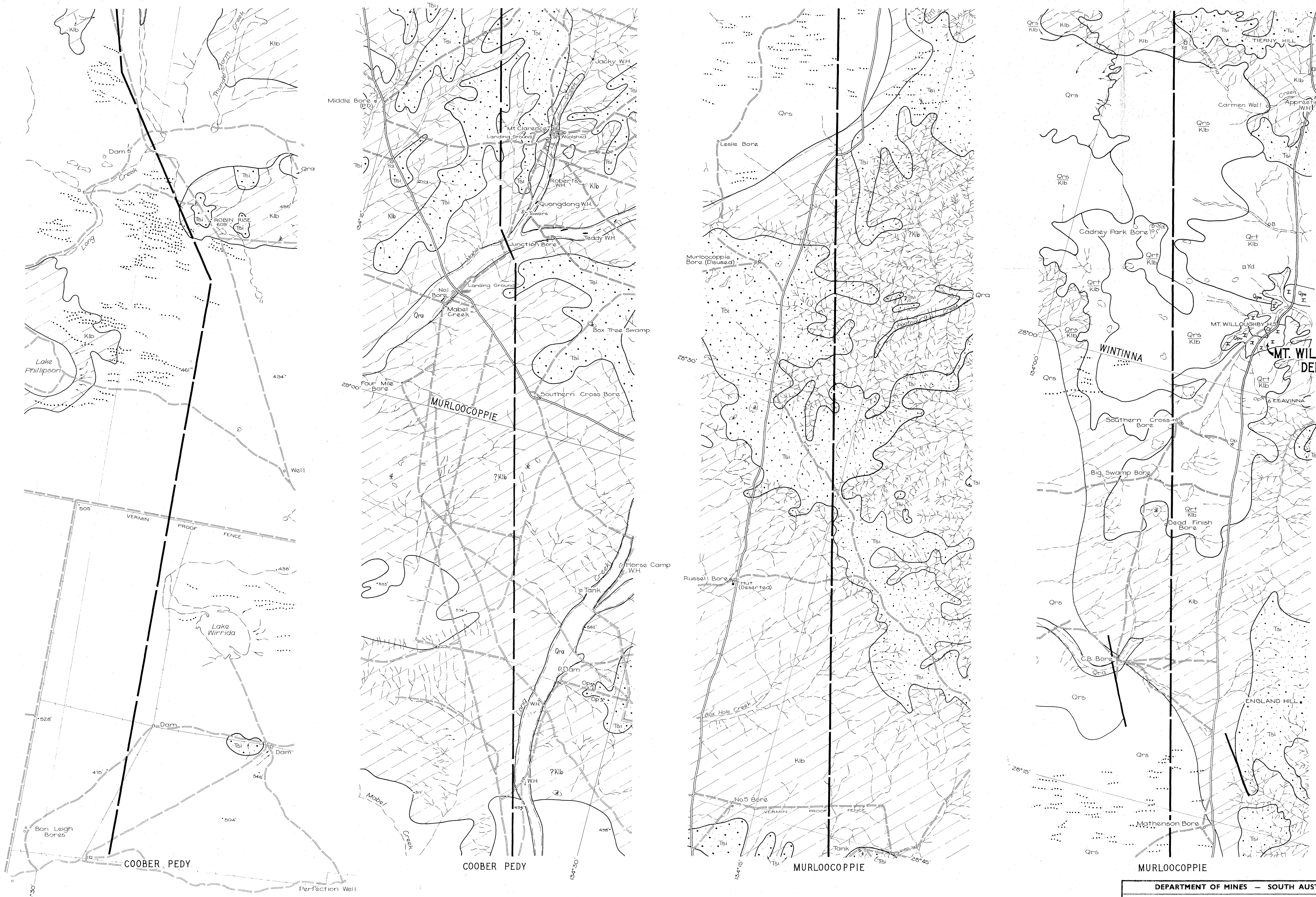

DEPARTMENT OF MINES — SOUTH AUSTRALIA			
TARCOOLA—ALICE SPRINGS RAILWAY			
GEOLOGICAL ROUTE MAP			
PERFECTION WELL TO MT. WILLOUGHBY			
MINERAL RESOURCES DIVISION		Compiled	Scale: As shown
	GEOLOGIST	J.B. Firman	Date: 25 June 1971
		Drn. IAGR	Drg. No. 72-760 Bab
Director of Mines		Ckd.	