# BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

## RECORD 1984/3

GEOLOGY OF ARUNTA BLOCK
IN THE SOUTHERN PART OF THE
HUCKITTA 1:250 000 SHEET AREA,
CENTRAL AUSTRALIA - PRELIMINARY DATA,
1980 SURVEY

by


R.D. Shaw, R.G. Warren & L.A. Offe (BMR)

M.J. Freeman & C.L. Horsfall (NTGS)



The information contained in this report has been obtained by the Bureau of Mineral Resources, Geology and Geophysics as part of the policy of the Australian Government to assist in the exploration and development of mineral resources. It may not be published in any form or used in a company prospectus or statement without the permission in writing of the Director.

CONTENTS

FIGURES



TABLES

## APPENDICES



## PLATES

Reduced compilation sheets of the northern two-thirds of DNEIPER, JINKA and JERVOIS RANGE 1:100 000 Sheet areas (reduced from 1:25 000) and the southernmost part of Huckitta 1:250 000 Sheet area (reduced from 1:80 000).

# ABSTRACT

Basement rocks in the southern part of the Huckitta 1:250 000 Sheet area are effectively divided into two groups by the Delny-Mount Sainthill Fault Zone.

South of the Fault Zone felsic and some mafic rocks metamorphosed to granulite facies (Kanandra Granulite) are juxtaposed against a layered, largely pelitic sequence (Harts Range Group) metamorphosed to the amphibolite facies. Migmatitic quartzofeldspathic gneisses in the eastern part of the region differ in their regional strike from pelites of the Harts Range and may unconformably underlie them.

North of the Delny-Mount Sainthill Fault Zone a number of granites, some of batholithic proportions (eg. Jinka and Jervois Granites), intrude metasedimentary sequences metamorphosed largely to amphibolite facies grade. In the northeast granitic and quartzofeldspathic gneisses (Mascotte Gneiss Complex) are overlain by a mainly pelitic schistose sequence (Bonya Schist). In the northwest pelitic and calcareous rocks are intercalated with para-amphibolite, quartzofeldspathic gneiss and cordierite gneiss/quartzite. (Cackleberry and Deep Bore Metamorphics).

Quartzite and adjoining schist, presumed to be younger than the other metamorphosed sequences occur both north (Utopia Quartzite and Ledan Schist) and south (Unit pCq) of the Delny-Mount Sainthill Fault Zone.

Highly altered gabbroic intrusions (eg. Attutra Metagabbro) intrude the northern sequences and some are thought to have preceded granite emplacement. Metadolerite dykes (Pd) intrude the Cackleberry Metamorphics and the Bonya Schist.

Retrograde schist zones containing amphibolite and greenschist facies assemblages occur along the Delny-Mount Sainthill Fault Zone (Pr) and also cut gneisses to the southeast of the fault zone (Pzr).

Younger unmetamorphosed Upper Proterozoic and Lower Palaeozoic sediments of the Georgina Basin sequence are not covered by this Report.

# INTRODUCTION

## Location

The area covered in the present survey is northeast of Alice Springs and is bounded by latitudes 22°30'S and 23°00'S, and longitudes 135°00'E and 136°30'E. DNEIPER* occupies the southwestern corner, JINKA the southern central part, and JERVOIS RANGE southeastern corner of the HUCKITTA** 1:250 000 Sheet area. Geological remapping of the northern part of HUCKITTA has subsequently being undertaken by the Northern Territory Geological Survey.

## Access

Access to and within the Sheet area is good. Alice Springs is about 200 km to the southwest via the Plenty River Highway, which is a formed dirt road. Licenced aerodromes are at Jervois and Huckitta homesteads, and authorised airstrips are maintained at Molyhil Mine, Jervois (Plenty River) Mine and Dneiper, Jinka, Mount Swan and Baikal homesteads. Radio telephones are in use at Jinka, Dneiper, Baikal, Mount Swan, and Jervois homesteads and at Molyhil and Jervois (Plenty River) Mines. A transceiver for the Royal Flying Doctor Service maintained at Huckitta homestead and transceivers are retained at most of the other homesteads.

## Population and industry

A police station is manned at Harts Range 4 km west of the Sheet area. Small family settlements are established at Huckitta, Jinka, Jervois, Dneiper, and Mount Swan homesteads to service the beef cattle industry. About 30 to 40 personnel were stationed at the Molyhil molybdenite-scheelite mine for about two years (1980-81). A settlement of similar size was established at Jervois (Attutra) in 1981 mine silver-copper ore by open cut. Open-cut mining was begun in early 1981 but postponed in 1982, pending an improvement in metal prices. A homestead at Baikal is occupied by a prospector.

---

* Refers to DNEIPER 1:100 000 Sheet area

** Refers to Huckitta 1:250 000 Sheet area

## Climate

The area has a semi-arid climate. Summer day temperatures commonly exceed 38 C, and some frosts occur during winter months. The area lies in the 21 to 23 cm rainfall belt; most rain falls during sporadic summer storms, Climate, soil, vegetation and land use are described in more detail by Perry & others (1962).

## Topography and drainage

Extensive areas of gently-undulating country covered by sand and soil interupted by isolated hills occur in the central and southern parts of the region. In the north the Mopunga, Elyuah and Jervois Ranges form a major belt of ranges. The highest elevation in the Elyuah Range is Mount Baldwin which is about 600 m above sea level. The hills commonly reach about 100 m or more above the plain and are surrounded by colluvial aprons.

The region is drained by the Plenty and Marshall Rivers, and by the Bundey-Sandover River System.

## Previous investigations

A summary of previous investigations is given in Smith (1963), Smith (1964), and Warren (1980). The present field research project involved reconnaissance geology, photo-interpretation and a pre-survey report over the whole basement area by Warren (1980). The tectonic setting of the region is outlined in Warren (1981) and the Delny-Mount Sainthill Fault System described in Warren (1978).

## Present Investigation

Field work was a cooperative effort between geologists from BMR (RDS, RGW, LAO, CJS and BRS) and two geologists from the Northern Territory Geological Survey (MJF and CLH). The work was completed by about 55 man-weeks of Landrover traverses. Field studies were preceded by photo-interpretation of colour air photos at a scale of 1:20 000 in areas of better outcrop and black and white 1:80 000 air photographs in areas of scattered exposures.

Photo-interpretation was combined with field data on photo-overlays and then transferred to National Mapping line-conversions at 1:25 000 for the parts covered by colour airphotos and 1:80 000 for areas of black and white photography. Part of the transfer of data was done in the field by J. Stirzaker (draftsman). Drainage was used for scale control. These field compilation sheets have been publically released through the Australian Government Copy Service at 1:25 000 and 1:80 000 scale and are also included in this Record (PLATES) in a reduced form. A reference set of data sheets, in a format suitable for storage on the BMR Hewlett Packard Computer, was compiled for each field point (FP) (about 2100) visited during the survey and located on the field compilation sheets. Field determinations of magnetic susceptibility and scintillometer count are given for some field points on these sheets. Some points for basement rocks collected previously are also recorded on data sheets. These sheets are to be stored on microfiche. Some pre-1980 structural data is not related to data points.

In addition, two ground magnetometer and scintillometer traverses combined with observations on rock types were carried out in the Jervois-Bonya area to obtain magnetic and radiometric signatures of rock types as an aid to regional interpretation of aeromagnetic data (Horsfall, 1981). These are available from NTGS and the Australian Government Copy Service.

## Rock nomenclature

Igneous rock nomenclature follows Streckeisen (1976) and the naming of sedimentary rocks conforms to Gary & others (1973). Field terms were used for metamorphic rocks and the usage adopted is explained in Appendix A. Mineral contents of rocks given in parenthesis as percentages in petrographic descriptions throughout the text are visually estimated modes only.

# OUTLINE OF GEOLOGY

Only igneous and metamorphic rocks are described in this Record. Rocks of the Georgina Basin sedimentary sequence are the subject of a separate study by the Northern Territory Geological Survey. A generalised distribution of metamorphic rock units is given in Figure 1. Destribution of the igneous rocks is shown in Figure 4. More detail on rock unit distribution is shown in the reduced compilation sheet (PLATES).

# METAMORPHIC ROCK UNITS

## Introduction

Rocks of the Arunta Block as a whole are divided into three broad lithological groups, previously described by Shaw & Stewart (1975), Shaw & others (1979) and by Stewart, Shaw & Black (in preparation). Division 1, presumed to be the oldest group, is characterised by interlayered mafic and felic granulites. Division 2 commonly overlies Division 1 with discordant, commonly faulted, contacts. What is believed to be the basal unit of Division 2 is dominantly quartzofeldspathic gneiss, but the main part of Division 2 is characterised by abundant pelitic rocks. Division 3, presumed to be the youngest Division, is characterised by quartz-rich metasediments.

In southern HUCKITTA a major easterly fault, the Delny-Mount Sainthill Fault Zone, effectively divides the crystalline rocks into two groups.

(1) Those units to the south are upper amphibolite to granulite facies in metamorphic grade and one made up of felsic and some mafic rocks (e.g. Strangways Metamorphic Complex) and layered, largely pelitic rocks (Harts Range Group). These units are assigned to Divisions 1 and 2 respectively. Rocks of the Strangways Metamorphic Complex are assigned to Division 1 and the Harts Range Group is assigned to Division 2. In HUCKITTA the contact between the Strangways Metamorphic Complex and the Harts Range Group is concealed by Cainozoic cover, but it is presumed to be faulted because there is a sharp change in metamorphic grade.

(2) To the north of the Delny-Mount Sainthill Fault Zone a number of granites intrude a dominantly pelitic sequence metamorphosed largely to amphibolite facies grade. In the northeast an older group of gneisses (Mascotte Gneiss Complex) comprising granitic gneiss and quartzofeldspathic gneiss underlies a sequence of mica schist, and minor calc-silicate rock and amphibolite (Bonya Schist). In the northwest pelitic and calcareous rocks are intercalated with para-amphibolite, quartzofeldspathic gneiss and cordierite gneiss/quartzite. (Cackleberry and Deep Bore Metamorphics). These sequences north of the Delny-Mount Sainthill Fault Zone are tentatively assigned to Division 2.

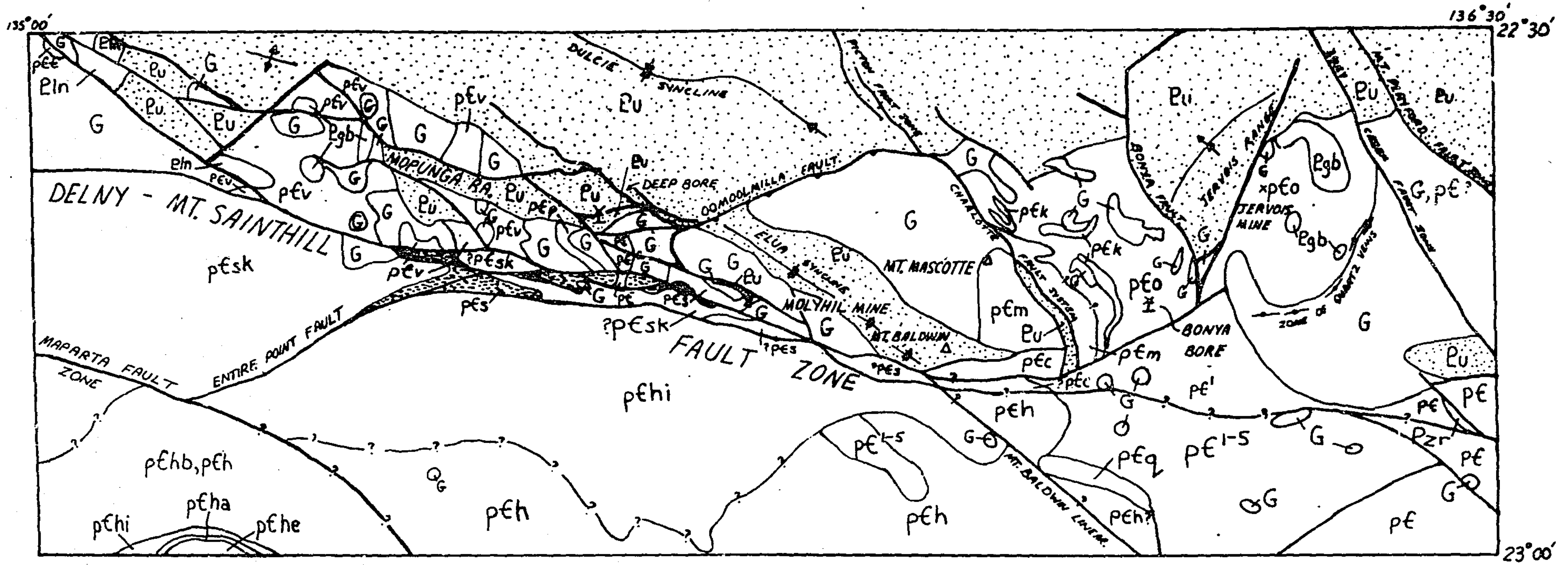



Figure 1

GEORGINA BASIN
LATE PROTEROZOIC & PALAEOZOIC

*Partly defined formal unit

0 10 20 30 km

| | |
|---|---|
| Ꞓu | Sediments |
| | ARUNTA BLOCK |
| | PALAEOZOIC? |
| Pzr | Retrograde Schist Zone, (greenschist facies) |
| Pr | PROTEROZOIC? Retrograde Schist Zone, (amphibolite facies, rare greenschist facies) |
| | MIDDLE PROTEROZOIC |
| G | Undivided granite, pegmatite |
| Ꞓgb | Gabbro, dolerite |
| | EARLY PROTEROZOIC? |
| Bln | LEDAN SCHIST, UTOPIA QUARTZITE - Schist, quartzite |
| pꞒq | Quartzite, schist |
| pꞒ | Inferred metamorphic rock |
| pꞒ$^{1-5}$ | Quartzofeldspathic gneiss, muscovite-biotite schist, quartzite |
| pꞒo | BONYA SCHIST* - Muscovite and biotite-muscovite schist andalusite schist, calc-silicate rock, amphibolite meta-acid volcanics, magnetite-quartz rock |
| pꞒk | KINGS LEGEND AMPHIBOLITE MEMBER* - Amphibolite |
| pꞒs | Quartzofeldspathic gneiss, biotite gneiss, calc-silicate rock, granitic gneiss |
| pꞒm | MASCOTTE GNEISS COMPLEX* - Granitic gneiss, quartzofeldspathic gneiss, granitoid, biotite gneiss, leucogranite, amphibolite |
| pꞒt | Quartzofeldspathic gneiss, metadolerite |
| pꞒV | CACKLEBERRY METAMORPHICS* - Calc-silicate rock, para-amphibolite, biotite felsic gneiss, hornblende felsic gneiss, anthophyllite-cordierite rock |
| pꞒp | DEEP BORE METAMORPHICS* - Cordierite felsic granulite, mafic granulite, para-amphibolite, calc-silicate rock, sillimanite, gneiss |
| pꞒh | UNDIVIDED HARTS RANGE GROUP - Calc-silicate rock, quartzite amphibolite, biotite gneiss, unclassified metamorphic rock |
| pꞒhb | BRADY GNEISS - Garnet-muscovite-biotite schist, muscovite-biotite gneiss, biotite gneiss, calc-silicate rock |
| pꞒhi | IRINDINA GNEISS - Garnet-biotite gneoss, sillimanite-garnet-biotite gneiss, biotite schist, biotite gneiss, calc-silicate rock marble |
| pꞒha | BRUNA GNEISS - Porphyroblastic gneiss |
| pꞒhe | ENTIA GNEISS - Quartzofeldspathic gneiss, layered amphibolite |
| pꞒc | Quartzofeldspathic gneiss, biotite schist, biotite gneiss, calc-silicate rock, quartzite, Kornerupine-bearing quartzo-feldspathic gneiss |
| | STRANGWAYS METAMORPHIC COMPLEX |
| pꞒSK | KANANDRA GRANULITE - Mafic granulite, quartzofeldspathic gneiss, garnet, quartzofeldspathic gneiss, biotite gneiss, migmatite |

## DIVISION 1

Division 1 rocks, thought to be the oldest in the region, occupy a fault block in the west of the area and are an extension of the Kanandra Granulite previously delineated to the west in ALCOOTA. The Granulite is intruded by several granites including the Mount Swan Granite and has faulted contacts with neighbouring metamorphic units to the north and south. It consists of felsic gneisses, subordinate mafic granulite and rare calcareous metasediments. The felsic gneisses are mainly garnet-bearing and typically migmatitic. Extensive retrogression to amphibolite facies assemblages is common close to faults.

Unnamed and undivided complex (p€) of mainly migmatitic quartzofeldspathic gneisses occur in the eastern part of region. They are intruded by several small granites. Their relationships to surrounding units is not understood and their contact with undivided Harts Range Group (p€h) to the southwest is obscured by superficial sediments. A regional difference in strike suggests that the contact may be an unconformity. These rocks (p€) which are largely quartzofeldspathic are in contact with a quartzite and schist unit (p€q) which is lithologically like Division 3 rocks (e.g. Utopia Quartzite, Ledan Schist in ALCOOTA). Minor rock types in unit pC include biotite gneiss, muscovite-biotite schistose gneiss, calc-silicate rock and magnetite-quartz rock. South of Mount Baldwin a unit made up of similar rock types and labelled p€c includes an albite-rich quartzofeldspathic gneiss containing kornerupine.

## DIVISION 2

Divsion 2 rocks are the most widespread of the Early Proterozoic rocks in southern HUCKITTA and are dominantly pelitic. The Harts Range Group crops out south of the Delny-Mount Sainthill Fault Zone, and based on evidence from ALICE SPRINGS is thought to unconformably overlie Division 1 rocks. The Harts Range Group is made up of the quartzofeldspathic Entia and Bruna Gneisses overlain by the pelitic Irindina and Brady Gneisses. The Irindina Gneiss is the most widespread formation in the Group and differs from its appearance in its type area in ALICE SPRINGS in containing a greater abundance of biotite and sillimanite gneiss and much less garnetiferous gneiss. Much of the undivided Harts Range Group (p€h) consists of calc-silicate rock, quartzite, amphibolite, and biotite gneiss.

Two groups of metamorphics are recognised north of the Delny-Mount Sainthill Fault Zone. Those in the west, principally the Deep Bore and Cackleberry Metamorphics have been metamorphosed to upper amphibolite and transitional granulite facies whereas those in the east have generally been metamorphosed to middle amphibolite facies.

Deep Bore Metamorphics crop out in northwestern JINKA. The nature of their contact with the Kanandra Granulite is uncertain due to lack of exposure, but is inferred to be faulted. They are intruded by the Marshall Granite and a small diorite, and are unconformably overlain by the Georgina Basin sequence. The metamorphics consist of cordierite-bearing quartzite, garnet-bearing quartzite, garnet-sillimanite gneiss, calc-silicate rock, minor granulite, and rare marble.

The Cackleberry Metamorphics crop out in northeastern DNEIPER. They are in faulted contact with the Kanandra Granulite and are inferred to be unconformably overlain by the Ledan Schist although the contact is not exposed. They are intruded by gabbro, dolerite,, several granites and pegmatites. The rock types in the Metamorphics are fine-grained albite-rich quartzofeldspathic gneiss, calc-silicate rock, para-amphibolite, biotite gneiss and lesser amounts of hornblende-bearing felsic gneiss, cordierite-bearing felsic and biotite gneisses and rare anthophyllite-cordierite gneiss.

A distinctive group of rocks (p€t) crop out near Tower Rock just outside and to the northwest of the area illustrated in Figure 1 (see PLATES). These rocks are intruded by the Mount Swan Granite and metadolerite. They consist of compositionally layered felsic granulite and quartzofeldspathic gneiss containing sillimanite and cordierite metaquartzite, sillimanite-cordierite-quartz gneiss, and in places calc-silicate rock. Only quartzofeldspathic gneiss and minor metadolerite are exposed in northern DNEIPER.

The Mascotte Gneiss Complex in central-western JERVOIS RANGE and eastern JINKA extends southeast from Mount Mascotte to beyond Charlotte Bore. It is overlain by the Bonya Schist and intruded by the Jinka Granite. It consists of granitic gneiss, granitoid, quartzofeldspathic gneiss, biotite-gneiss leucogranite, amphibolite and biotite schist. A similar group of rocks, p€s, west of Molyhil in central JINKA is lithologically correlated with the Mascotte Gneiss Complex, and is also intruded by granite. Unit p€s is made up of quartzofeldspathic gneiss, biotite gneiss, and minor to rare biotite schist, calc-silicate rock, quartzofeldspathic schist and quartz-rich metasediments.

The Bonya Schist crops out near Jervois Mine and Bonya Bore. It overlies the Mascotte Gneiss Complex and is overlain by the Georgina Basin sequence. A few younging determinations based on cross-bedding in both regions suggest that the Bonya Schist youngs eastwards. In both sequences amphibolite and schist are overlain by quartzofeldspathic muscovite-bearing schist and some andalusite schist intercalated with thin layers of calc-silicate rock and quartz-magnetite rock. Both sequences contain calcareous sequences in their upper parts. The sequence near Bonya Bore differs in containing the Kings Legend Amphibolite Member, a distinctive unit in the lower part characterised by coarse plagioclase spots.

## DIVISION 3

Ledan Schist conformably overlain by Utopia Quartzite crops out in two areas in central-western DNEIPER. The outcrops are confined to two fault blocks in the Mount Swan Granite. Possible intrusive contacts against Mount Swan Granite are concealed by Cainozoic cover.

The Ledan Schists consists of biotite-muscovite-quartz schist and small amounts of metaconglomerate. The Utopia Quartzite is a metaquartzite containing minor muscovite. A unit of quartzite and schist (pЄq), lithologically similar to the Ledan Schist and Utopia Quartzite, appears to underlie undivided unit (pЄ) of dominantly migmatitic quartzofeldspathic gneisses in southeastern JERVOIS RANGE.

# IGNEOUS ROCKS

## Basic Igneous Rocks

Highly altered gabbroic intrusive rocks (eg. Attruta Metagabbro) intrude the northern sequences and are thought to have preceded granite intrusion. Metadolerite dykes (Ꞓd) intrude the Cackleberry Metamorphics and the Bonya Schist.

## Granites

The large Jinka and Jervois granite batholiths in the central-eastern JINKA and southwestern JERVOIS RANGE and numerous small granite bodies occur north of the Delny Mount Sainthill Fault System whereas in the south granites are rare.

The granites are typically rich in potash feldspar and biotite. They are not muscovite granites as shown on the Huckitta 1st Edition (Smith, 1963) map. Traces of muscovite, where present, are due to later alteration. The smaller Marshall Granite, which largely encloses the Deep Bore Metamorphics, is predominantly hornblende-bearing granite, with a minor phase of coarse-grained K-feldspar-quartz granite with graphic texture.

### Late-stage Veins

Layered and brecciated, multiphase quartz veins, referred to as Oorabra Reefs cut both the Jinka and Jervois batholiths. At least one phase of veining is considerably younger because they also cut basal units of the unconformably overlying Upper Proterozoic sedimentary sequence of the Georgina Basin. Similar quartz breccia veins, which are older than the Georgina Basin sequence, occur west of the Mopunga Range.

Zoned pegmatites of the type that are prolific in the Harts Range cut the Irindina Gneiss in southern JINKA. These pegmatites are most likely of Late Palaeozoic age (Riley, 1968).

### LATE-STAGE SCHIST ZONES

Retrograde schist zones containing amphibolite and greenschist facies assemblages occur in the Delny-Mount Sainthill Fault Zone (Er) and in southeastern JERVOIS RANGE (Pzr). These are probably multiple-aged features.

## DESCRIPTIVE NOTES ON METAMORPHOSED ROCK UNITS

### DIVISION 1

Division 1 in HUCKITTA comprises mafic granulite, quartzofeldspathic gneiss and small amounts of calcareous and pelitic rocks assigned to the Kanandra Granulite, a unit within the Strangways Metamorphic Complex. Based on the regional distribution of rock types in ALCOOTA Shaw & Warren (1975) inferred that the Strangways Metamorphic Complex is unconformably overlain by the Harts Range Group and Division 2 units (Delny and Delmore Metamorphics) to the north.

## Strangways Metamorphic Complex

The name, Strangways Range Metamorphic Complex, was first used by Shaw & Warren (1975) and revised to Strangways Metamorphic Complex in Stewart & others, (1980). Its type area is in the Strangways Range in ALICE SPRINGS. The Kanandra Granulite is the only unit belonging to the Strangways Metamorphic Complex in HUCKITTA.

### Kanandra Granulite (Shaw & Warren, 1975)

Map Symbol: pCsk.

Nomenclature: Named by Shaw & Warren (1975) after Kanandra Gap in ALCOOTA.

Distribution: Shaw & Warren (1975) described outcrops of Kanandra Granulite from Kanandra Gap, northwest as far as the Bundey River, and northeast into HUCKITTA. Scattered outcrops occur north and northeast from Kanandra Dam to about 4 km east of Black Point. A second belt of outcrops extends from Middle Dam to 4 km northwest of Marshall Bore. It has been tentatively traced farther eastwards to within about 4 km of Marshall Bore. This belt is broken up by numerous shear and retrogressed zones. Retrogressed Kanandra Granulite also crops out between schist zones within the Delny-Mount Sainthill Fault Zone.

Reference area: Shaw & Warren (1975) did not nominate reference outcrops although they considered outcrops on the northwest slopes of Mount Swan (trig. Point) in ALCOOTA typical. Here, the Kanandra Granulite consists of quartzofeldspathic gneiss, garnet quartzofeldspathic gneiss, and migmatitic garnet-biotite-orthoclase-quartz gneiss, with lesser amounts of mafic granulite. Calc-silicate gneisses and cordierite-bearing quartzofeldspathic gneiss are minor components of the Granulite. The best exposures in HUCKITTA are about 2 km west of Dingo Bore and at Black Point.

Topographic expression and airphoto characteristics: The Kanandra Granulite forms low bouldery hills. Throughout its outcrop-area it has been exposed by late Tertiary to Recent erosion of the early Tertiary ferruginous deep-weathering profile and the mid-Tertiary siliceous weathering profile. Mafic granulite is the most resistant rock type and crops out more abundantly than the quartzofeldspathic gneisses in areas of poor exposure. (Amphibolite is less resistant to erosion than the quartzofeldspathic gneisses in retrogressed zones). Fresh material from the quartzofeldspathic and garnet-bearing quartzofeldspathic gneisses is difficult to obtain, though these rock types are widely distributed.

Because of the resistant nature of the mafic granulite, most outcrops of Kanandra Granulite have an even, dark photo-tone. Calc-silicate gneisses can only be distinguished from mafic granulite by field inspection.

General lithology: Mafic granulite (mn) is the dominant rock type in outcrops of the Kanandra Granulite in DNEIPER. However, the quartzofeldspathic and garnet-bearing quartzofeldspathic gneisses (f, vf) may be more abundant than mafic granulite, but less well exposed. Calc-silicate rocks (cs) are rare. In central-western JINKA quartzofeldspathic gneiss(f) is more abundant than mafic granulite, biotite gneiss(b) is present, and there is a variety of minor to rare rocks types including garnet-biotite gneiss(v), sillimanite gneiss(z) and hornblende gneiss(h).

Detailed lithology:

Mafic granulite and hornblende mafic granulite (mn): Fine-grained mafic granulites containing the assemblage orthopyroxene-clinopyroxene-plagioclase-hornblende are widely distributed. They are characterised by light-coloured veins containing orthopyroxene and quartz (FP 6109) or plagioclase and quartz (Fp 6128). In some outcrops two or more generations of veins are present. Hornblende is more common in mafic granulite in the belt extending from Middle Dam eastwards. It generally rims ferromagnesian minerals, or occurs in thin gneissic layers within the mafic granulite. Hornblende partly replaces orthopyroxene and clinopyroxene and is therefore considered to be a late phase.

Quartzofeldspathic gneiss (f) is a well-layered, generally medium-grained rock. Some outcrops, particularly in the belt eastward from Middle Dam, are virtually free of ferromagnesian minerals.

Garnet quartzofeldspathic gneiss (vf) is the predominant type of quartzofeldspathic gneiss. It ranges from well-layered to massive and also has a considerable range in garnet and biotite contents. Retrogression of garnet to biotite is common adjacent to faults and shears in the belt extending eastwards from Middle Dam.

Migmatitic garnet quartzofeldspathic gneiss (mi, vf) consists of coarse-grained, granoblastic leucosomes containing feldspar, quartz, and large garnets up to 2 cm across, and foliated melanosomes containing garnet, biotite, and, in places, sillimanite. Such gneiss is more common in Kanandra Granulite in the area from Black Point westwards. Some migmatitic garnet quartzofeldspathic gneiss contains small pods and boudins of mafic granulite.

Calc-silicate rocks (cs) are mainly dark massive rocks consisting of clinopyroxene with subordinate orthopyroxene and plagioclase. The largest outcrop-area of this rock type is at Black Point, in the ridge that contains the trig point. Well-layered calc-silicate gneisses cropping out about 2 km west of Black Point and also close to the Dneiper-Huckitta Boundary fence include garnet-diopside-quartz rocks. Massive calc-silicate rocks form a small hill about 3 km northwest of Yam Creek Bore.

Cordierite-bearing rocks (i) are very rare in the Kanandra Granulite, forming bodies too small to show at map scale. Cordierite formed as one of the products of retrogression of garnet occurs in material collected about 3 km north of Kanandra Dam and 2 km south of Dingo Dam. Cordierite-orthopyroxene-quartz assemblage from outcrops west of Black Point may have stabilized at granulite grade.

Biotite gneiss (b) is a subordinate rock-type in the unit east of Yam Creek Dam. It is a fine to medium-grained strongly foliated gneiss, which is commonly interlayered with and grades into quartzofeldspathic gneiss. Much of the gneiss is migmatitic. It includes both quartz-rich (?metasediment) and feldspathic types.

Garnet-biotite gneiss (v) is a similar rock type containing up to 15 percent garnet. Locally it contains sillimanite in which case it is designated sillimanite gneiss (z). It is generally medium to coarse grained, strongly foliated and locally migmatitic.

Hornblende gneiss (h) is an uncommon rock type rocorded south of Mount Sainthill. It consists of hornblende, biotite, quartz and feldspar (e.g. FP 2554).

Structure: Layering within the Kanandra Granulite shows a general north-south trend, but ranges from north-northeast to north-northwest.

Limited structural data suggests that the unit in the western part of DNEIPER is probably folded into elongate, north-south folds with steep axial-planes. However, minor fold structures preserved in the mafic granulite and migmatite indicate that there has probably been more than one episode of deformation.

East of Middle Dam the Kanandra Granulite is cut by later schist zones, possibly related to major shearing, which parallel the Delny-Mount Sainthill Fault Zone and the Entire Point Fault. Folds which pre-date these faults have steeply dipping axial-planes, and shallow plunges.

Metamorphism: Mineral assemblages preserved in specimens from the Kanandra Granulite show that the peak of metamorphism was well within the granulite facies (orthoclase-orthopyroxene sub-facies) Most specimens show evidence of later hydrations at lower pressure and temperature and many also show strain features related to major and minor faults and zones of shearing. The almost total absence of cordierite and widespread occurrence of garnet suggests the metamorphism may have been at moderate to high pressures. Mineral chemistry data may quantify this general statement.

A hydrous metamorphism may have preceded the granulite metamorphism. The best evidence of this is found in the more extensive exposures in ALCOOTA where there are two distinct types of mafic granulite. In the most common type, the mafic granulites form irregularly shaped lensoid bodies in the migmatites. These bodies show one or more generations of leucocratic bands and veinlets enriched in plagioclase or quartz relative to the host mafic rock. The other type lacks these characteristic leucocratic bands, and in good exposures is dyke -like and cross-cuts layering in adjacent rocks. One such body, about 6 km northwest of Mount Swan, has fine-grained margins (chilled) (70900641C) and a coarse-grained core (70900641D). Another body (80900080B) south of Mount Swan transgresses layering in migmatite. Both the segregation into migmatites and the formation of leucocratic veins in the mafic granulites are therefore considered to have formed before the granulite metamorphism, and to have been separated in time from the granulite metamorphism by an episode of mafic intrusion.

Hydration at elevated temperatures following the granulite metamorphism has produced biotite after garnet and orthopyroxene in quartzofeldspathic rocks, and hornblende in mafic rocks. Effects of hydration are particularly marked in speciemens collected east of Middle Dam and are also present in many specimens from the Mount Swan district. Hornblende produced in this early hydration has a distinctive brown to leaf-green pleochroism, generally indicative of a high $TiO_2$ content. In hornblende of similar appearance, collected from the Strangways Range in ALICE SPRINGS this colour is characteristic of a pargasite composition.

Cordierite in the cordierite-bearing rocks probably formed during this hydration. The stability field of cordierite relative to garnet increases with increasing $P_{H2O}/P_{Total}$ (e.g. Newton & Wood, 1979).

Sillimanite, which occurs very rarely in biotite-sillimanite assemblages in the melansomes of migmatites, may also have formed during this hydration, by reactions involving garnet and orthoclase.

An increase in oxygen activity is evident in specimen 80096114E. This specimen originally contained garnet-spinel-quartz. Most of the spinel, which must have had a high proportion of hercynite, has been oxidised to magnetite-corundum. (Since quartz-corundum is not stable the corundum is armoured by sillimanite). Garnet-orthoclase has partly hydrated to biotite-sillimanite.

A second, lower temperature, phase of hydration produced assemblages with chlorite, epidote and blue-green hornblende (tschermakite). In the least retrogressed specimens these minerals occur as rims on older minerals, along fractures in minerals, or in veinlets.

A widespread mode of this hydration is the pseudomorphing of earlier minerals by fine aggregates of hydrous minerals. The most common example of this is the replacement of garnet by biotite and chlorite. Other examples include the apparent replacement of diopside, orthopyroxene and hornblende by cummingtonite and actinolite (80096100A).

Myrmekite is common in quartzofeldspathic rocks affected by this hydration. It is generally Type F of Phillips (1980), invading potassium feldspar as vermincular intergrowths of quartz and albitic plagioclase. Phillips (1980) suggests such mymerkites are produced by sodium-bearing fluids and give rise in turn to potassium-bearing fluids (which then produce biotite from garnet).

Muscovite is a rare mineral in the Kanandra Granulite, and is only found close to the major deformed zones. It is characteristic of felsic rocks, within the deformed zones derived from Kanandra Granulite. The boundaries of these zones are not sharp and their effects extend out into rocks which retain the textural features of the Kanandra Granulite. All the examples of the low temperature hydration described above are due to water introduced along the faults and deformed zones. In addition, in many specimens of partly deformed Kanandra Granulite, strained, brecciated, and polygonized quartz, or, less commonly, brecciated and polygonised microcline indicate micro-deformed zones produced by mechanical deformation.

There are no metamorphic samples adjacent to granite intrusions.

Relationships: The Kanandra Granulite is intruded by granites including the Mount Swan Granite in the west and by a small ultrabasic body southeast of Middle Dam. It is weathered by the early Tertiary ferruginous deep weathering, overlain (unconformably) by the Waite Formation (late Miocene-Pliocene), and weathered by the siliceous weathering of late Tertiary age. The Kanandra Granulite is probably unconformably overlain by the Harts Range Group, but the contact is not exposed. Geophysical data suggest the contact in the HUCKITTA area is everywhere faulted.

Correlation and age: The Kanandra Granulite is part of the Strangways Metamorphic Complex (Division I). It has a Rb-Sr age of 1780 m.y. (Black & others, 1983).

Unnamed metamorphics, p€c, south of Mount Balwin

Map symbol: p€c.

Nomenclature: Unnamed because relationship and correlation with other units is uncertain.

Distribution: Small hills south of Mount Baldwin.

Topographic expression and airphoto characteristics: Scattered, low, rounded hills; yellow on coloured airphotos.

General lithology: Well-layered quartzofeldspathic gneiss (f) intercalated with minor to rare biotite schist (sb) and gneiss (b), calc-silicate rock (cs) and quartzite (qt). The quartzofeldspathic gneiss at FP 3423 contains kornerupine (Warren & McColl, 1983)

Detailed lithology:

Quartzofeldspathic gneiss (f) is typically a fine to medium-grained leucocratic rock in which biotite is minor (up to 5%) or negligible. At FPS 3421, 4111 the gneiss consists of rutile, quartz, kornerupine, biotite and albite (80096589B-F, 76096060). Some kornerupine has been retrogressed to tourmaline and phyllosilicates. In rare places (e.g. FP 3425) phlogopite and accessory pyroxene are present. In most of the gneiss the dominant feldspar is sodic plagioclase; only locally is K-feldspar (normally microcline) in excess of plagioclase. To the north the gneiss is mylonitised. Thin epidote-bearing bands are not uncommon in these deformed rocks.

Minor to rare rock types include quartzite (FP 3122), biotite gneiss (FP 3425), biotite schist (FP 3423) and calc-silicate rock (FP 3424, 80096589A). The calc-silicate rock is composed of plagioclase, quartz, hornblende, clinopyroxene, sphene, secondary clinozoisite and actinolite and accessory apatite and opaque grains.

Structure: A northwesterly to westerly-trending gneissosity is overprinted by a west-trending schistosity. To the north of the outcrop-area the schistosity is mylonitic.

Metamorphism: The presence of kornerupine in the gneiss suggest high-grade metamorphism (upper amphibolite or granulite).

Correlation and age: Lithologically similar to lower parts of Cadney metamorphics in the western Harts Ranges, Alice Springs 1:250 000 Sheet area. Kornerupine is also known in this unit (Warren & McColl 1983). The unit is tentatively assigned to Division 1 because (1) it is lithologically correlated with rocks of the Strangways Metamorphic Complex (i.e. Cadney metamorphics), (2) it has a high-grade metamorphic assemblage and (3) its location south of the Delny-Mount Sainthill Fault Zone. No age determinations have been carried out on the unit.

Undivided metamorphics in the Jervois homestead area
($p€^1$, $p€^2$, $p€^3$, $p€^4$, $p€^5$ in Fig. 2)

Scattered outcrops of metamorphics in the region of Jervois homestead are not readily subdivided into well-defined units. The most common rock types in this region are quartzofeldspathic gneiss (f), muscovite-bearing biotite schist (s) and quartzite (qt). These rocks are inferred to underlie rocks of the Harts Range Group based on regional lithological correlations. Five outcrop-areas are described separately. Their distribution is shown for ready reference in Figure 2. The five areas are-

- $p€^1$ Tourmaline-bearing quartzite 4-5 km south-southwest of Baikal homestead.
- $p€^2$ Quartzofeldspathic gneiss (f) grading locally into biotite gneiss (b) schist (s) and quartzite (qt) northwest and north of Jervois homestead.
- $p€^3$ Quartzofeldspathic gneiss (f), quartz-rich metasediment (j) and schist (s) northeast of Denara Bore (abandoned) east of Jervois homestead.
- $p€^4$ Biotite gneiss (b) granitic gneiss (gg), quartzofeldspathic gneiss (f), and quartzite (qt) near Marshall Bar.
- $p€^5$ Migmatitic quartzofeldspathic and biotite gneiss (f, b, mi) east of Ghost Gum Bore in JINKA.

The metamorphics are intruded by an indefinite number of small granite bodies which crop out very poorly. Six outcrop-areas of granite ($Pg^{1-6}$) are recognised and are described later in this Record.

1. <u>Map Symbol</u>: p€ (p€[1] in Fig. 2).

Nomenclature: Unnamed because its relationships to other rock units are uncertain.

Distribution: One outcrop-area 4-5 km west-southwest of Baikal homestead. Outcrops 8 km east-southeast of Mount Thring (eg. F.P. 4046) and 2 km south-southwest of Mount Thring (eg. F.P. 4048) may also belong to this unit.

Reference locality: 4-5 km southwest of Baikal homestead between FPS 1783 and 1784B.

Topographic expression and airphoto characteristics: A tourmaline-bearing quartzite forms a prominent steep-sided ridge about 2 km long and up to 30 m high.

Lithology: Tourmaline-bearing quartzite (jt) is a fine-grained, feldspathic quartzite containing up to 20 percent tourmaline occurring as distinct grains, some of which are rounded. Some parts of this rock show a granular texture, other parts appear schistose, lineated and contain augen of fine-grained tourmaline. The quartzite appears layered in both hand specimen and in aerial photographs. The rock appears to have been indurated during the Tertiary. Minor tourmaline-rock is also present.

Structure: The layering in the quartzite trends northeast to north-northeast. The change in strike and dip between FPS 4043B and 1783 may be due to a fault between FPS 4043B and 1783. A fault interpretation is supported by the schistosity in nearby granite and the location of quartz reefs containing a small amount of breccia at FPS 4045 and 1782.

Metamorphism: The metamorphic grade cannot be determined from the mineral assemblage present.

Relationships: The quartzite is faulted against muscovite pegmatite on its south-eastern margin (FP 1610). Other relationships are uncertain because the quartzite is surrounded by Cainozoic cover.

Correlations: Similar tourmaline quartzite occurs as float at FP 1663 near exposures of quartzite, quartzofeldspathic gneiss and pegmatite. The quartzite unit and accompanying schists (p€q) near Jervois homestead also include some apparently rare tourmaline quartzite. Rocks at both these localities may be correlates of the tourmaline quartzite, p€[1].

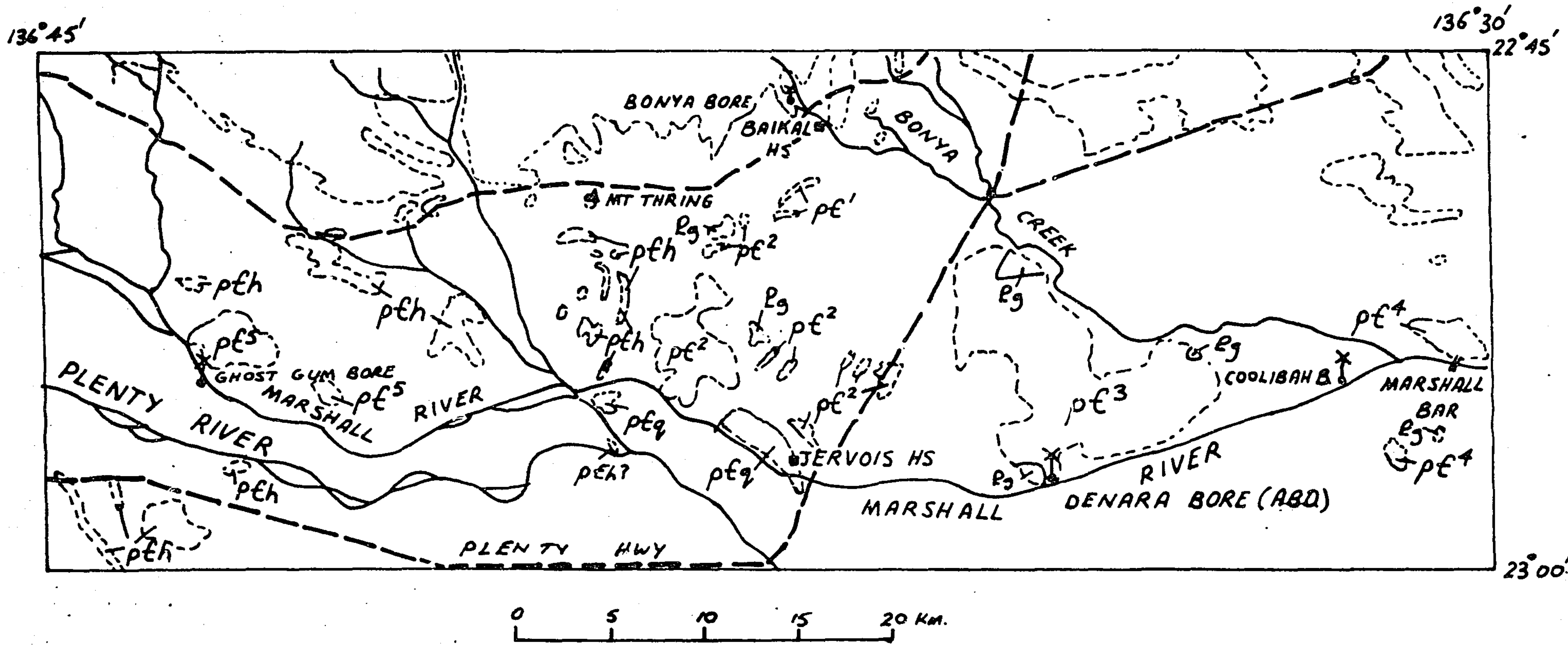



Figure 2

Єg Undivided granite

Єh HARTS RANGE GROUP

pЄ$^{1}$ Tourmaline-bearing quartzite

pЄ$^{2}$ Quartzofeldspathic gneiss, biotite gneiss, schist, quartzite

pЄ$^{3}$ Quartzofeldspathic gneiss, quartz-rich metasediment and schist

pЄ$^{4}$ Biotite gneiss, granitic gneiss, quartzofeldspathic gneiss, quartzite

pЄ$^{5}$ Migmatitic quartzofeldspathic and biotite gneiss, calc-silicate rock, sillimanite gneiss

2. Map Symbol: pЄ (pЄ$^{2}$ in Fig. 2)

Nomenclature: Unit is unnamed because its relationships to undivided Harts Range Group (pЄh) to the west and quartzite and schist (pЄq) to the east are uncertain.

Distribution: Small scattered hills and low rises northeast of Thring Bore and north of Jervois homestead. The unit excludes quartzite and schist immediately northwest of Jervois homestead (pЄq) and granitic rocks (Ᵽg$^{3}$ and Ᵽg$^{4}$) 7 and 10 km southeast of Mount Thring.

Reference locality: From 4.5 km east-northeast of Thring Bore to 10 km northeast of Thring Bore.

Topographic expression and airphoto characteristics: Forms small scattered hills, many of which are deeply weathered, and low rises which are largely covered with soil and quartz scree.

General lithology: Mainly migmatitic biotite and quartzofeldspathic gneiss (b, f), some of which contains muscovite (fm); scattered exposures of quartzite (qt), and quartz-rich metasediments (j); small amounts of muscovite-bearing biotite schist (s) and rare megacrystalline feldspar gneiss (p).

Detailed lithology:

Biotite gneiss (b) (FPS 3109, 3114, 3118) grades into quartzofeldspathic gneiss (f) (FPS 1638, 1639, 3112, 3116, 3118-20) depending on the biotite content, which in both cases is generally close to about 10 percent. Migmatitic: contains both concordant and locally cross-cutting medium to coarse grained leucosome. Locally, the migmatitic portion is pegmatitic and contains tourmaline (FP 3119). The rocks are commonly strongly foliated, are pale grey in fresher exposures and pale yellow in more weathered types, and are fine to medium-grained. At FP 3170 the quartzofeldspathic gneiss is coarse-grained and pegmatitic. At FP 3116 it is muscovite-bearing.

Quartzite (qt) forms a layer about 3 cm thick in schist at FP 3115. Quartzite also occurs in small amounts of FP 1638 where it is accompanied by a fine-grained quartz-epidote rock. Tourmaline quartzite (jt) occurs as float at FP 1663 near outcropping quartzites of FP 1662.

Quartz-rich metasediment (j) has been recorded in small amounts at FPS 1637 and 1796 where it is a foliated rock approaching quartzite in composition.

Magnetite-muscovite quartz-rich schist (sf) occurs at FP 3117. It shows a wide range in content of visible magnetite.

Muscovite-bearing biotite schist (s) occurs at FP 3115 where it is partly migmatitic and has a wavy foliation. It also occurs at FP 3112 where it overlies porphyroblastic feldspar gneiss (p).

Muscovite schist (sm) crops out poorly at FP 1633 where it is interlayered with vein quartz.

Structure: The exposures are too widely scattered to allow a meaningful reconstruction of the structure.

Metamorphism: The presence of muscovite in the non-migmatitic portions of the quartzofeldspathic gneiss and in the biotite-rich schists suggests lower amphibolite facies grade below the alkali-feldspar sillimanite-isograd. However, the development of a mobilisate phase implies conditions in the upper amphibolite facies; the muscovite is therefore regarded as a retrograde mineral.

Relationships: These rocks have undergone deep weathering presumably in the Tertiary (Tla). The relationships of Unit p€$^2$ to the surrounding rocks is uncertain because contacts are not exposed.

Unit p€$^2$ appears to be unconformable with the sequence of quartz-rich metasediments tentatively assigned to undivided Harts Range Group (p€h) to the west and to conformably structurally overlie a unit of bedded quartzite and two-mica schist p€q cropping out near Jervois homestead.

Distinguishing features: Unit p€$^2$ differs from rocks mapped as undivided Harts Range Group in being noticeably more quartzofeldspathic and in lacking calc-silicate rock. It lacks the garnet-biotite gneiss typical of the Irindina Gneiss.

Correlations: Unit p€$^2$ is lithologically similar to the Delny Gneiss in ALCOOTA (Shaw & Warren, 1975; Shaw & others, 1975) except that it lacks amphibolite and calc-silicate rock.

3. Map Symbol: p€ (p€$^3$ in Fig. 2)

Nomenclature: Because the relationships between p€$^2$ and p€$^3$ are problematical it is left unnamed.

Distribution: Generally small scattered low rises of highly weathered partly silicified rocks separated by aeolian sand (Qs) and oxidised red clayey sandy soil (Qr) crops out over an area of about 220 sq km between Bonya Creek and Marshall River northeast of Denara Bore (abandoned) SW JERVOIS RANGE. Some exposures can be found around the margins of the dissected former land surfaces (?Cz).

Reference locality: From FP 1690 (8 km east-northeast of Denara Bore) northward along the eastern margin of a highly weathered landsurface for a distance of 2 km.

Topographic expression and airphoto characteristics: Forms small scattered hills up to 10 m above the surrounding plain. These are deeply weathered and partly silicified, many having a thin covering of soil and scree of quartz and rock fragments. Small outcrops of fresh rock occur at the margins of these hills, which are considered remnants of a former land surface.

General lithology: Highly weathered and silicified quartz-rich metasediment (j) and quartzofeldspathic gneiss (f).

These rocks were previously mapped by Smith (1964) as Jervois Granite. However, the main rock type is a quartzofeldspathic gneiss with biotite-rich layers in places. A few isolated outcrops of biotite gneiss (b) and biotite schist (sb) are also present. Quartz-epidote calc-silicate rock (cs) is common in the southeast part of the unit, north of Marshall River. Quartz-rich metasediments (j) occur to the west. Layered magnetite (hematite) quartz rock (qf) is present at FPS 1674 and 1651. The magnetite-quartz rock is contiguous to garnet-epidote rock at FP 1681.

Detailed lithology:

Quartzofeldspathic gneiss (f) is mainly quartz-rich but in places includes biotite-rich layers. It grades into biotite gneiss (b), and rarely grades into biotite schist (sb). Muscovite in the weathered exposures in the northwestern portion of the outcrop-area may be a retrograde mineral. This muscovite-bearing schist (s) is cut by quartz veins which parallel the foliation. Layered garnet-epidote quartz calc-silicate rock (cs) is mainly in the southereastern corner of the outcrop-area, north of the Marshall River (FPS 1689, 1690). Non-layered calc-silicate rock occurs alongside layered magnetite (hematite) quartz rock at FP 1681.

Schistose quartz-rich metasediment (j) is found in the eastern portion of the outcrop-area (FP 1675, 1676, 1786, 1788). It is fine-grained, feldspathic and contains muscovite and a small amount of biotite.

Biotite schist (sb) occurs as small lenses in the quartzofeldspathic gneiss and biotite gneiss. In places it contains elongate clots of muscovite, which may be pseudomorphs after andalusite (FP 1693).

Layered magnetite/hematite quartz rock (qi) occurs adjacent to garnet-epidote-quartz-calc-silicate rock at FP 1681 and on its own at FP 1674.

Structure: The exposures are too scattered to allow any reconstruction of the structure. Foliation directions are highly variable. At one locality (FP 1693) a vertical crenulation-cleavage striking 090° forms the axial-plane to folds developed in biotite schist.

Metamorphism: The presence of elongate clots of muscovite in some of the biotite schist may imply retrogression from a higher metamorphic grade, most likely that in which andalusite was stable i.e. amphibolite facies.

Relationships: These rocks have undergone deep weathering in the Tertiary. Contacts with the surrounding units are not exposed. They are intruded by granite in the north near the confluence of Plenty River and Bonya Creek and in the southwest near Denara Bore.

Correlations: It is uncertain how this unit correlates with other metamorphic units in the region. It has been suggested by R.D.S. that the Delny Gneiss, Mapata Gneiss, Chiripee Gneiss (ALCOOTA) (Shaw & Warren 1975) or the Albarta Metamorphics (ILLOGWA CREEK) Shaw & others, 1982 may correlate with this unit. C.L.H. considers the Delny Gneiss to be the most likely correlative.

4. Map Symbol: p€ (p€$^4$ in Fig. 2)

Nomenclature: Unnamed because relationship to other units is uncertain.

Distribution: Two groups of outcrops: one near Marshall Bar and the other 4 km to the southwest both in southeast JERVOIS RANGE.

Topographic expression and airphoto characteristics: Scattered, low, rounded hills. Also a few outcrops in the bed of Marshall River including Marshall Bar. Several outcrops are not very evident on airphotos.

Lithology: Porphyritic granitic gneiss (gg) intertongued with fine, even-grained granitic gneiss (FP 53139, 3131), several small lenses of quartzofeldspathic gneiss (f) and rare biotite schist (sb). One extensive strike ridge of quartzofeldspathic gneiss (f) (FP 3140) contains very little mica and is intercalated with small amounts of very fine-grained quartzite (qt). Examples of biotite gneiss (b) and quartzofeldspathic gneiss to the south (FPS 2570 and 2509) are highly weathered.

Structure: The layered granitic gneiss at FP 3139 has a well-developed schistosity parallel to appressed folds, which are locally refolded by crenulation folds. The main unit of quartzofeldspathic gneiss and quartzite dips southwards at about 70° roughly parallel to the main schistosity in the granitic gneiss.

Metamorphism: Deformed under amphibolite facies conditions.
Relationships: Multiple deformed nature of the granitic gneiss suggest it is older than the Jervois Granite which is massive and undeformed.
Correlation and age: Granitic gneiss (gg) is unlike other granites in the region. The quartozfeldspathic gneiss and biotite gneiss show some lithological similarity to rocks in the unnamed metamorphics to the west ($p\mathrm{C}^{1-3}$ Fig. 2). No age determinations have been carried out on the unit.

5. Map Sumbol: pC ($p\mathrm{C}^{5}$ in Fig. 2)

Nomenclature: May be part of the Harts Range Group.
Distribution: Scattered outcrops 2-5 km northeast and 6-7 km east-southeast of Ghost Gum Bore in southern JINKA.
Reference locality: Three kilometres northeast of Ghost Gum Bore.
Topographic expression and airphoto characteristics: Scattered low hills. Dark grey on black and white airphotos.
Lithology: Mainly migmatic quartzofeldspathic gneiss (f, mi) (FPS 3130-35) grading into subordinate migmatitic biotite gneiss (b, mi) (FPS 3128-33). Much of the biotite gneiss is rich in biotite and this rock type locally contains garnet (FP 3131), sillimanite (FP 3128), or muscovite (FP 4013).
Calc-silicate rocks (cs) at FP 4014 northeast of Ghost Gum Bore are composed of (garnet?) quartz, biotite, scapolite, and diopside (76096003B) and at 76096003C, quartz, colourless hornblende, and diopside. An amphibolite (a) at the same locality is composed of quartz, biotite, plagioclase ($An_{40}$), and hornblende (76096003D). A medium to coarse-grained flaggy quartzite (FP 3129) occurs in the same outcrop. The unit includes ferruginous quartzite at FPS 3130 and 3136.
Structure: The outcrops are too scattered to enable a reconstruction of the structure.
Metamorphism: Middle amphibolite facies.
Relationships: Uncertain because surrounded by Cainozoic cover.
Correlation: Minor rock types such as calc-silicate rock are similar to those of the Harts Range Group although the main rock types are atypical of that unit. The rocks are also lithologically similar to those of the unnamed metamorphics $p\mathrm{C}^{3}$ to the east in JERVOIS RANGE.

DIVISION 2

Division 2 consists characteristically of metamorphosed pelitic rocks and compositionally layered quartzofeldspathic rocks (Shaw & Stewart, 1975) together with some psammitic and calcareous rocks. In the southern part of the Arunta Block, Division 2 also includes well-layered quartzofeldspathic rocks, thought to represent a sedimentary facies transitional with Division 1 rocks (Shaw & others, 1979; Stewart & others, in press). The Mascotte Gneiss Complex, the Bonya Schist, and the basal unit of the Harts Range Group (Entia Gneiss) possibly belong to the more quartzofeldspathic facies of Division 2. The upper part of the Harts Range Group (Irindina Gneiss and Brady Gneiss) is assigned to the pelitic facies of Division 2. The Bonya Schist may also belong to the lower part of this pelitic facies. The Deep Bore Metamorphics, Cackleberry Metamorphics, and the unnamed metamorphics near Tower Rock (p€t) are tentatively assigned to Division 2.

The relationship between rock units north and south of the Delny-Mount Sainthill Fault Zone is problematical. In general, units north of the Fault Zone have been metamorphosed to a lower metamorphic grade. For convenience Division 2 rocks south of the Fault Zone are described first, but they are not necessary older than units north of the Fault Zone.

<u>Harts Range Group</u>

Named and defined by Joklik (1955). Made up of the Entia Gneiss, overlain by Bruna Gneiss, then Irindina Gneiss, followed by Brady Gneiss. These form a conformable sequence in the southwest corner of <u>HUCKITTA</u>. In northeastern <u>ALICE SPRINGS</u> the Group overlies the Strangways Metamorphic Complex with a disjunctive boundary, which is thought to be a tectonically disrupted unconformity (Shaw & others, 1979).

<u>Entia Gneiss</u>

<u>Map Symbol</u>: p€he.
<u>Nomenclature</u>: Named after the Entia drainage basin, Joklik's term for saucer-like upper catchment of Entire Creek - then known as Entia Creek.
<u>Distribution</u>: Inner pound within Harts Range in southwest part of Sheet area.
<u>Reference area</u>: Joklik (1955) nominated only a broad reference area surrounding

Inkamulla Bore in ILLOGWA CREEK. The reference locality is taken to be 1.5 km north-northwest of Inkamulla Bore (GR 5751-447184) where Joklik collected specimen R4559, which has been described in detail and chemically analysed.
Thickness: Difficult to estimate because of the amount of internal folding, possibly 2700 m.
Topographic expression and airphoto characteristics: Hilly country interspersed with alluvial valleys. Has alternating pale and dark grey, well-layered expression on the black and white aerial photographs.
Lithology: Only the upper part of the unit is exposed in HUCKITTA. This consists of intercalated quartzofeldspathic gneiss (f), layered amphibolite (pa), hornblende gneiss (h) and biotite gneiss (b). The quartzofeldspathic gneiss contains biotite and ranges from granite to tonalite in composition. The layered amphibolite commonly contains hornblende, clinopyroxene, quartz and variable amounts of plagioclase. The amphibolite appears to be transitional with minor to rare calc-silicate rock. The hornblende gneiss is a transitional lithological type between the layered amphibolite and the quartzofeldspathic gneiss. The biotite gneiss also resembles the quartzofeldspathic gneiss but contains more than 10 percent biotite.
Structure: The unit forms the northern edge of a domal structure and dips 50-65° north-northeast.
Metamorphism. The metamorphic grade is considered to be uppermost amphibolite facies.
Relationships: Intruded by the Huckitta and Inkamulla Granodiorites in ILLOGWA CREEK, and is conformably overlain by the Bruna Gneiss.
Age: Considered to have been regionally metamorphosed during the Strangways Event at about 1800 m.y. (Black, 1975; Shaw & others, 1979; 1982).

Bruna Gneiss

Map Symbol: pЄha.
Nomenclature: Name derived from Mount Bruna in northwestern ILLOGWA CREEK.
Distribution: A northern horizon within the belt of hills that form the northern flanks of the Harts Range in southwestern HUCKITTA.
Reference section: Upper reaches of Entire Creek (see Shaw & others, 1982).
Thickness: 140 m or less in Sheet area.
Topographic expression and airphoto characteristics: Generally a smoothly rounded double ridge. Even-toned, medium grey continuous marker horizon on black and white photos.

Lithology: Porphyroblastic-feldspar gneiss. Granite composition. Megacrysts up to several centimetres across in places and generally of K-feldspar. Matrix biotite-rich in part (e.g. FP 2008). Some streaked aggregates. In other places (e.g. FP 2014) matrix consists of hornblende, garnet, biotite, quartz and feldspar. It is highly foliated in parts.

Structure: Dips 40° north-northeast. Lineated; some feldspar megacrysts are aligned in the lineation, others are not.

Metamorphism: The presence of hornblende and garnet in a rock of acid composition suggests conditions of the upper amphibolite facies.

Relationships: Sharp, conformable contact with underlying Entia Gneiss. Contact with overlying Irindia Gneiss is transitional over about two metres.

Correlation and age: Has no obvious correlates, and has not been the subject of age determination studies.

Irindina Gneiss

Map symbol: pЄhi.

Nomenclature: Named by Joklik (1955) after Irindina Creek in the southwest corner of DNEIPER.

Distribution: Occupies most of the central-southern part of JINKA, and southeastern DNEIPER, south of the Delny-Mount Sainthill Fault Zone. Forms part of Harts Range in southwestern corner of DNEIPER.

Reference section: Joklik (1955, p. 38) gave the valley of Irindina Creek as the type area. Joklik's type specimen, collected 3 km west-northwest of the Last Chance Mine in ILLOGWA CREEK, is a sillimanite-almandine-andesine-biotite-quartz gneiss.

Thickness: No estimate is possible because the scattered nature of the exposures makes it difficult to reconstruct the structure. At least 2000 m are estimated west of the Dinkum Extended Mica Mine (southwest of Yam Creek Bore).

Topographic expression and airphoto characteristics: Gneisses form mainly low, rounded, commonly closely spaced hills. Quartzites and some calc-silicate rocks form low discontinuous strike ridges. Some calc-silicate rocks crop out very poorly and weather to slight, smooth, well-grassed ridges. Photo-tones are commonly pale with greenish-tinge.

General lithology: The unit differs from that in the type area in containing less garnet, more sillimanite and in lacking the layered amphibolites of the Riddock Amphibolite Member. About 40 percent of the outcrop-area consists of various types of biotite-bearing gneiss (e.g. v, z, b, sb). More than half of this gneiss is garnetiferous (ie. v); about one-third lacks both garnet and sillimanite and is commonly schistose (b, sb). In addition to the listed rock-types about a quarter of the outcrop-area consists of calcareous or quartz-rich metasediments, such as marble (ma), calc-silicate rock (cs), quartzite (qt) or quartz-rich gneiss (j). Much of the Irindina Gneiss is extensively migmatised (mi) and compositional layering is generally very well-developed throughout. Amphibolite (a), although widely distributed, is present in very small amounts. Small amounts of quartzofeldspathic gneisses (f, fm, vf) and muscovite schist (sm, sv) are locally present. Very rare rock types include porphyroblastic gneiss (p) and magnetite-quartzite (qf).

On the northern flanks of the Harts Range in southwestern DNEIPER the Irindina Gneiss consists of amphibolite (a) interlayered with garnet-biotite-quartz-feldspar gneiss (v) and some muscovite-bearing schists (s and sv). Narrow layers of garnet-biotite and hornblende biotite gneiss are present: massive amphibolite (a), quartzofeldspathic gneiss (f) and clinopyroxene-scapolite-hornblende-plagioclase calc-silicate rock (cs) are minor rocks of more sporadic distribution. The unit thins out in its southwestern limits where it is estimated to be only 500 m thick as against 800 m in the western part of the outcrop-area. It is much thicker farther south in ILLOGWA CREEK.

Detailed lithology:

Garnet-biotite gneiss (v) is the most abundant and widely distributed rock type. It is particularly abundant in the Mount Margaret area. The gneiss is generally more biotite-rich and garnet poor compared with its counterpart in ILLOGWA CREEK. The more resistant varieties contain up to 65 percent quartz (e.g. FP 3303). It is medium to fine-grained, the garnet generally occurs as rare porphyroblasts up to 4 mm across, although near Mount Margaret the garnet content reaches about 12 percent.

Sillimanite gneiss (z) is a common variant of garnet gneiss. About a quarter of the gneiss contains muscovite, possibly as a retrograde mineral.

Calc-silicate rock (cs) lenses occur throughout the outcrop-area but are more abundant southeast of Jinka homestead, and west and southwest of Yam Creek Bore. It is flaggy and has a granular texture; a typical mineral assemblage (e.g. 4005) is scapolite-diopside-plagioclase-calcite-quartz-phlogopite. Sphene and rarely monazite are accessories. More mafic types (pa) contain hornblende and are rich in plagioclase (e.g. 4005).

At FP 2147 a prominant but low hill formed of medium to coarse-grained calc-silicate rock contains abundant wollastonite and also orange-red garnet, light green clinopyroxene, scapolite, calcite, sphene, and quartz.

Quartz-rich gneisses (j) (e.g. at FPS 3104, 1649 and 1647) grade into calc-silicate rock and quartzite (q) and quartz-rich garnet gneiss, both of which are also typically flaggy.

Amphibolite (a) forms numerous small pods and lenses, generally concordant, but locally cross-cutting. Although widespread, amphibolite accounts for less than 5 percent of the outcrop-area. Similar, but rare, rock containing orthopyroxene is mapped as mafic granulite (mn) (e.g. FP 3001).

Quartzofeldspathic gneiss (f), containing muscovite clots and very rare garnet, occurs 2.5 km northeast of Prosser Bore. Gneiss about 11 km south of Mount Baldwin (FP 2503) and at Mount Margaret (FP 3067) also contain garnet. Similar quartzofeldspathic gneiss forming small hills 3-12 km northeast and east of Ghost Gum Bore are tentatively assigned to unnamed unit pC.

Muscovite-biotite schist (s) is an uncommon rock-type recorded 3 km and 6 km southwest of Jinka homestead (FPS 3073, 3978). Similar gneiss 8 km south of Jinka homestead contains garnet. Muscovite is more common in southwestern JINKA and may be due to retrograde metamorphism.

Ferruginous quartzite (qf) occurs as isolated lenses at FPS 3130, 3136 and 2130 in southeastern JINKA.

Porphyroblastic feldspar gneiss (p) is a very rare rock type recorded 5.5 km southwest of Marshall Bore at FP 3001. It is a biotite-rich gneiss containing irregular feldspar megacrysts. Small feldspar porphyroblasts are not uncommon in the widespread garnet-biotite gneiss.

Dolerite (dl) crops out as exfoliated boulders within amphibolite and garnet-biotite gneiss in southwest DNEIPER in the Harts Range.

Structure: The overall structure of the unit is uncertain because the outcrops are limited and widely scattered. Minor folding has affected dip directions. Dips to the north and northeast are more common in the southeast and central parts of JINKA and southerly dips are common in the northern part of the outcrop-area. This overall pattern suggests that the unit forms a synclinal structure. A swing in the direction of dips associated with a change in rock type south of Mount Thring suggest the synclinal structure closes to the east. The unit appears to be in faulted contact with the Kanandra Granulite to the north.

Metamorphism: The co-existence of sillimanite with K-feldspar in the northern part of the unit indicates upper amphibolite facies conditions whereas the co-existence of muscovite with sillimanite (rock type zm) in southwestern JINKA indicates a metamorphism grade of lower amphibolite facies. However, much of the muscovite may be due to a second retrograde metamorphism which accompanied later pegmatite emplacement.

Relationships: The Irindina Gneiss is in faulted contact with the Kanandra Granulite in the northwest of the Sheet area. In ILLOGWA CREEK the Irindina Gneiss overlies the Bruna Gneiss with a gradational contact and is overlain by the Brady Gneiss again with a gradational contact. South of Jinka homestead in JINKA the Irindina Gneiss interfingers with rocks mapped as undivided Harts Range Group, pCh, which consist of calc-silicate rock, migmatite, biotite gneiss, metasediment and muscovite-biotite gneiss.

Correlation and age: The Irindina Gneiss is part of the Harts Range Group, and is assigned to Division 2 of the Arunta Block by Shaw & others (1979). No correlations can be made with other units in the Arunta Block.

The main metamorphism affecting it is thought to be the 1800 m.y. Strangways episode (Shaw & others, 1979; 1982).

Remarks: The well-layered sequence of biotite-rich schistose gneisses containing garnet and sillimanite is thought to represent a sequence of pelitic sediments. The intercalated marble, calc-silicate rock and quartzite suggest a shallow-water, warm, marine environment of the original sediments.

## Brady Gneiss

May symbol: p€hb$^1$, p€hb$^2$.

Nomenclature: Named after Mount Brady is northwest ILLOGWA CREEK by Joklik (1955).

Distribution: Marginal ridges and slopes of the Harts Range surrounding the Entia Dome in southwestern HUCKITTA.

Reference area: Surrounding chemically analysed specimen R4631, 1.5 km north-northwest of the Central Mica Mine, 6 km west of Mount Brady in ALICE SPRINGS.

Thickness: At least 1700 m.

Topographic expression and airphoto characteristics: Ridges and lower slopes of the Harts Range disrupted by major north-flowing creeks. Even-textured unit with pale grey photo-tones. Fine layering evident where not disrupted by abundant pegmatite.

Lithology: Schistose garnet-bearing muscovite biotite gneiss (sv) is the major and distinctive rock type of subunit p€hb$^1$, but is less common in subunit p€hb$^2$. Calc-silicate rock (cs) is also abundant in subunit p€hb$^2$ where it has a very irregular distribution. Biotite-hornblende-plagioclase gneiss (h) is a minor rock type of subunit p€hb$^2$ and is intercalated with the schistose rocks and calc-silicate rocks. Lithological layering ranges from several millimetres to tens of metres. Pegmatites are very abundant throughout.

Structure: Dips moderately to steeply north-northeast.
Metamorphism: The common assemblage sillimanite-muscovite in adjacent regions (Shaw & others, 1979; 1982) indicates that the Brady Gneiss was regionally metamorphosed to the middle amphibolite facies.
Relationships: Underlain by the Irindina Gneiss with a gradational contact. The unit is overlain to the north by unconsolidated Cainozoic sediments. The contact with the unnamed metamorphics of the Harts Range Group, p€h, to the east in ILLOGWA CREEK is problematical. The units are interpreted to be in faulted contact; however a major aeromagnetic lineament near the assumed boundary is obscured by Cainozoic cover. The unit p€h may be a facies equivalent of the Brady Gneiss and/or the Irindina Gneiss.
Correlation and age: Lithological similarity to the Hillsoak Bore metamorphics (Shaw & others, 1979). No age determinations have been carried out on the unit.
Remarks: Considered to be a metamorphosed psammo-pelitic sediment containing thin calcareous interbeds implying probable marine conditions.

## Undivided metamorphics of the Harts Range Group

Map symbol: p€h.
Nomenclature: These rocks clearly belong to the Harts Range Group, but it is not certain to which formation in the Group they should be assigned.
Distribution: Scattered outcrops in southern and eastern JINKA and in south-western JERVOIS RANGE.
Topographic expression and airphoto characteristics: Low hills and strike ridges separated by Cainozoic cover. Some bedrock is concealed by thin superficial cover; bedrock trends are visible on airphotos.
Lithology: Undivided metamorphics p€h consist of interlayered calc-silicate rocks (cs) and generally poorly exposed biotite gneiss (b) which is locally migmatitic (mi) or garnet-bearing (v). Metaquartzite layers occur throughout the outcrop-area, but are a minor component. Amphibolite (a) is present in places as narrow layers. In southeastern JERVOIS RANGE the Group is made up of muscovite-biotite schist (s), quartz-rich metasediment (j), quartzite (qt), biotite gneiss (b), quartzofeldspathic gneiss (f) and lesser amounts of sillimanite-garnet and sillimanite-muscovite gneisses (z, zm), biotite schist (sb) and para-amphibolite (pa). Metamorphic rock (mt) is applied to outcrops in JINKA which have not been field checked.

At FP 2142 migmatic, brown calc-silicate rock consists of fine-grained plagioclase, green hornblende, pale green clinopyroxene, scapolite, quartz, perthite, and accessory sphene and apatite. It is cut by pegmatites composed of medium-grained quartz, perthite, and plagioclase.

At FP 2141 several rock types are well exposed in a northeast-dipping sequence. At the base of the sequence garnet-biotite gneiss (v) containing minor foliated fine-grained amphibolite (a) is overlain by up to 25 m of white medium to coarse-grained metaquartzite (qt) which contains accessory biotite. Poorly exposed migmatite and biotite gneiss (b, mi) overlies the metaquartzite and is itself overlain by fine-grained calc-silicate rock (cs).

Relationships: The units are an extension of rocks mapped as undivided metamorphics of the Harts Range Group in northeastern ILLOGWA CREEK. This unit is lithologically similar to the Brady Gneiss to the east. However, it has a gradational contact to the north (southern edge of HUCKITTA) with rocks typical of the Irindina Gneiss which is known to underlie the Brady Gneiss in the Harts Range.

Minor rock types in p€h in southwestern JERVOIS RANGE such as sillimanite-garnet-biotite gneiss (z) and flaggy quartzite (qt) are typical rock types in the Irindina Gneiss.

Age: No isotopic work has been attempted on this unit.

## Units north of the Delny-Mount Sainthill Fault Zone

### Deep Bore Metamorphics

Map Symbol: p€p.

Distribution: Extend south of Deep Bore for about 5 km.

Reference area: In low hills about 4 kms southwest of Deep Bore (Lat. 22°41.5'S; Long. 133°33.5'E).

Topographic expression and airphoto characteristics: Crop out in low, bouldery, spinifex covered hills and ridges. On air photographs the unit is distinguished from adjacent Marshall Granite by its browner photo-colour.

General lithology: The Deep Bore Metamorhics consist of calc-silicate rock (cs), cordierite-bearing quartzite (i), rare garnet-bearing quartzose rocks and minor mafic granulite (mn). Small bodies of para-amphibolite (pa) in the Marshall Granite west of the main area of Deep Bore Metamorphics are also assigned to the unit.

Detailed lithology:

Calc-silicate rocks (cs, pa) includes diopside-rock, garnet-diopside-quartz-rock and rare carbonate-bearing rock. Some of the para-amphibolite forming roof pendants in the Marshall Granite is considered to be part of the calcareous unit in p€p. Fresh exposures of the calcareous rocks are rare. Many of the calc-silicate rocks are greenish in outcrop, giving the impression that diopside or clinozoisite is the dominant mineral; a thin section of a relatively fresh sample showed however that the green tint was due to fine-grained phyllosilicates pseudomorphing the original coarse-grained assemblage. An a-typical specimen (80096359) consists of wollastonite, colourless garnet, calcite, diopside and quartz.

Cordierite quartzite (i) with minor cordierite felsic gneiss is the predominant rock type in the northern coutcrops. These rocks consist of cordierite, plagioclase, biotite, and quartz. Cordierite commonly encloses spinel, corundum and sillimanite, indicating that some cordierite may have formed by inversion of garnet to lower pressure assemblages during hydration. Garnet-bearing outcrops are comparatively rare, and as in a thin section from one of these (80096396A) garnet is surrounded by biotite, cordierite and quartz, the garnet is probably relict from an earlier, less hydrous assemblage.

Mafic granulite (mn) contains orthopyroxene, clinopyroxene, plagioclase, and hornblende. Textures indicate the hornblende is part of the granulite assemblage. In 80096400 the plagioclase is bytownite ($An_{82}$), the hornblende is ferroan pargasitic hornblende to edenitic hornblende (nomenclature of Leake, 1978) with a high $TiO_2$ content (2.08-2.20 weight percent). The high $TiO_2$. content of the hornblende is consistent with the temperatures obtained for co-existing pyroxenes (820°C by the equation of Wood & Banno, 1973; 810°C by the equation of Wells, 1977).

Structure: The unit is not well enough exposed to show structural detail. Layering is controlled by composition. The discontinuous, lenticular layering in the calcareous rocks may be due to pre-metamorphic disruption, or the original protolith may have been lensoid.

Metamorphism: Granulite grade. Extensive retrogression of garnet-bearing assemblages to cordierite-bearing assemblages is apparent in thin sections.

Retrogression to amphibolite and epidote-bearing assemblages probably occurred mainly during the intrusion of the Marshall Granite. Major faults northeast and south of the area in which the Deep Bore Metamorphics occur may also have influenced some retrogression.

Relationships: The Deep Bore Metamorphics are intruded by quartz norite and by the Marshall Granite. They are overlain by the Georgina Basin sequence.

Correlations and age: The Deep Bore Metamorphics are assigned to Division 2 as they consist essentially of metamorphosed pelite and calc-silicate rocks. The cordierite-bearing rocks are compositionally similar to the Delmore Metamorphics in ALCOOTA. The Deep Bore Metamorphics are also compositionally similar to parts of the Bonya Schist in the Bonya hills, especially to the part of the section above the Kings Legend Amphibolite member near the Damacus Prospect.

The unit is presumed to have a metamorphic age of about 1800 m.y.

## Cackleberry Metamorphics

Map Symbol: p€v.

Nomenclature: Named from Cackleberry Bore (abandoned) on Dneiper Pastoral Holding (DNEIPER).

Distribution: North of the Delny-Mount Sainthill Fault, from 3 km east of Yam Creek Dam to 7 km south of 9 Mile Bore.

Reference areas: (1) For calcareous units about 5 km northwest of Yam Creek Dam at GR DNEIPER NQ 455912 (2) For quartzofeldspathic units: at GR DNEIPER NQ455934 (3) For pelitic unit 1 km west of the western end of the Mopunga Range at GR NQ 379986.

Topographic expression and airphoto characteristics: The Cackleberry Metamorphics crop out in low rocky rises and as boulders in soil covered areas. They crop out in topographic low areas relative to the unnamed granite Pgr, but at the same erosional level as the Dneiper Granite, and the unnamed granites Pgk, Pgy and Pgg.

Large areas of Cackleberry Metamorphics generally have a dark green photo-colour, and form low, rounded hills. Small outcrops in soil covered areas cannot be successfully delineated on air-photos.

General lithology: The Cackleberry Metamorphics are a layered sequence. In the eastern and southern area of outcrop the dominant rock types are well-layered calc-silicate gneisses including para-amphibolite, massive porphyroblastic calc-silicate rock and subordinate plagioclase-bearing quartzofeldspathic gneiss and minor cordierite-felsic gneiss and cordierite anthophyllite rock. In the western outcrop-area the Cackleberry Metamorphics consist dominantly of metapelite, small amounts of calc-silicate rock, and very rare cordierite-anthophyllite rock.

Detailed lithology: There are three distinct outcrop-areas: (1) northwest of Yam Creek Dam; (2) west of Mopunga Range; and (3) north and south of Mopunga Range.

(1) Area northwest of Yam Creek Dam

Well-layered calc-silicate rocks (cs & pa) are dark green, compositionally layered rocks containing hornblende, quartz, plagioclase, minor potassium feldspar or phlogopite and sphene. The plagioclase appears generally to be andesine, but is commonly very altered. Hornblende is sufficiently abundant in some layers for these to be termed para-amphibolite.

The massive porphyroblastic calc-silicate rocks are lineated dark rocks with porphyroblasts of plagioclase (white), quartz (white), and/or hornblende (dark) in a matrix of quartz, calcareous plagioclase, hornblende, biotite, and opaque phases.

Plagioclase-bearing quartzofeldspathic gneiss (f) is a light coloured, well-layered rock consisting of potassium feldspar (orthoclase, partly strained), sodic plagioclase (oligoclase, but mainly altered to phyllosilictes), biotite, hornblende, and opaque phases. Plagioclase is as abundant as potassium feldspar, hence the very light coloured outcrops. Hornblende is the predominant ferromagnesian mineral in some outcrops.

Cordierite felsic gneiss (if) occurs as small outcrops about 6 km west by north of Yam Creek Dam. The main rock type is a medium-grained gneiss with the assemblage biotite-cordierite-quartz-potassium feldspar. Small amounts of cordierite-bearing quartzite and calc-silicate gneiss are also present.

Anthophyllite-biotite-quartz-cordierite granofels (ia) occurs as pods in finely layered felsic gneiss, in cordierite felsic gneiss, and as isolated exposures. Thin layers of cordierite-anthophyllite-quartz rock also occur within the calc-silicate gneiss. Grain size is variable, but is generally very coarse. An exposure of cummingtonite gneiss (76096038 B) occurs 4 km northwest of Yam Creek Dam.

(2) Outcrops west of the Mopunga Range

West of the Mopunga Range the dominant rock type in the Cackleberry Metamorphics is medium to fine-grained dark gneiss (iz) containing cordierite and biotite, and, in some places, sillimanite. Quartz-rich calc-silicate pods are a minor component.

Mafic rocks, cropping out mainly southeast of No. 4 Dam and southwest of No. 3 Dam are tentatively assigned to the Cackleberry Metamorphics. The rocks consist mainly of dark amphibolite (a) with light coloured plagioclase porphyroblasts. Finer grained relics within the amphibolite contain pyroxene-bearing assemblages with a poorly preserved ophitic texture.

(3) Zones of quartzofeldspathic gneiss north and south of Mopunga Range.

Fine-grained foliated biotite quartzofeldspathic gneiss (b) crops out in a zone with a trend slightly west of north, both north and south of the Mopunga Range. It consists of quartz, biotite, hornblende and feldspars. It lacks the laminated appearance of the quartzofeldspathic gneiss near Yam Creek Dam, but is leucocratic by comparison with the biotite-cordierite gneisses which crop out to the west.

Structure: The Cackleberry Metamorphics generally are a well-layered sequence with a north-northwest trend, which becomes west-northwest west of No. 3 Dam. In some areas there is a well-developed lineation, similar to that in the Dneiper Granite.

Outcrops of finely layered felsic gneiss north of Yam Creek Dam show small-scale folds which may be slumps, or as these outcrops are very close to a probable major fault zone, the folds may be tectonic in origin. The folds are pre-metamorphic and produce no penetrative fabric.

Metamorphism: Grade ranges from upper greenschist to granulite, and most specimens show evidence of two metamorphic events.

Specimens from outcrops between Yam Creek Dam and the Mopunga Range whose thin sections have been examined contain an earlier upper amphibolite assemblage with a superimposed transitional lower amphibolite assemblage. In the earlier assemblages green amphibole lacks blue tints showing it has a low tschermakite content, cummingtonite is present, and cordierite and potassium felspar co-exist. The second event is represented by chlorite and epidote-bearing assemblages which have mainly formed adjacent to fractures and quartz segregations. A small outcrop of metadolerite, about 4 km west of Yam Creek Dam, shows only the second episode.

Both metamorphic events also occurred west of the Mopunga Range, but at higher grades. Cordierite-potassium feldspar-bearing assemblages formed in the earlier episode. Relict orthopyroxene occurs in a specimen of cordierite-anthophyllite rock from 7 km south of No. 4 Dam. This indicates that the earlier metamorphism may have reached granulite facies locally. The later episode of metamorphism produced green hornblende and cummingtonite in the mafic rocks, and biotite-sillimanite in the metapelites. One example of garnet formed by reaction between clinopyroxene and plagioclase is present in a calc-silicate rock collected from near Cackleberry Bore. The Ilappa dolerite dykes (Edi) are also metamorphosed by this event, though their igneous texture is retained. The norite about 9 km east of Dneiper homestead is partly metamorphosed by the later event. It is probable that the later event also affected the granites: in these rocks mymerkite is very common, hornblende is partly converted to biotite, and sphene forms rims on ilmenite.

The outcrop of Cackleberry Metamorphics west of Frazer Creek contains co-existing cordierite and muscovite, and is therefore lower amphibole grade.

There are three possible interpretations of the superimposed events:-

(a) the older event is the regional metamorphism at 1780 m.y., which was followed by an event equivalent to the pegmatite-producing event in the Jervois Range area at circa 1660 m.y., or

(b) the older event is the regional metamorphism at 1780 m.y. The younger event is the event which reset the K-Ar dates circa 1450 m.y., or

(c) the older event is a pre-1800 m.y. event, and the younger event is the regional 1800 m.y. event, which caused greenschist metamorphism in Division 3 units which were then at a higher crustal level.

Relationships: The Cackleberry Metamorphics are intruded by the Marshall and Dneiper Granites and by the unnamed granites Ꝑgr, Ꝑgy, Ꝑgg, Ꝑgc, Ꝑgk, and Ꝑg. They are also intruded by dolerite, and by pegmatites. They are cut by quartz veins. Sediments of the Georgina Basin sequence unconformably overlie Cackleberry Metamorphics. The Ledan Schist probably overlies the Cackleberry Metamorhics, but the unconformity is not exposed.

Correlation and age: The Cackleberry Metamorphics are compositionally equivalent to the Delmore Metamorphics in ALCOOTA, but are at a higher metamorphic grade. The dominant rock types in the Delmore Metamorphics, calc-silicate rocks and fine-grained biotite-bearing pelitic gneiss, are both present in the Cackleberry Metamorphics. In particular, both units contain porphyroblastic calc-silicate rocks with a pseudo-amygdaloidal appearance. The Cackleberry Metamorphics are assigned to Division 2 of the Arunta Block, because of their predominantly sedimentary character.

The metamorphic age of the Cackleberry Metamorphics is presumed to be in the range 1750-1800 m.y. based on a correlation of metamorphic events. The age of deposition is unknown. No age determinations have been carried out on the unit.

Origins: The units that make up the Cackleberry Metamorphics are all metasedimentary with the exception of biotite-bearing quartzofeldpathic gneiss. Their general composition (as deduced from their mineral assemblages) is consistent with a near shore environment of deposition. The biotite quartzofeldspathic gneiss may be a tuff or a greywacke because of its composition and layered character.

Unnamed metamorphics in the Tower Rock area

Map symbol: p€t.
Distribution: South and southwest of Tower Rock (MACDONALD DOWNS). The unit may extend into the northeastern part of ALCOOTA. A small outcrop-area of quartzofeldspathic rocks about 6 km southwest of Tower Rock and the host rocks (garnet-sillimanite quartzofeldspathic gneiss) at the Delmore wolframite deposit (ALCOOTA) probably belong to this unit.
Reference area: Outcrops about 2 km west of Tower Rock.
Topographic expression and airphoto characteristics. The unit forms low ridges and hills. The metamorphics can be distinguished from adjacent Mount Swan Granite by its lighter photo-tone and its layered appearance.
Lithology: Well layered felsic granulite, quartzofeldspathic gneiss, quartz-sillimanite-biotite-cordierite rocks, very minor calc-silicate gneiss, and metadolerite.
The small area containing outcrops assigned to p€t in DNEIPER contains quartzofeldspathic gneiss and metadolerite.

The felsic granulite (80096560B) contains orthoclase ($Or_{90}Ab_{10}$) and antiperthite (host $An_{32}$, exsolved $Or_{90}$). Orthopyroxene (ferrohypersthene to eulite) has been partly replaced by hornblende, and both hornblende and orthopyroxene are partly replaced by biotite.

Finely layered quartzofeldspathic gneiss contains hornblende, opaque phases, and minor biotite as the ferromagnesian phases.

Cordierite-orthypyroxene and cordierite-bearing assemblages have been partly hydrated to biotite and biotite-sillimanite assemblages (80096566B, 6567A&B).

The calc-silicate rocks are fine-grained, thinly laminated rocks, containing diopside, calcic plagioclase, and quartz, and accessory orthopyroxene, sphene and apatite.

Metadolerite is very fine-grained, with a hornblende-orthopyroxene-clinopyroxene assemblage and a granulite texture. Large plagioclase crystals are zoned from less calcareous core to more calcareous rims.

The outcrops of p€t on DNEIPER are retrogressed to lower amphibolite grade, possibly because of their proximity to a major fault.
Structure: Gneissic layering is parallel to compositional layering.
Metamorphism: Granulite assemblages (Opx-orthoclase, Cpx-Opx-Plag, antiperthite) are present in the metamorphics near Tower Rock, but have been hydrated and partly retrogressed.

The metamorphics occur in fault blocks containing higher grade rocks than occur to the south and west of 9 Mile Bore and to the west in ALCOOTA.

Correlations and age: The metamorphics near Tower Rock are assigned to Division 2.

Although they contain some siliceous metasediments they are not composed of the very siliceous and very aluminous metasediments that are characteristic of Division 3.

Correlations with nearby units of Division 2 is difficult because of the different metamorphic grades:-

The Delny Metamorphics contain potassic metasediments and rare quartz-rich layers, but no cordierite-bearing or chlorite-bearing metasediments. It is considered unlikely therefore that the metamorphics near Tower Rock are correlates of the Delny Metamorphics.

The Delmore Metamorphics and the Cackleberry Metamorphics both contain cordierite-bearing metapelites but not extensive felsic units (except in the extreme east of the Cackleberry Metamorphics), and so are unlike p€t.

The age of the unit is unknown.

Mascotte Gneiss Complex

Map Symbol: p€m.

Nomenclature: New name; named after Mount Mascotte in northeastern JINKA at GR 877003 (Lat. 22°42.9'S; Long. 135°53.S'E). Represents the lower felsic part of the Bonya Metamorphic Complex of Warren in Stewart & others, 1980.

Distribution: Crops out -

(1) As low hills, east and northeast of Charlotte Bore.

(2) Between Mount Mascotte and Mount Thring, west of a downfaulted block of late Proterozoic sediments that passes near Charlotte Bore (abandoned) (Charlotte Fault Zone).

Possibly also crops out -

(3) One kilometre west of Bonya Hill.

(4) Three kilometres east of Twin Bore.

Type and reference section: The type section from Charlotte Bore (Lat. 22°45.7'S; Long. 136°20.3'E) east-northeast for about 3.5 km to the Bonya Schist boundary.

The reference area is centred on a point 4 km north-northwest of Mount Thring, and covers an area of about 16 sq. km.

<u>Topographic expression and airphoto characteristics</u>: The granitic rocks (granitoid, granitic gneiss, leucogranite and granite) commonly form blocky hills, which are locally craggy and have steep faces. In some areas these granitic rocks are exposed as tor-like rounded boulders.

Regions where quartzofeldspathic gneiss is dominant are characterised by low rounded hills which are pale-orange on aerial photographs. Fine, closely spaced trend-lines, evident on the aerial photographs, are due to compositional layering in the quartzofeldspathic gneiss. Closely spaced jointing is common in places. More resistant quartzose rock types in this terrain form narrow ridges whereas the more feldspathic varieties tend to break down to lower, rounded hills covered with angular eluvial fragments and soil.

A weathered and dissected peneplain is developed west of Charlotte Bore. It has a thin soil cover containing numerous angular pebbles of quartz and rock fragments.

<u>General lithology</u>: <u>Area 1</u> - Northeast of Charlotte Bore the quartzofeldspathic gneiss (f) is intercalated with small amounts of biotite gneiss (b), biotite schist (sb), hornblende gneiss (h), massive amphibolite (a), and layered amphibolite (pa) To the northwest and southeast the quartzofeldspathic passes into granitic gneiss. The gneiss in the northwest is contiguous with leucogranite.

<u>Area 2</u> - Southwest of Charlotte Bore the quartzofeldspathic gneiss (f) and the granitic gneiss (gg) (eg. 1537-8) are mixed with lenses of fine-grained foliated amphibolite (a) (e.g. 1520, spotted and migmatitic amphibolite (a), and layers of hornblende gneiss (h), biotite schist (sb) and, locally, fine-grained foliated quartzite (qt) (eg. 1543). Farther to the west, southwest and northwest the unit is made up of granitoid (gt), granitic gneiss (gg), and leucogranite (gl). Locally quartz veins are common and at FP 1041 tourmaline pegmatite veins are present. Near Mount Mascotte the dominant rock type is quartzofeldspathic gneiss.

<u>Area 3</u> - One kilometre west of Bonya Hill leucocratic granitic gneiss (gg) contains pods and layers of medium-grained amphibolite (a); some hornblende gneiss (h) is also present.

<u>Area 4</u> - 9 km north of Bonya Mine a small body of Mascotte Gneiss Complex is intruded by granite, Pgf, and is cut by tourmaline pegmatite and rare hornblende aplite. The Complex consists of coarse-grained biotite-muscovite granitic gneiss (gg), fine-grained amphibolite, and one bed of fine-grained, banded quartz-magnetite rock.

Distinguishing features: The Mascotte Gneiss Complex is characterised by rocks having a granitic or granoblastic texture, whereas the overlying Bonya Schist is typified by schistose textures. The quartzfeldspathic gneisses in the Bonya Schist are generally fine-grained and more micaceous than those in the Mascotte Gneiss Complex. The Bonya Schist also contains in excess of several percent of schist whereas there is very little schist in the Mascotte Gneiss Complex. the first thick (roughly 300 m) amphibolite unit in the southeast of the reference section marks the base of the Bonya Schist.

Detailed lithology:

Quartzofeldspathic granitoid (gt) forms a large mass 3.5 km west and northwest of Charlotte Bore, west of the fault zone containing cover rocks. It is generally massive, homogenous, medium-grained and has a distinctive granular texture in which subordinate, grey, quartz grains are disseminated in a yellowish feldspar-rich matrix. In places, the quartz grains appear to form augen. Mica is rare. The granitoid is foliated only locally (eg. FP 3413), and forms closely jointed blocky outcrops rather than granite-like tors. Similar rocks, farther south and about 7 km west of Charlotte Bore have a gneissic layering outlined greater or less quartz concentrations. A minor variant in the southern outcrop-area contains quartz augen in a fine-grained granular matrix.

The granitoid in the Mascotte Gneiss Complex superficially resembles the Marshall Granite, but differs from it (1) in containing abundant yellow ?plagioclase rather than pink K-feldspar (2) having a granular rather than graphic texture (3) containing grey rather than bluish-grey quartz (4) lacking hornblende (5) having a consistently low, rather than variable, magnetic susceptibility.

Granitic gneiss (gg) is widely distributed east, north and southeast of Charlotte Bore where it is accompanied by lenses of spotted and foliated amphibolite. It extends eastwards to the layered amphibolite at the base of the Bonya Schist. Compositional layering is evident due to the biotite content, which ranges from nil to 10 percent. The compositional layering occurs on the scale of 20-30 m down to several millimetres. Most of the gneiss is even-grained and medium to coarse-grained. The gneissic texture is outlined by elongate quartz lenticules and segregations of biotite. The gneiss mostly forms tors, but at the contact with the Bonya Schist it forms a prominent ridge and has a more calcic composition (?granodiorite). At one site (FP 1162) the gneiss has a marked foliation and kink folding is well-developed.

Leucogranite (gl) occurs in dykes both east and west of Charlotte Bore and alsoforms a large body about 5-6 km west of Charlotte Bore. It is generally medium-grained and contains no micas, but locally contains up to 3 percent opaque grains. The granite locally shows a foliation marked by elongation of quartz. Although in some cases the granite forms tor-like outcrops, many outcrops are more rugged.

Quartzofeldspathic gneiss (f) ranges from very fine to medium-grained, and forms bodies from 0.2 to 5 m wide. It generally contains negligible mafic minerals and only very rarely does the colour index reach about 10. Locally it contains a pegmatite portion. Medium-grained varieties have a more granitic appearance and their compositional layering is only evident on close inspection (e.g. FP 3392). Such rocks are transitional to granitic gneiss.

Higher in the section in the reference area the quartzofeldspathic gneiss becomes more foliated, has thinner compositional layering, and is more micaceous (biotite 3-5%). Northwest of Charlotte Bore, at FP 3183, quartzofeldspathic gneiss is markedly layered, very fine to fine-grained, contains 60 to 65 percent quartz as subrounded to subangular grains, and is cut by thin tourmaline and granite veins.

Biotite schist (sb) occurs along the western side of the northerly trending quartz vein north of Mount Thring (FPS 1538-41) as pod-like masses in granitic gneiss and leucogranite gneiss, and northeast of Charlotte Bore as layers up to several metres wide. Many of the schist pods appear to be aligned along a photo-lineament, and may have formed due to retrograde metamorphism related to faulting. Biotite schist also occurs in small amounts as thin intercalations in the quartzofeldspathic gneiss sequence.

Biotite gneiss (b). A rare rock type, locally accompanying biotite schist (eg. FP 3396).

Layered amphibolite (pa). Also is a minor rock type in the quartzofeldspathic gneiss sequence (FP 3395-98). It is typically thinly layered to flaggy and contains biotite. In places it grades into biotite schist.

Quartz amphibolite (pa). Fine-grained, even-grained and has high quartz content. It occurs within the leucogranite, schist and felsic gneisses west of the northerly trending ridge of vein quartz north of Mount Thring. The amphibolite commonly shows thin compositional layering, possible of migmatitic origin. Its texture is granular locally. One sample (1517B), examined petrographically, consists of hornblende, quartz and magnetite.

Spotted amphibolite (a). A moderately common rock type in the area. In some places it is strongly foliated and lenses of this rock are nearly always concordant with the foliation or layering in the surrounding felsic rocks. The 'spots' of feldspar are not always single megacrysts but augen made up of clusters of small crystals.

Quartzite (qt) is a very fine-grained, strongly foliated rock occurring at the southern end of the northerly trending quartz reefs (FP 1543, 1546).

Marble (ma) is exceptionally rare. It occurs at FP 3395 as a dark brown, impure, brecciated variety in a pegmatitic quartzofeldspathic gneiss. It may be a vein filling.

Metadolerite (dl) occurs as a raft within granitic gneiss west of Bonya Mine. It is intruded at its margin by the granitic gneiss suggesting that it is older than other dolerites in the area.

Minor rock types include hornblende gneiss (b), pematite (peg) and aplite (apl).

Structure: The quartzofeldspathic sequences are probably folded in all three outcrop-areas, but because of a lack of marker horizons the nature of the folding has not been elucidated. From regional and geophysical considerations it appears that the southern contact of the Mascotte Gneiss Complex is faulted in all three areas.

The gneiss complex has been faulted along NNW trends and near Charlotte Bore sediments have later collapsed into a fault-bounded trough trending in this direction. Faults also trend at 045° and 110°. Foliation strikes range from 000° to 110° (commonly 015 to 095°) and dips are commonly subvertical.

Metamorphism: All five masses of Mascotte Gneiss Complex appear to have been metamorphosed to the middle part of the amphibolite facies.

Relationships: The Mascotte Gneiss Complex is conformably overlain by the Bonya Schist. A transitional contact is indicated because both units have similar common rock types. The Complex is intruded by the Jinka Granite. It is an older part of the metamorphic terrain north of the Delny-Mount Sainthill Fault Zone and is localised along the Fault Zone in all three cases. The Complex is intruded by dolerite at FP 1151 and by a large elongate metamorphosed basic dyke at FP 1160. It is unconformably overlain by the Mount Cornish Formation and the Elyuah Formation in the Charlotte Fault Zone.

Correlation and age: Lithologically very like the Albarta Metamorphics in southwestern ILLOGWA CREEK (Shaw & others, 1982). Also shows some lithological similarities to the Cavenagh metamorphics in central eastern ALICE SPRINGS (Shaw & others, 1979).

Remarks: A sedimentary or volcanic origin is indicated for the quartzofeldspathic gneisses by (1) their good compositional layering and (2) their intercalation with pelitic biotite gneiss and schist.
Mineralisation: Veins of coarsely crystalline barite were found at localities 1539 and 1513 north and north-northwest of Mount Thring respectively. Hematite is associated with faults and quartz reefs and an assay of one sample (1534) gave 560 ppm Cu, 190 ppm Pb, 150 ppm Zn, 1.5 percent Fe and 12.9 percent manganese.

Unnamed metamorphics west of Molyhil Mine

Map symbol: p€s.
Nomenclature: Part of unit previously named Mount Sainthill Grit by Joklik (1955) and undivided Arunta Complex by Smith (1964).
Distribution: Belt 3 km west to 10 km west-northwest Molyhil Mine. Strongly foliated and lineated leucocratic granitic gneiss 4 km north of Marshall Bore is also tentatively assigned to the unit, as is the calc-silicate rock at Molyhil Mine.
Reference area: Six and a half kilometre northeast of Marshall Bore (FPS 3199-3200, 3323).
Topographic expression and airphoto characteristics: Forms main range, which includes Mount Sainthill, and the foothills to the north. Ridges and hills are smoothly rounded. Pale yellow to orange-brown on coloured airphotos. Foliation expressed as fine, closely spaced, trend-lines on airphotos.
Distinguishing features: Superficially like granite, but distinguished by fine-scale compositional layering and granular texture. Gneiss is locally cut by mobilisate, pegmatite and granite (e.g. FP 3323); such relationships help to distinguish the gneiss from deformed granite.
Lithology: Fine to medium-grained, even-grained quartzofeldspathic gneiss (f) of granitic appearance containing thin quartz-rich layers which are medium-bedded to flaggy. Biotite content is generally 5 per cent or less and rarely reaches 10 per cent. Specimen 80093323B, for example, is a slightly foliated, granular gneiss visually estimated to be composed of K-feldspar (45%), quartz (30%), plagioclase 20%) partly altered to sericite, and chlorite associated opaque grains (together 4%) and probably formed by alteration of biotite. Specimen 80093352 is a schistose, fine-grained, weakly layered quartzofeldspathic gneiss of similar composition 1.5 km east-southeast of Mount Sainthill.

TABLE 1: PHYSICAL PROPERTY MEASUREMENTS, MASCOTTE GNEISS COMPLEX.

| ROCK UNIT | ROCK TYPE | MAGNETIC SUSCEPTIBILITY $x10^{-5}$ SI units | | | SCINTILLOMETER READINGS (1 m above ground level) mR/hr | |
|---|---|---|---|---|---|---|
| | | RANGE | NO. OF READINGS | ARITHMETIC AVERAGE | RANGE | ARITHMETIC AVERAGE |
| Mascotte Gneiss Complex | Quartzofeldspathic granitoid gt | 60 to 125 | (8) | 85 | 0.020 to 0.056 | 0.032 |
| | Granitic gneiss gl | 60 to 750 | (11) | 290 | 0.0125 to 0.050 | 0.021 |
| | Leucogranite | below 60 | (4) | - | up to 0.06 in places | 0.020 |
| | Quartzofeldspathic gneiss f | seldom exceeds 10, one reading at 190 | (6) | 82 | 0.015 to 0.027 | 0.020 |
| | Biotite schist sb | up to 125 | (2) | 90 | | about 0.030 |
| | Layered amphibolite pa | 30-40, very rarely up to 400 | | | | |
| | Quartz-rich amphibolite pa | | (2) | about 4400 | | about 0.014 |
| | Spotted amphibolite a | rarely exceeds 125 | - | 0.006 to 0.025 | | 0.017 |
| | Quartzite qt | | (2) | 63 | | |

A small proportion of the quartzofeldspathic gneiss grades into biotite gneiss (b) (e.g. FP 3348), which is more schistose and is a deformed biotite gneiss visually estimated to consist of strained and polygonised quartz (30%), plagioclase (42%) partly altered to sericite, K-feldspar (10%), biotite (15%) and epidote (3%).

In the region of Mount Sainthill the quartzofeldspathic gneiss is deformed by a later deformation which has converted it into a phyllonitic to mylonitic quartzofeldspathic schist. This deformed portion is included in the retrograde schist zone, Pr. Specimen 80093202 at FP 3202 0.4 km west of Mount Sainthill is an example of such a quartzofeldspathic schist(sf).

Strongly foliated and lineated granitic gneiss (gg) 4 km north of Marshall Bore (FP 3028) has been described by Morgan (in Smith, 1964) as aplo-granite. Morgan's description of the granite (HA 34) is given below:

> "In thin section the texture is xenomorphic, mylonitic, and porphyroclastic. The microcl· (45%) and acid plagioclase (10%) porphyroclasts have a generally rounded shape, but in detail their margins are rough and angular. In the matrix feldspar forms small granulated grains. Quartz (40%) occurs as isolated granules, and large fine-grained aggregates that appear to be drawn out in a fairly well defined direction, and which are wrapped around feldspar porphroclasts. The individual grains within the aggregates show an elongation in a common direction at an angle of 20° and 30° to the elongation of the aggregates. It is very probable that the quartz aggregates are remnants of original coarse grains that have been granulated and drawn out to their present state. Muscovite and biotite (5%) occur as aggregates of small flakes drawn out into zones parallel to the elongation of the quartz aggregates."

The granite is very similar to the quartzofeldspathic gneiss described above but appears to be more uniform in composition.

The calc-silicate rock occurs west of Molyhil (FP 3199, 3323) and at Molyhil (FPs 354-6) and at (FP 3420-21) where it is intercalated with marble (ma). At FP 3323A it is a fine-grained, granular rock visually estimated to be composed of diopside (44%), quartz (40%), scapolite (15%), and traces of microcline, biotite, carbonate, sphene, clinopyroxene and accessory tourmaline. The calc-silicate rock near Molyhil Mine has a complex mineralogy including clinopyroxene, scapolite, garnet (andradite), calcite, blue-green amphibole, epidote and sphene.

Other minor rock types intercalated with the quartzofeldspathic gneiss include muscovite-biotite gneiss (s) at FP 3205 and quartz-rich metasediment (j) at FP 3025. The metasediment (80093025A) is a compositionally layered, granular rock consisting of feldspar, quartz and biotite.
Structure: Slightly foliated in northern part of outcrop-area. Converted into mylonitic rocks in southern part. The foliation in the deformed part dips 45° to 75° south and is accompanied by a down-dip lineation. Foliation trends in the northern part of the outcrop-area are more irregular. Southern margin of the unit is interpreted to be a reverse fault.
Relationships: Intruded by the Marshall Granite and small apophyses of granite (e.g. FP 3323). Structurally underlies the Kanandra Granulite and is separated from it by a major fault interpreted to be a reverse fault.
Correlation and age: Lithologically like the Mascotte Gneiss Complex, and unit p€c south of Mount Baldwin. Metamorphically, it is similar in grade to the Mascotte Gneiss Complex, but is a lower grade than unit p€c. No age determinations have been carried out on the unit.
Remarks: Smith (1964) considered that most, if not all, of the apparent sedimentary features in the unit mapped by Joklik (1955) as the Mount Sainthill Grit are of metamorphic origin. The present investigation indicates that many of the rounded grains which Joklik (1955) thought were of sedimentary origin are relic grains or aggregates of grains surrounded by a deformed and polygonised matrix. The original rocks are believed to be of metamorphic or igneous origin.

## Bonya Schist

Map Symbol: p€o.
Nomenclature: First named by Warren (1978) as the Bonya Sequence. Warren in Stewart & others (1980) revised name to Bonya Metamorphic Complex which included rocks now assigned by us to the Mascotte Gneiss Complex, described elsewhere in this record. The Bonya Schist now comprises only the upper, dominantly schistose part. Named after Bonya Creek which drains the main outcrop-area. It has been divided tentatively into six units (units A to F) including the Kings Legend Amphilobite (unit D) in its lower part (Fig. 3).
Distribution: Occurs throughout the Bonya Hills and east of the Jervois Range. Total outcrop-area is about 300 $km^2$; another 100 $km^2$ occurs east of the Jervois Mine under thin Cainozoic cover.

Reference Sections: The section for the lower part is along a major east-flowing tributary of Bonya Creek (GR 116822 to GR 165854). The section through the upper part is along a tributary of Bonya Creek near the Tashkent Prospect (GR 164882 to GR 218890).

Thickness: No accurate estimate is possible because of an uncertain amount of folding. In the Bonya Hills the thickness may be in the order of 5 to 7 km. An eastward thickening is indicated in the upper part because that portion exposed east of the Jervois Range may be considerably thicker than the same portion in the Bonya Hills.

Topographic expression and airphoto characteristics:

The several different physiographic expressions, which correspond to distinctive rock types, are described below.

(i) In the west the basal unit of amphibolite, coarse-grained schist and feldspathic quartzitic metasediment (termed Units A and B later in this description) forms low, rolling hills with a close-spaced dendritic drainage pattern.

(ii) Coarse-grained schist overlying these (Unit C) also forms rolling hills of low to moderate relief, but exposures are commonly made up of numerous boulders. The airphoto colour is characteristically dark brown.

(iii) Kings Legend Amphibolite Member (Unit D) forms relatively high ground with steep-sided rounded hills. Drainage off these hills is normal to the strike. The hills have a distinctive smoothly rounded appearance on the airphotos.

(iv) Overlying the Kings Legend Amphibolite Member is a sequence of schist (Unit E). The lowermost part forms low foothills to the amphibolite. The overlying rocks near Bonya Creek and covered by superficial sediment. In the Jervois Mine area these rocks form rugged hills. On the airphotos this unit consists of narrow, closely spaced strike-ridges.

(v) The uppermost unit of the Bonya Schist (Unit F) consists of schist and calc-silicate rock forming low to medium, rolling hills with a dendritic drainage pattern.

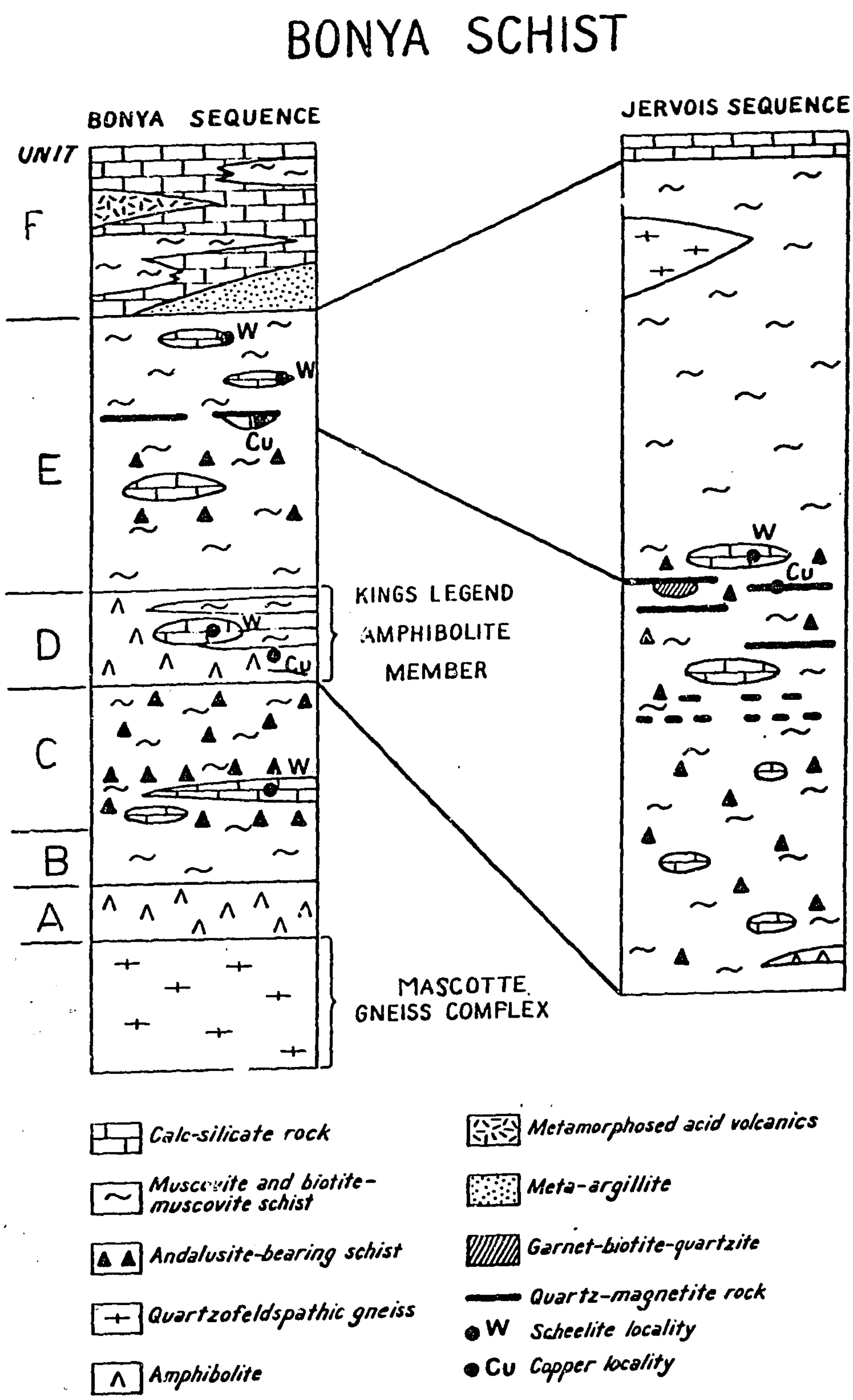



Figure 3 Diagrammatic stratigraphic sections, Bonya Schist.

General Lithology:

The dominant rock type is mica schist which includes muscovite schist (sm), two-mica schist (s), andalusite schist (x) and lesser amounts of biotite schist (sb). Massive amphibolite (a) and layered amphibolite (pa), hornblende gneiss (h), calc-silicate rock (cs), marble (ma), coarse-grained garnet-epidote-quartz rock, (sk), quartzite (qt), layered actinolite-K feldspar calc-silicate rock (ct), calcareous metapelite (ag) are less widespread. Minor rock types are acid volcanic ( ), layered quartz-hematite and quartz-magnetite rock (qf), cordierite schist (i), garnet schist (sv) garnet - biotite gneiss (v), feldspathic schist (sf), granitic gneiss (gg), and granitoid (gt).

A well developed sequence is recognised and is described below in detail from the base upwards. A composite summary of the units A to E is shown in Figure 2. The structure, metamorphism, relationships and age of the Bonya Schist is described immediately following the description of the sequence (i.e. Units A to F and undivided Schist).

Detailed description of informal and formal members:

UNIT A

The basal unit of the Bonya Schist is a homogeneous amphibolite (a) containing interlayers of layered amphibolite (pa). It extends from 5 km east-southeast of 3 km north of Charlottes Bore as a single layer up to 500 m wide. At its northern end the amphibolite is invaded by ubiquitous pegmatites. Pegmatite forming dykes and sills become predominant. The sparsely scattered outcrops of amphibolite are severely deformed and the northernmost limit of the unit appears to be faulted. The amphibolite conformably overlies the Mascotte Gneiss Complex with a sharp contact.

The homogeneous amphibolite is fine-grained and very mafic. A weak foliation is defined by a parallel mineral elongation. Feldspar occurs as grains generally up to 1 mm diameter and rarely up to 5 mm. The layered amphibolite contains equant to lenticular aggregates of fine-grained plagioclase ranging from 0.5 to 12 mm thick, spaced from 1 to 30 mm. Some contains up to 30% plagioclase as fine round grains disseminated throughout the rock. In places these are streaked out into laminae subparallel to the foliation (eg. field point 1077). Both the massive and layered amphibolite contain accessory epidote and clinopyroxene.

UNIT B

The unit characteristically contains fine-grained quartzofeldspathic rock (jf) and medium-grained hornblende gneiss (h). These rock types are interlayered with muscovite schist (sm) and biotite schist (sb). Rarer rock types are amphibolite, two-mica schist, layered calc-silicate rock, marble and coarse-grained epidote - quartz rock. Unit B occurs in two areas: one extends from 7.5 km southeast to 1 km southwest of the Bonya Mine and the second from 4 km west to 0.5 km east of the Bonya Mine. It rests on Unit A with a gradational contact up to 30 m wide (e.g. field point 1285, GR 082855). At this locality amphibolite, quartzofeldspathic gneiss and hornblende gneiss are intercalated.

Fine-grained quartzofeldspathic rock (if) containing feldspar laths, is pink or pink-grey and has a slight to prominent foliation. Specimen 1936A (GR 096854) is estimated to consist of quartz (40%) and K-feldspar (50%) both as fine granules about 0.5 mm in size and rare grains up to 1.2 mm with ragged boundaries. It also contains chlorite in a very fine-grained indeterminable matrix. At Bonya Mine migmatitic quartz-feldspar veins are present. A minor proportion of layers in this rock are very siliceous and contain less feldspar. Both muscovite and biotite occur in accessory proportions.

Hornblende gneiss (h) is a fine to medium-grained rock commonly with a characteristic segregation of hornblende and plagioclase-rich patches up to several cm long. Specimen 1035 (GR 096857) consists of green hornblende (40%), plagioclase (25%), andalusite (10%) quartz (10%) and traces of epidote, sphene, apatite and possibly biotite. It is a fine-grained rock in which the quartz and feldspar occur in one place as a lens about 5 mm long.

Muscovite schist (sm) is a highly-schistose, medium-grained rock, composed dominantly of muscovite with subordinate biotite, quartz and feldspar. Layers of muscovite schist up to 10 m wide occur in the unit between the fine-grained quartzofeldspathic rock and the hornblende gneiss. Contacts between these rock types are gradational.

Calc-silicate rock (cs), marble (ma) and coarse-grained epidote - quartz rock (sk) are a related suite of rocks. They occur distributed as irregular lenses up to 20 x 100 m in size, elongate parallel to the foliation. Calc-silicate rock is thinly-layered and consists of quartz, epidote, diopside and garnet. It is a fine to medium-grained rock with a distinct green colour. Marble is a white to light green, granoblastic diopside-epidote-calcite rock which is medium to coarse-grained. The coarse-grained epidote-quartz rock (sk) consists of an irregularly shaped patch of interlocking epidote and quartz grains up to several centimetres across. A broad range of other minerals occur in this rock type and include garnet, hornblende, diopside, clinozoisite, calcite, wollastonite, powellite, scheelite and chalcopyrite. Locally some of these minerals attain major proportions. This rock is texturally and mineralogically similar to a skarn, but this term is considered inappropriate because of its genetic connation.

Biotite schist (sb) is a minor rock type composed dominantly of medium to coarse-grained biotite and trace to accessory amounts of fine-grained quartz and feldspar.

Amphibolite (a) occurs as lenses up to 10 x 150m, elongate parallel to the foliation. Commonly it is fine-grained and even-textured although at field point 1079 (GR 125827) it contains megacrysts of feldspar up to 10 mm across. Some megacrysts have been highly tectonically elongated to form thin aggregates up to 1 mm thick and 20 cm long.

UNIT C

This unit is characterized by a variety of medium to coarse-grained schists. Outcrops are typically flaggy and very rocky. Schist types include muscovite schist (sm) and knotted (andalusite?) schist (x). Other rock types include calc-silicate rock (cs) and coarse-grained epidote - quartz rock (sk). Less important rock types include muscovite - biotite schist(s) and amphibolite(a). Two main outcrop-areas are recognised. One extends as a 100 m-thick layer from 7 km east-southeast of Charlotte Bore to 3 km northwest of Bonya Mine and a second extends 6 km northwest to 5 km north-northeast of the Bonya Mine Mine. The contact with the underlying quartzofeldspathic gneiss is very sharp at both field point 1080 (GR 128826) and near the White Violet Prospect (GR 096858). A 2m-thick layer of marble was observed between the units in some other places, for example over approximately 200 m from some 100 m south of field point 1080.

Muscovite schist (sm) is the dominant rock type in the northern outcrop-area, but is subordinant to the knotted andalusite schist in the southern outcrop-area. It is composed of medium-grained muscovite in grains up to 1 x 0.3 mmm (up to 60%), biotite in similar-sized grains (up to 20%), quartz as irregular grains up to 0.2 mm (up to 15%), and accessory amounts of fine-grained feldspar, andalusite, tourmaline and, at one site, ?hornblende. In some exposures there are noticeably more quartz-rich layers up to approximately 10 mm wide, and these define a compositional layering that may be primary bedding (e.g. at GR 079909, field point 1175).

The biotite is usually evenly distributed in the rock, but in some places, for example at field point 1236 (GR 112908), the biotite occurs as small lenticular aggregates parallel to the foliation.

Andalusite schist (x) is a medium to coarse-grained muscovite schist containing andalusite grains of variable size; subhedral megacrysts of andalusite are also present and are up to 20 x 10 mm. The proportion of andalusite varies gradually both along and across strike and this rock-type merges into muscovite schist. In places the andalusite schist occurs as pods or lenses roughly 50 m long and 5 m wide within the muscovite schist. Specimen 1028 (GR 117851) consists of muscovite (50%) as fine grains up to 0.2 mm long which are sub-parallel to the schistosity, biotite (25%) which is slightly coarser than the muscovite, quartz (15%) as irregular-shaped grains up to 0.15 mm diameter and rarely up to 0.5 mm, and megacrysts of andalusite (19%) up to 3 mm as randomly oriented grains containing some highly fractured zones. Specimen 1080 (GR 128825) consists of muscovite (55%) as grains up to 0.3 x 0.08 mm, and biotite (20%) up to 0.3 x 0.2 mm - both being thinly interlayered within each other, quartz (15%) as equant grains up to 0.2 mm, and andalusite (10%) as euhedral grains up to 1 mm containing a high proportion of very fine inclusions of ?quartz.

Calc-silicate rock (cs) and coarse-grained epidote-quartz rock (sk) occur in close association with each other and lesser amounts of marble (ma). They commonly form layers or lenses up to several metres wide. At field point 1982 (GR 133831) a sequence consists of dolomitic quartzite, poorly layered quartzite and metadolomite. Nearby, separating this unit from Unit B, is a lens of marble, approximately 200 x 1.5 m, which consists of disseminated fine to medium clinopyroxene grains embedded in calcite. At the Ultra Violet Prospect, scheelite occurs disseminated in a coarse-grained epidote-quartz rock. This rock is highly heterogeneous consisting of irregular patches and lenses of quartz and epidote together with lesser amounts of garnet, amphibole, clinopyroxene as well as the amounts of scheelite.

UNIT D - Kings Legend Amphibolite Member.

The Kings Legend Amphibolite Member (Unit D) is a fine to medium-grained amphibolite which characteristically contains aggregates of feldspar. It occurs as three bodies; one extends from 7 km southeast to 5 km north of Charlottes Bore, the second extends from 7.5 km north to 11 km northeast of Charlottes Bore; and the third outlines a steeply northwest-plunging syncline extending from 12 km northwest of Charlottes Bore. The name 'Kings Legend Amphibolite' originated in Company reports and is derived from the Kings Legend Copper Mine located at GR 143808. The maximum thickness of the unit is 900 m. The basal contact with the lower schist unit (C) is sharp. In the south the amphibolite rests on a calc-silicate bed. The upper contact is commonly obscured by soil as the overlying unit weathers readily. The unit is lenticular. At both the northern limit of the southern outcrop-area and the eastern limit of the northeastern outcrop-area possibly continuity of the unit cannot be established because it becomes progressively more deformed and foliated.

Amphibolite (a) is a fine to medium-grained, hornblende-rich amphibolite containing up to 30 per cent plagioclase as coarse to very coarse aggregates as well as individual crystals which produce the diagnostic spotty appearance of the rock. Aggregates are commonly equant and individual plagioclase crystals abut or are separated by a very thin veneers of ?hornblende. The crystals in the aggregates as well as single crystals commonly display simple twinning. Specimen (1144 (GR JINKA 015925), consists of calcic plagioclase (55%) as fine (up to 0.5 mm) grains and rare grains up to 3 mm, blue-green hornblende (35%) as randomly oriented laths up to 0.5 x 0.1 mm, and opaque grains (10%) as very fine inclusions in the plagioclase and hornblende as well as disseminated euhedra up to 0.5 mm. The hornblende and plagioclase contain fine oriented needles of ?epidote. Very locally this rock contains traces of pyrite and chalcopyrite. One specimen of this rock (1145), analyzed by AAS, contains 0.2% Cu. Several small copper prospects occur within the Kings Legend Amphibolite Member. Specimen 1023 (GR 124855) consists of two types of plagioclase, one, comprising 30%, as fine laths up to 1 x 0.5 mm as matrix and the second comprising 20%, as megacrysts and up to 10 mm across and megacrystlike aggregates of up to about six grains, hornblende (5%) as relics in the cores of originally larger grains, and chlorite (40%) derived from alteration of the hornblende. In addition the rock contains traces of opaque grains and scarce fine-grained garnet. At locality 1143 (GR 015930) quartz occurs as rounded coarse grains, and feldspar aggregates are absent.

Coarse-grained epidote - quartz rock (sk) is a coarse to very coarse-grained rock composed primarily of quartz and epidote together with garnet, hornblende, clinopyroxene, calcite and rare traces of scheelite and chalcopyrite. Malachite veneers occur on fracture surface. At field point 1163 (GR 09100) a one metre wide banded quartz-magnetite rock grades into an epidote - quartz rock over 20 m wide. An extensive outcrop of a very coarse-grained garnet - quartz rock caps a prominent hill at field point 1172 (GR 072906). A massive plug of coarse to very coarse-grained quartz-hematite rock occurs at field point 1129 (GR 134837).

Biotite schist (sb) forms elongate, commonly discordant, zones which are too small to be mapped. They are deeply weathered. No specimens were collected for sectioning, but it is thought they may contain abundant chlorite and may possibly be derived from retrograde metamorphism of the amphibolite.

UNIT E

This unit outcrops poorly and is composed dominantly of schist. It occurs in the Bonya Hills in two outcrop-areas (1) from 2 km southeast to 10 km north northwest of Bonya Bore and to 10 km northwest of Charlotte Bore and (2) in the Jervois area east of the Jervois Range from 7 km south to 7 km east of the Jervois Mine. It is a fine to medium-grained muscovite schist, some of which contains either biotite or fine knots of ?andalusite. The unit also contains beds of epidote-quartzite rock layered quartz-magnetite rock, and lenses of calc-silicate rock, coarse-grained epidote-quartz rock, feldspathic schist, and amphibolite.

In the Bonya Hills this unit is about 1000 m thick and possibly up to 500 m thick in the Jervois region, but the latter thickness may be grossly overestimated because structural repetition is suspected.

The contact with the underlying Kings Legend Amphibolite Member is commonly obscured by soil, but near the Ashmara Prospect (GR 115895) the contact is very sharp. From about 3 km northwest of the Bonya Mine Unit E adjoins Unit C. At field point 1147 (GR 034906) this contact is very sharp and no structural reason for the absence of UNIT D is apparent. Several thin layers of a black, very fine-grained chert-like rock are parallel to the folded contact and suggest stratigraphic conformity between the units.

The schist east of the Jervois Range is lithologically correlated with the Unit E schist because both are dominantly fine to medium-grained muscovite schists intercalated with calc-silicate, amphibolite, and layered magnetite - quartz rocks. Both are overlain by rocks typical of Unit F.

Schist (s, sm) is the dominant rock type. Differentiation between muscovite schist (sm) and biotite-muscovite schist (s) is commonly difficult because the biotite is not readily recognised when highly weathered. It is a fine-grained schist, generally homogeneous, but locally contains psammitic bands, some of which display relict sedimentary feature (e.g. at field point 1154, GR 045905). Compositional layering up to several metres across and extending for hundreds of metres is evident on airphotos, but the variation in rock types between some of these layers is very subtle. Much of the variation evident on the airphotos appears to be a minor change in the proportion of quartz plus feldspar to micas. Micas constitute from 50 to 100 percent of the rock; the remainder being quartz and/or feldspar. Near the Jervois Mine garnet, cordierite and ?andalusite occur. Tourmaline concentrations are common in this area and also in the Bonya area. Sample 1184 (GR 045907) consist of parallel-oriented muscovite, (55%), quartz (25%), as very fine interlocking grains, opaque grains (10%) chlorite (8%) as a vein or concentrated, fine to medium-grained even-textured schist. Sample 1189 A (GR 132850) consists of muscovite (60%) up to 0.4 mm long, quartz (20%) as dispersed very fine (0.1 mm) grains and as scattered grains up to 11 mm, biotite (10%) as megacrysts up to 1.5 cm, garnet (5%) as zoned megacrysts containing many inclusions in the core and largely devoid of inclusions in their rims, fine-grained opaque grains, and a trace of tourmaline. Garnet is a common accessory or minor component near Jervois Mine. Sample 1208 (GR 303928) is a staurolite-garnet-biotite-muscovite schist.

Andalusite schist (x) occurs throughout the unit as layers or zones within the mica schist. It is a fine to coarse-grained rock, commonly highly schistose, with medium to very coarse-grained knots of andalusite or cordierite, many of which have been pseudomorphed by mica. The knots constitute up to 10 percent of the rock. Muscovite and biotite are the dominant constituents and occur together with fine-grained quartz and feldspar, and traces of tourmaline, epidote and opaque grains. Sample 1211 (GR 297935) consists of muscovite (55%), quartz (20%), biotite (10%), and opaque grains together forming (10%) as a fine-grained schistose matrix containing up to 10 percent megacrysts of cordierite, now largely replaced by very fine-grained ?muscovite. The pseudomorphs contain sub-circular fine opaque inclusions. Traces of tourmaline and apatite occur in the matrix. Sample 1460C (GR 300943) consists of quartz (20%), feldspar (5%) muscovite (25%) biotite (10%), opaque grains (10%) and chlorite (5%). Also there are aggregates consisting of a mosaic of very fine-grained quartz and mica.

Calc-silicate rock (cs) is a well to poorly-layered epidote - quartz rock which contains feldspar, calcite, amphiboles, clinopyroxene, garnet and traces of fluorite, malachite and scheelite. The layering ranges from a few millimetres to a metre in width. Grainsizes range from fine to very coarse; locally altered patches occur where grains are up to 150 mm across. In the northern Jervois Mine region at GR 349991 (field point 1296) a hornblende-epidote-feldspar-quartz calc-silicate rock is intruded by fine silt-like granitic layers at intervals of 5 to 20 cm wide. They are a migmatitic granitoid containing clinopyroxene.

Immediately north of the Jervois Mine at GR 303954 a calc-silicate rock (specimen 1189 c) consists of epidote (50%) up to 10 mm in diameter, coarse-grained quartz (30%), and garnet. The garnet and patches of very fine grained ?chlorite (5%) occurs (1) as disseminated fine grains, (2) as coarse enhedra containing quartz cores. It is a well-crystallized rock which contains poorly defined layering. Traces of malachite and scheelite occur in outcrop at GR 303954.

Epidote-bearing and biotite-bearing quartzites (qt) occur totgether with the calc-silicate rocks. A zone some 1000-2000 m above the main mineralized zone in the Jervois Mine region contains epidote-bearing quartzite layers over a strike length of 12 km. Weak scheelite occurrences are localised in or near the quartzite layers. Specimen 1374 (GR 310972) from one of these scheelite occurrences consists of quartz (45%) as interlocking network of grains less than 0.3 mm, and epidote (30%), chlorite (10%), magnetite (5%), garnet (5%) and traces of zircon and apatite. Twenty metres along strike this rock type changes into a magnetite-rich quartzite. At field point 1021 (GR 129855) the rock consists of intricately-folded, thinly interlayered epidote-quartz calc-silicate rock and calcite-marble.

Coarse-grained epidote-quartz rock (sk) is a coarse to very coarse-grained rock which is non to poorly-layered. It contains a very broad range of minerals including garnet, calcite, zoisite, clinozoisite, amphiboles, clinopyroxene, feldspar, fluorite, vesuvianite, as well as economically important scheelite and powellite. The rock has been prospected or mined at about ten localities for its scheelite content. In the Bonya Hills region the rock type (sk) forms a basal discontinuous layer. At GR 277903 three plugs of vesuvianite occur, with the largest being 20 m in diameter. These are monomineralic rocks (Warren, 1980).

Marble (ma) accompanies calc-silicate rock and seldom occurs in isolation. It is composed dominantly of calcite with accessory to minor amounts of clinopyroxene and garnet. Marble commonly forms thin interlayers in the calc-silicate rocks. At field point 1402 (GR 338988) marble occurs as an isolated outcrop, 50 m in diameter. It contains euhedra of brown garnet up to 20 mm in diameter, as well as ?wollastonite and talc.

Quartz - magnetite and quartz - hematite rocks (qf) (commonly termed banded iron formation or BIF) occur extensively in this rock unit. These occur as layers from a few mm to several metres wide. The rocks are fine-grained and are commonly composed of quartz, magnetite (or its weathered equivalent) and traces of epidote, garnet and apatite. They appear to grade in outcrop from quartz - magnetite rock, through magnetite-bearing schist to mica schist. Specimen 1460C from the Jervois Mine consists of quartz (35%), opaque grains (30%) (as both magnetite and minor pyrite and/or chalcopyrite), muscovite (10%), biotite (8%), plagioclase (trace), garnet (trace) and epidote (5%). Garnet and epidote occur as megacrysts in a fine-grained matrix.

This rock type is important since it contains much of the mineralization at the Jervois Mine. There it is associated with mica schist, andalusite schist, calc-silicate rock, and coarse-grained, calcite-garnet-epidote-quartz rock.

Amphibolite (a) occurs as layers, commonly less than 5 m wide, throughout Unit E particularly in the lower part of the sequence near the Jervois Mine. Amphibolite layers occur within the schist and are generally concordant to the foliation and the compositional layering. The amphibolites are almost all fine-grained and consist of hornblende and plagioclase together with trace to accessory amounts of epidote, quartz and clinopyroxene.

At field point 1429 (GR 307885) a one-metre wide amphibolite dyke cuts the compositional layering at 90°, and is strongly foliated parallel to the schistosity in the enclosing schist. A specimen from the dyke consists of hornblende (30%) chlorite (25%), opaque (20%), plagioclase (5%) grains in a very fine-grained matrix (10%) consisting of ?hornblende and ?epidote. The maximum grain-size of the matrix is 0.3 mm.

Feldspathic schist and quartzofeldspathic gneiss (sf, f) occur only northeast of the Jervois Mine. Leucocratic, fine to medium-grained, schistose gneiss grades into gneissic schist which is homogenous and pink. Locally the gneiss is quartzitic and contains possible poorly preserved cross-bedding which if confirmed would suggest an eastward-younging sequence. At GR 349992 (1295) the gneiss can be recognized to be a well-laminated feldspathic quartzitic metasediment containing darker laminae of a hornblende-bearing quartzofeldspathic rock. Immediately to the west the gneiss grades into a quartz-rich calc-silicate rock, comprising a clinopyroxene-hornblende-epidote-feldspar-quartz assemblage. In this region the rock is intruded by small (1 to 30 cm wide) granitoid dykes and sills and there are small regions of migmatite.

North and northwest of this locality for some 2 km migmatitic (?lit-par-lit) quartzofeldspathic gneiss occurs. The gneissic portion of these rocks have a granular texture and are only faintly foliated. It is thought that these migmatites were produced by injection of considerable granitic or pegmatitic material into the sequence consisting of quartzofeldspathic gneiss - feldspathic schist - calc-silicate rock rather than being produced by local melting. These quartzofeldspathic rocks are indicated on the map as granitoid (gt) and the veining as granodiorite (gd).

Hornblende gneiss (h) is a minor rock type in Unit E and occurs mainly east and north of the Jervois Mine where layers up to 1 m wide occur within calc-silicate rock and quartzofeldspathic gneiss. It is a medium-grained rock consisting of hornblende (5-10%), quartz (10-30%), and feldspar (30-50%), along with epidote and ?clinopyroxene.

UNIT F

This is the uppermost - recognized unit of the Bonya Schist. It exhibits some significant changes in rock-type along strike. Unit F extends as a belt from 2 km south to 10 km north of the Bonya Bore. A single body of the same rock type occurs adjacent to Unca Hill (GR 395899). Distinguishing rock types in the unit are a laminated, K-feldspar-actinolite calc-silicate rock and a dark grey very fine-grained calcareous metapelite.

It also contains other calc-silicate rocks, schist, amphibolite, quartzite and a meta-acid volcanic.

The boundary Unit E and Unit F is gradational in the northern part of the outcrop-area. In the southern part, near Bonya Bore, there is a very sharp contact between the two units. The top of the Unit F is not exposed and the northern limit is fault-bounded.

Actinolite - K-feldspar calc-silicate rock (ct) characteristically is a well- and evenly-layered and laminated rock in which acicular to prismatic actinolite grains are disseminated in a white K-feldspar matrix. The layering is defined by variations in the proportion and grain size of these components. Specimen 1310 C (GR 146876) is composed of quartz (30%), clinozoisite (25%), K-feldspar (15%), actinolite (15%), plagioclase (5%), and traces of muscovite, tourmaline, sphene, ?apatite, and ?clinopyroxene. A lamination is outlined by alternating clinozoisite - plagioclase and actinolite - K-feldspar - quartz layers.

Calcareous meta-pelite (ag) is a very fine to fine-grained, even-textured rock which is homogeneous and very dark on fresh surfaces. Fine octahedra of magnetite are disseminated in the rock and it has a phyllitic parting. Weathered surfaces show a compositional layering in which the more calcareous layers are more deeply etched than other portions: this layering is on a millimetre to centimetre scale. Thin laminae of ?epidote parallel to the foliation are commonly discordant to the compositional layering. This rock (ag) is distinguished from fine-grained schists by the presence of magnetite octahedra, by the trace calcareous component, and by the very weak schistosity. Specimen 1065 (GR 158839) consists of very fine-grained biotite (40%), and very fine-grained quartz and feldspar (55% total) and traces of both rhombic-shaped and lath-shaped opaque grains, tourmaline and epidote. Specimen 1228 (GR 183840) consists of quartz plus feldspar (20%), biotite (20%), chlorite (15%), carbonate (35%), amphibole (?) (5%) and trace amounts of epidote and tourmaline. All components are fine to very fine-grained. The carbonate grains enclose large numbers of other mineral grains. The weak schistosity is outlined by poorly aligned mica grains.

Two-mica schist (s) is the dominant rock type within Unit F. The schist is a fine to medium-grained rock. Faint compositional layering is common and is caused by differences in the proportions of micas relative to quartz and feldspar. In the southern part of its outcrop-area, this schist is very fine-grained and locally is phyllitic. Its ease of weathering results in it commonly occurring in soil-covered flats or shallowly-sloping hillsides. Fine garnets occur in the schist at field points 1723-1730 (GR 170850).

Andalusite schist (x) occurs as a variant of the two - mica schist which contains fine to medium-grained megacrysts of andalusite. These contain large proportions of very fine mica either as sieve-textured grains or completely recrystallized and retrogressed pseudomorphs after andalusite.

Amphibolite (a) commonly is a fine to medium-grained rock which forms lenses up to several metres across or occurs as continuous layers up to 50 m thick. One extensive layer is hornblende-rich and contains conspicuous, finely disseminated grains of calcite (?) and pyrite (field point 1224, GR 173842). This hornblende-rich layer is a marker unit and outlines a number of fold structures.

Quartzite (qt) is a minor rock type, which is also a very useful marker unit. In the lower half of the unit a 100 m wide zone contains several layers of quartzite which are almost pure quartz rocks. These have a medium-grain size. Minor minerals present include epidote, feldspar and rare hornblende. They are interlayered with schist. At field point 1320 (GR 175882) bedding is well preserved. Several 0.2 to 2 m wide layers show cross-beds which young eastwards. It is considered reasonable to extrapolate this younging direction across the whole sequence because it appears to be a single sequences of metasediment.

Meta-acid volcanic rock (ɣ) occurs as a continuous layer up to 100 m wide in the stratigraphically middle part of Unit F. At the northern end this rock type forms a layer up 2 km wide, but this thickening may be a structural feature due to the proximity of a synformal axis. The acid volcanic rock is made up to a very fine-grained, slightly schistose matrix in which medium to coarse-grained quartz and feldspar grains are embedded. The quartz is blue and opalescent and has irregular angular outlines. The feldspar occurs mainly as medium, commonly angular grains, and also as subordinate coarse grains which are subcircular. One doubly-terminated quartz crystal is recognised in specimen 1229 (GR 185841). In the northern part, at field point 1450 (GR 182892), the metavolcanic contains fine grains of purple fluorite. In the southern part of its outcrop-area at field point 1309 (GR 179823), lenses of calc-metapelitic rock occur near the base of the metavolcanic layer and some of these show flame-like structures.

## UNDIVIDED BONYA SCHIST

Undivided Bonya Schist outcrops in the northern Bonya Hills consist of coarse-grained garnet-biotite schistose gneiss and amphibolite (GR 175910) bodies up to 100 x 20 m in size. These are separated from each other and the remaining Bonya Schist by alluvium. No lithological correlations can be drawn between these and other parts of the Bonya Schist. Near field point 1265 (GR 145964) schist, calc-silicate rock and amphibolite are unassigned because they cannot be related to the well defined sequence. Finally, schists north of the Zanten Copper Prospect (GR 119912) are unassigned because they may correlate with either of the stratigraphic units A, B or C.

They are also lithologically different from the Kings Legend Amphibolite Member. There is an area between these outcrops where the units become progressively more deformed and intruded by an increasing abundance of pegmatites until they are unrecognizable. These outcrops are also surrounded by an extensive alluvial cover thus adding to the problem. Some unusual rock types occur in this region of unassigned schists. At field point 1262 (GR 148961) there are several plugs or pods of coarse-grained chlorite rock, and at field point 1353 (GR 137934) a hornblende gneiss, composed of quartz, feldspar and hornblende, contains up to 15 percent magnetite as rounded megacrysts up to 15 mm in diameter.

Structure of the Bonya Schist:

The Units A to F of the Bonya Schist outline a number of major structures. In the south in the region of Bonya Bore there is a simple, steeply east-dipping, east-younging sequence. Northwestwards a doubly-plugging synform is outlined. Its northwest end plunges steeply to the northwest. At the eastern end two synformal axial-traces occur, offset in an en echelon fashion, but with no evidence of an intermediate synform. There is a large amount of very complex minor folding in many places within the Bonya Schist. Most of these folds have a very steep to vertical plunge as have those of the major folds.

Near the Jervois Mine, the "J-fold" is considered to be a steeply north-plunging synform. The sequence in the Jervois area is made up of Unit E schist overlain to the east by Unit F. Here Unit F contains actinolite - K feldspar calc-silicate rock and younging to the east as confirmed by cross-beds in the Bonya Hills at field point 1399 (GR 340992) and possible cross-beds and scour-and-fill structure in quartzite from Unit F support this younging direction.

East of the Jervois Mine the schistosity is axial-plane to isoclinal folded compositional layering. Throughout the "J-fold" the schistosity is gently folded and the crenulation cleavage is axial-plane to this gentle folding. The formed prior to the major "J-fold". No small-scale structures which could be correlated with this major folding event were detected three and possibly four during the present survey. It is considered that at least three deformational events have affected the Bonya Schist east of the Jervois Range.

Faults limit the Bonya Schist outcrops to the east. These faults are extensive northerly-trending quartz-filled zones up to 100 m wide. Recurrent movement along these faults is indicated by an earlier phase of quartz infilling which was subsequently brecciated and resilicified. These faults have also affected the Adelaidean and Palaeozoic Georgina Basin sedimentary rocks.

In the north of the Bonya Hills, three quartz-filled faults within the basement rocks are defracted to become strike faults within the cover rocks.

Metamorphism:

Both outcrop-areas of Bonya Schist are made up of rocks metamorphosed to the lower amphibolite faies. The common occurrence of andalusite along with minor occurrences of garnet and cordierite support this classification. Locally gneissic rocks occur which support this or a higher metamorphic grade. Adjacent to the Bonya Copper Mine sillimanite-bearing schist occurs associated with migmatite which indicates middle to upper amphibolite facies. Dobos (1978, unpublished) from a detailed study of metamorphic assemblages estimated conditions to have been 520-600°C, 2-3 kbars for the Bonya - Jervois area.

Retrograde metamorphism has occurred locally. Adjacent to and north of Bonya Bore, the schist is very fine grained, and has a phyllitic texture, possible suggesting a region of lower grade metamorphism. In both Unit C and in Unit E east of the Jervois Range, many of the andalusite megacrysts has been retrogressed to fine-grained muscovite.

Relationships:

The Bonya Schist apparently overlies the Mascotte Gneiss Complex with a gradational contact. This contact is problematical because the Mascotte Gneiss Complex rocks are overlain by successively younger units of the Bonya Schist in a northwest direction. Complex small-scale folding along the contact confuses the picture. It could be interpreted that the Bonya Schist onlaps onto a basement consisting of Mascotte Gneiss Complex rocks, but this would require a sharp non-gradational contact. East of Bonya Bore and east of Twins Bore the Bonya Schists are separated from Mascotte Gneiss Complex rocks by interpreted faults.

North of Jervois Mine the Bonya Schist grades into gneissic rocks. This change may be caused by injection of quartzofeldpathic material. It is, however, possible, though considered unlikely, that the gneissic rocks represent an inlier of Mascotte Gneiss Complex and are separated from the Bonya Schist rocks by a fault.

Many different types of igneous rocks have intruded the Bonya Schist. Widespread pegmatite intrusion throughout the Bonya is accompanied by the introduction of quartz-tourmaline (schorl) rock. Field relations at field point 1251 (GR JINKA 011949) indicate that an early phase of schorl-rock forming a discordant-like dyke structure, was itself intruded and partly assimilated by pegmatite. Within and adjacent to the schorl rock, the pegmatite contains considerable tourmaline, but not at a distance of a metre away from the schorl rock. The pegmatite occurs as both dykes and sills, and, immediately west of the Samarkand Scheelite Prospect, as a plug.

A biotite - hornblende granodiorite plug intrudes the Bonya Schist at field point 1264 (GR 149962). West of this site are extensive plugs of a foliated muscovite granite. In the Bonya Schist at field point 1347 (GR 221868) is a large plug of silicified leucogranite, the Zanten Granite.

North of the Jervois Mine is a triangular-shaped plug of the foliated muscovite-bearing Unca Granite.

The Jervois Granite is considered to have intruded the Bonya Schist south of the Jervois Mine, but relationships are concealed. The Jervois Granite contains large xenoliths of the actinolite - K-feldspar calc-silicate rock typical of Unit F of the Bonya Schist.

Northeast of the Jervois Mine a number of metagabbro plugs of the Attutra Metagabbro intrude the Bonya Schist. They range from 20 m in diameter up to 2 x 0.5 km and are discordant to the foliation and compositional layering in the Schist. At field point 1294 (GR 35995) the contact between the Metagabbro and the Schist is sharp, and the Metagabbro is conspicuously coarse-grained.

Metadolerite plugs and dykes are common throughout the Bonya Schist, ranging in size from 10 m in diameter up to 1 x 0.2 km. They have a large variation in composition and grain size. Most appear to have simple and sharp contacts with the enclosing schist. However at field point 1146 (GR 029915) a plug of fine-grained dolerite has intruded marble of Unit E and there is a reaction zone some 20 m wide between the two rock types. This is described in detail elsewhere.

<u>Age:</u>

The Bonya Schist is intruded by granites which have yielded ages of about 1775 m.y. (Black, 1980) and is older than this age.

<u>Remarks:</u>

The whole sequence is thought to be derived from metamorphism of a succession of pelitic and calcareous sediments, and basic volcanics. The two prominent amphibolites in the lower part are thought to represent basic extrusives; both containing plagioclase megacrysts which may have been derived from a cumulophyric volcanic. Unit B contains siliceous feldspathic, fine-grained rocks which include laths of feldspar and quartz. Unit E contains a similar rock which includes terminated quartz crystals. Both of these are thought to be derived from acid crystal or lithic tuffaceous rocks.

Mineralization:

Mineralization occurring in the Bonya Schist includes (1) copper - silver - lead - zinc - bismuth mineralization associated with banded ironstone -bearing schist and calcareous rocks as at the Jervois Mine, (2) copper mineralization as disseminated chalcopyrite in the Kings Legend Amphibolite Member, and (3) tungsten - copper mineralization in coarse-grained quartz - epidote rock.

DIVISION 3

Division 3 units consist of well-sorted quartz-rich metasediments, some pelites and, outside the Sheet area, acid porphyries. The Ledan Schist and Utopia Quartzite belong to Division 3. In adjacent ALCOOTA these two units unconformably overlie Division 2 rocks (Shaw & Warren, 1975; Shaw & others, 1975). Contacts between Division 3 and Division 2 rocks in HUCKITTA are not exposed. Unit pCq in southern JERVOIS RANGE is tentatively assigned to Division 3 because it is lithologically similar to the Ledan Schists and Utopia Quartzite.

Ledan Schist (Shaw & Warren, 1975)

Map Symbol: Pln.

Nomenclature: Named from Ledan Peak in ALCOOTA

Distribution: 14 km west and 14 km south of 14 Mile Bore, and about 4 km east southeast of Dneiper homestead.

Reference area: Shaw & Warren (1975) did not nominate a reference area. However, the best exposures of Ledan Schist are about 6 km west of Western Watering Point in ALCOOTA

Topographic expression and airphoto characteristics: The quartz-rich layers of the Ledan Schists form sharp ridges. This pattern of ridges is distinctive on air-photographs.

Lithology: The Ledan Schist consists mainly of biotite-muscovite-quartz schists with variable proportions of muscovite and quartz. Tourmaline is a characteristic accessory mineral (as in 80096555B). Deformed conglomerates which are a minor but characteristic component of the sequence in the reference area, are present in the outcrops east southeast of Dneiper homestead.

Metamorphism: The Ledan Schist is generally at lower amphibolite facies.

Relationships: In ALCOOTA Ledan Schist unconformably overlies Delmore Metamorphics, is conformably overlain by Utopia Quartzite, and is intruded by granite. The Mount Swan Granite may intrude the Ledan Schist but the contact was not found in ALCOOTA, and the two are exposed in separate fault blocks in HUCKITTA. Graded-bedding in the conglomerates of the Ledan Schist east-southeast of Dneiper homestead shows that the Utopia Quartzite there is also stratigraphically above the Ledan Schist.

Correlations and age: The Ledan Schist and Utopia Quartzite are equated with the Hatches Creek Group in the Davenport Range and the Reynolds Range Group in NAPPERBY. Both these Groups contain felsic volcanics (acid porphyries) which do not occur with the Ledan Schist and Utopia Quartzite.

The Ledan Schist and Utopia Quartzite are inferred to have been metamorphosed at 1750-1800 m.y. However, the only direct evidence of age is a 1532 ± 35 m.y. K-Ar age on muscovite schists in ALCOOTA (Webb, 1972).

Utopia Quartzite (Shaw & Warren, 1975)

May Symbol: Ꝑlu

Nomenclature: From Utopia Pastrol Holding (ALCOOTA)

Distribution: Forms a ridge extending from immediately south of Dneiper homestead about 5 km to the east-southeast, and in isolated ridges southeast from this main ridge.

Reference area: Shaw & Warren (1975) did not nominate a reference area, but the best exposures are in the syncline about 5 km south-southeast of Ledan Peak Bore in ALCOOTA.

Topographic expression and airphoto characteristics: The Utopia Quartzite forms sharp ridges. As the main outcrop-area in DNEIPER is in a partly dissected remanent of the Tertiary siliceous weathering surface, the characteric ridges occur only in limited areas in the dissected slopes of mesas.

On airphotos the Utopia Quartzite is generally lighter and forms broader and smoother ridges than the Ledan Schist.

Lithology: The Utopia Quartzite consists of metamorphosed quartz-rich rocks with accessory muscovite and tourmaline. In DNEIPER the Quartzite is a light grey rock. Muscovite occurs mainly in trace amounts on bedding planes, but there are minor micaeous quartzites and muscovite schists.

Structure: The main outcrop south of Dneiper-forms a tightly folded upright syncline. Foliation is parallel to compositional layering (bedding) and is folded. Outcrops in the axial zone of the fold are lineated.

Metamorphism: Lower amphibolite grade. (Biotite-muscovite assemblages occur in adjacent Ledan Schist.)

Relationships: Overlies Ledan Schist conformably or disconformably. Overlain by Tertiary units and probably by the Georgina Basin sequence. Intruded by pegmatites.

Correlations and age: The Utopia Quartzite is part of Division 3 and is considered to be amongst the youngest units in the Arunta Block. No age determinations have been made on the Utopia Quartzite.

Unnamed schist and quartzite near Jervois homestead

Symbol: p€q.

Distribution: North-northwest from Jervois homestead, Jervois Range.

Topographic expression and airphoto characteristics: A discontinuous quartzite ridge and poorly outcropping schists to the south. Quartzite is pale grey on black and white airphotos.

Reference area: Three kilometres northwest of Jervois homestead.

Lithology: Muscovite quartzite (qt) overlies and muscovite-biotite and muscovite schists (s, sm) intercalated with a small amount of quartzite. The main quartzite is muscovite-bearing, medium to fine-grained, and flaggy (FPS 3110, 1630, 1631, 4018). Most contains up to 90 percent quartz, but some is feldspathic. The schists grade into medium to coarse-grained biotite gneiss (b). Some of the schist and quartzites intercalated with the schist contain small amounts of tourmaline. A typical schist (76096041, FP 4016) is composed of K-feldspar, oligoclase, biotite, muscovite, quartz and accessory apatite. Garnet-sillimanite-bearing assemblages occur in equivalent rocks 2 km southeast of Thring Bore. (FPS 4019, 4020).

Metamorphism: Lower amphibolite facies.

Relationships: Structurally underlies undivided metamorphics $pC^3$ (Fig. 2) to the north. The relationship with the surrounding units is obscured by Cainozoic cover.

Correlation and age: The quartzites and schist are lithologically similar to the combined sequence made up of the Ledan Schist and Utopia Quartzite. The tourmaline content which is a characteristic of these units is also present in pCq. An alternative correlative is the quartzite and schist in the undivided Harts Range Group to the south in ILLOGWA CREEK. No age determinations have been carried out on unit pCq.

## DISCRIPTIVE NOTES ON INTRUSIVE UNITS (Fig. 4)

The Proterozoic granites are grouped into (1) formally named bodies such as the Dneiper, Jervois, Jinka, Marshall, Mount Swan, Unca and Xanten Granites; (2) unnamed informal granites e.g. Pga which are described in alphabetical order; and (3) small isolated granite bodies of uncertain affinity mapped as Pg.

Some of the granites may be metamorphosed. This particularly applies to the Dneiper Granite and Ꝑgg. In many granites biotite partly replaces hornblende, which itself may be a metamorphic mineral.

Intrusive basic rocks are classified as either metamorphosed (e.g. Ꝑd) or as unmetamorphosed or partly metamorphosed, (named from their original rock type e.g. dolerite, Ꝑdi, or norite, Ꝑgb).

The late-stage Oorabra Reefs which are closely associated with the Jinka Granite are described separately, but are not assigned to a rock unit on the compilation sheets. The Harts Range pegmatites may be of Palaeozoic age and are described separately from the rocks of the Harts Range Group, with which they are spatially associated. They are also unlabelled on the compilation sheets.

GRANITES

## Named granites

Dneiper Granite (Smith, 1964)

Map Symbol: Ꝑgd.

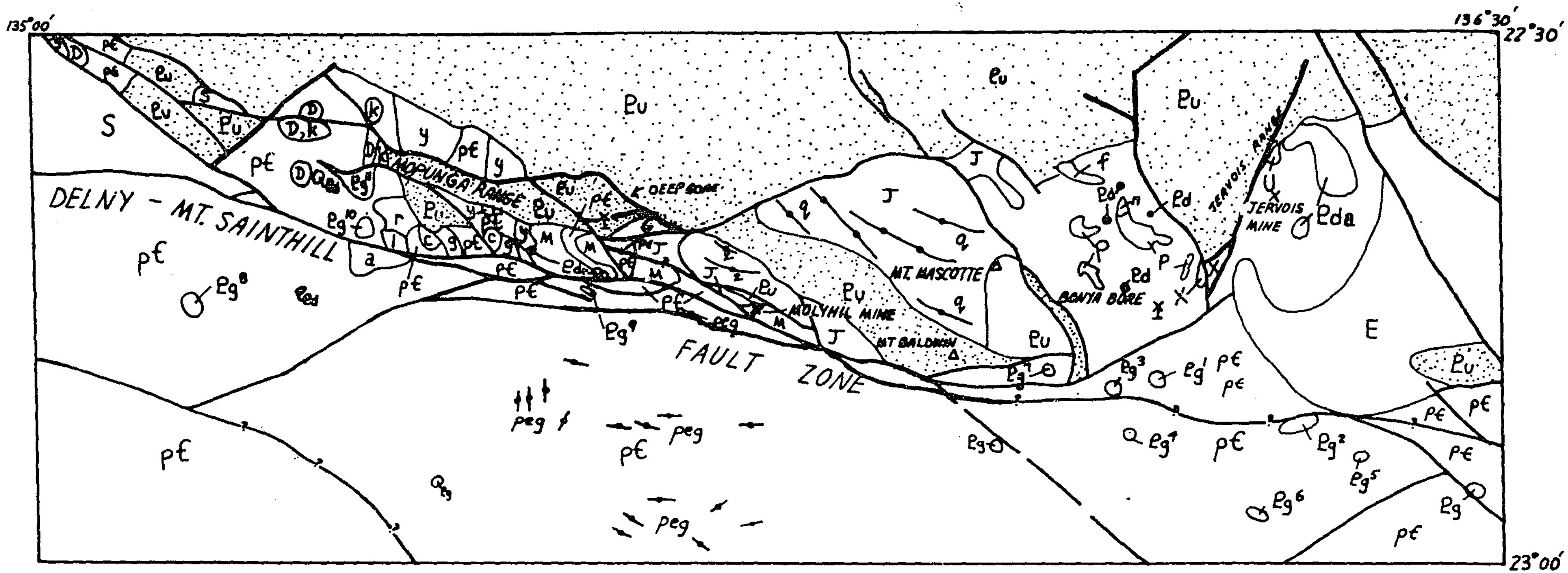
Nomenclature: The Dneiper Granite as defined by Smith (1964) extended from Dneiper homestead eastwards as far as Yam Creek Dam. This area contains several granites of very different types, and the term is now restricted to one of these granites: a distinctive grey biotite-rich hornblende-bearing gneissic granite.

Distribution: The Dneiper Granite extends westward from the western end of the Mopunga Range almost as far as the Bundey River west of Tower Rock. It may extend into ALCOOTA in the area north of the Bundey River, as part of the undivided granite Pg in that area.

Reference area: About 9 kms east of Dneiper homestead, immediately south of the disused track to No. 4 Dam.

Topographic expression and airphoto characteristics: The Dneiper Granite crops out as scattered boulders and rare tors separated by soil. The Granite is very difficult to delineate by photo-interpretation. Larger outcrops are dark toned, similar to adjacent outcrops of the biotite-rich gneisses of the Cackleberry Metamorphics, and soil covered outcrops with boulders of the granite are very like similar areas of other units.

Figure 4




0 10 20 30 km

| | |
|---|---|
| Bu | GEORGINA BASIN SEQUENCE |
| q | OORABRA REEFS - Brecciated hydrothermal quartz veins |
| peg | HARTS RANGE PEGMATITES - zoned or partly zoned pegmatites |
| dl | Dolerite, gabbro |
| Pdi | ILLAPPA DOLERITE DYKES |
| P | SAMARKAND PEGMATITE - pegmatite |
| Bg | Granite, granitic gneiss |
| Bg1 | Granite, leucogranite |
| Bg2 | Granite, granitic gneiss |
| Bg3 | Granite |
| Bg4 | Granite |
| Bg5 | Granite |
| Bg6 | Granite |
| Bg7 | Leucogranite |
| Bg8 | Adamellite strongly foliated |
| Bg9 | Porphyritic hornblende granite, augen gneiss |
| Bg10 | Porphyritic biotite granite |
| Bg11 | Gneissic granite |
| a | Garnet-bearing granite and adamellite |
| c | Granite - adomellite |
| D | DNEIPER GRANITE - Biotite and some hornblende granite, strongly foliated |
| E | JERVOIS GRANITE - Granite, leucogranite, granodiorite |
| f | Muscovite leucogranite, foliated and tourmaline-bearing |
| g | Biotite gneissic granite |
| J | JINKA GRANITE - Granite, adamellite-granodiorite, porphyritic granite, leucogranitic |
| k | Porphyritic biotite granite |
| l | Leucogranite |
| M | MARSHALL GRANITE - Hornblende granite, leucogranite, aplite |
| n | Biotite and hornblende, granodiorite, tonalite |
| r | Biotite granite |
| y | Biotile granite |
| S | MOUNT SWAN GRANITE - Porphyritic biotite-hornblende granite |
| U | UNCA GRANITE - Leucogranite, very weakly foliated |
| X | XANTEN GRANITE - Leucogranite, silicified |
| y | Biotite granite-adamellite, hornblende-biotite granite, porphyritic granite |
| Bdr | Diorite, gabbro, norite |
| Bd | Dolerite gabbro, partly metamorphosed gabbro |
| Bgb | Gabbroic and noritic intrusive rocks |
| Bp | Metamorphosed ultrabasic rock |
| Bda | ATTUTRA METAGABBRO - Altered gabbro and dolerite |
| pЄ | Undivided metamorphic rock |

Lithology: The Dneiper Granite is a grey granite containing abundant biotite, translucent or white potassium feldspar, white plagioclase, and, in some places, hornblende. The proportion of quartz is low for granite. The well developed foliation and strong (local) lineation may be metamorphic. If this is so, the Dneiper Granite should be classified as an orthogneiss.

The Dneiper Granite almost always contains small xenoliths, commonly fine-grained, biotite-rich rocks, but also calc-silicate rock and quartzite.

Structure: The foliation in the Dneiper Granite generally is parallel to that in adjacent Cackleberry Metamorphics (p€v). Outcrops west of Frazer Creek show a prominent lineation also reflected in the elongate shape of individual boulders.

Metamorphism: The granite is severely deformed adjacent to major faults. Widespread conversion of hornblende to biotite, plagioclase to white phyllosilicate, and myrmekite are probably equivalent to the second episode of metamorphism in the Cackleberry Metamorphics. The strong foliation may be an early metamorphic foliation.

Relationships: The Dneiper Granite intrudes Cackleberry Metamorphics and is itself intruded by several unnamed granites (Pgk, Pg. s.l.) The Dneiper Granite may be intruded by the Mount Swan Granite, and by dolerite and gabbro. It is considered to be older than the Ledan Schists and Utopia Quartzite, mainly because the retrogression in the Dneiper Granite and Cackleberry Metamorphics is the same facies as the prograde metamorphism in the Ledan Schist and Utopia Quartzite. Contacts between the Ledan Schist are either faulted, or are covered by Quaternary units.

Correlations and age: The Dneiper Granite may include the grey gneissic granite Pgg which crops out between Yam Creek Dam and the Mopunga Range. In the field the two were mapped separately because of differences in ferromagnesian minerals, and proportions of minerals. Detailed petrology shows that these differences may be partly ascribed to the less retrogressed nature of the Dneiper Granite, which contains hornblende. Geochemical study is required to determine whether the two granites are closely related.

The Dneiper Granite is very similar to the Copia and Crooked Hole Granites in ALCOOTA, and like these granites is considered to have been emplaced as a syntectonic granite. No age determinations have been carried out on any of these granites.

Jervois Granite

Map Symbol: Pge.

Nomenclature: Named by Smith (1964) after Jervois Range. Although the Jervois Granite resembles the Jinka Granite, Smith proposed a separate name because the two masses are not continuous in outcrop. Probably contains a large number of smaller granites of differing composition rather than one large granite.

Distribution: Crops out as isolated hills in an extensive area in the southeast corner of the Sheet area, n th of Bonya Creek and east of Unca Hill.

Reference localities: Outcrops of granodiorite occur 5 km northeast of Bonya Hill (FPS 3178-90), 7 km east-southeast of Unca Hill (FPS 2524-5) and 3.5 km north-northeast of Mount Cornish (FP 2517). The granite typical of the central and southern part of the Jervois Granite, is commonly deeply weathered and, for this reason, has no good reference localities.

Topographic expression and airphoto characteristics: Forms small isolated hills separated by extensive plains. In the central and southern parts of the outcrop-area these peaks are rounded and extensively weathered, but in some cases fresh granite crops out at their base. In the north the peaks form tors. The granite is cut by pegmatite and quartz veins and breccia zones, which are spacially associated with the Jervois Granite and form conspicuous ridges or low ridges surrounded by quartz scree. Mainly covered by thin stoney soils developed on a gently undulating plain.

General lithology: Medium-grained biotite granite (g) and leucogranite (gl) is extensive in the central part of the batholith. Fine and medium-grained biotite granodiorite (gd) is more common in the northern part of the outcrop-area. Most of the rocks are even-grained and massive or very slightly foliated. Coarser-grained variants of granite containing potassium-feldspar phenocrysts occur at several relatively restricted localities. Muscovite granite, recorded as the main rock type by Smith (1964), is rare. The batholith is cut by numerous quartz veins which have commonly been introduced alongside or within breccia zones occupied by earlier pegmatite or aplitic pegmatite dykes.

Detailed lithology:

Leucocratic granite (gl) and granite (g) (e.g. FPS 2323, 3163) are generally biotite-bearing and only very rarely contain muscovite (e.g. FPS 3164, 3168). Although commonly medium-grained, this variant locally contains pegmatite phases (e.g. FPS 3164, 3167), some of which are tourmaline and muscovite-bearing.

Granite and adamellite (g) are typically coarse and even-grained (e.g. FPS 2516-23, 2525) and are locally accompanied by slightly to moderately porphyritic varieties (e.g. GPS 2511, 2514, 2520, 2524). Such porphyritic variants are common north of Mount Cornish.

Granodiorite (gd) is the most abundant rock type in the northern part of the batholith. It ranges from fine to medium-grained and is generally even-grained. In places it contains numerous xenoliths and is locally slightly foliated but is more generally massive.

Metamorphic rocks (s, a) forming roof pendants or rafts within the Jervois Granite are rare and not as numerous as reported by Smith (1964). Two-mica schist (s) occurs at FP 3154 west of Mount Cornish and amphibolite (a) showing relict igneous plagioclase laths occurs at FP 2572, east of Unca Hill.

Late-stage dykes and breccis zones are widespread and are confined to the outcrop-area of the batholith. Breccia zones interlaced with quartz veins appear to be localised alongside dykes of muscovite and tourmaline-bearing pegmatite (FP 3169) or aplitic pegmatite (FP 3164), or alongside very leucocratic phases of granite with a graphic-like texture (e.g. FP 3169). In places brown cryptocrystalline quartz, containing brecciated earlier white quartz fragments, is cut by later thin white quartz veins (FP 3166). Such late-stage quartz veins rarely contain specular hematite (FP 3169). Such breccia-dyke zones have steep, nearly vertical dips and strike east-northeast and north-northwest.

Structure: The granite is mostly massive. A retrograde schist zone cuts the southern part of the batholith just north of Marshall Bar.

Relationships: The Jervois Granite is a composite body consisting of a variety of granites, each of which may form small individual plutons. It intrudes the Bonya Schist and probably the unnamed metamorphics, pЄ, which crop out south of Bonya Creek. It is cut by numerous pegmatite and some aplitic veins which are generally brecciated and into which quartz veins have been introduced. A east-striking schist-zone cuts the southern part of the batholith near the Marshall River.

Correlation and age: The Jervois Granite is lithologically very similar to the Jinka Granite. A potassium-argon date of 1420 m.y. has been obtained (Hurley & others, 1961) from granite within the Jervois Batholith 7 km east-southeast of Unca Hill (F 53/11/1 on 1964 geological map). Black (1980) obtained an Rb/Sr total rock age of 1808 ± 80 m.y. (initial ration = 0.698 ± 0.006 model 2 isochron with MSWD of 3.3) for samples from six sites (72090546-51) 10 km south of Jervois Camp.

Remarks: The initial ratio (0.698 ± 0.006) is extremely low for a rock of this age and suggests that it is an I-type granite (Chappell & White, 1974) and, as pointed out by Black (1980), "the initial ratio is so low that it precludes any but the briefest crustal history for the granite precursor." Based on the low initial ratio Black (1980) favoured an age around 1750 m.y. (i.e. the later part of the age bracket).

Jinka Granite

Map symbol: Egj.

Nomenclature: Joklik (1955, p. 33) named and described the Jinka Granite.

Distribution: Underlies the Jinka Plain and also extends west of the Elyuah Range. Rare outcrops of granite south of the Elyuah Range are also assigned to the Jinka Granite.

Type area: Joklik did not nominate a type area but describes a reference specimen (R4772) from 3 km east of Grant Bluff. A good reference locality is 3 km south-southeast of Jinka Springs where there is a variation in granite types and where age determination specimen F/53/11/12 was collected (i.e. FPS 3196, 3519-3521).

Topographic expression and airphoto characteristics: Crops out poorly. Generally covered with Cainozoic eluvium. Forms a few scattered hills some with steep boulder-covered slopes and is also exposed in several gullies particularly those also cutting the prominent quartz reefs in the region. The close correlation between the very flat Jinka Plain and the granite suggest that the granite is easily eroded. The more prominent hills appear to be formed of slightly more basic variants of the granite. Those few hills containing exposed granite have pale yellow-brown photo-pattern and a blocky appearance due to the numerous joints. The Plain is traversed by prominent anastomosing quartz reefs. Moderately close, branching drainage pattern.

General lithology: Mainly an even-grained biotite granite which is rich in K-feldspar and contains scattered phenocrysts of simply twinned feldspar. A subordinate amount of adamellite or granodiorite is present. Both the granite and granodiorite are characterised by a lack of xenoliths. Locally, the granite contains an aplitic (K-feldspar rich) pegmatite phase which grades in places into quartz-rich central portions.

Detailed lithology:

Granite (g): An even-grained, mainly medium-grained granite containing minor apple-green plagioclase, very pink K-feldspar, and 0 to 10 percent biotite. The biotite is slightly aligned. In addition, the granite commonly contains 1 to 2 percent muscovite, which tends to occur in slightly larger flaks than the biotite. Joklik's reference specimen (R4772) consists of microcline (40%), quartz (30%), plagioclase (20%), biotite (10%) and accessory magnetite and apatite (Joklik, 1955, p. 33). Brown (1971) has described a granite (0770074) from the southern part of the outcrop-area containing quartz (44%) as anhedral grains 0.15 to 3.0 mm across, microcline (29%), biotite (9%), oligoclase (7%) as grains 0.5 to 20 mm across, magnetite (6%) as grains 0.15 to 1.0 mm across, muscovite (3%), and accessory zircon, tourmaline and apatite (together 2%). Some microcline crystals are microperthitic and others contain rounded quartz grains. The biotite is an intensely pleochroic variety. In many places the granite contains scattered phenocrysts of simply twinned K-feldspar. Locally phenocrysts are more abundant forming a coarse-grained rock which generally has a low to negligible biotite content (gp).

Adamellite-granodiorite (gd): Fine to medium-grained and commonly porphyritic. Less commonly even-grained. The biotite and K-feldspar phenocrysts in the rock show some degree of alignment. An example is FP 2407 from 7 km north of Mount Baldwin. It has an even-grained, hypidiomorphic texture, a grain size of 1-3 mm, and is visually estimated to consist of plagioclase (35%) partly altered to sericite, microcline (35%), biotite showing some alteration to chlorite (13%), a trace of muscovite and accessory Fe-Ti oxides.

Xenoliths: These are remarkably rare. A few have been recorded near the granite margin near the Marshall River (Yam Creek on 1964 1:250 000 geological and topographic maps).

Structure: Generally massive, where foliated, biotite and K-feldspar phenocrysts are aligned easterly and the dip is steep to vertical.

Relationships: The Jinka Granite intrudes a possible extension of the Mascotte Gneiss Complex north of Mount Sainthill, which Joklik (1955) referred to as the Sainthill Grit. The Oorabra Arkose, the Elyuah Formation, and the Grant Bluff Formation to the north all rest on an eroded surface of the Granite. The Jinka Granite is cut by, and is spacially close to, the Oorabra Reefs. However, these reefs also cut units of the basal Georgina Basin sequence and are younger at least in part.

Age and correlation: The age by the K-Ar method is 1440 m.y. (Hurley & ohers, 1961). Wilson & others (1960) used the Rb-Sr method on the same specimen and obtained an age of about 1785 m.y. on muscovite (recalculated by Black (1980) after applying a 3 percent correction for known systematic bias in the Rb determination). Riley (in Compston & Arriens, 1968) derived an age of 1990 m.y. based on concordant total-rock, microcline, biotite and muscovite data. Black (1980) obtained a 1812 ± 85 m.y. age (initial ratio = 0.700 ± 0.003) from foliated hornblende-biotite granodiorite (72090541) and biotite granite (72090542) from two sites north-northwest of Bonya Bore which Black regarded as part of the Jinka Granite. This was a model 2 isochron (using regression model of McIntyre & others, 1966) with MSWD of 34. Black found mineral ages from the same rocks are significantly younger. A biotite-plagioclase pair from 72090561 yields an age of 1485 m.y. which is indistinguishable from that derived from a model 1 isochron for plagioclase, total-rock, K-feldspar and biotite fractions from 79090542 (1479 ± 23 m.y.; initial ratio = 0.731 ± 0.001). A widespread thermal event is indicated at about 1485 m.y.

The Jinka Granite is lithologically very similar to the Jervois Granite which yielded a 1808 ± 80 m.y. age (initial ratio = 0.698 ± 0.006) using similar methods (Black, 1980).

Remarks: The initial $^{87}Sr/^{86}Sr$ ratios are particularly low and indicate that the granites from the Bonya area are I-granites (Chappell & White, 1974).

Marshall Granite

Map Symbol: Pgm.

Nomenclature: Named from the Marshall River (Smith, 1964)

Distribution: Crops out from west of the Marshall River, to east of Yam Creek Dam, north of the Delny-Mount Sainthill Fault, and is overlain on the north by the basal units of the Georgina Basin. Outcrops of leucogranite 5.5 km north-northeast of Marshall Bore and immediately east of Molyhil Mine are also tentatively assigned to the Marshall Granite.

Reference area: Outcrops 4 kms east-northeast of Yam Creek Dam. Smith (1964) did not nominate a reference section.

Topographic expression and airphoto characteristics: The Marshall Granite crops out in steep-sided hills capped by partly silicified rock (late Tertiary surface) and covered by spinifex, and in tors and granite sheets left as relics during dissection of the late Tertiary land surface (cf. Holmes, 1965; Fig. 449).

These two landforms give two distinct types of airphoto expressions.

(1) The silicified hills are massive pink units; and

(2) the dissected areas are brown, with well-defined, incised drainage, and brown bouldery terrains.

General lithology: The Marshall Granite is a pink, slightly gneissic granite. Outcrops generally have a blocky appearance because of well-developed jointing. Most of the granite is a metamorphosed hornblende granite, containing pink potassium feldspar, blue quartz, cream (or, in some places, pale green) plagioclase, and dark brown hornblende. Potassium feldspar is greatly in excess of plagioclase. Along the eastern edge of the area of outcrop a leucocratic phase (gl), consisting of pink feldspar and blue quartz, is present. Aplite or microgranite dykes (apl) are common throughout the area of outcrop. Pegmatites and quartz veins, carrying large angular grains of magnetite, are common.

Detailed lithology: Speciman 80096586 from the type locality contains cloudy microcline, altered plagioclase, quartz, amphibole (hastingsite to ferro pargasite), hydrobiotite, chlorite, opaque phases and sphene.

Ha 38, described by Morgan (1959), and collected from the leucocratic phase, consists of microcline (60 percent) quartz (35 percent) and plagioclase (5 percent). Morgan (1959) described perthitic intergrowths, which are probably myrmekite, and microcline is partly altered to white mica. The accessory minerals are sphene and apatite.

Specimen 76096036, collected from the hornblende-bearing phase about 3 km south of Deep Bore, consists of perthitic microcline, quartz, hornblende partly altered to biotite, zircon and opaque minerals.

The specimen from the reference area, northeast of Yam Creek Dam has a higher ferromagnesian content than 76096036, and in general the proportion of ferromagnesian minerals is higher in specimens collected from the southern and western outcrop areas, than in those from the northern and eastern outcrop areas.

The Marshall Granite is essentially a hornblende granite, but some alteration of hornblende to biotite is visible in all thin sections. Chloritization of biotite is also present in some specimens.

The Marshall Granite is petrologically a granite in that the ratio of potassium feldspar to plagioclase is more than 2:1.

Structure: The fabric of the Marshall Granite ranges from gneissic to massive. A second gneissic fabric is developed adjacent to the Mount Sainthill Fault and other faults. The early gneissic fabric is considered to be primary flow banding. The aplite dykes show no preferred orientation and lack a gneissic fabric.

Metamorphism: Retrogressive metamorphism adjacent to major faults has produced muscovite (as in Specimen Ha 38 described by Morgan, 1959). Epidote is present on joint faces in some outcrops. The pale green colour of plagioclase is due to alteration to fine-grained phyllosilicates.

Relationships: The Marshall Granite intrudes the Deep Bore Metamorphics (p€e), the Cackleberry Metamorphics (p€v), and quartz-norite (Pdr). It is intruded by a plug of diorite (Pdr) and overlain by the basal unit of the Georgina Basin sequence.

Correlation and age: The Marshall Granite is one of the suite of granites that intrude the Arunta Block north of the Delny-Mount Sainthill Fault. It is considered to be among the younger granites in the area. No isotopic age data are available for the granite.

Mount Swan Granite

Map Symbol: Pgs.

Nomenclature: Named from Mount Swan pastoral holding (Smith, 1964).

Distribution: Crops out northwest of Mount Swan homestead as far north as the Bundey River. Extends west into ALCOOTA.

Type areas: (1) For pink phase, about 2 km east of Tower Rock (adjacent to age determination locality of Hurley & others, 1960) and (2) For grey-brown phase area, tors adjacent to main road at 22°32', 135°00'E.

Topographic expression and airphoto characteristics: Forms prominent tors and granite sheets. Soil covered open rolling downs occur between tors. Airphoto expression is that of a typical granite:- well-jointed grey bouldery outcrops within open grassland areas.

General lithology: Coarse-grained, porphyritic, biotite-hornblende granite containing large subhedral potassium feldspar crystals, and brown quartz. Potassium feldspar is greatly in excess of plagioclase. Muscovite is only present in the granite alongside major faults.

Detailed lithology:

1. Outcrops near Tower Rock (Northern reference area).

In the northern part of its outcrop-area the Mount Swan Granite is a pink porphyritic granite, medium to coarse-grained, phenocrysts of orthoclase are oval to subhedral, commonly 5 cms long, and in some outcrops to 10 cms. Quartz in hand specimen is amber-brown. The groundmass consists of orthoclase, plagioclase, quartz, hornblende (partly altered to biotite) with accessory ilmenite, magnetite, apatite, zircon and allanite. Microprobe analyses (80096581) showed that plagioclase is $An_{30}$, and the hornblende tends to be ferro-pargasite. Both the biotite and hornblende have appreciable chlorine contents (Chlorine in hornblende to 1.47 weight percent, in biotite to 1.01 weight percent).

2. Outcrops 6 km east of Elco Dam (Southern reference area).

In the southern outcrop-area the Mount Swan Granite contain scattered rounded orthoclase phenocrysts to about 4 cms across in a ground mass of orthoclase, green or white plagioclase (oligoclase) quartz, hornblende and minor biotite. Myrmekite occurs in orthoclase, and hornblende is partly replaced by biotite.

An even grained granite on the southeastern edge of the outcrop area, is mapped as a non-porphyritic phase of the Mount Swan Granite.

Structure: The granite has a poorly developed gneissic fabric shown mainly by a slight tendency to preferred orientation amongst the orthoclase phenocrysts. The elongate shape of large joint blocks is also due to the slight gneissic fabric.

A schistose fabric is superimposed in granite close to major faults.

Metamorphism: The hydration of hornblende to biotite and the formation of myrmekite may represent a separate metamorphic event, or may be deuteric alteration.

Relationships: The Mount Swan Granite intrudes Kanandra Granulite and metamorphics at Tower Rock (i.e. Division 1 and 2). Shaw & Warren (1975) considered it probably also intruded Division 3 units, but the contact is not exposed in either ALCOOTA or HUCKITTA.

Correlation and age: The Mount Swan Granite is younger than Division 1 and Division 2 units, and is probably younger than Division 3. It is considered to be younger than the Dneiper Granite (q.v.) because it lacks the strongly gneissic lineated fabric of the latter.

Hurley & others (1961) obtained a K-Ar age of 1470 m.y. (corrected for revised decay constants) on material collected near Tower Rock. It is considered probable that the Rb-Sr age would be in the range 1700-1800 m.y., similar to the age of the Jervois and Tinka Granites (Black, 1980).

Unca Granite

Map Symbol: Ꝑgu.

Nomenclature: New name derived from Unca Creek in JERVOIS RANGE.

Distribution: Main outcrop-area is a triangular outcrop covering about 1.3 $km^2$, 5 km north of Jervois Mine.

Reference locality: at southern end of the main outcrop at FP 1457 (age sampling site 72090543) GR JERVOIS RANGE 318989.

Topographic expression and airphoto characteristics: Low boulder strewn hills and some smooth elongate exposures and tors. The granite has a weathered crust up to 10 cm thick. A prominent jointing paralleling a weak north-northeast foliation has produced a linear micro-drainage pattern. A prominent north-trending joint set is also evident. The airphoto colour is orange-pink.

General lithology: Homogeneous, pink-orange, weakly foliated, leucocratic granite (gl).

Detailed lithology: Sample 80091457 from the reference locality described by Farrand (1981) is composed of quartz (40%) in aggregates up to 5 mm diameter made up of grains 1.5 mm across, microcline (25%) occurring as both corroded, subhedral perthitic grains up to 2.5 mm long and in a fine-grained mosaic, plagioclase (20%) muscovite (5%) and biotite (7%) closely crystallised together in ragged aggregates, chlorite (2%) altered from biotite, and opaque grains (trace) concentrated in or near the micas. Farrand (1981) suggests that the quartz may have been introduced into the rock after the crystallisation of feldspar.

Black (1980) following Dobos (1978), and Farrand (1981) suggested alaskite as an alternative name for this rock. We prefer the more general term 'granite' following the nomenclature of Streckeisen (1976) who considers alaskite to be a leucocratic type of alkali granite which should contain alkali amphiboles or pyroxenes.

Structure and metamorphism: Undeformed granite with a slight north-northwest-trending foliation. Slight alteration of plagioclase to very fine white mica may be due to a later retrograde metamorphism.

Relationships: Intrudes Bonya Schist. Cut locally by narrow quartz and pegmatite veins. Probably is nonconformably overlain by the Elyuah Formation, although the contact is obscured by colluvium and scree.

Age: An isochron made up of both mineral and multiple total-rock components gives an age of 1459 ± 10 m.y. and an initial ratio of 0.788 ± 0.003 (Black, 1980). Black thought the isochron is likely to represent the crystallisation age because it is a precise isochron and unlikely to be produced by resetting during structural-metamorphic events which are thought to yield less precise isochrons. Without the addition of plagioclase and K-feldspar analyses used above, a total rock age of 1559 ± 133 m.y. is obtained.

Xanten Granite

Map symbol: Ꝑgx.

Nomenclature: Name derived from Xanten copper prospect 11 km north-northeast of Bonya Bore, GR JERVOIS RANGE 108913.

Distribution: It occurs in three small fault-bounded blocks at the southern end of the Jervois Range. Total area covered is 3 $km^2$.

Reference locality: At FP 1454; GR JERVOIS RANGE 221864.

Topographic expression and airphoto characteristics: A relatively resistant rock type, it forms a high ridge. On airphotos it is a very light yellow-brown unit. Vegetation is very sparse.

Lithology: Leucogranite (gl) is the only rock type mapped. Farrand (1981) described it as containing quartz (65%), K-feldspar (20%), plagioclase (15%) and traces of muscovite, chlorite, sphene, epidote and opaques. Another specimen (1347) contains quartz (45%), K-feldspar (10%) and plagioclase (45%). The rock is white, coarse-grained and non-foliated. Quartz grains have embayed margins; some appear to be replacements. Some quartz appears to have been introduced into the rock after or, more likely, during the later stage of crystallization of the rock. Partial alteration of the plagioclase to fine sericite is concentrated along 0.1 mm wide zones and in ill-defined patches. Trace chlorite may be derived from the alteration of biotite. The rock has a metamorphic texture indicated by triple-junctions between quartz grains, lack of zoning in plagioclase and lack of perthite in potassium feldspar.

Structure: The rock is massive. It is cut by very closely spaced narrow (up to 10 cm) subparallel quartz veins.

Metamorphism: The slight plagioclase alteration indicates that the rock was subject to minimal post-crystallization metamorphic effects.

Relationships: The granite was possibly emplaced into the Mascotte Gneiss Complex or the Bonya Schists; boundaries between these are now masked by alluvium. It is separated from adjacent basal Georgina Basin sediments by faults.

Correlation and age: No rock types elsewhere can be correlated with the Xanten Granite, but it does bear some compositional similarities to the Unca Granite. It may have been intruded at a similar time as the Unca Granite and subsequently altered by the introduction of quartz.

## Unnamed granites

The following unnamed granites are recognised and described in alphabetical order because intrusive ages are unknown .

Pga Granite-adamellite northwest of Yam Creek Dam in DNEIPER.

Pgf Muscovite granite east of Twin Bore in JERVOIS RANGE

Pgg Gneissic granite south of Mopunga Range in DNEIPER and western-most JINKA

| | |
|---|---|
| Pgk | Porphyritic biotite granite northwest and north of Mopunga Range in DNEIPER |
| Pgl | Leucogranite west of Yam Creek Dam in DNEIPER |
| Pgn | Granodiorite and tonalite northeast of Bonya Copper Mine in JERVOIS RANGE |
| Pgr | Biotite granite south and west of Mopunga Range in DNEIPER |
| Pgy | Biotite granite in and north of the Mopunga Range in DNEIPER |

Map symbol: Pga.

Distribution: In the belt of Kanandra Granulite extending east from Middle Dam, the unnamed granite Pga forms numerous small outcrops ranging in size from a few thousand square metres to about four square kilometres.

Reference localities: (1) Porphyritic phase: about 4 kms southwest of the intersection of Yam Creek and the Dneiper-Huckitta boundary fence (FP 6171); (2) Non-porphyritic phase: about 1 km southwest of the intersection of Yam Creek with the Dneiper-Huckitta boundary fence (FP 6175); (3) Garnet-bearing phases: About 3 kms east-southeast of the intersection of Yam Creek with the Dneiper-Huckitta boundary fence (FP 6207).

Topographic expression and airphoto characteristics: Fresh outcrops of granite form rounded tors and low hills. However, most of the granite has been affected by the ferruginous deep weathering, eroded to the mottled zone or to levels between the mottled zone and fresh rock, affected by the late Tertiary silification, and partly eroded once more. Most outcrops are therefore weathered, silicified, and covered in spinifex.

The granite is a pale red-brown unit on coloured airphotographs, very similar to quartzofeldspathic gneiss, but is less well layered. In many areas the granite can only be delineated by ground traverse.

General lithology: Medium-grained granite, containing biotite, and in most outcrops, garnet. Potassium feldspar is in excess of plagioclase, but generally the ratio of the two is within the range of an adamellite. Plagioclase is commonly partly altered to epidote. The fabric is gneissic.

Detailed lithology:

(i) The porphyritic phase consists of biotite gneissic granite containing subhedral feldspars about 1 cm x 3 cm. The freshest sample collected has pink potassium feldspar; though this colour is probably due to ferric iron, released during weathering.

(ii) Non-porphyritic phase - Medium-grained biotite granite, slightly gneissic. Potassium feldspar is pink in weathered material, white in less weathered material. Plagioclase is commonly greenish, indicating alteration to epidote.

(iii) Garnet-bearing phases - The most common garnet-bearing phase is a medium-grained, slightly gneissic granite containing biotite, potassium feldspar and plagioclase. Garnet occurs as trails of rounded garnet crystals or aggregates, each up to one centimetre across. In some outcrops garnet is partly or wholly retrogressed to biotite.

Another garnet-bearing phase occurs about 2 km west of the Huckitta-Dneiper boundary fence. This consists of large clots of garnet-biotite-chlorite to 2 cm across in a medium-grained plagioclase-quartz-potassium feldspar matrix.

Small garnets, less than 1 cm across occur in a leucocratic granite immediately south of the reference locality for the main garnet-bearing phase.

Structure: The unnamed granite Ꝑga, has a slightly gneissic fabric, the foliation of which generally is parallel to the foliation in adjacent Kanandra Granulite. Schist zones commonly cut Ꝑga.

Metamorphism: Retrograde metamorphism is common, even in undeformed Ꝑga. The conversion of garnet to biotite and in places, to chlorite occurs in granite pods within or adjacent to the Delny-Mount Sainthill Fault Zone.

Relationships: The unnamed granite, Ꝑga, intrudes Kanandra Granulite. It is deformed by the Delny-Mount Sainthill Fault and other major faults. It is affected by the Tertiary ferruginous and siliceous weathering event.

Correlation and age: The unnamed granite, Ꝑga, is correlated with the extensive suite of synmetamorphic and late-tectonic granites that intruded the northern Arunta Block at about 1750-1800 m.y.

Map symbol: Pgc.

Distribution: Small outcrops scattered over about 30 square kilometres north and northwest of Yam Creek Dam.

Reference area: Exposures at GR DNEIPER 450895, about 5 km northwest of Yam Creek Dam.

Topographic expression and airphoto characteristics: The unnamed granite, Pgc, forms areas of corestones separated by soil cover, and less commonly crops out as small bouldery hills.

The airphoto tone given by areas with Pgc boulders surrounded by soil is indistinguishable from that of other granites with similar exposures in the same area. Larger outcrops form rough, light-brown areas.

Lithology: Pgc is a pale creamy-pink granite with a slightly gneissic fabric. It contains small quantities of biotite. Pale coloured xenoliths are common in outcrops of Pgc.

Pgc consists of quartz, microcline, altered plagioclase, and biotite, with accessory sphene, zircon, opaque minerals and apatite. Plagioclase is commonly altered to white mica, and in some specimens, to epidote. Some of the biotite is altered to chlorite.

The ratio of potassium feldspar to plagioclase ranges from a little greater than 1:1 to about 2:1.

Metamorphism: The formation of white mica in plagioclase, sphene at the edge of opaques and chlorite from biotite are all considered to be the result of retrogression. Similar retrogression is widespread in granites north of the Delny-Mount Sainthill Fault.

Relationships: The unnamed granite, Pgc, intrudes Cackleberry Metamorphics, and the unnamed granites Pgr and Pgg. As it occurs with Pgr it may be a phase of Pgr. However, the mineral assemblages present in thin sections from the two units are different indicating they are separate intrusions. Pgc may be a phase of Pgy which crops out to the north, but Pgy is coarse-grained, has a higher colour index than Pgc, and was originally a hornblende granite.

Correlations and age: The unnamed granite Ꝑgc is considered to be one of the main suite of granites intruded into the northern Arunta Block at about 1750 m.y.

Map symbol: Ꝑgf.

Distribution: Forms small bodies, each covering less than 4 sq km, 5 km and 10 km east of Twins Bore, and also 10 km slightly south of east.

Topographic expression and airphoto characteristics: Occupies low-lying areas, dotted with low irregular and rough hills.

Lithology: A medium-grained muscovite-granite (FPS 1264, 1355). At FP 1355 it contains accessory spherical magnetite aggregates up to 1.5 cm across. Distinguished from unnamed granite, Pgn, by its muscovite-content, its more foliated appearance and the common occurrence of traces of tourmaline; at FP 1258, the tourmaline forms aggregates up to 30 mm diameter with quartz. The type specimen (80091452) is an allotriomorphic granular rock visually estimated to consist of microcline (63%), quartz (25%), plagioclase (5%), muscovite (4%), biotite (3%), accessory blue tourmaline and a trace of secondary chlorite. The plagioclase forms subhedral to anhedral grains which are commonly altered in their cores to sericite. Grains range from 0.02 mm to 3 mm in size.

Metamorphism: Granite is considered to be late-stage tectonic or post-tectonic.

Relationship: Intrudes Bonya Schist.

Correlation and age: Unnamed granite, Pgf, is more foliated than the nearby unnamed granite, Ꝑgn, and is, therefore, possibly older. Pgn has a Rb-Sr age of about 1750 m.y. (Black, 1980).

A high K-feldspar content and the presence of tourmaline is characteristic of both Ꝑfg and the Samarkand pegmatite. However, Ꝑgf differs from the Samarkand pegmatite in that the pegmatites are coarse to very coarse-grained, and are not generally foliated, although some are well-banded.

Map Symbol: Pgg.

Distribution: Crops out from east of Yam Creek Dam westwards to the headwaters of Yam Creek between the Mopunga Range and the Delny-Mount Sainthill Fault. Also crops out northeast of the western end of the Mopunga Range.

Reference area: Outcrops about 12 km east-northeast of Middle Dam.

Topographic expression and airphoto characteristics: The unnamed granite, Pgg, forms nearly continuous outcrop where exposed in recently dissected areas. The outcrops have trends controlled by the foliation of the gneissic granite.

Identification of this granite on airphotos is virtually impossible where the granite intrudes calc-silicate gneisses of the Cackleberry Metamorphics because both form similar dark coloured patterns. Larger outcrops of Pgg and silicified surfaces developed on Pgg can be distinguished on RC9 photography, as there they show a slightly darker photo-tone.

Lithology: The unnamed granite, Pgg, is a dark grey gneissic granite with rare xenoliths.

Pgg consists of quartz, microcline, plagioclase, and abundant biotite. Hornblende is present in some specimens, particularly those collected from western (80096292) and northern outcrops (80096437). Allanite is a characteristic accessory. Sphene forms rims on opaque grains presumed to be ilmenite. Compositionally the unit is a granodiorite since plagioclase greatly exceeds potassium feldspar.

Alteration of plagioclase to white mica is widespread. Myrmekite at the edge of potassium feldspar is present in many specimens. Chloritization of biotite and rare muscovite occur in specimens collected close to the Delny-Mount Sainthill Fault.

The small outcrop of probable Pgg in Kanandra Granulite south of the Delny-Mount Sainthill Fault contains orthopyroxene as well as biotite, and orthoclase (with myrmekite) instead of microcline.

It is possible that Pgg was originally a hornblende granodiorite, and that some or all the biotite formed during a later hydration.

Structure: The foliation in the granite is parallel to compositional layering in adjacent metamorphic rocks. The granite generally forms sheet-like bodies interlayered with Cackleberry Metamorphics, though in detail contacts are intrusive.

Metamorphism: The main metamorphic effects are alteration of plagioclase to white mica and, rarely, to epidote; formation of myrmekite, partial replacement of hornblende by biotite, chloritization of biotite and formation of muscovite. Some of these are regional in extent, suggesting the Pgg has been affected by a regional metamorphic event. Formation of chlorite and muscovite are local features in outcrops close to the Delny-Mount Sainthill Fault, and are retrogressive effects related to the development of the Fault.

Relationships: The unnamed granite, Pgg, intrudes calc-silicate gneisses of the Cackleberry Metamorphics. It is intruded by the Marshall Granite, the unnamed granites Pgr, Pgc and Pgl, and pegmatites. It is overlain by the Elyuah Formation of the Georgina Basin sequence.

Correlation and age: The unnamed granite, Pgg, is presently subdivided from the Dneiper Granite because of its apparently higher percentage of biotite and coarser grain-size. This subdivision will be reviewed when geochemical information becomes available. Differences in field appearacne may be partly due to relict hornblende which is more common in the Dneiper Granite.

The unnamed granite Pgg, is regarded as a syntectonic granite, and is the oldest granite in the area in which it occurs because it is intruded by all the other granites. No age determinations have been carried out on the unit.

Map Symbol: Pgk.

Distribution: Extends northwest and north from the western edge of the Mopunga Range as far as No. 3 Dam on Dneiper Station.

Reference area: Approximately 3 km north of the westewn end of the Mopunga Range.

Topographic expression and airphoto characteristics: The granite, Pgk, crops out in the same area as Cackleberry Metamorphics and Dneiper Granite; and like the Dneiper Granite occurs mainly as boulders in soil-covered topographic rises.

Outcrops of Pgk cannot be distinguished on airphotos.

Lithology: Pgk is a grey granite containing numberous white phenocrysts of perthitic orthoclase, and in some outcrops, plagioclase, in a matrix of quartz, orthoclase, plagioclase and biotite. Accessory minerals include zoned zircons, apatite, and very rare opaque phases. Plagioclase (probably a sodic oligoclase) is almost entirely altered to fine-grained white phyllosilicate. Clinozoisite, and less commonly, epidote and fluorite are interlayered with biotite. Myrmekite at the edge of potassium feldspar is well developed. Some biotite has been altered to chlorite.

The thin sections from Pgk contain zones of small polygonal grains cutting across the coarse-grained granite and (in 80096506) muscovite occurs in these zones.

The main difference of composition within the granite is in the proportion of phenocrysts. Some rocks consists almost entirely of phenocrysts of potassium feldspar, whereas in others these account for only 50 percent of the minerals present.

Structure: The granite is massive or slightly gneissic. The gneissic fabric may be flow-banding.

Metamorphism: No effects of later metamorphism were observed in the field. However, thin sections show abundant myrmekite, formation of muscovite, and alteration of biotite to chlorite.

Relationships: The unnamed granite, Pgk, intrudes both the Cackleberry Metamorphics and Dneiper Granite. It may have provided water for the hydration reactions observed in mafic rocks and cordierite-bearing rocks of the Cackleberry Metamorphics west of the Mopunga Range.

Most of the pegmatites in the same general area as the granite also contain white potassium feldspar and may be comagmatic with Pgk.

Correlation and age: The unnamed granite, Pgk, is considered to be post-metamorphic, and is correlated with the late pegmatites in the Bonya area, dated by Black (1980) at circa 1660 m.y. No age determinations have been carried out on the unit.

Map Symbol: Pgl.

Distribution: Isolated outcrops and small intrusions close to the Delny-Mount Sainthill Fault west of Yam Creek Dam.

Reference area: At GR DNEIPER 370894, where outcrops are weathered, but free of spinifex.

Topographic expression and airphoto characteristics: The leucogranite, Pgl, forms weathered, spinifex covered outcrops. These outcrops generally are in rough hills with sharply incised drainage.

On airphotos the leucogranite forms light pink-brown areas, very similar to the unnamed granite, Pgr. The two can only be separated by ground traverses.

Lithology: The leucogranite, Pgl, mainly consists of pink potassium feldspar, and white or colourless quartz. It generally has a medium to coarse granular fabric, but this has been broken up by a superimposed fracture-cleavage.

The potassium feldspar is microcline, some grains of which are perthitic. Plagioclase is zoned and partly converted to phyllosilicates. Biotite, a minor constituent of the rock (1-2 percent), is partly altered to chlorite. Muscovite has formed along fractures. Myrmekite forms lobate masses at the edge of microcline.

Structure: The leucogranite, Pgl, lacks a strong primary gneissic fabric. However, most outcrops are close to the Delny-Mount Sainthill Fault, which commonly imparts a secondary foliation. Where the leucogranite has been caught up in intensely deformed zones, it is transformed into a distinctive light coloured quartz-muscovite schist.

Metamorphism: The main metamorphic effects (retrogression) are develo: d close to major faults where myrmekite, muscovite, and chlorite after biotite are common.

Relationships: The leucogranite intrudes the unnamed granite Pgg, and probably also the unnamed granite Pgr. It also intrudes Kanandra Granulite and Cackleberry Metamorphics.

Correlations and age: The leucogranite Pgl is thought to be a number of distinct granite intrusions. Pegmatite dykes, consisting of pink feldspar and quartz are common in the same general areas as the leucogranite, and are considered to be co-magmatic with the leucogranite.

Many of the pegmatite dykes are orientated north-northwest suggesting that their emplacement was tectonically controlled. Also, all outcrops of the leucogranite are close to the Delny-Mount Sainthill Fault or spurs of this Fault. It is therefore suggested that the leucogranite is a late granite, whose emplacement was controlled by the Delny-Mount Sainthill Fault.

No age determinations have been carried out on the unit.

Map Symbol: Pgn.

Distribution: Small bodies 8.5 and 11 km northeast of Bonya Copper mine.

Topographic expression and airphoto characteristics: At the northern occurrence the granodiorite forms a prominent, rounded hill. At the southern occurrence scattered tors up to 1.5 m of granodiorite are surrounded by soil. Photo-colours are medium grey.

Lithology: A coarse-grained, even-grained, weakly gneissic, biotite-quartz-granodiorite (FP 1264, 72090541) and tonalite (FP 1453). K-feldspar in the granodiorite is pink. The gneissosity is slightly undulatory. Migmatitic veins occur. In a number of places it contains small to trace amounts of hornblende. Specimen 1453 is a massive tonalite with an average grainsize of 3 mm and an allotriomorphic granular texture. It is visually estimated to consists of plagioclase (56%), quartz (20%), K-feldspar (5?%), biotite (12%), hornblende (1%), actinolite (1%), chlorite (2%), epidote (1%), magnetite (2%) and accessory muscovite and apatite. Biotite granodiorite at 72090542 (Black, 1980) probably also belongs to this granite.

Metamorphism: Granite is considered to be late-stage or post tectonic and is unmetamorphosed.

Relationships: Intrudes muscovite schist of Bonya Schist.

Correlation and age: Black (1980) regarded Pgn as a phase of the Jinka Granite (Pgi). Two samples from unnamed granite, Pgn, (72090541 and - 542) which are petrographically distinct from Pgf yielded a common age of 1812 $\pm$ 85 m.y. (initial ration = 0.700 $\pm$ 0.003) by Rb-Sr total rock methods (Black, 1980). Isotopic values from both sets of samples plot on a common model 2 isochron with MSWD of 34 (see McIntyre & others, 1966) for a discussion on regression models). Granite Pgn is very similar in age to the Jervois Granite (Pge) dated at site 72090546 10 km south of Jervois Camp. Simultaneous regression of all 28 data points from the three sites in Pgn and the Jervois Granite produces an age of 1775 $\pm$ 27 m.y. and an initial ratio = 0.0701 $\pm$ 0.001 (Black, 1980).

Remarks: The low initial ratio of Pgn (i.e. 0.700 $\pm$ 0.003) is consistent with petrographic and chemical data (Dobos, 1978) of an I-type granite (Chappell & White, 1974). Black (1980) points out that the initial ratio is very low for a granite of this age. According to Black (1980) "The initial ratio is so low that it precludes any but the briefest crustal history for the granite precursor". The very low initial ratio means that the lower age limit of 1750 m.y. is favoured for the time of granite crystolisation.

Map Symbol: Pgr.

Distribution: Several intrusions south and west of the Mopunga Range.

Reference area: Exposed at GR DNEIPER/400926 in the bottom of an incised creek.

Topographic expression and airphoto characteristics: The unnamed granite, Pgr, crops out in low rough hills covered in spinifex. It has a reddish, rough, bouldery appearance on airphotos. The leucogranite, Pgl, has a very similar appearance, so that the two can be distinguished only by ground traverse. The leucogranite does not extend as far north as Pgr.

Lithology: In the freshest outcrops, Pgr is a medium-grained, pink, biotite granite with a gneissic texture. Potassium feldspar is in excess of plagioclase, so that compositionally it is either a true granite or close to the division between granite and adamellite. Most outcrops of the granite are severely weathered. Specimen 80096342 collected southwest of the Mopunga Range consists of microcline, plagioclase (oligoclase) altered to white phyllosilicate, quartz, biotite and muscovite, and accessory opaque phases and zircon. Fluorite is interlayered as thin bands within biotite. In this specimen muscovite occurs as large flakes with biotite, and on textural grounds may be primary. In other specimens (e.g. 76096039, 80096295) muscovite occurs along late fractures and is more clearly a metamorphic mineral.

Relationships: The unnamed granite, Ꝑgr, intrudes Cackleberry Metamorphics and the unnamed granite, Ꝑgg. It is intruded by the unnamed granite, Ꝑgc, and probably by the leucogranite, Ꝑgl.

Correlations and age: The unnamed granite Ꝑgr may be equivalent to the unnamed granite Ꝑgy which occurs in more deeply eroded terrain to the north. In weathered outcrop the gneissic character of Ꝑgy is more apparent, and weathered outcrops of Ꝑgy are similar to the freshest outcrops of Ꝑgr. However, Ꝑgy is, at least in some outcrops, hornblende-bearing, and Ꝑgr is not. (If Ꝑgr is equivalent to Ꝑgy, it must be more retrogreased than presently delineated Ꝑgy).

The unnamed granite, Ꝑgr, is considered to be one of the granites intruded into the northern Arunta Block during the main phase of granite intrusion, and therefore to have an age similar to the Jervois and Jinka Granites (i.e. about 1750 m.y.).

No age determinations have been carried out on the unit.

Map Symbol: Ꝑgy.

Distribution: The unnamed granite, Ꝑgy, crops out south of the cover sequence of the Georgina basin in the Mopunga Range and in the area of basement rocks north of the Mopunga Range.

Reference area: Prominent tor at GR DNEIPER 490970 from which the thin-section sample 76096053 was collected.

Topographic expression and airphoto characteristics: The unnamed granite, Ꝑgy, forms prominent tors and large boulders of fresh granite within its area of outcrop. The tors give a normal granite pattern on the airphotos; but areas of boulders in soil cover are difficult to delineate on airphotos, even where the boulders are closely spaced and large.

General lithology: The granite is a light coloured, medium to coarse-grained, biotite granite with a weak gneissic fabric. In weathered outcrops it is pink; in fresher outcrops creamy brown. Most outcrops are non-porphyritic, but there are two areas where outcrops contain large phenocrysts of potassium feldspar. Some outcrops contain thin veins of leucogranite, considered to be a late phase of Egy. Allanite is an important accessory mineral. Fluorite occurs in some specimens as a late phase.

The proportion of potassium feldspar ranges from a little less than 2:1 to greater than 2:1 to greater than 2:1. The unit is therefore partly an adamellite and partly a granite.

Detailed lithology:

(1) Reference area GR DNEIPER 490970, specimen 76096053:- Medium-grained gneissic-granites consists of microcline, oligoclase, quartz, biotite and hornblende. Accessory minerals are zircon, apatite, sphene, opaques and an intergrowth of fluorite and allanite.

(2) Porphyritic phase GR DNEIPER 430955:- Groundmass of plagioclase, potassium feldspar, biotite, and quartz with large potassium feldspar phenocrysts. The proportion of feldspar phenocrysts and their size is variable. In the freshest rocks the potassium feldspar is creamy brown, but generally it is weathered and has a pink colour. Specimen 80096354 contains orthoclase partly altered to microcline, myrmekite, hornblende partly altered to biotite, sphene overgrowths on opaques, and zircon but no allanite.

Structure: The granite Egy has a slightly gneissic fabric. This probably indicates it is a late tectonic granite, but the fabric may be a primary igneous foliation in part.

Metamorphism: The unnamed granite, Egy commonly shows some metamorphic effects. In some outcrops plagioclase has a greenish tinge because of breakdown to phyllosilicates. Early orthoclase, which may be perthitic is commonly converted to microcline. Myrmekite is very common. Hornblende has been altered to biotite. Sphene rims opaque grains. Clinozoisite is intergrown with some of the biotite. Chlorite, formed from biotite, occurs in some thin sections.

Relationships: The unnamed granite Pgy intrudes Cackleberry Metamorphics, Dneiper Granite, and the unnamed granite Pgg. It is overlain unconformably by the basal units of the Georgina Basin sequence.

Correlation and age: The unnamed granite Pgy is considered to be one of the suite of granites intruded into the northern Arunta Block at about 1750 m.y., that is, just after the Strangways Metamorphic Event of Shaw & others (1979). No age determinations have been carried out on the unit.

## Undivided and unnamed granities, Pg

A number of small granites $Pg^{1-6}$ appear to intrude the undivided metamorphics (pЄ) in the Jervois homestead area in JERVOIS RANGE shown in Figure 1. In order of the descriptions the granites are:

1. $Pg^{1}$ 5.5 km west-southwest of Bonya homestead
2. $Pg^{2}$ 1.5 km south of the intersection of Bonya Creek and the the Plenty Highway
3. $Pg^{3}$ 8 km east-southeast of Mount Thring
4. $Pg^{4}$ 11.5 km southeast of Mount Thring
5. $Pg^{5}$ 7 km west of Coolibah Bore
6. $Pg^{6}$ 12 km east of Jervois homestead
7. $Pg^{7}$ At Mount Thring

Two other small granites $Pg^{8,9}$ intrude the Kanandra Granulite and $Pg^{10}$ intrudes the Cackleberry Metamorphics, all in DNEIPER.

8. $Pg^{8}$ 3 km east of Black Point
9. $Pg^{19}$ 5 km southeast of Yam Creek Dam
10. $Pg^{10}$ Near headwaters of Yam Creek
11. $Pg^{11}$ Between No. 4 Dam and Dneiper homestead.

N.B. Superscripts 1-11 used in this Record for reference are not applied to the compilation sheets or to the 1:100 000 maps.

Map Symbol: Pg ($Pg^{1}$ in Fig. 4)

Nomenclature: Unnamed because it is surrounded by superficial cover and its relationship to other units is unknown.

Distribution: A small-outcrop area 5-6 km west-southwest of Bonya homestead.

Togographic expression and airphoto characteristics: Highly weathered granite and leucogranite form a low rise.

Lithology: Exposures of granite (g) and leucogranite (gl) are localised to the area immediately southeast of the tourmaline-quartzite ridge. The granite (g) is generally medium-grained and contains about 5 percent biotite and one percent tourmaline. At FPS 1782, 4044, and 4045 $Pg^1$ is cut by west-northwest trending quartz reefs, which are non-foliated and contain a small amount of breccia. The biotite content diminishes in places to give leucogranite (gl) which contains a small amount of tourmaline at FP 1784. Some granite is highly schistose, especially near the quartz reef (FP 4045).

Structure: The foliation, where present in the granite, ranges from east to east-southeast.

Relationship: CLH considers that granites $Pg^1$ and $Pg^2$ are continuous and form the main portion of a fault bounded block.

Map Symbol: Pg ($Pg^2$ in Fig. 4).

Reference Locality: 1.5 km south of the intersection between the Plenty Highway and Bonya Creek including FPS 1668, 1824 and 1825.

Topographic expression and airphoto characteristics: Weathered granite forms low rises with rubbly low, rounded surface which are mostly highly weathered remnants of a former landsurface. Small exposures of fresh granite occur at the margins of these rises. Granite is recognised as a slightly elevated region which is pale orange on the coloured airphotos.

Lithology: The rocks consist of weathered medium to coarse-grained granite and gneissic granite. Exposures at FPS 1666 and 1667 classified as quartzofeldspathic gneiss, muscovite-biotite gneiss and schist may be foliated granite. These rocks are so highly weathered and ferruginized that distinction of rock types is difficult. Although the rocks appear foliated and gneissic in outcrop, in hand specimen they show a granitic texture.

Structure: Massive granite wtith some gneiss portions.

Map Symbol: Pg (Pg$^3$ in Fig. 4).

Nomenclature: The granite is unnamed because very little is known about it.

Distribution: Crops out 8 km east-southeast of Mount Thring.

Topographic expression and airphoto characteristics: Forms a series of low rises with a pale yellow-brown photo colour. The alignment of outcrops parallels both the orientation of quartz veins forming nearby ridges and the orientation of the foliation.

Lithology: Granite (g) forms a massive body which appears to have a gneissic margin of muscovite-bearing quartzofeldspathic gneiss such as at FP 1640.

Relationships: Granite intrudes quartzofeldspathic gneiss of pЄ$^2$.

Map Symbol: Pg (Pg$^4$ in Fig. 4)

Nomenclature: The granite is unnamed because it appears to form a small isolated body.

Distribution: Crops out about 11.5 km southeast of Mount Thring and covers about 1 sq km.

Topographic expression and airphoto characteristics: Forms a low rubbly rise with a pale grey colour on black and white airphotos.

Lithology: Foliated granite is recorded at FP 1635.

Relationships: It is likely that the granite intrudes unit pЄ$^2$ although contacts are not exposed.

Map Symbol: Pg (Pg$^5$ in Fig. 4).

Nomenclature: Unnamed, as its relationship to the Jervois Granite is uncertain.

Distribution: A small exposure of granite 7 km west of Colibah Bore. Granite also occurs as small scattered exposures throughout the metamorphics $p\mathcal{E}^3$.

Topographic expression and airphoto characteristics: The granite cannot be distinguished on the airphotos from the surrounding quartzofeldspathic rocks because both rocks have been subject to peneplanation and deep weathering in the Tertiary.

Lithology: At FP 1687 it is a medium to coarse-grained granite containing K-feldspar megacrysts.

Relationships: The granite intrudes metamorphics $p\mathcal{E}^3$.

Correlation: The granite may be an off-shoot of the Jervois Granite.

Map Symbol: Pg ($Pg^6$ in Fig. 4).

Nomenclature: This granite is unnamed because it appears to be separate from ther granite masses to the north.

Distribution: South-eastern JERVOIS RANGE: the granite only crops out over a small portion of the area that it is considered to underlie near Denara Bore, 12 km east of Jervois homestead and north of the Marshall River (FP 1697). Its area of distribution under the Cainozoic cover is deduced to be about 80 sq km from a combination of gravity and aeromagnetic data.

Reference locality: The reference locality lies 12 km east of Jervois homestead between the track running east on the northern side of Marshall River and Marshall Bar. Fresher outcrops are found in the creek.

Topographic expression and airphoto characteristics: The granite generally does not crop out and is only exposed near its contact with the unnamed unit, $p\mathcal{E}^3$ to the east. Here, apart from creek exposures it is highly weathered. The more gneissic granite is highly weathered and forms a northwest-trending broad ridge and is also expressed as low rounded hills.

Lithology: The rocks exposed in the creek west of the northwest-trending ridge show good granitic texture. Those rocks forming the ridge are gneissic and contain rare lenses of schist. These rocks may be part of $pC^3$ although they contain much more pegmatite. The aeromagnetic response, however, indicates that the boundary lies further east and is associated with a number of quartz reefs which trend parallel to the aeromagnetic gradient in a northwest direction. It is, therefore, considered more likely that these rocks represent the gneissic margin of the granite.

The exposed granite is medium-grained and contains 5 percent biotite. The more gneissic rock, forming the northwest-trending ridge, consists of highly weathered quartzofeldspathic gneiss containing up to 10 percent biotite and encloses some biotite schist.

Map Symbol: Pg ($Pg^7$ in Fig. 4).

Nomenclature: Unnamed because is a small isolated outcrop.

Distribution: Western part of outcrop at Mount Thring.

Topographic expression and airphoto characteristics: Western slopes of Mount Thring.

Lithology: Leucogranite (gl) containing lenses of tourmaline pegmatite (peg) and rafts of altered amphibolite (2) and rare schist. Granite is medium-to coarse-grained and foliated. (FPS 1621, 3101-2). Biotite content is generally negligible but reaches up to 10 percents in the southeast (FP 1804).

Relationships: Intrudes metasediments. Small cross-cutting relationships are evident at the top of the hill.

Map Symbol: Pg ($Pg^8$ in Fig. 4).

Distribution: Two small bodies about 3 km east of Black Point.

Topographic expression and airphoto characteristics: Small bouldery hill, forming a light coloured area on the airphotographs.

Lithology: The unit is a light coloured, strongly foliated, medium-grained, biotite adamellite, containing rare garnet. Outcrops have been affected by both ferruginous and siliceous weathering.

The granite is strongly deformed. Quartz forms elongate grains with undulose extinction. Perthitic feldspar has been polygonised so that large perthite grains are surrounded by a mosaic of plagioclase and microcline grains.

Structure: The granite is foliated.

Relationships: The granite probably intrudes the Kandandra Granulite, though the only observed contact is faulted.

Correlation and age: The granite does not resemble any other granite. It is considered to be syntectonic because of its strongly developed gneissic fabric.

Map Symbol: Pg ($Pg^9$ in Fig. 4)

Distribution: Small area of tors and granite sheets about 5 km east of Yam Creek Dam.

Topographic expression and airphoto characteristics: Granite tors, boulders and outcrops. The area does not appear to be different on the airphotos from areas with similar outcrops of other granites.

Lithology: Grey porphyritic granite partly deformed to augen gneiss. In thin section it consists of microcline with myrmekite, quartz, plagioclase (oligoclase), hornblende, biotite and accessory opaque phases, sphene, apatite, and zircon. Horblende has been partly altered to biotite, and sphene occurs as overgrowths on opaque grains.

Metamorphism: Formation of myrmekite, biotite, and sphene are all retrogressive effects.

Structure: The granite is partly deformed. It is adjacent to the Delny-Mount Sainthill Fault and spurs of this fault.

Relationships: The granite is bounded by faults and by soil covered areas.

Correlation and age: The granite is correlated with a similar deformed granite (76096037A at 6052) south of the Delny-Mount Sainthill Fault and about 3 km to the east. No other similar granite is known.

The granite is considered to be the same general age as other gneissic granites in the northern Arunta Block.

Map Symbol: Ꝑg (Ꝑg[10] in Fig. 4).

Distribution: Crops out over about 20 sq km in the headwaters of Yam Creek near DNEIPER GR 410905.

Topographic Expression and airphoto characteristics: The granite has been exposed through dissection of the silicified Tertiary surface (T), and the type of outcrop is dependent on the level to which the dissection has progressed. The northern outcrops consist of boulders and granite sheets in soil covered areas; the southern outcrops form a continuous granitic terrain. The more extensive outcrops have a dark red-brown photo-tone, and the bouldery pattern typical of granites in airphotos.

Lithology: The granite is a coarse-grained, pink, biotite granite containing large pink or cream potassium feldspar phenocrysts. These phenocrysts are less numerous close to the margin where there is a dark border phase with only scatterd phenocrysts.

The granite consists of perthitic microcline, partly altered to microcline, zoned plagioclase (calcic oligoclase), quartz, biotite and opaque phases. Accessory minerals are apatite, allanite and zircon. Epidote and rare fluorite occur with biotite. Myrmekite occurs along the edges of potassium feldspar, particularly adjacent to deformed zones.

Metamorphism: Chlorite has partly replaced biotite. Plagioclase is partly altered to white mica. Mymerkite occurs at the edge of potassium feldspar.

Relationshipa: The porphyritic granite Ꝑg intrudes Cackleberry Metamorphics and probably also Ꝑgg and Ꝑgr.

Correlations and age: The porphyritic phase of Ꝑgy and the Mount Swan Granite (10 kms to the northeast and 25 km to the northwest respectively) somewhat resemble this porphyritic granite, but both these were originally hornblende granites. It is possible the porphyrtitic granite Pg was originally a hornblende granite since the association of biotite, epidote and fluorite occurs in the partly metamorphosed hornblende granites. However the continue existence of perthite and orthoclase probably indicate that metamorphism was not intense.

The prophyritic granite Pg is one of the suite of granites that intrude the northern Arunta Block.

Map symbol: Pg ($Pg^{11}$ in Fig. 4).

Distribution: Weathered and poorly exposed granite extending from south of No. 4 Dam on Dneiper Pastrol Holding westward to about 8 km east northeast of Dneiper homestead. The outcrops are scattered and probably represent more than one intrusion.

Topographic expression and airphoto expression: Rocky rises, hills, and small bouldery outcrops which form light toned areas on the airphotos.

Lithology: Specimen 80096517, about 1 km south of No. 4 Dam is fine-grained gneissic granite and contains microcline, zoned plagioclase (calcic oligoclase), yellow-brown biotite and muscovite. Myrmekite is abundant.

Specimen 80096537, from a silicified gneissic granite consists of microcline, plagioclase (oligoclase) and accessory biotite. Myrmekite is abundant. Plagioclase is partly altered to fine white phyllosilicates.

Other outcrops, which were not sampled included a coarse-grained light coloured gneissic granite, and an augen gneiss or deformed granite cut by a light coloured non-gneissic granite.

Metamorphism: Alteration of plagioclase and formation of myrmekite are the principal effects of metamorphism found in these granites.

Relationships: These granites are not seen in contact with any other units.

Correlations and age: No correlations can be made with other units. Their age is unknown, but they are presumed to be part of the suite of granites that intruded the northern Arunta Block area at about 1750 m.y.

# INTERMEDIATE, BASIC AND ULTRA BASIC ROCKS

## Unnamed Diorite, Ƥdr

Distribution and reference area: A small plug about 200 m across on the east bank of a large creek, 2 km northeast of Yam Creek Dam in eastern DNEIPER.

Lithology: The rock is a partly metamorphosed diorite. In outcrop the diorite is a blocky, brown, even grained rock consisting almost entirely of biotite and green plagioclase. The plagioclase is almost completely altered (80096375B), although relict igneous zoning can still be recognized, and the biotite is extensively chloritized. The thin section also contains minor quartz and accessory monazite and an opaque phase.

Relationships: The plug is considered to be intrusive into the Marshall Granite. It has been affected by the same low-grade metamorphic event as the Marshall Granite and other granite in DNEIPER.

## Metamorphosed and partly metamorphosed basic igneous rocks; Ƥda, Ƥd, Ƥdi

A number of gabbros, norites and dolerites are partly metamorphosed and some may predate the granites. However, as several of the granites are also metamorphosed or partly metamorphosed no clear sequence of emplacement can be established on present data. Basic igneous rocks include the following:

1. Ƥda; Attutra Metagabbro, JERVOIS RANGE.
2. $Ƥd_{gb}$, $Ƥd_{a}$; Partly metamorphosed noritic intrusive rocks 10 km east of Dneiper homestead, DNEIPER.
3. Ƥd; Sill-forming dolerite, Harts Range, DNEIPER.
4. Ƥd; Small bodies of dolerite and gabbro in the Bonya region, JERVOIS RANGE.
5. Ƥd; Gabbro 2.5 km southwest of Gap Bore, JINKA.
6. Ƥdr; Metamorphosed norite south of Deep Bore, DNEIPER.
7. Ƥdi; Dyke-forming Ilappa Dolerite, DNEIPER.

1. Ɛda -Attuta Metagabbro, JERVOIS RANGE

Map Symbol: Ɛda.

Nomenclature: New name, named after the Attruta prospect, 12 km northwest of Bonya Bore, GR JERVOIS RANGE 082804.

Distribution: Crops out as low hills over approximately 90 $km^2$, from 5 km east-southeast to 10 km northeast of Jervois Mine.

Reference area: Immediately south of the road to Lucy Creek homestead and 8.5 km from the Jervois mine; GR JERVOIS RANGE 352994.

Topographic expression and airphoto characteristics: Low hills covered by soil or blocky tor-like boulders, are scattered around a plain.

Airphoto colours are dark greenish black where outcrop is good, but he soil-covered hills do not have a distinctive airphoto appearance.

General lithology: Gabbro, commonly highly altered to amphibolite. One outcrop is very leucocratic and is considered to be an altered norite. Several outcrops of coarse-grained magnetite occur in the eastern part and one in the west.

Detailed lithology: Six gabbro specimens described by Farrand (1981) range from slightly to completely altered. The least altered, FP 1462A, is composed of pyroxene, (45%) with an augite core and aegerine rim, some of which is altered to amphibole (5%), bytownite (35%) as subhedral to anhedral laths up to 9 mm long, biotite (5%) as relatively small ragged grains which are slightly chloritized, quartz (5%) occurring as a late stage interstitial replacement, chlorite (5%) as thin flakes in the biotite and as irregular masses within the amphibole, and opaque grains (2%). Very fine grains of opaques were initially exsolved from the pryoxene and during alteration some were amalgamated to form grains up to 0.5 mm diameter. Other samples described are much more altered.

Specimen 1462B is highly altered gabbro composed of pyroxene (5%), plagioclase (10%) as ragged remnants, amphibole (70%) which is pleochroic green to blue-green and occurs in felted masses of interlocking grains apparently replacing both pyroxene and plagioclase, chlorite (13%) replacing both amphibole and pyroxene, interstitial quartz (1%) and opaque grains (1%). Other specimens examined displaying similar alteration are 1294, 1370, 1397B, 1417B and 1456. In specimen 1462B pyroxene occurs with pleochroic green-light yellow-brown rims (probably aegerine) and colourless to very pale brown prisms (probably augite); early biotite.

A leucocratic, coarse-grained basic plug crops out at FP 1459. Sample 1459B from this locality is composed of fractured plagioclase (30%) up to 5 mm diameter, fine-grained amphibole (40%), and chlorite 10%, irregular grains of epidote (20%) and a trace of opaque grains. Specimen C contains about 20 percent ferromagnesian minerals.

Coarse-grained magnetite plugs occur in the gabbros. For example, at FP 1397 coarse magnetite wth a grainsize up to several centimetres diameter forms a almost-monomineerallic plug up to 50 m across. A small lens of highly altered and malachite stained gabbro occurs in the magnetite rock. Several of these magnetite plugs have been analysed (e.g. Sample 1397A contains 4200 ppm V, 330 ppm Cu, 110 ppm Co and 250 ppm Ni).

Sample 1433, collected from south of Unca Waterhole, was described by Farrand (1981) as an altered gabbro composed of pyroxene (15%), amphibole (75%), chlorite (9%), and opaque grains (1%). The rock is more foliated than usual.

At FP 1458 a fine to medium-grained, granuloblastic mafic rock, apparently within the metagabbro, is composed of calcic plagioclase (50%), hypersthene (40%), opaque grains (5%), and highly altered ? pyroxene or amphibole forming a narrow vein. Its exact relationship with adjacent metagabbro is concealed by soil cover.

Structure: The metagabbro appear to occurs as disconnected plugs intruding the Bonya Schist. In the west the plugs are clearly small. These range from plugs 2 m in diameter to elongate bodies several hundred metres wide and over a thousand metres long. The largest are aligned in an east-west direction. However, in the east the plugs are separated by up to several kilometres of soil-covered plain and their exact size is unknown. They may be large bodies several kilometres across. A gound magnetics survey was conducted by NTGS to assist in the determination of the shapes and distribution of the metagabbros, but the results are not yet available.

Metamorphism: The original ferromagnesian minerals and feldspar in the gabbro were replaced by amphibole, which in turn was replaced by chlorite. From other rocks in the region Dobos (1978) concluded that an earlier amphibolite facies metamorphism was followed by a later lower temperature event.

Relationships: The gabbros intrude the Bonya Schist. They have been subject to two later metamorphic events but their fabrics were not substantially altered. In the northern part the gabbro is unconformably overlain by the Oorabra Arkose.

Correlations: Several elongated north-south plugs of a basic intrusive south of Unca waterhole are weakly foliated; although they are shown as Pgm they may be older.

Age: No age determinations have been carried out on the unit.

Comments: These plugs containing small plugs of magnetite, has been prospected for vanadium by Union Corporation (see Economic Geology section, this report).

2. Ꝑdgb, Ꝑda - Partly metamorphosed norite, 10 km east of Dneiper homestead, DNEIPER.

Map symbols: $Ꝑd_{gb}$ and $Ꝑd_{a}$

Distribution: Three outcrops spread over 5 sq kms (10 kms east of Dneiper homestead) and one possible (photo-interpreted) outcrop about 6 km east of the main outcrop-area.

Topographic expression: Unmetamorphosed rocks form small bouldery hills; metamorphosed rocks (hornblende bearing) forms low outcrops in soil covered areas.

Lithology: Unmetamorphosed rock (Ꝑd) consists of orthopyroxene, clinopyroxene and calcic plagioclase (unzoned); and is a norite. Metamorphosed (hydrated) rocks (Ꝑd) consist of light coloured hornblende and plagioclase. All material collected from the outcrops contains some hornblends, but relatively unhydrated material retains an ophitic texture. The light colours of the ferromagnesian minerals indicate a high MgO/FeO bulk composition.

A basic dyke-like body in the southern part of the outcrop-area consists of more deeply coloured ferromagnesian minerals (indicating a lower MgO/FeO bulk composition) red (titaniferous) phlogopite, and strongly zoned plagioclase. Its mineralogy indicates it is chemically different from the norite and may be unmetamorphosed.

Metamorphism: The unit has been partly converted to amphibolite, most probably by hydration associated with the intrusion of nearby granite.

Relationships: Soil cover intervenes between the norite (s.l.). and the nearby granite which includes a large amphibolite xenolith, which in interpreted as a fragment of the norite.

Correlatioos and age: The norite is considered to be younger than the early regional metamorphism. If the relationship between the adjacent granite and the norite has been correctly interpreted then the norite is older than the granite.

Metamorphosed mafic rocks in the Cackleberry Metamorphics may include correlates of this unit, but are considered in general to be older.

3. Pd - Dolerite sill, Harts Range, DNEIPER

Map symbol: Undifferentiated from surrounding Irindina Gneiss because of its small size.

Distribution: Dolerite has been located at FPS 1737 and 2009 west of Entire Creek in the Harts Range within the Irindina Gneiss.

Reference area: Field locality FP 1737.

Topographic expression: Dark exfoliated boulders outline the outcrop which may be continuous between FPS 1737 and 2009.

Lithology: The dolerite is fine to medium-grained and consists of andesine, clinopyroxene, orthopyroxene, brownish hornblende, and accessory opaque grains, quartz, apatite, and zircon. The zoned nature of some andesine crystals and random orientation of the andesine suggests the dolerite is substantial unaltered. Some pyroxene is partly altered to hornblende.

Structure: The dolerite is concordant with the enclosing gneiss and amphibolite of the Irindina Gneiss.

Metamorphism: The dolerite has an igneous texture and shows no signs of low grade metamorphism.

<u>Relationships</u>: Intrudes the Irindina Gneiss.

<u>Correlation and age</u>: This sill-like body is compositionally similar to some mafic bodies grouped as Pd in ILLOGWA CREEK and may be the same age as the Stuart Dyke Swarm which crops out to the west. The Stuart Dyke Swarm has been isotopically dated at about 900 m.y. (Black & others, 1980).

4. <u>Ꝑd - Small bodies of gabbro and dolerite in the Bonya region, JERVOIS RANGE.</u>

Small plugs of basic igneous rock are scattered throughout the Bonya Schist, principally northwest of Bonya Bore. They range in size from less than 2 m across up to 1.5 km in diameter. Most are substantially metamorphosed under amphibolite facies conditions. Several of the basic bodies are outlined below to show the range of features developed.

1) A large basic body (1.5 km x 1 km), 8 km northwest of Bonya Copper Mine, is a very fine-grained, granular amphibolite composed of roughly equal amounts of hornblende and plagioclase. Where it abuts marble (FP 1146, GR 0228915) a reaction zone several metres wide is developed in which the garnet content (brown ?andradite) in the marble increases from a negligible proportion up to 75 percent of the rock. A 2 m wide, poorly banded quartz-garnet (almandine) rock is developed alongside the amphibolite.

2) Several east-striking basic dykes occur 5 km NNW of Bonya Copper Mine (FPS 1174, 1175). They are composed of medium-grained amphibolite in which the plagioclasic (50%) is extensively altered to fine epidote. They have a fine-grained, weakly foliated marginal phase. Weak copper and tungsten mineralisation, referred to as Wells' Show, (see Economic Geology) occurs in one of these dykes alongside a 1 m wide quartz reef.

3) A 2 m wide basic plug occurs about 5 km east of Bonya Mine at FP 1310. It consists of coarse-grained actinolite (60%) and plagioclase (30%) as well as clinozoisite, chlorite, and epidote formed by alteration. The plug is too small to show in the map.

Other metabasic bodies in the Bonya region are:-

(i) metagabbro 6 km at Bonya Bore (FP 1027).

(ii) metadolerite 7 km NW of Bonya Bore (FPS 1016, 1089).

(iii) a metadolerite sill 3 km NNW of Bonya Bore (FPS 1660, 1661).

(iv) metagabbro located 7 km NE of Bonya Mine (FP 1356).

(v) coarse-grained metamorphosed hornblende-plagioclase rock with an ophitic texture 10 km ESE of Twins Bore (FP 1356).

5. Ed - Gabbro 2.5 southwest of Gap Bore, JINKA

A small gabbro intrudes a granite 2.5 km southwest of Gap Bore (field point 3435). The gabbro is medium-grained. It has not been examined in thin section. The gabbro body is confined between two east-northeast trending breccia zones filled with quartz. The granitic country rock is tentatively assigned to the Jinka Granite.

6. Edr; Metamorphosed norite southeast of Deep Bore, DNEIPER.

Distribution and Reference Area: One large body about 4 km south of Deep Bore.

Topographic expression and airphoto characteristics: The unit forms rough bouldery areas within the Marshall Granite. On the colour airphotos the unit is a little darker than adjacent calc-silicate rocks of the Deep Bore metamorphics; on black and white RC9 photography the basic rocks form a distinctively darker toned unit.

Lithology: The unit is a medium-grained, even-grained rock (80096285A) consisting of orthopyroxene, clinopyroxene plagioclase (labradorite), phlogopite, and quartz and is classified as a quartz norite. The texture is ophitic, with laths of plagioclase surrounded and separated by granular pyroxene.

Close to the contact with the Marshall Granite the diorite has been recrystallized to a fine-grained dark green rock (8009685B) with hornblende and epidote. Xenoliths of amphibole which occur in nearby Marshall Granite are considered to be derived from the quartz norite.

Relationships: The quartz norite intrudes the Deep Bore Metamorphics, and is intruded by the Marshall Granite.

Correlationa and age: The quartz norite is considered to be post-metamorphic, but to predate the Marshall Granite. No age determinations have been carried out.

Remarks: In this area Ferguson (1975, unpublished open file report) reported 'Rare sulphides in a basic body'. The statement probably refers to this unit.

7. Edi; Dyke forming Ilappa Dolerite, DNEIPER.

Nomenclature: These are named from the aboriginal name for the area (Tindale, 1931). Aboriginal axe-making sites occur along all three dykes in the main outcrop area.

Distribution: Two long dykes southwest and southeast of Cackleberry Bore. A small, poorly exposed meta-dolerite south of the Mopunga Range may be part of the same suite. Several plugs (1-2 m in diameter) and poorly exposed dykes immediately west of the Myponga Range may also be correlates. These include both meta-dolerite and micro-norite.

Reference area: About 1 km southeast of Cackleberry Bore.

Topographic expression and airphoto characteristics: A semi-continuous line of fresh boulders and worked fragments. The two main dykes show as dark lines on the airphotos.

Lithology: In outcrop the rock is a fresh blue-grey fine-grained rock with fine laths of a light coloured mineral (cummingtonite). In thin section (80096519C, 80096520) the rock consists of laths of cummingtonite set in a ground mass of pale green actinolitic hornblende, titaniferous (to 1.85 weight percent) hydrobiotite, and intergrown clinozoisite and muscovite. Equant grains of an opaque phases occur in the ground mass.

The small bodies of fine-grained dolerite close to the Mopunga Range are less altered, and the specimen Ha 219C, which contains orthopyroxene, may be described as a micronorite.

An isolated outcrop of meta-dolerite south of the Mopunga Range consists of plagioclase (An 45-50), rare biotite (mainly pseudomorphosed by colourless phyllosilicates) and aggregates of cummingtonite surrounded by felted needles of blue-green hornblende.

Structure: The dykes are slightly oblique to the layering in the country rock.

Metamorphism: Greenschist to transitional amphibolite.

Relationships: Intrudes the Cackleberry Metamorphics and pegmatities.

Correlations and age: Considered to be the youngest unit of the crystalline rocks, but older than the Georgina Basin sequence.

Metamorphosed ultrabasic rock

Unit Ɛd

Distribution: Ultrabasic rock forms a small body about 10 m wide and 50 m long, about 0.4 km southeast of Middle Dam.

Topographic expression: The ultrabasic rock forms a slight depression in the adjacent units. It is indistinguishable from surrounding units on the air photographs.

Lithology: The ultrabasic rock is deeply weathered. Surface material includes magnesite, some stained by secondary nickel minerals, opaline nodules, and porous ferricrete. Float includes possible talc rocks; and pale apple-green mica is exposed at the base of a shallow trench.

Relationships: The ultrabasic body occurs within garnetiferous quartzofeldspathic gneiss of the Kanandra Granulite, and is elongated parallel to the strike of surrounding units.

Metamorphism: The mica and talc indicate the body may have been metamorphosed.

Correlations and age: The age of the ultrabasic body is unknown. Another ultrabasic body has been reported in the area south of 9 Mile Bore (Cooney, 1973) but was not located during this survey.

Comments: The body has been drilled by the Northern Territory Geological Survey as a nickel-copper prospect (Clarke, 1978).

PEGMATITE AND VEINS

Samarkand Pegmatite

Map symbol: Ɛps. Includes smaller pegmatites mapped as peg. within Bonya Schist.

Nomenclature: Name derived from Samarkand Tungsten Prospect 20 km west-southwest of Jervois Mine. Name used by Black (1980).

Distribution: Larger bodies (1) 500 m southwest of Samarkand Scheelite Prospect; (2) at the Jericho Scheelite Prospect; (3) 1 to 3 km farther east and northeast of the Jericho Prospect and (4) 2 to 10 km northwest of Damascus Scheelite Prospect. Also numerous small bodies thoughout the Bonya Schist, but are mainly concentrated west of Jervois Range and north of the Bonya Hills. Pegmatite occurs in lenses, pods, and irregular masses, commonly 200 m by 1000 m in size, but rarely up to 1 km by 3 km.

Topographic expression and airphoto characteristics: Very elongated lines of hills and ridges. Prominent hills are formed where the pegmatite is relatively wide. Outcrops are boulder strewn and rough. Evident as cream-white or pink coloured, structureless, irregular bodies on the airphotos.

Reference locality: Pegmatite adjacent to the western side of Samarkand Prospect (GR JERVOIS RANGE 281 860).

Lithology: Medium to coarse-grained tourmaline and muscovite-bearing pegmatite near Samarkand Prospect. A fine- to medium-grained pegmatite of similar mineralogy occurs near the Jericho Prospect. The pegmatite commonly shows weak to strong banding which is locally broadly folded and is locally truncated against itself (FP 1099). The pegmatites, particularly the larger body east of Jericho Prospect, grade into a cream-coloured granitic rock (FP 1272) which appears to be a partially mechanically disintegrated pegmatite (FP 1232). Tourmaline and muscovite are present in small to accessory amounts throught most of the pegmatites.

Relationship: Intrudes Bonya Schist. Pegmatite at FP 1335 contains small fragments of schist. Xenoliths of thinly-banded quartz-tourmaline rock (1232) with a strongly deformed appearance are at 1251, and similar quartz-tourmaline rock occurs along the edges of many of the pegmatite dykes. Pegmatite dykes are cut by quartz veins. Quartz-muscovite-biotite schist alongside the pegmatite at Jericho Prospect has a Rb/Sr total rock model 1 age of 1625 $\pm$ 50 m.y. (initial ration = 0.711 $\pm$ 0.015) which is indistinghishable from that of the pegmatite and indicates isotopic resetting of the schist by heat and volatiles emanating from the pegmatite (Black 1980).

Age: A Rb-Sr total rock age for the Samarkand pegmatite of 1648 $\pm$ 57 m.y. (initial ration = 0.757 $\pm$ 0.018, MSWD = 11) was obtained by Black (1980) after deleting the three microcline-rich samples out of a sample set of 8. These specimens were excluded because their Rb/Sr isotopes are considered to have been reset during a younger event (possibly about 1480 m.y.). The pegmatite at the Jericho Scheelite Prospect (72990540) gives a model 2 isochron age of 1642 $\pm$ 26 m.y. (initial ratio = 0.714 $\pm$ 0.015, MSWD = 3.7). Muscovite from the same pegmatite yields a Rb/Sr age of 1659 m.y. At Jericho a pegmatite several metres wide truncates a smaller pegmatite which concordantly intrudes the country-rock biotite schist.

Remarks: The high, but different, initial ratios of the pegmatites near Samarkand and Jericho indicate derivation from distinctly different upper crustal sources.

Oorabra Reefs (spacially associated with Jinka Granite)

Map symbol: No special symbol. Spacially correspond with the outcrop-area of Jinka Granite.

Nomenclature: Name applied to an extensive complex of quartz veins. First described as the Oorabra Reefs by Brown (1896, p. 6).

Distribution: Crop out on the Jinka Plan and west of the Elyuah Range.

Type area: The best known quartz veins are about 7 km west of Mount Sandy, which is itself a quartz vein.

Width of veins: Up to 9 m.

Topographic expression and airphoto characteristics: Individual reefs are up to 15 m high, 13 km long, and form a criss-cross pattern on the Jinka Plain. Many form prominent wall-like features. They are seen as sharp white linear features on the aerial photographs.

Lithology: Multi-zoned vuggy quartz, showing comb-structure and ribbon structure. Late-stage vughs are commonly lined with fine, crystalline quartz. Many of the quartz veins particularly those in the north, contain specular hematite deposited as a late-stage vugh filling. Several veins in the south and east contain fluorite and barite.

Structure: Near vertical to vertical dips predominate. The quartz veins mostly strike northwest, some strike west and west-northwest. In places veins are arranged in an en echelon pattern and a few form an anastomosing network. They have two prominent sets of joints trending 305-125° and 055-235°. Granite adjacent to many of the reefs is commonly brecciated and its matrix has been deformed and altered to produce a fine-grained purplish rock (bc). Alteration includes kaolinisation of feldspar, formation of epidote, and local silification.

Relationships: Although confined to the outcrop-area of the Jinka Granite at least some of the reefs are younger as they cut the Oorabra Arkose.

Correlation and age: Quartz veins, similar to the Oorabra Reefs in their size, abundance and multi-phase development, cut the Jervois Granite. One possibility is that introduction of the Oorabra Reefs be correlated with the time break represented by the unconformity at the base of the Mount Baldwin Formation. The Reefs were possibly emplaced in the Cambrian. Hill (1972) considered the veins to be introduced in the mid-Palaeozoic in the axial zone of a postulated anticline north of the Elyuah Syncline.

Remarks: The reefs are considered to have been deposited as fissure veins and stockworks in tension structures. Internal structures such as brecciation hydrothermal zoning and extreme changes in quartz grainsize allow a local chronology of formation to be established and indicated multiple stages of fracture, reopening and fissure filling. Hill (1972) considers the veins to be telethermal-epithermal. The reefs have also been examined by Brown (1971).

Mineralisation: In addition to barite and fluroite the reefs also rarely contain traces of copper carbonates (malachite, azurite) and galena.

Harts Range pegmatites (informal)
(after Joklik, 1955).

Map Symbol: peg. The pegmatites in the Plenty River Mica Field are shown on the map by the dyke symbol.

Distribution: In southern JINKA north of the Plenty River between Huckitta homestead and Mount Sainthill.

Topographic expression and airphoto characteristics: Not well-exposed. However, old mica working are easily recognised due to the high reflectivity of the mica waste.

Lithology: A well-zoned pegmatite, is exposed at the Whistleduck Mine (abandoned), and consists of a quartz core, an intermediate zone of microcline, a wall-zone of plagioclase and muscovite, and a border zone of fine-grained quartz and mica. In general, however, the zone is not completely developed and only one or two compositional charges are presents. Tourmaline is an accessory phase at the Black Prince and Princess Elizabeth Mine (abandoned). Beryl has been recorded at the Princess Elizabeth Mine.

Relationship: Veins cut the Irindina Gneiss.

Age: Riley (1968) obtained a Devonian Rb-Sr age from the Rex pegmatite in northeastern ALICE SPRINGS.

Remarks: Individual mines are described in detail by Joklik (1955).

## NOTES ON LATE-STAGE SCHIST ZONES

### Delny-Mount Sainthill and Entire Point Fault and Deformed Zones (Ꝑr)

Map Symbol: Ꝑr.

Nomenclature: The Delny Fault was named from Delny Pastoral Holding which it crosses. Schist and multiple deformed zones of Precambrian and younger age are:

(1) Delny Fault (Shaw & Warren, 1975).
(2) Delny-Mount Sainthill Fault Zone (Warren, 1978).
(3) Entire Point Fault Zone (Warren, 1980).

Distribution: The Mount Sainthill section of the fault is the eastern extension of east - southeast trending structure which passes through Mount Sainthill. The Entire Point Fault Zone passes about 3 km north of Entire Point, trending southwest from about 2 km south of Yam Creek Dam.

Crientation:

Reference area: Deformed rocks in the zones are exposed between Yam Creek and Yam Creek Dam and also about 6 km to the west, south of a prominent quartz ridge, along the fence line.

Width: Zones up to 2 kms wide.

Topographic expression and airphoto characteristics: The schist zones form a series of sharp ridges and valleys or topographic recessed belts.

Lithology: A variety of rock types in retrograde schist zones including schist, felsic schist, amphibolite, minor mylonite, chloritic schist, rare garnet-chlorite schist, and epidote-bearing rock.

Boundary characteristics: Boundaries of pCr against older units are generally diffuse, though a sharp fault contact can be observed in some areas. The boundary is placed where the original fabric of the older units can still be observed. Hydration and superimposed metamorphism may extend into older units well beyond these arbitrary boundaries.

Metamorphism: The metamorphic grade of rocks in pCr units ranges from greenschist ot lower amphibolite. It is very likely that more than one episode of metamorphism is involved. There is insufficient data to characterize separate episodes. Quartz segregation occurs in parts of the Delny-Mount Sainthill Fault and in places quartz segregations have been deformed by later events.

Age: The fault zones are thought to be older structures reactivated during several episodes in the development of the region (Warren, 1978; Black, 1980). It is suggested that they originally developed at depth as wide zones. Progressive uplift and erosion raised them gradually to higher crustal levels, where the faults became narrower, more sharply defined features. It is probable that the Delny-Mount Sainthill Fault controlled sedimentation during deposition of part of the Georgina Basin sequence (P. West, unpublished data). The system may also have been active in the Tertiary, displacing and warping the late Tertiary surfaces.

Palaeozoic Retrograde Schist Zones, Pzr

Map Symbol: Pzr.

Nomenclature: Classification restricted to narrow schist zones involving retrogression to greenschist facies.

Distribution: Mainly southeast corner of JERVOIS RANGE. For example, a retrograde schist zone, about 1 km or more wide, trends northwest from just north of Marshall Bar. A narrow retrograde schist zone occurs 6 km north-northwest of Demara Bore (abandoned).

Reference are: 1.3 km northwest of Marble Bar.

Topographic expression and airphoto characteristics: A low-lying belt of slight ridges and scattered low-lying exposures. Pale photo-tonee.

Lithology: North of Marshall Bar a unit of retrograde schists including sericite-bearing quartzofeldspathic schist (sf) enclosing some epidote-rich calc-silicate rock (cs) (3142B) and foliated amphibolite (a), is succeeded to the north by biotite schist (sb) or phyllonite, which is probably deformed granodioritic gneiss (gg) (e.g. 3143A).

Metamorphism: The rocks have been largely retrogressed to greenschist assemblages. Some relict minerals such as coarse-grained diopside in the calc-silicate rock are still preserved (e.g. 3142B).

Age: In ALICE SPRINGS (Shaw & others, 1979) and in southern part of ILLOGWA CREEK schist zones where retrogression was at greenschist facies are regarded as being Palaeozoic in age. One such schist zone has been dated (Armstrong & Stewart, 1975).

## NOTES ON CAINOZOIC UNITS

Cainozoic units in the region conceal much of the Arunta Block and are summarised in Table 1. Deeply weathered rocks with a trizonal laterite profile (Tlf) are generally elevated well above the present level of erosion. The Waite Formation (Tw), which crops out in central DNEIPER, consists of siltstone, claystone, limestone and sandstone. It has been traced eastwards from its type area in ALCOOTA where Woodburne (1967) established a Miocene-Pliocene age. Smith (1963) incorrectly assigned these rocks to the Arltunga Beds. Their thickness of DNEIPER ranges up to 30 m.

Mild tectonic activity or a major pluvial period, possibly in the late Pliocene, is postulated to explain extensive outwash plain (Czc) which are elevated relative to the present level of erosion. For example, on the Jinka Plain shallow stoney soil covers a flat weathered land surface, which is cut by an erosional surface made up of moderately closely-spaced, branching drainage pattern. Similar deposits occur on the gently undulating plains in the regions of the Jervois Granite. Here, the older plain is slightly dissected by open, broad shallow, branching valleys.

More recent extensive erosion of probably Quaternary age has exposed scattered outcrops of rock and lowered the level of peneplanation. Regions where a thin veneer of soil and alluvium conceals bedrock of the Arunta Block and less commonly rocks of the Georgina Basin sequence are referred to by the symbol Qe. Sand dune formation probably preceded this period of renewed erosion. Formation of red earth soils (Qr), deposition of alluvium, and movement of colluvium (Qc) probably continued throughout the Cainozoic, but mainly date from the later Quaternary.

## STRUCTURE

### BASEMENT FOLDING

The earliest deformation phase is an isoclinal folding of compositional layering. A regional schistosity is axial plane to these folds. In general the schistosity and compositional layering are parallel. To date only mesoscopic folds have been identified belonging to this earlier fold generation. Early lineations, probably paralleling these fold plunges, are outlined by the intersection of compositional layering with the schistosity and by mullion structures. They have shallow plungs of variable trend. The north-trending "J-fold" in the Jervois area is a late-stage fold in which a crenulation cleavage is developed as an axial-plane structure. This cleavage fans around the fold.

In the Bonya Hills area an east-south-east-trending fold is outlined by the repetition of the Kings Legend Amphibolite Member near the Damasus Prospect. If the Mascotte Gneiss Complex underlies the Bonya Schist, the fold is probably

TABLE 2: CAINOZOIC STRATIGRAPHY

| ERA | PERIOD | ROCK UNIT AND SYMBOL | MAIN OR CHARACTERISTIC ROCK TYPES | DISTRIBUTION IN SHEET AREA | REMARKS |
|---|---|---|---|---|---|
| | RECENT | Qa | Alluvium; sand, silt, clay, gravel | Throughout | Up to 15 m thick; alluvial channels date from latest pluvial period-either Holocene or lates Pleistocene |
| | | Qe | Soil, some alluvium and eluvium (scattered bedrock outcrops) | Northern part | Thin veneer of soil cover over rocks of the Arunta Block |
| | | Qr | Red earth soil; sand, silt, clay, gravel, proportion of fine sand and silt greater than in Qa | NW part | Underlies alluvium around ranges, partly developed over Waite Formation Tw |
| | | Qs | Sheet and dune sand | W & S parts | Up to 30 m thick |
| | | Qc | Colluvium, fanglomerate, eluvium scree; cobbles, sand, silt, clay | Sporadically throughout | Outwash fans and lower slopes of ridges |
| | | Cz | Slightly weathered rock related to Czc or underlying Czc | SE part | Flat to slightly undulating peneplain surface, commonly partly dissected by ?Holocene erosion |
| | | Czc | Fanglomerate; dissected alluvium and colluvium | S part | Outwash deposited on extensive peneplains flanking the ranges during or immediately preceding dune formation partly dissected lag gravel |

| ERA | PERIOD | ROCK UNIT AND SYMBOL | MAIN OR CHARACTERISTIC ROCK TYPES | DISTRIBUTION IN SHEET AREA | REMARKS |
|---|---|---|---|---|---|
| | Late Tertiary | Ts | Silicified rock | W part | Flat peneplain surface; commonly elevated and dissected with respect to Cz; possibly equivalent to Tlf |
| | Late Miocene and Early Pliocene | Waite Formation Tw | Siltstone, claystone limestone (commonly silicified), sandstone | NW part | Argillaceous sediments and chemical precipitates in very quiet, lacustrine environment. |
| | Early Tertiary or older | TlF | Laterite profile with well-developed ferruginous zone. | Southern-central & E parts | Best developed on coarsely crystalline rocks. Palaeomagnetic evidence suggests a Late Oligocene or Early Miocene age (Senior, 1980) |
| | | Tls | Siliceous lateritic rock silcrete | SE part | |
| | | Tla | Deeply weathered rock (undifferentiated) | NW par | |
| | Upper Jurassic to lower Cretaceous | Hooray Sandstone Jkh | Sandstone, feldspathic sandstone, siltstone, basal conglomerate in places. | SE part | Fluviatile. Age determined by palynomorphs from Eromanga Basin (Evans & Bunger in Exon & others, 1972). |

synclinal. The wide range in the sense of dip of the main schistosity in the Bonya Hills region suggest that this regional fold is of a different age to the regional schistosity and may be a second generation feature. In the area of Bonya Bore the informal members of the Bonya Schists are not repeated to the east so it is presumed that only the western limb of a synclinial structure is preserved. A fault block of Mascotte Gneiss Complex occurs farther east near Bonya Hill.

BASEMENT FAULTING

The basement in the region is divisible into two distinct structural provinces by the Delny-Mount Sainthill Fault Zone. South of the fault zone poorly exposed granulite and amphibolite facies rocks have dominantly northwesterly to northerly structural trends. North of the fault zone, rocks are of a slightly lower metamorphic grade although some are at granulite or upper amphibolite grade, and have a wide range of structural trends.

Rock types north and south of the fault zone are also markedly different. Granitic intrusions are abundant north of the fault-zone, whereas only minor granite occurs to the south. Pelitic rocks (Harts Range Group) south of the fault zone contain a predominance of oligoclase relative to potassium feldspar whereas north of the fault zone, schists, in particular the Bonya Schists, are rich in muscovite suggesting that they are more potassic. Mafic rocks, such as the mafic granulites in the Kanandra Granulites, are uncommon north of the Fault Zone.

Delny-Mount Sainthill Fault Zone (Warren, 1978)

The Fault System is discontinuously exposed and consists of anastomosing zones of schistose, deformed rock separating slivers of undeformed rock. In places the zone contains schistose and granular rocks showing retrogression to amphibolite facies and locally showing retrogression to greenschist facies. The Zone locally contains mylonitic quartz veins some of which are folded, indicating a prolonged history of movement. The extension of the Fault Zone east of Mount Thring is problematical. The Total Magnetic Intensity (TMI) map suggests that part of the Fault Zone may continue eastwards towards the Tarlton Fault in the Hay River 1:250 000 Sheet area (Northern Territory Department of Mines and Energy, 1982). The fault zone appears to splay near Mount Thring. One fault-arm separates Bonya Schist from the dominantly migmatitic quartzofeldspathic gneisses ($pC^1$) to the south. A second possible fault-arm corresponds to the Mount Baldwin Lineament (1981).

## Entire Point Fault

This is a southwest-trending deformed zone which merges with the Delny-Mount Sainthill Fault Zone west of Yam Creek Dam. An amphibolite facies schist zone occurs between two diverging faults, the southern of which is the Entire Point Fault. The foliation in the zone is south-dipping to vertical. Mylonite occurs in the zone at several localities (eg. DNEIPER GRS 406851 and 315814).

## Faults near Deep Bore, JINKA.

The rocks west of Deep Bore (e.g. Deep Bore Metamorphics) are transitional to the granulite facies whereas those to the east (e.g. Bonya Schist) have been metamorphosed under lower pressure conditions to the middle to upper amphibolite facies. This difference in metamorphic grade indicates a major northerly fault or faults in the Deep Bore area which must be Precambrian as Georgina Basin sediments unconformably overlie rocks of differing metamorphic grade to the east and west. The east-southeast photo-lineament immediately south of Deep Bore towards Molyhil may correspond to this pre-Georgina Basin Fault.

## Faults southwest of 9 Mile Bore, northwestern DNEIPER

North-westerly quartz-filled faults southwest of 9 Mile Bore (MACDONALD DOWNS GR 103 003) outline a fault zone which is also older than the Georgina Basin sequence because rocks between the faults are markedly different in metamorphic grade, but are nonconformably overlain by the same Georgina Basin units. Some of the quartz veins are themselves deformed. Tight folding in the Georgina Basin units along northwest-trending axes suggests reactivation.

## The Mount Baldwin Lineament (Warren, 1978; 1980, 1981)

This is a major lineament on LANDSAT imagery extending southeast from near Mount Baldwin. It is approximately coincides with the northeast edge of the Lake Caroline Gravity Ridge.

Maparta Fault Zone

This southeasterly trending fault extends into the Sheet area from the west. It marks the southern limit of outcrops of Kanandra Granulite and is possibly evident in the TMI magnetic map as far as the Entire Point Fault (NT Dept. Mines & Energy, 1982).

FAULTS DISPLACING BOTH BASEMENT AND COVER

Description of Faults

Major northwesterly faults are recognised east of Deep Bore. These fault blocks are terminated to the south against the Delny-Mount Sainthill Fault or its eastern extension. In the west of the region a complex belt of closely spaced west-northwesterly faults is developed.

Unnamed western faults

Several northwest-trending subparallel faults occur north of the Delny-Mount Sainthill Fault Zone in northern DNEIPER. They involve substantial vertical movement and may be high-angle reverse faults (BMR 1982). However, Simpson (1980) suggests these faults may be of a transverse (oblique) type as explained below.

Faults at the northern and eastern margins of the Bonya Block

An inferred splay of the Mount Saithill Fault extending eastwards from Mount Thring to near Baikal homestead forms the southern boundary of the Bonya Blcok. The Bonyer Fault displaces basement against the cover sequence at the eastern margin of the Bonya Block, and a series of en-echelon faults occur at the northeastern margin.

Faults at the northern and eastern margin of the Jervois Block

A fault at the northern margin of the Jervois Block by a sharp change in magnetic character, This fault diverges to the northeast. The Mount Playford Fault at the eastern margin of the Jervois Block is paralled some 4 to 6 km to the west by a complementary fault, the Lucy Creek Fault. A west-block-up movement is suggested for the Mount Playford Fault because a quiet magnetic response on the 1982 TMI map suggests sediments east of the fault. The same sense of movement is indicated for the Lucy Creek Fault and the two faults merge near Lucy Creek homestead.

Oomoolmilla Fault

The Fault is a high-angle reverse fault at the northern margin of the Jinka Granite. Structural planes in the fault Zone have a measured dip of about 75° south. Granite basement has been faulted northwards over steeply dipping to over-turned rocks of the Cambrian Arrinthrunga Formation and the Cambro-Ordovician Tomahawk Beds. A localised deposit of Oorabra Arkose up to 260 m thick alongside the fault (near Oorabra Rockhole immediately south of the fault) suggests that it may have been preceded by an earlier, possibly normal fault which was active in the Late Proterozoic during the early stages of depositon of the Georgina Basin sequence.

Charlotte Fault System

Two subparallel faults separate the Jinka Block from the Bonya Block to the east. The single fault in the north bifurcates to the south and these encloses a graben containing moderate to shallow south, as well as west and east-dipping, sediments of the Georgina Basin sequence. At field point H42 (GR JINKA 005913) adjacent formations (eg. Elkera and Mount Baldwin Formations) on either side of the Fault have an opposite sense of younging. Nearby quartz fault-fill also pervades the adjacent sediments.

AGE RELATIONSHIPS OF FAULTS

Numerous Palaeozoic and some Proterozoic faults affect the Georgina Basin sequence north of the Delny-Mount Sainthill Fault Zone. At least two generations of faults are recognised -

1) Late Proterozoic faults,
2) A Palaeozoic strike-slip and reverse fault system.

Late Proterozoic faults

Faults of possible Late Proterozoic age, are recognised locally throughout the region. Some faults with obvious Palaeozoic displacement are reactivated

Late Proterozoic or older features became the basement geology changes dramatically across them indicating larger displacement than can be accounted for by changes in the sedimentary sequence along..

The thickness and facies of sedimentary rocks making up the Lower Proterozoic successions differ from one major fault block to the next. For example, the Oorabra Arkose is of limited extent in the Jervois Block, absent in the Bonya Block, but present in the Blocks further west. Similarly, the Mount Baldwin Formation is evident only in the Jervois, Bonya and Jinka Blocks.

Walter (1980) recognised that the thicker successions of Late Proterozoic sediments in the eastern part of the Georgina Basin outline a series of northwest-trending troughs. Several of these troughs are thickest on their eastern edge and, as such, form half-grabens. In the Huckitta region Walter (1980) postulates half-grabens to explain local thickening of the Mount Cornish Formation east of Mount Cornish (S.E. JERVOIS RANGE) and the Oorabra Arkosa southeast of Elkera No. 2 Bore (E. DNEIPER).

A more localised example of Proterozoic faulting is the en-echelon group of faults near Twins Bore. These have large displacements in the basement and in the overlying Grant Bluff Formation, minor displacements in the Elkera Formation, and no or minor displacements in the unconformably overlying Mount Baldwin Formation. The faults are localised in the limb of asymmetrical folds. Penetration of the Mount Baldwin by one fault is considered to be due to later localised reactivation.

Another possible example of Proterozoic faulting is recognised east of Elkedra No. 2 Bore (in DNEIPER) where a fault affecting Elyuah Formation, and probably affecting the Oorabra Arkose, does not penetrate the Elkera Formation.

Similarly, the northwest-trending Oorabra quartz veins in the Jinka Block cut the Oorabra Arkose at several places (e.g. N of Mt. Thring, SE of Mapata WH, N of Elyuah Range). They also cut the Mount Cornish Formation, and probably cut the Elyuah and Grant Bluff Formations just west of Grant Bluff. However, they do not penetrate the Mount Baldwin Formation or younger units. Consequently, many of these faults and veins may have been formed during the time interval corresponding to the unconformity at or near the Cambrian-Precambrian boundary. Phenoclasts in the Oorabra Arkose contain both galena and fluorite in a matrix of vein quartz and are probably derived from erosion of Oorabra Reefs.

Palaeozoic strike-slip and reverse fault system

Palaeozoic faults, which may be of a transverse (oblique) type (Simpson, 1980), are particularly abundant west-northwest of Deep Bore. They have west-northwest trends and are accompanied by folding. The best example is the fault north of Mopunga Range. Here, a slight swing in strike 2.5 km northeast of Elkera No. 2 Bore suggests a right-lateral displacement and may explain the westwards displacement of the Elyuah Formation. However, the repetition of sedimentary strike ridges may also be explained by northerly dipping reverse faults as shown in the Preliminary 1:100 000 map of DNEIPER (BMR, 1982).

Palaeozoic strike-slip and reverse faults in the central and eastern part of the region form a fault-system similar in style to that of the Toomba Fault located about 250 km to the east-southeast (Simpson, 1980). For each major northwesterly fault between Deep Bore and Paradise Bore, the displacement of the basement-cover contact is farther north for each block lying progressively further to the west. The same sense of displacement also holds for sediments west of Deep Bore. This fault pattern suggests a major dextral (right-lateral) fault-system similar to the Toomba Fault (Cf. Harrison, 1980). The Toomba Fault system includes south-dipping thrust sheets shown in the cross-section of the Adam Special 1:100 000 map (BMR, 1978). Although wrenching may be involved in the Huckitta region, it has not been of the convergent-type as is the case with the Toomba Fault.

The Oomoolmilla Fault, although a high-angle reverse fault, may be a continuation of the Charlotte Fault Zone. Two curved, connecting faults occur northeast of Mount Sandy. As such the Charlotte Fault Zone may be predominantly a right-lateral strike-slip zone in its later stages and the Oomoolmilla Fault may have been formed by the same northerly directed compressional event. However, the distribution of the Mascotte Gneiss Complex, as presently mapped, does not support this interpretation.

A similar, smaller, sigmoidal curve in the Charlotte-Oomoolmitta fault system occurs at the western end of the Oomoolmilla Fault near Mappata Waterhole. Major splay faults continue to the northwest in both cases where the fault-system changes strike from northwesterly to easterly.

Further north the northwest-trending faults, such as the Lucy Creek and the Picton Fault Zones are combinations of high-angle normal and reverse faults, monoclines and belts of complex tight anticlines and synclines. They appear to be the result of reactivation of pre-existing structures in the basement.

FOLDING OF THE GEORGINA BASIN SEQUENCE

Sediments of the Georgina Basin were folded in two phases. The first, termed the Huckitta Movement (Walter, 1980) occurred in the very latest Precambrian and involved rocks up to the Elkera Formation. In the northeast Jervois Range these folds occurred along east-west axes. The overlying Mount Baldwin Formation is not folded. The second, undated but a probable correlate of the Alice Springs Orogeny, produced broad-scale folding along northwest axes and had its maximum development in the Dulcie Syncline. Reactivation of basement structures probably occurred during the same event.

REGIONAL METAMORPHISM

Metamorphic assemblages in rocks of the Kanandra Granulite in the northwest indicate granulite grade regional metamorphism. Typical mineral assemblages are orthopyroxene + clinopyroxene-plagioclase in mafic rocks. Brown - green hornblende in these mafic rocks is considered texturally younger and due to a later phase of hydration at lower temperatures and pressures. Calc-silicate assemblages include garnet + diopside + plagioclase and scapolite + wollastonite + diopside + calcite. Felsic rocks contain the assemblage garnet + orthoclase ± orthopyroxene ± biotite. The biotite may be due to hydration of garnet + orthoclase at elevated temperatures. Cordierite, present in rare aluminous felsic rocks is thought to be formed during a later phase of hydration. A second, lower temperature phase of hydration has produced assemblages containing blue-green hornblende, chlorite and/or epidote.

The metamorphics at Tower Rock and the Deep Bore Metamorphics to the north were also metamorphosed to granulite facies. The Cackleberry Metamorphics to the northeast contain the assemblage cordierite-K feldspar indicating upper amphibolite facies conditions. Retrograde sillimanite has been identified in pelitic rocks from this unit. Anthophyllite is widely distributed, but may be retrograde.

South and southeast of the Entire Point and Mount Sainthill Faults the Harts Range Group have been metamorphosed to amphibolite facies. Typical schistose gneiss in the Irindina Gneiss, for example consists of garnet-biotite-plagioclase-quartz ± sillimanite and pods of amphibolite in the Gneiss consist of hornblende-plagioclase ± quartz ± diopside. An upper amphibolite grade is indicated. A common assemblage in calc-silicate rocks is scapolite-diopside-plagioclase-calcite-quartz ± phlogopite. Further south near ILLOGWA CREEK muscovite becomes abundant in the schistose gneiss, but it is considered to be a later secondary mineral possibly related to the emplacement of the Harts Range pegmatites.

A lower pressure metamorphism affected the Bonya Schists and the Mascotte Gneiss Complex in the east; this metamorphism may be related to the igneous phase responsible for the emplacement of abundant higher-level granites in that region. Schists have the assemblage K-feldspar + muscovite + biotite ± andalusite. Rare schists of slightly different composition near Baikal in the south contain garnet + sillimanite and cordierite-bearing rocks occur near the Attutra Mine (Dobos, 1978). Dobos (1975) records the following assemblages -

Pelitic rock: quartz + muscovite + magnetite ± biotite ± andalusite ± cordierite ± chlorite and fibrolite at the highest grades.

Ferropelite: quartz + magnetite + almandine + chlorite ± staurolite ± andalusite ± biotite.

Banded iron information: quartz ± magnetite ± spessartine ± chlorite ± staurolite

Amphibolite: hornblende + plagioclase ± epidote ± quartz

The main metamorphism, in the Bonya-Jervois region at least, must pre-date the Jervois and equivalent granites which have a Rb-Sr age of about 1750 m.y. (Black, 1980). It is therefore likely to be the Strangways Metamorphic Event (Black, 1975; Iyer & others, 1976; definition of event in Shaw & others, 1979; 1980).

The youngest isotopic redistribution detected in the Jervois Range area at about 1470 m.y. (Black, 1980) may correspond to a retrogressive metamorphic event.

## ECONOMIC GEOLOGY

Smith & Woolley (1957), Woolley and Rochow (1965), Grainger (1967) Warren & others (1974, 1975), Stewart & Warren (1976) and Warren (1980) have previously briefly described the mineral occurrences and deposits in the region. The following is an outline of mineral commodities arranged in alphabetical order.

### APATITE

Coarse grained apatite crystals and aggregates occur in a quartz reef in the Delny-Mount Sainthill Fault at GR JINKA 736832 and 730833.

BARITE

Barite commonly accompanies fluorite in thick quartz veins. These deposits have been described by Ivanac & Pietsch (1976) (See description of Oorabra Reefs). Barite occurs in veins west and south of the Mopunga Range.

Barite also occurs in the Errarra Beds (Lower Cambrian) at field point H147 (GR JINKA 838850) as very coarse crystals and pseudomorphs of the hylithid Biconulites.

BASE METALS (Copper-lead-zinc)

Jervois Mining District (Cu, Pb, Zn)

Patchy copper-lead-zinc lodes occur in the Bonya Schist at various stratigraphic levels over a thickness of about 500 m immediately east of the Jervois Range; the mineralized section is referred to as the Attutra Zone (Watson, 1975). The lodes are stratabound. The mineralised section consists of andalusite muscovite and muscovite schists containing finely-layered quartz-magnetite horizons and ferruginous schist. Garnet-biotite quartzite, garnet-chlorite rock and cordierite-bearing schist have been intersected in drill holes throughout the mineralised section. Discontinuous layers of calc-silicate rock, typically containing galena, occur in the hanging wall. The mineralised interval can be traced along strike for about 7 km.

The copper bodies were discovered by Hanlon & Mudge in 1927. In 1939 Blanchard (1940) inspected the area for Mount Isa Mines and concluded that the copper potential was limited. Mapping was carried out in the Jervois Copper district in 1959 by BMR (Robertson, 1959) who noted scheelite mineralisation. The mining district has been investigated intermittently since then by a number of workers (see Summary and Bibliography by Warren & others, 1974). In particular, Gold Fields Pty Ltd investigated the principal lodes between 1961 and 1964 (Wilson & Ward, 1962). Gold Fields calculated established reserves at 2.4 million tons of 1.98% Copper to an average depth of 94.5 m. The reserves were identified over four areas known as Bellbird (GR JR 271 905), Green Parrot (GR JR 297935), Marshall and Reward (both GR JR 320950). An extensive drilling program was later carried out by Union Corporation (Golner, 1974, 1975; Golner & others, 1974). Union Corporation calculated ore reserves of 2,085 000 tonnes of 3.07% Cu and 55.0 gm/tonne Ag with an approximate average true width of 4.7 m; based on a 1% Cu cut-off grade. Petrocarb Exploration Ltd., have estimated reserves at 3.35 million tonnes of 0.3-4.1% Cu and 9.0-11.2% lead (Warren, 1980). Reported bismuth values range up to 0.01% (Holmes, 1972) and some silver occurs with lead. A grab sample (3544B) of part of the garnet-biotite-quartzite horizon collected in 1980 (containing chalcopyrite but without garnet) assayed 1.7% Cu, 620 ppm Zn, 170 ppm Pb, 10 ppm Ag, 90 ppm Bi, 7.4% Fe, 1700 ppm Mn and 250 ppm P (see Appendix). A surface grab sample (3342B) of copper-stained magnetite-quartzite within a thin zone of ferruginous schist contained 1000 ppm Cu, 65 ppm Pb, 60 ppm Zn, 3 ppm Ag, 18% Fe, 8800 ppm Mn, 1700 ppm P (analysis as above).

Watson (1975) pointed out that the type of banded iron formation present suggests a special relationship with a volcanic section in the sequence. He noted that probable altered rhyolites and tuffs are found in the southern section of the field and also to the east, outcropping with amphibolite, but warned that "field evidence is as yet too thin to propose a volcanic exhalative source for any or part of the lodes".

Copper lodes are localised in magnetite quartz schist in the eastern part of the mineralised sequence. Here, massive chalcopyrite is interbanded with the quartz and fine-grained sulphides (commonly chalcopyrite, pyrite, bornite and minor pyrrhotite) (Watson 1975). The copper mineralisation is localised in quartz magnetite lenses and in this respect the environment appears similar to that at Pegmont, 150 km south of Cloncurry (Stanton & Vaughan, 1977; Loscei 1977). However, unlike the Pegmont deposits those at Jervois are localised in and adjacent to calcareous sediments. Lead lodes occur in muscovite schist and calc-silicate rock (so-called 'skarn') and consist of medium-grained galena and sphalerite with subordinate bornite and pyrite, together with gangue minerals, chiefly garnet, calcite and diopside (Watson, 1975). Scheelite mineralisation is disseminated in the calc-silicate rocks in the western part of the mineralised sequence south and north of the main base metal deposits (see tungsten).

## Bonya Copper District (Cu)

Traces of copper carbonate in quartz veins are localised in the Kings Legend Amphibolite Member. Disseminated chalcopyrite and pyrite are also evident in the amphibolite locally (e.g. field point 1143 GR JERVOIS RANGE 016925). Several copper deposits including the Bonya Mine form cross-cutting ore bodies in a variety of country rocks and are considered to be hypogene.

Bonya Mine (GR JERVOIS RANGE 091869).

Copper occurs in quartzofeldspathic gneiss near the base of the Bonya Schist. Bornite, chalcopyrite, chalcocite and pyrite fill fractures in brecciated vein quartz which cuts the gneiss. Secondary minerals include malachite and azurite.

Green Hoard Prospect (GR JINKA 987959). (Also known as Yarraman Prospect).

Copper and minor scheelite also occur nearby in a skarn rock alongside a pegmatite. The Green Hornet is a small copper prospect nearby.

Kings Legend Mine (GR JERVOIS RANGE 142808).

A small copper occurrence associated with amphibolite.

Petra Prospect (GR JERVOIS RANGE 118889).

Copper carbonates occur in small folded amphibolite within a schist sequence and are also concentrated in the brecciated part of a cross-cutting quartz vein.

Ramsay's Prospect (GR JERVOIS RANGE 105892).

The Prospect is a small copper occurrence in the Kings Legend Amphibolite.

Xanten Prospect (GR JERVOIS RANGE 109912 - FP 1237).

Pyrite and copper sulphide occur in a small patch within a ferruginised quartz rock which persists along strike for 200 m. The surrounding rock is a muscovite-biotite schist containing small lenses of amphibolite some of which show traces of copper carbonate. A small granite body occurs nearby. The ferruginised rock is considered to be localised in a fault.

## Lead deposits 4a at the base of the Georgina Basin Sequence

Galena occurs as fine to very coarse grains in barite veins within the Oorabra Arkose (Late Proterozoic) at the southeastern end of the Elyuah Syncline

(GR JERVOIS RANGE 031767). Near the Oorabra Waterholes galena occurs as single and composite grains up to 15 mm across within the Oorabra Arkose (1896). The latter galena is considered to be detrital.

DIAMONDS

An assessment has been made of the region for diamonds (Keane & Hoyle, 1974).

FLUORITE

Fluorite and barite are a minor component of several of the Oorobra Reefs in the southern part of the Jinka Granite (Ransom, 1970). At least 20 fluorite occurrences are known in fissure veins and stockworks which cut the Jinka Granite (Hill, 1972). Comb and ribbon-structures in the veins indicate that tensional structures have been filled during several episodes. Several of these veins, known as the Oorabra Reefs (Brown, 1896, p. 6), cut the Late Proterozoic Elyuah Formation, and so are younger than the Jinka Granite. Fluorite, in concentrations up to 40%, has been intersected during company drilling over widths of about 5 m, and is commonly accompanied by up to 5% barite (Hill, 1972).

Fluorite and barite also occur in a quartz vein cutting granite Pgr west of the Mopunga Range. Cross-cutting fractures exposed on the Jervois opencut (1981) are filled by purple fluorite. A sheelite-fluorite-vesuvianite plug (Pioneer Prospect) occurs at the southern end of the Jervois synform.

MICA

Mica was mined in the Plenty River Field in southern JINKA up until about 1960. This field has been described in detail by Jensen (1947), Joklik (1955) and Woolley (1959). The best mica comes from coarse-grained, zoned, discordant pegmatites (Joklik 1955, P. 178).

MOLYBDENITE

Occurs with tungsten mineralisation at Molyhil. (see TUNGSTEN.)

TUNGSTEN

## General Setting

Scheelite in the region has been described by Watson (1971), Bowen & others (1971) and Ranson (1978). It is localised in calc-silicate rocks in three settings:

1. At the Molyhil Mine scheelite, molybdenite, pyrite, and a trace of chalcopyrite occur in a magnetite calc-silicate rock forming a lenticular roof-pendant in a leucogranite. The leucogranite is lithologically similar to the Marshall Granite.
2. In the Bonya area scheelite occurs in a quartz-epidote rock and also in a garnet amphibole (blue) calc-silicate rock within the Bonya Schist up to 5000 m above, 2000 m below, and within the Kings Legend Amphibolite Member. Molybdenum values are slightly anomalous in these calc-silicate rock lenses (i.e. 30 to 150 ppm, semi-quantitative emisssion spectroscopy for rock chips at field points 3528, 3536, 3542) and suggest that the region may be prospective for molybdenite.
3. Scheelite occurs in calc-silicate rocks at the Crystallisation Plant, Green Parrot-West, and Bellbird-East Scheelite Prospects; all within 200 m of the Jervois copper-bearing horizons. Many of the calc-silicate rocks are vesuvianite rich. Scheelite is present in the hanging wall of the Jervois base-metal lode (Attutra). In additional, a discontinuous siliceous quartz-epidote horizon, some 2000 m above the lode, also contains low-grade scheelite mineralization.

Scheelite commonly occurs with quartz, less commonly with small amounts of calcite and rarely with fluorite. It occurs in vughs and cross-cutting veins. In addition, it appears to be more prevalent in epidote-rich calc-silicates, and this epidote appears to be secondary. Secondary tremolite (after amphibole) and sericite (after ? plagioclase) and rarely chlorite (after ? ordierite) may have been formed at the same time as the epidote. The relatively homogenous garnet-bearing quartz-epidote rock (sk) forms highly irregular patches within units containing layered calc-silicate rocks. The garnetiferous rock (sk) appears to have formed due to partial metasomatic replacement of calc-silicate rocks and may have formed during the same event responsible for the introduction of scheelite. Ransom (1978) recognised that mineralised carbonate-fluorite veins parallelled the regional axial-plane cleavage at the Bellbird-east Prospect and thus may have been introduced during formation of the "J" - fold in the Jervois region.

Bowen & others (1971) noted that scheelite in the Bonya District is generally restricted to within 400 m of granitic pegmatites where they cut calc-silicate rocks. This relationship is not surprising as the pegmatite is very widespread and abundant. Many of the scheelite occurrences in the Bonya District occur near the margin of a regional gravity low which may correspond with a granite body.

## Descriptions of Prospects

The main tungsten prospects are described below in alphabetical order.

Ashmara Prospect; W, cu; GR JERVOIS RANGE 115895.

References: Watson, 1971; Ransom, 1978.

Surface Workings: Several very small pits and doep costeans.

Country rock: Lode is at the contact between the King's Legend Amphibolite Member and a sequence of interlayered muscovite-biotite schist and calc-silicate rock.

Mineralised unit: Scheelite occurs around the periphery of a unit of garnet-epidote calc-silicate rock and in a quartz "blow" some 30 m to north. Immediately east of the quartz "blow" the quartz passes into a layered quartz-epidote calc-silicate rock. Scheelite is disseminated in the later calc-silicate rock roughly 150 m east of the "blow". The calc-silicate unit is directly on top of the Kings Legend Amphibolite Member.

Ore and Gangue: Scheelite, trace of copper carbonate.

Production: Nil.

Bellbird-East Prospect: W, GR: JERVOIS RANGE 277903 (Also known as the Rockface Cu prospect).

References: Watson, 1975; Ransom, 1978.

Surface working: Several shallow bulldozer consteans.

Country rock: Schist and unmineralised calc-silicate rocks containing vesuvianite-diopside and diopside-anorthite. Several larger plugs of vesuvianite-rich rock occur 100 m to the north.

Mineralised Unit: Mineralised calc-silicate rock, 10-20 m wide and 150 m long, cut by thin veins of carbonate and fluorite oriented parallel to the axial-plane cleavage of the regional fold.

Ore and Gangue: Low-grade patchy concentrations with abundant pale purple to white fluorite. Veins of fluorite, scheelite and calcite occur in unmineralised calc-silicate rock to north and post-date the metamorphism.

Drilling: Six diamond drill holes.

Grade: Almost certainly less than 0.3% overall (Ransom, 1978).

Crystallisation Plant Prospect; W, GR: JERVOIS RANGE 304950

References: Holmes, 1972; Ransom 1978.

Surface workings: Intensive trenching.

Country rock: Calc-silicate rock including marble and garnet-epidote-tremolite-quartz-calcite rock. Neither carry scheelite.

Mineralised Unit: 2-3 m wide by 50 m long unit of calc-silicate rock.

Ore and Ganue: Coarse grains and aggregates of scheelite occur within an epidote-quartz-tremolite-actinolite layer.

Drilling: Intensive percussion drilling to a depth of 15 m (Holmes, 1972).

Grade: Holmes (1972) reports about 5000 tonnes of 0.83% $WO_3$ is indicated to a depth of 15 m.

Damascus Prospect; W, Cu; GR: JERVOIS RANGE 600902

References: Watson, 1971; Ransom, 1978;

Surface Wrokings: Several costeans.

Country rock: Andalusite-bearing mica schist; cross-cutting tourmaline-bearing pegmatites are common. Prospect lies from 50 to 200 m above top of Kings Legend Amphibolite Member.

Mineralised Unit: Tightly folded, epidote-garnet calc-silicate rock about 300 m long and 5-10 m wide. Layering is very fine. Scheelite mineralisation is patchy.

Ore and Gangue: Scheelite; copper carbonate stains surface of calc-silicate rocks. Grab samples (3528, 3531 this Record) of the calc-silicate rock gave up to 1000 ppm and 150 ppm Mo. (Appendix C).

Green Parrot-West Prospect, W. Cu; GR:JERVOIS RANGE 296938

Reference: Ransom, 1978.

Surface Workings: Three east-west trenches.

Country rock: Knotted schist.

Mineralised Unit: Two 3-6 m wide calc-silicate units occur over a strike length of 400 m. These units are within 200 m of the copper-bearing unit on the opposite side of the lode from the Crystallisation Plant Prospect. The calc-silicate rock is dominantly vesuvianite, diopside and garnet containing mineralised vughs and veins and some quartz-epidote rocks. The diopside is altered to epidote-sericite aggregates. The calc-silicate rock is interlayered with schist units.

Ore and Gangue: Vughs and veins consist of quartz, epidote, fluorite, calcite, and accessory scheelite.

Drilling: Five diamond drill holes designed to intersect calc-silicate units.

Grades: Generally low: a few narrow (less than 2 m) patches up to 1.5% $WO_3$ were intersected in drilling.

Jericho Mine; W, Cu; GR JERVOIS RANGE 143892

References: Ransom 1978; this Record.

Surface working: Small opencut.

Country rocks: Muscovite-biotite schist. Pegmatite cutting mineralised calc-silicate rock may have been intruded along an east-west fault (Ransom, 1978). This pegmatite also truncates a smaller north-south pegmatite dyke.

Lode: Scheelite is disseminated in a grossular (pale) epidote calc-silicate rock at its contact with a large body of pegmatite. The epidote may be a primary metamorphic mineral rather than an alteration product as at Jervois, Samakand and White Violet Prospects (Ransom, 1978). The calc-silicate rock is cut by quartz veins and vugh fillings. The calc-silicate rock trends north south parallel to the foliation in the surrounding schist and is exposed over a length of 100 m. It is up to 6 m wide.

Ore and Gangue: Scheelite is spacially associated with quartz veins and vughs. Copper carbonate stains lode rocks.

Drilling: One of six diamond drill holes drilled by Petrocarb Exploration NL (SJ5) intersected 5.6 m of 1.13% $WO_3$ but a second hole (SJ6) 15 m north intersected calc-silicate rock with values of less than 0.2%. Analysis of calc-silicate sample containing scheelite (3543 from mined ore - this report) gave 100 ppm V and 15 ppm Mo (Appendix C).

Grade: Erratic.

Production: Mined briefly by Petrocarb Exploration NL in 1972. Possibly several thousand tonnes are currently "at grass" awaiting treatment.

Kings Legend (Tungsten) Prospect; W, Cu; GR JERVOIS RANGE 147802

References: Paine, 1971c; this Record

Surface workings: Two costeans

Country rock: Spotted amphibolite and well-layered marble with siliceous bands and layers; some fine-grained muscovite schist.

Lode: Scheelite reputed to be in calcareous units.

Marrakesh Prospect; W, Cu, Mo; GR JERVOIS RANGE 082904

References: Watson, 1971; Ransom, 1978.

Surface Workings: Negligible.

Country rock: In Kings Legend Amphibolite Member close to its top.

Minerals Unit: Garnet-epidote calc-silicate rock (sk).

Ore and Gangue: Some coarse grains of scheelite occur in an extensive cover of coarse scree.

Production: Nil.

City of Medina Prospect; W; GR JERVOIS RANGE 125907

References: Watson 1971; Ransom, 1978; this Report.

Surface workings: One small pit, 2 m diameter and 1 m deep.

Country rock: Muscovite schist and biotite - muscovite schist. Foliation trends north.

Mineralised unit: Scheelite occurs in a well-layered carbonate quartz-vesuvianite-diopside-grossularite calc-silicate rock. Vesuvianite encloses and filled fractures in the grossularite and diopside, and is also weakly disseminated in a small body of pegmatite 100 m to the north. The calc-silicate rock trends east-west and cross-cut by a pegmatite.

Ore and Gangue: Scheelite forms an irregular mass cross-cutting a vesuvianite-epidote patch (in specimen 1168A), also forms subhedral crystal alongside carbonate and epidote (also specimen 1168).

Grade: The western half of the long calc-silicate unit may carry in excess of 0.5% $WO_3$ over a 3 m width (Ransom 1978), but the eastern half appears much lwoer grade at the surface.

Molyhil Mine; W, Mo, Cu; GR: JINKA 769828

References: Ransom, 1978; Barraclough, 1979.

Surface Working: 10 m deep. "U" shaped open-cut in 1980.

Country rock: Leucogranite like Marshall Granite.

Lode: A mineralised roof pendant of calc-silicate rock in the granite. Some scheelite occurs in patches of apatite-amphibole-magnetite-quartz rock (Ransom 1978) as well as in lesser amounts in later quartz and calcite patches in the calc-silicate rocks. These calc-silicate rocks consist of diopside (or hedenbergite), garnets, scapolite, and sphene and minor secondary chlorite epidote, and later calcite and quartz.

Ore and Gangue: Quartz-magnetite-blue-green amphibole (hastingsite or riebeckite) rock containing scheelite. Accessory minerals include pyrite, chalcopyrite, molybdenite and allanite. Blue-green amphibole shows minor alteration to tremolite.

Production: Pegged by the Johannsen family in 1971. A small-scale operation produced 350 tonnes of scheelite concentrate between 1974 and 1978.

Molyhil Pinnacle Prospect; W GR JINKA 761830

References: Ransom, 1978; Barraclough, 1979

Surface Working; Shallow trench.

Country rock: Uncertain, possibly granite under thin eluvial cover.

Lode: Scheelite occurs in concentrations parallel to bedding accompanied by quartz and calcite in a garnet-scapolite diopside (or hedenburgite) calcc-silicate rock containing accessory apatite and blue-green amphibole. Minor epidote alteration. The calc-silicate rock is finely layered.

Drilling: Two holes.

Remarks: Limited potential.

<u>Pioneer</u> 'B' Prospect; W. GR JERVOIS RANGE 301958

Coarse-grained scheelite occurs in a scheelite-fluorite-vesuvianite plug at the southern end of the Jervois synform (Robertson, 1959).

References: Ransom, 1978.

<u>Samakand Prospect</u>; W, Cu. GR. JERVOIS RANGE 120852

References: Henstridge, 1972; Ransom, 1978.

Surface Workings: Trenched with bulldozer.

Country rocks: Bonya Schist at upper contact with Kings Legend Amphibolite Member.

Mineralised rock: Small amounts of scheelite are scatterd through a 10-20 m wide calc-silicate unit over a length of 3000 m. The calc-silicate rock contains calcite-garnet-blue amphibole and quartz. Epidote, calcite, sphene and tremolite occur as products of alteration or retrograde metamorphism.

Ore and Gangue: Scheelite occurs as coarse-grains and aggregates in quartz fillings and veins in the calc-silicate rock.

Drilling: 40 shallow percussion drilling to depths of 16 m or less by Central Pacific N.L. Best intersections were 3.77% $WO_3$ in SAM-PH 678 at 5-6 m depth and 2.77% $WO_3$ in SAM-PH 100 at 6-8 m depth.

Grade: Estimated by Central Pacific N.L. to be of the order of 0.2 to 0.4%. $WO_3$. Distribution is very patchy.

Production: Nil.

Tashkent Prospect; W; GR JERVOIS RANGE 167883

References: Watson, 1971; Ransom, 1978

Surface Workings: A number of discontinuous costeans in one or two calc-silicate units.

Country rocks: Andalusite schist.

Mineralised unit: One unit of garnet-epidote - amphibole calc-silicate rock containing desseminated scheelite over a 70 m strike length. A second calc-silicate rock like that at Jericho-South, contains patchy scheelite mineralisation over a 150 m length and 2 m width.

Ore and Gangue: Scheelite.

Grade: Grade in first calc-silicate rock estimated to contain 1% scheelite overall (visual estimate from ultraviolet fluorescence, Ransom, 1978). Grade in second calc-silicate rock is unknown.

Production: Nil.

Wells Show Occurrence; W, Cu; GR JERVOIS RANGE 071909

References: Nye & Sullivan, 1942; Morrison, 1968; this Record.

Surface Workings: A hand excavated costean 1 m wide, 15 m long and up to 1 m deep. The first scheelite occurrence discovered in the Bonya Creek area.

Country rock: East-striking 100 m wide dolerite in well-crenulated muscovite schist; 200 m below base of Kings Legend Amphibolite Member.

Mineralised unit: Mineralised quartz vein cts dolerite, trends NNW.

Ore and Gangue: Minor scheelite presumed to occur (Nye & Sullivan, 1942). Copper carbonate stains quartz bein.

Production: Nil.

White Violet Prospect; W, Cu; GR JERVOIS RANGE 096858.

References: Paine, 1971a; 1971b; Henstridge, 1972; Ransom, 1978; Warren, 1980.

Surface Workings: Trenched.

Country rocks: Mica schist and some unmineralised epidote-bearing calc-silicate rock.

Mineralised unit: 150 m long by 8 m wide calc-silicate unit consisting of epidote and garnet-rich calc-silicate rock (sk), some epidote and garnet-rich calc-silicate layered amphibolite (pa) and marble (mb). The original calc-silicate assemblage seems to have been garnet (? andradite) hedenbergite-hastingsite (or riebeckite) - quartz. The epidote rocks are considered to be largely an alternation product. The marble contains some scapolite and accessory tremolite and sphalerite.

Ore and Gangue: The scheelite mainly occurs along joints, but is also finely disseminated in the marble.

Drilling: One (WV-PHZ4) of a series of percussion holes to shallow depths (less than 30 m) intersected the main mineralised lenses. (Henstridge, 1972). The best grade was 2.39% $WO_3$ over the interval 18-20 m.

Ore Grade: An average grade of 0.4% $WO_4$ was estimated by Central Pacific N.L. from point sampling (Henstridge, 1972).

Production: Nil.

ZINC, LEAD

Accompanies COPPER mineralisation at Jervois. (See earlier description).

VANADIUM

Small magnetite bodies in gabbro 8-10 km northeast of Jervois Mine contain traces of copper and vanadium (Wright, 1974).

REFERENCES

ARMSTRONG, R.L., & STEWART, A.J., 1975 - Rubidium strontium dates and extraneous argon in the Arltunga Nappe Complex, Northern Territory. Journal of the Geological Society of Australia, 22(1) 103-115.

BARRACLOUGH, D., 1979 - Geological investigations of the Molyhil Scheelite Mine, Central Australia. Northern Territory Geological Survey Report GS 79/6 (unpublished).

BEHY, H.J., DEN TEX, E., DE WAARD, D., MEHNERT, K.R., SCHARBERT, H.G., SOBOLEV, V., WATZNAVER, A., WINKLER, H.D.F. WYNNE-EDWARDS, H.P., ZOUBER, V., & ZWART, H.J., 1971 - Granulites. Results of a discussion. News Jahrbuch fur mineralogic, Monatshefte, H3, 97-123.

BELL, T.H., & ETHERIDGE, M.A., 1973 - Microstructure of mylonites and their descriptive terminology. Lithos, 6, 337-48.

BLACK, L.P., 1975 - Present status of geochronological research in the Arunta Block in PROTEROZOIC GEOLOGY 1st Australian Geological Convention, Adelaide, South Australia, May, 1975. Geological Society of Australia, Abstracts.

BLACK, L.P., 1980 - Rb-Sr geochronology of the Jervois Range area in the eastern part of the Arunta Block, N.T. BMR Journal of Australian Geology & Geophysics, 5, 265-270.

BLACK, L.P., SHAW, R.D. & OFFE, L.A. 1980 - The age of the Stuart Dyke Swarm and its bearing on the onset of late Precambrian sedimentation in central Australia. Journal of the Geological Society of Australia, 27, 151-155.

BLACK, L.P., SHAW, R.D., & STEWART, A.J., 1983 - Rb-Sr geochronology of Proterozoic events in the Arunta Block, central Australia. BMR Journal of Australian Geology & Geophysics, 8, 129-138.

BLANCHARD, R., 1940 - Report on Jervois Copper Mines. Anglo-Queensland Mining Pty Ltd Report (unpublished).

BOWEN, B.K., HENSTRIDGE, Q.A., & PRAIN, G.G., 1971 - Jinka Plain EP 603 - Geology of scheelite mineralisation in the Bonya area, Northern Territory. Central Pfacific Minerals NL Report NT-39. Open File Report - Northern Territory Geological Survey, Office File (unpublished).

BMR, 1978 - Adam special 1:100 000 Preliminary Map, Bureau of Minerals Resources, Australia.

BMR, 1982 - DNEIPER 1:100 000 Preliminary Map, Bureau of Mineral Resources, Australia.

BROWN, A., 1971 - Flourite mineralisation and its setting in the western part of the Jinka Plains, Northern Territory of Australia. B.Sc. (Hons) Thesis. University of New England, Armidale, NSW, Nov. 1971 (unpublished).

BROWN, H.Y.L., 1896 - Report on Arltungan Goldfield and Harts Mica Field. South Australian Parliamentary Paper 127.

CHAPPELL, B.W., & WHITE, A.J.R., 1974 - Two contrasting granite types. Pacific Geology, 8, 173-4.

CLARKE, D.B., 1978 - Dneiper-Middle Dam Locality Preliminary Report. Northern Territory Geological Survey Report GS 78/10 (unpublished).

COONEY, R.G., 1973 - Report on EL 339, Neptide Mineral Exploration Pty Ltd Report, (unpublished).

DIETRICH, R.V., 1960 - Nomenclature of migmatitic and associated rocks Geotimes, Jan-Feb 4 (5), 1960.

DOBOS, S.K., 1975 - Metamorphism in the northeast Arunta Block, N.T. - Geological Society of Australia Incorporated, Abstracts of First Australian Geological Convention - Proterozoic Geology - Adelaide, 1975, 38.

DOBOS, S.K., 1978 - Phase relations, element distributions and geochemistry of metamorphic rocks from the Eastern Arunta Block, N.T. Ph.D. Thesis, School of Earth Science, Macquarie University, North Ryde.

EXON, N.F., 1966 - Revised Jurassic to Lower Cretaceous stratigraphy in the southwest Eromanga Basin, Queensland. Queensland Government Mining Journal, 67 (771) 232-8.

FARRAND, M., 1981 - Thin section descriptions of rocks from near Jervois Range, Arunta Block. Australian Mineral Development Laboratories.

GARY, M., McAFEE Jr, R, & WOLF, C.L., (eds), 1973) - GLOSSARY OF GEOLOGY. American Geological Institute, Washington, DC.

GOLNER, P.T., 1974 - Final report to 29th August, 1974 EL 584. Union Corporation (Australia) Pty Ltd (unpublished).

GOLNER, P.T., 1974 - Final report to 29th August, 1975 EL 584. Union Corporation (Australia) Pty Ltd (unpublished).

GOLNER, P.T., 1975 - Final report to 29th August, 1975, EL 584. Union Corporation (Australia) Pty Ltd unpublished).

GOLNER, P.T., TURNER, A.T., & WRIGHT, J.F., 1974 - Report on the investigation of EL's 584, 740 and associated mineral claims, Jervois Range area, Northern Territory. Union Corporation (Australia) Pty Ltd (unpublished).

GRAINGER, D., 1967 - Jervois Range copper and lead deposits. Northern Territory Geological Survey Files, Alice Springs MBR/67/5.

HARRISON, P.C., 1980 - The Toomba Fault and the western margin of the Toko Syncline, Georgina Basin, Queensland and Northern Territory. BMR Journal of Australia, Geology & Geophysics. 5(3) 201-214.

HENSTRIDGE, D.A., 1972 - 1972 percusion drilling programme, NT-16 Jinka Plain, EL 603 (EX PA 2282), Samarkand & White Violet tungsten prospects. Central Pacific Minerals NL Report, (unpublished).

HILL, J.H., 1972 - Progress Report on Authorities to Prospect 2282 and 3156 with special reference to fluorite potential. Jinka Plain and Oorabra - Northern Territory. Central Pacific Minerals, NL Report NT 34 (unpublished).

HOLMES, A.P., 1972 - Prospecting Authority 3148. Report for year ending 10 May 1972. Petrocarb NL, Open File Report - Northern Territory Geological Survey, Office File (unpublished).

HOLMES, A., 1965 - Principles of Physical Geology (Second Edition). Nelson, London 1288 pp.

HORSFALL, C.L., 1981 - Notes on ground magnetometer and scintillometer traverses 1 and 2, Jervois Range area (Huckitta 1:250 000 sheet SF 53-11).Northern Territory Geological Survey, Technical Report GS 81/2 (unpublished).

HURLEY, P.M., FISHER, N.H., PINSON, W.H., & FAIRBURN, H.W., 1961 - Geochronology of Proterozoic granites in the Northern Territory, Australia. Part 1: K-Ar and Rb-Sr age determinations. Bulletin of the Geological Society of America, 72, 653-62.

IVANAC, J.F., & PIETSCH, B.A., 1976 - Jinka Plains Fluorite-Barite-Quartz Veins in Economic Geology of Australia and Papua New Guinea (Knight, C.L., ed) 4. Industrial Minerals and Rocks. Australian Institute of Mining and Metallurgy Monograph Series 8, 143-5.

IYER, S.S., WOODFORD, P.J., & WILSON, A.F., 1976 - Rb-Sr isotopic studies of a polymetamorphic granulite terrane Strangways Range, central Australia. Lithos 9, 211-224.

JENSEN, H.I., 1947 - The origin, distribution and mode of occurrence of mica in central Australia. Proceedings of the Royal Society of Queensland 57(4), 37-52.

JOKLIK, G.F., 1955 - The geology and mica-fields of the Harts Range, Central Australia. Bureau of Mineral Resources, Australia, Bulletin 26.

KEANE, E., & HOYLE, M.W.H., 1974 - Report for quarter ended 23/7/74, EL 984. Report for Anglo-America Ltd Northern Territory Geological Survey Files, Alice Springs, CR/78/18.

LAPWORTH, C., 1885 - The highland controversy in British geology. Nature 32, 558-559.

LEAKE, B.E., 1978 - Nomenclature of amphiboles. The Canadian Mineralogist 16(4), 501-520.

LOCSEI, J., 1977 - Pegmont: a stratiform lead-zinc deposit in the Precambrian of northwest Queensland. Australasian Institute of Mining and Metallurgy, Proceedings 262, 25-27.

McINTYRE, G.A., BROOKS, C., COMPSTON, W., & TUREK, A., 1966 - The statistical assessment of Rb-Sr isochrons. Journal of Geophysical Research, 71, 5459-68.

MORGAN, W.R., 1959 - The petrology of the Jervois Range Mining area. Bureau of Mineral Resources, Australia, Record, 1959/109 (unpublished).

MORRISON, M.E., 1968 - Jervois Range reconnaissance trip - July 1960 Miles "Big Copper Show". Wells Scheelite Show, Miles "Bony & Bone Copper Shows". VAM NL Report (unpublished).

NEWTON, R.C., & WOOD, B.J., 1979 - Thermodynamics of water in cordierite and some petrological consequences of cordierite as a hydrous phase. Contributions to Mineralogy and Petrology 68, 391-405.

NORTHERN TERRITORY DEPARTMENT OF MINES AND ENERGY, 1982 - Magnetic Intensity contours southern-half Huckitta 1:250 000 sheet area.

NYE, P.B., & SULLIVAN, C.J., 1942 - The tungsten deposits of the Northern Territory and the possibility of obtaining further supplies of ore from them. AERIAL Geological and Geophysical Survey of north Australia. Report for period ended 3 March, 1942.

PAINE, G.G., 1971a - White Violet Tungsten Prospect, Jinka Plain, Northern Territory. Progress Report on Authority to Prospect 2283 - sampling procedures and results. Central Pacific Minerals NL, Report NT-41 (unpublished).

PAINE, G.G., 1971b - White Violet Tungsten Prospect, Jinka plain, Northern Territory. Progress Report on Authority to Prospect 2283. Central Pacific Minerals NL Report NT-42 (unpublished).

PAINE,G.G., 1971c - Progress Report, Kings Legend Copper-Tungsten Prospect, Jinka Plain, Northern Territory. Central Pacific Minerals, NL Report NT-54 (unpublished).

PERRY, R.A., compiler, 1962 - Lands of the Alice Springs area, Northern Territory, 1956-57. Commonwealth scientific and industrial Research Organisation, Melbourne, Land Research Series 6.

PHILLIPS, E.R., 1980 - Progress Report, AP 2283, Jinka Plain. Report for Central Pacific Minerals NL. Northern Territory Geological Survey Files, Alice Springs CR/78/10.

RANSOM, D.M., 1978 - The scheelite prospects of the Jervois Range, Bonya Creek and Molyhil areas. Report for Afminco Exploration, Northern Territory Geological Survey Files, Alice Springs, CR/78/167.

RILEY, G.H., 1968 - Revision of granite ages in the Northern Territory, Australia. Geological Society of America, Special paper 115, 184.

ROBERTSON, W.A., 1959 - Jervois Range copper-lead deposits, Northern Territory.Bureau of Mineral Resources, Australia, Record 1959/103.

SEDERHOLM, J.J., 1935 - Selected Works: Granites and Migmatites. Wiley, New York.

SENIOR, B.R., 1980 - Geological Branch Summary of Activities, 1980 - Cainozoic studies of the Alice Springs Region. Bureau of Mineral Resources, Australia Record 1980/61 p. 7 (unpublished).

SHAW, R.D., LANGWORTHY, L.A., OFFE, L.A., STEWART, A.J., ALLEN, A.R., & SENIOR, B.R., 1979 - Geological report on 1:100 000-scale mapping of the southeastern Arunta Block, Northern Territory. Bureau of Mineral Resources, Australia Record 1979/47. BMR Microform MF 133.

SHAW, R.D., & STEWART, A.J., 1975 - Towards a stratigraphy of the Arunta Block. In Proterozoic Geology. 1st Australian Geological Convention, Adelaide, South Australia, May 1975. Geological Society of Australia, Abstracts.

SHAW, R.D., STEWART, A.J., & BLACK, L.P., in press - Tectonic history of the Arunta Block: a complex ensialic mobile belt in central Australia. Journal of the Geological Society of Australia.

SHAW, R.D., FREEMAN, M.J., OFFE, L.A., & SENIOR, B.R., 1982 - Geology of the Illogwa Creek 1:250 000 Sheet area, central Australia - Preliminary Data, 1979-80 Surveys. Bureau of Mineral Resources, Australia, Record 1982/23. BMR Microform MF193 (unpublished).

SHAW, R.D., & WARREN, R.G., 1975 - Alcoota, N.T. - 1:250 000 Geological Series.Bureau of Mineral Resources, Australia, explanatory Notes SF/53-10.

SHAW, R.D., WARREN, R.G., SENIOR, B.R., & YEATES, A.N., 1975 - Geology of the Alcoota 1:250 000 Sheet area, Northern Territory. Bureau of Mineral Resources, Australia, Record 1975/100, BMR Microform MF107.

SIMPSON, C.J., 1980 - Georgina Research for the period April-September, 1980. Bureau of Mineral Resources, Australia, Record 1980/74.

SMITH, K.G., 1963 - Huckitta, NT - 1:250 000 Geological Series. Bureau of Mineral Resoruces, Australia, explanatory Notes SF/53-11.

SMITH, K.G., 1964 - Progress report on the geology of Huckitta 1:250 000 Sheet area. Bureau of Mineral Resources, Report 67.

SMITH, J.W., & WOOLLEY, D.R., 1957 - The rocks and mineralisation of the Arunta Complex, Huckitta area. Northern Territory Geological Survey Files, Alice Springs, BMR/57/5.

STANTON R.C., & VAUCHAN, J.P., 1977 - Facies of ore formation a preliminary account of the Pegmont deposit as an example of potential relations between small "iron formations' and stratified sulphide zones. Australasian Institute of Mining and Metallurgy, Proceedings 270, 25-38.

STEIGER, R.H., & JAGER, E., 1977 - Sub-commission on geochronology: Convention on the use of decay constrants in geo- and cosmochronology. Earth and Planetary Science Letters, 36, 359-62.

STEWART, A.J., SHAW, R.D., & BLACK, L.P., in press - Major stratigraphic sub-divisions of a complex metamorphic terrain: the Arunta Block, central Australia. Journal of the Geological Society of Australia.

STEWART, A.J., SHAW, R.D., OFFE, L.A., LANGWORTHY, A.P., WARREN, R.G., ALLEN A.R., & CLARK, D.B., 1980 - Stratigraphic definitions of named units in the Arunta Block, Northern Territory. Bureau of Mineral Resources, Australia, Report 216; BMR Microform MF 104.

STEWART, A.J., & WARREN, R.G., 1977 - The mineral potential of the Arunta Block. BMR Journal of Australian Geology & Geophysics 2(1) 21-34.

STRECKEISEN, A., 1976 - To each plutonic rock its proper name. Earth Science Reviews, 12, 1-33.

TINDALE, N.B., 1931 - Geological notes on the Iliqura country northeast of the MacDonnell Range, Central Australia. Transactions of the Royal Society of South Australia, 55, 32-8.

WALTER, M.R. 1980 - Adelaidean and Early Cambrian stratigraphy of the southwest Georgina Basin: correlation chart and explanatory notes. Bureau of Mineral Resources, Australia, Report 214, Microfiche MF 92.

WARREN, R.G., 1978 - Delny-Mount Sainthill Fault System, eastern Arunta Block, Central Australia. BMR Journal of Australian Geology & Geophysics, 3, 76-9.

WARREN, R.G., 1980 - The Arunta Block in the Huckitta 1:250 000 Sheet area: a review of data to June 1980. Bureau of Mineral Resources, Australia, Record 1980/45 (unpublished).

WARREN R.G., 1981 - Tectonic setting of the eastern most Arunta Block. Bureau of Mineral Resources, Australia. Report 221.

WARREN, R.G., STEWART, A.J., & SHAW, R.D., 1974 - Summary of information on mineral deposits of the Arunta Complex, Alice Springs area, Northern Territory. Bureau of Mineral Resources, Australia, Record 1974/117 (unpublished).

WARREN, R.G., STEWART, A.J., & SHAW, R.D., 1975 - Arunta Block - mineralisation. In KNIGHT, C.L., (Ed). Economic Geology of Australia and Papua New Guinea: 1 Metals. Australasian Institute of Mining & Metallurgy, Mongraph Series 5, 443-44.

WARREN, R.G., & McCOLL, D.H., 1983 - Occurrences of boron-bearing kornerupine in the Western Harts Range and near Mount Baldwin, Arunta Block, central Austrlia. BMR Journal of Australian Geology and Geophysics, 8, 93-96.

WATSON, D.P., 1971 - Preliminary report on the Johannsen scheelite properties - Jinka Plain area, Northern Territory. Petrocarb Exploration NL (unpublished).

WATSON, D.P., 1975 - Attutra copper-lead and scheelite zone, Jervois Range. In KNIGHT, C.L., (Ed). Economic Geology of Australia and Papua New Guinea: 1 Metals. The Australasian Institute of Mining and Metallurgy - Monograph Series 5, 447-449.

WELLS, P.R.A., 1977 - Pyroxene thermometry of simple and complex systems. Contributions to Mineralogy and Petrology 62, 129-139.

WEBB, A.W., 1972 - Geochronological report. Australian Mineral Development Laboratories. Report AN 4194/72 (unpublished).

WILSON, A.F., COMPSTON, W., JEFFERY, P.M., & RILEY, G.H., 1960 - Radioactive ages from the Precambrian rocks in Australia. Journal of the Geological Society of Australia, 6, 179-95.

WILSON, G.I., & WARD, D.F. 1962 - Report on investigations, Jervois Range Cu-Pb prospects, Northern Territory. New Consolidated Goldfields (Australia) Pty Ltd, Report 15 (unpublished).

WOOLLEY, D.R., 1959 - The pegmatites of the Huckitta area, Northern Teritory. Bureau of Mineral Resources, Australia, Record, 1959/88 (unpublished).

WOOLLEY, D.R., & ROCHOW, K.A., 1965 - Mineral deposits in central Australia. In Geology of Australian Ore Deposits, 2nd Edition. 8th Commonwealth Mining and Metallurgical Congress, 1, 186-193.

WOOD, B.J., & BANNO, S., 1973 - Garnet-orthopyroxene and orthopyroxene-clinopyroxene relationships in simple and complex systems. Contributions to Mineralogy and Petrolgy 42, 109-124.

WOODBURNE, M.O., 1967 - The Alcoota fauna, Northern Territory. Bureau of Mineral Resources, Australia, Bulletin 87.

WRIGHT, J.F., 1974 - Exploration Licence No. 740 . Final Report to 23 November 1974. Union Corporation (Aust) Pty Ltd Open File Report - Northern Territory Geological Survey, Office File (unpublished).

## APPENDIX A. NOMENCLATURE AND TERMINOLOGY OF METAMORPHIC ROCKS

(With notes on rock-type symbols)

Igneous rock nomenclature is that of Streckeisen (1976) and sedimentary rock terminology is that of Gary & others (1973), unless specified otherwise.

Amphibolite (a): consists essentially of hornblende (30 to 80%) and plagioclase; also rock containing mainly actinolite if some relict hornblende is also present.

(ae)-Mg-rich rocks: consist almost entirely of either anthophyllite, or cummingtonite, gedrite, or enstatite.

ag: Fine-grained, tough, meta-pelitic and psammopelitic rock containing biotite, muscovite, quartz, plagioclase and minor carbonate.

apl: aplite.

av: for garnet amphibolite.

Biotite gneiss (b): field term for gneisses containing quartz, feldspar, and 10 per cent or more of biotite. Many of these gneisses are of granodiorite composition, but some, particularly the more biotite-rich varieties, are considered to be pelitic metasediments. Rocks photo-interpreted as biotite gneiss commonly have a brown photo-colour, as distinct from the pale brownish-yellow photo-colour diagnostic of quartzofeldspathic gneiss.

Biotite schist (sb): schist, with 20% or more, biotite, and little or no muscovite.

Calc-silicate rock (cs): consists of calcium-bearing silicate minerals-such as diopside, plagioclase, epidote, grossularite formed by metamorphism of impure marble or calcareous sediments (Gary & others, 1973).

Coarse-grained: refers to grains sizes in the range 5-30 mm.

Cordierite gneiss and sillimanite-cordierite gneiss(i): granular rocks containing cordierite, or cordierite and sillimanite. Cordierite-sillimanite metapelites contain the assemblage cordierite-potassium feldspar-sillimanite-biotite-quartz. Cordierite and an thophyllite rocks contain the assemblage cordierite - anthophyllite±quartz-spinel.

cm: symbol for metaconglomerate.

ct: actinolite-bearing calc-silicate rock and/or clinozoisite and microcline-rich calc-siliate rock. These rock types commonly accompany each other.

Deformed rock (d): a very general field term for highly strained or brecciated rocks such as mylonite, cataclasite, and highly foliated rocks.

dl: dolerite, metadolerite and micronorite.

Epidote rock or Epidosite (e): rocks rich in epidote.

Fine-grained: refers to grain sizes less than 1 mm, but resolvable

f: quartzofeldspathic gneiss (see Quartzofeldspathic gneiss).
fe: ironstone.

Granite (g): rocks of either granite or adamellite composition, having a mafic content of about 10 per cent, and a hypidiomorphic texture. Some metamorphically retrogressed quivalents are included in the same category.

gl: leucograite with no or negligible ferromagnesian minerals.

gb: gabbro and partly metamorphosed gabbro or norite.

gd: granodiorite, includes partly retrogressively metamorphosed granodiorite.

Granitic gneiss (gg): macroscopically (i.e. map-scale) heterogeneous gneiss of broadly granitic mineralogy. The rock is commonly texturally or compositionally layered on a small-scale (outcrop to hand-specimen). Differs from quartzofeldspathic gneiss in forming large, roughly equant to irregular bodies more than 1 km across rather than lenticular bodies within a compositionally layered sequence.

gp: granite or leucogranite containing abundant K-feldspar megacrysts.

Granulite (fn, mn, if, in): field term for hypersthene-bearing metamorphic rocks (White in Behy & others, 1971). In the Sheet area, the rocks are invariably granular, and include rare foliated and lineated varities.

Garnet-biotite gneiss (v): gneiss containing garnet, and biotite in excess of 10 per cent. Commonly also contains plagioclase and quartz, but lacks K-feldspar.

Gneiss: medium-to coarse-grained, irregularly layered (banded), and foliated rock in which the schistosity is commonly poorly defined because of the preponderance of quartz and feldspar over micaceous minerals (compare with Joplin, 1968).

Hornblende gneiss (h): gneiss containing hornblende and of acid to intermediate composition.

i: cordierite-bearing gneiss.

ia: cordierite-anthophyllite rock.

if: cordierite-bearing felsic granulite.

j: quartz-rich metasediment, mainly metasandstone.

jt: tourmaline-bearing quartz-rich metasediments.

Mylonite (m): is used in the sense of Lapworth (1885) for a fine-grained layered rock, but without the genetic connotation that mylonites are a product of brittle deformation (Bell & Etheridge, 1973).

ma: marble.

Mafic granulite (mn): nongenetic field term for hypersthene bearing metamorphic rocks in which the colour index exceeds 50.

Medium-grained: refers to grain sizes between 1 and 5 mm.

Migmatite (mi): composite rock composed of igneous or igneous looking and metamorphic materials, which are generally distinguishable megascopically (Dietrich, 1960 p. 50; Gary & others, 1973). Used also for migmatitic gneiss.

mt: unclassified metamorhic rock; identification normally based on photo-interpretation.

Schist: (s, sb, sc, sf, sm, sv): a cleaved or schistose rock in which the individual grains are visible to the naked eye. The symbol s is used for schist containing both muscovite and biotite; the symbol sb is used for biotite-rich varieties, particularly those that lack muscovite; the symbol sc is used for the retrogressed equivalents of amphibolite which commonly contain actinolite, tremolite, or chlorite; the symbol sf is used for highly schistose quartzofeldspathic rocks; the symbol sm is used for muscovite or sericite schist; the symbol sv is for garnet-bearing muscovite-biotite schist.

sk: coarse to very coarse-grained, poorly textured garnet-bearing quartz-epidote rock, containing lesser amounts of hornblende, clinopyroxene and calcite.

Un: meta-ultramafic rocks, such as meta-pyroxenite, meta-dunite; it does not necessarily imply a metamorphosed igneous rock.

v: garnet-biotite gneiss or schistose gneiss.

vf: garnet-bearing quartzofeldspathic gneiss.

vm: garnet-muscovite gneiss (i.e. lacks biotite).

x: andalusite-bearing phlogopite or biotite schist.

z: silimanite-bearing gneiss and garnet-sillimanite.

zm: sillimanite-a red muscovite bearing gneiss.

: Quartzofeldspathic rock containing quartz and/or feldspar megacrysts which are partly recrystallised, ovoid and prismatic quartz or feldspar grains with unusually straight, angular and rarely lobate grain boundaries, scattered in a granular fine-grained matrix of quartz, feldspar and mica. The rock is inferred to be an acid metavolcanic.

Porphyroblastic-feldspar gneiss (p): quartzofeldspathic gneiss, biotite gneiss, or biotite schist containing megacrysts of feldspar.

pa: compositionally layered amphibolites or calc-silicate rocks having a relatively high colour index (e.g. 20 or more) and for uncommon amphibolites which are unusually layered, quartz-rich or have some other unusual feature.

peg: pegmatite. Most pegmatite dykes are unlabelled in the Harts Range area because they are so numerous.

Quartzofeldspathic gneiss (f): a field term used for granular gneisses having a colour index of about 10 or less that form layers or lensoid bodies. They have a distinctive brownish-yellow colour on coloured aerial photographs. These rocks are similar to leptite; a Fennoscandian term for meta-acid volcanics (Sederholm, 1935). They are typically of granite, adamellite, or granodiorite composition. The gneiss commonly forms part of a layered sequence and shows internal compositional layering.

q: vein quartz.

qf: magnetite-quartzite, quartz-magnetite rock or hematite quartz rock.

qt: quartzite; is used for metamorphic quartzite, rather than diagenetic quartzite.

Retrogressed rock (r): field term for a wide variety of rocks which have been remetamorphosed generally at the greenschist facies.

APPENDIX B: ATOMIC ABSORPTION ANALYSES (AMDEL REPORT AC 2804/81-CODE C1) all numbers prefixed 8009; results in p.p.m. - less than

| Sample | Cu | Pb | Zn | Co | Ni | Cd | Bi | Mn | Ag | Mo | V | Fe | P | As | Cr |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1017A | 120 | 35 | 390 | 5 | 30 | 1 | 10 | 5 | 1 | 2 | 30 | 2.30% | 550 | 20 | 10 |
| 1018A | 340 | 15 | 30 | 35 | 55 | 1 | 10 | 320 | 1 | 2 | 140 | 32.1% | 230 | 20 | 10 |
| 1093 | 34 | 10 | 35 | 15 | 25 | 1 | 10 | 4.10% | 1 | 1 | 40 | 25.0% | 5500 | 20 | 10 |
| 1095 | 120 | 10 | 20 | 20 | 30 | 1 | 10 | 760 | 2 | 1 | 80 | 24.2% | 470 | 20 | 10 |
| 1103 | 90 | 10 | 36 | 60 | 45 | 1 | 10 | 350 | 2 | 2 | 70 | 43.5% | 21 | 20 | 10 |
| 1145 | 2000 | 10 | 12 | 10 | 25 | 1 | 10 | 2200 | 1 | 1 | 30 | 11.2% | 280 | 20 | 10 |
| 1152 | 1100 | 3000 | 80 | 10 | 30 | 1 | 10 | 120 | 3 | 18 | 40 | 40.5% | 170 | 20 | 10 |
| 1163 | 230 | 10 | 14 | 15 | 30 | 1 | 10 | 230 | 4 | 2 | 20 | 20.6% | 120 | 20 | 10 |
| 1183 | 36 | 5 | 14 | 5 | 25 | 1 | 10 | 160 | 1 | 1 | 60 | 6.30% | 940 | 20 | 30 |
| 1185 | 70 | 10 | 85 | 25 | 30 | 1 | 10 | 1.70% | 1 | 3 | 220 | 25.1% | 810 | 23 | 10 |
| 1188B | 570 | 1.00% | 930 | 30 | 30 | 1 | 1100 | 9300 | 6 | 12 | 120 | 39.5% | 3800 | 20 | 20 |
| 1189E | 700 | 100 | 1200 | 30 | 25 | 4 | 60 | 2.60% | 16 | 6 | 30 | 21.0% | 1300 | 20 | 10 |
| 1201 | 150 | 65 | 110 | 10 | 20 | 1 | 20 | 6200 | 3 | 2 | 20 | 19.8% | 1000 | 20 | 10 |
| 1209 | 160 | 40 | 75 | 40 | 10 | 1 | 90 | 210 | 1 | 18 | 20 | 33.0% | 550 | 20 | 10 |
| 1213 | 820 | 150 | 150 | 40 | 10 | 1 | 130 | 880 | 1 | 16 | 40 | 24.9% | 440 | 20 | 20 |
| 1219C | 300 | 45 | 110 | 15 | 35 | 1 | 10 | 700 | 3 | 1 | 70 | 15.8% | 1500 | 20 | 30 |
| 1237 | 390 | 40 | 18 | 25 | 25 | 1 | 10 | 110 | 1 | 5 | 20 | 27.6% | 26% | 20 | 10 |
| 1243 | 22 | 25 | 42 | 75 | 25 | 1 | 10 | 6400 | 1 | 3 | 150 | 14.5% | 660 | 20 | 60 |
| 1246 | 6 | 15 | 18 | 10 | 120 | 1 | 10 | 100 | 1 | 2 | 1200 | 38.0% | 7400 | 20 | 20 |
| 1255A | 90 | 10 | 12 | 5 | 20 | 1 | 10 | 1600 | 1 | 6 | 30 | 15.3% | 450 | 20 | 10 |
| 1267B | 28 | 20 | 34 | 15 | 45 | 1 | 10 | 3.70% | 1 | 1 | 50 | 18.2% | 3000 | 20 | 20 |
| 1372 | 180 | 15 | 42 | 20 | 40 | 1 | 30 | 960 | 1 | 4 | 20 | 15.2% | 1900 | 20 | 20 |
| 1374A | 26 | 10 | 85 | 35 | 45 | 1 | 10 | 1200 | 1 | 5 | 40 | 3.30% | 430 | 20 | 10 |
| 1374B | 18 | 15 | 70 | 15 | 40 | 1 | 10 | 880 | 1 | 1 | 40 | 22.8% | 4200 | 20 | 30 |
| 1375 | 12 | 10 | 46 | 15 | 40 | 1 | 10 | 710 | 1 | 1 | 60 | 17.4% | 1200 | 20 | 40 |
| 1378B | 16 | 5 | 46 | 20 | 55 | 1 | 10 | 440 | 1 | 1 | 70 | 24.1% | 3800 | 20 | 30 |
| 1397A | 330 | 15 | 110 | 110 | 250 | 1 | 10 | 350 | 1 | 1 | 4200 | 32.7% | 100 | 20 | 80 |
| 1402 | 30 | 25 | 170 | 5 | 20 | 1 | 20 | 490 | 1 | 1 | 40 | 1.90% | 140 | 20 | 10 |
| 1403 | 1200 | 4500 | 1500 | 90 | 35 | 17 | 40 | 3.40% | 5 | 9 | 50 | 35.2% | 800 | 20 | 10 |
| 1429A | 100 | 50 | 36 | 10 | 20 | 1 | 430 | 1.00% | 4 | 2 | 30 | 27.8% | 5200 | 20 | 10 |
| 1432C | 20 | 40 | 46 | 15 | 30 | 1 | 20 | 1.80% | 1 | 2 | 40 | 28.4% | 5400 | 1 60 | 20 |
| 1501C | 10 | 5.90% | 260 | 5 | 20 | 2 | 10 | 4300 | 9 | 4 | 20 | 3.20% | 330 | 20 | 10 |
| 1534 | 560 | 190 | 150 | 45 | 25 | 1 | 10 | 12.9% | 7 | 12 | 50 | 9.50% | 450 | 20 | 10 |
| Dentn limit | (2) | (5) | (2) | (5) | (5) | (1) | (10) | (5) | (1) | (1) | (20) | (5) | (10) | (20) | (10) |

APPENDIX B: ATOMIC ABSORPTION ANALYSES (CONTINUED)

| Sample | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1599B | 334 | 20 | 24 | 20 | 40 | 1 | 10 | 800 | 2 | 3 | 120 | 46.9% | 400 | 20 | 10 |
| 1612B | 150 | 10 | 14 | 15 | 25 | 1 | 10 | 1.90% | 1 | 12 | 70 | 14.9% | 210 | 20 | 10 |
| 1631 | 30 | 50 | 190 | 30 | 50 | 1 | 10 | 530 | 2 | 1 | 50 | 42.1% | 8200 | 20 | 80 |
| 1651 | 65 | 15 | 160 | 15 | 85 | 1 | 10 | 470 | 2 | 2 | 110 | 48.5% | 8100 | 20 | 20 |
| 1674A | 6 | 5 | 26 | 10 | 15 | 1 | 10 | 460 | 1 | 1 | 20 | 19.0% | 80 | 20 | 10 |
| 1681 | 2 | 15 | 20 | 5 | 20 | 1 | 10 | 1.50% | 1 | 5 | 20 | 9.50% | 80 | 20 | 10 |
| 1801B | 32 | 15 | 200 | 90 | 90 | 1 | 10 | 920 | 1 | 3 | 20 | 38.1% | 4900 | 20 | 10 |
| 1802B | 60 | 10 | 970 | 190 | 310 | 1 | 10 | 600 | 1 | 1 | 20 | 45.9% | 690 | 20 | 20 |
| 2401 | 40 | 15 | 95 | 40 | 35 | 1 | 10 | 2.20% | 1 | 1 | 80 | 29.1% | 2700 | 20 | 20 |
| 2408 | 410 | 1100 | 65 | 60 | 55 | 1 | 10 | 8400 | 1 | 22 | 40 | 16.6% | 360 | 60 | 20 |
| 3019 | 130 | 45 | 12 | 15 | 5 | 1 | 10 | 180 | 1 | 1 | 30 | 10.4% | 140 | 20 | 20 |
| 3020 | 16 | 10 | 10 | 15 | 35 | 1 | 10 | 180 | 1 | 1 | 50 | 5.10% | 330 | 20 | 20 |
| 3027 | 65 | 15 | 6 | 5 | 5 | 1 | 10 | 200 | 1 | 1 | 20 | 2.20% | 170 | 20 | 10 |
| 3028A | 85 | 110 | 10 | 15 | 10 | 1 | 10 | 160 | 1 | 1 | 20 | 7.90% | 100 | 20 | 10 |
| 3039B | 26 | 30 | 16 | 5 | 25 | 1 | 10 | 5700 | 1 | 2 | 180 | 10.6% | 170 | 20 | 50 |
| 3044 | 14 | 15 | 40 | 5 | 20 | 1 | 10 | 3300 | 1 | 3 | 20 | 32.8% | 6200 | 20 | 20 |
| 3130 | 10 | 10 | 12 | 15 | 10 | 1 | 10 | 300 | 1 | 1 | 130 | 21.3% | 110 | 20 | 10 |
| 3154A | 20 | 5 | 10 | 5 | 10 | 1 | 10 | 140 | 1 | 8 | 50 | 3.30% | 90 | 20 | 10 |
| 3163A | 12 | 65 | 18 | 5 | 5 | 1 | 10 | 120 | 1 | 1 | 50 | 5.40% | 130 | 20 | 10 |
| 3210A | 2 | 20 | 4 | 5 | 5 | 1 | 10 | 230 | 1 | 1 | 20 | 5000 | 40 | 20 | 10 |
| 3212 | 2 | 10 | 28 | 10 | 45 | 1 | 10 | 430 | 1 | 8 | 40 | 2.50% | 120 | 20 | 10 |
| 3220A | 12 | 30 | 50 | 45 | 55 | 1 | 10 | 3.20% | 2 | 7 | 40 | 31.9% | 40 | 20 | 20 |
| 3222 | 2 | 15 | 12 | 5 | 10 | 1 | 10 | 490 | 1 | 1 | 20 | 1.60% | 400 | 20 | 10 |
| 3234D | 18 | 10 | 6 | 30 | 15 | 1 | 10 | 130 | 1 | 2 | 20 | 17.7% | 100 | 90 | 20 |
| 3270A | 4 | 5 | 26 | 5 | 10 | 1 | 10 | 210 | 1 | 4 | 30 | 1.80% | 1300 | 20 | 10 |
| 3325 | 30 | 20 | 310 | 120 | 190 | 1 | 10 | 6.00% | 1 | 4 | 30 | 28.8% | 1700 | 20 | 20 |
| 3344B | 100 | 40 | 12 | 20 | 50 | 1 | 10 | 2900 | 1 | 4 | 50 | 1.20% | 440 | 20 | 10 |
| 3390 | 65 | 20 | 120 | 20 | 35 | 1 | 10 | 480 | 1 | 4 | 30 | 17.1% | 4900 | 20 | 20 |
| 3442B | 12 | 170 | 95 | 15 | 30 | 1 | 10 | 890 | 1 | 1 | 30 | 10.2% | 270 | 20 | 20 |
| 3532 | 150 | 25 | 6 | 10 | 40 | 1 | 10 | 200 | 1 | 1 | 70 | 10.9% | 260 | 20 | 20 |
| 3542A | 1000 | 65 | 60 | 5 | 10 | 1 | 10 | 8800 | 3 | 8 | 30 | 18.0% | 1700 | 20 | 20 |
| 3544B | 1.70% | 170 | 620 | 50 | 15 | 3 | 90 | 1700 | 10 | 3 | 40 | 7.40% | 250 | 20 | 30 |
| Dentn limit | (2) | (5) | (2) | (5) | (5) | (1) | (10) | (5) | (1) | (1) | (20) | (5) | (10) | (20) | (10) |

APPENDIX C: SEMI-QUANTITATIVE EMISSION SPECTROSCOPY RESULTS (AMDEL REPORT 2804/81).

| Sample No. | Co (5) | Mn (10) | Ni (5) | Ta (100) | V (10) | Yb (1) | Cr (20) | Mo (3) | W (50) | Ce (300) | La (50) | Nb (20) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30093303 | 20 | 600 | 60 | x | 100 | 5 | 100 | x | x | x | 150 | x |
| 303 | 20 | 600 | 60 | x | 100 | 4 | 100 | x | x | x | 50 | 20 |
| 303 | 15 | 600 | 60 | x | 100 | 4 | 100 | x | x | x | 50 | x |
| 064 | 60 | 1000 | 100 | x | 150 | 6 | 60 | x | x | x | x | x |
| 095A | x | 6000 | 5 | x | 30 | x | x | x | x | x | x | x |
| 528A | 40 | 5000 | 100 | x | 60 | 1 | 80 | 40 | 1000 | x | 100 | x |
| 145E | 20 | 10000 | 60 | x | 60 | 4 | 60 | x | x | x | x | x |
| 422A | 10 | 600 | 10 | x | 60 | 6 | x | x | x | x | 50 | x |
| 234C | x | 80 | x | x | 40 | 20 | x | x | x | 600 | 250 | 40 |
| 145D | 40 | 300 | 30 | x | 80 | 25 | x | x | x | 800 | 600 | 20 |
| 193B | x | 80 | x | x | 30 | 2 | x | x | x | x | 100 | x |
| 137 | x | 800 | 20 | x | 60 | 1 | 60 | x | x | x | x | x |
| 532C | 60 | 500 | 200 | x | 100 | x | 40 | 30 | x | x | x | x |
| 524 | 40 | 3000 | 150 | x | 80 | 3 | 100 | x | | x | 50 | x |
| 039A | 25 | 10000 | 60 | x | 250 | 40 | 200 | x | x | x | x | x |
| 539C | 60 | 1500 | 500 | x | 500 | 1 | x | x | x | x | x | x |
| 539D | 60 | 2500 | 300 | x | 4000 | 1 | 60 | x | 50 | x | x | x |
| 80093142B | 10 | 8000 | 100 | x | 100 | 6 | 20 | x | | 300 | 250 | x |
| 80092406 | 10 | 2000 | 50 | x | 60 | x | x | x | | x | x | x |
| 80093038A | 15 | 250 | 15 | x | 80 | 80 | x | x | | 1000 | 800 | x |
| 523B | 30 | 3000 | 150 | x | 200 | 2 | 150 | x | | x | x | x |
| 547C | 60 | 400 | 80 | x | 100 | 2 | 60 | 150 | | x | x | x |
| 536C | 5 | 2500 | 80 | x | 60 | 2 | 40 | 30 | 8000 | x | 50 | 20 |
| 546A | 40 | 2500 | x | x | 80 | 30 | 60 | 10000 | 50 | x | 250 | x |
| 531C | 20 | 8000 | 50 | x | 100 | 2 | 80 | 150 | | x | x | x |
| 3009353A | 10 | 10000 | 50 | x | 100 | x | 40 | 150 | 10000 | x | x | x |

APPENDIX D: X-RAY DIFFRACTION IDENTIFICATIONS _ J.L. Fitzsimmons (BMR)

Mineral samples were prepared and analysed by X-ray Diffraction Techniques. A Philips PW 1010 diffractometer with a Philips SW 1050/25 goniometer, was used in the analysis. Operating conditions - Cu/Ni Radiation Slits 1°-0.2-1°, TC4 40 KV/24MA and CPS as appropriate.

X-ray traces showed the following results:

80091251 - Mica poss. muscovite - chemical analysis needed for further identification of the mica. Feldspar quartz and kaolinite also present in the sample.

80091315 - Mineral in the "green zone" - Tourmaline V. Dravite. Mica also present in the sample.

88091622A - Quartz, Mica, Kaolinite (weathered zone-Mount Thring)

80092330 - Hydroxy apatite

80093017 - Chlorite, Amphibole, Cordierite may be present - a thin section would confirm or deny this. (4.5 Km NNE Marshall Bore).

80093025B - Mica, well crystalline kaolinite, poss. chlorite; no evidence of diopside

80093025C - Chlorite, Mica, Quartz; no evidence of diopside

80093056B - Chlorite, amphibole and possibly cordierite (again a thin section needed) (6 km NW Yam Creek Bore)

80093071 - Mica, Quartz; no evidence of Sillimanite

80093079A - 2 samples 1. Mica poss. Muscovite (8 km SW Prosser's Soak
2. Margarite

80093084B - Chlorite, Mica, Quartz, Calcite poss. Magnesite - no evidence of scapolite (8.6 km WNE Plenty River Crossing, near Huckitta hcmestead).

80083421A - Scapolite, poss. Calcite (South of Molyhil Mine)

80093422B - Garnet (poss. uvarovite $Ca_3Cr_3(Si)4)_3$) Calcite, Illite, Chlorite (North mine dump, Molyhil)

80093428B - Montmorillonite, poss. Quartz and Amphibole

80093529 - Chlorite, Quartz, Mica; no evidence of Sillimanite (Damascvs Prospect)

80093551 - Mica pattern only (Iolite locality - Entia Gneiss - Illogwa Creek 1:250-000 Sheet area)

# PLATES

Reduced compilation sheets of DNEIPER, JINKA and JERVOIS RANGE 1:100 000 Sheet areas, reduced from 1:25 000 scale in northern two-thirds and from 1:80 000 in southern third. Eastern third of DNEIPER is also reduced from 1:80 000. Geological sketch of basement in SW MACDONALD DOWNS is also included.

# REFERENCE TO ACCOMPANY COMPILATION SHEETS FOR THE DNEIPER 1:100 000 MAP AREA

| | | | | | |
|---|---|---|---|---|---|
| CAINOZOIC | QUATERNARY | | | Qa | *Soil, alluvium, undivided Quaternary units* |
| | | | | Qe | *Thin veneer of soil cover over rocks of the Arunta Block* |
| | | | | Qr | *Red soil (partly developed over Waite Formation)* |
| | | | | Qc | *Conglomerate, fanglomerate, colluvium* |
| | | | | Qs | *Sheet and dune sand* |
| | | | | Czc | *Lag gravels* |
| | LATE TERTIARY | | | T | *Silicified rock* |
| | MIOCENE - PLIOCENE | | Waite Formation | Tw | *Siltstone, claystone, limestone (commonly silicified), sandstone* |
| | EARLY TERTIARY | | | Tla | *Deeply weathered rock* |
| PALAEOZOIC | CAMBRIAN-ORDOVICIAN | Georgina Basin Sequence | Tomahawk beds | ЄOt | *Calcareous sandstone, green siltstone, brown dolomite, grey limestone, sandy dolomite* |
| | CAMBRIAN | | Arrinthrunga Formation | Єua | *Brown massive dolomite, yellow flaggy dolomite, blue and purple oolitic limestone, thin beds of siltstone and sandstone* |
| | | | Arthur Creek beds | Єma | *Buff shale, laminated blue-black limestone, sandstone with lenses of calcareous sandstone, ferruginous shale, dolomite* |
| | | | Errarra beds | Єle | *Pale brown dolomite, micro cross-laminated silty dolomite at base; archaeocyatha-bearing* |
| PROTEROZOIC | LATE PROTEROZOIC | Georgina Basin Sequence; MOPUNGA GROUP | Elkera Formation | Ꝑuk | *Interbedded siltstone, dolomite, sandstone and shale* |
| | | | Grant Bluff Formation | Ꝑug | *Sandstone, shale* |
| | | | Elyuah Formation | Ꝑue | *Basal pebbly sandstone, brown and green shale* |
| | | KEEPERA GROUP | Oorabra Arkose | Ꝑuo | *Arkose* |
| | | | | pЄr | *Deformed rock, schist, mylonite, amphibolite, rare chlorite schist, garnet-chlorite schist Age uncertain; several phases of reactivation probable* |
| | MIDDLE PROTEROZOIC | | | Ꝑdr | *Diorite (possible lamprophyre)* |
| | | | Ilappa dykes | dl Ꝑdi | *Dolerite* |
| | | | | Ꝑp | *Ultramafic rock* |
| | | | | peg | *Pegmatites* |
| | | | | Ꝑgl | *Leucogranite* |
| | | | Marshall Granite | Ꝑgm | *Hornblende granite, leucogranite, aplite* |
| | EARLY PROTEROZOIC | | | Ꝑg | *Undivided granite* |
| | | | | Ꝑgk | *Porphyritic granite* |
| | | | Mount Swan Granite | Ꝑgs | *Porphyritic granite* |
| | | | | Ꝑgy | *Granite-adamellite, includes porphyritic granite* |
| | | | | Ꝑgc | *Granite - adamellite* |
| | | | | Ꝑgr | *Adamellite -granodiorite* |
| | | | | Ꝑga | *Garnetiferous granite* |
| | | | | Ꝑd | *Partly metamorphosed dolerite, gabbro and norite* |
| | | Division 3 | Utopia Quartzite | Ꝑlu | *Metaquartzite with minor muscovite* |
| | | | Ledan Schist | Ꝑln | *Biotite - muscovite - quartz schist, minor metaconglomerate* |
| | | | Dneiper Granite | Ꝑgd | *Strongly foliated biotite granite or orthogneiss, minor hornblende granite* |
| | | | | Ꝑgg | *Strongly foliated adamellite - granodiorite, minor charnockite* |
| | EARLY PROTEROZOIC ? | Division 2; HARTS RANGE GROUP | | pЄh | *Undivided rocks, mostly garnet - biotite gneiss, calc - silicate rock* |
| | | | Brady Gneiss | pЄhb2 | *b2 Biotite gneiss, calc-silicate rock, schistose garnet-muscovite-biotite gneiss* |
| | | | | pЄhb1 | *b1 Schistose garnet-muscovite-biotite gneiss, muscovite-biotite gneiss* |
| | | | Irindina Gneiss | pЄhi | *Garnet - biotite gneiss, sillimanite gneiss, calc-silicate rock, amphibolite* |
| | | | Bruna Gneiss | pЄha | *Porphyroblastic feldspar gneiss* |
| | | | Entia Gneiss | pЄhe | *Quartzofeldspathic gneiss, layered amphibolite* |
| | | Division 2 | Cackleberry metamorphics | pЄv | *Calc-silicate rocks, para-amphibolite, biotite gneiss, minor hornblende felsic gneiss, felsic gneiss, anthophyllite -cordierite rock* |
| | | | | pЄt | *Quartzofeldspathic gneiss, metasediment* |
| | | Division 1 | Kanandra Granulite | pЄsk | *Quartzofeldspathic gneiss, commonly migmatitic and garnetiferous, mafic granulite, calc-silicate rock* |

*Geological boundary*

*Unconformity* } *Top of "U" opens towards younger formation (reference only)*

*Disconformity*

*Anticline*

*Syncline*

*Fault*

70 *Shear zone, showing dip*

*Where location of boundaries, folds and faults is approximate, line is broken; where inferred, queried; where concealed, boundaries and folds are dotted, faults are shown by short dashes*

*Facies boundary (reference only)*

35 *Minor anticline*

25 *Minor syncline*

20 35 *Minor fold with dip of axial plane, and plunge of axis with parallel lineation*

*Locality of superposed fold*

*Arrow indicates trend of plunge of fold axis, value indicates plunge*

*Undifferentiated lineation*

*Mineral elongation*

*Crenulation*

50 *Strike and dip of strata*

*Strike and dip of strata, dip not estimated*
*Strike and dip of strata, dip less than 5°*
*Strike and dip of strata, dip 5° to 15°*
*Strike and dip of strata, dip 15° to 45°*
*Trend-line*
*Joint pattern*
*Lineament*
} *Airphoto Interpretation*

35 *Strike and dip of foliation*

*Vertical foliation*

50 *Late stage schistosity, associated with retrograde metamorphism*

*Some structural elements observed at a single locality are combined on the map*

peg *Dyke; ba - barite, dl - dolerite, peg - pegmatite, q - quartz*

*Drillhole*

*Mine, abandoned*

·Cu *Minor mineral occurrence; Ba - Barite, Cu - Copper, Fl - Fluorite, Mi - Mica*

×0036 *Field point*

pЄhi b *Stratigraphic unit symbol eg. Irindina Gneiss, with rock type symbol eg. biotite gneiss, CI > 10*

*Bore*

*Bore with windpump*

E *Earth dam*

T *Water tank*

*Waterhole*

*Road*

*Track*

L/G *Landing ground*

■Dneiper *Homestead*

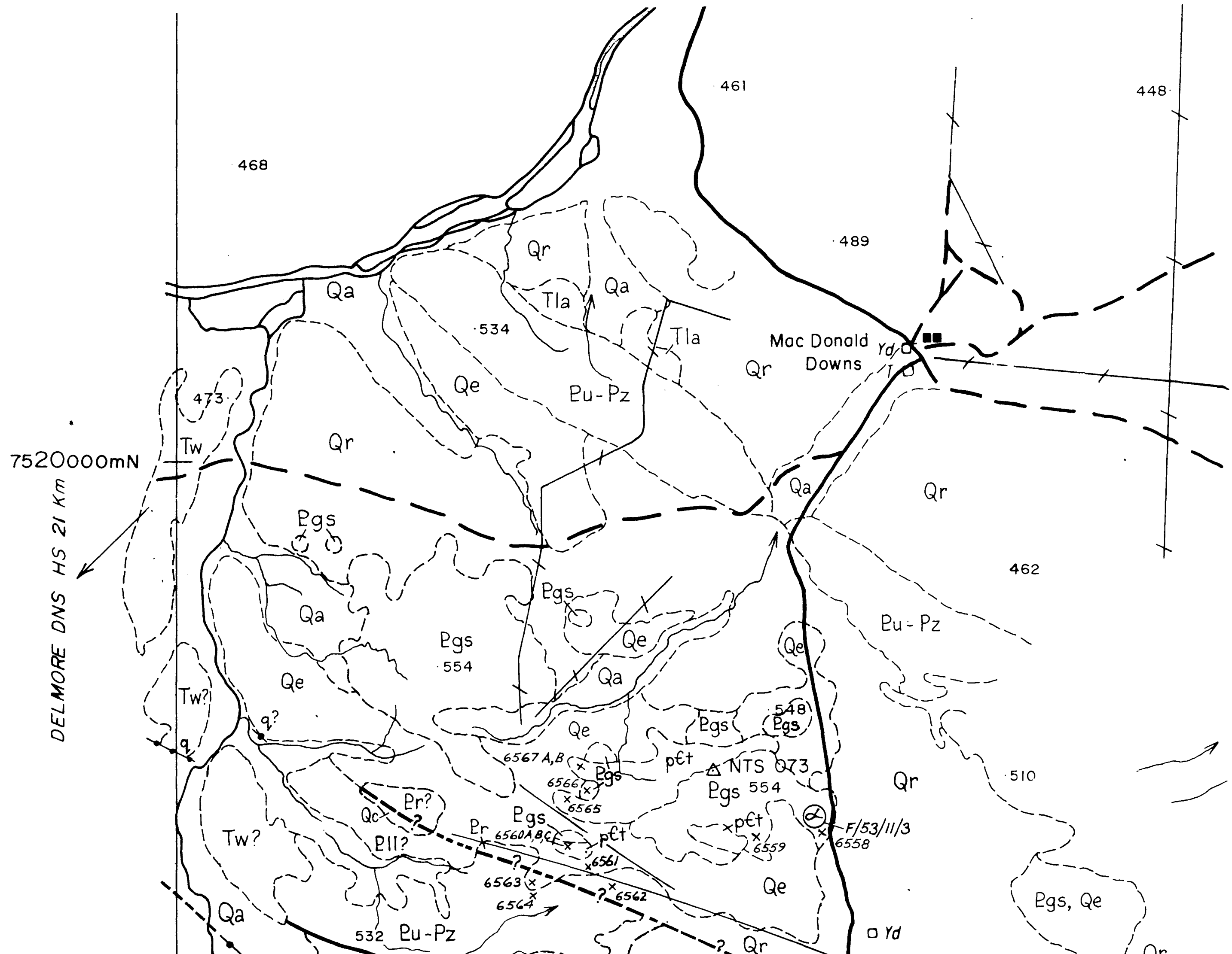
*Yard*

*Fence*

▲ *Trigonometrical station*

·450 *Spot elevation in metres*

| | |
|---|---|
| a | *Amphibolite* |
| b | *Biotite gneiss, CI > 10* |
| cs | *Calc-silicate rock* |
| d | *Undifferentiated deformed rocks eg mylonite, cataclastic, highly foliated rock* |
| e | *Epidote rock, epidosite* |
| f | *Quartzofeldspathic gneiss, CI < 10* |
| gb | *Gabbro, norite, partly metamorphosed gabbro* |
| h | *Hornblende gneiss* |
| ia | *Cordierite - anthophyllite rock* |
| if | *Cordierite - felsic granulite* |
| iz | *Cordierite - sillimanite metapelite* |
| j | *Quartz-rich metasediment* |
| m | *Mylonite* |
| ma | *Marble* |
| mi | *Migmatite* |
| mn | *Mafic granulite, CI > 10* |
| mt | *Unclassified metamorphic rock* |
| p | *Porphyroblastic-feldspar gneiss* |
| pa | *Para-amphibolite, layered amphibolite* |
| qt | *Quartzite* |
| r | *Metamorphically retrogressed rock, generally greenschist facies* |
| s | *Muscovite biotite schist or gneiss* |
| sb | *Biotite schist* |
| sc | *Chlorite schist, tremolite - actinolite schist* |
| sf | *Felsic schist* |
| sm | *Muscovite schist, sericite schist* |
| sv | *Garnet schist* |
| v | *Garnet-biotite gneiss* |
| vf | *Quartzofeldspathic garnet gneiss* |
| z | *Sillimanite bearing gneiss, garnet-sillimanite gneiss* |
| zm | *Sillimanite - muscovite gneiss* |




Ꝑu-Pz : Amadeus Basin sequence

x6558 Field data point (All points prefixed by 8009 eg. 80096558 )

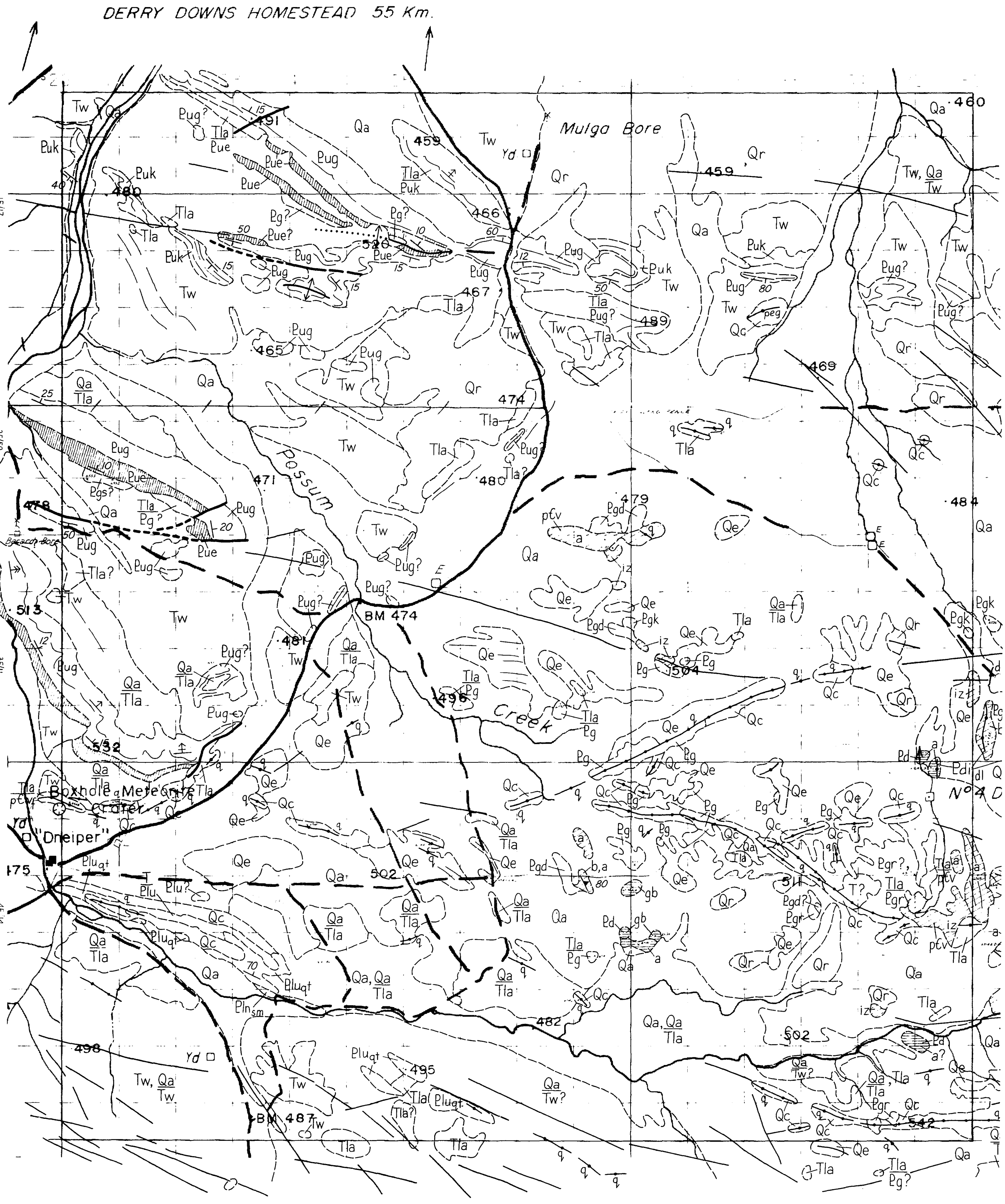
0 5 km

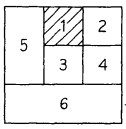
DNEIPER

MACDONALD DOWNS

Geology 1980 by R.G. Warren

Scale 1: 80 000 approx.



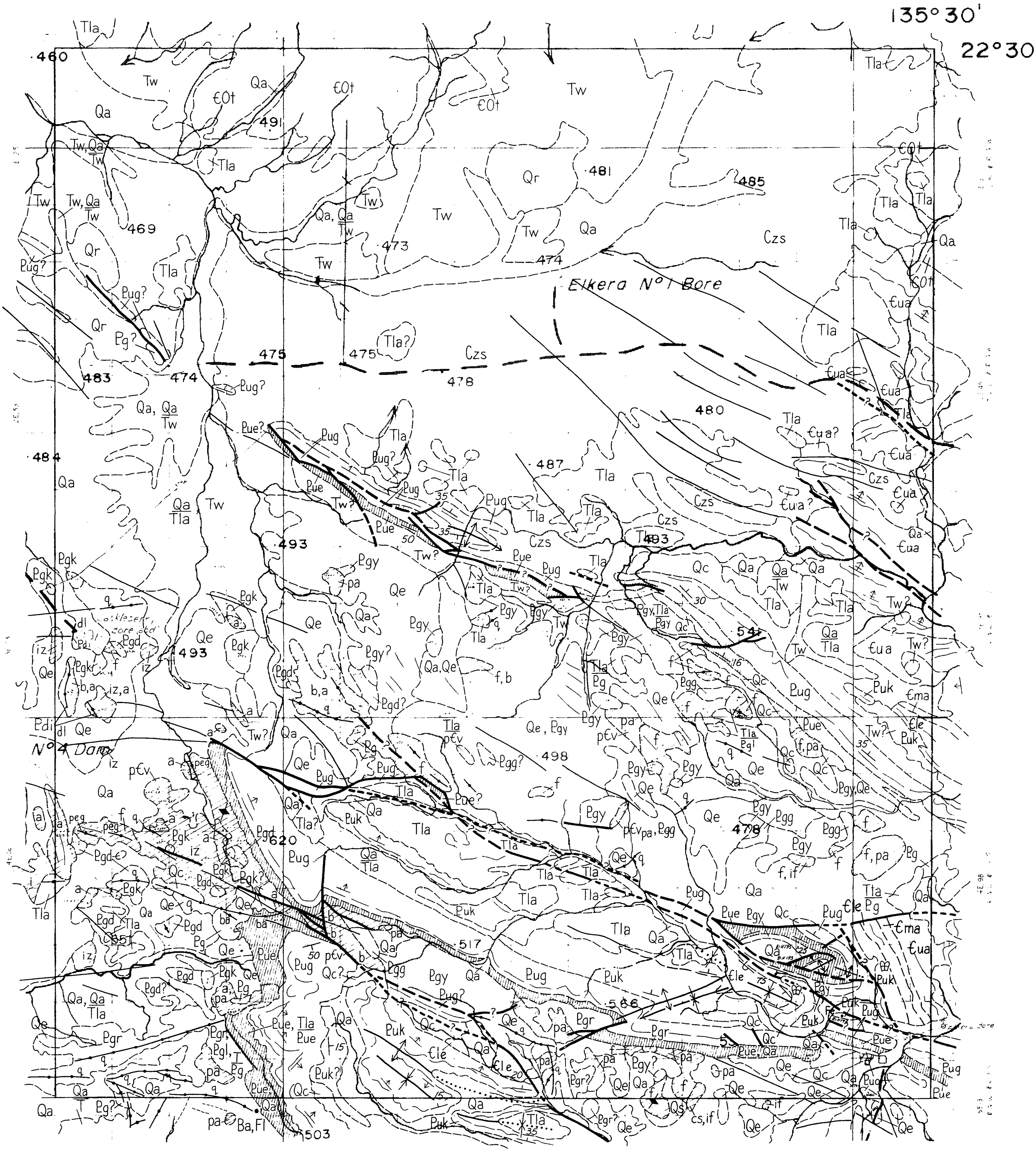



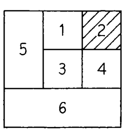

DNEIPER
Geology 1980 by C. Simpson, R. Warren BMR
Compiled 1980-81 by B. Holden BMR

Scales (1-4) 1:25000 approx, (5-6) 1:80000 approx

Compiled by the Bureau of Mineral Resources, Geology and Geophysics, in collaboration with the Northern Territory Geological Survey, Department of Mines and Energy as part of the policy of Government to assist in the exploration and development of mineral resources

© Commonwealth of Australia
Persons purchasing transparencies of this map may reproduce it for their own use or for that of their staff, but not for any other purpose except with the written permission of the Director, BMR, PO Box 378, Canberra City, ACT 2601



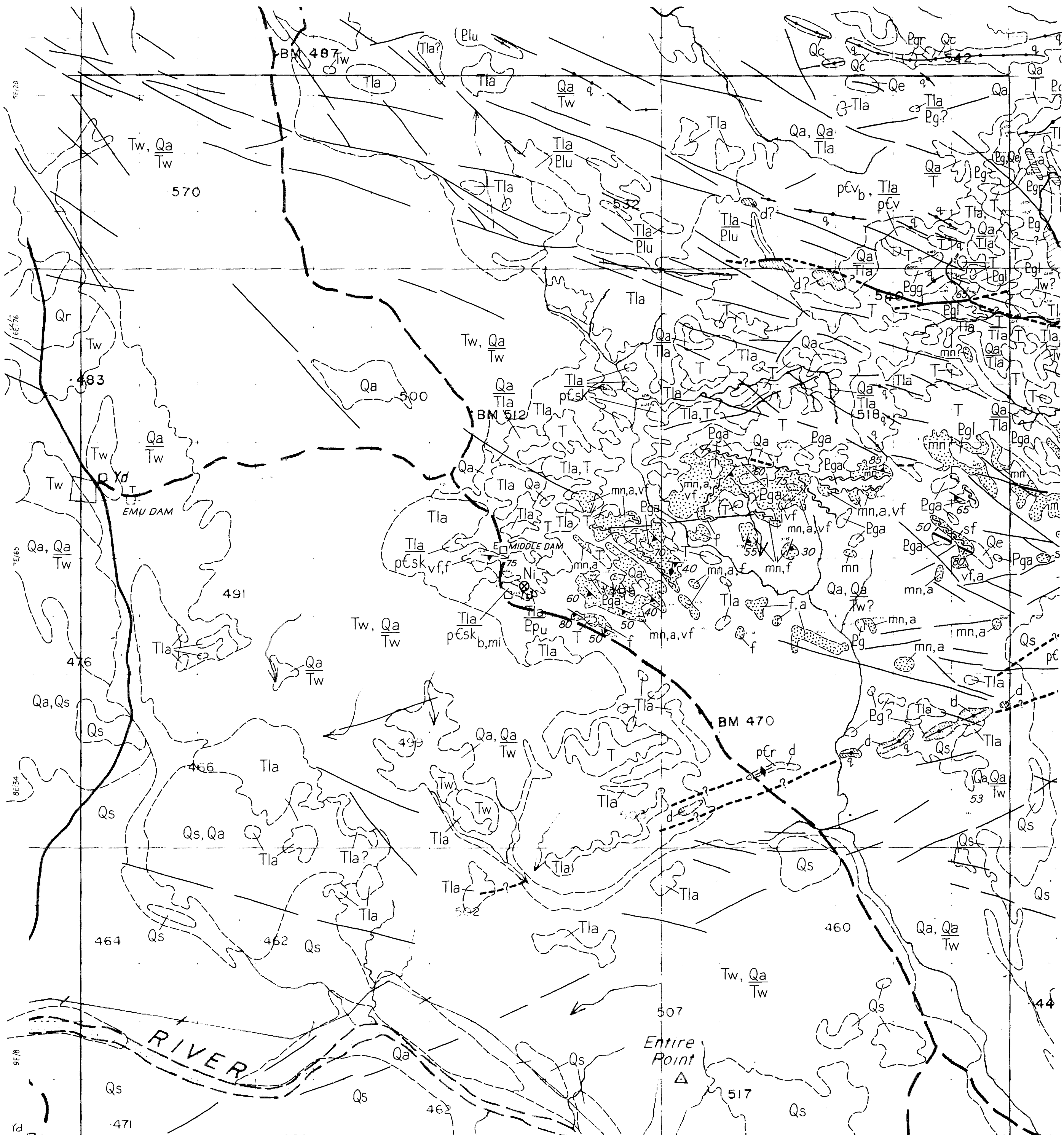

DNEIPER
Geology 1980 by C. Simpson, R. Warren BMR
Compiled 1980-81 by B. Holden BMR

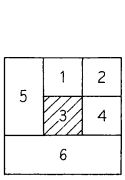
Scales (1-4) 1:25000 approx, (5-6) 1:80000 approx

Compiled by the Bureau of Mineral Resources, Geology and Geophysics, in collaboration with the Northern Territory Geological Survey, Department of Mines and Energy as part of the policy of Government to assist in the exploration and development of mineral resources

© Commonwealth of Australia

Persons purchasing transparencies of this map may reproduce it for their own use or for that of their staff, but not for any other purpose except with the written permission of the Director, BMR, P.O. Box 378, Canberra City, ACT 2601



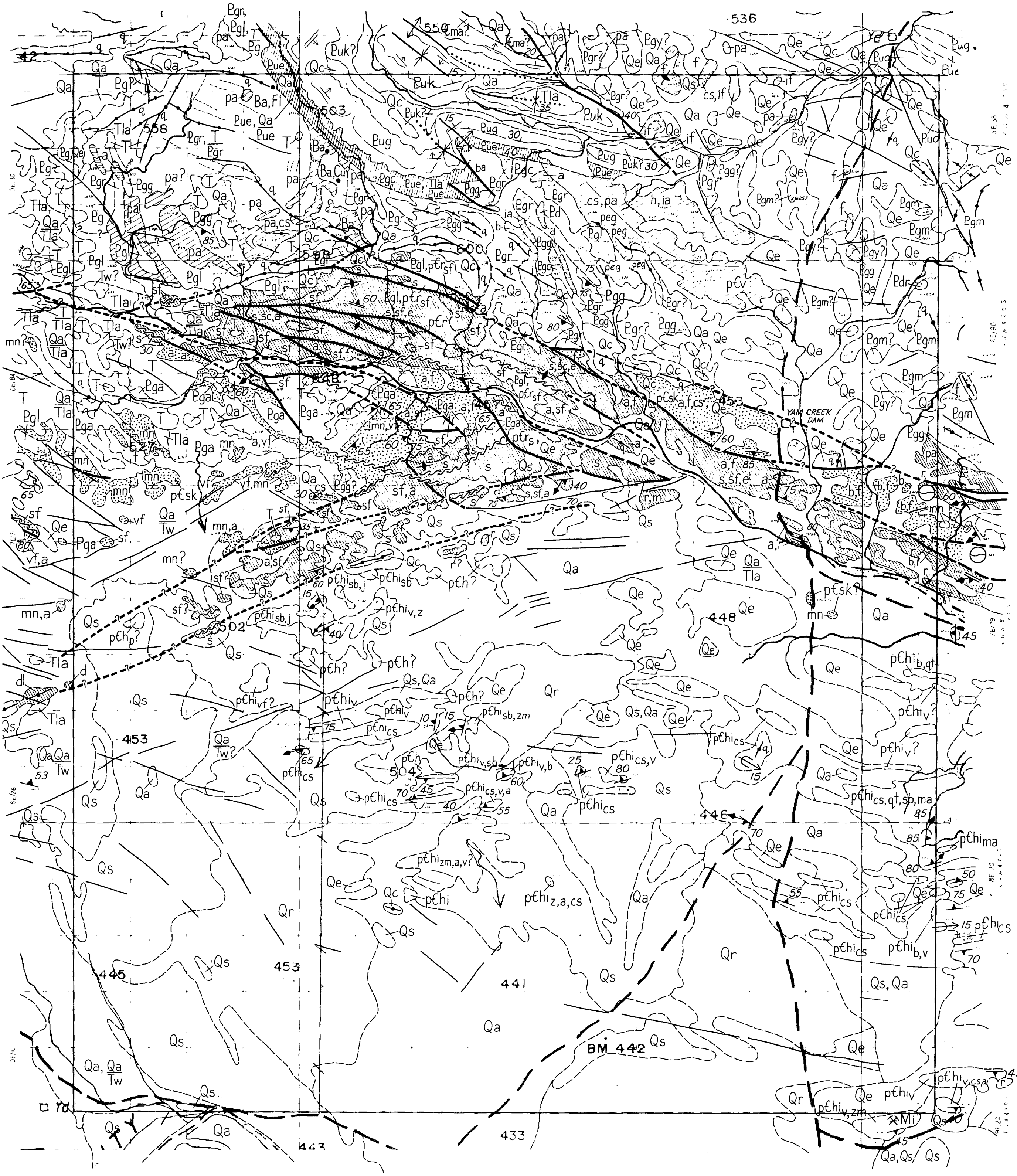


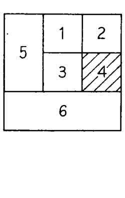

DNEIPER
Geology 1980 by R.Warren BMR
Compiled 1980-81 by B.Holden BMR

Scales (1-4) 1:25000 approx, (5-6) 1:80000 approx

Compiled by the Bureau of Mineral Resources, Geology and Geophysics, in collaboration with the Northern Territory Geological Survey, Department of Mines and Energy as part of the policy of Government to assist in the exploration and development of mineral resources.

© Commonwealth of Australia
Persons purchasing transparencies of this map may reproduce it for their own use or for that of their staff, but not for any other purpose except with the written permission of the Director, BMR, P.O Box 378, Canberra City, ACT 2601




DNEIPER

Geology 1980 by C. Simpson, R. Warren BMR

Compiled 1980-81 by B Holden BMR

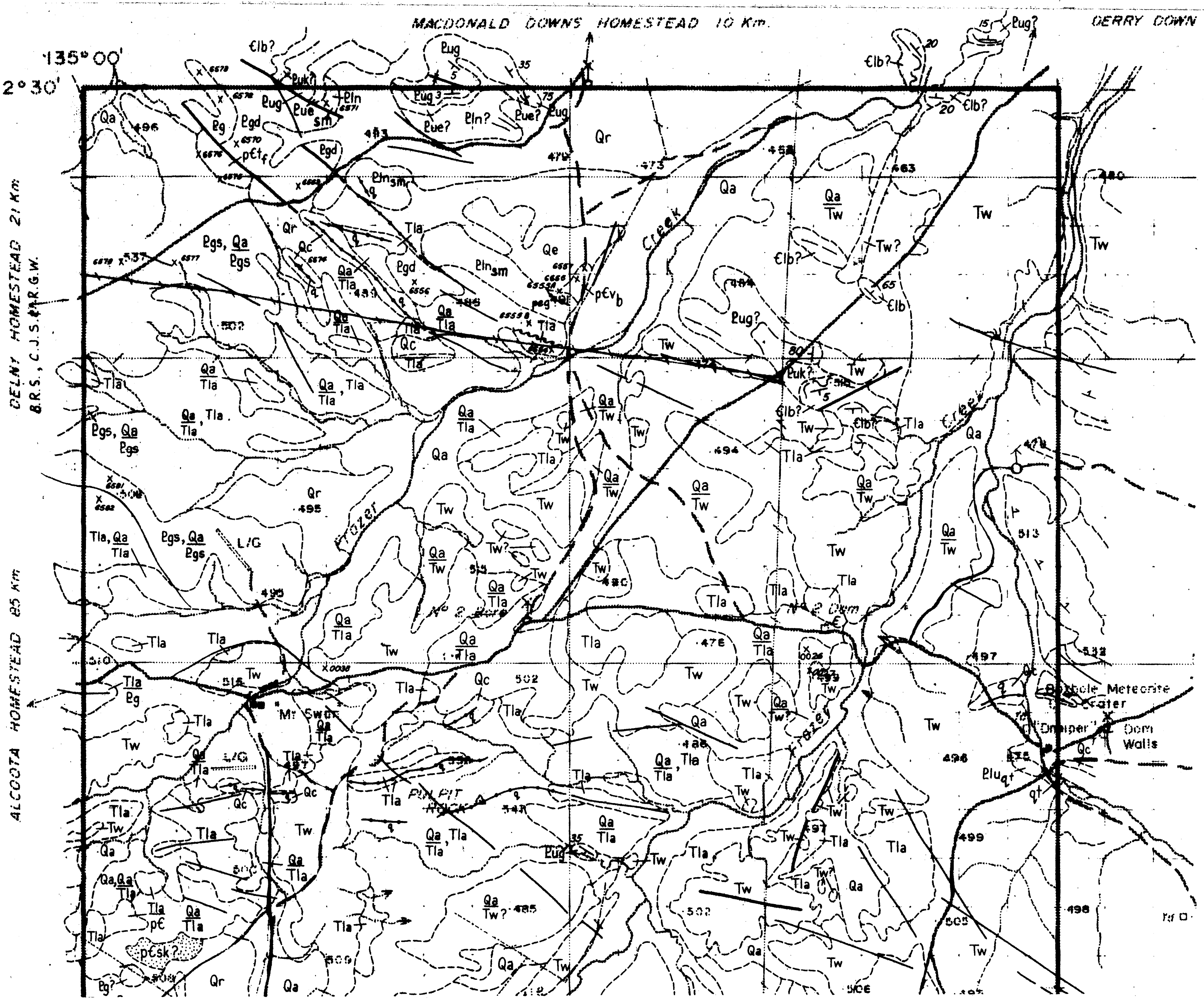
Scales (1-4) 1:25000 approx, (5-6) 1:80000 approx

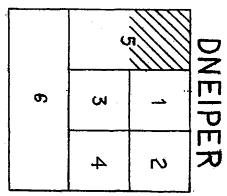
Compiled by the Bureau of Mineral Resources, Geology and Geophysics, in collaboration with the Northern Territory Geological Survey, Department of Mines and Energy as part of the policy of Government to assist in the exploration and development of mineral resources.

© Commonwealth of Australia

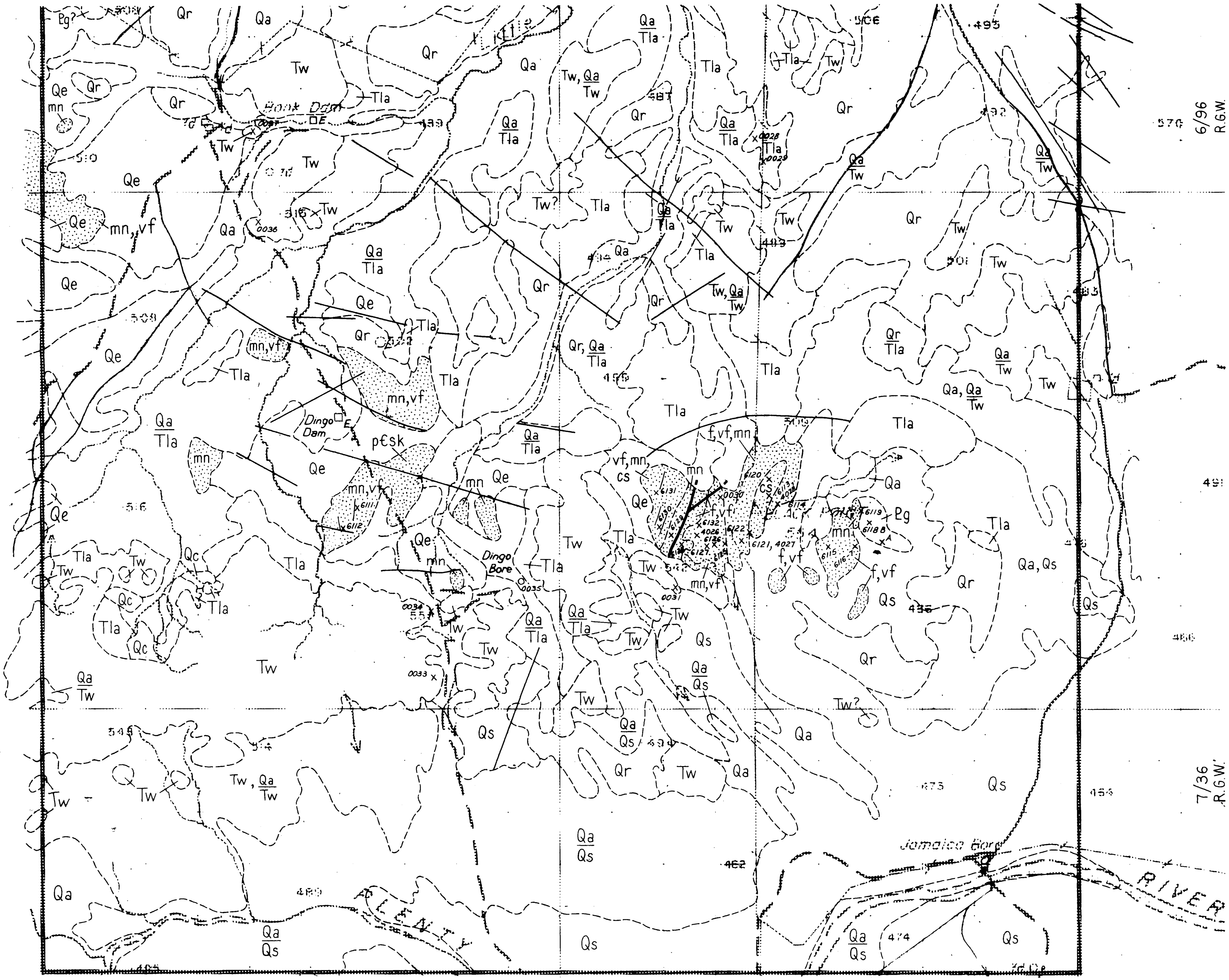
Persons purchasing transparencies of this map may reproduce it for their own use or for that of their staff, but not for any other purpose except with the written permission of the Director, BMR, P.O Box 378, Canberra City, ACT 2601

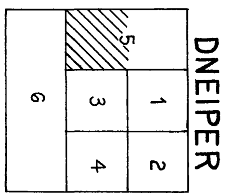
Record 1984/3

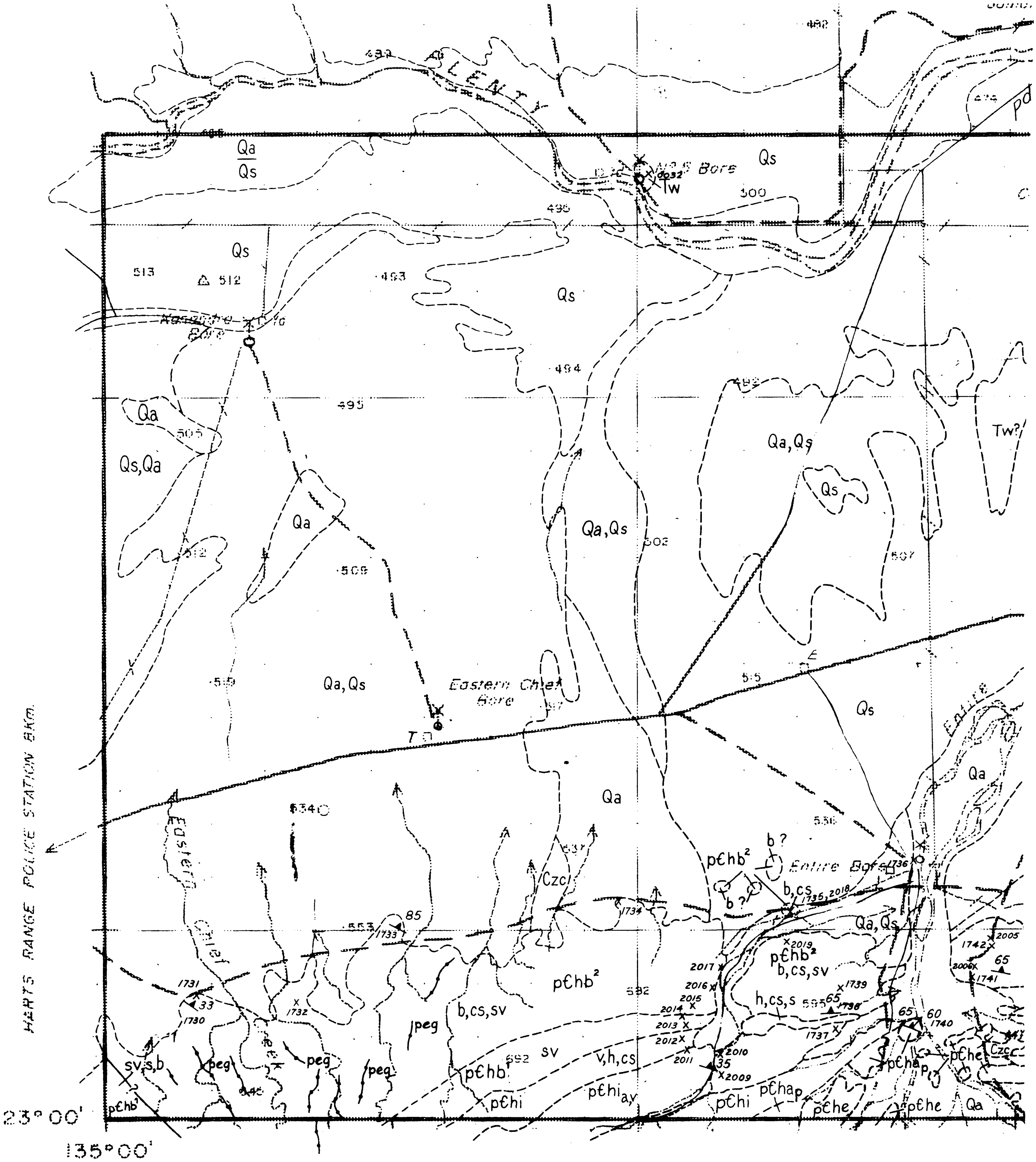


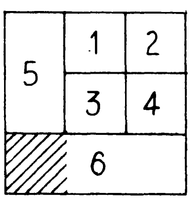




(7 of 33) 16/F53-11/12

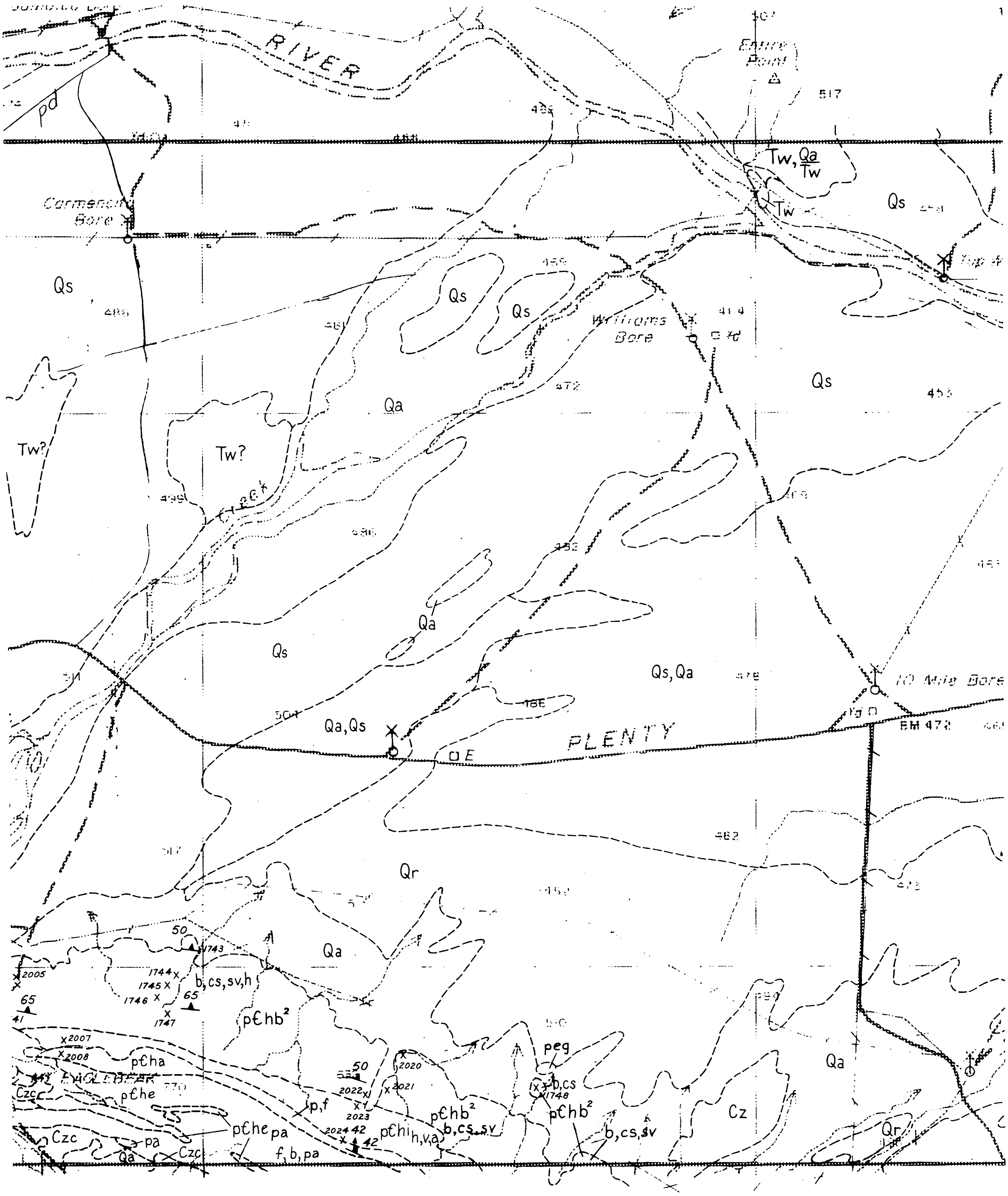

6/00
R.G.W. & B.R.S.
6/96
R.G.W.
7/32
R.G.W. & B.R.S.
7/36
R.G.W.
Bank Dam
Dingo Dam
Dingo Bore
Jamaica Bore
PLENTY
RIVER


DNEIPER
5
1
2
3
4
6


Qa
Qs
Qs
Qa,Qs
Qs,Qa
Qa, Qs
Qa
Eastern Chief Bore
Entire Bore
Tw
Tw?
pЄhb²
b,cs,sv
h,cs,s
v,h,cs
sv
peg
Czc
pЄhi
pЄha
pЄhe
HARTS RANGE POLICE STATION 8Km
23°00'
135°00'

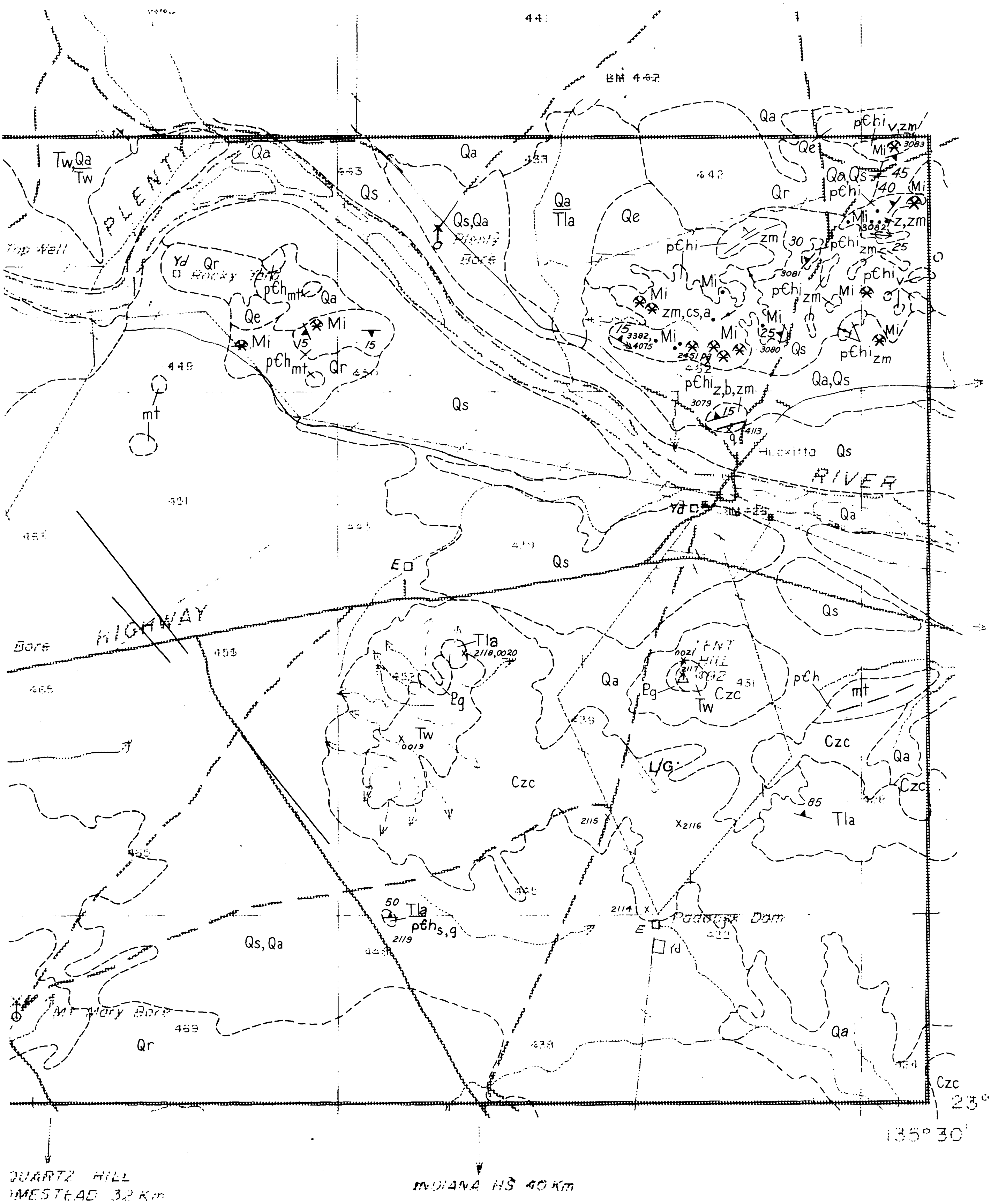

1
2
3
4
5
6

DNEIPER

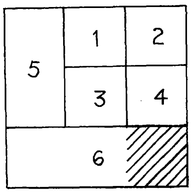



| | | |
|---|---|---|
| 5 | 1 | 2 |
| | 3 | 4 |
| | 6 | |

DNEIPER


PLENTY
RIVER
HIGHWAY
Top Well
Rocky Hill
Plenty Bore
Huckitta
Paddock Dam
Mt Mary Bore
Bore
BM 442
135° 30'
23°
QUARTZ HILL
HOMESTEAD 32 Km
INDIANA HS 40 Km

## DNEIPER


1
2
3
4
5
6

# JINKA REFERENCE

| | | | | |
|---|---|---|---|---|
| CAINOZOIC | QUATERNARY | | Qa | Alluvium, soil, undivided units |
| | | | Qe | Thin veneer of soil and some eluvium and alluvium overlying subsurface rocks of the Arunta Block, scattered bedrock outcrops |
| | | | Qr | Red soil, sand silt, clay, gravel, proportion of fine sand and silt greater than in Qa |
| | | | Qc | Colluvium, eluvium, scree, cobbles, sand, silt, clay |
| | | | Qs | Sheet and dune sand |
| | | | Czc | Lag gravel, fanglomerate, dissected alluvium, eluvium and colluvium |
| | | | Cz | Slightly weathered rock underlying Czc or related to Czc |
| | LATE TERTIARY | | Ts | Silicified rock |
| | LATE MIOCENE OR EARLY PLIOCENE | Waite Formation | Tw | Chalcedonic limestone, red-brown sandstone, silty sandstone, clay sandstone and sandy claystone |
| | EARLY TERTIARY | | Tla | Deeply weathered rock |
| | | | Tlf | Laterite profile with well developed ferruginous zone |
| MESOZOIC | JURASSIC — CRETACEOUS | Hooray Sandstone | JKh | Deeply weathered sandstone, feldspathic sandstone, siltstone basal conglomerate |

# GEORGINA BASIN

| | | | | |
|---|---|---|---|---|
| PALAEOZOIC | LATE DEVONIAN | Dulcie Sandstone | Dud² | Silicified, thick-bedded, prominently jointed, well-sorted, fine to medium quartz arenite with clay cement; subordinate medium to thin-bedded arenite. Rare conglomerate |
| | | | Dud¹ | Recessive, leached, thin to medium-bedded, well-sorted, clay-cemented, fine to medium quartz arenite; subordinate thick beds. Minor silicified arenite, rare conglomerate |
| | EARLY ORDOVICIAN | Nora Formation | Oln | Siltstone, dolomite, oolitic ironstone, sandstone |
| | CAMBRIAN-ORDOVICIAN | Tomahawk beds | ꞒOt | Calcareous sandstone, green siltstone, brown dolomite grey limestone, sandy dolomite |
| | MIDDLE TO LATE CAMBRIAN | Arrinthrunga Formation | Ꞓua | Grey dolomite and limestone stromatolitic and oolitic limestone, yellow chert and stromatolitic dolomite, rare thin beds of siltstone and sandstone |
| | | Eurowie Sandstone Member | Ꞓue | Fine to medium thin-bedded quartz sandstone, calcareous siltstone, shale and dolostone; rare quartz granule conglomerate |
| | | Arthur Creek beds | Ꞓma | Dull-yellow shale, laminated blue-black limestone sandstone with lenses of calcareous sandstone, dolomite |
| | EARLY CAMBRIAN | Errarra Beds | Ꞓle | Pale brown fossiliferous dolomite |
| | | Mount Baldwin Formation | Ꞓlb | Red-brown cross bedded sandstone thin to thick bedded, rare siltstone |
| PROTEROZOIC | | MOPUNGA GROUP: Elkera Formation | Ᵽuk | interbedded red-brown siltstone, dolomite, sandstone and shale stromatolitic dolomite (Georginia howchini) |
| | | MOPUNGA GROUP: Grant Bluff Formation | Ᵽug | Fine-grained thin-bedded sandstone, shale |
| | | MOPUNGA GROUP: Elyuah Formation | Ᵽue | Red-brown and green shale, basal pebbly sandstone |
| | | KEEPERA GROUP: Oorabra Arkose | Ᵽuo | Arkose, sedimentary breccia, dolomite |
| | | Mount Cornish Formation | Ᵽuc | Blue-grey diamictite |

# ARUNTA BLOCK

| | | | | |
|---|---|---|---|---|
| PALAEOZOIC | | Oorabra Reefs | q,br | Anastomosing brecciated hydrothermal quartz veins [illegible] Ba-Barite, Fl-Fluorite, and Fe Hematite in places. Spacially associated with Jinka Granite [Ᵽgj]. Locally cut Georgina Basin sequence |
| | | Harts Range pegmatites | peg | Zoned or partly zoned pegmatite with quartz core, microline zone plagioclase-muscovite wall zone and fine-grained quartz mica border zone. Spacially associated with Irindina Gneiss [pꞒhi] |
| | | | Ᵽr | Biotite schist (sb), quartzofeldspathic schist (sf), minor to rare r, d sc, e, relict a, mn, cs, g, f (Locally reactivated in Palaeozoic) |
| PROTEROZOIC | MIDDLE PROTEROZOIC | Samarkand and equivalent pegmatites | Ᵽps | Pegmatite (peg) |
| | | | Ᵽg | Granite (g), granitic gneiss (gg) |
| | | Marshall Granite | Ᵽgm | Hornblende granite (g), leucogranite (gl), aplite (apl), rare ga[illegible] |
| | | Jinka Granite | Ᵽgj | Granite (g), adamellite-granodiorite (gd), porphyritic granite (gp), leucogranite (gl); minor br, rare rafts of a, mi, pa, cs f, s, sb |
| | | | Ᵽgg | Gneissic biotite granite (g) |
| | | | Ᵽdr | Norite (gb), minor diorite (dr) |
| | | | Ᵽd | Gabbro (gb) or dolerite (dl), partly metamorphosed dolerite or gabbro (a) |
| | EARLY PROTEROZOIC | * Bonya Schist | pꞒo | Biotite-muscovite schist (s), muscovite schist (sm), quartzofeldspathic schist (sf), calc-silicate rock (cs) andalusite schist (x), marble (ma) amphibolite (a), minor to rare pa, qf, b |
| | | Kings Legend Amphibolite Member | pꞒi | Amphibolite with coarse plagioclase spots (a) |
| | | * Mascotte Gneiss Complex | pꞒm | Granitoid (gt), quartzofeldspathic gneiss (f), leucogranite (gl), granitic gneiss (gg), amphibolite (a); rare sb, qf |
| | | | pꞒs | Quartzofeldspathic gneiss (f), biotite gneiss (b), calc-silicate rock (cs), granitic gneiss (gg), minor to rare sb, ma, sf, j, r, s, sb |
| | | * Cackleberry Metamorphics | pꞒv | Calc-silicate rock (cs), cordierite-anthophyllite rock (ia), rare para-amphibolite (pa) |
| | | * Deep Bore Metamorphics | pꞒp | Cordierite felsic granulite (if), mafic granulite (mn), para-amphibolite (pa), calc-silicate rock (cs), sillimanite gneiss (z), rare qf, f, b, a |
| | | HARTS RANGE GROUP: Undivided Harts Range Group | pꞒh | Calc-silicate rock (cs), quartzite (qf), amphibolite (a), biotite gneiss (b), unclassified metamorphic rock (mt), minor to rare j, v, mi, qf, q, ma, z, peg, s (formation identification uncertain) |
| | | HARTS RANGE GROUP: Irindina Gneiss | pꞒhi | Garnet-biotite gneiss (v), sillimanite-garnet-biotite gneiss (z), biotite schist (sb), biotite gneiss (b), calc-silicate rock (cs), marble (ma), minor to rare a, mi, ql, j, f, fm, vf, s, sv, p, pa, mn, peg, r, z, zm |
| | | | pꞒ | Migmatitic quartzofeldspathic and biotite gneiss (f, b, mi), calc-silicate rock (cs), minor to rare a, z, qf, qt, mn |
| | | | pꞒc | Quartzofeldspathic gneiss (f), intercalated with minor to rare biotite schist (sb), biotite gneiss (b), calc-silicate rock (cs), and quartzite (qf), rare m, q |
| | | STRANGWAYS METAMORPHIC COMPLEX: Kanandra Granulite | pꞒsk | Quartzofeldspathic gneiss (f), mafic granulite (mn), biotite gneiss (b), garnet quartzofeldspathic gneiss (vf), migmatite (mi), minor to rare peg, a, cs, v, z, p, pa, j, h, localised reactivated zones of retrograde metamorphism sb, sf, s, d |

* Partly defined formal stratigraphic units

## STRUCTURAL AND TOPOGRAPHIC SYMBOLS

- p€o — Stratigraphic unit symbol eg Bonya Schist (Arunta Block only)
- a — Rock type symbol eg amphibolite (Arunta Block only)
- Lithological boundary (Arunta Block only)
- Stratigraphic boundary (Arunta Block only)
- Extrapolated stratigraphic boundary (Arunta Block only)
- Marker bed with rock type (p€o only) (Arunta Block only)
- Angular unconformity (reference only) (Top of v or u opens towards younger unit)
- Disconformity (reference only) (Top of v or u opens towards younger unit)
- Unconformity (Top of v or u opens towards younger unit)
- Extrapolated unconformity (Top of v or u opens towards younger unit)
- Fault containing: q - quartz, br - breccia
- High-angle reverse fault, triangle on upthrown side
- Schist zone
- Anticline showing plunge
- Syncline
- Monocline

Where location of folds and faults is approximate, line is broken; where inferred, queried; where concealed, folds are dotted, faults are shown by short dashes

- Locality of superposed folds
- Minor anticline with plunge
- Minor antiform with plunge
- Minor fold with dip of axial plane and plunge of axis

Style of arrowhead indicates type of lineation parallel to fold axis

- Trend and plunge of undifferentiated lineation
- Trend and plunge of mineral elongation
- Trend and plunge of compositional layering-schistosity intersection
- Trend and plunge of crenulation
- Strike and dip of strata
- Strike and dip of strata, facing not known
- Vertical strata
- Vertical strata showing facing based on sedimentary structures
- Horizontal strata
- Strike and dip of overturned strata
- Strike and dip of strata, dip not estimated (airphoto interpretation)
- Strike and dip of strata, dip < 5° (airphoto interpretation)
- Strike and dip of strata, dip 5°-15° (airphoto interpretation)
- Strike and dip of strata, dip 15°-45° (airphoto interpretation)
- Strike and dip of strata, dip > 45° (airphoto interpretation)
- Horizontal strata (airphoto interpretation)
- Trend-line (airphoto interpretation)
- Lineament (airphoto interpretation)
- Joint pattern (airphoto interpretation)

- Strike and dip of joint
- Strike and dip of foliation
- Vertical foliation
- Strike of foliation, dip indeterminate
- Strike and dip of foliation, second folding episode (crenulation cleavage)
- Late-stage schistosity associated with retrograde metamorphism
- Strike and dip of cleavage
- Macrofossil locality
- Stromatolite locality
- Stromatolite (*Georginia howchini*) locality
- Trace fossil locality
- Dyke or vein; apl-aplite, peg-pegmatite, q-quartz
- Measured section with reference number
- SH-Scout hole, DD-Diamond-drillhole with NTGS reference number
- Minor mineral occurrence
- Prospect
- Abandoned prospect
- Mine
- Abandoned mine
- Open cut or quarry
- Costean
- Petroleum exploration well with show of oil

Ap-Apatite, Ba-Barite, Cu-Copper, Fe-Iron, Fl-Fluorite, Mi-Mica
Mn-Manganese, Mo-Molybdenum, Pb-Lead, W-Tungsten (sheelite)

- x1794 Data point

- Windpump
- Bore
- Abandoned bore
- Water tank
- Earth dam
- Waterhole
- Road
- Track
- Fence
- Landing ground
- Jinka Homestead
- Yard
- ·532 Spot elevation in metres

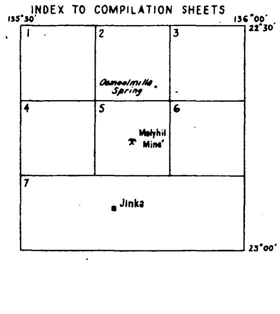
Some symbols are combined on the map eg

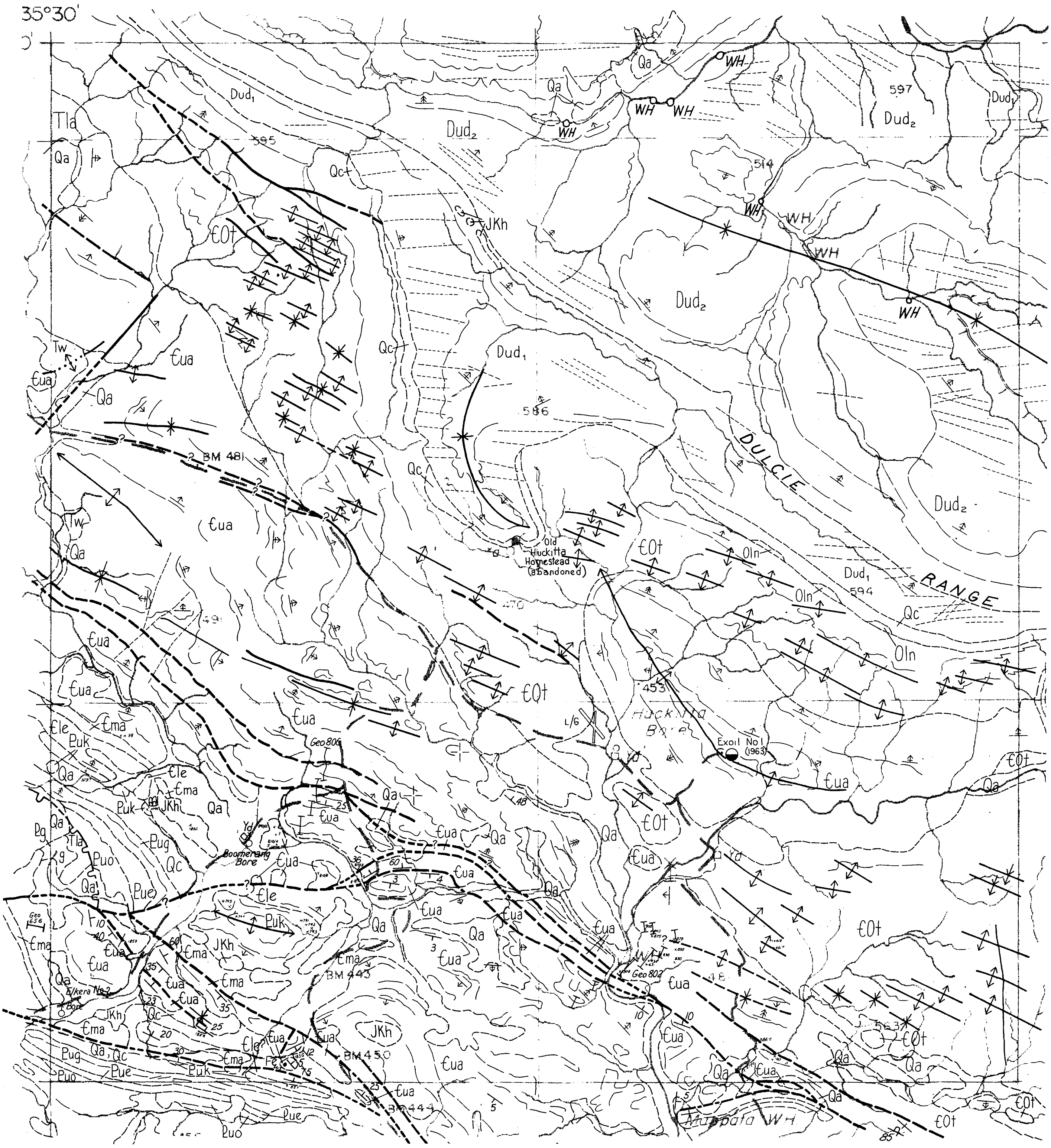
All symbols in reference are drawn to 1:100 000 specifications (4 times smaller than on comp. sheets)

- a — Amphibolite, metadolerite
- apl — Aplite
- b — Biotite gneiss
- br — Tectonic breccia
- cs — Calc-silicate rock
- d — Unclassified deformed rock (eg mylonite, cataclasite, highly foliated rocks)
- dl — Dolerite
- dr — Diorite
- e — Epidote rock, epidosite
- f — Quartzofeldspathic gneiss
- fm — Muscovite-bearing quartzofeldspathic rock
- g — Granite
- gb — Gabbro, partly metamorphosed gabbro or norite
- gd — Adamellite-granodiorite
- gg — Granitic gneiss
- gl — Leucogranite with no or negligible ferromagnesium mineral
- gp — Granite or leucogranite containing abundant k-feldspar phenocrysts
- gt — Granitoid ie granitic composition, even-grained, granular, mainly anhedral grains
- h — Hornblende gneiss of acid to intermediate composition
- ia — Cordierite-anthophyllite rock
- if — Cordierite-bearing felsic granulite
- j — Quartz-rich metasediment
- m — Mylonite
- ma — Marble
- mi — Migmatite, migmatitic gneiss
- mn — Mafic granulite
- mt — Unclassified metamorphic rock
- p — Porphyroblastic-feldspar gneiss
- pa — Mafic calc-silicate rock, compositionally layered amphibolite
- peg — Pegmatite
- q — Vein quartz
- qf — Magnetite quartzite
- qt — Quartzite
- r — Metamorphically retrogressed rock
- s — Biotite-muscovite schist, muscovite-biotite schist
- sb — Biotite schist
- sc — Chlorite schist, tremolite-actinolite schist
- sf — Quartzofeldspathic schist
- sm — Muscovite schist
- un — Meta-ultramafic rock
- v — Garnet-biotite-plagioclase-quartz gneiss
- vf — Garnet-bearing quartzofeldspathic gneiss
- x — Andalusite-mica schist
- z — Sillimanite-bearing gneiss, sillimanite-garnet-biotite gneiss
- zm — Sillimanite and muscovite-bearing gneiss
- (w) — weathered

# JINKA

INDEX TO COMPILATION SHEETS






1 2 3
4 5 6
7

## JINKA

Geology 1949-51 G F Joklik and others
1957-60 K G Smith, J W Smith, Dr G Wooley, J M Polley, R R Vine, K Gough, E H Milligan
1976 R G Warren, BMR
1980 R D Shaw, R G Warren, L A Offe, BMR, M J Freeman, C L Horsfall, NTGS
1981 J Laurie, NTGS

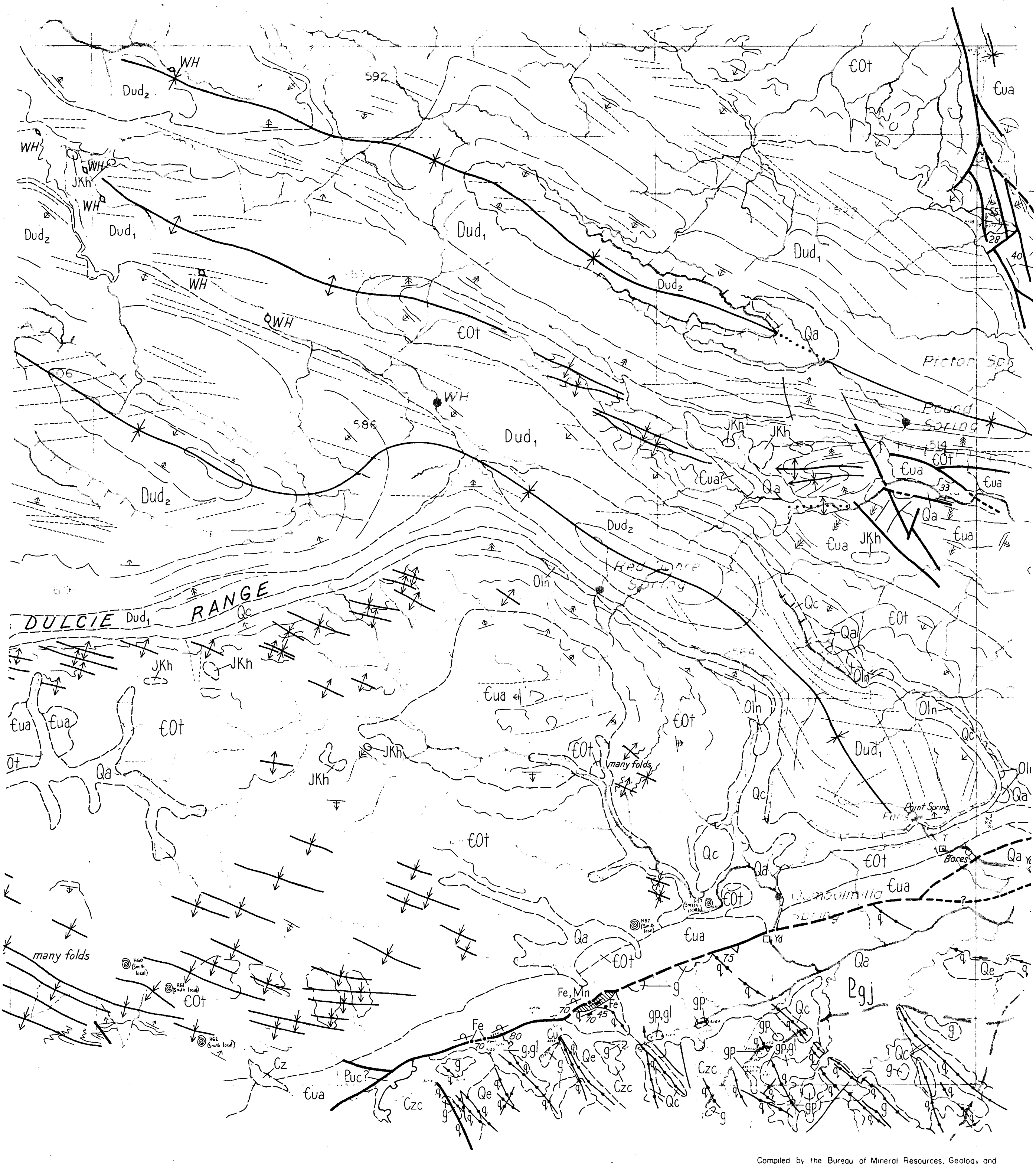
Compiled 1981-82 J Stirzaker, C Johnson, C Knight, BMR

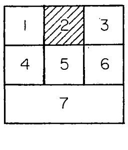
Scale (1-6) 1 26 042, (7) 1 80 000

Compiled by the Bureau of Mineral Resources, Geology and Geophysics, in collaboration with the Northern Territory Geological Survey, Department of Mines and Energy as part of the policy of Government to assist in the exploration and development of mineral resources

© Commonwealth of Australia

Persons purchasing transparencies of this map may reproduce it for their own use or for that of their staff, but not for any other purpose except with the written permission of the Director, BMR, PO Box 378, Canberra City, ACT 2601




## JINKA

Geology 1949–51: G F Joklik and others
1957–60: K G Smith, J W Smith, Dr G Wooley, J M Polley, R R Vine, K Gough, E H Milligan
1976: R G Warren, BMR
1980: R D Shaw, R G Warren, L A Offe, BMR, M J Freeman, C L Horsfall, NTGS
1981: J Laurie, NTGS

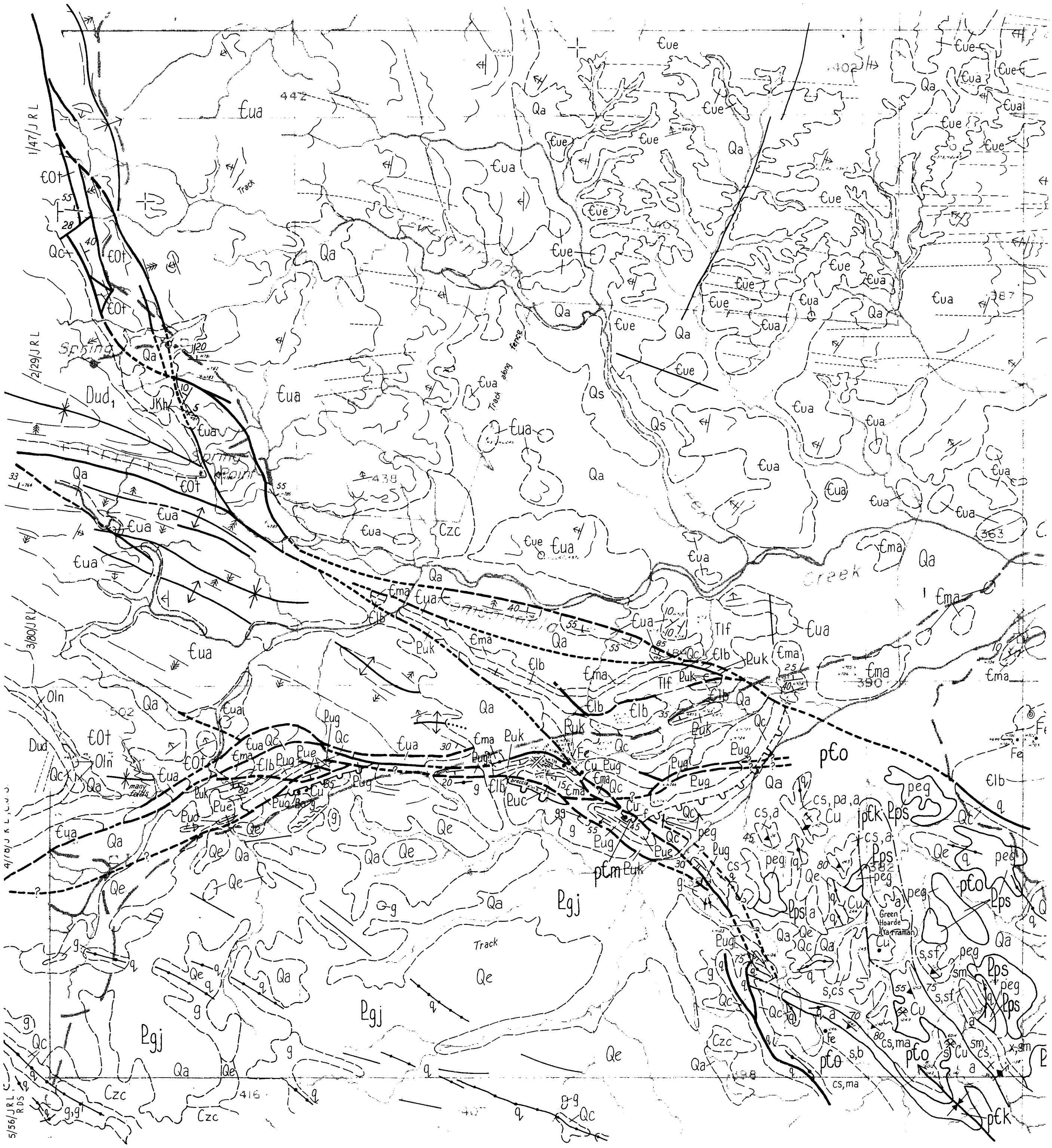
Compiled 1981–82 J Stirzaker, C Johnson, C Knight, BMR

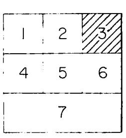
Scale (1–6) 1:26 042, (7) 1:80 000

Compiled by the Bureau of Mineral Resources, Geology and Geophysics, in collaboration with the Northern Territory Geological Survey, Department of Mines and Energy as part of the policy of Government to assist in the exploration and development of mineral resources

© Commonwealth of Australia

Persons purchasing transparencies of this map may reproduce it for their own use or for that of their staff, but not for any other purpose except with the written permission of the Director, BMR, PO Box 378, Canberra City, ACT 2601




# JINKA

Geology 1949-51 G F Joklik and others
1957-60 K G Smith, J W Smith, Dr G Wooley, J M Polley, R R Vine, K Gough, E H Milligan
1976 R G Warren, BMR
1980 R D Shaw, R G Warren, L A Offe, BMR, M J Freeman, C L Horsfall, NTGS
1981 J Laurie, NTGS

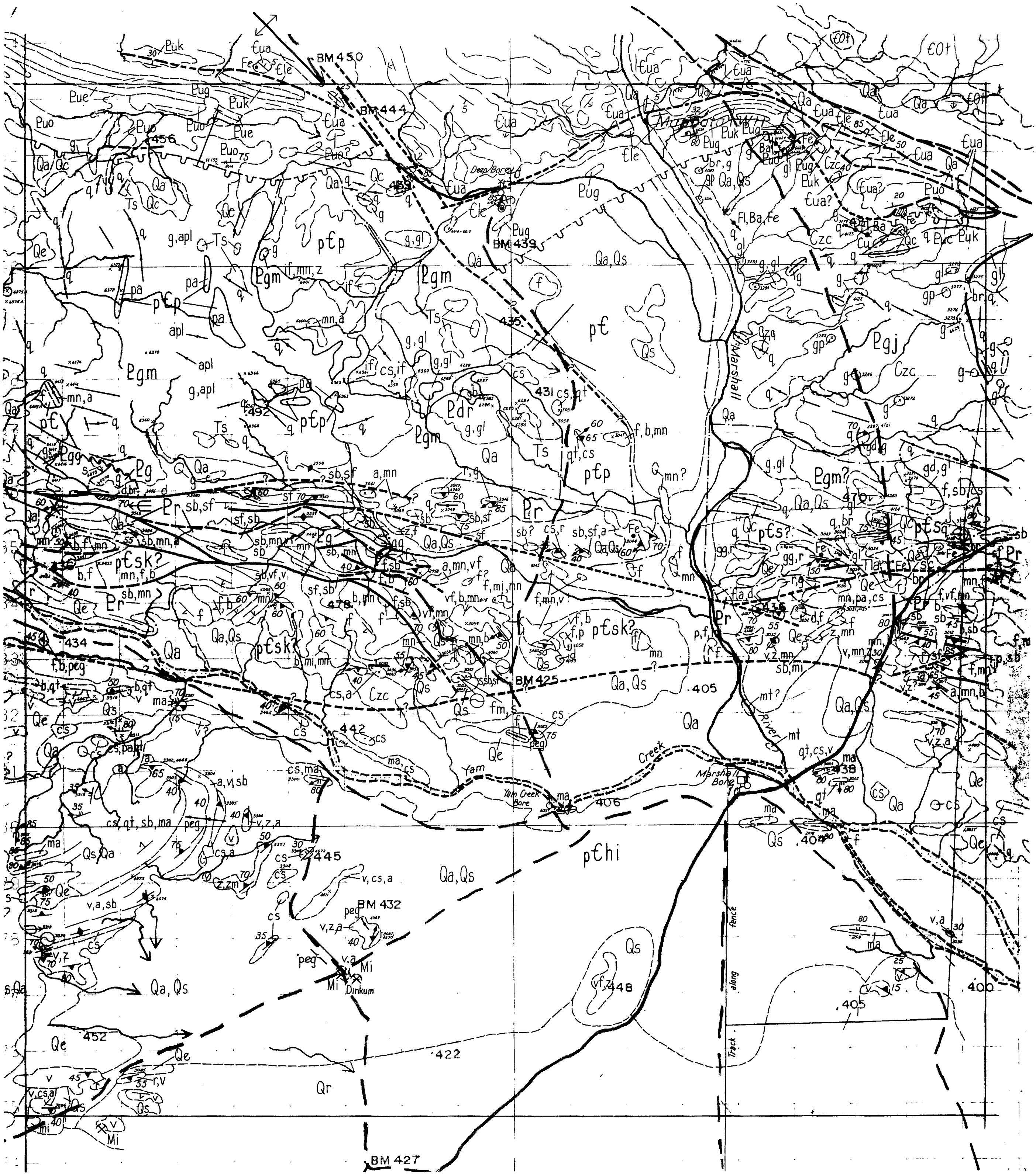
Compiled 1981-82 J Stirzaker, C Johnson, C Knight, BMR

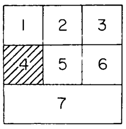
Scale (1-6) 1 26 042 , (7) 1 80 000

Compiled by the Bureau of Mineral Resources, Geology and Geophysics, in collaboration with the Northern Territory Geological Survey, Department of Mines and Energy as part of the policy of Government to assist in the exploration and development of mineral resources

© Commonwealth of Australia

Persons purchasing transparencies of this map may reproduce it for their own use or for that of their staff, but not for any other purpose except with the written permission of the Director, BMR, PO Box 378, Canberra City, ACT 2601




# JINKA

Geology: 1949–51: G F Joklik and others
1957–60: K.G Smith, J.W.Smith, Dr.G.Wooley, J M Polley, R R Vine, K Gough, E H Milligan
1976: R.G Warren, BMR
1980: R D Shaw, R.G Warren, L.A.Offe, BMR; M J Freeman, C.L.Horsfall, NTGS
1981: J Laurie, NTGS

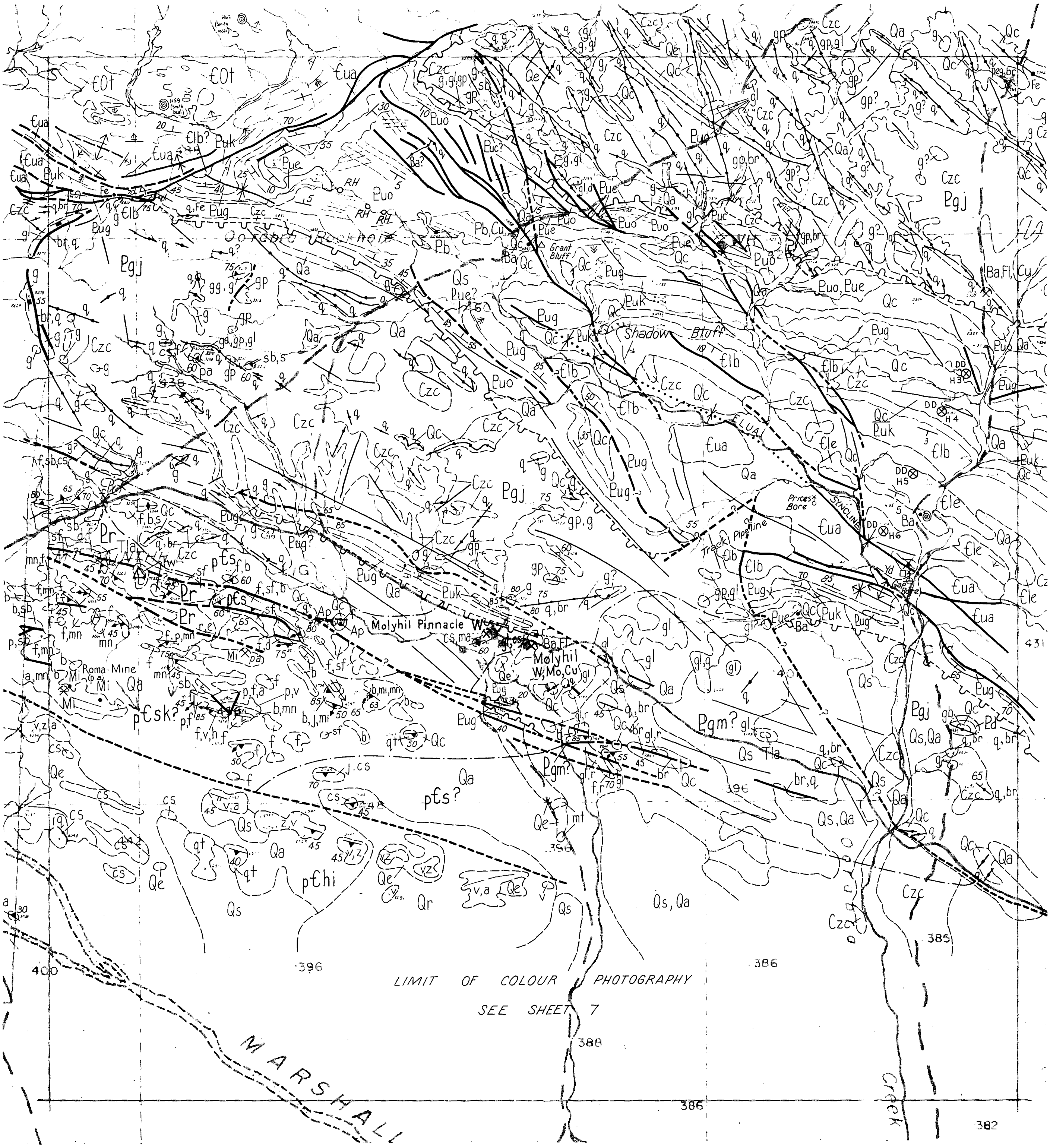
Compiled 1981–82: J Stirzaker, C.Johnson, C Knight, BMR

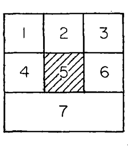
Scale (1-6) 1 26 042, (7) 1 80 000

Compiled by the Bureau of Mineral Resources, Geology and Geophysics, in collaboration with the Northern Territory Geological Survey, Department of Mines and Energy as part of the policy of Government to assist in the exploration and development of mineral resources

© Commonwealth of Australia

Persons purchasing transparencies of this map may reproduce it for their own use or for that of their staff, but not for any other purpose except with the written permission of the Director, BMR, P.O. Box 378, Canberra City, ACT 2601




JINKA

Geology 1949-51 G F Joklik and others
1957-60 K G Smith, J W Smith, Dr G Wooley, J M Polley, R R Vine, K Gough, E H Milligan
1976 R G Warren, BMR
1980 R D Shaw, R G Warren, L A Offe, BMR, M J Freeman, C L Horsfall, NTGS
1981 J Laurie, NTGS

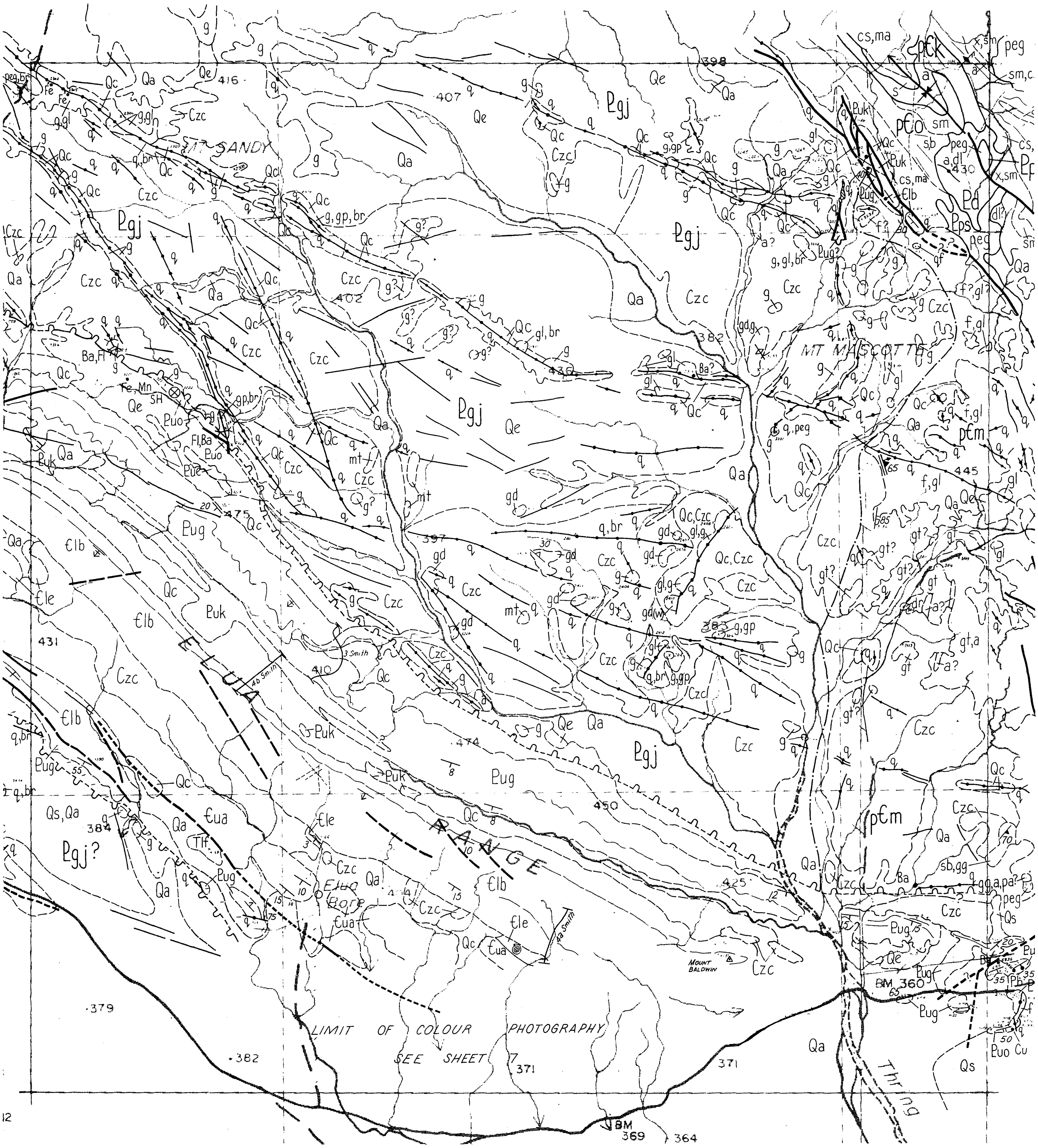
Compiled 1981-82 J Stirzaker, C Johnson, C Knight, BMR

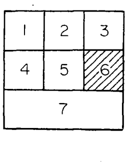
Scale (1-6) 1 26 042, (7) 1 80 000

Compiled by the Bureau of Mineral Resources, Geology and Geophysics, in collaboration with the Northern Territory Geological Survey, Department of Mines and Energy as part of the policy of Government to assist in the exploration and development of mineral resources

© Commonwealth of Australia

Persons purchasing transparencies of this map may reproduce it for their own use or for that of their staff, but not for any other purpose except with the written permission of the Director, BMR, PO Box 378, Canberra City, ACT 2601




JINKA

Geology 1949–51 G F Joklik and others
1957–60 K G Smith, J W Smith, Dr G Wooley, J M Polley, R R Vine, K Gough, E H Milligan
1976 R G Warren, BMR
1980 R D Shaw, R G Warren, L A Offe, BMR, M J Freeman, C L Horsfall, NTGS
1981 J Laurie, NTGS

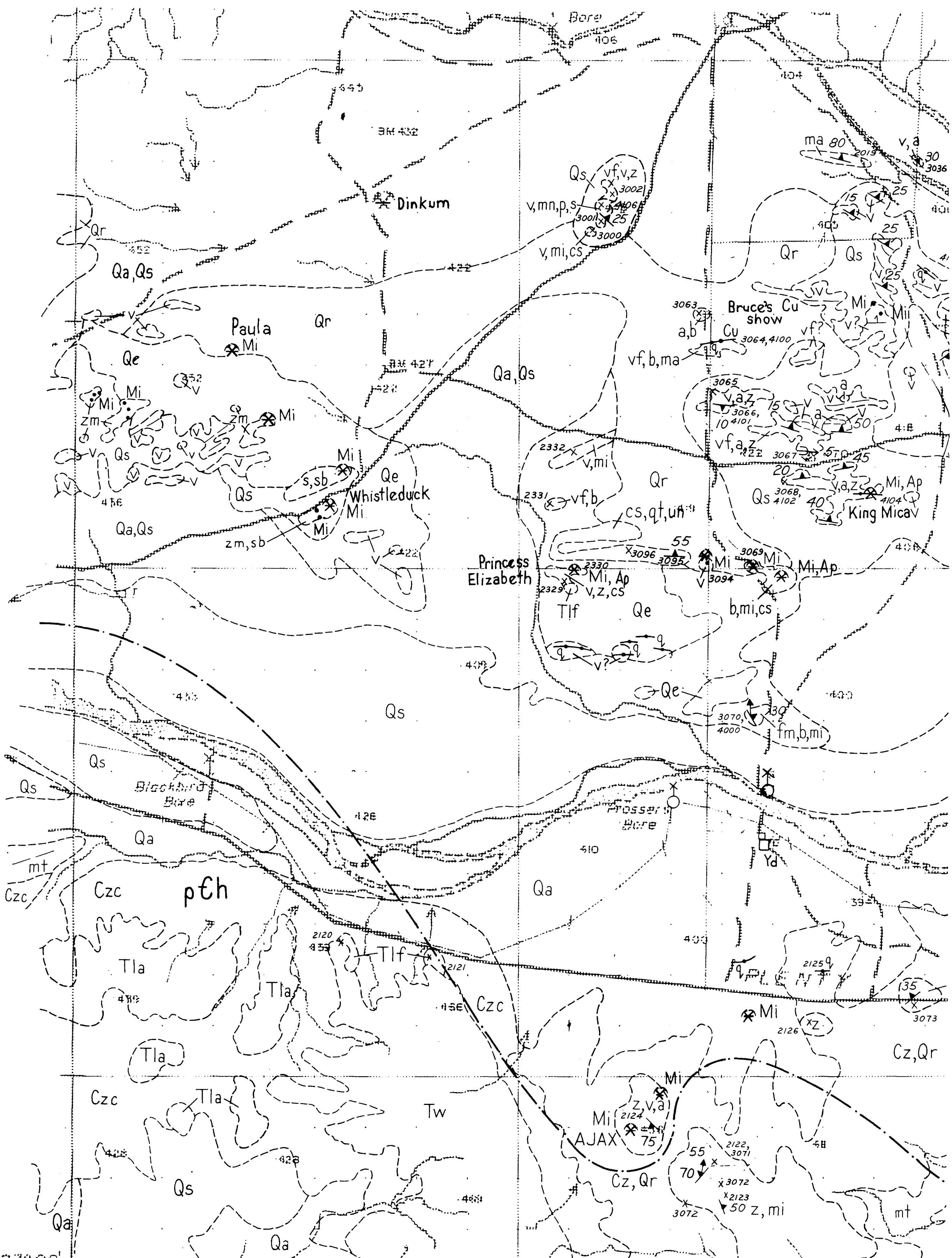
Compiled 1981–82 J Stirzaker, C Johnson, C Knight, B M R

Scale (1–6) 1 26 042, (7) 1 80 000

Compiled by the Bureau of Mineral Resources, Geology and Geophysics, in collaboration with the Northern Territory Geological Survey, Department of Mines and Energy as part of the policy of Government to assist in the exploration and development of mineral resources

© Commonwealth of Australia

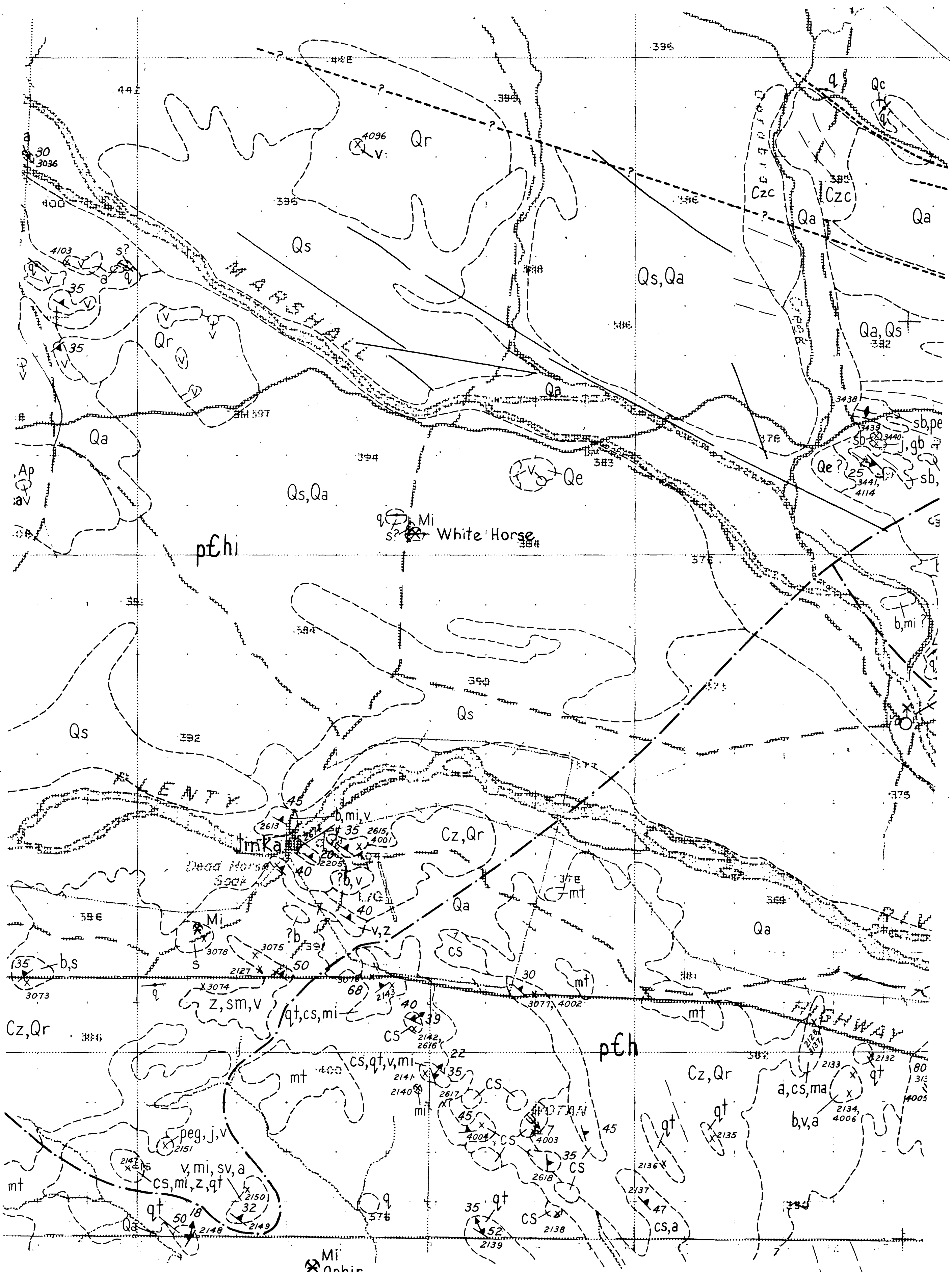
Persons purchasing transparencies of this map may reproduce it for their own use or for that of their staff, but not for any other purpose except with the written permission of the Director, BMR, PO Box 378, Canberra City, ACT 2601

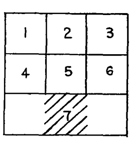



| | | |
|---|---|---|
| 1 | 2 | 3 |
| 4 | 5 | 6 |
| | 7 | |

JINKA

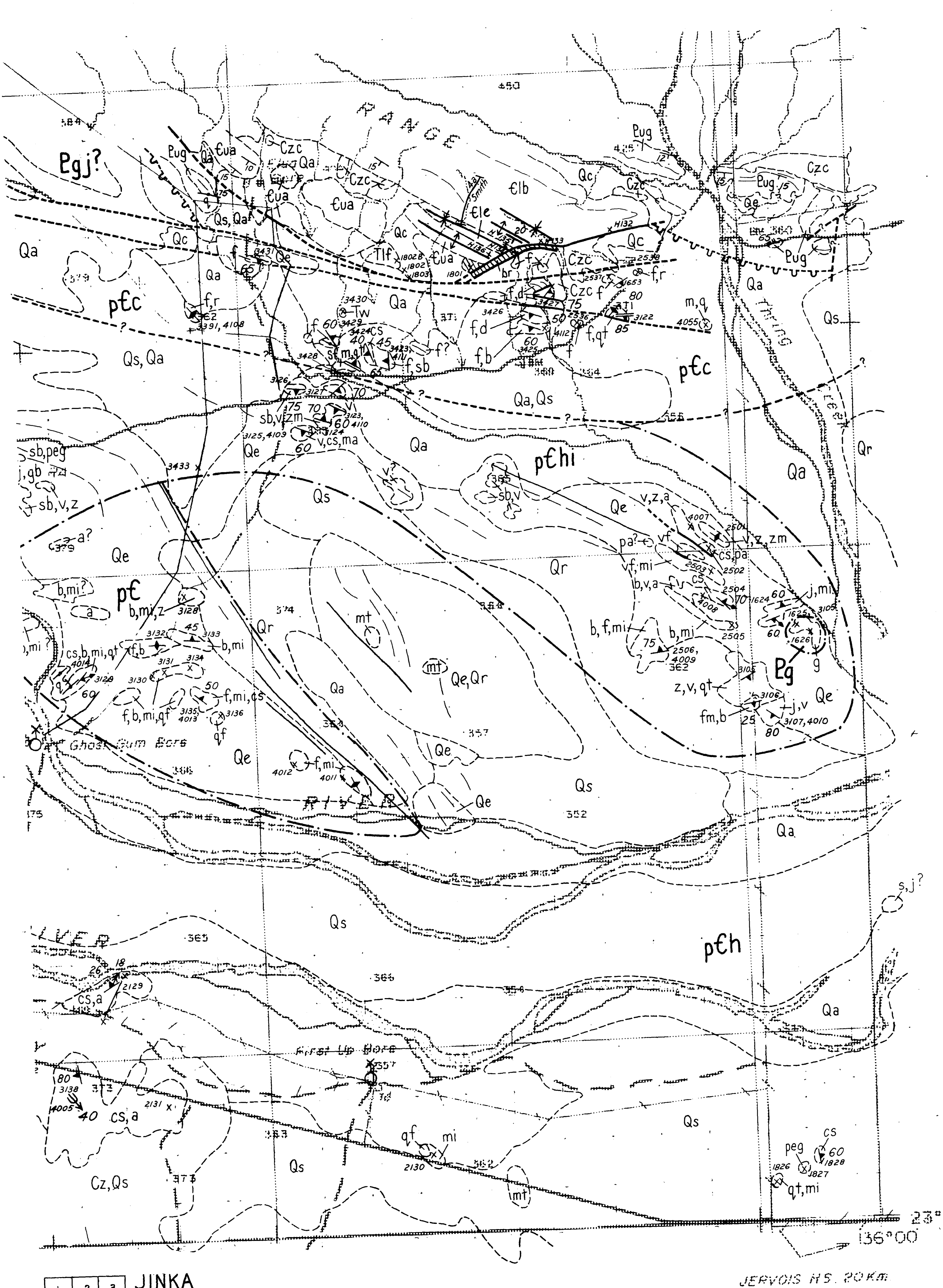
Record 1984/3




JINKA

Record 1984/3




JINKA

| 1 | 2 | 3 |
|---|---|---|
| 4 | 5 | 6 |
| | 7 | |

JERVOIS H.S. 20Km

Record 1984/3

(22 of 33) 16/F53-11/27

# JERVOIS RANGE REFERENCE

| | | | | |
|---|---|---|---|---|
| CAINOZOIC | QUATERNARY | | Qa | *Soil, alluvium, undivided Quaternary units* |
| | | | Qe | *Thin veneer of soil cover and some eluvium over subsurface rocks with scattered bedrock outcrops* |
| | | | Qr | *Red soil* |
| | | | Qc | *Conglomerate, fanglomerate, colluvium, scree slope deposits* |
| | | | Qs | *Sheet and dune sand* |
| | | | Czc | *Lag gravels* |
| | MIOCENE–PLIOCENE | Waite Formation | Tw | *Chalcedonic limestone* |
| | | | Tls | *Siliceous lateritic rock, silcrete* |
| | | | Tlf | *Ferruginous lateritic rock* |
| | EARLY TERTIARY | | Tla | *Deeply weathered rock* |
| MESOZOIC | JURASSIC–CRETACEOUS | Hooray Sandstone | JKh | *Sandstone, feldspathic sandstone, siltstone, basal boulder conglomerate* |

## GEORGINA BASIN

| | | | | |
|---|---|---|---|---|
| PALAEOZOIC | CAMBRIAN–ORDOVICIAN | Tomahawk beds | €Ot | *Calcareous sandstone, green siltstone, brown dolomite, grey limestone, sandy dolomite* |
| | LATE CAMBRIAN | Arrinthrunga Formation | €ua | *Grey dolomite and limestone, stromatolitic oolitic limestone, yellow cherty and stromatolitic dolomite, rare thin beds of siltstone and sandstone* |
| | CAMBRIAN | Arthur Creek beds | €ma | *Buff shale, laminated blue-black limestone, sandstone with lenses of calcareous sandstone, dolomite* |
| | | Errarra beds | €ie | *Friable feldspathic sandstone, thin basal pebble conglomerate, mostly deeply weathered* |
| | | Mount Baldwin Formation | €lb | *Thin to thick-bedded, cross-bedded sandstone, and rare siltstone* |
| PROTEROZOIC | LATE PROTEROZOIC | MOPUNGA GROUP: Elkera Formation | Ꝑuk | *Interbedded siltstone, dolomite, sandstone and shale, stromatolitic (Georginia howchini) dolomite* |
| | | MOPUNGA GROUP: Grant Bluff Formation | Ꝑug | *Thin-bedded fine sandstone, shale* |
| | | MOPUNGA GROUP: Elyuah Formation | Ꝑue | *Basal pebbly sandstone, brown and green shale* |
| | | KEEPERA GROUP: Oorabra Arkose | Ꝑuo | *Arkose, sharpstone, conglomerate, dolomite, basal tillite locally (▲▲▲)* |
| | | Mount Cornish Formation | Ꝑuc | *Diamictite, siltstone, varved beds* |
| | | Yackah beds | Ꝑuy | *Sandstone, granule conglomerate, dolomite* |

## ARUNTA BLOCK

| | | | | |
|---|---|---|---|---|
| PALAEOZOIC | | | Pzr | *Retrograde schists (r) including sericitic quartzofeldspathic schist (sf), biotite schist (sb), mylonite (m); relict granodioritic gneiss (gg), calc-silicate rock (cs) and amphibolite (a)* |
| PROTEROZOIC | MIDDLE PROTEROZOIC | Unca Granite | Ꝑgu | *Leucogranite (gl), very weakly foliated* |
| | | Xanten Granite | Ꝑgx | *Leucogranite (gl), silicified* |
| | | Samarkand and equivalent pegmatites | Ꝑps | *Pegmatite (peg)* |
| | | Jervois Granite | Ꝑge | *Granite (g), leucogranite (gl), granodiorite (gd), amphibolite (a); minor to rare s, peg* |
| | | | Ꝑgf | *Muscovite leucogranite (gl), foliated and tourmaline-bearing* |
| | | | Ꝑgn | *Biotite and hornblende granodiorite (gd)* |
| | | | Ꝑg | *Granite (g), leucogranite (gl); minor to rare r, peg, fm, s* |
| | | | Ꝑd | *Gabbro (gb), dolerite (dl), some metamorphosed dolerite (a)* |
| | | Attutra Metagabbro | Ꝑda | *Altered gabbro (gb), dolerite (dl), rare metanorite (n) and diorite (dr)* |
| | EARLY PROTEROZOIC ? | *Bonya Schist | p€o | *Muscovite schist (sm), biotite-muscovite schist (s), andalusite schist (x), well-banded actinolite and clinozoisite-microcline calc-silicate rock (ct), fine-grained metapelite and calcareous metapelite (ag), acid volcanics (Ɣ), fine-grained quartzofeldspathic rock with plagioclase laths (jf), massive and layered amphibolite (a, pa), magnetite quartzite (qf); minor to rare cs, ma, qt, h, z, zm, g, peg, sf, f, v, sc, sb, d, r, b, gg, gt, gd, gb* |
| | | Kings Legend Amphibolite Member | p€k | *Amphibolite with coarse plagioclase spots (a), muscovite schist (sm), calc-silicate rock (cs), deformed rock (d), coarse-grained garnet-quartz-epidote rock (sk); rare s* |
| | | *Mascotte Gneiss Complex | p€m | *Granitic gneiss (gg), quartzofeldspathic gneiss (f), granitoid (gt), biotite gneiss (b), leucogranite (gl), amphibolite (a), layered and quartz amphibolite (pa), biotite schist (sb); minor to rare h, peg, qt, dl, apl, mi, s* |
| | | | p€q | *Quartzite (qt), muscovite schist (sm), biotite-muscovite schist (s), biotite gneiss (b), tourmaline quartzite (jt), garnet-sillimanite gneiss (z)* |
| | | HARTS RANGE GROUP (Undivided) | p€h | *Muscovite-biotite schist (s), quartz-rich metasediment (j), quartzite (qt), biotite gneiss (b), quartzofeldspathic gneiss (f); minor to rare z, zm, pa, sb, mi* |
| | | | p€ | *Quartzofeldspathic gneiss (f), biotite gneiss (b), granitic gneiss (gg), muscovite-biotite schist (s); minor to rare sb, mi, qf, fm, q, un, qt, j, cs, jt, sm, r, mt, peg, p* |

* *Partly defined formal stratigraphic unit*

## STRUCTURAL AND TOPOGRAPHIC SYMBOLS

p€o *Stratigraphic unit symbol eg Bonya Schist* } *Arunta Block only*
a *Rock type symbol eg amphibolite*
*Lithological boundary*
*Stratigraphic boundary*
*Extrapolated stratigraphic boundary*
*Marker bed with rock type (p€o only)*

*Angular unconformity (reference only)* } *Top of v or u opens towards younger unit*
*Disconformity (reference only)*
*Unconformity*
*Extrapolated unconformity*

*Fault containing:* q-*quartz*, br-*breccia*
*Schist zone*
*Anticline showing plunge*
*Syncline*
*Monocline*

*Where location of folds and faults is approximate, line is broken; where inferred, queried; where concealed, folds are dotted, faults are shown by short dashes*

*Minor anticline with plunge*
*Minor antiform with plunge*
*Minor fold with dip of axial plane and plunge of axis*
*Plunge of minor fold showing 'S' vergences*
*Plunge of minor fold showing 'Z' vergences*
*Plunge of minor fold showing 'M' vergences*
*Style of arrowhead indicates type of lineation parallel to fold axis*

*Trend and plunge of undifferentiated lineation*
*Trend and plunge of mineral elongation*
*Trend and plunge of compositional layering-schistosity intersection*
*Trend and plunge of crenulation*
*Strike and dip of strata*
*Strike and dip of strata, facing not known*
*Vertical strata*
*Vertical strata showing facing*
*Horizontal strata*
*Strike and dip of overturned strata*

*Strike and dip of strata, dip not estimated* } *airphoto interpretation*
*Strike and dip of strata, dip < 5°*
*Strike and dip of strata, dip 5°–15°*
*Strike and dip of strata, dip 15°–45°*
*Strike and dip of strata, dip > 45°*
*Horizontal strata*
*Trend-line*
*Lineament*
*Joint pattern*

*Strike and dip of joint*
*Strike and dip of foliation*
*Vertical foliation*
*Strike of foliation, dip indeterminate*
*Strike and dip of foliation, second folding episode (crenulation cleavage)*
*Late stage schistosity associated with retrograde metamorphism*
*Strike and dip of cleavage*
*Macrofossil locality*
*Stromatolite locality*
*Stromatolite (<u>Georginia howchini</u>) locality*
*Sample locality for isotopic age determination*
*Dyke or vein;* apl-*aplite*, br-*breccia*, dl-*dolerite*, peg-*pegmatite*, q-*quartz*, qf-*magnetite-quartz*, sk-*skarn*
L1 *Measured section with reference number (Laurie No. 1)*
CH(pd) *Core hole (position doubtful)*
Cu *Minor mineral occurrence*
*Prospect*
*Abandoned prospect*
*Mine*
*Abandoned mine*
*Open cut or quarry*
*Abandoned open cut*
*Costean*

Ag-*Silver*, Ba-*Barite*, Bi-*Bismuth*, Cu-*Copper*, Fe-*Iron*, Gp-*Gypsum*, Mt-*Magnetite*, Pb-*Lead*, Rm-*Road material*, T-*Talc*, V-*Vanadium*, W-*Tungsten*, Zn-*Zinc*

x 1794 *Data point*

*Windpump*
*Bore*
*Abandoned bore*
T *Water tank*
E *Earth dam*
WH *Waterhole*
*Road*
*Track*
*Fence*
L/G *Landing ground*
Jervois *Homestead*
Yd *Yard*
.332 *Spot elevation in metres*

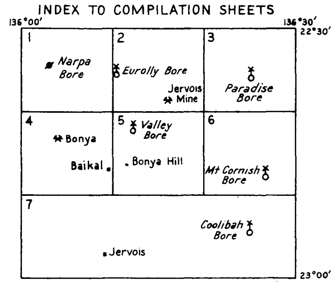
*Some symbols are combined on the map eg*

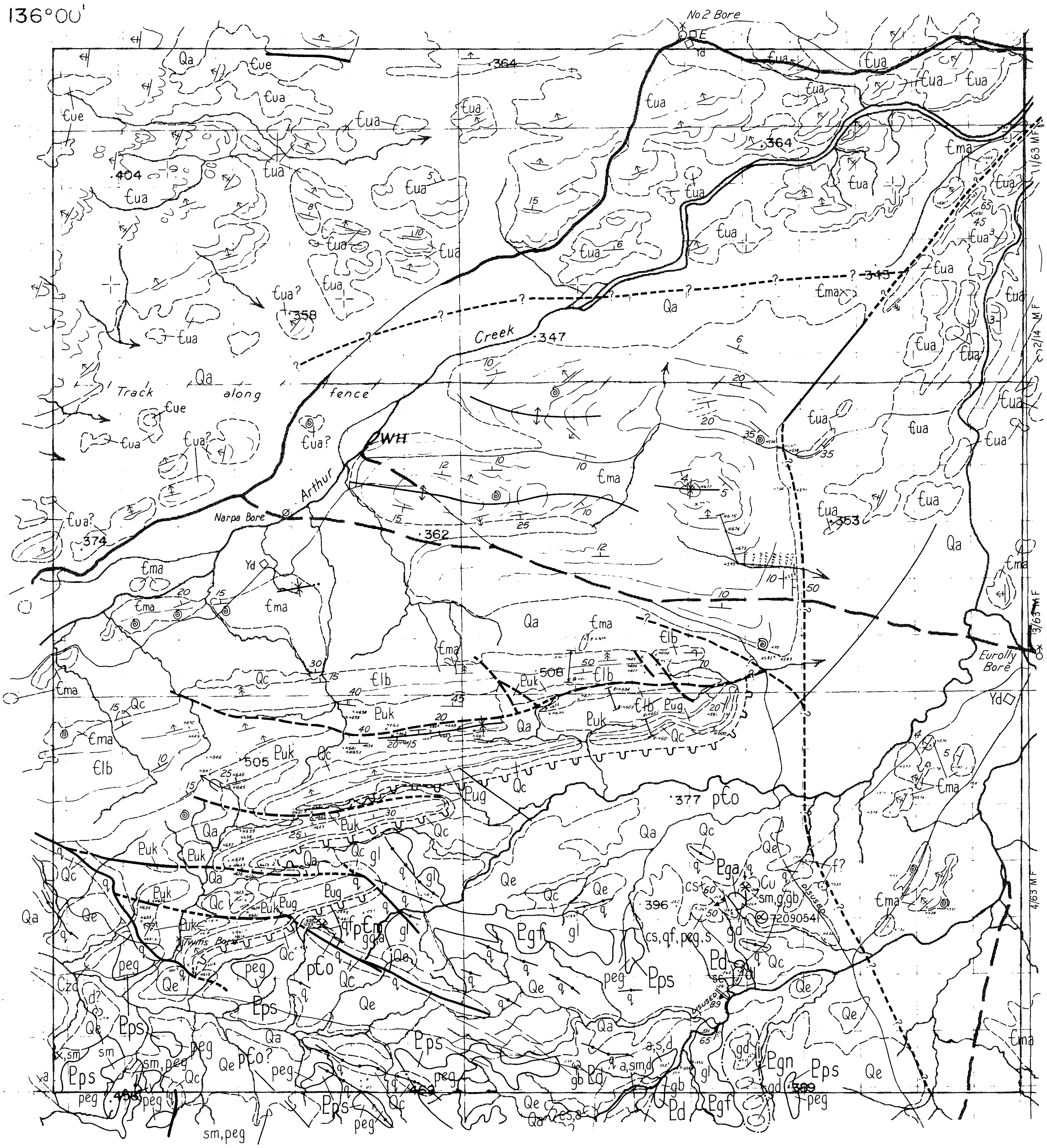
*All symbols in reference are drawn to 1:100 000 specifications (4 times smaller than on comp. sheets)*

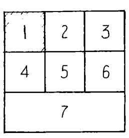
## METAMORPHIC AND IGNEOUS ROCK TYPES

a *Amphibolite*
ag *Fine-grained meta-psammo-pelite, locally calcareous*
apl *Aplite*
b *Biotite gneiss CI > 10*
cs *Calc-silicate rock*
ct *Actinolite-bearing calc-silicate rock, clinopyroxene and microcline-rich calc-silicate rock*
d *Undivided deformed rocks eg mylonite, cataclasite, highly foliated rock*
dl *Dolerite, metadolerite*
dr *Diorite*
f *Quartzofeldspathic gneiss CI < 10*
fm *Muscovite-bearing quartzofeldspathic rock*
g *Granite*
gb *Gabbro, norite, partly metamorphosed gabbro*
gd *Granodiorite*
gg *Granitic gneiss*
gl *Leucogranite, no or negligible ferromagnesian minerals*
gt *Granitoid ie granitic composition, even-grained, granular, mainly anhedral grains*
h *Hornblende gneiss*
j *Quartz-rich metasediment*
jf *Fine-grained metamorphosed quartzofeldspathic rock containing rare feldspar laths*
jt *Quartz-rich metasediment containing tourmaline*
m *Mylonite*
ma *Marble*
mi *Migmatite, migmatitic gneiss*
mt *Unclassified metamorphic rock*
n *Metanorite*
p *Gneiss containing feldspar megacrysts*
pa *Para-amphibolite, layered amphibolite*
peg *Pegmatite, some banded, some aplitic*
qf *Quartz-magnetite rock*
qt *Quartzite*
r *Metamorphically retrogressed rock, generally greenschist facies*
s *Muscovite-biotite schist*
sb *Biotite schist*
sc *Chlorite schist, tremolite-actinolite schist*
sf *Quartzofeldspathic schist*
sk *Garnet-epidote-quartz rock*
sm *Muscovite schist, sericite schist*
un *Meta-ultramafic rock*
v *Garnet-biotite-plagioclase-quartz gneiss*
x *Andalusite schist*
z *Sillimanite-bearing gneiss, garnet-sillimanite gneiss*
zm *Sillimanite-muscovite gneiss*
γ *Quartzofeldspathic rock containing small euhedral and subhedral quartz and/or feldspar megacrysts (Inferred to be an acid volcanic rock)*

INDEX TO COMPILATION SHEETS






## JERVOIS RANGE

Geology 1980 by C.J. Simpson, BMR; M.J. Freeman, NTGS
1981 by J.R. Laurie, NTGS

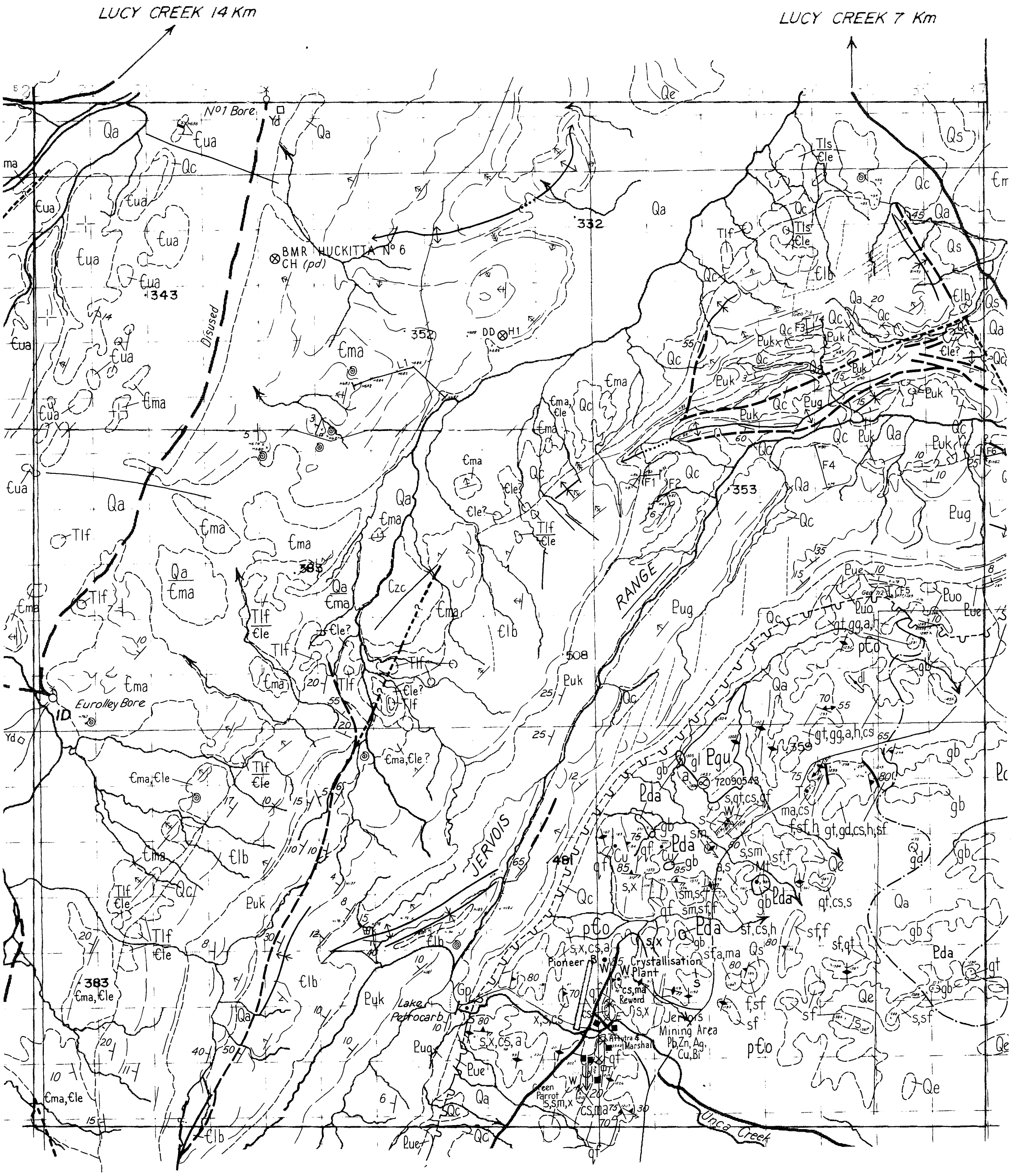
Compiled 1980 by J.F. Stirzaker, BMR
1981 by C.R. Johnson, BMR

Scale (1-6) 1:25 000, (7) 1:80 000

Compiled by the Bureau of Mineral Resources, Geology and Geophysics, in collaboration with the Northern Territory Geological Survey, Department of Mines and Energy as part of the policy of Government to assist in the exploration and development of mineral resources

© Commonwealth of Australia

Persons purchasing transparencies of this map may reproduce it for their own use or for that of their staff but not for any other purpose except with the written permission of the Director, BMR, PO Box 378, Canberra City, ACT 2601




| 1 | 2 | 3 |
|---|---|---|
| 4 | 5 | 6 |
| 7 | | |

JERVOIS RANGE

Geology 1980 by C.J Simpson, BMR; M.J. Freeman, NTGS
1981 by M.J. Freeman, J R Laurie, NTGS

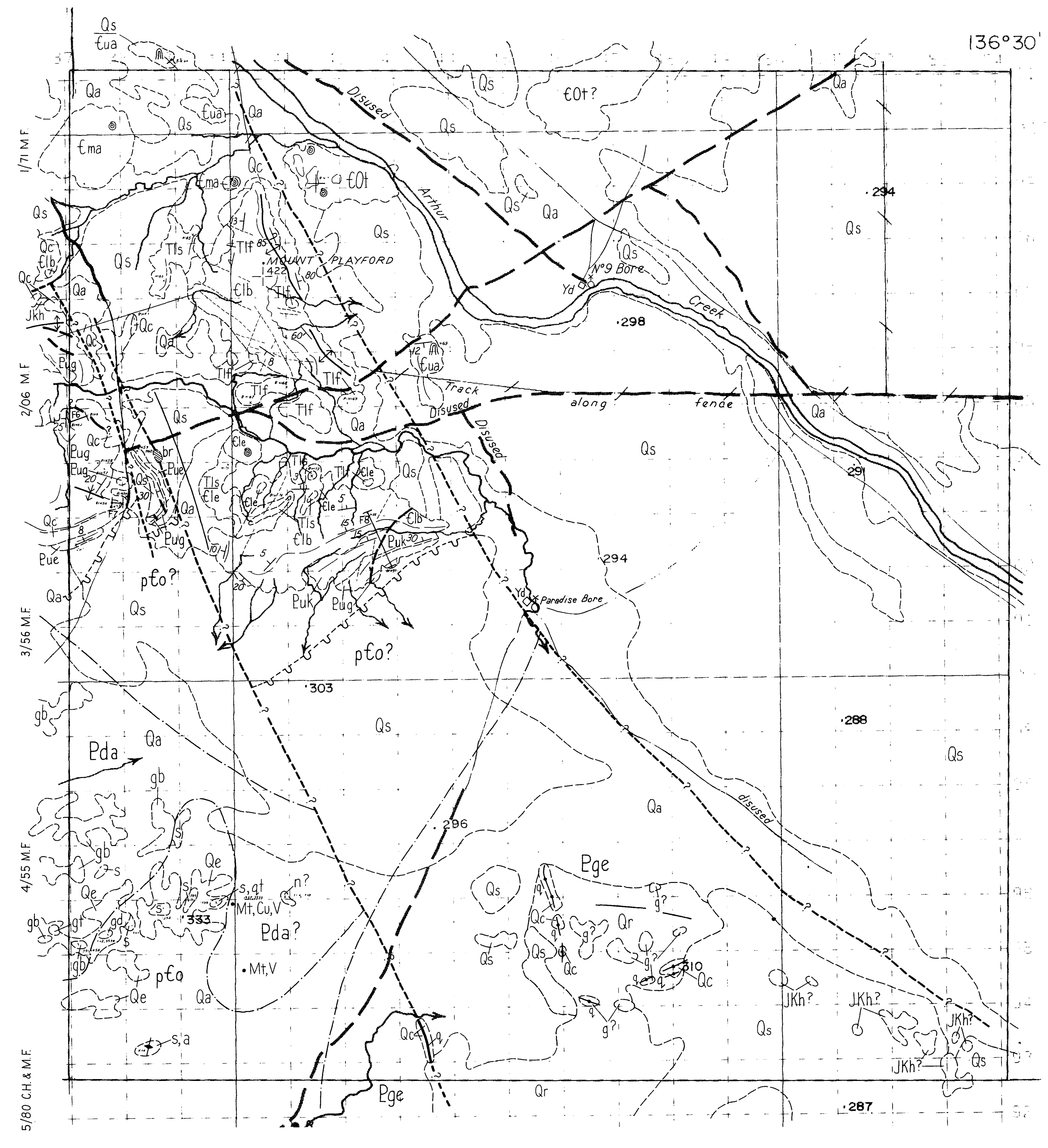
Compiled 1980 by J F Stirzaker, BMR
1981 by C R Johnson, BMR

Scale (1-6) 1 25 000, (7) 1 80 000

Compiled by the Bureau of Mineral Resources, Geology and Geophysics, in collaboration with the Northern Territory Geological Survey, Department of Mines and Energy as part of the policy of Government to assist in the exploration and development of mineral resources

© Commonwealth of Australia

Persons purchasing transparencies of this map may reproduce it for their own use or for that of their staff, but not for any other purpose except with the written permission of the Director, BMR, PO Box 378, Canberra City, ACT 2601




| 1 | 2 | 3 |
|---|---|---|
| 4 | 5 | 6 |
| 7 | | |

JERVOIS RANGE

Geology 1980 by C.J. Simpson, BMR; M.J. Freeman, NTGS
1981 by M.J. Freeman, NTGS

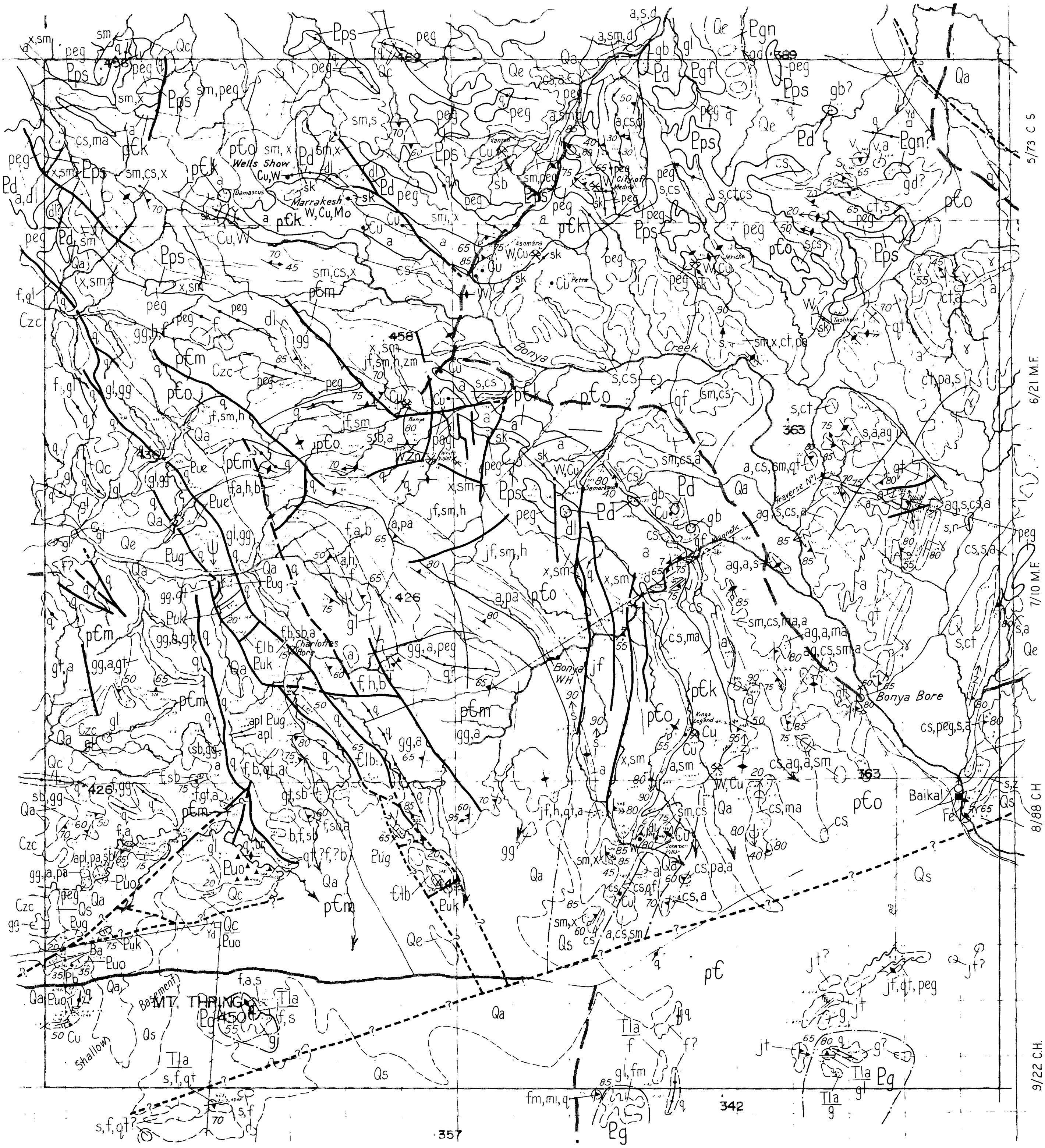
Compiled 1980 by J.F. Stirzaker, BMR
1981 by C.R. Johnson, BMR

Scale (1-6) 1:25000, (7) 1:80000

Compiled by the Bureau of Mineral Resources, Geology and Geophysics, in collaboration with the Northern Territory Geological Survey, Department of Mines and Energy as part of the policy of Government to assist in the exploration and development of mineral resources.

© Commonwealth of Australia

Persons purchasing transparencies of this map may reproduce it for their own use or for that of their staff, but not for any other purpose except with the written permission of the Director, BMR, P.O. Box 378, Canberra City, ACT 2601




| | | |
|---|---|---|
| 1 | 2 | 3 |
| 4 | 5 | 6 |
| 7 | | |

JERVOIS RANGE

Geology 1980 by M J Freeman, C L Horsfall, NTGS
1981 by M J Freeman, NTGS

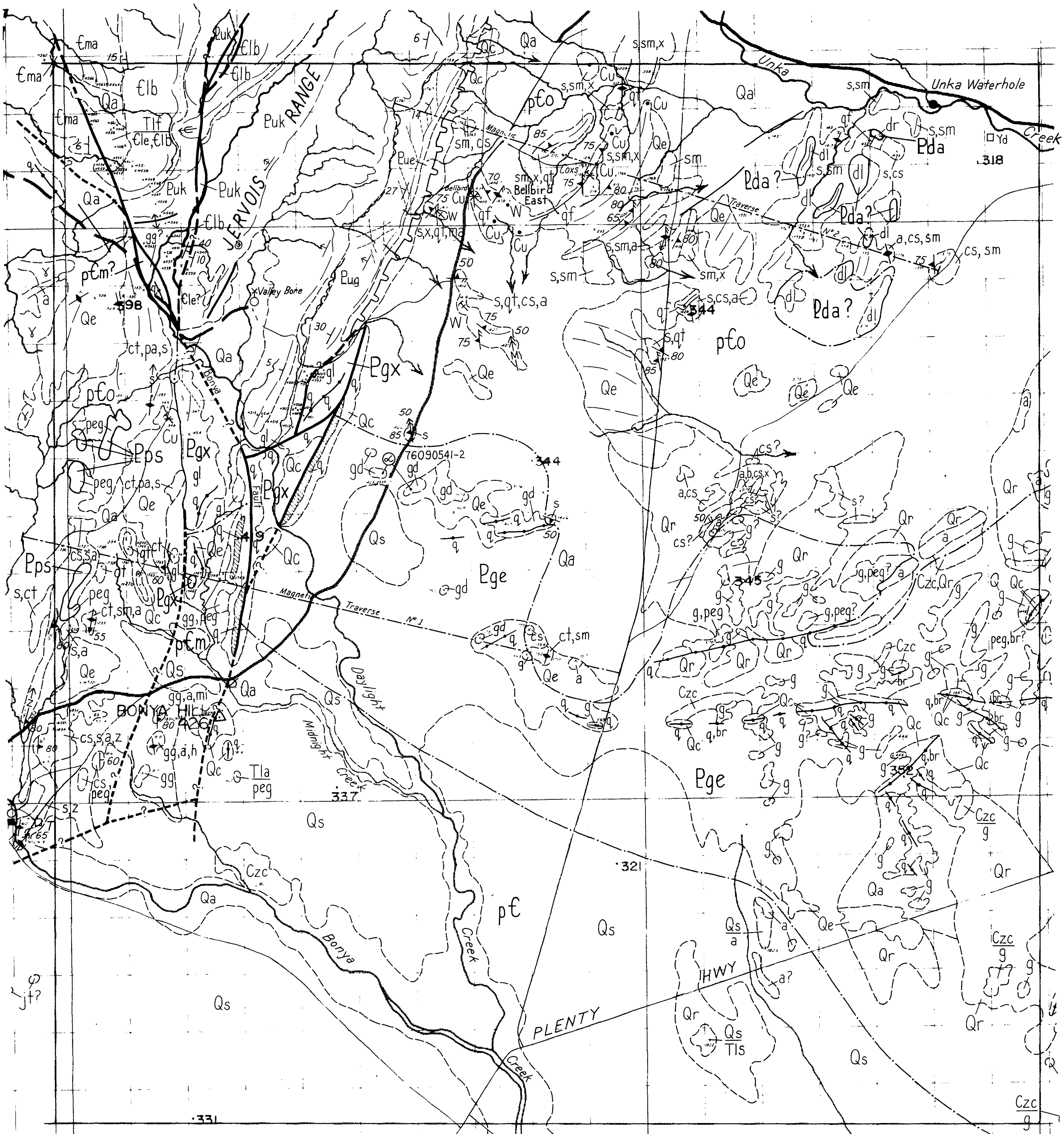
Compiled 1980 by J F Stirzaker, BMR
1981 by C R Johnson, BMR

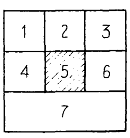
Scale (1-6) 1 25 000, (7) 1 80 000

Compiled by the Bureau of Mineral Resources, Geology and Geophysics, in collaboration with the Northern Territory Geological Survey, Department of Mines and Energy as part of the policy of Government to assist in the exploration and development of mineral resources

© Commonwealth of Australia

Persons purchasing transparencies of this map may reproduce it for their own use or for that of their staff, but not for any other purpose except with the written permission of the Director, BMR, PO Box 378, Canberra City, ACT 2601




JERVOIS RANGE

Geology 1980 by R.D. Shaw, C.J. Simpson, BMR; M.J. Freeman, C.L. Horsfall, NTGS
1981 by J.R. Laurie, NTGS

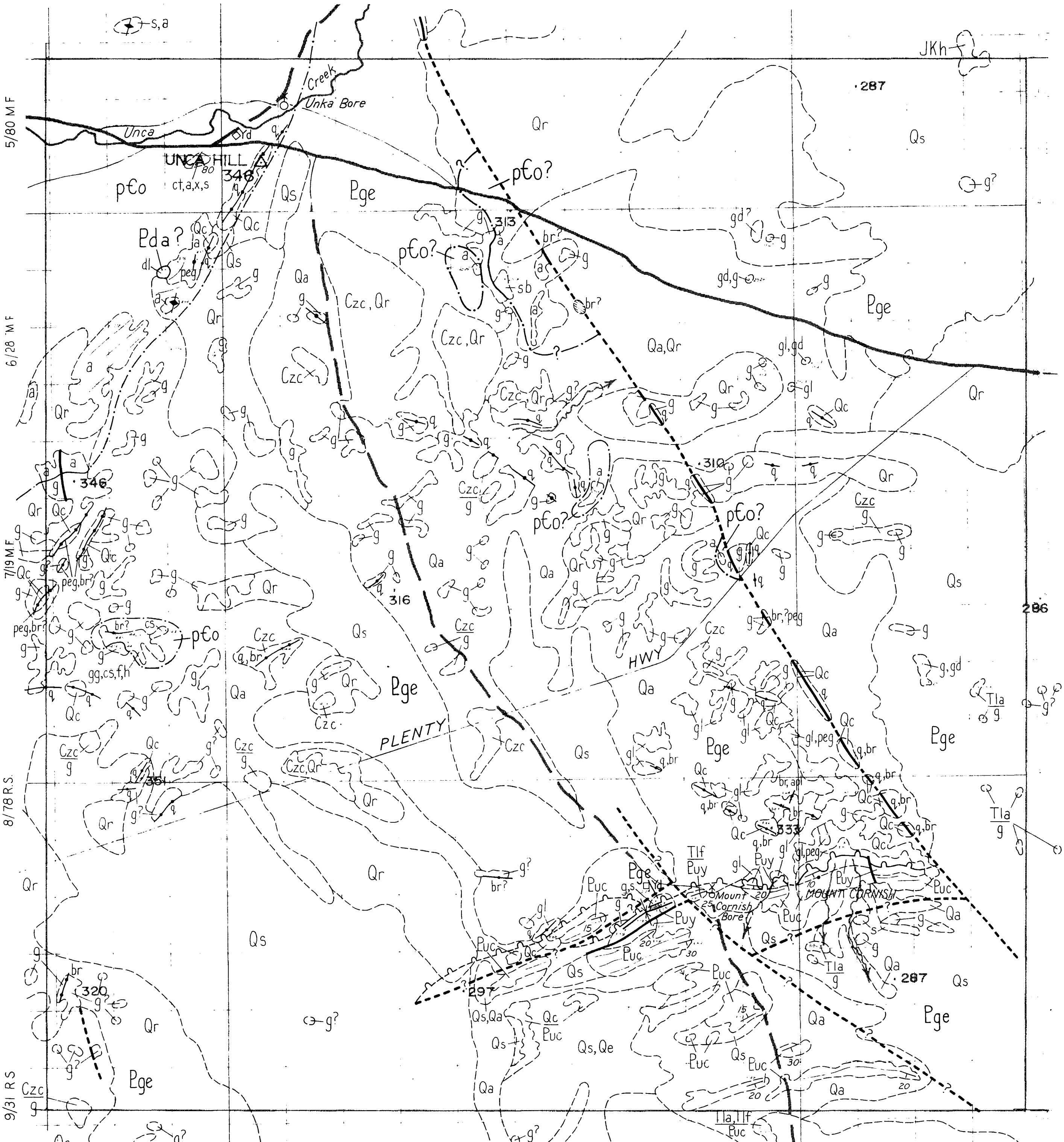
Compiled 1980 by J.F. Stirzaker, BMR
1981 by C.R. Johnson, BMR

Scale (1-6) 1:25 000, (7) 1:80 000

Compiled by the Bureau of Mineral Resources, Geology and Geophysics, in collaboration with the Northern Territory Geological Survey, Department of Mines and Energy as part of the policy of Government to assist in the exploration and development of mineral resources

© Commonwealth of Australia

Persons purchasing transparencies of this map may reproduce it for their own use or for that of their staff, but not for any other purpose except with the written permission of the Director, BMR, P.O. Box 378, Canberra City, ACT 2601




| | | |
|---|---|---|
| 1 | 2 | 3 |
| 4 | 5 | 6 |
| | 7 | |

JERVOIS RANGE

Geology 1980 by R D Shaw, BMR, M J Freeman, NTGS
1981 by M J Freeman, NTGS

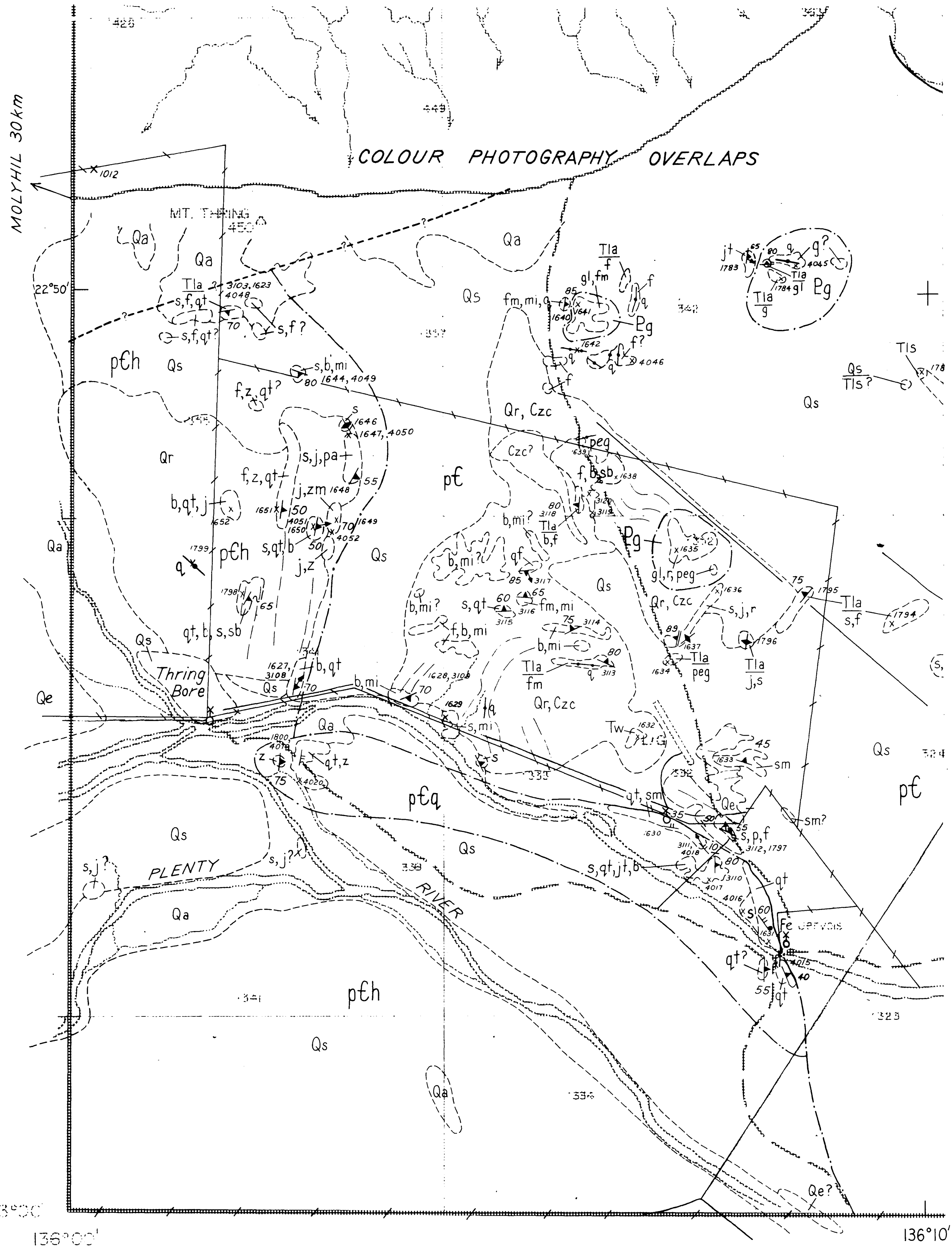
Compiled 1980 by J F Shirzaker, BMR
1981 by C R Johnson, BMR

Scale (1-6) 1 25 000, (7) 1 80 000

Compiled by the Bureau of Mineral Resources, Geology and Geophysics, in collaboration with the Northern Territory Geological Survey, Department of Mines and Energy as part of the policy of Government to assist in the exploration and development of mineral resources

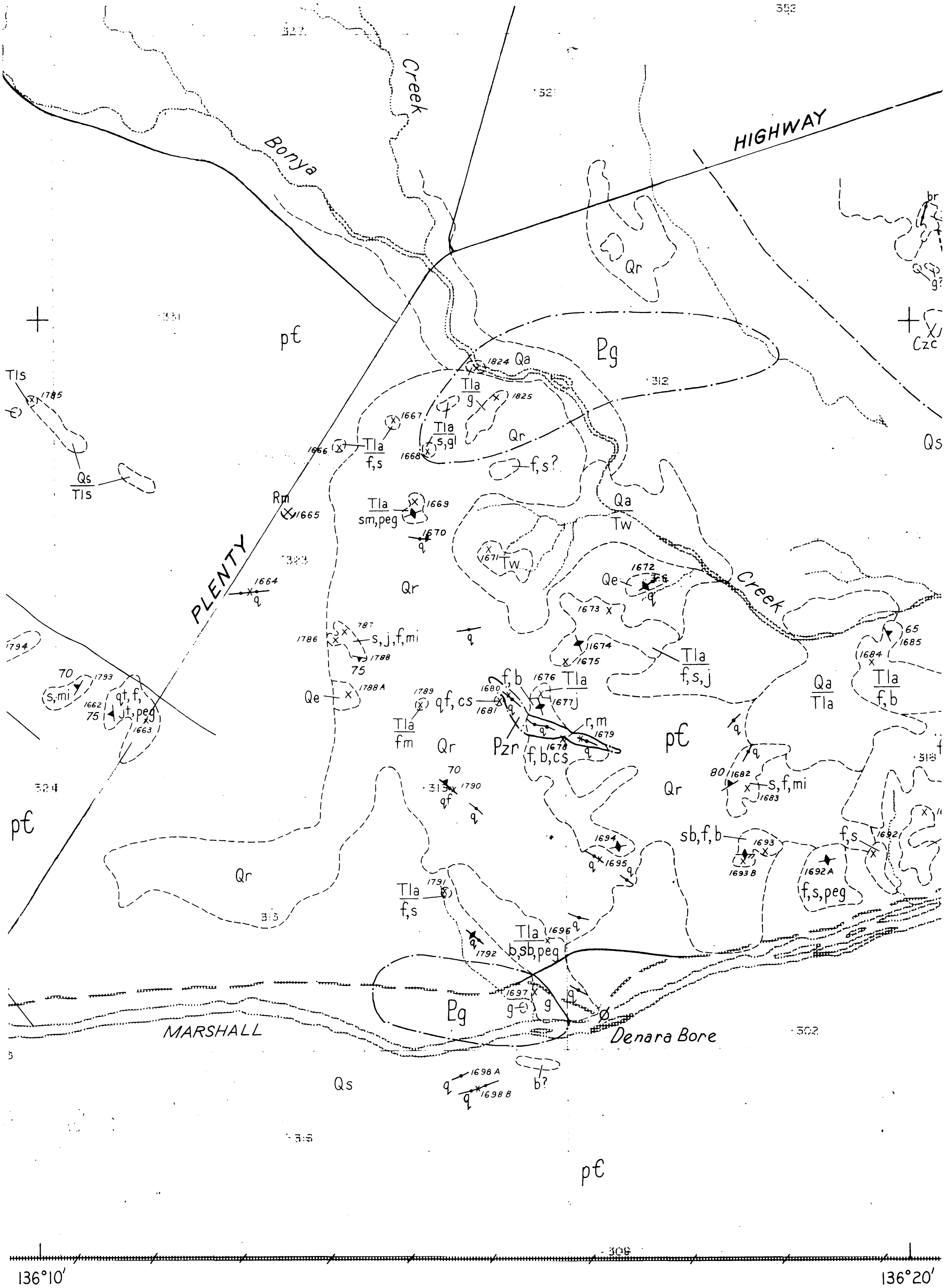
© Commonwealth of Australia

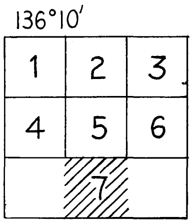
Persons purchasing transparencies of this map may reproduce it for their own use or for that of their staff, but not for any other purpose except with the written permission of the Director, BMR, P.O Box 378, Canberra City, A.C.T 2601



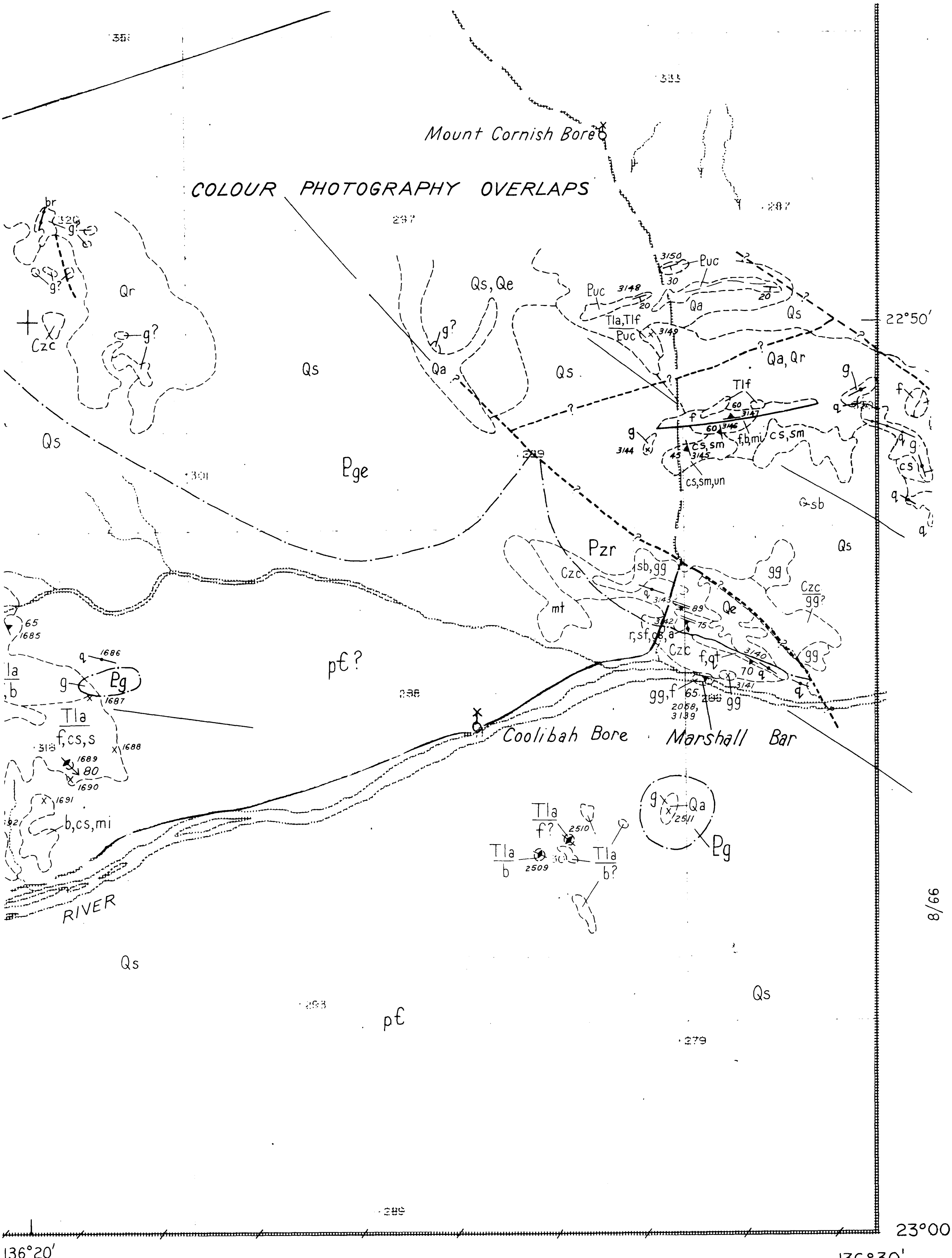

# JERVOIS RANGE

Record 1984/3




# JERVOIS RANGE




| | | |
|---|---|---|
| 1 | 2 | 3 |
| 4 | 5 | 6 |
| | 7 | |

# JERVOIS RANGE