1:100 000 GEOLOGICAL MAP COMMENTARY

MARY RIVER – POINT STUART REGION

NORTHERN TERRITORY

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

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NORTHERN TERRITORY GEOLOGICAL SURVEY

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NORTHERN TERRITORY

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INTRODUCTION

MARY RIVER – POINT STUART REGION* covers the area between latitudes 12°12′30″ and 13°00′S and longitudes 131°30′ and 132°00′E, centred about 100 km east of Darwin (Fig. 1). The Arnhem Highway crosses the southern part of the region; access north of the highway is provided by unsealed roads to Point Stuart and Wildboar homesteads, and numerous tracks on the Annaburroo, Wildman River, Point Stuart, Marrakai, and Koolpinyah pastoral leases. The Mary River flood plain bisects the region, and is inaccessible throughout most of the year.

Climate, physiography and vegetation

MARY RIVER – POINT STUART REGION lies within the monsoonal climatic zone, and has an average annual rainfall of about 1500 mm, most of which falls during the summer wet season from November to April.

Most of the region lies within the catchment of the Mary River, which flows north through the centre of the region to the Van Diemen Gulf. The main physiographic units are the coastal, alluvial, and northern plains, and the dissected foothills (Fig. 1). The physiography is described by Malone (1962) and Williams (1969).

The *coastal plains* form an extensive flat coastal strip less than 7 m above sea level, and penetrate up to 50 km into the northern plains along the Mary River flood plain. They consist of poorly drained estuarine mud and clay flats covered by patches of paperbark forest, herbaceous swamp vegetation, and sedgeland. Four subparallel lines of active and fixed sand dunes lie within 4 km of the coast and converge towards Point Stuart, and another discontinuous line up to 20 km inland roughly parallels the seaward margin of the northern plains. Calcic and saline muds occur on tidal flats adjacent to the coastline and river inlets, such as Sampan Creek, and are commonly fringed by mangroves. Freshwater black clays laid down during seasonal flooding overlie the estuarine muds and cover most of the plains. Perennial sedge and paperbark swamps are common in low-lying parts of the plains, particularly in embayments and depressions adjacent to the northern plains.

The coastal plains grade southwards into floodplains, incised channels, and levees of the Mary River, which form the *alluvial plains*. These plains have a gentle gradient of about 1 in 2000. They comprise Quaternary alluvium with deep sandy or silty soils which support open savannah or grassland with scattered trees.

The most extensive physiographic unit is the *northern plains*, which is developed over flat-lying Cretaceous and upper Tertiary sediments and peneplaned Early Proterozoic sedimentary rocks. Uniform or gradational gravelly and sandy soils are common, and are covered by tall open eucalypt forest, woodland, or scrub.

Rugged boulder-strewn granite hills, and resistant strike ridges of Early Proterozoic metasediments, form the *dissected foothills*, which rise up to 200 m above the alluvial plains in the southeast of the region. Stripping of the Cretaceous and Cainozoic cover adjacent to river courses has also exposed undulating rubbly rises between the strike ridges. The Early Proterozoic rocks are deeply weathered and covered in places by shallow skeletal soils, which support eucalypt woodland and tall to mid-height grasses.

History of investigations

Investigations in the region before 1968 were confined to a Bureau of Mineral Resources, Geology and Geophysics (BMR) survey of the Katherine–Darwin region (Walpole & others, 1968). The results for MARY RIVER – POINT STUART REGION were presented at 1: 250 000 scale (Malone, 1962), and at 1: 63 360 scale (only the southern third of the region; BMR, 1959).

Following the first announcement of the discovery of uranium mineral deposits in the Alligator Rivers Region east of MARY RIVER – POINT STUART REGION in 1970, BMR initiated semidetailed (1: 100 000-scale) investigations. The work has been done in conjunction with the Northern Territory Geological Survey (NTGS) since 1976. Work took place in MARY RIVER – POINT STUART REGION in 1978 (Stuart-Smith & others, 1980b).

Since 1968 exploration companies have been prospecting for uranium, gold, and base-metals in the region. Reports of their activities are lodged with the Northern Territory Department of Mines and Energy, Darwin, and are summarised below (under 'MINERAL RESOURCES'). All relevant open-file company reports are listed in the Appendix.

* Names of 1: 100 000 Standard and Special Sheet areas are printed in capitals.

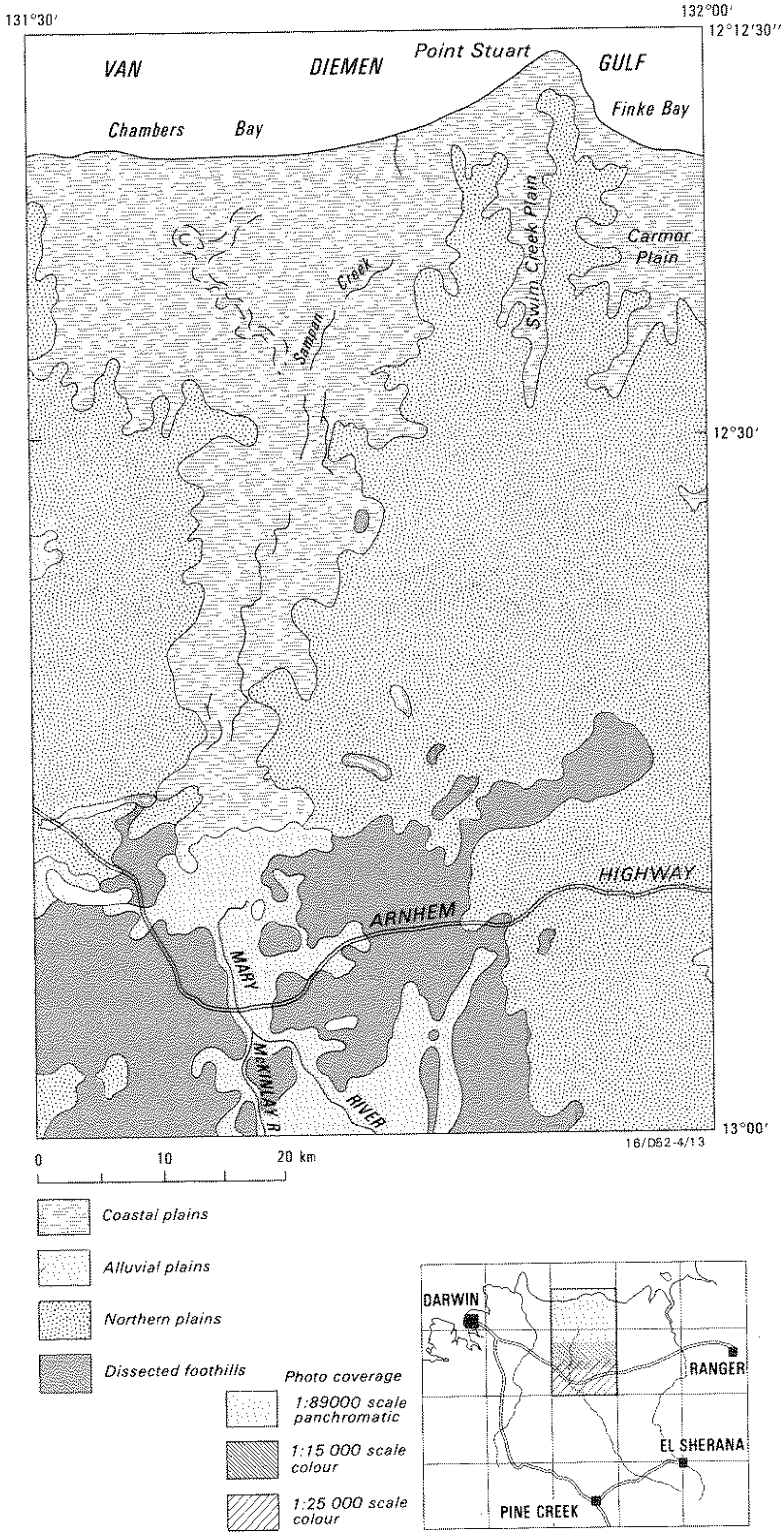

Fig. 1 Location and physiography.

REGIONAL SETTING

MARY RIVER–POINT STUART REGION covers the northern central part of the Pine Creek Geosyncline (see illustration on map sheet). The geosyncline contains Early Proterozoic metasediments resting on a gneissic and granitic Archaean basement (Needham & others, 1980a). The metasediments represent a preserved basinal sequence up to 14 km thick out of a possible original thickness of up to 20 km (Ferguson, 1980). At 1800 m.y. the sequence was folded and metamorphosed, mostly to the greenschist facies but in places to the amphibolite facies. The 1800 m.y. age represents the culmination of a long episode of deformation and metamorphism which began with the intrusion of a large granite—subsequently migmatised—in the northeast.

The metasediments of the geosyncline are mainly shale, siltstone, slate, sandstone, conglomerate, carbonate rocks, greywacke, schist, and gneiss; the pelitic rocks are commonly carbonaceous. They are intruded by pretectonic dolerite sills and post-tectonic granite plutons and dolerite lopoliths and dykes. Largely undeformed Carpentarian (Middle Proterozoic), Adelaidean (Late Proterozoic), and Mesozoic strata rest on these rocks with marked unconformity.

STRATIGRAPHY

ARCHAEAN

A negative gravity anomaly centred on Woolner homestead (KOOLPINYAH) and extending into the northwestern part of POINT STUART was interpreted, by Tucker & others (1980), to be caused by a concealed low-density body with outward sloping contacts similar to the Rum Jungle Complex and Jim Jim Granite.

Detailed gravity surveys have since delineated three separate low-density bodies, and drilling has confirmed the presence of gneissic granite beneath 60 to 80 m of Cretaceous cover (W. Johnson, CRA Exploration Pty Ltd, personal communication 1982). Although no dates are available, an Archaean age is suggested by its gneissic fabric and its inferred stratigraphic position beneath the Mount Partridge Group.

EARLY PROTEROZOIC

MOUNT PARTRIDGE GROUP

A poorly exposed sequence of psammitic and pelitic rocks of the Mount Partridge Group crops out north of the Arnhem Highway and in the southeast of the region. The group contains the oldest exposed units in the area, and is unconformably overlain by younger Early Proterozoic sedimentary rocks and Cretaceous and Cainozoic sediments.

Units within the group are the Mundogie Sandstone, and the Wildman Siltstone, which contains a volcanic unit in the Annaburro area.

Mundogie Sandstone (Ꝑpm)

The Mundogie Sandstone crops out as discontinuous rubbly rises and strike ridges, mostly in the eastern half of the region. The most extensive outcrops are north of the Arnhem Highway, where prominent strike ridges protrude through a thin veneer of Cretaceous and unconsolidated Cainozoic sediments. Eight kilometres northeast of Mount Goyder, continous strike ridges rising up to 50 m above the level of the northern plains are folded into an elongate dome surrounded by rubbly rises of Wildman Siltstone.

The Mundogie Sandstone, the oldest exposed unit in the region, unconformably overlies the Namoona Group elsewhere in the Pine Creek Geosyncline (Needham & others, 1980a), and is conformably overlain by the Wildman Siltstone. Its contact with the Wildman Siltstone is well exposed around the dome northeast of Mount Goyder, and is defined by an increase in the proportion of pelitic to psammitic units from less than 50 percent to about 90 percent, and the absence of arkose and conglomerate above the contact. Psammitic units in the Mundogie Sandstone are less mature than those in the Wildman Siltstone. In places, the Mundogie Sandstone is unconformably overlain by the Koolpin Formation or by remnant Tertiary lateritic cappings.

Lithology

The Mundogie Sandstone consists of an interbedded sequence of quartz sandstone, quartzite, arkose, and minor conglomerate, shale, and siltstone. At least 500 m of the formation is exposed in the dome northeast of Mount Goyder.

Quartz sandstone, quartzite, and arkose comprise over 50 percent of the formation and crop out as quartz-veined, well-jointed, and blocky strike ridges. They form beds between 0.2 and 1 m thick which are commonly graded and in which cross-bedding and scour structures are present in places. The rocks, which are light grey to bluish grey, consist of coarse, moderately to poorly sorted quartz, chert, and kaolinised feldspar grains set in a recrystallised, optically continuous granoblastic quartz matrix. Relict well-rounded grain boundaries are preserved, marked by rings of fine reddish brown iron oxide granules. Trace amounts of secondary muscovite and well-rounded detrital monazite and tourmaline are common.

Pebble *conglomerate*, which comprises less than 10 percent of the formation, forms graded beds between 0.5 and 1 m thick within the arenaceous units. The pebbles are less than 1 cm across and consist of subrounded to well-rounded quartz, quartzite, white chert (silicified dolomite?), and minor fine limonitic quartz sandstone and carbonaceous shale clasts. The matrix comprises a poorly sorted recrystallised sand composed of coarse quartz and chert cemented by reddish brown iron oxides and minor sericite. Relict well-rounded grain boundaries are rarely preserved.

Shale and siltstone are poorly exposed as ferruginous rubble between the more resistant ridges of psammitic rocks, but probably comprise 40 to 50 percent of the formation. They are reddish brown, finely cleaved to massive friable rocks, and are micaceous in places.

Discussion

The rock types and sedimentary structures present in the Mundogie Sandstone are similar to those present in the formation in other areas of the Pine Creek Geosyncline, and are consistent with the depositional model proposed by Stuart-Smith & others (1980c). The sandstone probably formed as a coalesced alluvial fan deposit flanking an Archaean granitic complex, interpreted by Tucker & others (1980) to underlie the present Van Diemen Gulf north of the region. The deposits graded southwards into the subtidal deposits of the Wildman Siltstone, which later transgressed over them.

The thickness of conglomerate beds and the size of pebbles decrease from those in KAPALGA, to the east (Needham & Stuart-Smith, 1978), possibly reflecting a greater distance from the source area. Chert (silicified dolomite) pebbles are also less abundant in conglomerates in MARY RIVER – POINT STUART REGION, possibly reflecting less Cahill Formation in the source area. (The Cahill Formation is the only older formation known to contain carbonate rocks—Needham & others, 1980a.)

Wildman Siltstone (Ɛpw)

The Wildman Siltstone is poorly exposed throughout the region, occurring mostly as low undulating rubbly rises north of the Arnhem Highway. Low strike ridges of quartzite and quartz sandstone are exposed along the eastern margin of the Mary River flood plain, where thin skeletal soils or veneers of flat-lying Cretaceous and Cainozoic deposits which commonly cover the formation have been stripped off. Road-cuttings and borrow pits along the Arnhem Highway provide the best exposures.

The Wildman Siltstone conformably overlies the Mundogie Sandstone, and is unconformably overlain by the Koolpin and Petrel Formations. In the southwest the formation is intruded and hornfelsed by the Mount Bundey Granite, Mount Goyder Syenite, and minor minete, aplite, and felsite dykes.

Lithology

The formation consists mainly of laminated pelitic rocks with minor quartz sandstone, quartzite, and silicified dolomite. The total thickness of the unit in the region is difficult to estimate because of poor exposure and tight to isoclinal folding, but a section of at least 1000 m is present east of Mount Goyder. In the same area, particularly around the dome of Mundogie Sandstone and near Annaburroo homestead, deeply weathered intermediate volcanics are interbedded with the Wildman Siltstone.

Pelitic rocks comprise over 90 percent of the formation and include *sandy siltstone*, *siltstone*, *silty shale*, and *shale*. They are poorly exposed as ferruginous rubble and are commonly colour-banded (mauve, buff, brown, red, white, and grey). Slaty cleavage is well developed, and in outcrop predominates over bedding, which is typically laminated to thin. Small-scale lenticular cross-bedding and ripple marks are rarely present. The rocks consist essentially of scattered angular silty quartz grains in a foliated limonite–sericite–quartz matrix. In places they are silicified to a granoblastic mosaic of quartz, sericite, chlorite, iron oxides, and minor feldspar. Iron oxides commonly infill fractures and may constitute up to 40 percent of some laminae.

At depth these pelitic rocks are composed of about equal proportions of dark grey to black pyritic and dolomitic carbonaceous shale on the one hand and light to medium grey shale and siltstone on the other, and up to 15 percent fine sandstone interlayered in bands commonly less than 1 cm but up to 6 cm thick (R.S. Needham, BMR, unpublished data). The sandstone bands are light grey, or ironstained in medium brown tones where weathered, and less than 5 mm wide. Bedding is typically markedly planar, and boundaries between bands are commonly sharp. Graded beds are common, however, where each set comprises basal very fine sandstone grading into grey shale which is overlain by black carbonaceous shale. The carbonaceous shale is in places scoured by the basal sandstone of the next set, and may be brecciated and recemented by the sandstone or by grey shale. In thicker sandstone beds, cross-bedding is common, and lenticular to cusp-shaped swellings of these beds suggest that in places the sandstone is rippled. The sandstone bed between the swellings may thin to less than 1 cm, but is continuous.

Pyritic carbonaceous shale interbedded with volcanics near Annaburroo homestead consists of foliated very fine chlorite, sericite, granular pyrite, and streaked carbonaceous matter. Chlorite also occurs with carbonate and quartz as coarser undeformed scattered grains, which are probably replacement products of unstable mineral fragments or glass, reflecting a tuffaceous component.

Within the contact aureole of the Mount Goyder Syenite, pelitic rocks have been metamorphosed to chiastolite hornfels—consisting of very fine-grained foliated granoblastic quartz, graphite, and muscovite, and porphyroblasts of chiastolite.

Grey *quartz sandstone* commonly forms thin to massive interbeds less than 1 m up to about 5 m thick in pelitic rocks. It consists of medium to coarse, moderately sorted, subrounded to well-rounded quartz and minor chert grains cemented by a limonitic, sericitic, and siliceous cement. In places, optically continuous quartz surrounds grains, and forms a granoblastic aggregate. Minor amounts of well-rounded detrital monazite, shale fragments, and euhedral pyrite (commonly pseudomorphed by limonite) may be present. Sedimentary structures are common and include fine low-angle planar cross-bedding, lenticular cross-bedding, ripple marks, current lineations, flute markings, load casts, and rare intraformational breccia.

Fine to very fine brown, yellow, pink, or white *quartzite* forms laminae or thin interbeds (less than 10 cm thick) in siltstone. It consists of granoblastic quartz, minor sericite, scattered iron oxides (commonly after pyrite), and trace amounts of well-rounded detrital monazite, sphene, and tourmaline. Relict well-rounded grain boundaries are rarely preserved.

Isolated outcrops of massive *silicified dolomite* occur at GRs 985920, 827015, and 730912. The stratigraphic position of the dolomite is unclear owing to poor exposure, but it appears to be conformable and at least 1000 m above the Mundogie Sandstone contact.

Volcanics form at least two conformable beds, ranging from 50 to 100 m thick, about 250 m and 500 m above the base of the Wildman Siltstone. They crop out as boulder-strewn ridges or hills over about 200 km^2 around the dome of Mundogie Sandstone north of Annaburroo homestead. Between outcrops the subsurface presence of the volcanics is indicated by a deep reddish brown soil, and dense tall vegetation which imparts a dark phototone similar to that of the Koolpin Formation.

At the surface the volcanics, which were previously mapped as dolerite by Dow & Pritchard (1958), are extremely weathered ferruginous brown to mauve massive rocks. They consist of iron oxides and clay, and contain, in places, rounded or flattened limonite patches up to 1 cm across (altered chlorite-infilled amygdales) and rare altered white kaolinised feldspar laths (less than 5 mm long). At depth they are either altered fine even-grained amygdaloidal andesite or altered slightly porphyritic andesite (Stuart-Smith & others, 1980b).

The even-grained andesite consists of interlocking andesine laths, minor subhedral potash feldspar crystals, scattered fine opaques, and interstitial pale green chlorite, and patchy carbonate. Carbonate also occurs as veins or with muscovite and chlorite as fillings in ovoid amygdales. The margins of the amygdales are commonly lined by a concentration of opaques and aligned feldspar laths.

The porphyritic andesite is finer, and consists of slender euhedral andesine laths and rare stout orthoclase crystals (less than 1 mm long) in a groundmass of altered hypocrystalline radiating groups of feldspar laths and longulites, pale green chlorite, carbonate, and acicular opaques. Coarser patches of anhedral quartz and euhedral pyrite are concentrated in planes which possibly represent flow banding, as they parallel the bedding in interbedded pyritic carbonaceous shale.

Discussion

Poor exposure in the region precludes subdivision of the Wildman Siltstone; the twofold subdivision recognised in MUNDOGIE and McKINLAY RIVER (Stuart-Smith & others, 1983; Needham & others 1980b) is not apparent. The presence of silicified dolomite and minor dolomitic carbonaceous shale, absent from the other areas, may indicate a partial sedimentary facies transition towards that of the Coomalie Dolomite and Whites Formation (see Fig. 2) in the Rum Jungle area, 50 km to the west.

The volcanics are similar to and a probable correlative of the Mount Deane Volcanic Member in the Rum Jungle area. Their andesitic composition, the lack of a volcanic pile, and the lack of disruption to the sedimentary sequence suggest that they were probably products of local subaqueous calc-alkaline volcanism in an otherwise stable shallow marine environment.

SOUTH ALLIGATOR GROUP

South of the Arnhem Highway, a distinctive conformable sequence of iron-rich and tuffaceous sediments of the South Alligator Group crops out as a sinusoidal belt that is open to tightly folded about gently south-dipping axes. The group includes the Koolpin Formation, Gerowie Tuff, and Mount Bonnie Formation. It rests unconformably on the Mount Partridge Group, and is conformably overlain by the Finniss River Group. Its lower contact is exposed at GR 110620, where ferruginous and cherty siltstones of the Koolpin Formation rest unconformably on fine-grained quartzite of the Wildman Siltstone. The regional character of this unconformity is indicated by converging trends and by different fold styles between the two groups elsewhere.

Koolpin Formation (Ꞧsk)

The Koolpin Formation is well exposed as a sequence of iron-rich sediments at the base of the South Alligator Group. Outcrops are typically oxidised and gossanous, and form small hills or strike ridges in a narrow belt of deep reddish brown clayey skeletal soil covered by dense and tall vegetation. These characteristics indicate the subsurface presence of the formation and are represented on aerial photographs as a dark tone. The contrast between this tone and the white phototone of the conformably overlying Gerowie Tuff enables the unit to be traced semicontinuously throughout the southern part of the region.

The formation unconformably overlies the Mount Partridge Group, and is conformably overlain by the Gerowie Tuff. It is intruded and hornfelsed by the Mount Bundey Granite and Mount Goyder Syenite; small quartz dolerite sills of Zamu Dolerite transect the formation 10 km south of Mount Bundey.

Lithology

The Koolpin Formation consists of ferruginous siltstone and shale, ferruginous silicified breccia, and minor silicified dolomite. The formation is about 100 m thick, but ranges up to 200 m in fold hinges owing to tectonic thickening. West of the Mary River a breccia consisting of angular blocks of silicified dolomite and quartz in a red ferruginous matrix commonly forms the base of the unit, and is overlain by a sequence of ferruginous siltstone commonly containing chert bands, lenses, and nodules.

Ferruginous siltstone and *shale* are the predominant rock types of the formation. They are laminated to thinly bedded and, in places, contain bands, lenses, and nodules (less than 10 cm across) of white, grey, or black chert. Interbedded carbonaceous material is probably also present, but is not readily recognisable in weathered surface outcrop. However, where hornfelsed by the Mount Bundey Granite, the rocks are pyritic and more recognisably carbonaceous. In road-cuttings along the Arnhem Highway the rocks are well exposed and are either mauve, purplish grey, or white. At the surface they are commonly weathered to reddish brown ferruginous rubble or a massive ironstone

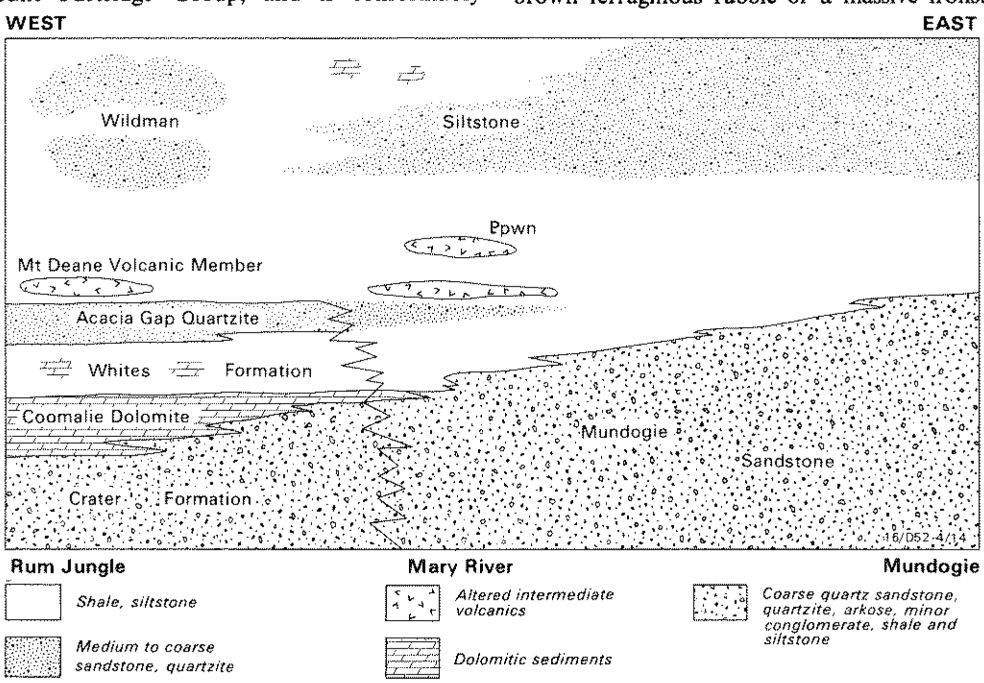

Fig. 2 Schematic representation of facies relationships in the Mount Partridge Group across the northern part of the Pine Creek Geosyncline.

consisting of massive to granular limonite and hematite, minor finely crystalline quartz, and sericite. Very fine sandy to silty angular quartz grains are commonly present. Iron oxides are concentrated in laminae or as cross-cutting veins of specular hematite.

The chert bands, lenses, and nodules consist of a granoblastic quartz mosaic which contains concentric bands of iron oxides in places. The chert was probably formed by replacement of carbonate-rich bands within carbonaceous rocks during diagenesis (Stevens & Roberts, *in* Walpole & others, 1968; Stuart-Smith & others, 1983).

In surface outcrop, carbonaceous shale is recognised only within the contact aureoles of the Mount Bundey Granite and Mount Goyder Syenite, where it has been altered to graphitic chiastolite hornfels. Chiastolite occurs as randomly oriented porphyroblasts set in a laminated microcrystalline matrix of chlorite, sericite, carbonaceous matter, and minor quartz. White cloudy spots up to 1 mm across which cross-cut the laminae are present in places and are probably altered cordierite porphyroblasts.

Two types of *ferruginous silicified breccia* occur in the formation: massive hematite breccia and silty chert breccia.

The massive hematite breccia consists of angular and rarely rounded clasts (less than 10 cm across) of quartz and brown or white silicified dolomite in a red or greyish brown ferruginous matrix. Limonite and hematite are the main oxides present in the matrix, but coatings of manganese oxides on clasts are common. In road-cuttings (e.g. at GR 003770) the breccia can be seen to grade into undisturbed quartz-veined ferruginous siltstone and shale, indicating formation by surficial lateritisation processes.

The silty chert breccia commonly forms the base of the formation west and south of Mount Bundey. It consists of chaotic, coalesced, and broken chert 'ooliths' (less than 1 cm across) in a laminated ferruginous silty matrix. Rare angular clasts (less than 30 cm) of siltstone, quartz sandstone, and quartzite similar to rock types in the underlying Mount Partridge Group are present. The breccia possibly formed by slumping of a calcareous oolitic siltstone which was silicified during diagenesis (Dow & Pritchard, 1958), or as a regolith.

Minor discontinuous lenses of grey, yellow, or pink *silicified dolomite* up to 4 m thick occur in the middle of the formation (e.g., at GRs 911700 and 900660). They crop out as isolated large rounded boulders or pavements throughout the region. The rock consists of a microcrystalline granoblastic quartz mosaic with granular iron oxides present in fractures or breccia zones. Cross-cutting veinlets of coarser recrystallised granuloblastic quartz are commonly present. Similar rocks in KAPALGA, to the east, were found to grade at depth into fine granoblastic dolomite (Needham & Stuart-Smith, 1978).

Gerowie Tuff (Ɇsg)

Tuffaceous and cherty rocks of the Gerowie Tuff crop out south of the Arnhem Highway as a low range of dissected rubbly rounded hills covered by sparse and stunted vegetation and poor skeletal soils. Because of the thinly bedded and well-jointed nature of the rocks, outcrops are low and relatively sparse; the best exposures are in creek beds and road-cuttings along the Arnhem Highway, and the low range of hills in the southeast of the region.

The formation's conformable contact with the Koolpin Formation is defined as the base of the lowermost tuffaceous unit. An excellent exposure of the formation and the lower contact is contained in a road-cutting on the Arnhem Highway 750 m west of the Mary River. The contact can be readily distinguished on aerial photographs throughout the region by the marked contrast between the dark phototone of the Koolpin Formation and the white tone of the Gerowie Tuff.

In most areas the Gerowie Tuff is readily distinguished from the conformably overlying Mount Bonnie Formation by its different lithology and outcrop pattern. However, in the east, where the unit crops out in an 8-km-wide north-trending belt, it is difficult to differentiate the Gerowie Tuff from the Mount Bonnie Formation owing to complex folding and the lack of continuous marker beds.

Like other formations in the South Alligator Group, the Gerowie Tuff is intruded and hornfelsed by the Mount Goyder Syenite.

Lithology

The formation consists predominantly of thinly interbedded silicified siltstone, green and grey argillite, black glassy crystal tuff and tuffaceous chert, siliceous siltstone, shale, and minor tuffaceous greywacke and arenite. The thickness of the unit, which averages 600 m, ranges between 500 and 800 m owing to tectonic attenuation on fold limbs and thickening in hinge areas.

Argillite and *silicified siltstone* are by far the most predominant rock types, and include grey, brown, and red silicified sediments, and blue, grey, green, and brown cherty rocks. They are laminated to thinly bedded, mostly between 10 and 20 cm thick and rarely up to 80 cm thick, and are intensely jointed. They consist of microcrystalline quartz with sericite or chlorite and minor granular iron oxides. Coarser granoblastic quartz forms interlaced veinlets in places. The presence of chlorite, which is common in interbedded tuffs, may reflect a tuffaceous (probably altered glass) component in the argillites.

Crystal tuff and tuffaceous chert are black glassy flinty rocks which break with a conchoidal fracture, and commonly have a spotted weathered white to pale brown shell. The rocks were used extensively by Aboriginals for spearpoints and other implements, and there are numerous 'quarries' or 'factories' in the area. Bedded outcrops are rare, as the tuff commonly crops out as rounded bouldery rubble. Bedding is mostly massive, but in places is laminated; microlenticular cross-bedding is rare.

The crystal tuff is fine-grained (less than 0.5 mm), and consists of angular and splintery crystal fragments of quartz and alkali feldspar in a finer base of angular and curved crystals and crystal fragments of quartz and feldspar (K> Na feldspar) and minor biotite, chlorite, and iron oxides; the feldspars are commonly sericitised, and a weak eutaxitic structure is present in places. The tuffaceous chert is similar in composition to the crystal tuff but finer (microcrystalline), contains fewer coarse crystal fragments, and is more chloritic, possibly indicating a higher devitrified glass component.

Thin interbeds of siliceous *siltstone* and *shale* within tuff and argillite are poorly exposed, as they weather more readily than the more silicified enclosing rocks. They are similar to sediments in the Koolpin and Mount Bonnie Formations in that they contain rare chert nodules, but they are not as iron-rich.

Rare graded beds of siliceous *tuffaceous greywacke* and *arenite* up to 15 cm thick are present in places. They consist of coarse, poorly sorted angular fragments (<1 cm) of quartz and sericitised feldspar crystals, chert (silicified dolomite), tuffaceous chert, and minor biotite in a finer matrix of the same composition. Trace amounts of monazite and opaques may be present.

Mount Bonnie Formation (Ɇso)

A poorly exposed sequence of pelites, greywacke, and tuffaceous sediments of the Mount Bonnie Formation conformably overlies the Gerowie Tuff, and is conformably overlain by the Burrell Creek Formation; it is intruded and hornfelsed by the Mount Bundey Granite, Mount Goyder Syenite, and Zamu Dolerite. The contact with the Gerowie Tuff is exposed in an erosional bank of the Mary River at GR 947640, and is defined as the base of the lowermost greywacke unit.

Outcrops of the formation are readily distinguished on aerial photographs by a darker phototone than those of the adjacent units, and by low rounded hills intermediate in relief between the higher dissected hills of the Gerowie Tuff and the low rises of the Burrell Creek Formation. Bedding trends are well defined owing to contrasting pale phototones of minor siliceous tuffaceous interbeds.

Lithology

The Mount Bonnie Formation consists of interbedded shale and siltstone, with minor tuffaceous sediments, greywacke, and banded iron formation, and rare silicified dolomite. The sequence averages 650 m thick throughout the region, and shows no significant variations.

Laminated reddish brown, purple, pink, and yellow *shale* and *siltstone* comprise about 70 percent of the formation, and crop out in incised creek beds in the Mary River flood plain or as splintery rubble on low rises. The rocks are mostly ferruginous and are gossanous or siliceous in places. Like similar rocks in the Koolpin Formation, they contain bands of laminated white, grey, and black chert, and minor chert nodules and banded iron formation. They are composed essentially of laminated microcrystalline to silty quartz, fine sericite, and iron oxides, but sericite is absent in the chert and in the iron formation. Pyrite and hematite are present in the iron formation and are commonly altered to limonite. Carbonate rhombs and granules are also rarely present in the iron formation, commonly being replaced by coarser iron oxides which also infill cross-cutting fractures.

Massive, dark-green medium to coarse *greywacke* forms beds up to 1 m thick within shale, and comprises about 20 percent of the formation. The rock is readily weathered and crops out only in creek beds. It consists of poorly sorted angular fragments of quartz, alkali feldspar, microperthite, chert, and felsic volcanic rocks in a chloritic and sericitic matrix. The rock fragments include tuffaceous chert and crystal tuff identical with interbeds in the sequence and the underlying Gerowie Tuff.

Laminated to thinly bedded *argillite, tuffaceous chert*, and *crystal tuff* similar to those in the Gerowie Tuff occur throughout the formation and probably form less than 10 percent of it, but are prominent—as are ferruginous siltstone and shale—in outcrop.

Rare lenses up to a few metres thick of pale brown to grey *silicified dolomite* crop out as strike ridges with ferruginous shale and siltstone. The lenses probably had a similar origin to those in the Koolpin Formation, and probably represent chert replacement of carbonate-rich beds within the shale and siltstone during diagenesis.

Discussion of the South Alligator Group

The shallow restricted environment which characterised deposition of the Koolpin Formation probably continued throughout deposition of the South Alligator Group. The great influx of ashfall material starting in Gerowie Tuff times would have temporarily swamped chemical and organic sediment deposition, but this was gradually re-established as volcanic activity waned in Mount Bonnie Formation times.

The Mount Bonnie Formation represents a transitional facies between the South Alligator and Finniss River Groups, as it contains interbedded greywacke and shale, which dominate the Finniss River Group. Stuart-Smith & others (1980c) suggested that this change in sedimentary facies reflects a fundamental change in the tectonics of the Pine Creek Geosyncline. Basement uplift and volcanism which occurred in the western part of the geosyncline at this time resulted in the influx of flysch-type sediment into the geosyncline.

FINNISS RIVER GROUP

Burrell Creek Formation (Ɛfb)

The Burrell Creek Formation is the youngest Proterozoic sedimentary unit, and the only unit of the Finniss River Group to crop out in the region.

The formation crops out southwest of Mount Bundey as low rubbly rises, or as deeply weathered exposures in incised creeks in the McKinlay and Mary River flood plains. Although in-situ outcrop is poor, bedding trends produced by low strike ridges of resistant greywacke beds in a dominantly pelitic sequence are evident on aerial photographs.

The contact with the underlying Mount Bonnie Formation is not exposed but is defined as the top of the uppermost unit of either argillite, tuff, shale containing chert bands, lenses, or nodules, or banded iron formation. The 'Burrell Creek facies' component in the underlying Mount Bonnie Formation indicates continuous sedimentation and probably a transitional relationship between the two formations.

Owing to poor exposure and the lack of marker horizons, the thickness of the Burrell Creek Formation is difficult to determine. At least 1000 m is estimated to be present in the region.

Lithology

The Burrell Creek Formation consists of an interbedded sequence of shale, siltstone, phyllite, and greywacke.

Laminated red, yellow, brown, pink, green, and purple *shale*, *phyllite*, and *siltstone* comprise over 75 percent of the formation, and crop out as flaggy rubble or as deeply weathered exposures in creek beds. They are micaceous in places, and consist of microcrystalline to fine quartz, sericite, iron oxides (hematite and/or limonite), and rare greenish brown chlorite. In places, scattered silty quartz grains are present, and a weak foliation marked by aligned sericite cross-cuts bedding laminae.

Either quartzose, feldspathic, or calcareous *greywacke* forms thin interbeds 10 to 50 cm thick, in shale, phyllite, and siltstone. It crops out as weathered brown, grey, purple, or red massive exposures in creek beds or as rough blocky low strike ridges. The unweathered rock is dark greenish grey with coarse poorly sorted grains of quartz, chert, feldspar (commonly sericitised), and quartz-sericite rock fragments set in a fine recrystallised matrix of quartz, feldspar, sericite, chlorite, and iron oxide. Randomly oriented biotite and muscovite are present in the matrix within the contact aureole of the Mount Bundey Granite.

'Tombstone greywacke', a dark grey silicified calcareous greywacke which weathers to form characteristic tombstone-like outcrops and which is typical of the Burrell Creek Formation throughout the Pine Creek Geosyncline, was found only in one small creek-bed exposure 5 km southwest of Mount Bundey.

ZAMU DOLERITE (Ɛdz)

Small bodies of quartz dolerite and gabbro crop out south of the Mount Bundey Granite, and were intersected in a drillhole at Quest 29 prospect (Twist, 1977). The bodies range up to 60 m thick, and intrude sediments of the Koolpin Formation. They appear broadly conformable with the enclosing sediments, and are commonly altered and veined by quartz–feldspar pegmatites. Their pre-granite age, as indicated by their alteration and conformable nature, suggest that they may be *Zamu Dolerite*, which forms extensive pre-orogenic sills in Early Proterozoic metasediments in other parts of the Pine Creek Geosyncline.

MOUNT BUNDEY GRANITE (Ɛgu) AND MOUNT GOYDER SYENITE (Ɛgd)

The Mount Bundey Granite and Mount Goyder Syenite form a cogenetic plutonic complex which crops out over an area of about 80 km^2 between Old Mount Bundey and Annaburroo homesteads. The Mount Bundey Granite forms the southern two-thirds of the complex, and crops out as rugged bouldery hills rising over 140 m above the adjacent Mary River flood plain. The Mount Goyder Syenite forms the northern third of the Mount Bundey pluton, and a separate small pluton east of the Mary River at Mount Goyder, 7 km north of Annaburroo homestead. The syenite also crops out in places as rugged bouldery hills, but is mainly covered by thin sandy residual soils.

The granite and syenite have been described by Dow & Pritchard (1958), Hasan (1958), Walpole & others (1968), and Hochman (1980). Rb-Sr data for feldspar, hornblende, and whole-rock analyses indicate an age of 1790 ±110 m.y. for the Mount Bundey Granite (Riley, 1980).

The granite and syenite intrude a south-plunging folded belt of Early Proterozoic metasediments, which are hornfelsed in an aureole about 500 m wide. The contact is sharp and mostly discordant. On the eastern side of the Mount Bundey pluton, the contact is concordant and follows a shallow easterly dipping anticlinal limb; a drillhole at Quest 44 prospect showed that the contact dips outwards at about 40° (Twist, 1977). The Mount Bundey Granite intrudes the Mount Goyder Syenite.

Aplite, syenite, and minette dykes up to 3 m wide are common in the granite, syenite, and surrounding metasediments up to 10 km from the Mount Bundey pluton. Xenoliths of country rock are also common near the contact. Pritchards Lode (the Mount Bundey iron deposit), a hematite–martite body within the Mount Goyder Syenite, is thought to have formed in part by replacement of an iron-rich sedimentary raft or pendant (Ryan, 1976).

Both the granite and syenite are well-jointed in three predominant directions: 340–350°, 50–60°, and 80–90°. The northeast and east-trending joints correspond to some postdeformational fault orientations in the Early Proterozoic metasediments. In places the joints are sheared and contain pyrite concentrations.

Petrography

The *Mount Bundey Granite* comprises a massive medium to pale-pink granite and minor adamellite. It is composed of potash feldspar, quartz, plagioclase, hornblende, biotite, and trace amounts of sphene, apatite, zircon, allanite, epidote, magnetite, hematite, leucoxene, and pyrite.

The potash feldspar is microperthite and typically forms coarse (<2 cm) subhedral crystals, commonly rimmed by graphic intergrowths with quartz; zoning is present in places, and rounded inclusions of plagioclase, quartz, biotite, and hornblende are common. Quartz occurs as anhedral grains, and comprises between 20 and 50 percent of the rock; inclusions of feldspar and the accessory minerals are common. Plagioclase ranges in composition from An_{28-36} (Hasan, 1958), and forms zoned tabular crystals, commonly with cores altered to kaolin, sericite, carbonate, and epidote; the outer zones are more sodic, and the borders of some crystals are probably pure albite.

Hornblende and biotite are present in minor amounts and decrease as quartz increases. In rocks containing over 40 percent quartz, hornblende is absent, biotite shows progressive alteration to chlorite, and quartz–feldspar graphic intergrowths are common. Hornblende, where present, is green to pale brown, and forms euhedral prisms, granular aggregates, and irregular grains moulding feldspar crystals; it is commonly corroded and partly altered to biotite. Rust-red biotite occurs as irregular grains or decussate aggregates showing partial alteration to chlorite. In places euhedral hornblende, apatite, and anhedral quartz form the cores of biotite clots which are surounded by opaque rims.

The *Mount Goyder Syenite* is a medium to coarse, slightly porphyritic massive rock compositionally similar to but distinguished from the Mount Bundey Granite by its lower quartz content (less than 10 percent), higher hornblende content (greater than 10 percent), and commonly the presence of clinopyroxene.

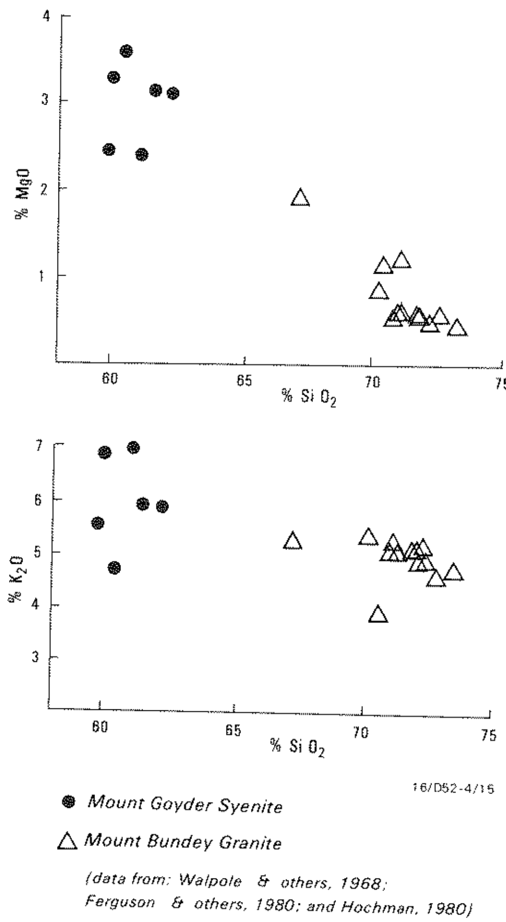

Fig. 3 MgO (top) and K_2O (bottom) v. SiO_2 for samples from the Mount Bundey Granite and Mount Goyder Syenite.

TABLE 1. CHEMICAL DATA, MOUNT BUNDEY GRANITE

Sample No.	PCGR272[1]	PCGR273[2]	PCGR274[2]	PCGR275[2]	G3[3]	G3A[3]	G4[3]	G5[3]	G6[3]	GT1[3]	GT2[3]	GT3[3]	GQ[3]	GQ2[3]
					Major elements—percent									
SiO_2	72.71	70.40	73.40	71.16	71.97	72.02	72.03	72.03	67.25	72.36	70.99	71.00	70.15	71.78
TiO_2	0.28	0.34	0.26	0.09	0.27	0.26	0.28	0.30	0.46	0.29	0.31	0.31	0.34	0.24
Al_2O_3	13.15	15.18	13.00	13.82	13.77	13.54	13.66	13.16	13.12	13.50	13.62	13.74	13.95	13.63
Fe_2O_3	1.06	1.57	0.94	1.59	} 2.35	2.24	2.37	2.62	4.50	2.52	2.82	2.59	2.72	2.33
FeO	1.25	1.36	1.29	1.09										
MnO	0.04	0.05	0.03	0.03	0.02	0.02	0.02	0.04	0.10	0.04	0.04	0.04	0.03	0.01
MgO	0.59	1.16	0.47	1.23	0.57	0.55	0.55	0.55	1.93	0.53	0.65	0.63	0.87	0.56
CaO	1.50	1.53	1.66	1.45	1.47	1.23	1.42	1.52	2.50	1.42	1.29	1.36	1.65	1.31
Na_2O	3.65	3.39	3.50	3.71	3.91	3.80	3.79	3.54	3.47	3.67	3.71	3.75	3.85	3.73
K_2O	4.54	3.84	4.65	5.05	5.01	5.08	5.06	4.87	5.16	4.80	5.09	5.10	5.32	5.05
P_2O_5	0.15	0.16	0.14	0.07	0.11	0.10	0.10	0.11	0.38	0.11	0.12	0.11	0.16	0.10
S	0.01	<0.01	<0.01	<0.01	–	–	–	–	–	–	–	–	–	–
H_2O^+	0.55*	0.63	0.51	0.58	0.47*	0.59*	0.43*	0.48*	0.38*	0.43*	0.68*	0.54*	0.31*	0.51*
H_2O^-	–	0.03	0.06	ND	–	–	–	–	–	–	–	–	–	–
CO_2	<0.05	–	0.10	–	–	–	–	–	–	–	–	–	–	–
Total	99.48	99.64	99.92	99.87	99.91	99.42	99.71	99.20	99.24	99.67	99.33	99.17	99.35	99.25
					Minor elements—ppm									
Ba	696	–	–	–	920	1 000	890	820	855	760	845	905	1 170	850
Sr	420	–	–	–	430	400	430	375	365	400	400	430	665	405
Rb	280	–	–	–	255	275	265	285	345	275	275	270	250	295
Y	19	–	–	–	10	–	12	17	29	14	17	18	13	–
Zr	206	–	–	–	210	180	200	245	250	225	205	220	260	120
Nb	–	–	–	–	23	25	24	28	30	26	22	25	30	55
Ce	309	–	–	–	115	97	120	155	195	150	145	140	120	110
Nd	–	–	–	–	32	31	35	42	81	41	44	46	33	29
Sc	7	–	–	–	4	–	3	4	9	5	4	3	5	–
U	10	–	–	–	14	–	–	–	11.1	–	–	–	12.3	–

1 Ferguson & others (1980)
2 Walpole & others (1968)
3 Hochman (1980)
- not determined
* loss on ignition
ND not detected

The rock consists of potash feldspar phenocrysts in a hypidiomorphic granular to allotriomorphic groundmass of potash feldspar, hornblende, and minor clinopyroxene, anhedral quartz, golden brown biotite, and sodic plagioclase. Accessory minerals present are subhedral magnetite, sphene, euhedral apatite, zircon, and epidote. Rare allanite and fluorite may be present (Hasan, 1958).

Potash feldspar, as in the Mount Bundey Granite, is micropherthitic, and forms subhedral to euhedral tabular pale pink phenocrysts up to 2 cm across which are commonly zoned and contain rare inclusions of biotite, clinopyroxene, apatite, hornblende, plagioclase, and quartz. In places the presence of oscillatory zoning suggests that the feldspar was originally plagioclase which has subsequently been replaced by potash feldspar (Hasan, 1958).

Hornblende mostly forms colourless to pale brown and green anhedral crystals in the groundmass, and less commonly greenish brown twinned and zoned euhedral phenocrysts. Magnetite and biotite have replaced hornblende in places. Inclusions of feldspar, biotite, sphene, apatite, and opaque minerals are common.

Colourless clinopyroxene occurs as altered euhedral inclusions in feldspar or as altered cores within hornblende.

Discussion

The petrography and geochemistry of the Mount Bundey Granite and Mount Goyder Syenite indicate that they are genetically related. Apart from the presence of clinopyroxene in the syenite, the major and accessory minerals of both rock units are the same. Modal analyses (Hasan, 1958) show a continuous range from granite to syenite. Total mafic minerals and the ratio of potash feldspar to plagioclase decrease as silica increases.

Geochemical differentiation plots show linear trends (Hochman, 1980; Tables 1 and 2), which are well illustrated by the MgO v SiO_2 plot (Fig. 3a). The negative correlation between K_2O and SiO_2 (Fig. 3b) reflects the decreasing potash-feldspar-to-plagioclase ratio with increasing fractionation. Other postorogenic granites in the Pine Creek Geosyncline show a positive correlation between alkalis and silica, which may be a result of feldspar alteration (Ferguson & others, 1980).

The lack of rocks with a silica content between 62 and 67 percent in the Mount Bundey Granite/Mount Goyder Syenite plutonic complex is reflected by the absence of granites with a quartz content less than 20 percent, and the sharp contact between granite and syenite. Field relations and geochemical trends indicate that the Mount Bundey Granite is younger and more fractionated than the Mount Goyder Syenite.

Using chemical, mineralogical, and field criteria established by Chappell & White (1974) to distinguish two types of granitoids in the Palaeozoic Lachlan Fold Belt of southeastern Australia, Ferguson & others (1980) and Hochman (1980) concluded that the Mount Bundey Granite and Mount Goyder Syenite, like other postorogenic granitoids of the Pine Creek Geosyncline, were derived from an igneous source. Ferguson & others (1980) suggested that the granitoids possibly represent products of partial melting of the uranium-enriched igneous component of the Archaean basement. Hochman (1980) prefers a model in which the granitoids were derived by partial melting of siliceous granulite, as a result of mantle plume activity in the lower crust.

TABLE 2. CHEMICAL DATA, MOUNT GOYDER SYENITE

Sample	PCGR276[1]	PCGR277[1]	G1[2]	G2[2]	GS[2]	GS1[2]
		Major elements—percent				
SiO_2	59.76	60.40	61.05	59.95	62.24	61.49
TiO_2	0.15	0.35	0.72	0.76	0.63	0.59
Al_2O_3	16.56	17.21	14.74	14.16	14.21	14.19
Fe_2O_3	5.38	1.99	4.99 (total Fe_2O_3 + FeO)	5.59	5.09	5.12
FeO	1.52	2.84				
MnO	0.09	0.04	0.10	0.10	0.07	0.07
MgO	2.44	3.60	2.40	3.26	3.12	3.13
CaO	2.14	4.02	2.53	3.26	3.53	3.74
Na_2O	4.98	3.24	4.62	3.91	3.54	3.67
K_2O	5.52	4.70	6.96	6.89	5.85	5.90
P_2O_5	0.10	0.08	0.49	0.74	0.44	0.43
S	<0.01	<0.01	–	–	–	–
H_2O^+	0.94	0.92	0.35*	0.39*	0.43*	0.74*
H_2O	ND04	–	–	–	–	–
CO_2	–	–	–	–	–	–
Total	99.58	99.43	98.94	99.01	99.15	99.07
		Minor elements—ppm				
Ba	–	–	2300	2850	2840	3130
Sr	–	–	1670	1790	1470	1535
Rb	–	–	225	220	220	195
Y	–	–	18	16	23	–
Zr	–	–	805	740	35	33
Ce	–	–	310	250	285	265
Nd	–	–	110	95	105	85
Sc	–	–	9	12	16	–
U	–	–	12	12.3	15.7	–

– not determined
* loss on ignition
ND not detected
[1] Walpole & others (1968)
[2] Hochman (1980)

OTHER INTRUSIVE ROCKS

Minette

Numerous deeply weathered and poorly exposed medium-grained porphyritic minette dykes intrude the Early Proterozoic metasediments and the

Mount Bundey Granite and Mount Goyder Syenite. The dykes are up to several metres wide and are confined to within 10 km of Mount Bundey.

The minette is dark greenish grey when fresh (e.g., at GR 897638), but is commonly weathered to a soft ferruginous clayey rock. It consists of euhedral pale brown biotite phenocrysts up to 1 cm across in a groundmass of euhedral biotite, cloudy potash feldspar, sodic plagioclase, and minor anhedral quartz; accessory minerals are granular sphene, patchy carbonate, magnetite, acicular apatite, and rare prismatic zircon. The feldspars are commonly sericitised, and biotite is altered to chlorite, muscovite, quartz, and iron oxides. In places, biotite is replaced by fibrous tremolite/actinolite, and minor colourless clinopyroxene (party altered to biotite) may be present.

The mineralogy and the spatial distribution of the minette suggest an affinity and probable genetic relationship with the Mount Bundey Granite and Mount Goyder Syenite.

Felsite

Felsite dykes 1 to 3 m wide and up to 200 m long intrude the Early Proterozoic metasediments of the Mount Partridge and South Alligator Groups in the southern part of the region. The contact relations are obscure owing to poor exposure. However, they appear to parallel the northerly trend of the metasediments, which suggests that they are post-orogenic; similar felsite dykes in McKINLAY RIVER have cross-cutting contacts.

The felsite is a massive pale green aphanitic rock with a characteristic high radioactivity (two to four times background). It consists of fine potash feldspar prisms, quartz, and micrographic intergrowths of both minerals which are commonly altered to a mosaic of quartz, sericite, and iron oxides. Iron oxides also occur as pseudomorphs after pyrite. In places the felsite is porphyritic, containing phenocrysts (<2 mm) of embayed subhedral to euhedral quartz and minor sericitised stout euhedral alkali feldspar crystals or aggregates. Feldspar also commonly forms rims around quartz phenocrysts.

PALAEOZOIC

Several narrow linear dolerite and picrite dykes intrude the Early Proterozoic rocks throughout the region. They are not exposed, but their presence is indicated by prominent northeast-trending positive magnetic lineaments and northwest-trending negative magnetic lineaments. Drilling by NTGS in NOONAMAH, to the west, on a continuation of a negative magnetic lineament passing through Mount Bundey, intersected altered dolerite and picrite at depth (W. Newton, NTGS, personal communication 1982). The dykes have a preliminary minimum Palaeozoic K/Ar mineral age of about 400 m.y. (AMDEL determination for NTGS).

MESOZOIC

Petrel Formation (Kp)

Flat-lying Late Jurassic to Early Cretaceous sediments cover most of the northern two-thirds of the area. The sediments are covered by a thin veneer of laterite and unconsolidated Cainozoic sand which support a dense woodland of tall eucalypts. The rocks were mapped as 'Mullaman Beds' by Skwarko (1966), but were later reclassified as Petrel or Bathurst Island Formations by Hughes (1978). Without fossil evidence the two formations cannot be distinguished readily as they are lithologically similar. However, as the sediments in MARY RIVER-POINT STUART REGION form the base of the sequence they are most likely the Petrel Formation.

The sediments are exposed as rubble at the edges of the Mary River flood plain and as remnant mesa-like cappings over Early Proterozoic sedimentary rocks in the southeast. They range from 3 m in the south to about 60 m thick where intersected by drillholes (PSP5, GR 025061; PHD4, GR 003036) near Jimmys Creek (P. Goldner, Union Oil Development Corporation, personal communication 1981), and dip gently northwards from 75 m in the south to less than 20 m above MSL at Mordy Island (GR 015195)—i.e., a gradient of about 1 in 600.

The formation consists of a basal sequence, 3 m thick, of porous dark brown poorly sorted limonitic quartz sandstone, minor conglomerate, and breccia, overlain in the north by a thicker sequence of unconsolidated quartzose sand. Pebbles and grains in the limonitic sandstone and conglomerate consist of well-rounded quartz, chert, and quartzite. Breccia, where present, forms the base of the formation, and contains angular blocks of fine quartzite similar to that in the underlying Early Proterozoic Wildman Siltstone.

CAINOZOIC

Cainozoic deposits form a thin veneer over most of the region. They have been grouped as follows: early Tertiary laterite, late Tertiary sand, Tertiary to Quaternary colluvial silt and sand, and Quaternary continental and marine sediments. Where these deposits are undifferentiated or consist mainly of skeletal soils they are designated Cz.

Tertiary

Laterite (Czl)

Generally the laterite profiles in the region are either detrital, or truncated remnants of the standard laterite profile described by Whitehouse (1940).

Of the laterite types described by Williams (1969) in the Adelaide River/Alligator Rivers area, four types have been recognised.

Detrital laterite is formed mainly from reworked material cemented by a ferruginous matrix. It generally forms blocks (up to 1 m) and pavements on low hills or breakaways over the Early Proterozoic rocks.

Pisolitic laterite is the upper part of the standard laterite profile, and consists predominantly of cemented ovoid ironstone pisoliths, between 0.25 and 1 cm in diameter, which are commonly case-hardened or varnished. It occurs as blocks or pavements, mostly exposed in the stable regime at the margins of the depositional environment of the coastal plains. Isolated detrital deposits of pisolitic laterite occur in places within depositional drainage systems. It can also be detrital.

Mottled-zone laterite is the middle part of the standard laterite profile, and consists of deeply weathered bedrock grading up into a ferruginous zone of generally pisolitic laterite, and down into a pallid zone. It commonly occurs in the bottom of amphitheatres at the head of creeks, and is typically surrounded by a breakaway of pisolitic or detrital laterite.

Concretionary laterite is pedogenetic in origin, and, unlike the varieties already described, has continued to form to the present. It is expressed as ferruginous mottling in poorly drained alluvial soils, or as ironstone nodules in situ in the soil profile.

Sand (Czs)

Coarse unconsolidated quartz sand forms the remnants of the Koolpinyah Surface, which covers most of the northern plains; in places it is dissected. It is probably a late Tertiary fan deposit (Story & others, 1969) derived from Mesozoic sand, silt, and claystone, Kombolgie Formation sandstone, and Early Proterozoic rocks. Where it has been almost completely removed, structures within the underlying weathered rocks are apparent on aerial photographs.

Tertiary to Quaternary

At the margins of the coastal plains, erosion and redeposition of the late Tertiary sand (Czs) has produced a narrow but distinctive photogeological unit which is characterised by a relatively steep slope of 5°; further erosion has resulted in the development of a *winnowed sand* (Cza) veneer on the slope. Because they are a direct product of erosion of unconsolidated sand, and not part of the open drainage system, the clay and silt deposits found in isolated swallow holes developed on the Koolpinyah Surface are also included in the winnowed sand unit; their formation has probably been continuous since the early Tertiary.

Quaternary

Continental deposits

Deposition in a continental environment during the Quaternary is represented by a variety of alluvial types.

Alluvial silt, sand, and clay (Qa) occur in the courses and flood plains of active rivers. Large bodies of *unconsolidated quartz sand* within the channels of the Mary and McKinlay Rivers, and *outwash deposits* over the adjacent flood plains (both Qs), consist mostly of material derived from the Early Proterozoic rocks or late Tertiary sand, and were mostly deposited during floods. *Silty levee deposits* (Qal) are developed along the course of the Mary River south of the Arnhem Highway.

Marine deposits

During the wet season, brackish water in the Mary River drainage system extends up to 50 km inland.

Intertidal mangrove swamps (Qcm) extend along the coastline, and up to 4 km inland in Sampan Creek. *Coastal alluvial deposits* (Qca) are comparatively well-drained silt and clay with sparse vegetation cover, such as sedge or samphire; they interfinger with and overlie the poorly drained *black soil plains* and *mud and salt pans* (Qcp), which are also developed adjacent to, and within, estuarine channels. Adjacent to late Tertiary sand deposits, black soil swamplands which support paperbark and waterweed growth are developed in areas which are perennially waterlogged.

The *sediments of abandoned river courses* (Qas) consist mostly of silt and mud. The oxbow lakes were developed before the late Pleistocene to Recent emergence, and are shallow depressions in the surface of the flood plain into which the present drainage system is incised.

The *coastal sand ridges* (Qcr) are generally parallel to and within 4 km of the present coastline, or are adjacent and parallel to the edge of the coastal plains up to 20 km inland. They are composed of shelly sand, and probably formed as beaches during cyclonic storms (Hopley, 1973) or else by winnowing of intertidal muds following the destruction of mangroves. The ridges extended southwestwards from the now-wooded recurved sand spits at Point Stuart, shifting progressively seawards and northwards. The oldest of these now-discontinous ridges, originally a smoothly curved bay-mouth bar dated at 7000 years BP (Clarke & others, 1979), extends from Point Stuart southwest along the margin of the northern plains to west of the Mary River near Alligator Head, where it changes direction and runs northwest; this landward ridge is different from the other cheniers in that it is composed of sand and gravel, is much deeper, and probably formed as beach deposits during the post-Pleistocene sea-level rise (Baker, 1981). The close grouping of ridges parallel to the present coastline, and their similar levels, indicate a relatively static sea level with no significant fluctuations since 7000 BP (Clarke & others, 1979).

METAMORPHISM

All the Early Proterozoic rocks in the region have been regionally metamorphosed to the lower greenschist facies, and locally contact-metamorphosed by the Mount Bundey Granite and Mount Goyder Syenite.

The Early Proterozoic metasediments show little alteration of their original texture and mineralogy. Typical metamorphic changes in the pelitic rocks are the development of fine-grained, weakly foliated sericite, microcrystalline quartz, chlorite, and minor muscovite; feldspar, where present, particularly in tuffaceous sediments of the South Alligator Group, is invariably sericitised. Psammitic rocks commonly exhibit fractured and strained grains with recrystallised optically continuous quartz overgrowths; relict grain boundaries are preserved in places; minor recrystallised sericite or muscovite may be present. Both pelitic and psammitic metasediments are commonly veined by coarse granoblastic quartz. Intermediate volcanics in the Wildman Siltstone are extensively chloritised and carbonated, and none of their original mafic minerals or glass are preserved; carbonate occurs as veins or with muscovite and chlorite as amygdaloidal fillings.

Metasediments of the Wildman Siltstone, Koolpin Formation, Gerowie Tuff, Mount Bonnie Formation, and Burrell Creek Formation are in contact with the Mount Bundey Granite and/or Mount Goyder Syenite, and are hornfelsed in an aureole up to 500 m wide. Within the aureole, carbonaceous rocks are altered to chiastolite hornfels. The chiastolite occurs as randomly oriented porphyroblasts set in a laminated microcrystalline matrix of chlorite, sericite, carbonaceous matter, and minor quartz. Sandstone is altered to quartzite, and greywacke is recrystallised and contains biotite and muscovite in the matrix. White cloudy spots up to 1 mm across cross-cut the laminae of pelitic rocks in all formations, and are probably altered cordierite porphyroblasts. A skarn within the Koolpin Formation occurs at Quest 44 prospect (Twist, 1977).

STRUCTURE

The Early Proterozoic metasediments form the northern margin of a broad synclinorium which extends southwards to Pine Creek and westwards to Batchelor (see regional setting illustration on map sheet). This synclinorium is separated from the West Alligator Syncline to the east by an anticlinorium whose axis roughly coincides with the eastern boundary of the region.

Stratigraphic discontinuities have been used to define four separate structural domains (Fig. 4): 1, areas of extensive Cretaceous and Cainozoic cover; 2, outcrops of Mount Partridge Group; 3, outcrops of South Alligator and Finniss River Groups; and 4, outcrops of the Mount Bundey/Mount Goyder plutonic complex.

The Early Proterozoic metasediments have undergone one major phase of folding. Beds in the South Alligator and Finniss River Groups are tightly folded, whereas those in the Mount Partridge Group are tight to isoclinally folded. Fold axes in all the groups are subhorizontal to shallow, plunge southwards, and trend 180° to 200°. Minor northward plunges are common, particularly in the Mount Partridge Group. The change in fold axis orientation is gradational from 180° in the south to 200° in the north, and reflects a regional rotation about a west-northwest-trending flexure, the Marrakai–Coirwong Flexure Zone. A weak near-vertical axial-plane slaty to phyllitic cleavage is well-developed in pelitic rocks of the Wildman Siltstone, Mount Bonnie Formation, and Burrell Creek Formation.

Stereographic contour plots indicate that folds in the Mount Partridge Group (domain 2; Fig. 5) are asymmetrical; limbs dipping eastwards at about 70° predominate over limbs dipping westwards between 80° and 90°. In contrast, folds in the South Alligator and Finniss River Groups (domain 3; Fig. 6) are symmetrical, and their limbs dip between 60° and 90°. The apparent asymmetry of folding in the Mount Partridge Group is probably a result of overturning, as overturned dips were observed and fold hinges—where exposed—are symmetrical.

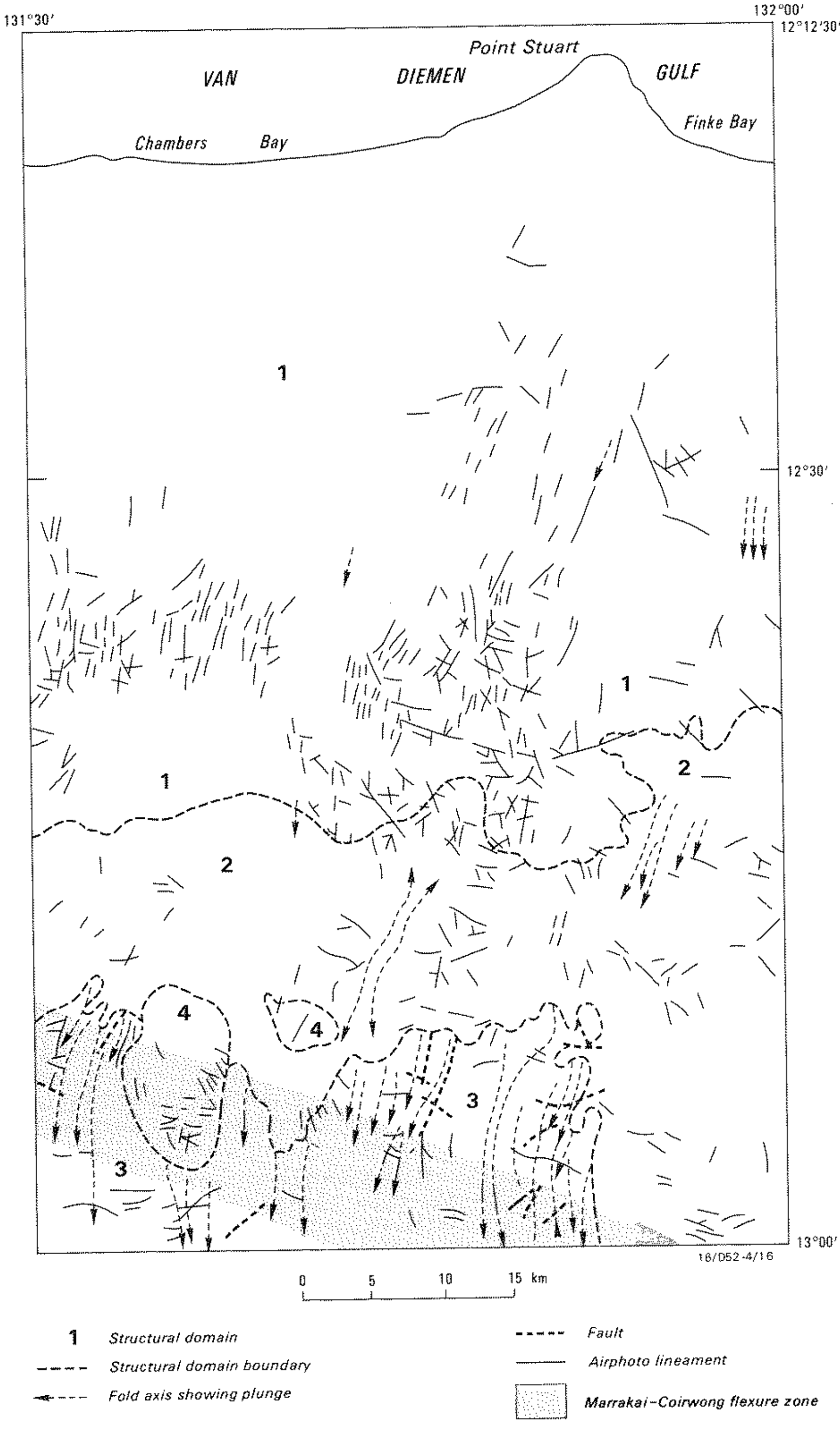

Fig. 4 Major structural elements.

Beds in the Mount Partridge Group (domain 2) dip westwards less than 20° relative to the unconformity plane that separates them from the overlying South Alligator Group; this is consistent with the Koolpin Formation overlying the Mundogie Sandstone in the eastern part of the region and the Wildman Siltstone in the west. This relationship is not uniform throughout the Pine Creek Geosyncline, but is consistent with the low degree of deformation indicated by warping and minor folding of the Mount Partridge Group before deposition of the South Alligator Group in MUNDOGIE (Stuart-Smith & others, 1983).

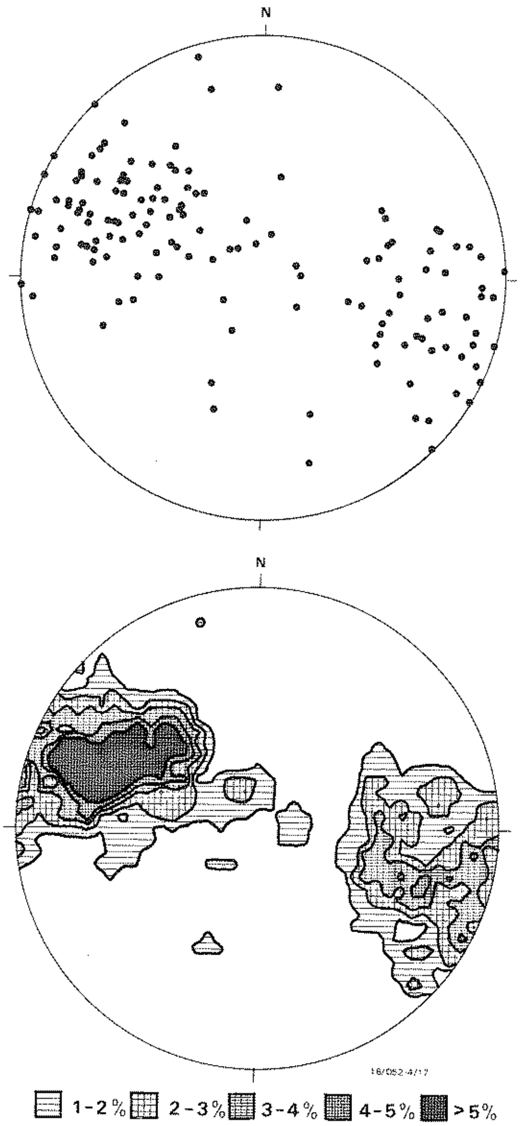

Fig. 5 Orientation data and contour plot of poles to bedding, domain 2.

The regional structure is locally modified by faults up to 10 km long which typically have small displacements ranging from a few metres to 1 km. The faults show one major concentration at 010–030°, and two minor concentrations at 050–060° and 130–140° (Fig. 7). Faults with a 010–030° orientation show strike-slip displacements, and were most probably contemporaneous with the major period of folding, as they parallel the axial plane of folds and have been rotated about the Marrakai–Coirwong Flexure Zone. Faults in the other two orientations are short and postdate folding, as they displace fold limbs and the northerly faults.

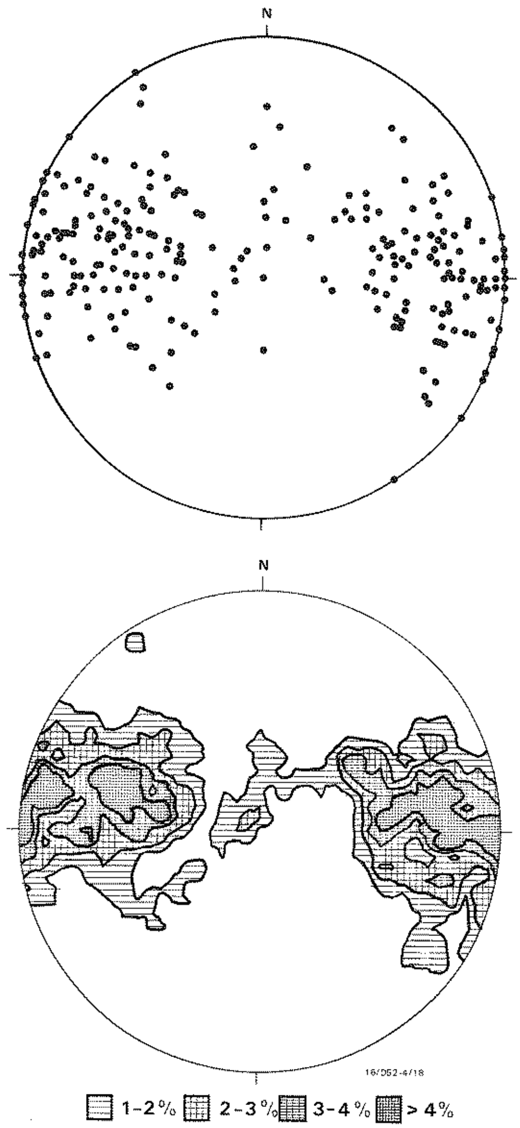

Fig. 6 Orientation data and contour plot of poles to bedding, domain 3.

Airphoto and LANDSAT lineaments are common throughout the region, particularly in areas of Cretaceous and Cainozoic cover. The airphoto lineaments (Fig. 4) are commonly between 1 and 2 km long but can be up to 8 km long; LANDSAT lineaments are markedly longer, ranging from 5 to over 50 km in length (see structural sketch on map sheet).

Lineaments in all structural domains (Fig. 7) show low to high concentrations between 90° and 100°, an orientation that roughly coincides with faults associated with the Marrakai–Coirwong Flexure Zone. A high 020°–040° concentration, particularly in areas of Cretaceous and Cainozoic cover, corresponds to the predominant bedding and fault orientations in the underlying Early Pro-

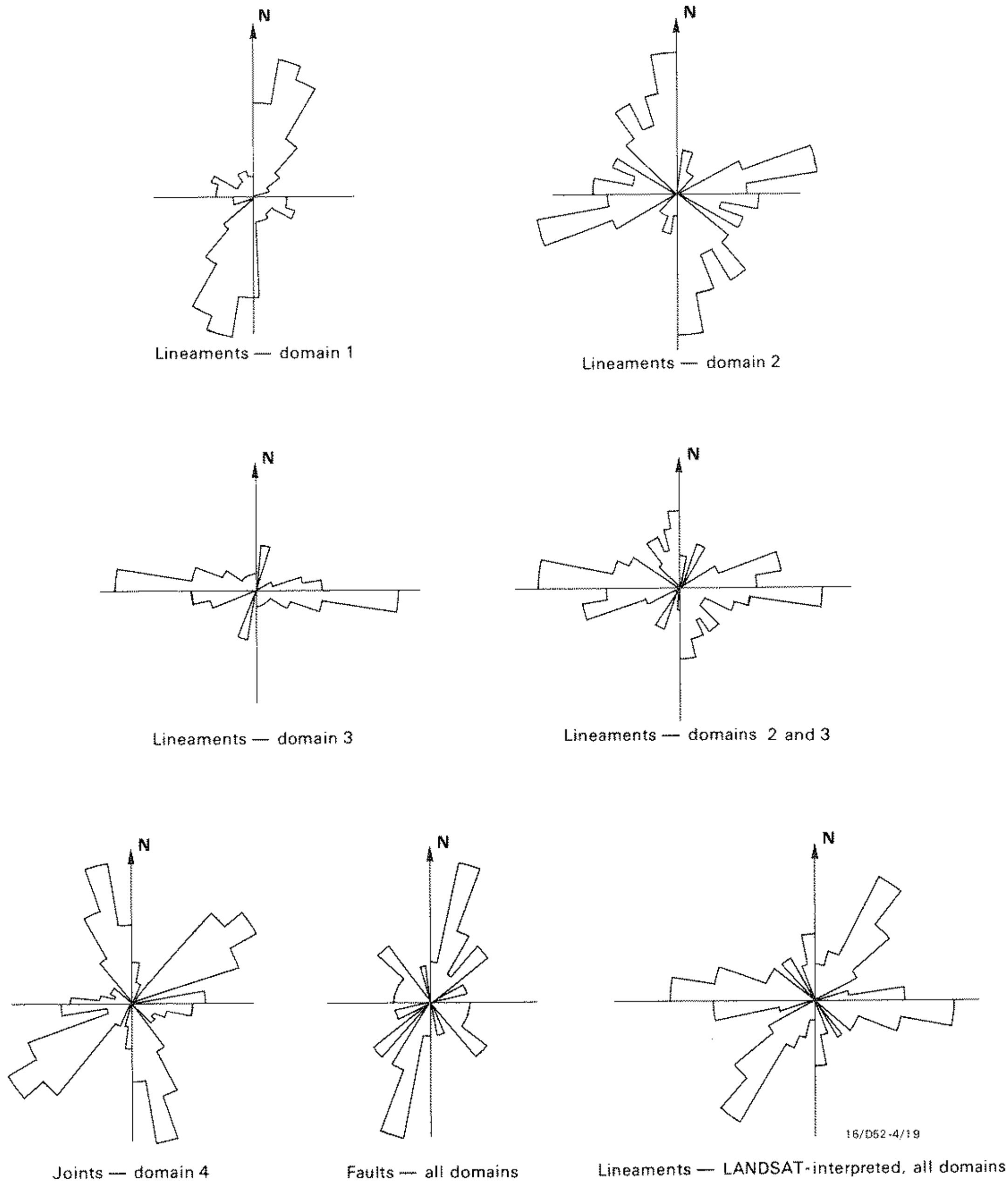

Fig. 7 Azimuthal distribution of structural features.

terozoic metasediments. A prominent northeast trend (030°–040°) in LANDSAT lineaments corresponds to major positive magnetic lineaments interpreted by Tucker & others (1980) to be caused by dykes; this orientation is not reflected in airphoto-lineament concentrations. Northwest-trending negative magnetic lineaments, which parallel a minor fault orientation in Early Proterozoic rocks, are probably caused by Palaeozoic dykes.

GEOLOGICAL HISTORY

Most deposition, and virtually all of the tectonism, metamorphism, and igneous intrusion, took place in Precambrian times, although there are several breaks in the depositional record. Apart from isostatic changes, the region has been stable since Adelaidean (Late Proterozoic) time.

Early Proterozoic sedimentation took place in an intracratonic basin mainly under alternating continental and shallow-marine conditions, but with deeper-water conditions towards the end.

Marginal arenaceous rocks exposed in the Rum Jungle and Alligator Rivers areas (Needham & others, 1980a) form the basal part of the Early Proterozoic sequence. Equivalents of these may have been deposited in MARY RIVER – POINT STUART REGION, particularly in the northwest against the postulated Archaean granitic rocks of the Woolner area. These were overlain by interbedded carbonaceous and carbonate rocks at the margins of the Pine Creek Geosyncline, and by a thicker sequence of fine clastic and chemical sediments in the deeper parts of the basin. None of these rocks is exposed in the region, but they may underlie Mesozoic and Cainozoic sediments in the north.

Uplift of basement below the Van Diemen Gulf caused an influx of coarse clastics (Mundogie Sandstone) into the basin as alluvial fans, which graded southwards into finer littoral and subtidal sediments (Wildman Siltstone). MARY RIVER – POINT STUART REGION was the locus of minor submarine intermediate volcanism during this time.

The region was subjected to minor uplift, tilting, and peneplanation, and a sequence of chemical and organic-rich sediments of the South Alligator Group was deposited after a shallow-marine transgression. Felsic subaerial volcanism during this stage at about 1880 m.y. (R.W. Page, BMR, personal communication 1983) resulted in deposition of tuff and argillite of the Gerowie Tuff and the Mount Bonnie Formation. Chemical and organic sedimentation resumed as volcanism waned during Mount Bonnie Formation time, and later deepening of the geosyncline resulted in an influx of flysch-type sediment and deposition of the Burrell Creek Formation.

Sills of Zamu Dolerite intruded probably near the close of Early Proterozoic deposition. Regional deformation and metamorphism probably took place spasmodically between the time of emplacement of the Nimbuwah Complex granite in OENPELLI and GOOMADEER farther east at 1870 m.y. (Page & others, 1980), and about 1800 m.y. Post-orogenic granites (Mount Bundey Granite and Mount Goyder Syenite) and minor dykes were then emplaced at about 1790 m.y.

Although not present in MARY RIVER – POINT STUART REGION, the braided alluvial fan sandstone and interbedded volcanics of the Kombolgie Formation, which was deposited from a northwesterly provenance in mid-Carpentarian time (Ojakangas, 1979), probably extended across the area after an erosional period of about 150 m.y.

A long stable to erosional period followed for about 1250 m.y. before long linear dolerite and picrite dykes were emplaced. Carpentarian rocks were peneplaned, and Mesozoic seas eroded much of these to expose Early Proterozoic rocks and form sea cliffs against Kombolgie Formation sandstone. The only remaining evidence of Mesozoic deposition is scattered outcrops of epicontinental sediments of the Petrel Formation. Since the Cretaceous the existing land area has remained above sea level, and been exposed to wide fluctuations in sea level and climate until early Holocene times, when the present sea level was attained. The dominant forces which have moulded today's landscape of lowland areas were chemical weathering to produce laterites, sheet washing of sands derived from the Kombolgie Formation, and cut-and-fill modification of the land surface by repeated erosional and aggradational cycles.

MINERAL RESOURCES

Apart from the Mount Bundey iron mine, no economic mineral deposits have been located in MARY RIVER – POINT STUART REGION. Several small base-metal and gold prospects occur in the Koolpin Formation within the contact aureole of the Mount Bundey Granite. Crushed rock and sand are being extracted from the region.

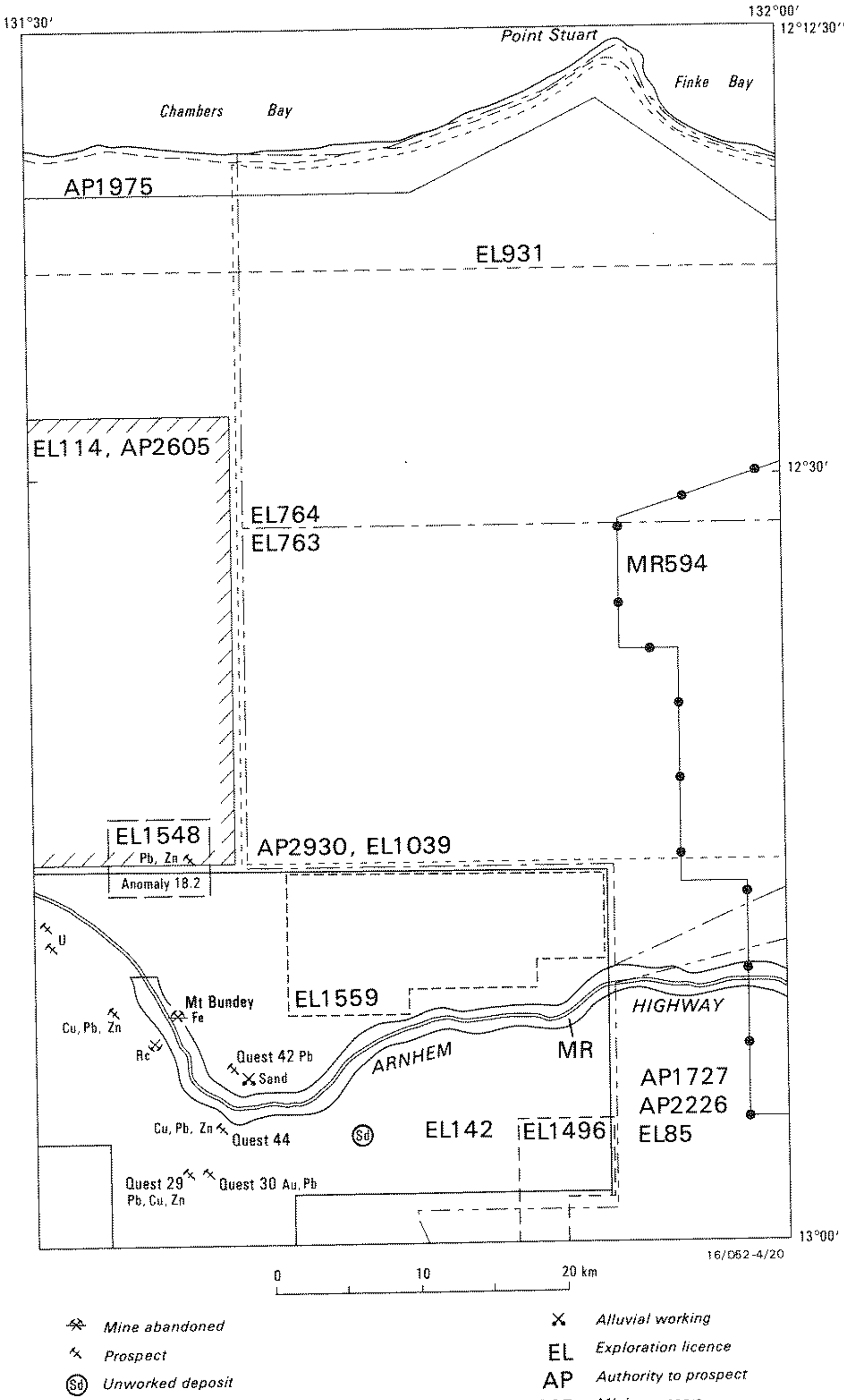

Fig. 8 Locations of mines, prospects, and exploration leases.

Before 1968, field investigations of the region were confined to activities carried out by BMR as part of an evaluation of the Darwin–Katherine region (Walpole & others, 1968), and assessment of the Mount Bundey iron deposits. Exploration for uranium, base-metals, and gold within the Early Proterozoic rocks, and heavy minerals and lime in coastal sand ridges, began in 1968, when the first authorities to prospect in the region were issued. (Note: The term 'Authority to Prospect' has since been superseded by the term 'Exploration Licence'.)

Between 1968 and 1979 most of MARY RIVER – POINT STUART REGION was covered by exploration licences. Investigations were regionally oriented and included geological mapping, airborne and ground radiometric and magnetic surveys, stream-sediment surveys, rock-chip sampling, and auger-drilling. Elements assayed in stream-sediment samples included Cu, Pb, Zn, Au, As, Ni, Co, and U. Rock-chip and soil samples were analysed for all or some of the following: U, Cu, Pb, Zn, Ag, Au, As, Mn, Fe, Ti, Cr, V, Ni, Co; uranium was also analysed in stream waters.

These investigations revealed that low-order radiometric anomalies in the region are related to a thin surficial Cainozoic laterite capping on Early Proterozoic metasediments. Most geochemical anomalies were also low-order, and were considered to reflect changes in rock type. Auger-drilling by CRA Exploration Pty Ltd in the northern part of MARY RIVER showed that basic to intermediate dykes in the Wildman Siltstone were probably the source of base-metal anomalies. Later work in EL 1559 (Fig. 8; Wills, 1979a) showed that anomalies coincide with strike ridges of interlayered volcanics (mapped as dolerite) in the Wildman Siltstone. Significant base-metal and gold prospects located during these regional investigations are Quest 29, 30, 42, and 44, and Anomaly 18.2.

IRON

Mount Bundey

The Mount Bundey iron ore deposit (Dow & Pritchard, 1958; Dunn, 1964; Milsom & Finney, 1965; Ryan, 1969, 1976; Taube, 1966; Walpole & others, 1968), known originally as Pritchard's Lode and located 2 km north of Mount Bundey, was first noted by Dow & Pritchard during regional mapping by BMR. The deposit was mined between 1968 and 1971, yielding 843 063 tonnes of ore at an average grade of 63.43% Fe, 0.108% S, and 0.057% P_2O_5; about 60 percent was produced from the lode and the balance from scree and rubble. The mine closed when the sulphur content in the ore at depth became too high to warrant further production (Ryan, 1976).

The geology of the deposit is reviewed in detail by Ryan (1976), who described two groups of tabular ironstone bodies. These bodies are thought to represent the limbs of a major syncline, each interbedded with near-vertical banded sedimentary rocks and surrounded by the Mount Goyder Syenite. The lodes are well jointed, faulted, and brecciated in part. The easternmost of the two is about 700 m long and up to 50 m wide, and provided most of the ore. The ironstone bodies consist of massive martite with varying amounts of hematite and goethite. At the surface a little pyrite is present, but below the zone of oxidation it is more abundant, forming a pyrite–magnetite rock. Finely bedded ferruginous sedimentary rock, mica schist, chlorite–mica schist, and hornfels envelop the ironstone bodies and are interbedded with them. Aplite and granitic dykes and diffuse zones of chlorite cut the ironstone and the sediments. The enclosing syenite is markedly porphyritic, and commonly shows a crude gneissic texture close to the contact with the metasediments, which ranges from sharp and obviously intrusive to gradational and indefinable.

Ryan (1976) discussed the genesis of the deposit and suggested that the lodes formed by pre-Cretaceous supergene enrichment (which has continued to the present day) of iron-rich sediments included in the Mount Goyder Syenite during intrusion; these iron-rich sediments were probably hornfelsed dolomitic, pyritic, and carbonaceous sediments of either the Koolpin Formation or Wildman Siltstone which crop out near the Mount Bundey and Mount Goyder Syenite. The presence of abundant carbon and pyrite may have helped produce a reducing environment in which magnetite formed during contact metamorphism of the sediment.

BASE-METALS

Base-metal mineral concentrations occur in shear zones, dykes, and chlorite zones within hornfelsed metasediments of the Koolpin Formation near the Mount Bundey Granite. Investigations by exploration companies have included rock and soil geochemistry, trenching, diamond and auger-drilling, and magnetic, self-potential, and electromagnetic surveys. High surface values are due to secondary enrichment of primary sulphides—commonly consisting of galena, sphalerite, chalcopyrite, arsenopyrite, pyrite, and in places bismuth, molybdenite, and pyrrhotite.

The most significant of these prospects are: Quest 44, where a primary mineral concentration with grades of 1.2% Pb, 1.9% Zn, and 231 ppm Cu was intersected over 1 m in a chloritic zone; and Quest 29, where a quartz-veined gossan up to 10 m wide at the surface passes down into a lode less than 3 m wide which has a grade of 0.4% Pb and 1.3% Zn at a depth of 45 m (Twist, 1977). The base-metals at Quest 29 are associated with siderite–quartz bands within brecciated and sericitised minette dykes. Other significant surface anomalies of up to 12% Pb were found in gossanous shear zones at Quest 30 (Twist, 1968), and 0.4% Pb and 0.5% Zn in massive quartz–hematite fracture fillings at Quest 42 (Twist, 1977; Howard & Browne, 1975).

Low-grade lead and zinc in a zone about 20 m wide and 200 m long occur within metasediments of the Wildman Siltstone at Anomaly 18.2, about 13 km north of Mount Bundey (Wills, 1979b; Sevensson, 1979). Primary galena and sphalerite were intersected at depth, the most significant intersection being 4 m of 9245 ppm Pb, 1475 ppm Zn, and 258 ppm Cu.

GOLD

At Quest 29, gold with a grade of up to 57.3 g/t occurs at the surface in a lode 60 m long and 1 m wide about 1 km south of the lead occurrence (Twist, 1977); the gold persists at depth as a low-grade occurrence (less than 2.19 g/t Au). It is associated with small pyrite, pyrrhotite, and arsenopyrite-bearing quartz–feldspar pegmatites which intrude metasediments of the Koolpin Formation and bodies of Zamu Dolerite within the contact aureole of the Mount Bundey Granite.

MINERAL SANDS

Presently active and older stranded coastal sand ridges flanking Chambers and Finke Bays have been prospected for heavy minerals and their lime content. Shallow scout boring by Placer Prospecting Australia Pty Ltd (Murphy, 1969) failed to locate significant sand bodies or heavy-mineral concentrates. The bores ranged from 3 to 8 m in depth, and showed that a shallow zone of black loam covered the coastal plains and was underlain by a coarse shelly base. About 95 percent of the area traversed consisted of mud and shell fragments with little sand.

The sand ridges were investigated by Northern Cement Pty Ltd in 1973 and 1974 for their lime content. Analyses of 19 hand-auger samples showed that they contain an average of 35.4% CaO, and 0.38% MgO. No further work was carried out.

SAND AND CRUSHED ROCK

Three companies currently hold mining leases for river sand along an 8 km stretch of the Mary River around the Annaburroo homestead. Total production for the two years ending June 1979 was 43 123 tonnes.

Crushed rock and weathered sands from the Mount Bundey Granite are presently being extracted about 2 km south of the abandoned Mount Bundey iron mine. No production figures from the operations are available.

ACKNOWLEDGEMENTS

We thank T. Baldwin of Annaburroo homestead for his much appreciated hospitality, and BP Minerals and Union Oil Development Corporation for freely supplying company information and for discussions with their field geologists.

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APPENDIX
COMPANY REPORTS RELEVANT TO MARY RIVER–POINT STUART REGION

The following company reports are filed at the Northern Territory Department of Mines & Energy, Darwin.

NT Dept Mines & Energy file no.	*Lease no.*	*Main prospected minerals*	*Abbreviated title and leaseholder*
CR 68/7	AP1727	Cu, Ni, Co, Pb, Zn	Phase I investigations of 8 mile Creek, Rosie Creek, Nagi Hill, Jim Jim, Mary River. Australian Geophysical.
CR 69/31	AP1975	Heavy minerals	Report, Chambers and Finke Bays, heavy-mineral beach sands. Placer Prospecting Aust. Pty Ltd.
CR 71/6	AP2226	U, Ag, Pb, Zn	Report on phase II investigations. Australian Geophysical.
CR 71/97	AP2226	U	Final report of the 1971 airborne and ground spectrometer surveys. Australian Geophysical.
CR 72/85A	AP2930	U, Cu, Pb, Zn	Annual report, lower Mary River. CRAE.
CR 72/85	EL763, 764	U, Cu, Pb, Zn	Report for year ended 30.9.72, lower Mary River, parts A–B. CRAE.
CR 73/10	EL85	U	Report on exploration and expenditure, quarter ended 28.8.72. Ada Explorations.
CR 73/48	EL114	U	Quarterly report No. 3, Marrakai. Kewanee.
CR 73/60	EL623	U	Quarterly report No. 1, period ending 21.1.73, Rum Jungle area D, parts A–B. Kewanee.
CR 73/65	AP2605	Cu, Pb, Zn, Co, Ni	Final report and maps, Marrakai area, parts A–C. Kewanee.
CR 73/90	EL763, 764	U, Cu, Pb, Zn	Final report, lower Mary River. CRAE.
CR 73/124	EL142	Cu, Pb, Zn	Progress report, Quest 30 prospect. Geopeko.
CR 73/149	EL85	U	1972 exploration report—Mary River uranium joint venture. Macmine.
CR 74/111	EL142	Cu, Pb, Zn, U, Ag, Au, As, Mn, Fe, Ti, Co	Report on area relinquished at 30.3.74. Geopeko.
CR 74/150	EL142	Cu, Pb, Zn, U, Ag, Au, As, Mn, Fe, Ti, Co	Report on areas retained at 30.3.74. Geopeko.
CR 75/120	EL142	Cu, Pb, Zn, U, Ag, Au, As, Mn, Fe, Ti, Co	Report on areas retained as at 31.3.75. GD 75/3. Geopeko.
CR 75/121	EL142	Cu, Pb, Zn, U, Ag, Au, As, Mn, Fe, Ti, Co	Report on areas relinquished as at 31.3.75. GD 75/3. Geopeko.
CR 75/132	EL142	Cu, Pb, Zn, U, Ag, Au, As, Mn, Fe, Ti, Co	Progress report, Quest 42 prospect. Geopeko.
CR 76/49	EL142	Cu, Pb, Zn, U, Ag, Au, As, Mn, Fe, Ti, Co	Report on areas relinquished from EL142 at 30.8.76. Geopeko.
CR 76/68	EL142	Cu, Pb, Zn, U, Ag, Au, As, Mn, Fe, Ti, Co	D76/2 work on areas retained as at 31.3.76. Geopeko.
CR 77/94	EL142	Cu, Pb, Zn, U, Ag, Au, As, Mn, Fe, Ti, Co	Progress report on Quest 29 prospect. Geopeko.
CR 78/4	EL931	limestone	Final report for the year 1973–74. Northern Cement Pty Ltd.
CR 78/113	EL1496	Cu, Pb, Zn	Final report Annaburroo East, Pine Creek Basin. CRAE.
CR 78/125	EL1559	Cu, Pb, Zn	Mount Goyder annual report, Pine Creek Basin. CRAE.
CR 79/59	EL1559	Cu, Pb, Zn	Final report Mount Goyder, Pine Creek Basin. CRAE.
CR 79/97	EL1548	Cu, Pb, Zn	Report for 2 years ending 24.4.79, Dora Creek. CRAE.
CR 79/194	EL1548	Cu, Pb, Zn	Final report, Dora Creek. CRAE.