COMMONWEALTH OF AUSTRALIA.

DEPARTMENT OF NATIONAL DEVELOPMENT.

BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS.

RECORDS.

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EXPLANATORY NOTES ON

KENNEDY RANGE 4-MILE GEOLOGICAL SHEET

Sheet G/50-1, Australian National Grid

by

M.A. CONDON

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GEOLOGICAL INVESTIGATIONS

Gregory's section (1861) eastward from Babbage Island (Carnarvon) is the earliest published record of geological work in the area of the Kennedy Range 4-Mile Sheet. West-dipping Palaeozoic sediments were shown as Devonian (?), Carboniferous (? and Permian (?); the overlying "Cretaceous (?)" included the sandstone of the Kennedy Range.

Hudleston (1883) described a collection of rock and fossils specimens forwarded by John Forrest. Fossils (from the Callytharra Formation between the Gascoyne and Minilya Rivers) were described and referred to the Lower Carboniferous.

Maitland (1901) discovered the glacial sediments which he named Lyons Conglomerate (1912). He examined the Palaeozoic sediments in the area between the Gascoyne and Lyndon Rivers (1909). He described limestone (belonging to the Callytharra Formation and the Moogooree Limestone) and sandstone (Kennedy Group). In 1919 he named the "North-West Artesian Basin" and showed the outline of the basin on a very small-scale map of Western Australia.

Waterford, in about 1937, examined the area south of Merlinleigh. This work was not published but he made a good collection of fossils from the Callytharra Formation and Byro Group that were examined by Crespin (1937).

Between 1940 and 1950, Teichert did several reconnaissance trips through the area (Teichert, 1941, 1947, 1949, 1950, 1952).

Raggatt carried out a reconnaissance of the area north of the Gascoyne River for Oil Search Ltd. in 1934. He established the main outlines of the stratigraphy of the Permian and Cretaceous (Raggatt, 1936). Raggatt and Fletcher (1937) listed the species then known from the Carnarvon Basin and examined the problems of the Carboniferous-Permian boundary in Australia and the Indian Ocean area generally.

Geologists of the Bureau of Mineral Resources mapped the Kennedy Range Sheet in 1949, 1953 and 1955 (Condon, 1954).

The present sheet is entirely the result of the mapping by the Bureau geologists, although much of the stratigraphic nomenclature is adapted from Raggatt's and Teichert's work.

PHYSIOGRAPHY

The area consists mainly of plains at two levels, the higher at 900 to 1200 feet above sea level and the lower from about 100 to 800 feet above sea level; the two plains are generally separated by a steep scarp 100 to 400 feet high; both plains slope gently westward.

The Kennedy Range consists of the largest part of the high level plain and the surrounding scarps. Smaller erosional remnants of the high level plain include the mesa on which is Trig. Point K-43, buttes at K-35 and K-49, and the

mesa 10 miles east-south-east of Moogooree Homestead. The low level plain includes the alluvial fan of the Gascoyne River, the sand plain west of the Kennedy Range (probably a plain of marine erosion cut mainly in Cretaceous sedimentary rocks) and the outcrop plain to the north, east and south of the Kennedy Range in the drainage of the Minilya, Lyons and Gascoyne Rivers.

The north-flowing drainage in the north part of the area is tributary to the Minilya River; the Lyons River drains the eastern part and the Gascoyne River the southern. The drainage west of the Kennedy Range disappears in the sand plain - none of the streams reaches the sea or even the Salt Lake. All streams are intermittent, flowing only for short periods after heavy rain. In the Kennedy Range deep young gorges are cut but elsewhere the valleys are open.

In the north-eastern part of the sheet, the drainage is dendritic and the minor relief is about 100 feet. The surface is mainly undulating with some sharp ridges where quartz reefs crop out.

Longitudinal (seif) dunes, generally somewhat anastomosing, cover the high level plain and much of the western part and small areas of the eastern part of the low level plain. The dunes of red quartz sand range in height up to about 50 feet. They are fixed by spinifex and other vegetation.

A low range in the eastern plain is a strike ridge formed by the outcrop of Callytharra Formation and Moogooree Sandstone.

STRATIGRAPHICAL NOMENCLATURE

Rock units are named according to the Australian Code of Stratigraphical Nomenclature (A.N.Z.A.A.S., 1956).

STRATIGRAPHY

PRECAMBRIAN

Very little geological work has been done on the Precambrian rocks of the area. The distribution of rock types shown on the map results from air-photograph interpretation based on a few traverses by Bureau geologists.

Precambrian rocks crop out in the north-eastern part of the area and in an inlier in the south-east. They probably form the floor of the Palaeozoic sedimentary basin.

Crystalline schist covers the greater part of the outcrop area; quartz schist, biotite schist, quartz-feldspar biotite schist (or micro-gneiss), amphibole schist, tremolite schist, sericite schist, talc schist are among the types presented.

Discordant granite crops out in the north part of the Precambrian outcrop area.

Dykes of quartz, pegmatite and basic igneous rock ("dolerite") stand out clearly on the ground and in air-photographs.

No mineral deposits have been reported from this area although the Yinnietharra mica mines are only about 50 miles to the east, in probably the same suite of rocks.

DEVONIAN

The oldest Palaeozoic rocks exposed in the area are of Devonian age. The basal formation is the Nannyarra Greywacke (Condon, 1954) which was deposited on a surface of considerable relief (about 500 feet) on the Precambrian rocks. In this area the formation consists mainly of medium-grained and coarse-grained quartz greywacke with angular fragments of quartz and schist in the lower beds. The thickness ranges from 200 feet downwards and is variable within short distances.

The Frasnian (Hill, 1954) Gneudna Formation (Teichert, 1949; Condon, 1954) consists of friable calcarenite and quartz greywacke, hard calcarenite and calcilutite, and soft siltstone and rests conformably on the Nannyarra Greywacke. It is about 980 feet thick in the eastern outcrop belt. There is a transitional conformable passage upwards into the Munabia Sandstone and in places e.g. 12 miles south-south-east of Moogooree, the upper part of the Gneudna changes laterally into the Munabia.

The Munabia Sandstone (Condon, 1954) is a clean medium-grained and fine-grained quartz sandstone. In the western outcrop belt the thickness varies from 1200 feet in the north to 4450 feet near the middle and 900 feet near the south end. In the north of the area the Willaraddie Formation rests conformably on the Munabia but farther south the Moogooree Limestone, Austin Formation or Coyango Greywacke rests unconformably on it.

The Willaraddie Formation (Condon, 1954) consists of quartz greywacke, conglomerate and siltstone and minor limestone; in this area its thickness ranges downwards from about 500 feet. There is a strong erosional unconformity between the Willaraddie and the overlying Moogooree Limestone.

CARBONIFEROUS

The Moogooree Limestone (Teichert, 1949; Condon, 1954) consists mainly of hard and friable calcilutite with minor calcarenite, coquinite and quartz greywacke. It is 820 feet thick at the north end and 1000 feet near the south end. It includes several richly fossiliferous beds containing Spirifer fluctuosus, Punctospirifer plicatosulcatus and Syringothyris spissus (Glenister, 1956) and Syringopora, Rhipidomella, Linoproductus, Schellwienella, Composita, Cleiothyridina, Camarotoechia, and cf. Eomartiniopsis, (Thomas, in McWhae et al, 1958). The age is certainly Lower Carboniferous and probably Tournaisian.

The overlying Williambury Formation (Teichert, 1949; Condon, 1954) is very little exposed in the area - only the top is exposed in a few places. The thickness indicated by the distance between the Moogooree Limestone and the Yindagindy Formation and the dips in those formations is about 200 feet downwards.

The Yindagindy Formation (Condon, 1954) crops out 1½ mile north of Moogooree where it is about 120 feet thick and from the homestead southward, where it ranges from about 100 feet downwards. Brachiopods, crinoid stem ossicles and brachials, small gastropods, a nautiloid and ostracods, have been found but are difficult to develop and no detailed work has been done on them. Their general appearance is Lower Carboniferous.

A major erosional unconformity separates the Devonian and Carboniferous sediments from the overlying Permian. In the area south of Moogooree this unconformity cuts obliquely across the whole Carboniferous and Devonian sequence and, about one mile north of Mt. Sandiman homestead, reaches the Precambrian.

PERMIAN

The Harris Sandstone (Condon, 1954) which is the basal formation of the Permian in the Minilya Sheet area to the north is not present in the Kennedy Range Sheet area. Its equivalent is the lowermost part of the Austin Formation.

The Lyons Group (Maitland, 1908; Raggatt, 1936; Condon, 1954) was indicated by Condon (1954) to be divisible into formations which at that time had not been mapped and therefore were not named. The formations have now been mapped, and are named, in ascending order, Austin Formation, Coyango Greywacke, Dumbardo Siltstone, Koomberan Greywacke, Mundarie Siltstone, Thambrong Formation and Weedarra Shale. This mapping has established a very strong erosional unconformity between the Lyons Group and the Callytharra Formation.

The Austin Formation (new name) is defined as the formation of pebbly quartzwacke with several arenaceous tillite beds, and sandy siltstone with silty boulder beds, that rests unconformably on the Carboniferous and Devonian formations and on the Precambrian rocks and is overlain conformably by the Coyango Greywacke. The name is taken from Austins Creek which flows into the Lyons River from the [illegible] 9½ miles south of Mt. Sandiman Homestead. The type locality is Mt. Sandiman Homestead. Because of its position on an erosional unconformity of marked relief the thickness is very variable; on this sheet it is absent in outcrop (overlapped by Coyango Greywacke) from the northern edge of the sheet to 15 miles south-south-east of Moogooree Homestead; 1240 feet thick in the type locality; 1080 feet 8 miles north-north-east of Mt. Sandiman Homestead; 920 feet 7 miles north-east of Lyons River Homestead; and absent (overlapped by Coyango Greywacke) on the west side of the Precambrian inlier east of Lyons River Homestead. No fossils have been found in the Austin Formation but, because of the major erosional unconformity with the Lower Carboniferous and the presence of Lower Permian plants in the Coyango Greywacke, the Austin Formation is referred to the Lower Permian (Sakmarian).

The Coyango Greywacke (new name) is the formation of quartz greywacke with minor boulder beds and siltstone beds that is conformable between the Austin Formation and the Dumbardo Siltstone; it commonly overlaps the Austin Formation and rests unconformably on Carboniferous, Devonian or Precambrian rocks. The type locality is half a mile to east and west of Coyango Well, Williambury, 13 miles west-north-west of the homestead (Minilya 4-mile sheet). In the type section the formation is 1325 feet thick. On the Kennedy Range Sheet, the thickness is 330 feet north of Moogooree, where it is unconformable on Yindagindy Formation; 150 to 400 feet 7 to 13 miles southward from Moogooree, where it is unconformable on Moogooree Limestone or Munabia Sandstone; 2900 feet ½ to 2½ miles west of Mt. Sandiman Homestead, 1480 feet 8 miles north-north-east of that homestead and 1420 feet 6 miles north-east of Lyons River Homestead (conformable on Austin Formation at those three places); and 350 feet 4½ miles east of Lyons River Homestead to absent 10 miles south-east of that homestead (unconformable on Precambrian schist and overlapped by Dumbardo Siltstone). The Lycopod plant fossils found north of Moogooree (Condon, 1954, p.33) are in the Coyango Greywacke; similar plant fossils have been found in that formation near Williambury (Minilya Sheet) and six miles south-south-east of Arthur River Woolshed (Mt. Phillips Sheet). These plants are regarded as Permian by White (White and Condon, 1957). Brachiopods and bryozoa have been found 5¾ miles south-south-east of Mt. Sandiman Homestead.

The Dumbardo Siltstone (new name) is the formation dominantly of tillitic siltstone with tillitic boulder beds, conformable between the Coyango Greywacke and the Koomberan Greywacke. The name is taken from Dumbardo Bore, Williambury Station (Minilya 4-mile sheet); the Dumbardo Siltstone crops out 2½ miles east-north-east of Dumbardo Bore. The type locality is one mile west of Coyango Well, Williambury and 13 miles west-north-west of Williambury Homestead (Minilya Sheet). In the type section the Dumbardo Siltstone is 500 feet thick. In the Kennedy Range Sheet area, the Dumbardo Siltstone is 740 feet (± 50 feet) thick west from Moogooree, 1280 feet four miles west of Mt. Sandiman Homestead, 1300 feet 2 to 4 miles east of Lyons River Homestead, and 850 feet at the far south of the sheet. The Dumbardo Siltstone is unconformably overlain by the Callytharra Formation from 5½ miles north-west to 3½ miles west of Mt. Sandiman Homestead, and rests unconformably on Precambrian schist 10 to 16 miles south-south-east of Lyons River Homestead.

Marine fossils have been found in the Dumbardo Siltstone 2¼ miles north of Moogooree and three and five miles north-west of Mt. Sandiman Homestead; the fauna includes bryozoa, brachiopods (productids and spiriferids) pectinids and solitary corals (Dickins and Thomas, 1959, p.). The assemblage includes two species not known from the higher parts of the Lyons Group but otherwise is similar to that found throughout the middle and upper formations of the Group; the general assemblage is regarded as Sakmarian in age (Dickins and Thomas, 1959).

The Koomberan Greywacke (new name) is the formation consisting mainly of quartz greywacke with several tillitic boulder beds and few siltstone beds, conformable between the Dumbardo Siltstone and the Mundarie Siltstone; in places it is unconformably overlain by the Callytharra Formation. The name is taken from Koomberan Bore, Middalya Station (Minilya 4-mile sheet); the formation crops out to the east of the Vermin Proof Fence which is the eastern fence of Koomberan Paddock. The type locality is ¾ to one mile west-south-west of Coyango Well, Williambury Station. In the type section the formation is 420 feet thick. In the Kennedy Range Sheet area, the Koomberan Greywacke is about 700 feet thick 2½ miles south-west of Moogooree; 700 feet 12 miles south of Moogooree; 760 feet 4 miles south of west of Mt. Sandiman Homestead; 1400 feet three miles north of Lyons River Homestead; 560 feet 8 miles south of Lyons River Homestead, where it is unconformably overlain by Callytharra Formation; 360 to 720 feet 22 miles south-south-east of Lyons River Homestead, where the top of the formation is eroded and the lower part changes laterally into siltstone of the Dumbardo Siltstone; and 160 feet at the Arthur River 1¾ miles east of K-35.

Fossils have been found in the Koomberan Greywacke only at two localities: 1 mile north of Lyons River Homestead (mainly brachiopods), and 5½ miles south-east of Grays Well, Lyons River Station (bryozoa, corals, crinoid stem ossicles, brachiopods including spiriferids, and pectinids). These fossils have not been examined critically but by reference to the faunas in underlying and overlying formations of the Lyons Group, the Koomberan Greywacke is Sakmarian in age.

The Mundarie Siltstone (new name) is the formation, consisting of tillitic siltstone with tillitic boulder beds, conformable between the Koomberan Greywacke and the Thambrong Formation; in places it is unconformably overlain by younger formations of the Lyons Group or by the Callytharra Formation. The name is taken from Mundarie Well, Middalya Station (Minilya 4-mile sheet); the formation crops out across the north-eastern corner of Mundarie Paddock. The type locality is

in the north-east corner of Mundarie Paddock and the adjoining south-east corner of Blairs Camp Paddock; there the Mundarie Siltstone is 520 feet thick. On the Kennedy Range Sheet, the Mundarie Siltstone is 950 feet thick. Mundarie Siltstone is about 800 feet thick 2 miles south-south-west of Moogooree Homestead, 600 feet 5½ miles west of Mt. Sandiman Homestead; 720 feet 500 to 1400 yard west of Lyons River Homestead; 480 to 600 feet 22 miles south-south-east of Lyons River Homestead where it appears to rest on an eroded surface of the Koomberan Greywacke; and 660 to 750 feet at the Arthur River, 1 mile east of K-35, where it is unconformably overlain by Callytharra Formation. The Mundarie Siltstone is absent in outcrop from one mile south-east to 20 miles east of south of Lyons River Homestead, where the Callytharra Formation rests unconformably on the Koomberan Greywacke.

The Mundarie Siltstone includes several beds containing marine fossils (Fenestellid bryozoa, corals, spiriferids, productids, crinoid stem ossicles, pelecypods and foraminifera); although preservation is poor at outcrop, good material may be found in some localities. Detailed examination of the faunas is not complete but the work to date (including Dickins, 1956; Dickins and Thomas, 1958) indicates a Sakmarian age.

The Thambrong Formation (new name) is the formation of quartz greywacke, tillitic siltstone, shale and tillitic boulder beds conformable above the Mundarie Siltstone and overlain conformably by the Weedarra Shale or unconformably by the Callytharra Formation or by younger Permian formations. Its name is taken from Thambrong Pool on the Minilya River 9 miles downstream from Williambury Homestead (Minilya 4-mile sheet). The formation crops out two to 5½ miles east of the Pool; the type locality is along the south side of South Branch, Minilya River from its junction with Minilya River to 6½ miles upstream. In the type locality the Thambrong Formation is 1840 feet thick in a syncline; it is 1500 feet thick 2½ miles south-west of Moogooree Homestead; 1100 feet 6 miles west of Mt. Sandiman Homestead, where it is unconformably overlain by Callytharra Formation; 440 feet one mile west of Lyons River Homestead (unconformably overlain by Callytharra Formation); 320 feet 22½ miles south-south-east of Lyons River Homestead (unconformable under Callytharra Formation. The Thambrong Formation is absent in outcrop from 15 to 23 miles southward from Moogooree, from Lyons River Homestead for 23 miles southward, and at the Arthur River east of K-35. Fossils have been found in the type locality and in the Minilya sheet area. These indicate Sakmarian age.

The Weedarra Shale (new name) is the formation, consisting of sandy shale, sandy and pebbly siltstone with boulder beds and a quartz greywacke member with several boulder beds, that conformably overlies the Thambrong Formation and is unconformably overlain by the Callytharra Formation. It is the uppermost formation of the Lyons Group in outcrop. The type locality is 3¼ to 5¼ miles west of Coondoo Well, Coondoo Outstation, and 3½ miles north ofWeedarra Paddock, Bidgemia Station, from which the name of the formation is taken (Mt. Phillips 4-mile sheet). In the type locality the Weedarra Shale is 1200 feet thick; on the Kennedy Range sheet it is 640 to 800 feet thick three miles westward from Moogooree Homestead where the unconfo mity truncates the formation; it is absent in outcrop southward from five miles south of Moogooree; it is 80 to 480 feet thick 10 miles eastward from Lyons River Homestead, on the eastern side of the Weedarra Ridge (Condon, 1956 and Fig. 1). Fossils have been found near the Lyndon River, in the type locality and west of Moogooree; these include species common to the older formations of the Lyons Group and to the Carrandibby Formation (Dickins and Thomas, 1959); the Weedarra Shale is regarded therefore as Sakmarian in age.

The Callytharra Formation (Raggatt, 1936; Condon, 1954a) is here re-defined as the formation of fossiliferous hard and friable sandy and silty calcarenite and calcilutite unconformably overlying the Weedarra Shale or older Permian formations and overlain unconformably by formations of the Wooramel Group. In the Kennedy Range sheet area it is 412 feet thick 4 miles south-west of Moogooree, and also 6 miles west of Mt. Sandiman Homestead; 355 feet 10 miles south of east of Lyons River Homestead; and 210 feet at the Arthur River, in the south-eastern corner of the sheet. The thickness of the Callytharra Formation is probably very much more variable than is indicated by the above figures: it rests on a surface, eroded in the sediments of the Lyons Group, with a minor relief of several hundred feet and very youthful valleys; thicknesses larger than the above are indicated in these valleys, and above the ridges the thickness may be very much less. A variable amount of the upper part of the Callytharra Formation was removed by erosion before the deposition of the sediments of the Wooramel Group. The abundant fossils include foraminifera (Crespin, 1958), bryozoa, corals, crinoids (Calceolispongia and other genera), brachiopods (Chonetes, Neospirifer, Spiriferella, Syringothyris (?), Cleiothyridina, Phricidothyris, Dictyoclostus, Linoproductus, Streptorhynchus)pelecypods, gastropods, nautiloids and a single goniatite (cf. "Metalegoceras"). The brachiopods and the goniatite indicate an early Artinskian age (Thomas and Dickins, 1954).

The Wooramel Group (Konecki et al., 1958, p.28) in the Kennedy Range Sheet area comprises the Moogooloo Sandstone and the Billidee Formation. The Cordalia Greywacke (Condon, 1954a) is not present in this area. The unit now named Billidee Formation was included (by Raggatt, (1936) and Condon (1954a)) in the Byro Group but, in terms of the definition of the Wooramel and Byro Groups in their type localities, should be part of the Wooramel Group.

The Moogooloo Sandstone (Craig, 1951) is the formation (incorrectly given the name "Wooramel Sandstone" by Raggatt, 1936 and Condon, 1954) that overlies the Callytharra unconformably and is conformably overlain by the Billidee Formation; it consists mainly of quartz sandstone with minor thin beds of siltstone. The type locality is here defined as at the south end of Moogooloo Range on Middalya Station (Minilya 4-mile sheet) where the thickness is 170 feet. On the Kennedy Range Sheet it is 250 feet thick 4 miles south-west of Moogooree; 150 feet 6½ miles west of Mt. Sandiman Homestead; 160 feet 9 miles south of east of Lyons River Homestead; 170 feet 8 miles south of Lyons River Homestead and 30 feet 21 miles south of Lyons River Homestead. Plant fossils have been found in the area west of Moogooree, but no marine fossils have been found in this sheet area. By reason of its position between the Artinskian Callytharra Formation and Newman Formation, the Moogooloo Sandstone is Artinskian in age.

The Billidee Formation (new name) is the formation consisting of quartz greywacke and minor siltstone resting conformably between the Moogooloo Sandstone and the Newman Formation. It is the lower part of the sequence previously called the Coyrie Formation (Condon, 1954); it was included in the "Byro Group" (Raggatt, 1936; Condon, 1954) but is now included in the Wooramel Group because it is dominantly arenaceous, like the formations of the Wooramel Group in its type locality.

The name is taken from Billidee Well, Moogooree Station 5½ miles south of the homestead; the well is sunk in the Billidee Formation. The type locality is 3 miles north-west of Billidee Well at the original type locality of the Coyrie Formation.

In the type section the Billidee Formation is 242 feet thick; 5 miles west of Moogooree it is 185 feet; half a mile north of Mt. Sandiman Woolshed it is about 400 feet; 9 miles E.S.E. of Lyons River Homestead it is 310 feet and 20 miles southward from Lyons River Homestead it is 255 feet thick. Fossil wood is common in the Billidee Formation. Marine fossils are found only near the top including brachiopods, pelecypods, nautiloids, goniatites (?Propinococeras) gastropods (bellerophontid and pleurotomarid) calceolispongid plates. No precise work has been done on this fauna. The age of the formation by reference to the Callytharra and Newman Formations is Artinskian.

The Byro Group was named, as Byro Formation, by Condit (1935, p.870). Raggatt (1936) and Condon (1954a) included all the beds between the Wooramel Group and Kennedy Group in the Byro although in the Minilya River Raggatt separated in other units the beds above the unit later named Bulgadoo Shale. As I have established a disconformity above the Bulgadoo Shale in the Merlinleigh Basin and as this disconformity is closely related stratigraphically to the top of the Byro Group in the type locality (Byro Plains) it is proposed to redefine the Byro Group, in terms of Condit's original description and the formations of Konecki et al (1958), as follows: the Byro Group is the sequence of fossiliferous siltstone and quartz greywacke with minor calcareous beds overlying the Wooramel Group and truncated by an erosion surface, unconformably overlain by possibly Eocene sediments or, in the Merlinleigh Basin, overlain disconformably by the Minilya Group. In the Kennedy Range Sheet area the Byro Group consists, in ascending order, of Newman Formation, Mallens Greywacke and Bulgadoo Shale and is overlain disconformably by the Cundlego Formation.

The Newman Formation (new name) is the formation consisting of fossiliferous siltstone and fine-grained quartz greywacke conformable between the Billidee Formation and the Mallens Greywacke. It is the upper part of the sequence formerly called Coyrie Formation (Condon, 1954a).

The name is taken from Newmans Creek on Mt. Sandiman Station, which flows over the outcrop of the formation for 5 miles north of Mt. Sandiman Woolshed. The type locality of the formation is 4½ miles south-west of Moogooree Homestead, at the original type locality of the Coyrie Formation. The base of the Byro Group in the Merlinleigh Basin is revised at the base of the Newman Formation. This agrees with its lithological position in the type locality of the Byro Group at the change from dominantly arenaceous formations to the dominantly siltstone formation.

The Newman Formation is 613 feet in the type locality (Condon, 1954); 470 feet 8 miles W.N.W. of Moogooree; about 400 feet half a mile north of Mt. Sandiman Woolshed; about 330 feet 3 miles west of Lyons River Homestead and 420 feet 20 miles southward from Lyons River Homestead.

A fairly large and distinctive fauna is present in the Newman Formation at the type locality; this includes foraminifera - Ammodiscus, Ammobaculites, Hyperammina, Reophax, Sacculinella, Spiroplectammina, Textularia, Thurammina and Thuramminoides (Crespin, 1958), bryozoa, brachiopods - chonetid, productid and spiriferid, pelecypods, small gastropods, Propinacoceras, and a trilobite (?Ditimopyge). Fossil wood and ?Gangamopteris leaves are also found. The fauna is different from that of the Callytharra Formation but generally similar to that of the Wandagee Formation although with sufficient differences in species to allow faunal distinction.

The age is Artinskian by reference to the Artinskian Callytharra Formation and Wandagee Formation (Thomas and Dickins, 1954).

The Newman Formation may be correlated by fauna and lithology, with the Madeline Formation of the Wooramel River area. There is a possibility that the Bogadi Greywacke and Warra Warringa Formation are equivalent to the upper part of the Newman Formation.

The Mallens Greywacke (Teichert, 1950; Condon 1954a) is the formation of quartz greywacke resting conformably between the Newman Formation and the Bulgadoo Shale. The type locality is 5½ to 6½ miles south of west of Moogooree Homestead.

The Mallens Greywacke on the Kennedy Range sheet is 517 feet thick at the type locality, 600 feet 10 miles west-north-west of Mt. Sandiman Homestead, 420 feet 4½ miles west of Lyons River Homestead and about 600 feet thick 22 miles south of Lyons River Homestead.

The Mallens Formation contains several beds of pelecypods and spiriferids in the lower part and several fossil beds containing foraminifera-(Ammodiscus, Hyperammina Thuramminoides Crespin, 1958)- spiriferids, streptorhynchid, pelecypods and gastropods.

The age by reference to the Callytharra Formation and Wandagee Formation is Artinskian.

The Mallens Greywacke possibly may be correlated, by stratigraphic position, lithology and, indefinitely, by fossils, with the Bogadi Greywacke (Konecki et al. 1958) of the Wooramel River area.

The Bulgadoo Shale (Teichert, 1941, Condon, 1954) is the formation, dominantly of carbonaceous shale and siltstone with minor quartz greywacke and limestone, conformably on the Mallens Greywacke and disconformably overlain by the Cundlego Formation.

The reference section, where relationships and thickness can be determined, is 6½ to 8 miles south of west of Moogooree Homestead in the northern scarp of the Kennedy Range.

The Bulgadoo Shale is 626 feet thick in the reference section, 520 feet 3 miles south-east of Kimbers Well, Williambury, 400 feet 9½ miles north of west of Mt. Sandiman Homestead; 245 feet 6½ miles west-south-west of Lyons River Homestead, and 260 feet near the south edge of the sheet 7½ miles east of the Lyons River.

Fossils include foraminifera - Ammobaculites, Ammodiscus, Hemigordius, Hyperammina, Nodosaria, Pelosina, Rectoglandulina, Reophax, Sacculinella, Spiroplectammina, Thurammina, Thuramminoides (Crespin, 1958) - bryozoa, Thamnopora, Calceolispongia and crinoid stem ossicles, brachiopods - chonetid, spiriferid, productid - pelecypods, gastropods, nautiloid.

The age of the Bulgadoo Shale by reference to its position between the Callytharra Formation and the Wandagee Formation is Artinskian.

The Bulgadoo Shale correlates by stratigraphic position and lithology with the Warra Warringa Formation of the Wooramel River area (Konecki et al. 1958).

The Minilya Group (new name) is defined as the sequence of fossiliferous siltstone, quartz greywacke, shale and calcareous beds disconformably overlying the Byro Group and disconformably (locally unconformably) overlain by the Kennedy Group. The sediments of the Minilya Group were included by Condon (1954a) and in the Kennedy Range area by Raggatt (1936) in the Byro Group. As a disconformity is present above the sequence in the Merlinleigh

Basin that is the lateral equivalent of the Byro Group in its type locality, the Byro Group should be restricted to the sequence below that disconformity. The Minilya Group in the Kennedy Range area consists, in ascending order, of Cundlego Formation Quinnanie Shale, Wandagee Formation, Norton Greywacke and Baker Formation. It includes many beds of marine fossils that indicate (Thomas and Dickins, 1954) the Artinskian age.

The Cundlego Formation (Teichert, 1941; Condon 1954a) is the formation of quartz greywacke and carbonaceous siltstone disconformably overlying the Bulgadoo Shale. The Quinnanie Shale conformably overlies the Cundlego Formation or grades laterally into it; where the Quinnanie Shale is absent the Cundlego Formation is overlain conformably by the Wandagee Formation.

In the Kennedy Range sheet area, the Cundlego Formation is 1040 feet thick 5 miles north of Paddys Outcamp, Middalya; 975 feet 3 miles south-east of Kimbers Well, Williambury; more than 730 feet in Bore B.M.R. 7; 445 feet 2 miles east-south-east of Merlinleigh Homestead, 365 feet 7½ miles west-south-west of Lyons River Homestead and about 560 feet near the south edge of the sheet immediately east of the Lyons River.

Fossils occur sporadically in the Cundlego Formation; they include foraminifera - Ammobaculites, Ammodiscus, Glomospirella, Hemigordius, Hyperammina, Lugtonia, Nodosaria, Pseudohyperammina, Reophax, Spiroplectammina, Streblospira and Trochammina (Crespin, 1958) - bryozoa (rare), Calceolispongia, brachiopods - chonetid, productid, spiriferid, martiniopsid - Conularia, pectenids, gastropods, nautiloids.

The age of the Cundlego Formation, because of its position between the Callytharra Formation and the Wandagee Formation, is Artinskian.

The Quinnanie Shale (Teichert, 1950; Condon, 1954) is the formation of carbonaceous shale and siltstone and minor quartz greywacke conformable between the Cundlego Formation and the Wandagee Formation. In the Kennedy Range sheet area it grades laterally into the Cundlego Formation.

The thickness of the Quinnanie Shale is 125 feet 5 miles north of Paddys Outcamp, Middalya; 195 feet in Bore B.M.R. 7, Muderong; 115 feet 5 miles north of Bakers Bore, Middalya, 110 feet 3¼ miles south of Kimbers Well and 85 feet 4½ miles south-east of Kimbers Well, Williambury; the stratigraphical equivalent of the Quinnanie Shale has the same lithology as the Cundlego Formation east of the Kennedy Range and is therefore included in that formation.

Very few fossils have been found in the Quinnanie Shale on the Kennedy Range Sheet. Foraminifera, bryozoa and chonetids were noted.

The age of the Quinnanie Shale is Artinskian.

The Wandagee Formation (Condit, 1935; Teichert, 1950; Condon, 1954) is the formation of siltstone, quartz greywacke (some calcareous) and minor limestone, very fossiliferous in the lower part and sporadically fossiliferous in the upper part, that is conformable between the Quinnanie Shale or the Cundlego Formation and the Norton Greywacke.

On the Kennedy Range sheet, the Wandagee Formation is 800 feet thick 5 miles north of Paddys Outcamp, Middalya; 295 feet in Bore B.M.R. 6, Muderong; 280 feet in Bore B.M.R. 7, Muderong; 695 feet 4 miles south of the mouth of Norton Creek, 650 feet 3½ miles south-east of Kimbers Well, Williambury, 525 fee 9 miles west-south-west of Lyons River Homestead, 350 feet ¼ to 3

miles east of Walbarune Peak, 600 feet 10 miles north of east of Winnemia Woolshed and 750 feet 6½ miles east of Winnemia Woolshed. At the last locality (near Calvary Well) the Wandagee Formation is unconformably overlain by the Coolkilya Greywacke.

The rich fauna of the Wandagee Formation is still being studied by palaeontologists; it includes foraminifera - Ammobaculites, Ammodiscus, Hyperammina, Giraliarella, Proteonina, Reophax, Thurammina, Tolypammina, and Trochammina (Crespin, 1958) - bryozoa, Stenoporids, crinoid stem ossicles, Calceolispongia, brachiopods - spiriferids, productids, streptorhynchids, chonetids - pelecypods, gastropods including bellerophontids, Conularia.

The age of the Wandagee Formation is fairly definitely established as Artinskian (Teichert, 1941, 1944, 1946; Thomas and Dickins, 1954; Coleman, 1957) although no Fusulines have been found.

The Wandagee Formation may be correlated by fauna and to some extent by lithology with the Noonkanbah Formation of the Fitzroy Basin (Guppy et al, 1952).

The Norton Greywacke (Condon, 1954) is the formation of quartz greywacke conformably between the Wandagee Formation and the Baker Formation. Near Calvary Well, at the south-western end of Kennedy Range, the Coolkilya Greywacke is unconformable on the Norton Greywacke.

The type locality of the Norton Greywacke is 5 miles south-west of Kimbers Well, Williambury and 15 miles south-west of Moogooree Homestead.

The Norton Greywacke is 250 feet thick at Paddys Outcamp, Middalya; doubtfully present in B.M.R. 6, Muderong; 240 feet thick in Bore B.M.R. 7, Muderong; 235 feet at the type locality; 160 feet 7 miles south of the mouth of Norton Creek; 190 feet 3 miles south-east of Kimbers Well; 160 feet 9½ miles west of south of Merlinleigh; 140 feet 21 miles south of Merlinleigh; 173 feet 37 miles south of Merlinleigh, and 90 feet 10 miles north of east of Winnemia Woolshed.

Pelecypods and brachiopods are found in several beds near the bottom of the formation; several beds mainly containing brachiopods occur near the top. Fossils include brachiopods - chonetid, productid, spiriferid (including Strophalosia kimberleyensis, Etheridgina muirwoodae (Coleman, 1957) - pelecypods (including Oriocrassatella stokesi (Dickins, 1956), gastropods and Calceolispongia.

The age is upper Artinskian.

The Norton Greywacke may be stratigraphically equivalent to the Nalbia Greywacke (Teichert, 1950), but because 1. the exposure in the type locality of the Nalbia Greywacke is so poor as to obscure relationships with other formations, 2. Teichert's mapping of the "Nalbia Greywacke" in the Wandagee Hill area (Teichert, 1957) is not correct (e.g. the formation in the axial part of the Coolkilya Syncline is not 'Coolkilya' but Norton as it directly overlies the Wandagee Formation with its characteristic upper Strophalosia bed), 3. the Nalbia lithology is not present in the Minilya Syncline, and 4. the stratigraphical position of the Nalbia Greywacke is not certain, it is incorrect to extend it as a formation beyond its type locality.

The Norton Greywacke may be correlated with the upper part of the Noonkanbah Formation of the Fitzroy Basin.

The Baker Formation (Condon, 1954a) is the formation of siltstone and quartz greywacke conformable on the Norton Greywacke and disconformably overlain by the Coolkilya Greywacke. At the south end of Kennedy Range the Coolkilya Greywacke is unconformable on the Baker Formation.

The type locality is 6¼ miles south-south-west of Kimbers Well, Williambury and 15 miles south-west of Moogooree Homestead.

The Baker Formation is 70 feet thick 3½ miles south of Paddys Outcamp, Middalya; probably absent in Bore B.M.R. 6, Muderong; 310 feet in Bore B.M.R. 7, Muderong; 125 feet 7 miles south of the mouth of Norton Creek; 198 feet in the type locality; 121 feet 9 miles south of Merlinleigh; 90 feet 21 miles south of Merlinleigh, 85 feet 37 miles south of Merlinleigh and 140 feet 11 miles north of east of Winnemia Woolshed.

Fossils occurring sporadically in the Baker Formation include Brachiopods (spiriferid, chonetid and productid) and pectenid pelecypods.

The age of the Baker Formation is somewhat in doubt but as there appears to be significant differences in the fauna of the overlying Coolkilya Greywacke and as there is a minor unconformity between the Coolkilya Greywacke and the Baker Formation it is probable that the Baker Formation is upper Artinskian. It probably correlates with the top of the Noonkanbah Formation of the Fitzroy Basin.

The Kennedy Group (Raggatt, 1936; Condon, 1954a) is the sequence of predominantly arenaceous sediments disconformably overlying the Minilya Group and unconformably overlain by Cretaceous and Eocene sediments.

The Kennedy Group comprises the Coolkilya Greywacke, Mungadan Sandstone and Binthalya Formation.

The Kennedy Group is 2540 feet thick near Venny Peak; elsewhere an erosion surface cuts into the Group so that the sequence represented is less than near Venny Peak.

The Coolkilya Greywacke (Teichert, 1950; Condon, 1954) is the formation of quartz greywacke, some calcareous, disconformable on the Baker Formation and conformable with the Mungadan Sandstone. At the south-western end of the Kennedy Range the Coolkilya Greywacke is unconformable on the Baker Formation, Norton Greywacke and Wandagee Formation.

The reference section showing relationships and complete sequence is north and south of Southern Cross Bore, Middalya (Condon, 1954).

The Coolkilya Greywacke is 650 feet thick in the reference section; possible Coolkilya Greywacke is 280 feet (incomplete) in Bore B.M.R. 6, Muderong; Coolkilya Greywacke is 190 feet (incomplete) in Bore B.M.R. 7; 565 feet 15 miles south-south-east of the mouth of Norton Creek; about 450 feet along the eastern scarp of Kennedy Range; and 400 feet 7 miles north-north-east of Winnemia Woolshed.

There are many fossil beds in the Coolkilya Greywacke, most of which appear to be somewhat lenticular. Fossils found on the Kennedy Range sheet include foraminifera Hyperammina acicula (Crespin, 1958), bryozoa, Calceclispongia, brachiopods (chonetid, productid, spiriferid - including Aulosteges, Linoproductus cancriniformis (Coleman, 1957) - pelecypods including Nuculana, Parallelodon, Stutchburia, Astartila,

Atomodesma, Pseudomyalina, Undulomya, Schizodus, Oriocrassatella and Middalya (Dickins, 1956).

The age is generally regarded as Kungurian (Teichert, 1951; Thomas and Dickins, 1954; Dickins, 1956).

The Coolkilya Greywacke may be correlated with the lower part of the Liveringa Formation (Guppy et al., 1952) of the Fitzroy Basin.

The Mungadan Sandstone (Teichert, 1950; Condon, 1954a) is the formation of quartz sandstone conformable between the Coolkilya Greywacke and the Binthalya Formation.

In the Kennedy Range sheet area the Mungadan Sandstone is 70 feet thick one mile south of Southern Cross Bore, Middalya; 50 feet 10 miles west of Lyons River Homestead; 160 feet 6½ miles east-north-east of Winnemia Woolshed and 70 feet 2½ miles north-west of K-38.

No fossils have been found in the Mungadan Sandstone in the Kennedy Range area.

By reference to the Coolkilya Greywacke its age is Kungurian.

The Binthalya Formation (Condon, 1954) is the formation of quartz greywacke and quartz sandstone, with minor siltstone, conformably overlying the Mungadan Sandstone. It was termed 'Subgroup' by Condon but as the smaller units within it are not named the unit should be called 'Formation'.

As this is the uppermost Permian formation in the Carnarvon Basin, and as its maximum stratigraphic development is limited to a small area east of Venny Peak, the only thickness available is 1725 feet in the type locality east of Venny Peak.

The only fossils found are sparse spiriferids and pelecypods in the lower part of the formation.

The Binthalya Formation, because of its position above the Coolkilya Greywacke is not older than Kungurian. Because of its thickness, there is some possibility that it may range up into the Kazanian but there is no palaeontological evidence for or against this.

JURASSIC:

No outcrops of rocks of Jurassic age have been found on this sheet.

CRETACEOUS:

Cretaceous rocks crop out in an area running north-south across the middle of the sheet, and underlie the sand of the western part of the sheet. The Winning Group and the lowermost formation of the Cardabia Group are present.

The Winning Group (Raggatt, 1936; Condon, 1954; Johnstone et al, 1958) in this area comprises in ascending order the Birdrong Formation, Muderong Shale, Windalia Radiolarite and Gearle Siltstone.

The Birdrong Formation (Condon, 1954) is the formation of quartz sandstone (some glauconitic), quartz greywacke and siltstone resting unconformably on Permian rocks and conformably overlain by Muderong Shale.

The type locality is 0.6 mile south-west of Birdrong Spring which is 21½ miles north of east of Hill Springs Homestead.

The Birdrong Formation is very variable in thickness: it is 97 feet thick in the type locality and elsewhere on the sheet ranges from 5 feet (25 miles east of Mardathuna Homestead) to 105 feet (19 miles east of Mardathuna). The thickness variation is related to irregularities in the surface of the Permian rocks on which the Birdrong Formation was deposited.

Only fossil wood has been found in the formation on this sheet. By reference to the overlying Muderong Shale, the age of the Birdrong Formation is probably Aptian or Neocomian.

The Birdrong Formation is probably stratigraphically equivalent to the upper part of the Blythesdale Sandstone of Queensland.

The Muderong Shale (Condon, 1954) is the formation of bentonitic shale, claystone and siltstone conformable between the Birdrong Formation and the Windalia Radiolarite.

The type locality is one mile south-west of Muderong Bore, Middalya Station.

The Muderong Shale ranges from 3 feet to 50 feet thick in the area west of Kennedy Range.

Foraminifera and radiolaria have been identified in Muderong Shale in this area.

Edgell (in Condon, 1954a) regarded the foraminifera as indicating Albian to Cenomanian age but Crespin and Glaessner (in McWhae et al, 1958) regard the age as Aptian and Cookson and Eisenack (1958) described Aptian microplankton from bores in the formation.

The Windalia Radiolarite (Condon, 1954; Condon et al, 1956) consists of radiolarite, sandy radiolarite, and chert, conformably between the Muderong Shale and the Gearle Siltstone.

On the Kennedy Range sheet the junction with the Gearle Siltstone is not exposed. Exposed thickness of the Windalia Radiolarite ranges from 50 to 144 feet in the area west of Kennedy Range.

The Windalia Radiolarite contains many radiolaria, and few foraminifera, ammonites, pelecypods, ostracods and belemnites.

The formation was regarded by Brunnschweiler (in Condon, 1954) as of Albian to Cenomanian age. Glaessner (in McWhae et al, 1958) indicates a lower Albian to Aptian age and Brunnschweiler (1959) agrees with this.

The Gearle Siltstone (Condon 1954; Condon et al, 1956) consists of bentonitic siltstone and claystone, conformable on the Windalia Radiolarite and disconformable beneath the Korojon Calcarenite.

The Gearle Siltstone is very poorly exposed in the Kennedy Range area; on the basis of the separation of the outcrops of the Windalia Radiolarite and the Korojon Calcarenite the formation is about 300 feet thick.

No fossils have been found in the sheet area; in coastal bores the age (McWhae et al, 1958) is regarded as Albian to Turonian.

The Korojon Calcarenite (Condon, 1954; Condon et al, 1956) is the only formation of the Cardabia Group cropping out in the sheet area. It consists of calcarenite and calcilutite, disconformable on the Gearle Siltstone. It is overlain unconformably by the Eocene Merlinleigh Sandstone.

It is poorly exposed in the plain to the west of Kennedy Range. Its thickness there is about 200 feet.

Only Inoceramus fragments have been recognized in this area. In the coastal area the formation is very fossiliferous. Its age is Campanian to lower Maestrichtian (Belford in McWhae et al, 1958).

TERTIARY

The only Tertiary rocks known in the sheet area are Eocene and possibly Upper Tertiary.

EOCENE

The Merlinleigh Sandstone (Teichert, 1950) consists of quartz sandstone with minor conglomerate and siltstone unconformably overlying Permian and Cretaceous formations.

The type locality is one mile east-south-east of Merlinleigh Homestead.

In the Kennedy Range area the Merlinleigh Sandstone ranges in thickness from 10 feet to 55 feet. Its surface is commonly lateritized.

Fossils occur sporadically: they include Aturia clarkei, corals, small pelecypods, fossil wood with boring molluscs.

The Merlinleigh Sandstone is probably of Middle Eocene age (Glaessner, 1955; Brunnschweiler, Dickins and Crespin in Condon, 1955) and correlates with the coastal Giralia Calcarenite.

UPPER TERTIARY

Laterite

Laterite (in the sense of the profile of lateritization) is widespread in the sheet area.

It is developed on rocks ranging from Precambrian to Eocene. Eight miles west of Moogooree Homestead, laterite is developed on Permian Mallens Greywacke beneath Merlinleigh Sandstone which is also lateritized. Near Merlinleigh Homestead the Permian Wandagee Formation is lateritized beneath the Merlinleigh Formation which is also lateritized. The surface of the Permian Coolkilya Greywacke beneath the Cretaceous Birdrong Formation west of Kennedy Range is lateritized in places. The surface of the Callytharra Formation beneath the Moogooloo Sandstone is strongly ferruginized, silicified and leached (i.e. lateritized). The surface of the Yindagindy Formation beneath the Coyango Greywacke is lateritized.

There is thus evidence of lateritization in the intervals between Lower Carboniferous and Lower Permian, between Callytharra Formation and Moogooloo Sandstone, between Permian and Lower Cretaceous, between Permian and Eocene, and

post-Eocene. Thus, although the laterite on this sheet is symbolized as Tul, Upper Tertiary is regarded as only the youngest likely age of the well-developed laterite. Some of the exposed laterite surfaces may have been covered by Cretaceous or Eocene sediments that have been stripped off.

Billy

Billy, the hard pale-grey chalcedonic quartzite with or without quartz grains and pebbles, is developed in some places near the top of the laterite profile. It is most common in profiles developed in sandstone but occurs also above siltstone, especially the siltstone of the Lyons Group.

As it is such a distinctive rock type, it has been mapped separately. It is also, apparently, more restricted in age than the laterite generally as it has been observed only on the Tertiary surface and not on any of the pre-Tertiary unconformities.

The Nadarra Formation (Condon, in McWhae et al, 1958) consists of silicified limestone, chert, limestone, siltstone and sandstone with detrital limonitic pisolites.

In this sheet area only a small outcrop was recognized in the area 25½ miles east of Mardathuna Homestead where there is a thickness of 20 feet of chalcedonic limestone overlying Windalia Radiolarite.

No fossils have been found in the Nadarra Formation.

The only evidence of its age is its relationship to the lateritized surface. As it is always found in low areas of the lateritized surface that have been deeply dissected by recent stream action, the Nadarra Formation is probably slightly younger than the lateritization. As the Middle Eocene Merlinleigh Sandstone is strongly lateritized the Nadarra Formation is younger than Eocene. An Upper Tertiary age is tentatively given to the Nadarra Formation although it may be somewhat younger.

QUATERNARY

Deposits probably of Quaternary age cover large areas of the sheet. There has been no palaeontological age determination of these deposits; their relative ages have been determined by mutual relationships and by their relationships to the geomorphology.

? PLEISTOCENE

The Joolabroo Formation (Condon, 1954a) is a fluviatile deposit of gravel, sand, silt and travertine mainly on terraces related to the present stream system.

No fossils have been found in the formation; its tentative Pleistocene age is indicated by its physiographic position - deposited on the flat floor of wide valleys cut in the ?Upper Tertiary lateritized surface, and dissected by the present streams the beds of which are about 15 to 30 feet below the base of the Joolabroo Formation.

The red Sand of both the high-level plain and the low-level plain was probably developed as the surface zone of the laterite profile. At some time since the development it has been moved by wind action during an arid period into seif dunes. The most likely period for this aridity is during the Pleistocene glaciation when the ice advances of the northern hemisphere were accompanied by relatively dry conditions elsewhere.

RECENT

Recent deposits are mainly the superficial soils still in process of formation or deposition.

Travertine is formed at the surface of calcareous formations such as the Korojon Calcarenite, probably by deposition of calcium carbonate in the residual soil.

Residual Soil is developed from outcropping rock where the surface is flat or very gently sloping. It is common on the outcrop of the Lyons Group, Gneudna Formation and Gearle Siltstone but has been mapped only where there is no exposure of the underlying formation.

Alluvium covers the flood plains of rivers and smaller streams and on this sheet includes the upstream part of the deltaic flood plain of the Gascoyne River. The alluvium is dominantly arenaceous with layers of gravel and silt.

The sediment covering the clay pans has been mapped as alluvium although it is only in part a stream deposit.

Wash is the thin veneer of alluvial gravel, sand and clay over bedrock. It covers large areas, particularly at the base of scarps and in areas of sheet flow. Commonly small areas of outcrop are exposed through the wash.

Pale brown quartz Sand covers a fairly large area of the plain east of the east scarp of the Kennedy Range. It is in part a piedmont apron against this scarp and was deposited by streams draining the Kennedy Range.

STRUCTURE

The main structural elements of the Sheet area are shown in Figure I. The contours of the Bouguer gravity anomalies, from a Bureau of Mineral Resources unpublished map No. G. 98-38, are also shown.

The Precambrian schist trends generally east-west. Steep north and south dips have been measured but fold axes have not been established. Granite intrusive into the schist, is known only at the far north of the Sheet. The only indication of major faulting is in the north-eastern corner of the sheet where a strong north-south dyke separates east-west trends (to the west) from northward trends (on the east). Dykes of quartz appear mainly to follow the trends of the schist foliation although some are oblique to the trends. Dykes of basic rock have two main trends - east of north and north of east. The topography of the surface of the Precambrian rocks beneath the Palaeozoic sediments appears to be related more to the directions of these basic dykes than to the trend of the schist.

The regional dip of the Palaeozoic and Mesozoic sediments is westward at angles ranging from about 40° in the Devonian to less than 1° in the Cretaceous. The Eocene sediments are sub-horizontal.

The regional dip is interrupted by several synclines associated with angle of rest unconformities (Condon, 1956).

The gravity survey by Bureau of Mineral Resources (Chamberlain, Dooley and Vale, 1954), a later seismic reflection survey in the Wandagee Hill area, Minilya 4-mile sheet (Condon, 1955), geological work in the Murchison River area and the results of WAPET's YANREY No. 1 bore indicate

that the Carnarvon Basin is divided into smaller structural basins by ridges of Precambrian basement. On the Kennedy Range sheet the Wandagee Ridge separates the Gascoyne Basin from the Merlinleigh Basin, and the Weedarra Ridge (including outcropping Precambrian rocks in inliers) separates the Merlinleigh from the Bidgemia Basin.

The gravity map (Fig. 1) indicates that the axis of the Merlinleigh Basin may run north-west and east of south from Merlinleigh Homestead. The axis of the Gascoyne Basin appears to run north-south near the western margin of the sheet.

ECONOMIC GEOLOGY

WATER. The only mineral of economic importance produced in the Kennedy Range sheet area is the underground water on which the pastoral industry largely depends. Although good stock water is obtained from springs, wells and bores in many parts of the area, available underground water can be developed much more than it has been to date. In much of the western part of the sheet large supplies of very good stock water are available in the Birdrong Formation at approximate depths indicated in Figure 2. Some drillers have been daunted by the "black-jack" - the dark shale of the Winning Group - from continuing drilling in this area but it is necessary to drill through this to reach the Birdrong Formation aquifer. It is likely that artesian water (rising to the surface) will be encountered in the aquifer west of the line indicated from Manberry to about 4 miles west of Winnemia Woolshed.

East of the area underlain by the Birdrong aquifer, ground water is contained in the more permeable Palaeozoic formations, the outcrop and dip of which are indicated in Fig. 2. These formations are the Munabia Sandstone (good water and supply, e.g. Redhill Well, Moogooree Station), Austin Formation (e.g. Gap Well, Moogooree), Coyango Greywacke (e.g. Bores and wells along Woodcock and Austins Creeks, Mt. Sandiman) and Koomberan Greywacke (e.g. Millers Bore, Mt. Sandiman Station) (some good stock water, generally small supplies), Moogooloo Sandstone (good water and supply e.g. Tabletop Well, Lyons River Station), Mallens Greywacke (good stock water, fair supply, e.g. Binthabooka Bore, Mt. Sandiman Station) and Norton Greywacke (stock water, small to good supplies, e.g. Muderong Bores, Middalya Station).

In the Precambrian rocks water can be obtained in alluvium in the larger stream valleys (e.g. 7-mile Well, Moogooree) and in quartz reefs particularly where they cross stream courses. Elsewhere any water obtained is commonly too saline for stock water.

In the area of alluvium west to north-west of Doorawarrah Homestead good to small supply of good water can be obtained at depths of 50 to 100 feet.

The following rocks and minerals of possible future economic significance have been found: limestone (for road surfacing, concrete aggregate, cement and lime manufacture, agricultural lime) in the Callytharra Formation extending from 8 miles west-north-west of Moogooree Homestead to the Arthur River at the south-east corner of the sheet, in the Moogooree Limestone from 4 miles north to 9 miles east of south of Moogooree Homestead, and in the Gneudna Formation from 4 miles north-north-east of Moogooree to 4 miles north of Mt. Sandiman Homestead; friable limestone (for cement and lime manufacture and agricultural lime) in the Callytharra and Gneudna For-

mations as above and in the Korojon Calcarenite from 10 miles east of Manberry Homestead to Rocky Pool on the Gascoyne River and from 8½ miles north of Hill Springs Homestead to 11½ miles west of Binthalya Homestead (covered intermittently by travertine and sand); gypsum and possibly other evaporites in the Bulgadoo Shale on Mt. Sandiman, Lyons River and Bidgemia stations; bentonitic shale in the Gearle Siltstone and Muderong Shale from 13 miles east of Manberry to 6 miles east of Hill Springs Homestead (mainly covered by thin Quaternary deposits); radiolarite (for filtration, insulation and fine abrasive) in the Windalia Radiolarite from 15 miles east of Manberry to 2 miles north-west of Paddys Outcamp and southward to 2½ to 8 miles east of Binthalya Homestead; shale (for brick-making, portland cement manufacture) in the Gearle Siltstone and Muderong Shale, the Baker, Wandagee and Newman Formations and Bulgadoo Shale, the Weedarra Shale, the Mundarie and Dumbardo Siltstone and the Austin Formation.

The following have not been found in the area but geological evidence suggests that they may be found:-

Salt. The presence of outcropping evaporite gypsum in the Bulgadoo Shale and of brine in bores in Wandagee Formation in the west part of Lyons River station suggest the possibility of evaporite salt deposits in these formations below the water table.

Petroleum. The outcropping Palaeozoic sequence is about 14,000 feet thick, of which about 5,000 feet is of petroleum source-bed type or likely to pass into that type. Formations of permeability adequate for reservoirs and with impermeable formations overlying them include Nannyarra Greywacke, Munabia Sandstone, Austin Formation, Coyango Greywacke, Koomboran Greywacke, Moogooloo Sandstone, Mallens Greywacke, Norton Greywacke and Birdrong Formation. The only large structure probably of anticlinal form is the Wandagee Ridge where pre-Permian sediments may be present covered by Lyons Group sediments. The Permian sediments probably wedge out against the east side of this ridge and may form stratigraphic traps there. There may be traps along the depositional unconformities to the west of Kennedy Range and there is some indication of an anticline or terrace in the Birdrong Sandstone between Hill Springs and Doorawarrah.

The presence of stromatoporoids and corals in the outcropping Devonian indicate a possibility of Devonian reef development on the Wandagee Ridge.

No metalliferous minerals have been reported from the Precambrian rocks of this sheet, although they are found to the east at Yinnietharra (Mt. Phillips sheet). As the rocks are schistose with quartz reefs and basic dykes, there is some possibility of metallic minerals occurring.

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TABLE I.

ROCK UNITS OF THE KENNEDY RANGE FOUR-MILE SHEET

AGE	ROCK UNIT GROUP	FORMATION (SYMBOL)	LITHOLOGY	FOSSILS	THICKNESS (FEET) NORTH	CENTRE	SOUTH	TOPOGRAPHY	AIR PHOTO PATTERN	ECONOMIC GEOLOGY	REMARKS
RECENT		Alluvium (Qra)	Sand, silt, gravel, clay.	Land snails, plants.	15-20	15-30	5-100	Flood plain	General dark band along drainage. Gascoyne delta: light coarse grained pattern with dark spots and dark anastomosing bands.	Ground water 20 to 100 ft. depth. Possible agricultural soils.	Clay pans are included.
		Wash (Qrw)	Gravel, sand.	Land snails.	1-10	1-20	1-20	Scree slopes and erosion plains.	Very light coarse grained with fine dark lines anastomosing.	Gravel for road surfacing.	
		Residual Soil (Qrr)	Clay, some sand.	Derived fossils from underlying formation.	1-10	1-10	1-10	Flat, or very gently sloping or undulating.	Fine grained pattern; commonly medium tone.	Possible agricultural soils.	
		Travertine (Qrt)	Travertine, lime clay.	-	1-10	1-10	1-10	Undulating.	Speckled (fine grain with small dark spots) medium to moderately dark tone.		Developed over calcareous formations.
		Sand (Qrs)	Yellow sand.	-	5-20	5-20	5-20	Generally flat, small undulations small clay pans.	Fine grain; medium tone.		Difficult to separate from Qps.
PLEISTOCENE		Sand (Qps)	Red sand	-	5-50	5-50	5-30	Generally flat with seif dunes or small undulations. Clay pans.	Fine grain; medium tone with ovoid areas, small to large, of smooth tone.	Small supplies of good water in dunes.	Probably mainly derived from the A-horizon of the laterite profile; re-arranged by wind action.
		Joolabroo Formation (Qpj)	Bedded sand, gravel, travertine, silty sand.	-	30	10	20	Flat, capping minor interfluves near main streams.	Fine grain; light tone; close dissection pattern at edges.		Flood plain deposits of an earlier stage of development of the rivers.
UPPER TERTIARY		Nadarra Formation (Tun)	Bedded pale grey chalcedonic limestone.	-	-	20	-	Mesa cap		-	Only one small outcrop seen on this sheet.
		Billy (Tub)	Hard pale grey chalcedonic quartzite, commonly with sand grains and quartz pebbles	-	1-5	1-10	1-5	Flat, capping mesas.	Medium pattern; medium to light tone.		Developed near surface of laterite profile.
		Laterite (Tul)	Hard pisolitic ferruginous laterite at surface overlying mottled zone and pallid zone	-	10-30	10-50	10-30	Flat to gently undulating.	Fine pattern; medium-dark tone.	Gravel for road surfacing.	No bauxite has been found but could be present over shaly formations.

AGE	ROCK UNIT GROUP	ROCK UNIT FORMATION SYMBOL	LITHOLOGY	FOSSILS	THICKNESS (FEET) NORTH	THICKNESS (FEET) CENTRE	THICKNESS (FEET) SOUTH	TOPOGRAPHY	AIR PHOTO PATTERN	ECONOMIC GEOLOGY	REMARKS
EOCENE		Merlinleigh Sandstone (Tem)	Quartz sandstone minor siltstone and conglomer-	Aturia, corals, gastropods, wood.	5-20	5-50	5-20	Flat, capping mesas.	Fine pattern, medium-dark tone.	-	Invariably lateritized.
CRETACEOUS	CARDABIA	Korojon Calcarenite (Kuk)	Calcarenite calcilutite.	Inoceramus	?200	?200	?200	Low undulating hills with small scarp on east side in places.	Smooth grain, light to very light tone.	Possible source of agricultural lime and Portland cement.	Exposure very poor.
	WINNING (Kl)	Gearle Siltstone (Klg)	Bentonitic siltstone and shale	Foraminifera, belemnites, radiolaria.	?300	?300	?300	Low crab-holey plain.	Smooth, moderately dark.	Possible source of bentonite, brick clay.	Exposure very poor
		Windalia Radiolarite (Klw)	Bedded to laminated radiolarite.	Radiolaria belemnites, pelecypods, ammonites.	50 to 100	50 to 144	30 to 100	Caps mesas and buttes and forms closely dissected undulating low hills.	Smooth, medium to light tone.	Possible source of material for filtration, insulation.	Commonly lat-itized(leached and silicified).
		Muderong Shale (Klm)	Laminated bentonitic shale.	Foraminifera	10 to 50	5 to 40	3 to 30	Generally near base of scarp of Windalia Radiolarite.	-	Possible source of brick clay and bentonite. Cap rock for artesian water, and suitable cap for oil accumulation.	Generally poorly exposed.
		Birdrong Formation (Klb)	Sandstone, some glauconitic siltstone, quartz greywacke, conglomerate.	Wood, spores.	10 to 50	5 to 105	10 to 70	At base of scarp or undulating.	Coarse pattern, medium tone.	Aquifer, artesian at depth; possible reservoir bed for oil. Doubtful structure between Hill Springs & Doorawarrah.	Contained oil in Wapet's Rough Range Bore No. 1.
PERMIAN	KENNEDY	Binthalya Formation (Pkb)	Quartz greywacke, quartz sandstone, minor siltstone.	Few pelecypods	-	1725	-	Strongly dissected west side of Kennedy Range.	Contour line pattern in valleys (smooth light and medium-dark fine bands). Fine grained medium tone on interfluves.	-	Crops out only in Kennedy Range.
		Mungadan Sandstone (Pkm)	Quartz sandstone fine quartz conglomerate.	Few pelecypods	70	50	70 to 160	Commonly capping scarp of Kennedy Range.	Smooth, light to very light tone.	Ground water.	ditto.
		Coolkilya Greywacke	Quartz greywacke, calcareous beds.	Brachiopods	565 to 650	450	400	Kennedy Range scarp. Rounded hills.	Smooth, dark tone.	-	

AGE	ROCK UNIT GROUP	FORMATION (SYMBOL)	LITHOLOGY	FOSSILS	THICKNESS (FEET) NORTH	CENTRE	SOUTH	TOPOGRAPHY	AIR PHOTO PATTERN	ECONOMIC GEOLOGY	REMARKS
PERMIAN	MINILYA (new name)	Baker Formation (Pak)	Dark siltstone and laminated quartz greywacke	Chonetid brachiopod, foraminifera.	70 to 198	90 to 120	85 to 140	Plain with crabholes.	Smooth, light tone.	Source of brick clay. Oil source bed and possible cap rock.	
		Norton Greywacke (Pan)	Thin bedded quartz greywacke.	Brachiopods, pelecypods, goniatites.	160 to 250	140 to 160	90 to 173	Rounded strike ridge.	Smooth, dark tone.	Possible oil reservoir bed. Aquifer (stock water, variable supply).	
		Wandagee Formation (Pag)	Dark siltstone, quartz greywacke, calcareous beds.	Brachiopods Calceolispongia Foraminifera Pelecypods, etc.	650 to 800	525	350 to 750	Plain with very low strike ridges.	Smooth, banded in places, light to medium tone.	Source beds for oil. Possible brick clays. Possible evaporite salts.	
		Quinnanie Shale (Paq)	Dark shale and siltstone, quartz greywacke.	-	85 to 125	-	-	Plain	Smooth, light tone.	Source beds for oil. Brick clay.	Grades laterally (southward) into upper part of Cundlego Formation.
		Cundlego Formation (Pau)	Laminated quartz greywacke and siltstone.	Brachiopods Calceolispongia	975 to 1040	365 to 445	560	Plain with very low strike ridges.	Smooth, banded light and dark tone.		
	BYRO	Bulgadoo Shale (Pab)	Dark shale and siltstone minor quartz greywacke. Evaporite gypsum.	Brachiopods Foraminifera Ostracods.	520 to 626	245 to 400	260	Plain	Smooth, light tone.	Source beds for oil. Possible source of brick clay. Possible evaporite salts.	
		Mallens Greywacke (Pam)	Thin bedded quartz greywacke	Pelecypods Brachiopods	517	420 to 600	600	Sandy plain, rounded low hills.	Medium grain, medium tone.	Aquifer (good stock water, good supply). Possible reservoir bed for oil.	
		Newman Formation (Paj)	Dark siltstone, quartz greywacke.	Foraminifera, brachiopods, pelecypods, goniatites, Gangamopteris	470 to 643	330 to 400	420	Plain	Smooth	Oil source beds. Possible brick clay.	New name (upper part of Coyrie Formation).
	WOORAMEL	Billidee Formation (Pae)	Quartz greywacke, dark siltstone.	Wood, foraminifera.	185 to 242	400	255 to 310	Strike ridge.	Smooth, dark tone.		New name (Lower part of Coyrie Formation).
		Moogooloo Sandstone (Paw)	Quartz sandstone.	-	250	150 to 160	30 to 170	Strike ridge.	Medium grain medium to light tone.	Aquifer (good) water, good supply); possible reservoir bed for oil.	Previously (Condon, 1954) called Wooramel Sandstone.
		Callytharra Formation (Pac)	Calcarenite, calcilutite quartz greywacke.	Crinoids, brachiopods, bryozoa, foraminifera.	412	412	210 to 355	Strike ridge.	Smooth, dark tone.	Limestone for road and concrete aggregate and possibly for lime and portland cement. Some source beds for oil.	

AGE	ROCK UNIT GROUP	FORMATION (SYMBOL)	LITHOLOGY	FOSSILS	THICKNESS (FEET) NORTH	CENTRE	SOUTH	TOPOGRAPHY	AIR PHOTO PATTERN	ECONOMIC GEOLOGY	REMARKS
PERMIAN		Weedarra Shale (Psw)	Sandy shale, tillitic siltstone, quartz greywacke member, boulder beds	Brachiopods bryozoa, pelecypods crinoids	800		480	Plain	Smooth light tone.	Brick clay;water in quartz grey-wacke member.	New name.
	LYONS PsL	Thambrong Formation (Pst)	Siltstone, quartz greywacke, tillite, limestone.	Brachiopods, Bryozoa Crinoids	500	700	350	Plain	Smooth, light tone.		New name.
		Mundarie Siltstone (Psm)	Tillitic siltstone, tillite.	Brachiopods, pelecypods, bryozoa, Calceolispongia.	420 to 610	430	475 to 700	Plain or low strike ridge.	Smooth, moderately dark tone.		New name.
		Koomberar Greywacke (Psk)	Quartz greywacke, tillite.	Brachiopods, pelecypods, bryozoa.	200 to 450	415	200 to 700	Plain, low hills.	Smooth, light to medium tone.	Aquifer, stock water, variable supply.	New name.
		Dumbardo Siltstone (Psd)	Tillitic siltstone, tillite.	Brachiopods, pelecypods, bryozoa.	1100	600	850	Plain, low strike ridge.	Smooth, moder-ately dark tone.		New name.
		Coyango Greywacke (Psc)	Quartzy greywacke, tillite.	Lepidodendron Brachiopods bryozoa	1330	1900	510	Plain, low hills.	Smooth, light to medium tone.	Aquifer, stock water, variable supply.	New name.
		Austin Formation (Psa)	Quartz greywacke, siltstone, tillite.		-	1240	-	Strike ridge.	Smooth moderately dark tone.	Aquifer, stock water.	New name.
CARBONIFEROUS		Yindagindy Formation (Cly)	Calcilutite, quartz greywacke.	Brachiopods, ostracods.	100 to 120	-	-	Strike ridge.	Smooth, finely banded light and medium tone.		
		Williambury Formation (Clw)	Quartz greywacke, conglomerate, siltstone.		?200	-	-	Strike valley.	-		Very poorly exposed.
		Moogooree Limestone (Clm)	Calcilutite, calcarenite.	Brachiopods, corals, pele-cypods.	820 to 1000	-	-	Rounded strike ridge.	Medium pattern, medium tone.	Limestone for aggregate, lime & portland cement.	
DEVONIAN		Willaraddie Formation (Duw)	Quartz greywacke, conglomerate.		500	-	-	Flat-topped strike ridge.	Medium pattern finely banded medium tone.		
		Munabia Sandstone (Dum)	Quartz sandstone, minor siltstone.		1200 to 4450	0 to 900	-	ditto.	ditto. with dark bands.	Aquifer. Possible oil reservoir bed.	
		Gneudna Formation (Dug)	Calcarenite, quartz greywacke, sandstone, calcilutite.	Brachiopods, nautiloids, corals, stromatopor-oids.	980 to 1900	0 to 900		Plain.	Smooth, finely banded medium tone.	Some source beds.	
		Nannyarra Greywacke (Dmn)	Quartz greywacke.	-	0 to 200	0 to 200	-	Strike ridge.	Smooth, dark tone.		
PRECAMBRIAN		(pC)	Granitic rocks.					Mature dissection undulating.	Fine grained, medium to moderately dark tone.	Possibly some metallic minerals.	Not mapped. (Photo-interpreted only).
		(pCs)	Schist (biotite, hornblende, sericite, quartz, etc.)								

24°

EASTERN LIMIT OF OUTCROP OF CRETACEOUS ROCKS

WANDAGEE RIDGE

MERLINLEIGH BASIN

GASCOYNE BASIN

BIDGEMIA BASIN

WEEDARRA RIDGE

-20 -10 -15 -20 -15 -5 -10 -15 -20 -25 -55 -50 -45 -40 -35 -30 -25 -20 -15 -40 -35 -30 -25 -20 0 -5 -20 -25

25°

114°00 115°00 115°30'

REFERENCE

- Basement ridge
- Unconformity
- Anticline, showing plunge
- Syncline, showing plunge
- 4Y Regional dip
- Depositional unconformity
- Trends in Precambrian
- -20- Bouguer Anomaly Contours - interval 5 milligal: adapted from drawing No G98-38, B.M.R. (unpublished).

SCALE

16 0 16 32 48 64 miles

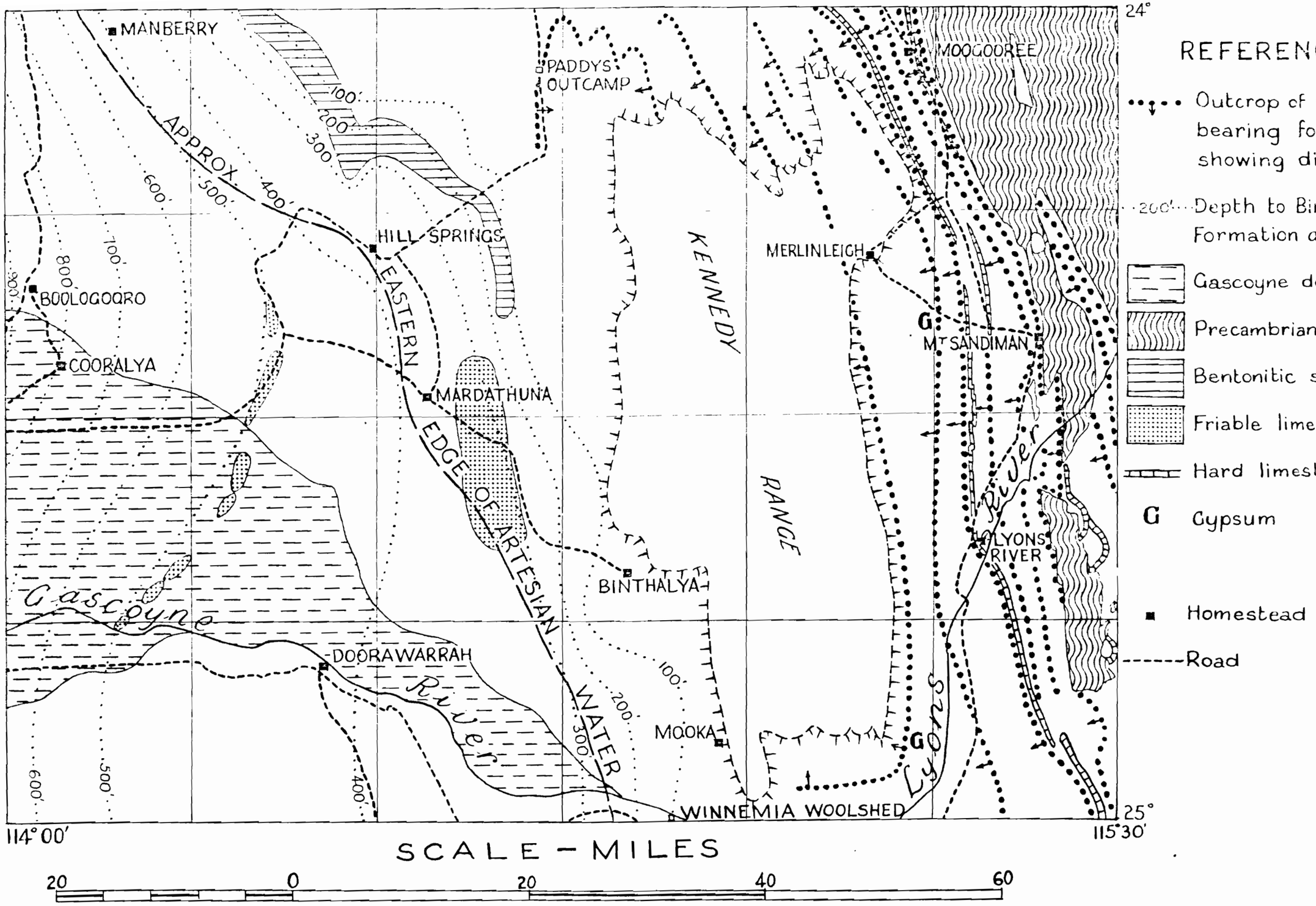
A REDUCE AB (15·0") to AC (7·5")

C

B

M. A. CONDON

PLATE 1



A	C	B
REDUCE AB (15·0") to AC (7·5")		M. A. CONDON

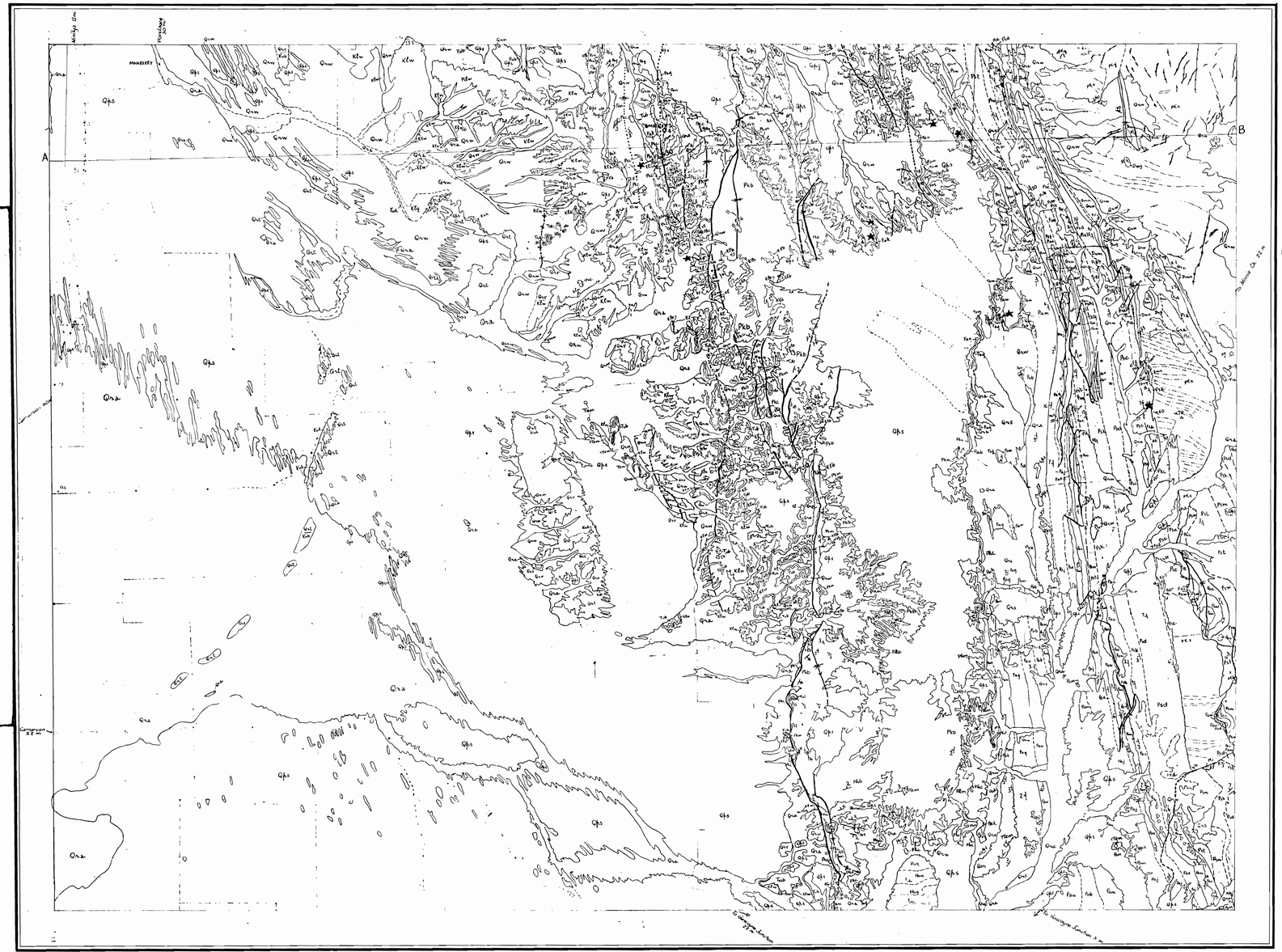
KENNEDY RANGE

AUSTRALIA 1:253,440 — WESTERN AUSTRALIA — 4 MILE GEOLOGICAL SERIES SHEET G50-1 — FIRST EDITION 1958

~~Reference~~

Reference

- Established geological boundary, position accurate
- " " " approximate
- Inferred boundary
- Strike and dip of strata
- Horizontal strata
- Dip < 15° } Air-photo interpretation
- Trend lines }
- Established anticlinal crest, position accurate, showing plunge
- " " " approximate.
- synclinal trough, position accurate
- " " approximate
- " " , concealed
- Monocline, concealed.
- Inferred fault
- Depositional unconformity, positions accurate, showing dip
- " " " approximate
- " " , concealed
- Strike and dip of 'foliation'.
- Dyke
- Sand dune
- Significant small outcrop
- Macrofossil locality
- Plant fossil "
- Type section
- Highway
- Road
- Vehicle track
- Fence
- Station boundary
- Telephone line
- Telephone line along fence
- Coorallya — Station name
- "Mandenga" — Homestead
- Outcamp
- Landing ground
- Stratigraphic boree
- Bore
- Well
- Spring
- Pool
- Windpump
- △1213 Trigonometrical station } height in feet
- · 320 Spot height



Reference

AGE	ROCK UNIT		LITHOLOGY
RECENT		Qta	Alluvium - sand, gravel, silt
		Qtw	Wash - sand, gravel
		Qtr	Residual soil, clay
		Qst	Travertine
		Qds	Brown sand
		Qhs	Red sand
PLEISTOCENE	Joolabroo Formation	Qhj	Sand, gravel, travertine (old river deposits)
		2b	
?UPPER TERTIARY	Nadarra Formation	Tsn	Limestone, chert
		Tub	Bitty- opaline sandstone & conglomerate.
		Tul	Laterite- pisolitic ironstone, leached rock
		1&b	
EOCENE	Merlinleigh Sandstone	Tem	Sandstone, siltstone, marine fossils
	Unconformity 2b		
UPPER CRETACEOUS	Korojon Calcarenite	Kuk	Soft white calcarenite and calcilutite
	Disconformity 1&b		
LOWER CRETACEOUS — WINNING GROUP	Gearle Siltstone	Klg	Soft grey bentonitic siltstone
	Windalia Radiolarite	Klw	Bedded white radiolarite, opalite
	Muderong Shale	Klm	Soft grey bentonitic shale; marine microfossils
	Birdrong Formation	Klb	Sandstone, some glauconitic, and siltstone, plant fossils
	Unconformity 2b		
PERMIAN — KUNGURIAN — KENNEDY GROUP	Binthalya Formation	Pkb	Sandstone, quartz greywacke, siltstone; few marine fossils
	Mungadan Sandstone	Pkm	Quartz sandstone, few marine fossils
	Coolkilya Greywacke	Pkc	Quartz greywacke, some calcareous, marine fossils
	Unconformity or Disconformity 1&b		
ARTINSKIAN — MINILYA GROUP	Baker Formation	Pak	Micaceous siltstone, quartz greywacke; marine fossils
	Norton Greywacke	Pan	Quartz greywacke, some calcareous; marine fossils
	Wandagee Formation	Pag	Fossiliferous siltstone & quartz greywacke
	Quinnanie Shale	Paq	Carbonaceous shale; marine fossils
	Cundlego Formation	Pau	Quartz greywacke (calcareous) & siltstone; fossils
	+ DISCONFORMITY 1b		
ARTINSKIAN — CARNARVON BASIN GROUP	Bulgadoo Shale	Pab	Carbonaceous shale, evaporites; marine fossils
	Mallens Greywacke	Pam	Quartz greywacke; marine fossils
	Newman Formation	Paj	Fossiliferous siltstone & quartz greywacke
	Billidee Formation	Pae	Quartz greywacke & siltstone, marine & plant fossils
	Meogoolee Sandstone	Paw	Quartz sandstone
	Unconformity 1b		
	Callytharra Formation	Pac	Fossiliferous calcarenite, calcilutite, quartz greywacke & siltstone
	Unconformity 1&b		
SAKMARIAN — LYONS GROUP	Thambrong Formation	Pbt	Quartz greywacke, siltstone, marine tillite; marine fossils
	Mundarie Siltstone	Pam	Tillitic siltstone, marine tillite; marine fossils
	Koomberan Greywacke	Pak	Quartz greywacke, marine tillite; marine fossils
	Dumbardo Siltstone	Psd	Tillitic siltstone, boulder beds; marine fossils
	Coyango Greywacke	Psc	Quartz greywacke, boulder beds, minor siltstone
	Austin Formation	Psa	Tillitic quartz greywacke & siltstone, boulder beds
	Wecdarra Shale	Psw	Shale, tillitic siltstone, quartz greywacke, boulder beds.
	Unconformity 2b		
LOWER CARBONIFEROUS	Yindagindy Formation	Cly	Quartz greywacke & fossiliferous oolitic limestone
	Williambury Formation	Clw	Pebbly quartz greywacke
	Moogooree Limestone	Clm	Siliceous calcarenite, calcilutite, sandstone, fossils
	Disconformity 2b		
UPPER DEVONIAN	Willaraddie Formation	Duw	Pebbly quartz greywacke, siltstone, minor limestone
	Munabia Sandstone	Dum	Quartz sandstone
	Gneudna Formation	Dug	Calcarenite, quartz greywacke, calcilutite, marine fossils
	1&b		
MIDDLE? DEVONIAN	Nannyarra Greywacke	Dmn	Quartz greywacke, quartz sandstone, siltstone
	2b		
PRECAMBRIAN		pCg	Granitic rocks
		b	
		pCs	Schist (Biotite; Quartz; Sericite, Talc; Hornblende)

[bi indicate legend spacing]

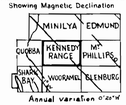
Names Minilya + Byro Groups still to be approved by Federal Secretary S-N-C. 21/1/60

Compiled and published by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development. Topographic base compiled by Division of National Mapping and Department of Lands and Surveys, Western Australia.

Transverse Mercator Projection.

INDEX TO ADJOINING SHEETS

Showing Magnetic Declination



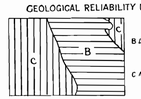
Annual variation 0°49'W

Scale
4 Miles to 1 inch

4 0 4 8 12 16 Miles

6 0 6 12 18 20 Kilometres

GEOLOGICAL RELIABILITY DIAGRAM



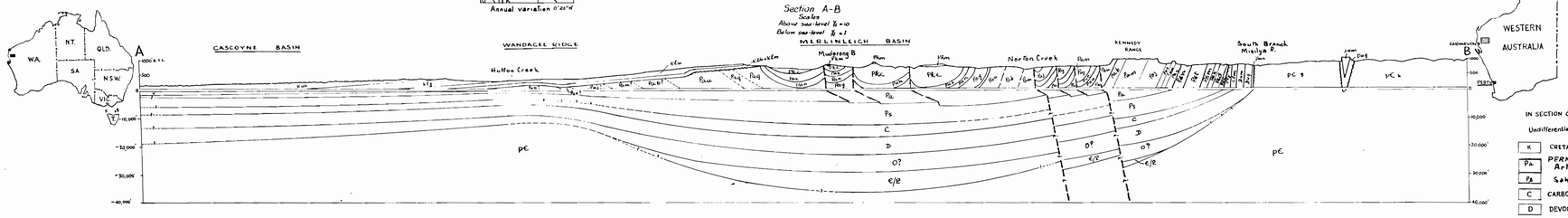
B Detailed reconnaissance - numerous traverses with photo interpretation

C Mainly photo interpretation

Geology by: M.A. Condon, D. Johnstone, C.E. Prichard, M.H. Johnstone, C.A. Thomas, N.G. Riggall, C. Teichert.
Compiled by: M.A. Condon, January, 1958
Drawn by:

Section A-B

Scales
Above sea-level ½ = 1
Below sea-level ½ = 1

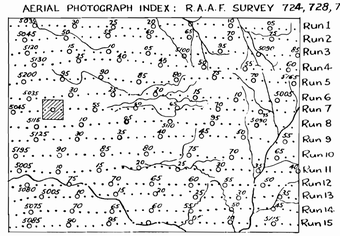


IN SECTION ONLY

Undifferentiated

K	CRETACEOUS.
Pa	PERMIAN Artinskian
Ps	Sakmarian
C	CARBONIFEROUS
D	DEVONIAN
O	ORDOVICIAN?
€/P	CAMBRIAN? or PROTEROZOIC
pE	PRECAMBRIAN

AERIAL PHOTOGRAPH INDEX: R.A.A.F. SURVEY 724, 728, 729, 719



KENNEDY RANGE
SHEET G50-1

FIRST DRAFT M.A.C. 17.1.58
CHECKED & CORRECTED M.A.C. 1.5.58
CORRECTED M.A.C. 14.7.59

Copies of this map may be obtained from the Bureau of Mineral Resources, Geology and Geophysics, Canberra A.C.T., or the Geological Survey of Western Australia, Perth, W.A.