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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

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EXPLANATORY NOTES

MOUNT MARUMBA, N.T.

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Compiled by H. G. Roberts and K. A. Plumb

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Explanatory Notes on the Mount Marumba
Geological Sheet

Compiled by
H. G. Roberts and K. A. Plumb

The Mount Marumba 1:250,000 Sheet area lies mostly within the Arnhem Land Aboriginal Reserve, in the north-eastern part of the Northern Territory. It is bounded by latitudes 13° and 14° S and longitudes 133° 30' and 135° E. A graded track from Mainoru Homestead to the Bulman mines provides the only access to the area. The mines are 30 miles north-north-east of Mainoru, which is 180 road miles from Katherine. Rainfall averages 25 inches per annum and occurs mainly during the period November to April. The area is uninhabited, but is visited occasionally by itinerant aborigines.

Maps and air-photographs covering the Sheet area and available during the course of the surveys were: air photographs at 1:50,000 scale flown by the Royal Australian Air Force in 1950; a photomosaic at a scale of 4 miles to 1 inch, prepared by the Division of National Mapping, Department of National Development, in 1952; and a 1:250,000 topographic map prepared by the Royal Australian Survey Corps in 1961. The accompanying geological map was compiled by transferring information from photographically reduced overlays to the Survey Corps base.

Previous Investigations

In 1845 Leichhardt (1847) travelled through part of the western sector of the Sheet area and described the sandstones now known as Kombolgie Formation. Lindsay (1884) traversed several parts of the area in 1883 and recorded numerous geological observations.

The Bulman zinc-lead deposits were discovered about 1910, when a company was formed to exploit them. The company failed when the field was given an unfavourable report by a consultant (A.R.G.N.T., 1910). The activity in the Bulman area led to mineral search in surrounding areas; S. G. Love in 1911 and Murphy (1912) made long journeys through Arnhem Land in search of minerals, but without success. Interest in the Bulman field was renewed in 1925 (A.R.G.N.T., 1925), but it was short-lived. In 1952 the Enterprise Exploration Company examined the deposits (King, 1952; Knight, 1952; Sturmfels, 1952), and subsequently tested them by diamond drilling (Patterson, 1954). Opik and Walpole also examined the deposits in 1952 (Opik, 1952). In 1954 the Broken Hill Proprietary Company mapped a large segment of Arnhem
Land, including the eastern part of the Mount Marumba Sheet area (Crohn, 1956). Later, Campbell (1956) mapped the rocks in the vicinity of the Balman field, and Patterson (1958) made a helicopter reconnaissance of a large part of the Mount Marumba Sheet area for the Enterprise Exploration Company; the company engaged botanists to conduct geobotanical investigations in the Balman district in 1962.

The accompanying map is based on field work undertaken by the Bureau of Mineral Resources during 1962 as part of a survey of Arnhem Land. As an aid to the field mapping Raker (1962) prepared a photogeological map of the Sheet area with accompanying notes. The adjoining 1:250,000 Sheet areas have been mapped by the Bureau of Mineral Resources; Mount Evelyn was mapped between 1954 and 1958 (Walpole, 1963); Urapunga in 1958 and 1959 (Dunn, 1963) and Milingimbi and Blue Mud Bay–Port Langdon in 1962 (Rix, 1965; Plumb & Roberts, 1965).

PHYSIOGRAPHY

The Sheet area contains parts of two of the three major physiographic divisions of Arnhem Land, viz., the Gulf Fall and the Arafura Fall (Roberts, Dunn, & Plumb, in prep.). The distribution of the divisions is shown in Figure 1.

Gulf Fall.—The Gulf Fall includes all the country drained by streams flowing into the Gulf of Carpentaria and occupies the central and southern parts of the Sheet area. Most of the Gulf Fall consists of hilly, dissected country, but in the west a flat elevated area has been named the Lindsay Tableland. The topography in the rest of the Gulf Fall is controlled to a marked degree by the differential resistance to erosion of the various underlying strata. In the headwaters of the Wilton River arenites of the Katherine River Group form strong strike ridges and plateaux, and the less resistant lutites, carbonates, and volcanics tend to underlie valleys and depressions. Relief in this area locally reaches 400 feet; elevations are up to 1250 feet, but gradually decrease to the south-east, along the course of the Wilton River, to about 300 feet near the southern margin of the Sheet area. Rocks of the Dook Creek Formation generally form rounded hills, in contrast to the rocks of the Roper Group, which form cuestas and hogback ridges along low, gently undulating country.

The Lindsay Tableland is bounded to the north by the Arnhem Land Plateau; elevations along the watershed separating the Tableland and Plateau are about 1300 feet, and the Tableland falls to the south-east to about 1000 feet. It is mostly flat and soil-covered, but contains numerous hills and rises of Precambrian and Mesozoic rocks. Most of the Tableland is underlain by horizontal Mesozoic strata and laterite, which are exposed along watercourses and in small scarpis both within the Tableland and along its margin. The marginal scarp is more pronounced in the headwaters of the Wilton River (where it is up to 50 feet high) than farther south.
Arafura Fall.—The Arafura Fall occupies the north-western and north-eastern sectors of the Sheet area and is bounded to the south by the Gulf Fall; it comprises the country drained by streams flowing into the Arafura Sea. Two subdivisions—the Arnhem Land Plateau and the Guyuyu Plain—are shown on Figure 1.

The Undifferentiated Arafura Fall is in the eastern part of the Sheet area and is underlain mainly by rocks of the Roper Group. The topography, although similar to that in the corresponding part of the Gulf Fall adjoining to the south, is more subdued; local relief rarely exceeds 100 feet. Elevations range from about 600 feet in the south to 250 feet in the north.

The Guyuyu Plain adjoins the Undifferentiated Arafura Fall. The Plain has an elevation of about 650 feet at its southern margin and slopes gently to 250 feet at its northern boundary. Most of the area is covered by sand and soil; numerous sink-holes suggest that carbonate rocks, probably of the Dook Creek Formation, may underlie much of the Plain.
The *Arnhem Land Plateau* occupies the north-western part of the Sheet area and a small area adjoining the Guyuyu Plain. It extends northwards onto the Milingimbi Sheet area (Rix, 1965), where its northern boundary is clearly defined. In the Mount Marumba Sheet area the Plateau ranges in elevation from 500 feet in the east to over 1400 feet in the west; local relief rarely exceeds 300 feet. Most of the rocks exposed on the Plateau are arenites of the Katherine River Group; they crop out in low rises, mesas, and broad craggy hills and ridges. Narrow gullies and clefts, which have developed along joints, are common in the Plateau.

*Drainage.*—The Gulf Fall is drained by the Wilton, Phelp, and Mainoru River systems. The principal drainage is through the Wilton River, which flows southwards to join the Roper River in the Urapunga Sheet area. For most of its length the Wilton River flows through wide alluvial plains; anabranches are common. The Arafura Fall is drained by the north-flowing Mann, Blyth, and Goyder River systems. The Goyder River system includes Annie Creek, Guyuyu Creek, and several un-named streams in the eastern part of the Sheet area.

In both the Arafura and Gulf Falls the major streams are superimposed consequent streams; the minor streams are largely controlled by the structure and lithology of the underlying rocks.

**STRATIGRAPHY**

The stratigraphy of the Sheet area is summarized in Table 1. The stratigraphic nomenclature used will be fully defined and in some cases redefined in Dunn, Smith, & Roberts (in prep.) and Roberts, Dunn, & Plumb (in prep.).

*Agicondian System (Lower Proterozoic)*

The *Jimbu Granite* is the oldest unit exposed in the Sheet area. It is unconformably overlain by rocks of the Katherine River Group, and is probably related to the similarly disposed rocks of the Agicondian System in the Katherine–Darwin region (Walpole et al., in prep.).

The most common rock exposed is a pink porphyritic microgranite consisting of phenocrysts of potash feldspar and quartz embedded in a medium-grained groundmass of micrographic quartz-feldspar, quartz, potash feldspar, and chlorite. Dykes of pegmatite and granophyre cut the granite mass.

*McArthur Basin Succession (Proterozoic)*

A sequence of about 10,000 feet of sedimentary and volcanic rocks unconformably overlies the Jimbu Granite. The rocks were deposited in the McArthur Basin, which extended from beyond the Queensland Border in the south to the Arafura Sea in the north. Sediments accumulated most thickly in a
narrow north-south zone trending through the Arnhem Bay and Blue Mud Bay Sheet areas (Roberts et al., in prep.), and several Sheet areas to the south (Dunn et al., in prep.). On the Mount Marumba Sheet area, which was a relatively stable part of the McArthur Basin, the succession is divided into three Groups—the Katherine River, Mount Rigg, and Roper Groups. The Katherine River Group is now regarded as Lower Proterozoic in age, but it was formerly thought to be Upper Proterozoic (Walpole, 1962; Randal, 1963; Rüker, 1959). The Mount Rigg Group is tentatively assigned to the Lower Proterozoic and the Roper Group tentatively to the Upper Proterozoic.

Lower Proterozoic

*Katherine River Group.*—The Katherine River Group unconformably overlies the Jimbu Granite and is exposed in the north-western part of the Sheet area. Topographic relief in the basement and local tectonism affected the distribution of the sediments during the initial stages of sedimentation; the basal unit of the Group (the Kombolgie Formation) has been overlapped in places by the McKay Sandstone, which locally rests directly on the Jimbu Granite.

The *Kombolgie Formation* consists dominantly of medium and coarse-grained quartz sandstone, but contains basic volcanic flows in the middle, which constitute the *Nungbalgarri Volcanic Member*. The Member is only poorly exposed but probably represents several separate lava flows; vesicular and amygdaloidal lavas are common. The sandstone beds above and below the Volcanic Member are similar; both are characteristically massive to flaggy, medium and coarse-grained, cross-bedded, ripple-marked, and locally pebbly. Minor amounts of detrital feldspar occur in some beds.

The *McKay Sandstone* conformably overlies the Kombolgie Formation in the Mount Marumba Sheet area, but in the adjoining Milingimbi Sheet area the Sandstone grades laterally into the upper part of the Kombolgie Formation (Rix, 1965). In general, the unit is more thinly bedded than the Kombolgie Formation, contains much more non-quartz detritus, and is finer-grained.

Rocks of the *Cottee Formation* conformably overlie the McKay Sandstone. The lower part of the unit consists of interbedded flaggy to fissile purple dolomitic siltstone and shale, glaucanitic dolomitic quartz greywacke, quartz sandstone, dolarenite, sandy and silty dolomite, siltstone, shale, and basalt. The upper part consists dominantly of purple algal dolomite composed almost entirely of hemispherical algal mounds with radii up to 30 feet. The mounds consist of concentric layers of laminated dolomite up to a few inches thick; the laminae are 'wavy'.

The *Shadforth Sandstone* overlies the Cottee Formation with slight angular unconformity; it consists essentially of blocky, medium-grained, white quartz sandstone, with minor feldspathic zones. Thin beds of glauconitic quartz sandstone occur at the top.
<table>
<thead>
<tr>
<th>Era</th>
<th>Age</th>
<th>Rock Unit and Symbol</th>
<th>Maximum Thickness in Feet*</th>
<th>Lithology</th>
<th>Physiographic Expression</th>
<th>Distribution</th>
<th>Stratigraphic Relationships</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cenozoic</td>
<td>Quaternary</td>
<td>Alluvium</td>
<td>20</td>
<td>Level to gently sloping plains</td>
<td>Mostly along Wilton, River and Amur Creek</td>
<td>Widespread</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Undifferentiated</td>
<td>20</td>
<td>Fluvial deposits; river terraces</td>
<td>Widely distributed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4(Cdf)</td>
<td>20</td>
<td>Fluvial deposits; river terraces</td>
<td>Western sector</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tertiary</td>
<td>Annie Creek Limestones (P)</td>
<td>20</td>
<td>Massive, buff to grey</td>
<td>Low rubble rias</td>
<td>Along Annie Creek</td>
<td>Relationship to laterite not known</td>
<td>No fossils found</td>
<td></td>
</tr>
<tr>
<td>Cenozoic</td>
<td>Lower Cretaceous</td>
<td>Mulligan Beds (KIm)</td>
<td>50</td>
<td>Massive, white to yellow, sandy siltstone and claystone; quartz sandstone, clastic sandstone</td>
<td>Soil-broad-crested platina, mesos</td>
<td>Widespread</td>
<td>Probably unconformably overlain below Mulligan Beds</td>
<td>Contains shell fossils</td>
</tr>
</tbody>
</table>

**Upper (7) Proterozoic**

<table>
<thead>
<tr>
<th>Rock Group</th>
<th>Member</th>
<th>Rock Unit and Symbol</th>
<th>Maximum Thickness in Feet*</th>
<th>Lithology</th>
<th>Physiographic Expression</th>
<th>Distribution</th>
<th>Stratigraphic Relationships</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>PreCambrian</td>
<td>(Pdi)</td>
<td>Fine to coarse-grained dolerite, porphyritic and melanocratic dolerite</td>
<td>370</td>
<td>Porphyritic; forms low-relief terraces and valleys. Produces black soil</td>
<td>Widespread in eastern part</td>
<td>Intruded Roper Group, unconformably overlain by Mulligan Beds</td>
<td>Sills and dykes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Besse Creek Sandstone (Pre)</td>
<td>Massive, fine to medium-grained white dolerite with fluvial deposits; cross-beded quartz sandstone</td>
<td>50</td>
<td>Massive, fine to medium-grained white dolerite with fluvial deposits; cross-beded quartz sandstone</td>
<td>Broad north-eastern sector zone in east</td>
<td>Unconformably overlain by Mulligan Beds</td>
<td>Joinable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Corcoran Formation (Pre)</td>
<td>Fluvial deposits; river terraces</td>
<td>400</td>
<td>Fluvial, sedimentary deposits; cross-beded quartz sandstone</td>
<td>Cross-beded, ripple-marked</td>
<td>Conformably overlain by Mulligan Beds</td>
<td>Strongly ferruginous in places</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Muny Member (P1m)</td>
<td>Fluvial deposits; river terraces</td>
<td>150</td>
<td>Fluvial, sedimentary deposits; cross-beded quartz sandstone</td>
<td>Cross-beded, ripple-marked</td>
<td>Conformably overlain by Muny Member</td>
<td>Joinable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hogdon Sandstone Member (P1m)</td>
<td>Fluvial deposits; river terraces</td>
<td>150</td>
<td>Fluvial, sedimentary deposits; cross-beded quartz sandstone</td>
<td>Cross-beded, ripple-marked</td>
<td>Conformably overlain by Hogdon Sandstone Member</td>
<td>Abundant sedimentary structures</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Jabo Member (P1m)</td>
<td>Fluvial deposits; river terraces</td>
<td>400</td>
<td>Fluvial, sedimentary deposits; cross-beded quartz sandstone</td>
<td>Cross-beded, ripple-marked</td>
<td>Conformably overlain by Jabo Member</td>
<td>Lenses out in place</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Arnold Sandstone Member (P1m)</td>
<td>Fluvial deposits; river terraces</td>
<td>100</td>
<td>Fluvial, sedimentary deposits; cross-beded quartz sandstone</td>
<td>Cross-beded, ripple-marked</td>
<td>Conformably overlain by Jabo Member</td>
<td>Lenses out in place</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Crawford Formation (P1m)</td>
<td>Fluvial deposits; river terraces</td>
<td>400</td>
<td>Fluvial, sedimentary deposits; cross-beded quartz sandstone</td>
<td>Cross-beded, ripple-marked</td>
<td>Conformably overlain by Crawford Formation</td>
<td>Characteristic weathering habit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mainau Sandstone Member (P1m)</td>
<td>Fluvial deposits; river terraces</td>
<td>500</td>
<td>Fluvial, sedimentary deposits; cross-beded quartz sandstone</td>
<td>Cross-beded, ripple-marked</td>
<td>Conformably overlain by Mainau Sandstone Member</td>
<td>Characteristic weathering habit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Limmen Sandstone (P1m)</td>
<td>Fluvial deposits; river terraces</td>
<td>200</td>
<td>Fluvial, sedimentary deposits; cross-beded quartz sandstone</td>
<td>Cross-beded, ripple-marked</td>
<td>Conformably overlain by Limmen Sandstone</td>
<td>Contains algal structures; interbedded</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dock Creek Formation (P1m)</td>
<td>Fluvial deposits; river terraces</td>
<td>1000</td>
<td>Fluvial, sedimentary deposits; cross-beded quartz sandstone</td>
<td>Cross-beded, ripple-marked</td>
<td>Conformably overlain by Dock Creek Formation</td>
<td>Glaucolithic towards top</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bone Creek Formation (P1m)</td>
<td>Fluvial deposits; river terraces</td>
<td>250</td>
<td>Fluvial, sedimentary deposits; cross-beded quartz sandstone</td>
<td>Cross-beded, ripple-marked</td>
<td>Conformably overlain by Bone Creek Formation</td>
<td>Glaucolithic towards top</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lower Proterozoic</td>
<td>West Branch Volcanics (P1m)</td>
<td>300</td>
<td>Basalt, medium-grained purple quartz greywacke</td>
<td>Poorly resistant, low-slightly undulating country</td>
<td>Central west and south-west</td>
<td>Unconformably overlain by West Branch Volcanics</td>
<td>Very poorly exposed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Goudi Greywacke (P2g)</td>
<td>300</td>
<td>Basalt, medium-grained purple quartz greywacke</td>
<td>Poorly resistant, low-slightly undulating country</td>
<td>Central west and south-west</td>
<td>Unconformably overlain by West Branch Volcanics</td>
<td>Very poorly exposed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>McCoy Formation (P2k)</td>
<td>500</td>
<td>Basalt, medium-grained purple quartz greywacke</td>
<td>Poorly resistant, low-slightly undulating country</td>
<td>Central west and south-west</td>
<td>Unconformably overlain by West Branch Volcanics</td>
<td>Very poorly exposed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Shadforth Sandstone (P2k)</td>
<td>350</td>
<td>Basalt, medium-grained purple quartz greywacke</td>
<td>Poorly resistant, low-slightly undulating country</td>
<td>Central west and south-west</td>
<td>Unconformably overlain by West Branch Volcanics</td>
<td>Very poorly exposed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Curn Formation (P2k)</td>
<td>1000</td>
<td>Basalt, medium-grained purple quartz greywacke</td>
<td>Poorly resistant, low-slightly undulating country</td>
<td>Central west and south-west</td>
<td>Unconformably overlain by West Branch Volcanics</td>
<td>Very poorly exposed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>McCoy Formation (P2k)</td>
<td>700</td>
<td>Basalt, medium-grained purple quartz greywacke</td>
<td>Poorly resistant, low-slightly undulating country</td>
<td>Central west and south-west</td>
<td>Unconformably overlain by West Branch Volcanics</td>
<td>Very poorly exposed</td>
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<tr>
<td></td>
<td></td>
<td>Kombo Formation (P2k)</td>
<td>200</td>
<td>Basalt, medium-grained purple quartz greywacke</td>
<td>Poorly resistant, low-slightly undulating country</td>
<td>Central west and south-west</td>
<td>Unconformably overlain by West Branch Volcanics</td>
<td>Very poorly exposed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nungu Kugur Volcanic Formation (P2k)</td>
<td>170</td>
<td>Basalt, medium-grained purple quartz greywacke</td>
<td>Poorly resistant, low-slightly undulating country</td>
<td>Central west and south-west</td>
<td>Unconformably overlain by West Branch Volcanics</td>
<td>Very poorly exposed</td>
</tr>
</tbody>
</table>

* Mostly estimates based on air photographs.
The McCaw Formation conformably overlies the Shadforth Sandstone. The superpositional sequence within the Formation is obscured by faulting and by the overlap of unconformably overlying strata, but purple dolomitic siltstone, fine-grained dolomitic sandstone and fine-grained, dolomitic, glauconitic quartz greywacke constitute a major part; algal dolomite, silty and sandy dolomite, and dolutite are interbedded, and occasional beds of sandstone, siltstone, and amygdaloidal basalt occur. The purple dolomitic siltstone beds locally contain halite pseudomorphs.

 Arenites of the Gundi Greywacke unconformably overlie rocks of the McCaw Formation, Shadforth Sandstone, and Cottie Formation. The Greywacke was first mapped by Ruker (1959) in the north-western part of the Katherine 1:250,000 Sheet area, where it contains much more non-quartz detritus than in this Sheet area, and called the Gundi Greywacke Member of the Diljin Hill Formation; this nomenclature was subsequently used by Walpole (1963) and Randal (1963). The unit is here given formation status because of the wide areal extent of the unconformity at its base. In the Mount Marumba Sheet area the unit consists of massive and blocky arenites containing varying amounts of feldspar. At the base, red-brown quartz greywacke and feldspathic quartz sandstone are dominant but upwards white to red quartz sandstone becomes more prominent. Large-scale cross-beds and strong joints are characteristic, and ripple-marking is common.

The West Branch Volcanics are poorly exposed and occur only in the central west. They were formerly classified as a member of the Diljin Hill Formation on adjoining areas (Ruker, 1959; Randal, 1963; Walpole, 1962). but are treated here as a formation and will be fully defined by Roberts et al. (in prep.). The base of the Volcanics cannot be clearly seen in the Sheet area, but Ruker (1959) reported a local unconformity between them and the underlying Gundi Greywacke. The only rocks exposed are basalt and medium-grained purple quartz greywacke.

Lower (?) Proterozoic

Mount Rigg Group.—The Katherine River Group is unconformably overlain by the Mount Rigg Group, which, in the Sheet area, consists of two formations—the Bone Creek and Dook Creek Formations.

The Bone Creek Formation lies unconformably on the West Branch Volcanics, Gundi Greywacke, and the McCaw Formation; it contains conglomerate beds in the Katherine 1:250,000 Sheet area (Ruker, 1959; Randal, 1963), but in the Mount Marumba Sheet area is entirely arenitic. The rocks are cross-bedded and ripple-marked.

The Dook Creek Formation conformably overlies the Bone Creek Formation. The carbonate component of the dolomitic strata usually has the composition of a slightly calcitic dolomite, although dolomitic limestones occur in parts of the unit.
Algal structures are common in the relatively pure dolomites and limestones; the rocks are frequently exposed as discrete biothermal mounds or as groups of bioherms, particularly near the base of the sequence (west of Mount Jean) and near the top, in the Bulman district. The thickness of the Dook Creek Formation is difficult to estimate, but is probably between 1000 and 2000 feet.

*Upper (?) Proterozoic*

*Roper Group.*—Öpik (1952) recognized an unconformity in the Bulman district at the base of the present Roper Group, which has since been recognized over extensive areas of the McArthur Basin (Dunn et al., in prep.). The Roper Group is a conformable sequence of arenites and lutites and has been divided into numerous stratigraphic units which show great lateral lithological consistency; many have been mapped throughout the McArthur Basin.

The *Limmen Sandstone* is the basal unit of the Roper Group and unconformably overlies the Dook Creek Formation. A local conglomerate at the base contains pebbles of chert, quartz sandstone, and algal chert. Quartz sandstone overlies the conglomerate and forms the bulk of the unit. The sandstone is fine to medium-grained, cross-bedded and ripple-marked.

The lower part of the *Mainoru Formation*, a carbonate/cherty siltstone sequence, is poorly exposed; on the adjoining Urapunga Sheet area (Dunn, 1963), a limestone, the Mountain Valley Member, has been differentiated. The upper part, a glauconitic sandstone is much better exposed.

The *Crawford Formation* continues the arenaceous sequence. The overlying *Abner Sandstone* contains four Members. The lowest, the *Arnold Sandstone Member*, is lenticular, and consists of medium-grained quartz sandstone. The *Jalboi Member* overlies the Arnold Sandstone Member and is lithologically similar to the Crawford Formation. It is overlain by the *Hodgson Sandstone Member*, which consists of white, medium-grained quartz sandstone. The *Munyi Member* overlies the Hodgson Sandstone Member and consists of interbedded ferruginous sandstone and siltstone, with minor beds of quartz sandstone and micaceous shale. Cross-beds and ripple marks are common in the Abner Sandstone, particularly in the three lower Members.

Rocks of the *Corcoran Formation* conformably overlie the Munyi Member. The Formation is poorly exposed in the Mount Marumba Sheet area; outcrops of flaggy micaceous quartz sandstone and quartz greywacke, shale, and siltstone occur, but represent only parts of the unit.

The *Bessie Creek Sandstone* is a massive, medium-grained, white quartz sandstone; cross-beds and ripple marks are common.
Intrusive Rocks: Numerous dolerite sills and dykes intrude the Precambrian rocks. The sills extend over wide areas and are closely concordant with the bedding; their thickness is difficult to estimate from exposures, but in the Bulman district a sill 370 feet thick (Patterson, 1954). Some differentiation has occurred in the dolerite. Dykes are comparatively rare; the only one of mappable dimensions intrudes along a fault plane east of the Wilton River.

Lower Cretaceous

The Mullaman Beds are exposed mainly in the south-west, but outlying remnants occur at widely separated localities throughout the remainder of the Sheet area. Shelly fossils have been collected from one locality (TT64) north-west of Mount Jean; Skwarko (1964) has placed them in the late Neocomian. Sandy siltstone and claystone, quartz sandstone, and clayey sandstone are the main rocks exposed.

Cainozoic

The Annie Creek Limestone is exposed in small areas along Annie Creek in the north-eastern part of the Sheet area. It lies unconformably on the Mainurru Formation, but as it is only found along the banks of Annie Creek it may also post-date the Lower Cretaceous strata. By analogy with similar deposits elsewhere in the Carpentaria Province the limestone is tentatively regarded as being of Tertiary age. The unit consists of massive buff to grey limestone with a characteristic fluted weathering habit.

Considerable parts of the Sheet area are covered by laterite, lateritic soil, and ferricrete (map symbol C31), sand, and residual soil (Czs), and alluvium (Qa). The laterite has developed on a number of rock units, but mainly on the Mesozoic strata; in places pisolitic material is abundant. An analysis of a single sample of pisolitic laterite developed on Mesozoic clayey sandstone a few miles west of the main dome in the north-western part of the Sheet area showed it to contain 24.5 percent SiO₂, 43.3 percent Fe₂O₃, and 18.3 percent Al₂O₃; loss on ignition was 12.6 percent (J. R. Bevers, pers. comm.).

Structure

In the Mount Marumba Sheet area the rocks of the McArthur Basin succession, although faulted and locally folded, retain the broad features assumed upon their deposition; the sequence dips south-east, with the oldest rocks, those of the Katherine River Group, exposed in the north-west and the youngest, those of the Roper Group, in the south-east (Fig. 2).

Faulting: The most prominent fault in the Sheet area is the Bulman Fault, which trends at 310°. The fault has a wrench component and probably also a slight vertical component; the southern block has moved to the west, but the displacement does not at any point appear to be great. Subsidiary faults parallel to the Bulman Fault also have wrench components.
A major set of faults trends between north and north-north-east; they are probably steeply dipping faults whose vertical displacement rarely exceeds 200 feet. A second group of normal faults trends roughly north-east and similarly shows little vertical displacement; they are usually less persistent than the former set.

**Folding:** Three domes occur in the north-western part of the Sheet area. The largest is about 12 miles long and 6 miles wide; the long axis trends about north-north-west. The smaller domes are almost circular and are from 4 to 6 miles wide. Dips on the limbs of the three domes are mostly between 15 and 25°. The presence of such prominent structures in an otherwise shallowly dipping sequence is anomalous. Exposures of basement rocks in the core of two of the domes and the abutment unconformity between the basement rocks and the overlying sediments suggests that the structures may be due partly to initial topographic irregularities in the basement—the attitude of the various stratigraphic
units indicates that the most of the doming occurred before the deposition of the Gundi Greywacke; slight movements subsequent to its deposition are indicated by curved joints in the Greywacke in the triangle between the domes.

A broad anticline with shallowly dipping limbs occurs in the south-eastern part of the Sheet area. The axis trends at 350° and is parallel to faults which may be responsible for the structure.

*Jointing*: Jointing is a common feature in many of the stratigraphic units. The most conspicuous joints are in the arenites of the Kombolgie Formation, particularly where the rocks are horizontal or gently dipping. Joints are also conspicuous in the Gundi Greywacke, the Dook Creek Formation, the Limmen Sandstone, the Arnold and Hodgson Sandstone Members of the Abner Sandstone, and in the dolerite sills.

**GEOLOGICAL HISTORY**

The oldest rocks in the Sheet area are those of the Jimbu Granite; they possibly intruded sedimentary rocks of the Agiconian System. A period of erosion after the Jimbu Granite was emplaced was succeeded by the subsidence of a vast area (the McArthur Basin) extending from Arnhem Land south-eastwards beyond the Queensland border. The subsidence was accompanied by the accumulation of thick deposits of clastic, bioclastic, biogenic, and chemical sediments, and, locally, the extrusion of basic or intermediate lavas. Areas of relatively high topographic relief in the basement initially persisted as non-depositional surfaces, but were ultimately buried under substantial thicknesses of sediment. The Sheet area was a relatively stable part of the McArthur Basin; the maximum thickness of strata deposited was about 10,000 feet, whereas 35,000 feet of equivalent strata were deposited farther east in the Blue Mud Bay Sheet area.

Local unconformities developed in the Mount Marumba Sheet area in response to slight tectonic adjustments, but to the east sedimentation proceeded without interruption. The only unconformity which can be traced to the east is at the base of the Roper Group. Slight, but widespread, erosion of the Mount Rigg Group and its equivalents resulted from regional epeirogenic uplift. The deposition of the Roper Group was followed by the intrusion of extensive dolerite sills and dykes. Faulting and minor folding in Precambrian times was followed by erosion. The next recorded event was the ingress of the sea in the Lower Cretaceous, during which the Mullaman Beds were laid down. Epeirogenic uplift or marine regression exposed the Mullaman Beds to lateritization either in the late Cretaceous or early Tertiary. Either before or, more probably, after the lateritization, the Annie Creek Limestone was deposited, probably in a freshwater lake. Further uplift induced the present erosion cycle.
ECONOMIC GEOLOGY

Zinc and Lead

Deposits of zinc and lead were discovered in the Bulman Waterhole district about 1910. The deposits were worked briefly in 1910–11 and again in 1925, and although no records are available, the extent of the workings suggests that production was not very substantial. The Enterprise Exploration Company became interested in the deposits in 1952, and has investigated the mineralized area in some detail.

The known deposits occur within an area, 8 miles by 4 miles, west of Mount Marumba. The host rocks are near-horizontal beds of dolomite, limestone, and chert, in the upper part of the Dook Creek Formation. The three largest groups of deposits occur about 1 mile west of the Wilton River, where a cellular crust composed of oxidized zinc and lead minerals is their main surface expression. The crust is from 1 to 2 feet thick and is underlain by horizontally bedded rocks containing more zinc than lead. The mineralization extends to depths ranging from 17 to 25 feet; the ore-shoots are bounded by vertical walls, and may therefore be localized along joints and fractures.

Water

No bores have been sunk specifically for water, but the Enterprise Exploration Coy’s No. 2 Bore, drilled in 1953 to test mineralization in the Bulman district, encountered artesian water at 400 feet at the contact of a dolerite sill with underlying dolomitic strata (Patterson, 1954). Patterson suggests that the artesian water is derived from a local depression coinciding with the maximum thickness of the dolerite sill; the initial flow was 360 gallons per hour, but it has diminished and in 1962 amounted to less than 50 gallons per hour.

Permanent surface water is confined mainly to isolated waterholes along the lower part of the Wilton River and along the Mann River.
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