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AN OUTLINE OF THE GEOLOGY OF THE ALICE SPRINGS AREA

by

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(a) Introduction

The geology of the Alice Springs Area is described briefly to provide a background for investigations into the agricultural and pastoral potential of the area. Three broad stratigraphic units, based primarily on lithology, have been used in defining the individual Land Systems, these are:

(1) the metamorphic and igneous rocks of Precambrian age.

(2) the sedimentary rocks of Lower Proterozoic to Upper Palaeozoic age.
These rocks are consolidated and they have been folded and faulted.

(3) sedimentary rocks of Permian to Recent age.
These rocks are unconsolidated and they have not been folded.

Rocks of the three units control the distribution of various soil types and govern the occurrence of underground water.

The older Precambrian metamorphic and igneous rocks crop out in three main areas:

(i) in an area trending east between the Reynolds Range and Mt. Doreen Station in the northwestern part of the Alice Springs Area.

(ii) in the MacDonnell and Harts Ranges in the centre of the Area.

(iii) in the area about Kulgera and Mulga Park Stations, close to the South Australian Border.

Names have been proposed for some of the basins of deposition of the sedimentary rocks (Bureau of Mineral Resources 1960). The original limits of these basins were certainly not the same as the present limits of outcrop of the sedimentary rocks. The sedimentary rocks are preserved in five main areas:

(i) A basin trending east between Yuendumu Native Settlement and the Stuarts Bluff - Hann Range, to the north west of Alice Springs. Sediments believed to be of Upper Proterozoic and Upper Palaeozoic age crop out in this area.

(ii) The Amadeus Basin - which contains the Upper Proterozoic and Palaeozoic sedimentary rocks between the MacDonnell Ranges and the Precambrian rocks which crop out along the South Australian border.

(iii) The Huckitta - Marqua Region (Casey and Gilbert - Tomlinson 1956) - sediments of Upper Proterozoic to Upper Palaeozoic age crop out in this area. In this report, the Cambrian limestones which crop out in the north east corner of the Alice Springs Area, and the greywackes which crop out at Barrow Creek and Central Mt. Stuart are included in this region.

(iv) The Warramunga and the Davenport Geosynclines - in the north eastern portion of the Alice Springs Area. The lower Proterozoic sediments of the area about Tennant Creek and of the Davenport Range were deposited in these two geosynclines.

(v) The Great Artesian Basin - portion of this large basin extends into the south east corner of the Alice Springs Area. Cretaceous shales overlie sand and sandstone probably of Jurassic age.

The basins of deposition may not have been discrete units throughout their development; it is possible that one or more of them were connected for varying periods. The sediments of Mesozoic age and younger were not confined to any one area or basin, as isolated outcrops of these rocks have a widespread distribution throughout the Alice Springs Area.

As geological mapping of the area continues some of the present ideas on stratigraphy and general geology will undoubtedly be modified. This will not involve any basic alterations in the Land Systems outlined in this report because geologically, these are based on lithology rather than age. Much of the information presented here is based on the results of field work by other geologists of the Bureau of Mineral Resources to whom acknowledgement is gratefully made. Hossfeld (1954) gives an extensive bibliography for the area.

(b) General Geology

The three main lithological units above may be sub-divided according to their age:

(1) Undifferentiated Precambrian,

(2) Lower Proterozoic,

(3) Upper Proterozoic,

(4) Lower Palaeozoic,

(5) Upper Palaeozoic,

(6) Permian,

(7) Mesozoic,

(8) Tertiary,

(9) Quaternary.

These nine units have been further sub-divided on the basis of lithology into 32 rock units. A geological map (Plate 1) shows the geographical distribution of the 32 units. Some of them can be correlated as approximate time equivalents, and these relationships are indicated on Table 1 and Plate 1.

(i) Undifferentiated Precambrian

Included in this unit are the oldest rocks which crop out in the Alice Springs Area. They are metamorphic rocks consisting of tightly folded and faulted schists and gneisses, which have been intruded by granites, pegmatites, and basic igneous rocks. Originally these metamorphics were sedimentary sandstones, limestones and shales with some volcanic rocks.

Because of insufficient field work no attempt has been made to sub-divide them or to assign relative ages to them. It is convenient however to describe them in terms of their geographical position.

(1) Musgrave Range - The belt of older Precambrian rocks which extends along the South Australian border west from Umbeara forms a portion of the Musgrave-Mann Ranges.

Recently geologists from South Australia have described these rocks as consisting of strongly metamorphosed sedimentary rocks intruded by granite, adamellite, charnockite, pegmatites, dolerite dykes, basic and ultrabasic rocks (Glaessner and Parkin, 1957, p.81-2). These types are not all represented within the Alice Springs Area where the complex consists mainly of granites, granodiorites and metamorphics with several groups of olivine dolerite dyke swarms.

Within the Alice Springs Area the intrusions of granite appear to be restricted to the eastern portion of the complex. The granite is cut by numerous pegmatitic segregations of graphic intergrowths of microcline perthite and quartz. The granodiorites occur mainly in the central and western portions of the complex. The texture of the granodiorites is often porphyritic. Other rock types identified in the field were gneiss, quartz schist and amphibolite.

(2) Arunta Complex - The gneissic and schistose rocks of the Harts and MacDonnell Ranges have been termed the Arunta Complex (Mawson and Madigan, 1930, p.417). It is thought that these were originally sedimentary rocks with some interbeds of volcanic rocks, which have been strongly folded and metamorphosed. Subsequently they were intruded by acid (granite and pegmatite), intermediate (granodiorite), and basic (gabbro and dolerite) igneous rocks. The main intrusions of granite are limited to the area between the Jervois and the Harts Ranges. The basic rocks are not limited in their distribution. The pegmatites which bear mica of commercial quality occur only in the Harts Range and in the Plenty River Area.

Joklik (1955) has shown the Harts Range to be the "core of an anticlinorium" with the rocks of the Harts Range Group "closely folded about axes which plunge parallel" to the axis of the anticlinorium. He has divided the metamorphosed sedimentary rocks into several formations. Lithologically the rocks are quartz - mica - feldspar schists

with varying amounts of kyanite, garnet and ferromagnesian minerals. The "facies as observed range from the low grade greenschist facies to pyroxene hornfels facies".

Joklik (1955) has shown that the structure of the Harts Range is complex. However the general structural pattern indicates that there have been two periods of folding and deformation. During the first, the rocks were strongly metamorphosed and they were foliated and lineated. This foliation was subsequently folded during the second phase.

(3) Precambrian metamorphic rocks and acid and basic intrusives crop out in the Reynolds Range - Mt Doreen area, to the north west of Alice Springs.

Petrological examination of a collection of specimens from the area indicates that two main groups of metamorphic rocks are represented. The areas of outcrop of the two groups have not been mapped and their field relations have not been determined. The first group consists of gneissic rocks which have suffered intense thermal metamorphism and deformation. It includes garnet-sillimanite gneiss which contains a green spinel. The second group consists of rocks of sedimentary origin (phyllite and sandstone) and some amphibolites, which may be of volcanic origin. They have been subjected to thermal metamorphism but they have not been extensively deformed. Quartz schist and quartz-mica schist were also identified in the field.

The regional strike of the foliation in the Reynolds Range is north-west and it dips to the north east. To the west of Mt. Doreen homestead the regional strike swings to the west.

The metamorphic rocks are intruded by granite, and by small bodies of basic igneous rocks. The granite is coarsely porphyritic, with aggregations of quartz and microcline phenocrysts up to 9 inches across. The rock has not been much deformed but is cut by pegmatite and aplite dykes.

Sedimentary rocks, possibly of Upper Proterozoic age, have been faulted and infolded into the metamorphic rocks. The quartzites of the Reynolds Range appear to rest unconformably on the granite.

(ii) Lower Proterozoic

The arenaceous and argillaceous sediments, and the volcanic and hypabyssal rocks which crop out in the Davenport Range are considered to be Lower Proterozoic in age. A sub-division has been made by Smith and Stewart (1959 MS) into the Warramunga Group (Ivanac, 1954, p.19) and the overlying Hatches Creek Group (Hossfeld, 1954, p.115) separated by an unconformity. Sedimentary rocks of both groups were deposited in the north west trending Warramunga and Davenport Geosynclines.

(1) Warramunga Group - This group consists of strongly deformed and slightly metamorphosed, interbedded sandstones, greywacke, siltstones and shales with subordinate grits and conglomerates. These rocks invariably crop out in low rounded rises covered by laterite rubble, and fresh exposures are rare. The Warramunga Group has been intruded by a two mica microcline granite.

Outcrop of rocks of this group have been traced from Tennant Creek to the northern and western margins of the Davenport Range, a distance of 60 miles in a south east direction. Rocks of similar lithology crop out 12 miles south east of Mt Doreen homestead and 8 miles east of Coniston homestead. It is possible that these and similar rocks at present mapped as undifferentiated Precambrian will be found to correlate with part of the Warramunga Group.

The age of the group is uncertain, but it has been assigned to the lower part of the Lower Proterozoic. Granite samples have been taken for radioactive age determinations, and the results should provide a basis for an estimate of the age of the group. Structures which may possibly be organic remains have been found in siltstones of the group at Tennant Creek (A.A. Öpik, personal communication).

(2) Hatches Creek Group - the interbedded sandstones, shales, siltstones, greywackes and basic volcanics of the Hatches Creek Group are considered to be Lower Proterozoic in age. They have been intruded, in the cores of anticlines, by granite, gabbro and quartz feldspar porphyry. Sills of basic hypabyssal rocks which intrude sediments of the group have been folded with them. The folding is complex. The axial planes of the anticlines have been deformed to give a sigmoidal trace in plan, and the synclines are long and attenuated, or they are faulted out.

Sediments of the Hatches Creek Group also crop out in the Crawford and the Osbourne Ranges 170 miles north of Alice Springs. Isolated and small outcrops have been found on the sandplain to the north east of the Davenport Range.

(iii) Upper Proterozoic

Sandstones, limestones and shales were deposited in the Amadeus and Ngalia Basins and in the Huckitta - Marqua region during this time. As a result of detailed work in some areas several formations and groups will be defined (Smith et al, 1959 M.S., and Prichard and Quinlan, 1959 M.S.). These units cannot be extended to describe fully the whole area as the rock types are known to change in character and are not everywhere present. Further lithological correlations cannot always be made where there is no continuity of outcrop. The information which is available regarding their names, lithology and the relative ages assigned to them is summarised in the legend on Plate 1, and in Table 1.

The oldest Upper Proterozoic rocks crop out in the MacDonnell Ranges; these rest unconformably on the metamorphic rocks of the Arunta Complex. To the north progressively younger formations rest on the basement rocks. In the Davenport Ranges the middle Cambrian "Sandover Beds" unconformably overlie the basement rocks of Lower Proterozoic age.

(1) Amadeus Basin - The Upper Proterozoic section at Alice Springs and at Ellery Creek (50 miles west of Alice Springs) commences with a discontinuous siltstone formation deposited on the uneven surface of the Arunta Complex. This is followed in turn by the Heavitree Quartzite (Heavitree Gap Quartzite of Chewings, 1928, p.63) (of approximately 1500 feet of sandstone and silicified sandstone) and by the Bitter Springs Limestone (Joklik, 1955, p.27) (2000 to

3000 feet of interbedded dolomitic limestone, limestone and shale).

Disconformably overlying the Bitter Springs Limestone is the "Pertatataka Series" (Madigan, 1932 a, p.685). The "basal Pertatataka conglomerates" (Madigan, 1932 b, p.106) are now known to contain boulder beds with striated and faceted cobbles and pebbles of glacial origin (Mawson 1957, Prichard and Quinlan 1959 M.S.).

The total thickness of Upper Proterozoic sediments at Ellery Creek is approximately 6000 feet (Prichard and Quinlan 1959 M.S.). Stromatolitic algae are the only fossils which have been found in these rocks.

The thickness and lithology of each of the four Upper Proterozoic units is known to vary along the east trending MacDonnell Ranges. The thickness of the Heavitree Quartzite decreases from 1500 feet at Ellery Creek (50 miles west of Alice Springs) to 600 feet at Alice Springs. The ratio between the amount of pyritic shale and the amount of dolomitic limestone in the Bitter Springs Limestone increases from Ellery Creek to Alice Springs. To the east of Alice Springs, the Heavitree Quartzite increases in thickness and the ratio of shale to dolomitic limestone in the Bitter Springs Limestone decreases.

The "basal Pertatataka conglomerates" at Ellery Creek has been divided into an upper unit, which consists of 550 feet of medium grained quartz greywacke and a lower unit 740 feet thick (Prichard and Quinlan, 1959 M.S.). The latter consists of interbedded pebble and cobble conglomerates, boulder beds and thin lenses of dolomitic limestone. The "basal conglomerates" are known to crop out only between the Finke River and Ellery Creek and at Areyonga native settlement, 100 miles south west of Alice Springs.

The "Pertatataka Series" at Ellery Creek, above the "basal conglomerates", is composed of thick beds of shale and siltstone. To the south east of Alice Springs, at Aralka Well on the Hale River the lithological units are not as distinct. The unit is thinner and the sediments are of a coarser texture than at Ellery Creek. There is also an increase in the amount of carbonate sediments. The lithology of the "Pertatataka Series" on Henbury station is similar to that at Aralka Well, but the unit is thicker.

(2) Huckitta - Marqua Region - A generalised section of the Upper Proterozoic sediments of the Jervois Range (K.G. Smith, personal communication) is, in descending order:

725' shale, dolomite and silty sandstone

115' coarse to very coarse granite arkose, with some boulders, and thin beds of dolomite. This is the Oorabra Arkose of Joklik (1955).

40' interbedded boulder beds and beds of thin dolomite. This section, together with the conformably overlying unit of 1300 feet of quartz greywacke, shale and limestone of Lower Cambrian age constitutes the Mopunga Group (Noakes 1956).

The top unit of shale, dolomite and silty sandstone does not show marked variations in thickness or lithology, except that where it lies directly on Precambrian rocks it is thinner. The variation in the thickness and lithology of the Corabra Arkose and the basal unit is considerable, and it appears to be due to original relief in the floor of the basin of deposition.

(3) Ngalia Basin - The interbedded sandstones, limestones, shales and dolomites which crop out to the south of Yuendumu Native Settlement and Mt Doreen homestead have been assigned to the Upper Proterozoic succession. These sediments rest unconformably on the Precambrian metamorphic rocks, and they are overlain unconformably by sediments possibly of Upper Palaeozoic age.

(iv) Lower Palaeozoic

In the Huckitta - Marqua Region the base of the Cambrian (K.G. Smith, personal communication) is placed at the base of the "ferruginous quartz greywacke.... about 1300 feet thick", which is the highest unit of the Mopunga Group (Noakes 1956). This greywacke contains the oldest known shelly fossils in the Alice Springs Area.

The base of the Cambrian, in the Amadeus Basin, is placed at the base of the "No.3 Quartzite" of the "Pertaoorrta Series" (Madigan 1932 b). No shelly fossils have been found in the "No.3 Quartzite", but arthropod trails have been found in the formation in the Ross River Section, 40 miles east of Alice Springs (J. Gilbert-Tomlinson, personal communication).

(1) Amadeus Basin - The Upper Proterozoic succession is followed conformably by a sequence of marine sediments of Cambrian and Ordovician age, the "Pertaoorrta Series" and the "Larapintine Series" (excluding the Mareenie Sandstone). Madigan (1932 a, b) described these units at Ellery Creek in some detail. The Cambrian-Ordovician boundary has not yet been established, but it probably occurs above the base of the "Larapintine Series" (J. Gilbert-Tomlinson, personal communication). The "series" consists of shale, sandstone and quartz greywacke, limestone, and limestone and shale. Eight formations will be defined within the two "series" by Prichard and Quinlan (1959, M.S.). The "Pertaoorrta Series" increases in thickness from Ross River (40 miles east of Alice Springs) to the west and to the south; this increase is accompanied by a decrease in the carbonate content of the group. The carbonate to clastic ratio at the Ross River is estimated to be 1, this falls to 0.05 at Ellery Creek, to 0.02 at Stokes Pass 110 miles west of Alice Springs, and to approximately 0.02 at Areyonga Native Settlement. The "Larapintine Series" (excluding the Mareenie Sandstone) is 4200 feet thick at Ellery Creek and approximately 8000 feet at Stokes Pass. The limestone and shale formations thicken more than the arenaceous formations. The thickening is not accompanied by marked variations in lithology.

(2) Huckitta-Marqua Region - Conformably overlying the Mopunga Group, in the Jervois Range, is a sequence of interbedded shale, sandstone, limestone, dolomite and quartz greywacke. These rocks are of Cambrian to Ordovician age and have a total thickness of approximately 3500 feet. Three formations will be defined by Smith et al (1959, M.S.),

but they do not have the same clear lithological distinctions as the Cambrian and Ordovician formations of the Amadeus Basin. The three formations do not show marked variation in thickness or lithology.

(v) Upper Palaeozoic

The Mareenie Sandstone of the Amadeus Basin (Madigan, 1932 a, p.690) is correlated with the Dulcie Sandstone of the Huckitta-Marqua Region (Smith, K.G., 1959) on lithological grounds. The Dulcie Sandstone is of Upper Devonian age. These formations overlie the Cambrian and Ordovician sediments and are separated from them by a regional unconformity.

In the type areas both formations consist of medium grained quartz sandstone. Typically the formations are cross bedded on a very large scale, individual sets of cross beds are up to 100 feet thick and they may be up to a quarter of a mile long. The size of the sets is smaller (in the order of 1 to 5 feet) in some areas where the sandstones have an appreciable silt content.

In the Amadeus Basin syn-orogenic deposits of the "Pertnjara Series" follow unconformably on the Mareenie Sandstone. On the north side of the Missionary Plain the "Pertnjara Series" consists of a thick sequence of conglomerates. The number and the size of the boulders and cobbles decreases to the south. The "Pertnjara Series" on the south side of the Missionary Plain consists of calcareous sandstones with some pebbles. The measured thickness at Ellery Creek is approximately 25,000 feet. The true stratigraphic thickness is estimated to be 10,000 feet, after allowing for initial dips. Within the "Pertnjara Series" evidence can be found for at least three main and distinct phases of movement during the orogeny.

The sediments of the Treuer Range, Ayers Rock and Mt. Olga are of similar lithology to the "Pertnjara Series" and are tentatively correlated with it.

(vi) Permian

The glacial deposits, conglomerates and silty sandstones which crop out in the area about Crown Point, Yellow Cliffs and the Lilla Creek are of uncertain age. They have been assigned to the Permian (David and Browne 1950, p.305). These sediments form the lower portion of the "Finke Series" (Finke River sandstone series of Chewings, 1914, p.44). The upper sandstone portion of the "Series" is considered to be the De Souza Sandstone (Sullivan and Öpik, 1951, p.14) of assumed Jurassic age. A regional unconformity separates the De Souza Sandstone and the lower portion of the "Finke Series". The glacial sediments consist of boulders, cobbles and pebbles of quartzite, metamorphic and igneous rock set in a massive matrix of sandy clay. The cobbles and pebbles, which comprise 5 to 10% of the deposit, are striated, facetted and characteristically of tetrahedral and "flat iron" shape. The glacial beds are variable in shape and size, from lenses 10 to 20 feet thick and 200 feet wide to large massive units of unknown shape and size. They are overlying and interbedded with thinly bedded siltstones and very fine sandstones which are contorted and deformed. The regional dip is low, less than 5° to the south.

(vii) Mesozoic

Following the "Post Ordovician Orogeny" and before the start of Mesozoic sedimentation there was widespread erosion throughout the area. This produced relief of the order of 1,000 feet in the form of narrow strike valleys and both large and small erosional basins. This relief has been of prime importance in the distribution and preservation of the Mesozoic sediments.

(1) Great Artesian Basin - Drillers logs and samples from the south eastern part of the Alice Springs Area show that the sedimentary sequence is similar to that in large areas of the Great Artesian Basin. Cretaceous shales overlie the Jurassic to lower Cretaceous sandstones (Glaessner and Parkin, p.92). The greatest thicknesses known are, for the shale, 1127 feet in the Anacoora Bore and of the sand 860 feet in the Charlotte Waters Bore. The sections in these bores are not complete and the total thicknesses of these units must be greater.

(2) "Deep Alluvium" - Sometime during the Mesozoic the sea moved northward and westward from the Great Artesian Basin, flooding the strike valleys and erosional basins. The northern limit of this transgression is not known. Sediments, possibly of Mesozoic age, crop out at Barrow Creek, and the northern most areas of "Deep Alluvium" known are on Willowra, Pine Hill, Bond Springs and Mt. Riddock stations.

Within the MacDonnell and Harts Ranges the maximum thickness of the Mesozoic sediments is between 100 and 300 feet. Lithologically the sediments are sandy siltstones and siltstones. Lignitic material has been reported by drillers from several water bores on Ambalindum station.

On the northern front of the MacDonnell Ranges Mesozoic sediments filled old river valleys. These sediments were penetrated in the "16 Mile Bore", 16 miles north of Alice Springs. Basement of schist was struck between 617 and 639 feet. In the "16 Mile Bore..... the sediments consist predominantly of shale with some beds of grit" (Hossfeld 1954, p.154). Crespin (1950) found "lignite..... glauconite..... gypsum..... numerous spherical bodies referred to radiolaria, fragments of molluscan shells and an ostracod" in samples from this bore, and on this basis suggested a Lower Cretaceous age for the samples.

It is not always possible to distinguish in samples from a bore hole the Mesozoic or pre-laterite sediments from the unconformably overlying Tertiary to Quaternary Alluvium. Until palaeontological evidence is available these sediments are grouped together as "Deep Alluvium". Lithologically the group consists of gravel, sandy clays, shale and clay.

The lithology and the morphology of these deposits suggests that in addition to the marine environment some sediments were deposited in a piedmont environment. It is thought that as the old alluvial fans grew they coalesced to form a deposit with a prismatic shape.

(viii) Tertiary

(1) Period of Tertiary Deep Weathering - Earth movements after the Mesozoic Era brought the whole of the area above sea level and this was followed by a long period of erosion and weathering. During this period laterite and "Grey Billy"

profiles were developed. These two types of profiles are considered to be complementary, with a "Grey Billy" profile developing on a parent rock with a low iron content and the laterite profile developing on a parent rock with a high iron content.

The Tertiary weathering surface as it is preserved is a broad regional dome with superimposed local relief of the order of 100 feet. Its culmination is approximately 20 miles north of Alice Springs at an elevation of 2350 feet. Approximate elevations at other points on this surface are Kulgera 1650 feet, Tennant Creek 1200 feet, near Mt. Razorback (100 miles west of Alice Springs) 2300 feet, and 2200 feet south west of Arltunga. In addition to the local relief residuals of Older Precambrian, Proterozoic and Palaeozoic rocks stand above this surface in the MacDonnell and Harts Ranges. It is thought that they are remnants of older erosion surfaces which underwent further weathering during this period.

The regional warping which produced this regional doming is considered to be, in part, of Quaternary age. It has been partly responsible for the rejuvenation of stream erosion which has now almost exhumed the pre-Mesozoic land surface in the MacDonnell and James Ranges.

(2) Tertiary - Irregularities and erosional depressions in the deep weathering surface became small fresh water basins of deposition later in the Tertiary. These are now filled with thin sequences of interbedded calcareous siltstones, gypseous siltstones and chalcedony. Gastropods and lamellibranchs have been obtained from these sediments at Arltunga and gastropods from outcrops near the Phillipson Pound. The calcareous sediments are restricted to the basins near the MacDonnell Ranges, while to the south in the area about Erldunda and Mt Ebenezer the siltstones interbedded with the chalcedony are gypseous.

(ix) Quaternary

The Quaternary deposits cover 104,400 sq. miles of the 140,800 sq. miles of the Alice Springs Area. They have been assigned to two main groups, those considered to be Pleistocene to Recent and those to be Recent in age. No evidence is yet available on their absolute ages.

The areas of "Deep Alluvium" undoubtedly include sediments of possible Tertiary to Quaternary age, but these have not been mapped out as they are everywhere covered by Recent deposits.

The Quaternary deposits which have been mapped out are:

(1) Terrace Gravels - On the southern flank of the Western MacDonnell Ranges a thin deposit of gravel lies on the bevelled surface of sandstones of the Pertnjara Group. The boulders, cobbles and matrix are derived and have been transported from topographically higher outcrops of the Pertnjara Group. Similar deposits exist within the strike valleys of the MacDonnell and the Reynolds Ranges; in this case the boulders are derived from the walls of the valleys. These gravels are thought to be associated with a period of erosion during the Pleistocene.

(2) Aeolian Sand - Both ancient and active longitudinal seif type dunes and redistributed aeolian sand, cover large areas of the Alice Springs Area. There are two main trends, north-north-west in the eastern portion of the Area and east-west in the western province. These directions appear to be controlled by the prevailing winds. The ancient dunes and the redistributed sand fields are fixed by vegetation.

(3) Evaporites - There are two main areas of salt lakes, the Lake Amadeus and the Central Mt. Wedge systems. These are basins of internal drainage in which salts have been concentrated by evaporation from surface waters and from groundwater. The stratigraphy and economic significance of these deposits has yet to be studied.

(4) Kunkar, Calcrete and Alluvium - Marginal to the salt lakes are areas of calcareous accumulation from groundwater. Calcium carbonate is deposited as large concretionary masses of "Travertine" within the alluvium to form kunkar, or as a calcareous cement in the alluvium, to form calcrete.

Small deposits of nodular travertine and calcrete also occur in drainage channels and on the slopes of low rises with Mesozoic Shales, at shallow depth, in the Mt Ebenezer and Kingston Range area. These deposits while superficially similar to the Kunkar deposits about the salt lakes may have been deposited from soil moisture or from perched groundwater.

(5) The deposits of Recent age - the red earth soils, creek alluvium and the wash forming the alluvial fans, are superficial.

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TABLE I

FIELD RELATIONSHIPS OF STRATIGRAPHIC UNITS

	I	II	III	IV	V
	KULGERA CHARLOTTE WATERS	MACDONNELL RANGES	JERVOIS RANGE	DAVENPORT RANGE	MOUNT DOREEN NAPPERBY
TERTIARY	Tl Chalcedony Gypseous Shale & Calcareous Shale *				
	Period of extensive deep weathering with development of laterite and grey billy profiles				
Cretaceous MESOZOIC	K Rumbalara Shale *	M * Sandstone Siltstone Claystone			
Jurassic	J De Souza Sandstone +				
PERMIAN	P Finke "Series" +				
UPPER PALAEOZOIC		Pzp Pertnjara "Series" +			?Pz Sandstone, Shale, Conglomerate +
DEVONIAN		?Dm Mareenie Sandstone +	Dd Dulcie Sandstone *		
ORDOVICIAN	Є/O Sandstone * and Shale	Є/O Larapintine * "Series"	Є/O Dolomite, quartz greywacke, siltstone		
CAMBRIAN		Є Pertaoorrta "Series" *	Єud Dolomite, sandstone; Shale, limestone, sandstone; Greywacke, siltstone thin dolomites	Ems Sandover Beds *	?Cl Greywacke, shale & Conglomerate +
UPPER PROTEROZOIC		"No.3 Quartzite" Pu Pertata-taka "Series"; Pu Bitter Spring Lst. Heavitree Qtzite. Shale; ?Pu White Range Qtzite +	Pu Shale, dolomite, silty sandstone, arkose. Pu Boulder Beds, dolomite		Pu Sandstone, Greywacke, Shale, Limestone, Dolomite +
LOWER PROTEROZOIC				Plg Granite; Plp Porphyry; Plv Basic Intrusives; Plt Hatches Ck Group; Plw Warramunga Group	
UNDIFFEREN-TIATED PRECAMBRIAN	gr Granite and Granite gneiss; pЄ Gneiss and schist granite, dolerite	gr Granite, Granite Gneiss; pЄ ARUNTA COMPLEX (including Harts Range Group) Gneiss, amphibolite, granite, granodiorite pegmatite, basalt, dolerite, gabbro.			gr Granite and Granite gneiss; pЄ Sandstone and slate Basic intrusives, Schist Gneiss & amphibolite

|| Unconformities * Possible erosional units + Relative position uncertain

APPENDIX I.

THE MINERAL DEPOSITS OF THE ALICE SPRINGS AREA

by

G.R. Ryan

The mineral deposits of the Alice Springs Area fall, geographically, into six distinct districts, which can be sub-divided again into various localities. These divisions, together with their principal products, are given in Table 2. The main mineral producing localities are shown on the geological map (Plate 1).

The geographical positions of the six mineral districts are:

1. Davenport Range District - the north-eastern corner of the Alice Springs Area.

2. Barrow Creek District - a small district around Barrow Creek, 150 miles north of Alice Springs.

3. Mt. Hardy District - an east-trending belt of Precambrian rocks in the north-western part of the Alice Springs Area.

4. Jervois Range District - between the Davenport Range District and the eastern end of the Arunta District.

5. Arunta District - an east-trending belt of metamorphic and igneous rocks in the centre of the Alice Springs Area.

6. Amadeus District - a broad area of sedimentary rocks south of the MacDonnell Ranges.

Districts 1, 2, 3, and 4 are mineralogically and genetically very similar; wolfram and copper are the main products, with small amounts of gold, bismuth, tin, tantalite, silver, lead and zinc. All these deposits, as far as is known, are epigenetic, and derived from granite. Districts 5 and 6 are distinct from the other four, and from each other. The mineral deposits of the Arunta District (No.5) are, with few exceptions, epigenetic and derived from granite, but they include pegmatitic products such as mica and beryl, as well as metallic ores. The deposits of the Amadeus Trough Province are primarily of sedimentary origin.

Geologically the six mineral districts are more diverse. The Hatches Creek Group, which is ?Lower Proterozoic in age, is host to most of the mineral deposits in the Davenport Range District, except at Mosquito Creek where the host rock is the ?Lower Proterozoic Warramunga Group. The age of the rocks in the Barrow Creek District and the Mt. Hardy District has not been established, as very little work has been done in those areas. The rocks have been subjected to varying degrees of metamorphism, and they are considered to be Older Precambrian in age. Farther south the metamorphic rocks of the Arunta District are also assigned to the older Precambrian, and the host rocks of the Jervois District are thought to be a north-eastern extension of the Arunta District.

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Metalliferous deposits are almost unknown in the Amadeus Trough District, with the exception of some unimportant copper lodes in the Upper Cambrian sandstones at Areyonga and Owen Springs. Lower Palaeozoic and Upper Proterozoic sandstones and limestones are used as building stone in Alice Springs. The Rumbalara ochre deposits lie at the base of Lower Cretaceous rocks. Lime is won from travertine near Alice Springs, and evaporites in the more arid areas south of Alice Springs have been tested as possible sources of salt and gypsum.

Mica and tungsten are the principal mineral products from Central Australia. The Arunta District is Australia's most important source of mica, the value of mica production since 1892 being slightly more than £1,000,000. Wolfram and scheelite concentrates from Hatches Creek have realised approximately £1,300,000 since 1915. This mineral field has also produced some bismuth. Wolfram at Wauchope and Mt. Doreen; copper at the Jervois Range and the Home of Bullion mine; ochre at Rumbalara; and gold at Arltunga are the next most important deposits. None of the mineral deposits, except the mica at Harts Range and Plenty River, is large by Australian standards. The distance from markets and the arid nature of the country have inhibited exploration and production and will continue to do so. Only large and rich deposits can be profitably exploited, and none has so far been found.

TABLE 2

MINERAL DEPOSITS OF THE ALICE SPRINGS AREA

District	Major Producer Locality	Major Producer Product	Minor Producer Locality	Minor Producer Product
1. Davenport Range	Hatches Ck.	W, Bi, Cu, (Au)	Woodenjerrie	W
			Kurundi	Au
	Wauchope	W, (Sn)	Silver Valley	Pb
	Mosquito Ck	(U)	Bonny Well	Cu
			(Elkedra)	(Cu, W)
			(Skinner Pound)	(Cu)
2. Barrow Ck	Home of Bullion	Cu, Pb, Zn	Anningie	Sn, Ta
			Ivy	Ta, Sn, W
3. Mt Hardy	Mt. Hardy	Cu	Lander	Cu
	Mt Doreen	W	Brooks Soak	W
	Mt Singleton	W, Cu	Coniston	Sn
			Vaughan Sps.	Pb, Cu, Ag.
			Yuendumu	Cu, W
			(Tilmouth Well)	(Fe)
4. Jervois Range	Jervois Range	Cu, Pb, Zn, Ag (Bi)	Bonya	Cu, Bi
5. Arunta	Harts Range	Mica, (U, Be)	Strangways Ra.	Mica, Cu, (P, U)
	Plenty River	Mica	Pinnacles	Cu, lst
	Arltunga	Au	Delny	W, Sn, Ta
	Undippa	Mica	(Haasts Bluff)	(Cu)
			(Goyder Pass)	(Nitrate)
6. Amadeus Trough	Rumbalara	Ochre	Areyonga	Cu
			Owen Sp.	Cu
			Alice Sp.) Ooraminna)	Building stone
			Alice Sp.	Lime
			Alice Sp.	Aggregate
			(Lake Amadeus)	(Salt)
			(Erldunda)	(Gypsum)
			(Jay Ck)	(Ochre)

Ag - Silver
Au - Gold
Be - Beryl
Bi - Bismuth
Cu - Copper
Fe - Iron
Lst - Limestone
P - Phosphate
Pb - Lead
Sn - Tin
Ta - Tantalum
U - Uranium
W - Tungsten
Zn - Zinc

(Elkedra) (Cu, W) - Non Producer

W, Bi, Cu - Tungsten is principal product.