COMMONWEALTH OF AUSTRALIA.

DEPARTMENT OF NATIONAL DEVELOPMENT.

BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS.

RECORDS.

1961/86

EXPLANATORY NOTES ON THE STANSMORE 4-MILE GEOLOGICAL SHEET

Compiled by

A.T. Wells

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INTRODUCTION

The Stansmore 4-mile Sheet lies in the north-east part of Western Australia and is bounded by latitudes 21°00' and 22°00' South and longitudes 127°30' and 129°00' East. The northern margin of the map is 60 miles south of Balgo Mission, which is the closest point of habitation and the most convenient point for access to the area. A track runs south from Balgo Mission to the abandoned Djaluwon Mission. The Western part of the Sheet includes about 2800 square miles of the Canning Basin; the eastern part is occupied by Precambrian basement rocks. The Canning Basin is an intracratonic sedimentary basin with a floor and margin composed of Precambrian rocks. The term Great Sandy Desert, a geographical term used by Warburton (1875), includes the desert areas of the Canning Basin covered by sand plain and seif dunes.

No tracks cross the Sheet area and the only inhabitants are nomadic aborigines, who depend on the scant native fauna and the sporadic water in rock-holes for their existence. Rainfall is generally less than 10 inches per year and surface water is absent except for small rock-holes and pools in creeks.

The conditions encountered during the survey by the Bureau of Mineral Resources party in 1955 and the method of survey are described by Casey & Wells (1956). The area is covered by widely spaced traverses and a great deal of the geology has been photointerpreted. No systematic geological work was carried out on the Sheet area until it was investigated by geologists of the Bureau of Mineral Resources in 1955 and 1956.

In 1873, P.E. Warburton (1875) travelled from Alice

Springs to the Oakover River and his route passed through the north-east corner of the Sheet near Lake Lucas. In 1896, D.W. Carnegie (1898) investigated the Stansmore Range during his return journey to the West Australian Goldfields from Halls Creek. He named many prominent features in this area after members of the expedition.

M. Terry (1937) mentions an expedition by Westen in 1926, who travelled from Tanami to the Sydney Margaret Range. No other published record of this expedition is available. Terry himself investigated and named many topographical features on the eastern half of the Sheet, including the Sydney Margaret Range, Red Cliff Pound, Brookman Waters, and Nicker Creek.

D.F. McKay (1934) carried out an aerial survey of the Canning Basin and produced a topographic map of the area. Several flight lines cross the Stansmore Sheet. Reeves (1949) carried out a geological and aerial reconnaissance of a large part of the Canning Basin, but no ground traverses were made as far south as the Stansmore Sheet.

In 1953 the Sheet was photographed by the R.A.A.F. at a scale of 1:50,000 and uncontrolled 4 mile mosaics were prepared by the Division of National Mapping.

In 1955 a joint party of Bureau of Mineral Resources and West Australian Petroleum Co. geologists and State surveyors investigated the area. Gravity readings were taken by the West Australian Petroleum Co. geologists and astrofixes by State surveyors. The 1956 Bureau geological party which investigated the southern and eastern part of the Sheet was accompanied by a geophysicist who took gravity readings and a State surveyor who observed astrofixes. Astrofixes on the Sheet are detailed in Table 1.

TABLE 1. Astrofixes on the Stansmore 4-mile Sheet

Astro Station	Latitude	Longitude	East	North
N16	21° 01' 21.4"	128° 59' 11.6"	739659	2369482
N26	21° 29' 10.64"	128° 03' 59.7"	634255	2314970
N27	21° 14' 53.1"	128° 02' 19.7"	631479	2343867
A17	21° 18' 18"	128° 58' 02"	169294	2336981
A18	21° 36' 21"	128° 47' 38"	150129	2300271
A19	21° 48' 09"	128° 13' 24"	651481	2276416
A20	21° 51' 38"	127° 51' 17"	609691	2269935
A22	21° 04' 07"	128° 28' 02"	680479	2364919

PHYSIOGRAPHY

The area cannot be readily subdivided into distinct physiographic divisions; the main features can be grouped into dissected hills, sand plains, and salt lakes, all of which are found both in the intracratonic Canning Basin and in the Precambrian basement rocks.

Dissected Hills.

The most prominent ranges and hills on the Sheet are the Murabba Range, Evans Hills, Waterlander Range, Sydney Margaret Range, Erica Range, Red Cliff Pound, Stansmore Range, White Hills, Warri Peak and isolated mesas and buttes of the desert. The highest peaks in the Stansmore Range are about 1670 feet above sea level and the highest hills in the eastern area are about 1250 feet high.

Strike ridges of hard quartz sandstone and silicified sandstone are common throughout the Sheet area, and rise about 150 feet above plain level. "Pounds" have formed at Red Cliff Pound and in the Sydney Margaret and Stansmore Ranges. The familiar mesas and buttes, resulting from the dissection of flat-lying sediments or lateritic caps, constitute the main hills of the Canning Basin within the Sheet area; they mostly rise 30-120 feet above the plain.

Sand Plain

Sand plain covers most of the Stansmore Sheet. Much of it is notable for the presence of innumerable seif chain dunes. The measured heights give no indication of a pronounced regional slope; the plain is nearly level, ranging from 1350 feet to 1100 feet above sea level. The seif dunes may stretch for 50 miles, are mostly half a mile to two miles apart, and average 40 feet in height, with some up to 100 feet. Some small areas, of 50 square miles or less, are covered by dense braided dunes which may be only a few yards apart. The dunes have migrated westward but they are now fixed by a sparse growth of spinifex, small shrubs and herbaceous plants. The crests of some dunes are devoid of vegetation.

Playa Lakes

Lakes Wills, White, and Hazlett, in the eastern half of the Sheet area, are salt lakes formed by internal drainage. Some small salt pans are present on the western margin of the Sheet, but the largest is only 2 miles across.

The formation and shape of the easternmost salt lakes have been controlled by the structure and lithology of the upper Proterozoic rocks. Lake White on the north-eastern corner of the Sheet has a bed of impermeable laminated claystone and sandstone of the Lucas Beds. The larger salt lakes are connected by salt-encrusted stream channels and the pattern on the lake surface and in the stream bed suggests movement of water from one lake to another.

The only height measured was at Lake White, which is 1060 feet above sea level. The stream pattern shows that water drains southward from the northern into the southern arm of Lake White, but its movement farther south has not been ascertained.

Drainage Channels

The Sheet area contains no large drainage channels. Numerous small streams, such as Warr Creek, drain the Stansmore Range and flow on to the sand plain and disappear in a proliferation of distributaries. Alluvial fans mark their debouchment on to the plain, and some have accumulated narrow piedmont deposits. Similar well developed drainage channels with deeply dissected courses are present on areas of exposed sedimentary rocks in the western area and in some of the dissected ridges on the eastern margin of the Sheet. However some streams in this eastern area such as Brookman Waters, Nickel Creek and unnamed creeks draining the Murraba Range and the Sydney Margaret Range drain directly into Lakes Hazlett, Wills, and White. Brookham Waters is reported to be fed by a spring by Terry (1937).

Most of the drainage is subterranean, and water draining from the eastern slopes of the Stansmore Range flows towards the salt lakes by passage through the surface sand layers. Subterranean drainage from the western slopes of the Stansmore Range is no doubt responsible for the salt lakes near the western margin of the Sheet and for the large deposits of caliche and travertine near the western and south-western margins of the Sheet.

Development of Topography

The area has reached a stage of late maturity. The initial surface (Cotton, 1945, p.39) in this area was probably first lateritized and later subjected to desert weathering, leaving breakaway scarps, and is in the process of reduction to a plain of arid erosion at a lower level. The initial plain, however, was probably modified by some structural elements of the Palaeozoic and Mesozoic rocks and partly by the basement rocks in the east. The strike ridges in the Precambrian rocks persisted: in the south-eastern part of the Sheet south of Brookman Waters, Palaeozoic rocks are preserved in low-lying areas in the Upper Proterozoic rocks. The basin sediments are being dissected in a large area in the Stansmore Range, but elsewhere the landform has resulted by erosion of mountains. The mountains were rimmed by pediments which gradually coalesced to give a pediplain with residual hills. Pediments were later modified by deflation and redistributed to form plains and seif dunes. Dunes grew in height and width largely through the action of cross winds. The mesa and butte topography was a result of differential weathering aided by rain-wash.

The predominant land forms therefore, are plains, including playas with alkali flats; bajadas; pediments; and structural plains. Structural plains are probably the most important. The bajadas are small and poorly developed; in most cases alluvial fans have not coalesced sufficiently to form true bajadas.

The internal drainage has formed local and temporary base levels which were aggraded during dissection of the highlands. The continued rise of local base levels as a result of basin aggradation has controlled the reduction of the upland areas.

STRATIGRAPHY

The rocks exposed include a large area of Permian, Mesozoic, and Quaternary sediments in the western half of the Sheet and predominantly Precambrian basement rocks in the eastern half of the Sheet. A synopsis of the stratigraphic succession is shown in Table 2. Selected rock specimens have been described by Lovering (in Casey & Wells, 1961).

PRECAMBRIAN

The Precambrian rocks have been divided into Upper and Lower Proterozoic. The validity of this twofold division has been demonstrated on the adjoining Lucas Sheet, where a long time break marked by considerable erosion, occurs between the Lower Proterozoic metamorphics and granitic intrusions and the Upper Proterozoic quartz sandstones.

On this Sheet, only one or two small areas of metamorphics (Halls Creek Metamorphics of Traves, 1956) have been identified; they were photointerpreted but not visited in the field. They show steep dips and intricate fold structures. The lithology is not known (a comparison of photopatterns with neighbouring outcrops that have been visited suggests that it consists of slate and quartzite). The neighbouring outcrops of Upper Proterozoic rocks by comparison show only gentle dips.

The Upper Proterozoic rocks in the north-east Canning Basin have been divided into Kearney Beds, Gardiner Beds, and Phillipson Beds on the basis of their distribution, structure, and lithology. They may be co-eval, although possible contacts have been demonstrated on the northern half of the Sheet.

The Kearney Beds (Casey & Wells, 1961) have not been mapped on this Sheet, but the silicified quartz sandstones in some outcrops near Carnegie Bluff may belong to them. There is no sharp dividing line between the possible Kearney Beds and the Gardiner Beds to the east. The beds are silicified sandstone with some thin conglomerate geds and fine clay pellets, and generally have steep dips. Bedding is not easily visible and the rock is generally massive and breaks unevenly. In some outcrops the rock is bedded, but still breaks irregularly.

Gardiner Beds (Casey & Wells, 1961)

The Gardiner Beds are the most widespread Upper Proterozoic rocks on this Sheet and show the widest range of lithology. They are in some places hard and silicified and in others friable and porous. The quartz sandstone varies from fine to medium grained. Some sections are composed dominantly of fine laminated siltstone. Bedding is very thick in some of the coarser silicified quartz sandstones and well developed jointing is a characteristic feature. Most of the sandstone is well sorted, but rare pebbles, clay pellets, and muscovite occur. In some recently dissected sections of the Gardiner Beds (e.g. S55) shale, medium-grained sandstone, and coarse sandstone are rhythmically bedded; the shale is drag folded. Some thin conglomerate beds occur in the sandstone, with quartz and chert pebbles up to about ½" across. Cross-bedding and ripple marks are commonly seen in the sandstone. Smooth bedding-planes are characteristic of the better sorted quartz sandstones.

At Red Cliff Pound the friable sandstone and shale dip at about 25-30° on the eastern limb of a syncline, but the corresponding beds on the western limb are almost vertical. At S61 the beds are silicified sandstone with numerous quartz and ladder veins. The rock contains some thin fine conglomerate beds. Much of the sandstone is laminated, but silicification of the rock gives it a massive appearance. Cross-bedding is common. Dolomite occurs in the Gardiner Beds at Brookman Water (near S81) and Red Cliff Pound (S82). At both localities the dolomite is fine-grained, pink, and laminated. At C82 on the eastern margin of Red Cliff Pound the dolomite is current-bedded and ripple marked.

From photointerpreted outcrops in the Red Cliff Pound area it appears that the thickness exposed is about 5000 feet, but the thickest measured section was about 250 feet.

Phillipson Beds. (Casey & Wells, 1961)

The Phillipson Beds are the least altered of the three groups of Upper Proterozoic rocks. The beds occur in several small outcrops in the north-eastern part of the Sheet and appear to conformably overlie the Gardiner Beds. The contact is gradational, with no apparent break in sedimentation. Dips in the sediment are generally less than 10° and the rock is friable. It has wave ripple marks, is well sorted and current bedded, and bedding planes are very smooth. The thickness of the Phillipson Beds is about 200 feet.

PALAEOZOIC

Lucas Beds

The Lucas Beds crop out in a small area on the north-east corner of the Sheet, where they have been deposited in a small basin in Upper Proterozoic sandstone. The beds consist of calcareous sandstone, showing lustre mottling, and interbedded shale, which form the impermeable bed of Lake Lucas. The outcrops on this Sheet have no relief and for the most part are covered by sand; strike lines are visible on the aerial photographs. The beds dip consistently at 3-4° to the east-north-east The stratigraphical position of the Lucas Beds is unknown. They unconformably overlie Upper Proterozoic rocks and at Yam Hill on the neighbouring Lucas Sheet are overlain by horizontal rocks possibly Permian in age. In some places the photo-pattern is suggestive of the Noonkanbah Formation, but there is no fossil evidence to suggest correlation with any Palaeozoic or Mesozoic rocks of the Canning Basin.

PERMIAN.

Numerous plant and marine macro- and micro-fossil localities in the sedimentary rocks on the western half of the Sheet prove the widespread occurrence and predominance of Permian rocks. The sediments are well exposed in the Stansmore Range, where dissected fold structures are present. The Grant Formation and Poole Sandstone have not been recognized and Palaeozoic rocks (other than the Lucas Beds) older than Permian are absent, although they may be overlapped by the Permian rocks.

The oldest Permian formation exposed, the Noonkanbah Formation, crops out in small areas in the Stansmore Range. At S11(a) the Noonkanbah Formation consists of coarse calcareous sandstone which contains many concretions and is faulted against the Condren Sandstone Member and the Balgo Member of the Liveringa Formation.

No other sections that could be assigned to the Noonkanbah Formation were seen. No fossils were found and the outcrops are mapped by lithology and photopattern and stratigraphical position only, but in the southern part of the Waterlander Range, at S 74 just south of the Stansmore Sheet, numerous fragments of arenaceous foraminifera-*Hyperammina coleyi* Parr & *Hyperammininita rudis* (Parr) - are present in a siltstone (I.Crespin, pers.comm.). Both species are fairly common in the Noonkanbah Formation of the Fitzroy Basin.

In the N.E. Canning Basin the Liveringa Formation has been divided into three members - the Balgo Member, the Condren Sandstone Member and the Hardman Member. The marine Hardman Member is not present on this Sheet. The fossiliferous marine Balgo Member crops out over a very large area and consists of ferruginous shale, fine and coarse sandstone, and quartz greywacke. The member has no characteristic topographic expression but mostly forms low ferruginized rises, crops out at the base of breakaways where it is overlain by more resistant beds, or, rarely, forms steep-sided breakaways where resistant sandstone beds occur in the member, or where steeply dipping beds are dissected. The Balgo Member is similar in lithology to the Noonkanbah Formation except that it contains no calcareous or coquina beds. The greatest measured thickness of the Balgo Member is 260 feet, but the dissected sediments of the Member in folds in the Stansmore Range indicate that the maximum thickness is possibly 800 feet.

The Balgo Member is overlain by the Condren Sandstone Member with no apparent discordance between them. The Condren Sandstone Member differs greatly in lithology from the Balgo Member and consists predominantly of quartz sandstone which is in some places unsorted and has fine conglomerate laminae and scattered pebbles. Ripple marks and cross-bedding are common and mica is present in the interbedded well-bedded finer-grained sandstone. Wood and fossil plant fragments are common. The coarser sandstone is generally massive. The thickest measured section of the Condren Sandstone Member is 250 feet, but sections measured in dissected folded sediments of the Member in the Stansmore Range indicate a maximum thickness of about 1000 feet.

The basal marine and middle plant-bearing members of the Liveringa Formation corresponding to the Balgo and Condren Sandstone Members were first recognised in the Fitzroy Basin (Guppy et al., 1958) but were not differentiated in the geological maps.

TRIASSIC

Only photointerpreted outcrops of the Blina Shale are mapped on this Sheet. These outcrops have a similar photopattern to the fine micaceous sandstone and shale of the Blina Shale found in other areas in the north-east Canning Basin.

CRETACEOUS.

Probable Cretaceous rocks occur as duricrusted mesa cappings in small isolated outcrops in various parts of the Sheet. The more easterly outcrops are of fine well-bedded sandstone or siltstone, and the more westerly of claystone. The only fossils found in the Sheet area, are radiolaria from S60 (cf Cenosphaera, I. Crespin, pers. comm.). The thickest measured section is 35 feet, but one unmeasured section, at S61, which abuts against Upper Proterozoic rocks and dips at 25° - 30° off them, may be thicker.

The Cretaceous sediments unconformably overlie Upper Proterozoic dolomites and the Gardiner Beds. Other radiolaria-bearing fine sediments have been found in the southern part of the Canning Basin on the Morris 4-mile sheet (F/51-16). The Cretaceous Godfrey Beds on the adjacent Cornish 4-mile Sheet (F/52-1) are predominantly sandstones and contain the worm Rhizocorallium and the pelecypod Etea ? sp. (J.M. Dickins, pers.comm.).

TERTIARY

Pisolitic ironstone and laterite cover many of the Palaeozoic sediments of the Canning Basin but are rare on the Proterozoic rocks. In the Sydney Margaret Range at S54, 40 feet of limonite and limonitic breccia overlie silicified sandstone of the Gardiner Beds. This deposit of very dark brown limonite does not appear to be part of a laterite profile. It occurs on the banks of a small gorge and on top of the low surrounding hills. The deposit may be formed by a spring or as a small lake deposit from waters impounded upstream, in the synclinal basin.

A laterite profile with pisolitic ironstone cap up to 15 feet thick is developed on the clayey sediments in the Permian rocks, particularly those of the Balgo Member. No laterite profile is developed on the Condren Sandstone Member, but a pisolitic ironstone crust has formed in some places.

QUATERNARY

Alluvium only occurs as small fan deposits where small upland streams terminate on the sand plain. Black soil occurs as a thin veneer, chiefly on the flat-lying clayey sediments of the Balgo Member in the western area. Caliche and travertine are present near the large salt lakes and cover large areas on the south-western and western sectors of the Sheet. The western deposits consist of low rounded hills of thick travertine which has probably formed in low-lying areas by evaporation of ground water. Thin deposits of evaporites occur on the salt lakes. Evaporites on the surface of Lake White consist of hard travertine lumps scattered on the surface of the lake or set in half an inch of white calcareous powdery caliche, which is underlain by about 2 inches of crystalline salts, probably calcium sulphate and sodium chloride.

STRUCTURE

The two principal structural units on this Sheet are the intracratonic Canning Basin and the Precambrian basement rocks which form the floor and margins of the basin. A minor basin, the Lucas Basin, lies in the north-east corner of the Sheet.

The basement rocks cropping out in the eastern half of the Sheet are faulted and asymmetrically folded and although few faults have been mapped, others may be obscured by Quaternary deposits. The degree of folding in the Precambrian rocks varies greatly and dips from horizontal to nearly vertical were measured but no overturning has been seen. The major fold axes generally trend parallel to the margin of the basin.

The Lucas Basin in the north-eastern corner of the Sheet contains calcarenites and lutites (the Lucas Beds) deposited in a depression in Upper Proterozoic rocks. The sediments are tilted to the east at about 3°. Trend-lines on the bed of Lake White demonstrate the presence of dip faults with small displacements, but no strike faults are visible.

The flat-lying basin sediments in the western half of the Sheet are separated from the Precambrian rocks to the east by a fault which terminated the Stansmore Range on the east side.

The attitude of the Permian sediments changes from near horizontal west of the fault into basins and domes, which become more disturbed as the fault line is approached; sand usually obscures the sediments east of the fault line.

The structure in this area, including both the fault and the associated folds, is called the Stansmore Structure, and it probably represents the south-eastern extension of the Lonergan Hinge, a Palaeozoic feature which divides the cratonic shelf into an eastern stable shelf and a western unstable zone in the Mount Bannerman area.

Dips in the folds of the Stansmore Structure range up to 40° near the main fault; other smaller but parallel faults also are present.

The throw of the main fault cannot be measured in outcrop because of the poor exposures to the east, but gravity contours show a steep gradient across the Structure and they have been interpreted by Garrett (1956) to indicate a throw of 7800 feet down to the west, assuming a density contrast of 0.4gm/cc..

The zone of steep gravity gradients continues to the south-west, where it corresponds with a large fault in the Evans Hills. However the steep gravity gradients do not follow the Stansmore Structure: it swings away to the north-west, but the gradients continue to trend to the north.

The gravity high near the west of the sheet is likely to be related to thinning of the Proterozoic sediments. The Bouguer anomalies allow a great thickness of sediments even over this high.

The broad negative anomaly at the north-east corner of the Sheet coincides with the small Lucas Basin. There is no surface indication of the prominent positive anomaly near the centre of the Sheet. It could indicate the presence of Lower Proterozoic granite or metamorphics at a shallow depth beneath the upper Proterozoic sediments.

ECONOMIC GEOLOGY.

Petroleum Potentialities

The sediments exposed over the western half of the Sheet and in the Stansmore Range contain possible source beds for petroleum. From the structural interpretation of this area, pre-Permian Palaeozoic rocks may occur in the trough area near the Stansmore Range and act as source beds for petroleum. Reservoir as well as source rocks are known in the Ordovician and Devonian elsewhere in the Fitzroy Basin and rocks of this age may extend tothis Sheet at depth. Suitable cap rocks are present in the exposed Permian sediments. Upper Devonian and Ordovician rocks exposed to the north (Knobby Hills area) are shoreline or shelf deposits, which may have deeper water equivalents in the basin areas in the western part of the Stansmore Sheet.

Gravity information suggests that the Canning Basin on this Sheet contains both a trough and a shelf. The hingeline between the two is probably represented by the Stansmore Structure and is a continuation of the Lonergan Hinge near Lake Lonergan on the Mount Bannerman Sheet. The Lonergan Hinge area may include closed anticlines and Ordovician and Devonian organic reefs may have developed along it, and in several hingeline areas are attractive areas for petroleum exploration,

The small area of Lucas Beds in a small basin on the north-east corner is not known to contain any source beds or structures suitable for petroleum accumulations.

Water

There is no immediate demand for either subterranean or surface water on this Sheet. In the Canning Basin area good supplies of ground water are generally present at depths from 20 to 80 feet and may yield 200 to more than 2,000 gallons per hour. A similar yield could be expected in areas of Precambrian sandstone on the eastern margin of the Sheet. Saline water would be yielded from rocks near salt lakes in flat-lying areas underlain by the Noonkanbah Formation or Balgo Member and in the calcareous sediments of the Lucas Beds.

Surface water occurs chiefly as semi-permanent pools in the creeks, or small rock-holes. Lucky Pool, a small pool in a creek in the Sydney Margaret Range named by Terry in 1937, was dry when visited by the Bureau of Mineral Resources party in 1956. Several small rock-holes with small supplies of fresh water occur on the top of breakaways at Brookman Waters, but pools in the creek bed contain saline water. Several large rock-holes with fresh water occur in the creeks draining the dissected sediments in the Stansmore Range.

Dolomite

Dolomite crops out on the eastern and western margins of Red Cliff Pound. Megascopically the rock is a very fine grained bedded deposit and is slightly sandy. Large reserves are available, but they are too inaccessible for exploitation.

Evaporites

Thin deposits of evaporites occur on the numerous salt lakes and probably consist of a mixture of sodium chloride and calcium sulphate.

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TABLE 2. STRATIGRAPHY OF THE STANSMORE SHEET

AGE		FORMATION	MAP SYMBOL	THICKNESS	LITHOLOGY	FOSSILS	CORRELATION
QUATERNARY	RECENT		Qa and Qb Qs Qt Qc Ql	20'+ 0-120'± 1'+ 1'± 10'±	Alluvium and black soil Aeolian sand Evaporites Caliche and tufa Travertine		
TERTIARY			Tp	30'±	Laterite profile & isolated outcrops of pisolitic ironstone.		
MESOZOIC	CRETACEOUS	Undifferentiated	K?	35'+	Fine white claystone and well bedded white sandstone	Indeterminate radiolaria cf. *Cenosphaera*.	Godfrey Beds of N.E. Canning Basin and radiolaria-bearing rocks of S. Canning Basin.
	TRIASSIC	Blina Shale	Rb	100'+	Fine micaceous sandstone and shale.		Blina Shale in Fitzroy Basin.
		--DISCONFORMITY?--					
PALAEOZOIC	PERMIAN	Liveringa Formation: Condren Sandstone Member.	Pr	1000'±	Quartz sandstone, with fine conglomerate laminae and some scattered pebbles.	Plant fossils *Gangamopteris*, *Glossopteris*.	Plant-bearing beds in Liveringa Formation of Fitzroy Basin (Guppy et al.1958)
		Liveringa Formation: Balgo Member	Po	800'±	Ferruginous shale, fine & coarse sandstone and quartz greywacke.	Marine fossils *Atomodesma exarata*, *A. fletcheri*, *Stutchburia* cf. *muderongensis* *Aviculopecten*?cf. *hardmani*	Lightjack Member of Fitzroy Basin (Guppy et al.1958).
		Noonkanbah Formation	Pn	100'+	Coarse calcareous sandstone with many concretions.	-	Dora Shale of S.W. Canning Basin and Noonkanbah Formation of Fitzroy Basin.
	Undifferentiated	Lucas Beds	P21	100'+	Calcareous sandstone with lustre mottling, interbedded with laminated claystone.	-	Possibly equivalent in age to extensions of L.Palaeozoic rocks from the Northern Territory.
		---UNCONFORMITY---					
PROTEROZOIC	UPPER	Phillipson Beds	Pui	200'±	Friable current-bedded ripple marked quartz sandstone with some scattered pebbles.	-	
		Gardiner Beds	Pud	250'measured 5000'app. photo-interpreted ±	Fine & medium grained quartz sandstone, laminated siltstone. Well sorted. Thin conglomerate beds, and inter bedded dolomite.	-	Kimberley Plateau Succession
		---UNCONFORMITY---					
	LOWER	Lewis Granite (section only)	Plw		Granite batholiths with quartz dykes.	-	Granite of Lamboo Complex
		Halls Creek Metamorphics.	Plh	-	Slate & quartzite	-	Halls Creek Metamorphics & metamorphics of Lamboo Complex

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STANSMORE

WESTERN AUSTRALIA

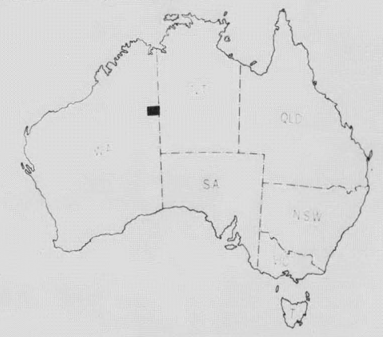
4 MILE GEOLOGICAL SERIES SHEET F 52-6

Reference

CAINOZOIC	QUATERNARY		Qb	Black soil
			Qa	Alluvium
			Qs	Sand
			Ql	Hard travertine, tufa
			Qc	Caliche or travertine powder
			Qt	Evaporites
	TERTIARY		Tp	Pisolitic ironstone
MESOZOIC	CRETACEOUS		K	Siltstone and claystone
	TRIASSIC	Blina Shale	Rb	Shale and fine sandstone
		Disconformity		
PALAEOZOIC	PERMIAN	Liveringa Formation: Condren Sandstone Member	Pr	Medium sandstone with some fine micaceous sandstone and fine conglomerate
		Liveringa Formation: Balgo Member	Po	Sandstone, quartz greywacke with some greywacke
		Noonkanbah Formation	Pn	Quartz greywacke, shale and fine sandstone
		Undifferentiated	P	Sandstone and shale
	UNDIFFERENTIATED		Pz	Undifferentiated sediments
		Lucas Beds	Pzl	Calcareous sandstone and claystone
		Unconformity		
PROTEROZOIC	UPPER	Phillipson Beds	Pui	Soft quartz-sandstone
		Gardiner Beds	Pud	Shale, silicified sandstone, dolomite and some fine conglomerate
		Unconformity		
	LOWER	Lewis Granite	Plw	(section only)
		Halls Creek Metamorphics	Plh	Slate and quartzite

- Established geological boundary, position approximate
- Inferred boundary
- Established fault, position approximate, relative movement and dip indicated where known
- Established fault, concealed
- Inferred fault
- Inferred fault, concealed
- Strike and dip of strata
- Vertical strata
- Horizontal strata
- Dip < 15° (air-photo interpretation)
- Dip 15°— 45° (air-photo interpretation)
- Dip > 45° (air-photo interpretation)
- Trend of bedding (air-photo interpretation)
- Joint pattern (air-photo interpretation)
- Strike and dip of cleavage
- Marine macrofossil locality
- Marine microfossil locality
- Plant fossil locality
- ×558 Text reference to specimen locality
- Route of geological party's traverse
- Sand dunes
- W.H. Waterhole
- R.H. Rockhole
- P.D. Position doubtful
- State boundary
- •1153 Height in feet, barometric, datum: mean sea level Derby
- A53 Astro station

Compiled and published by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development.
Transverse Mercator Projection.



INDEX TO ADJOINING SHEETS

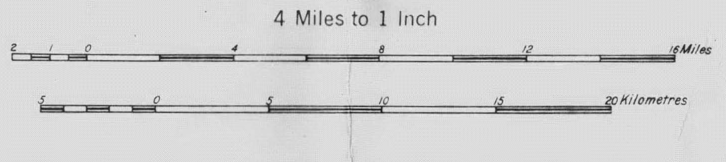
Showing Magnetic Declination

CORNISH	LUCAS	THE GRANITES
HELENA	STANSMORE	HIGHLAND ROCKS
WILSON	WEBB	LAKE MACKAY

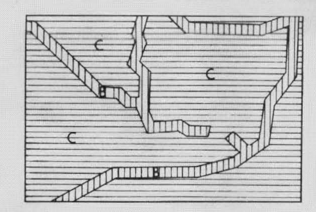
ANNUAL CHANGE 0°40'E

Scale

4 Miles to 1 Inch



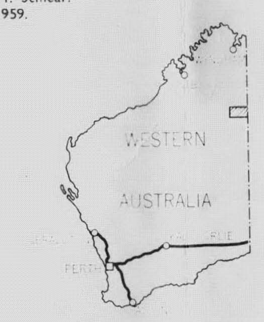
GEOLOGICAL RELIABILITY DIAGRAM



B. Reconnaissance—regional traverses and air-photo interpretation

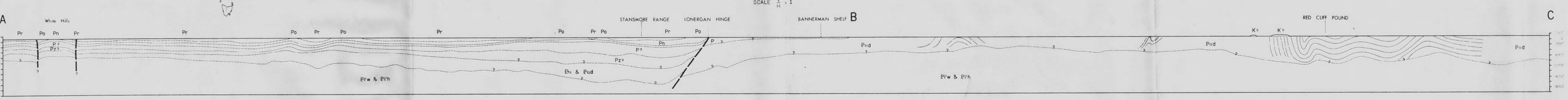
C. Sketchy—air-photo interpretation

Geology by: J.N. Casey, A.T. Wells, B.H. Stinear.
Compiled by: J.N. Casey, A.T. Wells, 1959.
Drawn by: Adastra Aerial Surveys.

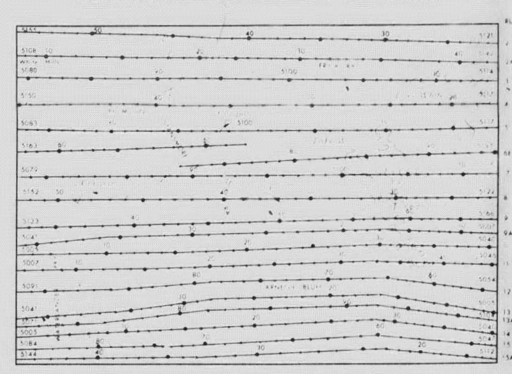


Section A—B—C

SCALE V/H : 1



AIR-PHOTOGRAPH FLIGHT DIAGRAM



Air-photography by the Royal Australian Air Force ; complete vertical coverage at 1 : 50000 scale ; Mission Numbers 961 1477 1478 1494 1545 1549 [illegible] 1555 1556 1557 1558 1559 1560 1568 1574 June 1950 - July 1953

STANSMORE

SHEET F 52-6

Copies of this map may be obtained from the Bureau of Mineral Resources, Geology and Geophysics, Canberra, A.C.T., or Darwin, N.T.