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DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS

RECORDS:

1967/36

ORIENTATION GEOCHEMICAL SAMPLING IN THE LANSDOWNE 1:250,000 SHEET AREA SE 52-5, WESTERN AUSTRALIA.

by

D.C. Gellatly

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CONTENTS

INTRODUCTION

The geochemical sampling described in this report was carried out during regional mapping of the Lansdowne 1:250,000 Sheet area, Western Australia by a joint Bureau of Mineral Resources and Geological Survey of Western Australia geological field party in 1964 (Gellatly, Derrick and Plumb, 1965). The geological work forms part of a programme of regional mapping commenced in 1962with the object of mapping the whole of the Kimberley region on 1:250,000 scale. In addition to the mapping, orientation geochemical samples were collected as time permitted. Sampling was confined mainly to the northern part of the Sheet area outside a Temporary Reserve for prospecting for base metals held by Pickands Mather International.

The formation most intensively sampled was the Carson Volcanics, which was known from previous mapping to contain traces of chalcopyrite. The most striking results have been obtained from outcrop samples of gossanous quartz veins cutting the Whitewater Volcanics. Partly because of the anomalous values obtained from these samples and partly because of indications in adjoining areas, all rock specimens collected from the Whitewater Volcanics are being analysed for Cu, Pb, Zn, Co, Ni, Cd, Ag, Sb, Mn.

The results presented here give some indication of the general trace element background values to be expected in certain of the formations in the area, and of the more favourable rock types for prospecting in this area, and possibly also in adjoining areas in the Kimberleys.

The collection of the specimens and the preparation of the accompanying geological map have been carried out by D.C. Gellatly, G.M. Derrick, K.A. Plumb, and A.D. Allen[1]. The analytical work was done by A.D. Haldane assisted by W. Hibberson.

METHODS

Sampling Methods

The Kimberley area is one of moderately low rainfall (20 in. to 30 in.) with a long dry winter, when the field work was carried out, and consequently it was possible to collect all geochemical samples in the dry state. The methods outlined by Mather (1964) were followed in collecting all the sediment samples. In most localities stream bottom alluvium was collected but in a few localities where sample spacing closer than the drainage channels was required, residual soils were sampled. These samples were sieved through nylon 80 mesh sieves and the minus 80 mesh portion retained for analysis. Nine heavy mineral concentrates prepared by panning stream sands were submitted for analysis to test for the presence of valuable heavy detrital minerals. In addition, a few rock specimens, mainly slightly gossanous quartz veins from the Whitewater Volcanics, were collected for analysis.

Analytical Methods

Trace element contents were determined spectrographically on a Hilger Large Littrow Spectrograph. Ni, Co, Cu and V are reported for all specimens. Other trace element contents are reported only where the amounts are significantly above the limits of detectability.

[1] Geological Survey of Western Australia.

GENERAL GEOLOGY

The Lansdowne Sheet area is underlain almost entirely by Precambrian rocks that range in age from ?Archaean through Carpentarian to Adelaidean. Most of the rocks in the area are assigned to the Carpentarian.

The oldest rocks present in the area, the Halls Creek Group, of ?Archaean age consist of shales and greywackes which have been tightly folded and metamorphosed to low Greenschist Facies. These rocks are overlain unconformably by the Whitewater Volcanics which constitute the basal formation of the Carpentarian succession. Granites of the Lamboo Complex intrude the Halls Creek Group and the Whitewater Volcanics.

The Whitewater Volcanics are overlain with slight angular unconformity by the Carpentarian Kimberley Basin Succession comprised of the Speewah, Kimberley and Bastion Groups. These form part of a continuous sequence and consist respectively of feldspathic arenites and lutites; arenites and basic volcanics with minor lutites and carbonates; and lutites. This succession is extensively intruded by dolerite with associated granophyre, and is overlain unconformably by the Adelaidean Mount House Group which consists of tillite, dolomite, lutite, and arenite.

A summary of the lithologies of the Precambrian formations of the Lansdowne 1:250,000 Sheet area is given in Table 1.

EXPLANATION OF RESULTS

The results of the analyses are tabulated in Table 2 where they are grouped according to the dominant rock formation acting as the source for the sediments. Average values for the Lansdowne sediments are given in Table 3. For purposes of general comparison some average trace element contents of common rock types (from Turekian and Wedepohl, 1961) are given in Table 4. The localities of all specimens listed are shown on the accompanying 1:250,000 outline geological map.

(I) Halls Creek Group

The main interest in the Halls Creek Group is its gold mineralisation to the south-east in the Halls Creek area. Only a few samples derived from Halls Creek Group source rocks have been collected in the Lansdowne area, mainly from the O'Donnell River, from near Wireless Creek, and from south of Six Mile Yard. The source rocks are predominantly phyllitic siltstone. Gold was not detected in any of the samples. They show relatively low values of Ni(5- to 12), Co(10 to 15) Cu(2- to 15), and V(20 to 50) with Pb present in small amounts. Although the metal contents are low, Cu is appreciably higher than in some of the other siltstones (see Elgee Siltstone) in the area.

(2) Whitewater Volcanics

Minor copper mineralisation was recorded in the field from the Greenvale Fault where it cuts Whitewater Volcanics about 3 miles north-west of Tumagee Yard. A few stream sediment samples from streams crossing the fault were collected to test for possible extensions of this mineralisation. The values obtained are too low to be considered anomalous, but only a very small part of the total length of the fault has been examined, and more detailed sampling along it should be undertaken.

All values are quoted in parts per million. Minus(-) after a figure denotes 'less than', and a plus (+) denotes 'more than'.

Some quartz veins carrying disseminated patches of earthy red-brown limonitic gossanous material were noted cutting the Whitewater Volcanics about six miles east of Goad's Yard. These, and gossanous specimens from the Greenvale Fault, gave Cu values ranging from 700 to 5000+ ppm, and lead up to 1500 ppm. The quartz veins range from one to four feet thick and are up to half a mile in length. Because of their low grade it is unlikely that any of the veins found so far could prove to be economic. However, to use the terminology of Zimmerman (1965), they may be regarded as "visible geochemical anomalies", and as such are indicators of an area that warrants further investigation.

(3) Acid Intrusives

Sand samples from creeks in the granite country in the south-west of the area were panned to test for the possible presence of tin. None was recorded. The presence of V in one of the samples is probably related to a moderately high magnetite content in the concentrate. The presence of Pb in this sample is curious but not sufficiently high (50 ppm) to be considered anomalous.

(4) Basic Intrusives

These samples are derived from the Hart Dolerite. Values obtained are in keeping with normal background values for basic igneous rocks. A high concentration of V in one concentrate is attributed to a high magnetite content.

(5) O'Donnell Formation

The two samples derived solely from rocks of this formation are similar to others derived from siltstones (e.g. from the Halls Creek Group) but contain higher Pb (50 ppm).

(6, 7) Lansdowne Arkose and King Leopold Sandstone

Conglomerates from these formations were sampled to test for the presence of valuable heavy detrital minerals. The conglomerates in the Lansdowne arkose, which is apparently derived from erosion of underlying Speewah Group Sandstones, is of no economic interest, but that from the King Leopold Sandstone, which includes pebbles and cobbles of vein quartz, contains 150 ppm of Sn. This conglomerate has been traced continuously over a strike length of 32 miles in the King Leopold Ranges between Lansdowne and Gigee Cliffs and intermittently for a further 40 miles. Its thickness varies from 25 feet down to 2 inches. (See accompanying map). It is considered to be worth further examination.

(8) Carson Volcanics

This formation, which consists essentially of basalt and spilite, has been sampled more extensively than the others in the area principally because it contains small amounts of disseminated chalcopyrite. The chalcopyrite is found mainly in spilitic flows that make up the basal 250 to 300 feet of the succession.

In order to investigate the distribution of copper throughout the succession closely-spaced samples were collected across the Carson Volcanics outcrop at three different localities. Sample spacing of about $\frac{1}{4}$ mile was closer than the drainage channels, and residual soils were thus sampled. With the possible exception of V which tends to be about 20% more abundant in the soils than in the stream sediments, metal values in the two types of sample are similar and the results are comparable.

Copper values throughout the basic rocks range from 5 to 50 ppm, with an average of about 30 ppm. Samples of soils and stream sediments derived from the basal spilites contain an insignificant 8 ppm of copper more than the other basic rocks. Values of all metals tested for are of the same order of magnitude as (though somewhat lower than) those reported for basalts by Turekian and Wedepohl (1961). Slightly anomalous values for lead (up to 50 ppm) in certain of the Lansdowne samples are probably due to small amounts of disseminated galena in the rocks. Traces of galena have been noted in the Carson Volcanics north-east of Elgee Homestead, but have not been reported from the Fitzroy Valley where these Pb-bearing soils occur.

(9) Elgee Siltstone.

Values for Ni, Co, Cu, and V are low in all samples derived from this formation. No other metals were reported. There are significant differences between samples derived from the Teronis Member (siltstone + dolomite) (marked T in Table 2), and those from the rest of the Elgee Siltstone. Those from the Teronis member average 10 ppm Cu and 32 ppm V as against 2ppm Cu and 11 ppm V for the rest of the formation.

(10) Mount House Group

These samples are derived mainly from the Throssell Shale. Values are similar to those from the Teronis Member of the Elgee Siltstone, but in addition, contain detectable amounts of Mo and up to 70 ppm of Pb.

SUMMARY AND CONCLUSIONS

The data presented above give a general idea of background values to be expected from the principal formations of the Lansdowne area. The values found, although locally anomalous, do not in themselves indicate the presence of economic mineralisation, but may be regarded as indicators of areas of possible economic value that warrant further work.

The principal anomalies worth further investigation are:-

(I) Mineralisation (mainly Cu) associated with the Greenvale Fault

(2) Mineralisation (mainly Cu and Pb) in Whitewater Volcanics, especially in the area about 6 miles east of Goad's Yard.

(3) The presence of tin in the King Leopold Sandstone conglomerate in the King Leopold Ranges north and north-east of Lansdowne Homestead.

The Carson Volcanics, despite the presence in them of visible chalcopyrite and galena, appear to be only poorly mineralised and are not considered to be worth further work in the areas already sampled.

Extensive parts of the Lansdowne Sheet area are not represented in the results presented here or are only poorly represented, and should be examined further as part of any systematic geochemical prospecting work in the area.

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Table 1

Summary of Precambrian Stratigraphy - Lansdowne 1:250,000 Sheet Area

Age	Group	Formation and Thickness (feet)	Lithology
ADELAIDEAN	MOUNT HOUSE GROUP	Estaughs Formation (255)	Hematitic quartz sandstone, and siltstone
		Throssell Shale (575)	Chloritic, micaceous shale
		Traine Formation (20 to 50)	Dolomitic sandstone; shale and dolomite
		Walsh Tillite (15 to 200)	Tillite, with overlying dolomite
CARPENTARIAN		Hart Dolerite	Dolerite and granophyre
CARPENTARIAN	BASTION GROUP	Mendena Formation (?100)	Siltstone, quartz sandstone, and feldspathic sandstone
	KIMBERLEY GROUP	Pentecost Sandstone (Ca 2,800)	Quartz sandstone and feldspathic sandstone; glauconitic sandstone
		Elgee Siltstone (700)	Red-brown siltstone: Teronis Member (70-300 feet) at base consists of grey shale and algal dolomite.
		Warton Sandstone (900-1200)	Quartz sandstone, and feldspathic sandstone.
		Carson Volcanics (1300-2300)	Tholeiitic basalt and spilite; chert and siltstone at top.
		King Leopold Sandstone (3500-4000)	Quartz sandstone; conglomerate and granule sandstone
	SPEEWAH GROUP	Luman Siltstone (240)	Micaceous shale and siltstone
		Lansdowne Arkose (1300-1600)	Feldspathic sandstone, quartz sandstone and arkose; siltstone
		Valentine Siltstone (140)	Grey mudstone and siltstone
		Tunganary Formation (740-940)	Feldspathic sandstone, siltstone
		O'Donnell Formation (480-760)	Quartz sandstone, siltstone
		Unconformity	
		Whitewater Volcanics (?6000-9000)	Quartz feldspar porphyry

TABLE 2 - ANALYTICAL RESULTS

Field No.	Source	Soil or Rock Type	Parent Material	Ni	Co	Cu	V	Other
(1) Halls Creek Group								
0160083	Heavy mineral conc.	Sedimentary	Phyllite	10	15	15	30	Pb(20)
0160084	Stream sed.	"	"	10	12	15	30	Pb(10)
0160088	"	"	"	12	15	15	50	Pb(10)
0160089	"	"	"	5-	12	15	40	Pb(10)
0160094	"	Composite	Phyllite+ rhyolite	5-	10	2-	25	
0160095	"	Sedimentary	Phyllite	5-	12	5	20	
0160096	"	"	"	7	12	7	25	
(2) Whitewater Volcanics								
0160071	Stream sed.	Igneous	Rhyolite	5-	15	2	30	
0160072	"	"	"	5-	15	7	30	
0160073	"	"	"	5-	12	10	30	
0160074	"	"	"	5-	10	2	30	
0160075	"	"	"	5	15	10	60	
0160086	Gossan	"	"	5-	15	700	5	Mo(30), Bi, Ag
0160097	"	"	"	30	20	5000	5-	Mo(10),I
0160098	"	"	"	50	20	15	12	I
0160101	"	"	"	60	20	5000+	30	Mo(50),I
0160102	"	"	"	50	12	700	20	Mo(3)Pb(
0160090	Heavy min. conc.	"	"	5-	10	2	20	
(3) Acid Intrusives								
0160085	Heavy min. conc.	Igneous	Granite	5-	5	2-	30	Pb(20)
0160092	"	"	"	5-	15	10	200	Pb(50)
0160093	"	"	"	5-	10	2	60	
(4) Basic Intrusives								
0160076	Stream sed.	Igneous	Dolerite	12	30	50	200	
0160077	"	"	"	5	15	12	80	
0160081	Heavy min. conc.	"	"			NO RESULT		
0160082	"	"	"			NO RESULT		
0160091	"	"	"	5	40	50	1500	
0160099	Outcrop	"	"	30	25	50	100	

0160033	"	"	"	5-	10	10	20	
0160034	"	"	"	5-	15	15	30	
0160035	"	"	"	20	20	40	60	
0160036	"	"	"	20	20	30	60	
0160037	"	"	"	20	20	20	60	
0160038	"	"	"	30	25	15	60	
0160039	"	"	"	50	25	30	80	
0160040	"	"	"	5-	5-	2	10	
0160041	"	"	Claystone	5-	7	2-	10	
0160051	Residual soil	"	Basaltic	5-	15	30	30	
0160052	"	"	"	5	10	30	30	
0160053	"	"	"	40	30	30	200	
0160054	"	"	"	12	20	30	100	
0160055	"	"	"	30	30	40	100	Pb(50)
0160056	"	"	"	15	25	30	100	Pb(30)
0160057	"	"	"	20	25	30	50	Pb(15)
0160058	"	"	"	5-	10	5	10	
0160059	"	"	"	10	20	15	50	
0160060	"	"	"	12	30	50	150	
0160061	"	"	"	50	30	30	100	Pb(10)
0160062	"	"	"	70	30	40	150	
0160063	"	"	"	40	20	35	100	
0160064	"	"	"	40	20	30	100	
0160065	Stream sed.	"	"	40	25	30	100	
0160066	Residual soil	"	"	40	20	30	100	
0160067	"	"	"	40	30	30	100	
0160068	"	"	"	70	30	40	100	
0160069	"	"	"	50	30	40	60	
0160070	"	"	"	30	30	50	200	

(9) Elgee Siltstone

0160023	Stream sed.	Sedimentary	Siltstone	5-	7	5	10	
0160030 T	"	"	"	10	12	7	40	
0160042	"	"	"	5-	12	2-	12	
0160043	"	"	"	5-	5	2-	7	
0160044	"	"	"	5-	10	2-	10	
0160045	"	"	"	5-	5	2	10	
0160046	"	"	"	5	10	2	15	
0160047T	"	"	"	5-	12	10	20	
0160048T	"	"	"	5-	7	12	10	
0160049T	"	"	"	5	12	7	30	
0160050T	"	"	"	12	20	15	60	

(5) O'Donnell Formation

0160078	Stream sed.	Sedimentary	Siltstone	5-	15	10	40	Pb50
0160079	"	"	"	5-	15	15	60	Pb50
0160080	"	"	Dolerite+ Siltstone	5-	25	70	400	

(6) Lansdowne Arkose

0160087	Heavy min. conc.	"	Conglomerate	5	20	30	400	

(7) King Leopold Sandstone

0160100	Outcrop	"	"	50	10	30	50	Sn(150), Pb(20).

(8) Carson Volcanics

0160001	Stream sed.	Igneous	Basaltic	50	30	50	100	
0160002	"	"	"	50	30	40	100	
0160003	"	"	"	30	30	40	100	
0160004	"	"	"	20	20	50	100	
0160005	"	"	"	50	40	40	100	
0160006	"	"	"	40	30	40	100	
0160007	"	"	"	40	30	30	80	
0160008	"	"	"	30	30	30	100	
0160009	"	"	"	40	30	30	100	
0160010	"	"	"	30	30	25	80	
0160011	"	"	"	30	25	30	100	
0160012	"	"	"	40	25	30	80	
0160013	"	"	"	40	25	30	80	
0160014	"	"	"	40	30	40	100	
0160015	"	"	"	10	20	20	100	
0160020	"	"	"	12	15	30	30	
0160021	"	"	"	5-	10	10	50	
0160024	Stream sed.	"	"	5-	12	7	40	
0160025	"	"	"	5-	15	12	30	
0160026	"	"	"	5	20	35	60	
0160027	"	"	"	15	25	40	100	
0160028	"	"	"	15	20	30	60	
0160029	"	"	"	20	30	40	80	
0160031	"	"	"	10	20	15	40	
0160032	"	"	"	5-	12	10	40	

(10) Mount House Group

0160016	Stream sed.	Sedimentary	Siltstone	5	15	12	60	Mo (3) Pb (10)
0160017	"	"	"	5-	7	5	12	Mo (2) Pb (10)
0160018	"	"	"	7	15	15	30	Mo (2) Pb (20)
0160019	"	"	"	10	20	30	60	Mo (15) Pb (70)

5- less than 5 ppm
5000+ greater than 5000 ppm
Plate Nos. 867-872
Serial No. 1948
T indicates sample derived from the Teronis Member of the Elgee Siltstone

TABLE 3

Average Trace element content of Lansdowne soils (grouped according to source rock type 1, 2)

Source rock type	Co	Cu	Mo	Ni	Pb	Sn	V
Basalt	23.0	29.4	-	25.4	2.0	-	80
Rhyolites (excludes associated gossans)	13.4	6.2	-	1.0	-	-	36
Siltstone and claystone	11.7	8.5	0.9	3.4	10.0	-	33.6

Notes: (1) Ignores heavy mineral concentrates

(2) In compiling these averages, amounts less than the limit of detectability have been treated as nil.

TABLE 4

Average trace element content of common rock types

(After Turekian and Wedpohl, 1961)

Rock Type	Co	Cu	Mo	Ni	Pb	Sn	V
Basalt	48	87	1.5	130	6	1.5	250
Granite (low Ca)	1	10	1.3	4.5	19	3	44
Shales	19	45	2.6	68	20	6	130

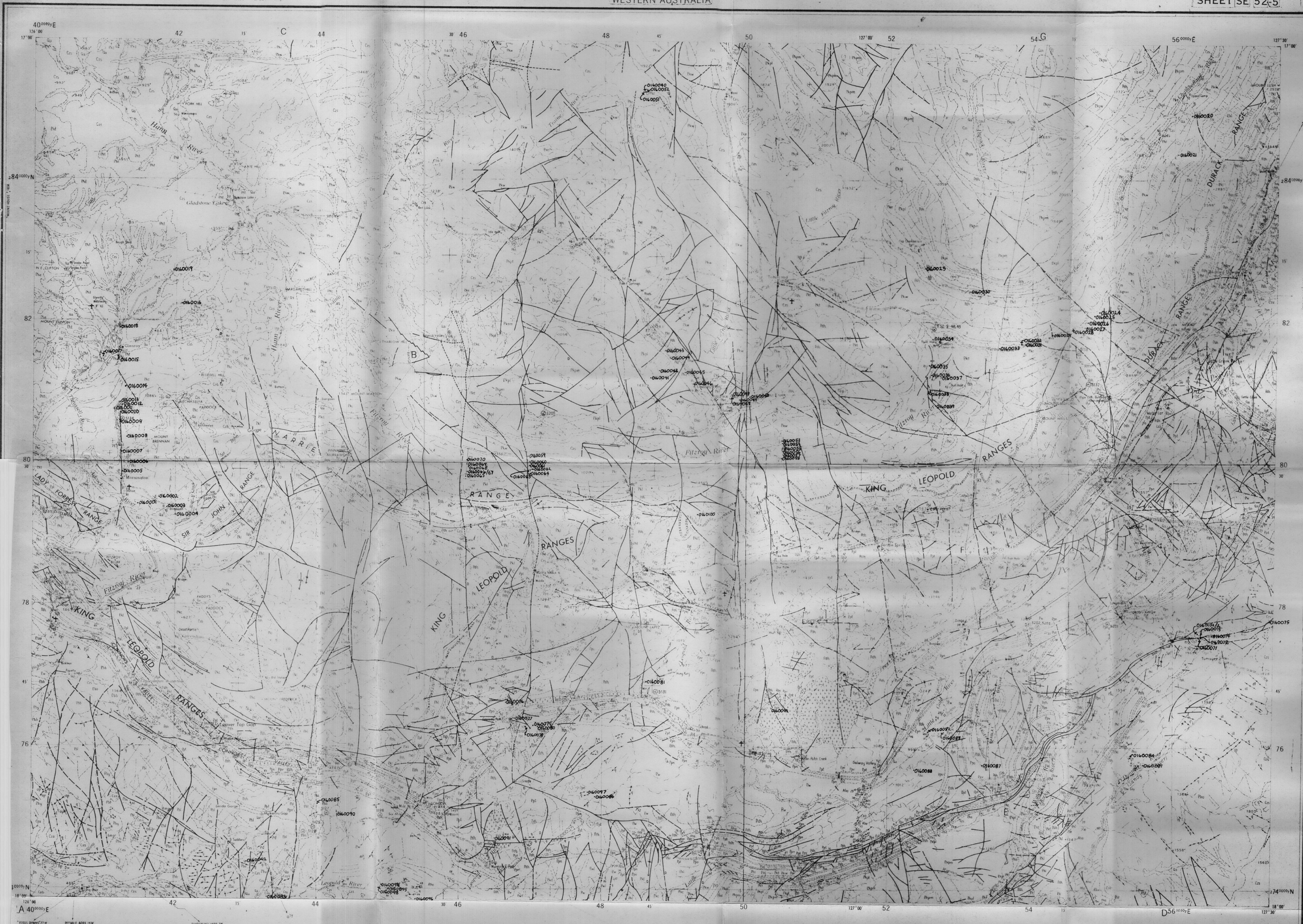
GEOCHEMICAL SAMPLE LOCALITIES

AUSTRALIA 1:250,000 GEOLOGICAL SERIES

LANSDOWNE
WESTERN AUSTRALIA

SHEET SE 52-5

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS
FIRST EDITION 1967



Reference

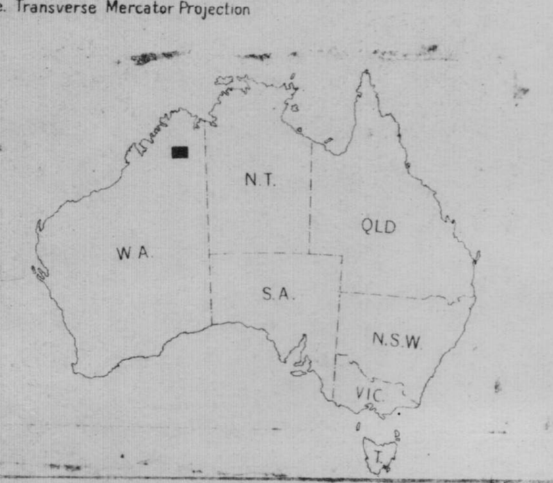
Era	Period / Age	Unit	Symbol	Description
CAINOZOIC	QUATERNARY		Qa	Alluvium: boulder gravels, fluviatile sand
	UNDIFFERENTIATED		Czs	Residual red and grey soils, sand, and ferricrete
			Czb	Residual black soil
PALAEOZOIC	DEVONIAN & (?) PERMIAN		D-Pc	Conglomerate: mainly pebbles, cobbles, and boulders of quartzite set in arkosic matrix
	DEVONIAN	Stony Creek Conglomerate	Ds	Conglomerate: pebbles, cobbles, and boulders of granite, quartz, quartzite, and sheared acid volcanics
	GIVETIAN (?) TO FAMENNIAN	Windjana Limestone	Dw	Reef facies: limestone with colonial organisms and interstitial calcareous sediment, partly dolomitised
		Pillara Limestone	Dp	Back-reef facies: well-bedded stromatoporoid limestone, partly dolomitised
	FAMENNIAN	Napier Formation	Dn	Fore-reef to inter-reef facies: silty limestone, calcarenite and calcirudite: partly dolomitised
PROTEROZOIC (UPPER PROTEROZOIC*)	ADELAIDEAN	Mount House Group: Estaughs Formation	Phe	Hematitic quartz sandstone and siltstone, purple-green micaceous siltstone and fine-grained subgreywacke
		Throssell Shale	Pht	Chloritic micaceous shale, grey-green micaceous sandstone, dolomitic sandstone, dolomitic breccia, flaggy dolomite
		Traine Formation	Pha	Purple-brown ferruginous sandstone*
		Walsh Tillite	Phw	Tillite, pink dolomite and quartz sandstone
UNDIFF.	ADELAIDEAN OR CARPENTARIAN	Hart Dolerite	Pdh	Pyroxene-bearing granophyre; Tholeiitic dolerite and gabbro
LOW. & MID. PROT.	CARPENTARIAN	Bastion Group: Mendena Formation	Ptm	Purple siltstone, quartz sandstone, micaceous feldspathic sandstone
		Kimberley Group: Pentecost Sandstone	Pkpu	Upper: coarse-to-medium-grained white quartz sandstone
			Pkpm	Middle: buff to white fine-to-medium-grained feldspathic sandstone and quartz sandstone, grey siltstone and glauconitic sandstone at base
			Pkpl	Lower: white to pale brown medium-grained quartz sandstone
		Elgee Siltstone	Pke	Red-brown friable siltstone, flaggy brown to white quartz sandstone
		Teronis Member	Pkt	Grey micaceous siltstone, limestone, and dolomite with algal structures
		Warton Sandstone	Pkw	Pale purple to brown feldspathic sandstone, white cross-bedded quartz sandstone
		Carson Volcanics	Pkc	Tholeiitic basalt and minor spilite, amygdaloidal in part; rhyolitic tuff and agglomerate, feldspathic sandstone, siltstone, limestone, chert
		King Leopold Sandstone	Pkl	Massive white to pale purple cross-bedded poorly sorted quartz sandstone, minor siltstone. Localised pebble to boulder conglomerate, granule sandstone
LOWER PROTEROZOIC		Speewah Group: Luman Siltstone	Ppl	Purple-grey and green-grey micaceous shale and siltstone
		Lansdowne Arkose	Ppo	Buff to pale pink cross-bedded feldspathic sandstone, arkose, purple-grey quartz sandstone; purple, green, and grey micaceous siltstone and shale
		Valentine Siltstone	Ppv	Chloritic siltstone, grey-green mudstone, feldspathic sandstone, rhyolitic tuff
		Tunganary Formation	Ppt	Buff to pale grey feldspathic sandstone, quartz sandstone, pink arkose, granule sandstone, grey-green shale, micaceous siltstone and chert
		O'Donnell Formation	Ppn	Khaki shale, siltstone, and greywacke; white, purple, and brown quartz sandstone, glauconitic sandstone, granule sandstone, conglomerate, localised feldspar porphyry
		Little Gold River Porphyry	Pwl	Dark grey orthopyroxene-feldspar porphyry with sporadic quartz phenocrysts; strongly xenolithic in places
		Whitewater Volcanics	Pw	Quartz-feldspar porphyry, feldspar-pyroxene porphyry, lapilli tuff, volcanic conglomerate: siltstone interbeds
		Lamboo Complex: Bickleys Porphyry	Pbb	Grey acid porphyry and porphyritic microgranite with quartz and feldspar phenocrysts
		Mulkerins Granite	Pbu	White coarse and even-grained leucocratic granite, tourmaline-muscovite aplite, quartz-feldspar pegmatite
		Lerida Granite	Pbl	Grey porphyritic biotite granite with pale green feldspar phenocrysts
		Chaneys Granite	Pby	Coarse and even-grained biotite granite, foliated and locally sheared
		Long Hole Granite	Pbg	Grey coarse-grained porphyritic biotite granite, biotite gneiss, augen gneiss
		Violet Valley Tonalite	Pbv	Medium to coarse-grained tonalite
		Bow River Granite	Pbo	Grey coarse-grained biotite granite, pink coarse-grained porphyritic biotite granite, minor granodiorite
		Tickalara Metamorphics	Pbt	Biotite paragneiss with cordierite, sillimanite and staurolite
ARCHAEAN OR PROTEROZOIC	ARCHAEAN OR LOW. PROT.	Halls Creek Group: Olympio Formation	Aho	Phyllitic shale and siltstone with interbedded greywacke, minor quartzite and limestone

* Subdivisions of the Precambrian time-scale used by the Geological Survey of Western Australia, shown in grey

- Geological boundary
- Anticline, showing plunge
- Syncline, showing plunge
- Monocline, showing plunge
- Plunge of minor anticline
- Plunge of minor syncline
- Plunge of drag fold
- Plunge of fold axes
- Fault, showing relative horizontal movement (q-indicates quartz filled); D-indicates downthrown side
- Vertical fault
- Inclined fault
- High-angle reverse fault
- Shear zone
- Where location of boundaries, folds, and faults is approximate, line is broken; where inferred, queried; where concealed, boundaries and folds are dotted, faults are shown by short dashes
- Strike and dip of strata
- Prevailing strike and dip of strata
- Vertical strata
- Horizontal strata
- Overturned strata
- Horizontal strata, Trend lines, Joint pattern — air-photo interpretation
- Vertical cleavage
- Strike and dip of foliation
- Prevailing strike and dip of foliation
- Vertical foliation
- Inclined platy flow
- Strike and dip of joints
- Strike and dip of cleavage
- Plunge of lineation
- Lineation on bedding

- Macrofossil locality
- Type section locality
- D1 Measured section with reference number
- 5131 Sample locality for age determination with reference number
- Dyke: q-quartz, dl-dolerite, rd-rhyodacite, tm gr-tourmaline granite, ap-aplite, rh-rhyolite
- .Pb Minor mineral occurrence
- Cu Copper
- F Fluorine
- Pb Lead
- Bore, salinity < 2500 p.p.m.
- Well, salinity < 2500 p.p.m.
- T Tank
- E Earth tank
- Windpump
- pe Equipped with pump engine
- Spring
- WH Waterhole
- Road
- Vehicle track
- Fence
- "Lansdowne" Homestead
- Landing ground
- Yd Yard
- Astronomical station
- Trigonometrical station
- .375' Height in feet; datum: mean sea level

Compiled and published by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development, in conjunction with the Geological Survey of Western Australia. Issued under the authority of the Hon. David Fairbairn, Minister for National Development. Base map compiled by the Royal Australian Survey Corps. Aerial photography by the Royal Australian Air Force; complete vertical coverage at 1:50,000 scale. Transverse Mercator Projection



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Showing Magnetic Declination

CAMDEN SOUND SD 51-15	PRINCE REGENT SD 51-16	ASHTON SD 52-13	CAMBRIDGE GULF SD 52-14	AUVERGNE SD 52-15
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NO ANNUAL CHANGE

Scale 1:250,000

5 0 5 10 15 MILES

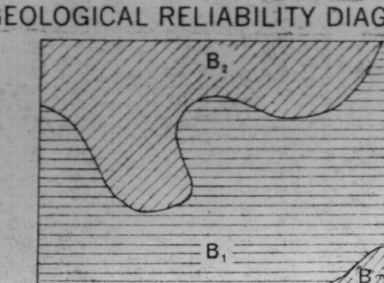
5 0 5 10 15 20 25 KILOMETRES

GREY NUMBERED LINES INDICATE THE 20,000 YARD TRANSVERSE MERCATOR GRID, ZONE 3 (AUSTRALIA SERIES)

Sections

Cainozoic sediments omitted from sections
Attitude of faults not known; folding schematic
Scale $\frac{V}{H} = 1$

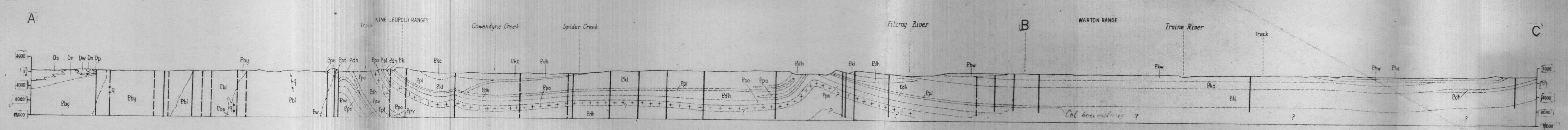
GEOLOGICAL RELIABILITY DIAGRAM

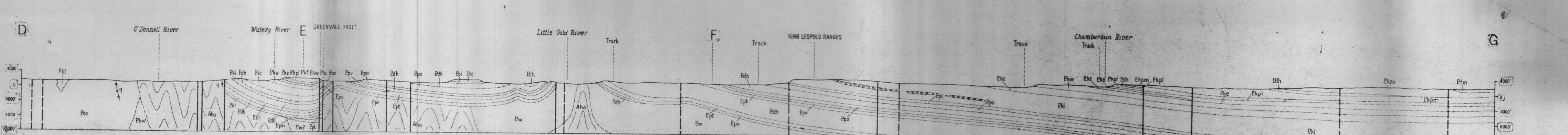


B1 Detailed reconnaissance: numerous ground traverses and air-photo interpretation

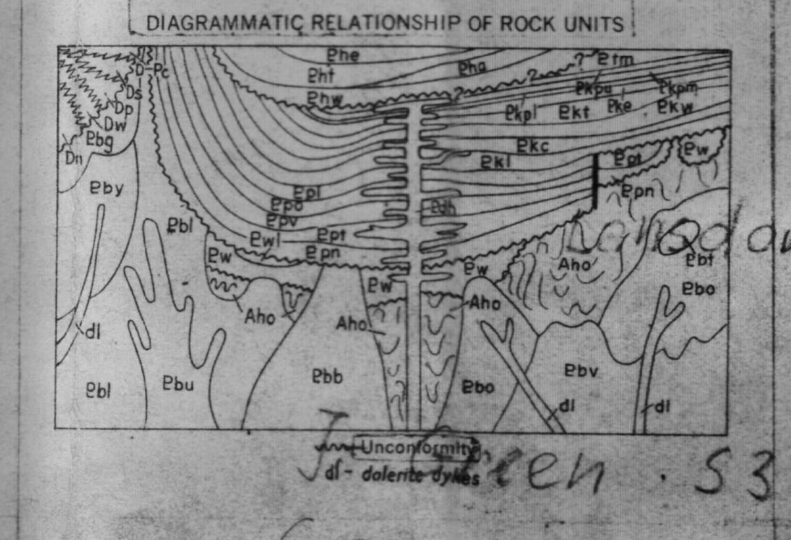
B2 Reconnaissance, some ground and helicopter traverses, and air-photo interpretation

Geology, 1964, by: K.A. Plumb, D.C. Gellatly, G.M. Derrick, J.F. Ivanac (B.M.R.); A.D. Allen, P.E. Playford, D.C. Lowry (G.S.W.A.)
Compiled, 1965, by: G.M. Derrick, D.C. Gellatly, A.S. Mikolajczak
Cartography by: Geological Branch, B.M.R.
Drawn by:





DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS



Lansdowne

J. Green 530
(Topo plate)

LANSDOWNE
SHEET SE 52-5