DEPARTMENT OF MINES
SOUTH AUSTRALIA

GEOLOGICAL SURVEY
EXPLORATION SERVICES DIVISION

A REVIEW OF GEOPHYSICAL WORK IN THE POLDA BASIN

KIMBA and ELLISTON 1:250,000 Sheets

by

R.G. Nelson
Geophysicist
Exploration Geophysics Section

Rept.Bk.No.72/45

5th April, 1972

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ABSTRACT

A summary of all geophysical work done in the area around the Polda Basin in Eyre Peninsula is presented. Electrical resistivity soundings originally made for hydrogeological purposes have been reinterpreted in terms of depth to infinitely resistant bedrock. A map of basement contours based on this work has been prepared. This map should be regarded as preliminary, serving only to guide future exploration in the basin.

INTRODUCTION

R. Lockhart Jack, then Assistant Government Geologist, delineated in 1911 the outlines of the Polda Basin and described it briefly (Jack, 1912). The Polda Basin is the northern lobe of a large area of ground waters that cover most of the Hundreds of:

Squire
Tinline
Talia
Calton
Blesing
Kappawanta
Hudd
Ward
Haig
Pearce
Way
Kiana

Other basins can also be found within this area, and a number of Water Reserves have been defined.

Various factors make this area favourable for the location of sedimentary uranium deposits. Among these are:

1. the presence to the north and east of igneous and metamorphic source rocks;
2. limited basins containing sands and clays with some lignitic material;

and 3. favourable climatic conditions (viz. warm and humid in the Pliocene permitting leaching of uranium from the source rocks, followed by periods of semi-arid to arid conditions which have continued up to the present).

See Robertson and Douglas (1970) for further details.

Because the subsurface stratifaction and the lateral extent of the basin is poorly known, the use of geophysical methods may prove useful if any major search for uranium deposits is initiated. In view of this a review has been made of previous geophysical work. Some reinterpretations have enabled a pr preliminary map of basement contours to be made.

GEOLOGY (after Rowan, 1968)

Apart from the prominence of Mt. Wedge near Elliston and the Cleve Uplands to the east, the area is basically an undulating plain covered with aeolian sands and swamp deposits of Pleistocene to Recent age.

ARCHAEAN (?)

Archaean (?) schists and gneisses with banded iron formations and the Warrow Quartzite form the western part of the Cleve Uplands.

Scattered small outcrops of schists and gneisses are also found along the northern part of the area investigated. In particular, drilling based on large aeromagnetic anomalies has shown the presence of iron-rich beds in the Warramboo and Kopi areas.

ARCHAEAN (?) TO UPPER JURASSIC

Conglomerates, grits and sandstones, thought to be of Middle Proterozoic age, have been mapped at the following localities:

1. northwest of Cleve (where they overlie the Archaean schists and gneisses unconformably and dip shallowly to the west);
2. at Blue Range;
3. at Pt. Labatt;
4. at Talia caves;

and 5. at Mt. Wedge (coarse cross-bedded sands, grits and conglomerate with 10^{o} - 15^{o} westerly dip).

UPPER JURASSIC TO RECENT

The Polda Basin and the other basins in the area are probably of Tertiary age. Drilling of Polda stratigraphic hole No.1 in the Polda Basin revealed a sequence of aeolianite, sands and clays, followed by grey lignitic and micaceous silts and clays to a depth of 565 feet. It is uncertain whether it finished in "basement" at this depth or whether it was still in Upper Jurassic sediments (Harris, 1964).

The sand cover over the area comprises Pleistocene Calc-aeolianite forming fossil dune systems for about 30 miles inland from the west coast. East of this the sand cover comprises Recent siliceous dunal sands with interdunal clay pans.

REVIEW OF GEOPHYSICAL WORK

(1) Aeromagnetic

Central Eyre Peninsula was investigated using a high level aeromagnetic survey by the Bureau of Mineral Resources druing 1953-1955. This survey was flown at a height of 1500 feet using Shoran ocntrol for navigation and a nominal flight line spacing of one mile. As detail was lacking from contours of the high level survey a low level aeromagnetic survey (height 300 feet, nominal flight line spacing ¼ mile) was flown by Adastra Hunting Geophysics Ltd. for the S.A. Department of Mines in March, 1960 covering the Warramboo and Kopi anomalies.

In 1966 an aeromagnetic survey was flown over part of the Great Australian Bight offshore from Eyre Peninsula (O.E.L.33 and O.E.L. 38) by Aeroservices Ltd., on behalf of Outback Oil Co. N.L. and Shell Development (Aust. Pty. Ltd.). Interpretation of this survey by Geophysical Associates Pty. Ltd. indicated the existence of a trough, 5000-8000 feet deep, in the magnetic basement extending easterly from the continental slope in the Bight to the north of Elliston on the west coast of Eyre Peninsula.

(2) Seismic Refraction and Reflection

A seismic refraction and reflection survey made within O.E.L.38 by Western Geophysical Co. of America for Shell Development in 1966 showed in the area of the deep magnetic trough a sharp depression in high speed basement filled with lower speed sediments (Smith, 1967). A north-south reflection traverse (line SA66.03) shows high velocity first breaks (18000-19700 ft./sec.) on either side of the aeromagnetic trough. Within the trough a number of reflections were recorded down to 1.25 seconds at a calculated depth of 6600 feet; below 0.8 seconds the velocity distribution function implied part of the section had a velocity of 15000ft./sec.

A refraction probe (V.P.5) shot in an east-west direction parallel to the trend of the trough recorded a shallow section with velocities of

6500 - 9800 ft./sec. followed by a westward dipping refractor of 14700 ft./sec. (or greater) velocity. A lower 21000 ft./sec. refractor probably coincides with the 1.25 seconds reflection recorded.

Smith (1967) suggests a narrow deep depression possibly with steep faulted sides filled with Proterozoic or younger sediments.

In 1967 R. Coppin, then of this Department, carried out a seismic refraction survey at Colton, ten miles north of Elliston. He encountered difficult drilling and shooting conditions in a fossil dune system and his results were inconclusive. He reported the following section (Coppin, 1967):

Depth From (ft)	Depth To (ft)	Thickness (feet)	Seismic Velocity (ft./sec.)
0	60	60	4,500
60	260	200	6,700
260	760	500	11,000
760	2260	1500	13,500
2260	-	-	16,200

(M.S.L. is at - 136 ft., taking surface level as 0 feet).

Taking an overall view of the seismic results and the known geology the following picture emerges:

Age of sediments	Seismic velocity range
Cainozoic to Mesozoic	4,500-9,800 ft./sec.
Precambrian (Mt. Wedge grit)	15,000 ft./sec. (approx.)
Crystalline basement (Archaean?)	21,000 ft./sec.

(3) Ground Magnetics

As a follow-up to the aeromagnetic work in the central part of the Peninsula, ground magnetic and gravity surveys were made over anomalies in Hundreds of Ripon, Cungena, Inkster and Warramboo (Whitten 1963, Whitten and Riseley 1965, Webb 1966) by this Department.

(4) Gravity

From 1956 to 1961 widely spaced gravity readings were taken along railway lines and main highways by officers of the Exploration Geophysics Section. A denser network of stations was established in 1967 with a nominal spacing of four miles between stations by B.G. Riseley, I.S. Rowan and R.J. Coppin. A report on the regional gravity of the KIMBA and ELLISTON sheets was prepared (Rowan, 1968).

Rowan relates certain features on the gravity map, to the known geology. In particular he notes a low of about 40 milligals north of Elliston corresponding to the onshore continuation of the magnetic trough. He considers that the outcrops of grits, sandstones and conglomerates are significant when an attempt is made to relate the geological and geophysical data and speculates that these form the basal part of the infill to the trough and that younger sediments may possibly overlie these grits in the deepest parts of the trough.

(6) Electrical Resistivity

Electrical resistivity work began in the Polda Basin in 1963 when J. McG. Hall, B.J. Taylor and J.C. Benlow made some experimental surveys (Hall, 1963). A more quantitative approach was made in 1964 by Hussin (Hussin, 1964(a) and (b)) who used the method of vertical electrical soundings to estimate the geoelectrical structure of the subsurface. Further work was done in 1967 by Hussin (Hussin, 1967) and McPharlin (McPharlin, 1967).

Originally this work was done to aid hydrogeological investigation of groundwater in the basin, and hence estimation of basement depth was not of great concern. However, many of the resistivity curves show near-surface basement and so a reinterpretation of the original data from these surveys has been made by the author. Using results from this as well as known depths to basement from boreholes a preliminary sketch of basement contours has been prepared (see Drawing 79-88).

It should be noted that no differentiation can be made between crystalline basement and the hard Mt. Wedge grit on the basis of resistivity measurements, as these are both almost certainly highly resistive. Therefore, some doubt may arise as to what is actually "basement" on the map. The map o basement contours should be viewed as an exploration guide only.

RECOMMENDATIONS

If further geophysical work is to be carried out to define the basin limits, the following methods merit consideration:

1. gravity;
2. seismic refraction and/or reflection;
3. deep-sounding electrical resistivity.

The fact that hydrogeological bores in the area have been optically levelled makes gravity a particularly attractive method. Small surveys using the other methods could be carried out to provide controls for the gravity work. In areas covered by aeolianite fossil dunes the use of directional line sources may help to overcome shooting difficulties for seismic work.

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TABLE I

LIST OF BORES IN THE POLDA BASIN

WHICH HAVE BEEN LOGGED GEOPHYSICALLY (GAMMA LOG)

Note: most of these bores have depths less than 100 feet and consequently barely penetrate beyond the calc-aeolianite surface cover. In general, whenever high gamma activity has been noted on these logs it seems to be related to clay bands in the sedimentary sequence.

Logging was done by S.A. Department of Mines (B.P. Taylor) for Kerr - McGee Aust. Pty. Ltd.

Bore No.	Log Depth (ft).	Remarks
Elliston 4E	48	-
Polda No.1 Strat	32	-
PT 8G	68	-
PT 10A	48	-
PT 11B	66	-
30	21	-
33	20	-
34	29	-
35	38	-
36	42	-
37	22	-
38	10	-
39	18	-
41	14	-
42	10	-
43	20	-
44	19	-
45	20	-
46	36	-
47	16	-
52	28	-
86	47	-
87	28	-
88	63	-
89	79	-
90	52	-
91	39	-
92	60	-
93	34	-
101	18	-
102	19	-
103	18	-
104	15	-
147	34	-
148	46	-
149	20	-
164	22	-
165	59	Peak 80 counts above background at 47'

Bore No.	Log Depth (ft).	Remarks
166	29	-
168	31	-
169	20	-
170	32	-
171	24	-
172	34	-
173	35	-
176	48	-
177	21	-
178	38	-
180	20	-
181	39	-
182	55	-
183	88	-
184	42	-
185	39	-
186	45	-
187	51	-
189	39	-
190	40	-
191	37	-
192	43	Peak 50 counts above background at 40'
193	41	Peak 140 counts above background at 34' Clays at 33' - 42'
194	75	Peak 50 counts above background at 50'
195	65	Peak 50 counts above background at 60'
197	42	-
198	46	-
206	49	-
207	41	-
208	30	-
209	41	-
210	37	-
211	40	-
212	29	-
213	38	-
214	40	-
215	39	-

Bore No.	Log Depth (ft.)	Remarks
216	26	-
217	42	-
218	32	-
219	20	-
220	26	-
221	42	-
222	64	-
223	70	-
224	55	-
225	70	-
226	48	-
228	63	-
229	64	-
230	104	-
231	54	-
232	66	-
233	41	Peak 50 counts above background at 22'
234	46	-
235	34	-
241	59	-
262	82	-
277	62	-
279	71	Peak 50 counts above background at 50'
280	54	-
281	38	-
282	25	-
283	23	-
288	50	-
289	47	-
290	35	-
291	20	-
292	20	-
293	30	-
294	47	-
295	27	-

Bore No.	Log Depth	Remarks
319	75	-
331	88	-
3321	106	-
333	42	-
334	30	-
335	34	-
336	21	-
337	23	-
338	32	-
339	42	-
334	22	-
345	16	-
347	35	-
348	20	-
348A	26	-
349	28	-
350	22	-
351	14	-
353	29	-
354	31	-
356	29	-
357	25	-
371	35	-
389	65	-
390	65	-
391	78	-
392	29	-
470	23	-
471	36	-
472	26	-
473	58	-
474	48	-
485	46	Peak 70 counts above background at 30'
486	16	-
487	26	-
488	34	-
489	31	-

Bore No.	Log Depth	Remarks
490	40	-
491	66	-
492	42	-
493	41	-
494	74	-
495	66	-
496	56	-
497	95	Peak 140 counts above background at 86' Corresponds to clay band at 86'
498	53	-
499	50	-
500	62	-
529	43	-
539	86	-
543	101	-
544	69	-
545	87	-
546	109	-
547	1377	-
552	52	-
562	128	-
563	106	-
564	67	-
565	105	-
567	53	-
568	75	-
570	76	-
571	38	-
572	59	-
573	49	-
574	64	-
575	50	-
577	51	-
578	48	-
579	74	-
580	30	-
581	64	-

TABLE II

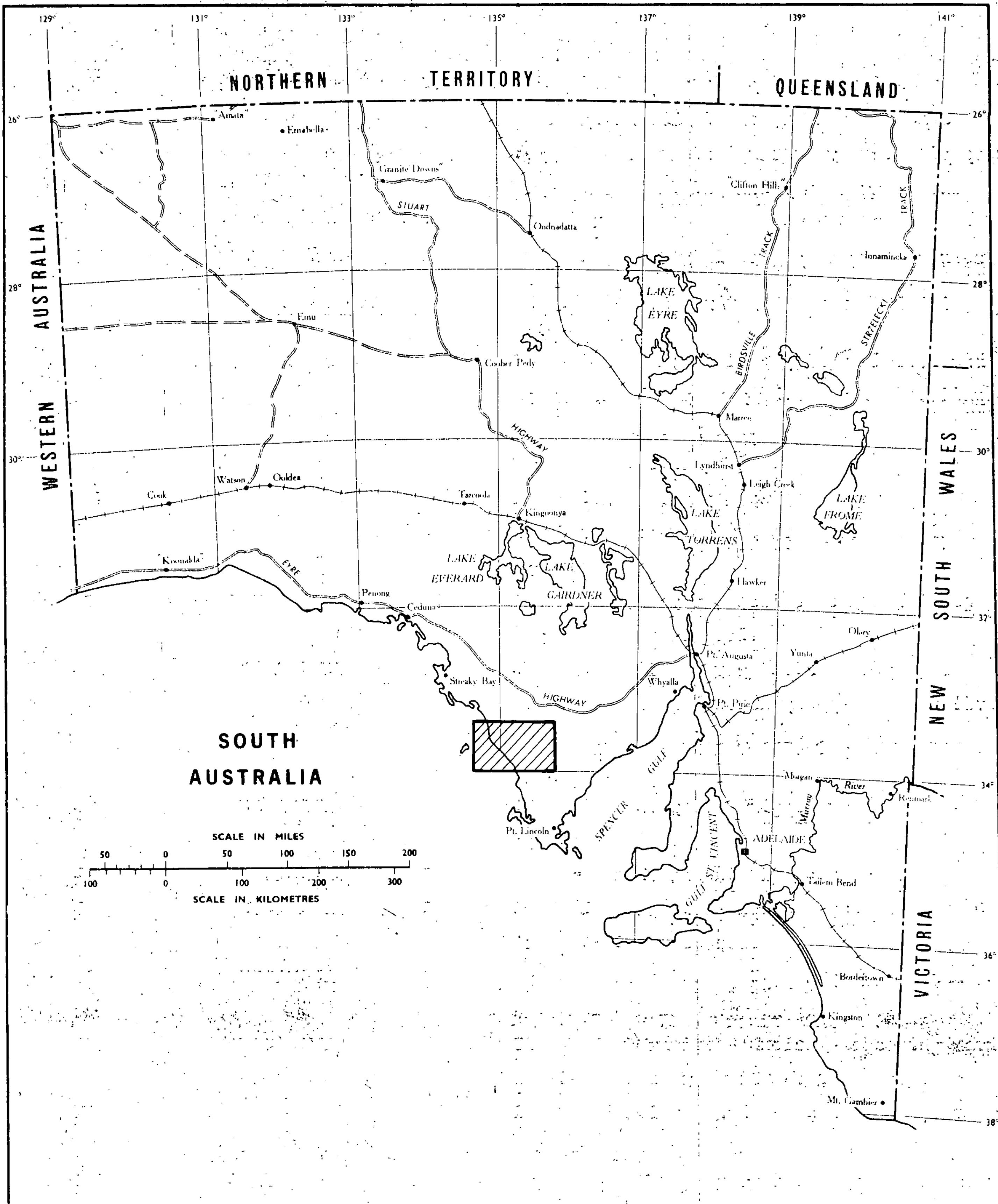
LIST OF BORES WHERE BEDROCK?

HAS BEEN INTERSECTED

BORE NO.	LOCATION	DEPTH	
212	HAIG	115'	71' - 115' Off white micaceous clay. Weathered bedrock.
575	TALIA	48"	38' - 48'. Sandstone, mainly ironstained red to purple (Mt. Wedge Grit?).
578	TALIA	52'	Sand. Very fine to coarse, subrounded to well rounded quartz from 0.1mm to 2mm. Uncemented with numerous strongly cemented bands (Mt. Wedge Grit?).
593	TALIA	137'	86' - 106' Sand contains several strongly cemented bands 0.2' to 0.5' thick, bands are siliceous cemented quartz pale grey to dark grey, often ironstained. (Mt. Wedge Grit?)
201	PEACHNA	73'	52' - 73' Weathered granite - mostly quartz. Basement.
499	PEARCE	61'	55' - 56' Weathered bedrock. Material in sand, gravel very fine to coarse grained and silty. Grains are mica, quartz, calcrete and ironstone, generally angular to subrounded Contains grit and gravel of strongly cemented calcite, sandstone, ironstone, quartz and granite. 56' - 61' No samples.
502	PEARCE	53"	40' - 53' Weathered bedrock. Sand well sorted subangular to well rounded, grains are calcite shell fragments, quartz, mica contains fragments to grit size of calcite sandstone, quartz, granite and ironstone.
504	PEARCE	74'	69' - 74' Schist. Completely weathered, contains angular to subrounded quartz grains. Micaceous.
505	PEARCE	93'	80' - 81' Bedrock - highly weathered. Felspar is reduced to clay. Fine to coarse quartz and someclear mica. Off white and pale greenish grey. 81' - 93' No sample

BORE NO.	LOCATION	DEPTH	
529	WAY	73'	36' - 63' Bedrock. Completely weathered. Grains and angular to subrounded quartz and mica. Contains fragments of gneiss to 15mm and fragments of limestone. 63' - 73' No sample driller reports bedrock.
547	WAY	175'	162' - 175' No samples. Drillers note bedrock at 175'.
549	WAY	69'	36' - 57' Bedrock schist - completely weathered. Pinkish brown to 39' - then yellow brown. 57' - 69' No samples - driller reports bedrock at 69'
555	WAY	40'	18' - 40' Bedrock. Highly to completely weathered above 33' grading to fresh to slightly weathered at bottom - gneiss.
570	WAY	93'	Bedrock from 27-93'. 75' - 93' Bedrock completely weathered. Grains are quartz t and mica. Angular to subangular. Contains a few fragments of quartz and gneiss. Dark brown - Green.
574	WAY	75'	42' - 75' Bedrock - completely to highly weathered. Material is clay generally soft. Contains rounded ironstone fragments in top 1ft. Contains rounded ironstone fragments in top 1ft. Contains abundant angular quartz to 5mm rare mica grey, green, brown and khaki/
382	BLESING	50/	48' - 50' Sand - fine to coarse sub-angular quartz sand - common felspar and mica - brown (Decomposed Gneiss).
384	BLESING	37'	Bedrock - decomposed gneiss - brown.
415	BLESING	66'	60' - 66' Granite Gneiss - Bedrock
416	BLESING	40'	37' - 40' Gneiss - very soft and highly weathered.

BORE NO.	LOCATION	DEPTH	
485	WAY	67.5'	64' - 67.5' Bedrock schist, completely weathered. Offwhite clay with abundant very fine to medium quartz grains. Micaceous Rare slicken-siding and rare ferruginous pockets.
495	WAY	104'	58' - 70' Material is very clayey, abundant quartz with muscovite and some biotite. Mica schist. 70' - 1[illegible]' Material is mainly biotite and fragments of dark very fine grained foliated rock, abundant quartz. Quartz - biotite gneiss.
497	WAY	120'	99' - 120' Bedrock schist, micaceous. Completely to highly weathered. Pinkish brown.
515	WAY	51'	34' - 51' Bedrock, schist, completely to very highly weathered.
401	KADPAWANTA	60'	45' - 60' Clay - very stiff - abundant quartz grains and weathered gneiss - yellow brown and off-white mottled. (Decomposed bedrock).
402	KAPPAWANTA	52'	43' - 52' Bedrock - highly weathered granite gneiss.
403	KAPPAWANTA	75'	Gneiss - soft and highly weathered.
404	KAPPAWANTA	72'	70' - 72' Granite-Gneiss - soft and extensively weathered.
408	KAPPAWANTA	75'	Granite-Gneiss 65' - 70' Decomposed and soft. 70' - 75' Granite Gneiss.
429	KAPPAWANTA	996'	72' - 96' Granite - Gneiss - becoming harder and less weathered with depth - grey.
346	HUDD	55'	22' - 55' Clay - sandy micaceous. Weathered basement.
347	HUDD	53'	43' - 53' Clay - very stiff, very micaceous grey brown mottled. Weathered basement.
348A	HUDD	35'	34' - 35' Clay stiff very micaceous weathered basement.



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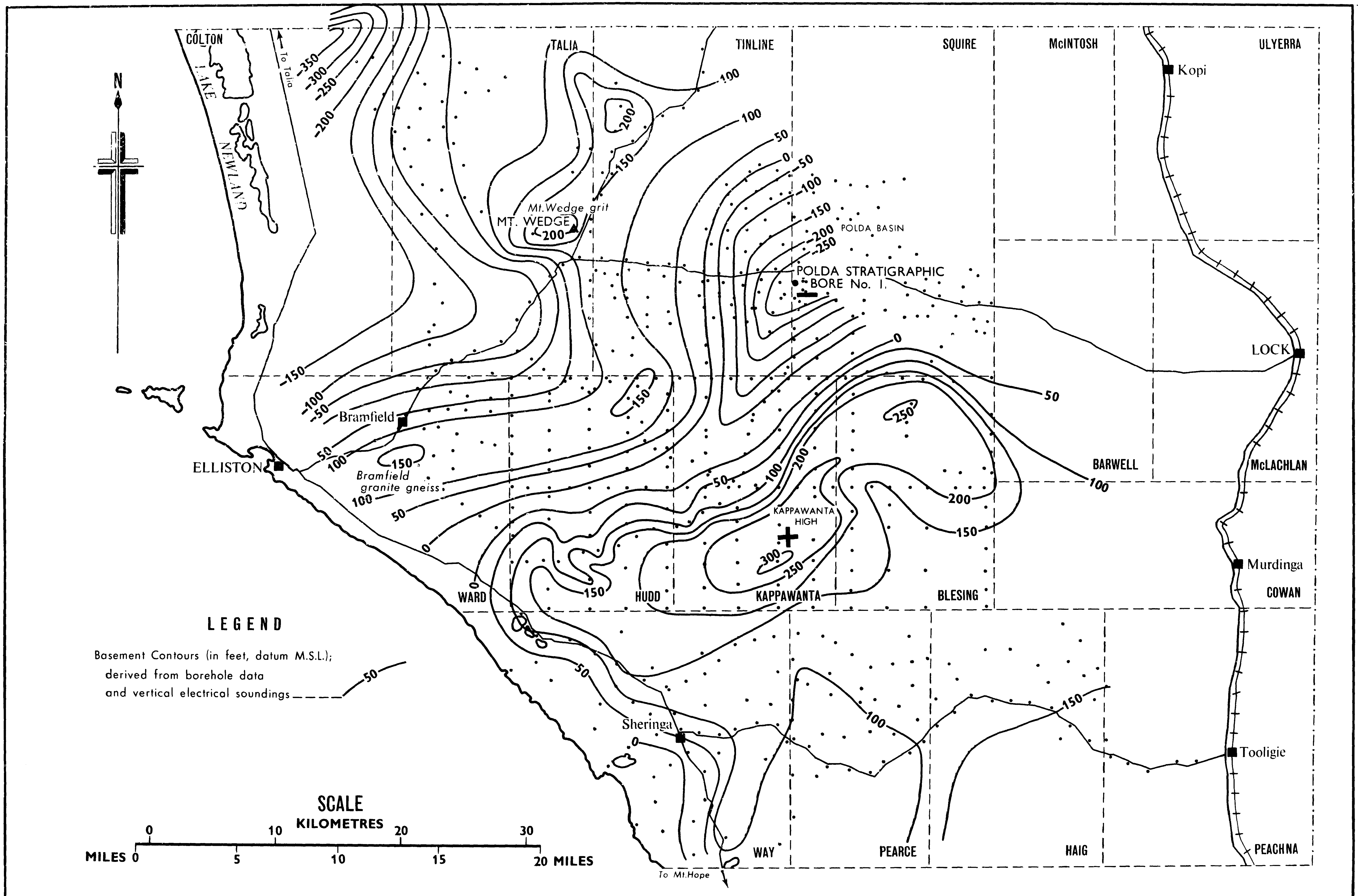

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