DEPARTMENT OF MINES
SOUTH AUSTRALIA

EXAMINATION OF BORE SAMPLES FOR SEDIMENTARY PHOSPHATE, MURRAY BASIN AND GAMBIER EMBAYMENT OF THE OTWAY BASIN

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SUMMARY

In a reconnaissance for sedimentary phosphate, sludges and cores were examined from one hundred widely-scattered bores in the Murray Basin and the Gambier Embayment of the Otway Basin in South Australia. Microscopic inspection and molybdate-testing were followed in selected cases by partial chemical analysis. Out of more than four hundred analyses the highest showed 1.66% P_2O_5, only three exceeded 1%, and most were less than 0.5%. Sporadic phosphorite grains and contents of P_2O_5 higher than 0.5% tend to occur in upper Knight Group, Buccleuch Group, or Ettrick Formation in the vicinity of Port MacDonnell, Beachport, Kingston to Naracoorte, Keith, and Wellington. No phosphate deposits of economic significance were encountered.

INTRODUCTION

New sources of phosphate are being sought with some urgency in Australia and interest has been focussed on the sedimentary basins as possible sources of sedimentary phosphate. This Department has recently undertaken a reconnaissance for phosphate in the Murray Basin and Gambier Embayment by the examination of both outcrop and selected bore samples. The writer examined samples from almost one hundred water, oil, and foundation bores between August 25th and November 2nd, 1964. Phosphate analyses were made of selected samples.

OBJECTIVES

The objectives of this investigation were:

1. To test the occurrence of sedimentary phosphate in the Murray Basin and Gambier Embayment by the examination of selected bore samples. Techniques were to include inspection under binocular microscope, and testing with ammonium nitro-molybdate. Partial chemical analysis for P_2O_5 would be made of intervals warranting closer attention.
2. To relate any such occurrence to the stratigraphy.
3. To find significant concentrations of sedimentary phosphate.

OTHER INVESTIGATIONS

At about the same time, but independently of this departmental investigation, Mr. R.T. Russell (Geologist) of Mines Exploration Pty. Ltd., by arrangement with this Department, tested a number of bore samples from counties Buccleuch, Alfred, Hamley, and Grey. This work is summarized in two unpublished reports: (1)(Russell, R.T. September, 1964. Report on an investigation of the Tertiary succession, Murray Basin, South-eastern South Australia, for sedimentary phosphate.

(2)Russell, R.T. October, 1964. Report on an investigation of the Tertiary succession, Gambier Basin, for

sedimentary phosphate.)

Data from these reports are included herein and are marked throughout by an asterisk *.

EXAMINATION OF BORE SAMPLES

Choice of bores

In order to achieve adequate systematic coverage of the basins it was decided to aim at the principle of examining one bore from each hundred. Where several bores were available from a hundred, the most useful one (generally the deepest) was chosen. However in about one half the hundreds there was either no bore available, or such as were available were too shallow to be useful. In some hundreds two or more bores were examined to supplement one another or to investigate areas and levels of particular interest. Bores used in this report are listed in Appendix I and plotted on locality plan 64-1028. They have been given consecutive numbers for ease of reference.

Material tested

All bore samples used were obtained from storage at the Department of Mines Core Laboratory, Thebarton, and tested there. Most of them were unwashed, dried, enveloped, percussion sludge samples from water bores which had been submitted at some time for palaeontological examination. In some cases samples had been kept from 5 or 10-feet intervals, but other bores had been "skeletonized" to representative samples of longer intervals. Oil well samples examined consisted of unwashed, dried, bottled, rotary cuttings, and trayed cores. From two punt approach foundation tests, portions of percussion-tube samples were available, taken at 1-foot intervals.

Visual examination

A representative portion of each sample was briefly examined under a binocular microscope, mostly at low power. Notes were made of the lithology and of any obvious microfossils

of stratigraphic value. The presence of phosphatic oolites or fragments, glauconite and fish remains were recorded.

The ammonium molybdate test

The reagent used in this test was a mixture of approximately equal parts of saturated ammonium molybdate solution and concentrated nitric acid. A dropper-bottle of this mixture was made up as required from carefully stored bulk supplies about once a day. A hard cream precipitate gradually coated the inside of the dropper bottle over a period of several weeks, indicating some instability of the nitro-molybdate solution.

A representative small quantity of the sample (about ½ gram or "a pinch") was scraped off the picking tray after visual examination into one of the depressions of a porcelain test plate. The reagent was cautiously added until the depression was nearly full, more or less vigorous effervescence occurring with calcareous samples. Where phosphatic grains were suspected they were tested individually. A centre of strong phosphatic reaction in matrix was taken to be a phosphorite grain. Twelve tests were made in each run using two test plates each with six depressions. The contents of each depression were labelled with appropriate identification on a sheet of paper under the test-plate. Time was given for reactions to develop and all the twelve reactions were then recorded.

The following terms were used as a rough scale to describe the relative degrees of reaction:

"No reaction"	-	no yellow coloration produced.
"Very weak"	-	a faint yellow transparent coloration.
"Weak"	-	a distinct but weakly-developed transparent yellow.
"Fair"	-	a definite, somewhat cloudy yellow.
"Moderate"	-	quite a cloudy yellow, thicker and brighter than for "fair".
"Strong"	-	a thick, opaque, bright yellow.

In some tests, coloration was patchy due to small phosphatic centres of reaction. Many samples gave a reaction classed as

"very weak", and, as it was found that such samples could assay up to 0.28% P_2O_5, a "very weak" reaction is included as a 'positive molybdate test' in the diagrammatic sections at the end of the report. An attempt was made to distinguish between ferric coloration and molybdate reaction. When yellow limestones (e.g. of the Mannum Formation) are tested, ferric coloration tends to mask a "very weak" or "weak" molybdate reaction although a "fair" or better reaction can usually be detected.

The molybdate tests and P_2O_5 analyses of 210 samples were compared in an attempt to correlate the two. The following table summarizes this comparison.

Result of molybdate test	Number of samples	Range of content of P_2O_5(%)	Average content P_2O_5(%)
"Very strong"	3	0.06 - 0.45	0.25
"Strong"	42	0.04 - 1.00	0.15
"Quite strong" "Moderately strong" "Moderate to strong"	30	0.04 - 0.41	0.16
Patchy showing moderate to strong centres of reaction	3	0.30 - 0.65	0.48
"Moderate"	29	0.06 - 1.25	0.21
"Fair to moderate"	11	0.06 - 0.65	0.21
"Fair"	11	0.02 - 0.58	0.18
"Weak"	30	0.03 - 0.50	0.19
"Very weak to weak"	5	0.04 - 0.40	0.17
"Very weak" but patchy e.g. 'with fair patches'	4	0.03 - 0.16	0.08
"Very weak"	35	0.00 - 0.28	0.12
"Almost no reaction" "No reaction"	7	0.00 - 0.16	0.09

From the above it is apparent that distinct molybdate reactions can be developed by samples having bulk compositions low in phosphate. One chance phosphatic fragment in the small portion tested can probably produce a "moderate" to "strong" overall reaction. From the tabulation above it is clear that this exaggerated response was common and the concentrated

ammonium nitro-molybdate reagent used was probably over-sensitive, magnifying any molybdate reaction, especially those involving long-continued effervescence of the sample. On the other hand it was possible to record only "moderate" in the case of a sample assaying 1.25% P_2O_5, "fair" for 0.58%, "weak" for 0.50%, "very weak" for 0.28%, and "almost no reaction" for 0.16%, presumably by the chance absence of a phosphatic grain in the small portion of sample tested. Due to such sampling problems and the use of a sensitive testing solution, a certain molybdate reaction can be produced by samples having in bulk a relatively wide range of actual phosphate composition. In the comparatively few cases where definite centres of phosphatic reaction were seen, or where phosphatic pellets were recognized, the analyses show a more consistent upward trend.

Molybdate testing as described has limitations as a routine method of selecting phosphatic samples for chemical analysis and its use in this investigation led to the chemical analysis of many samples low in phosphate content. The method, however, allows rapid examination and further experience may produce more consistent results.

Chemical analysis

Initially several hundred feet of consecutive samples from selected bores were submitted for chemical analysis; these were of the ?Middle to Upper Eocene section (Upper Knight Group and Buccleuch Group) in the Mount Salt bores, where phosphatic grains had been detected. The results showed that even in the few cases where phosphatic grains were recognized visually, phosphate content of the bulk sample did not exceed 1.5% P_2O_5. Nearly all of the analyses were less than 0.5%, and most were less than 0.2%.

Thereafter, only individual samples which had given "moderate" to "strong" molybdate reactions were submitted for analysis. In all, 409 samples were analysed, the best showing 1.66% P_2O_5.

STRATIGRAPHIC CONTROL

The stratigraphy of most of the bores investigated had been previously outlined by Ludbrook in a series of publications and unpublished reports. In O'Driscoll (1960, Appendix 1, Summary of Bore Records, pp. 150-238), palaeontological inspection by Ludbrook provided stratigraphic control in representative bores from many hundreds. Many of these bores were still the most suitable ones available for phosphate testing. Other bores were described in greater detail in "Stratigraphy of the Murray Basin in South Australia" (Ludbrook, 1961). These two publications proved to be of particular value while an outline of Tertiary correlation in South Australia (Ludbrook, 1963) was also found useful.

A number of unpublished reports are available for relevant bores as under (see Appendix I and locality plan 64-1028).

Mount Salt project

/1/ Ludbrook, N.H. 1963. O.D.N.L. Mt. Salt No. 1 Well, Subsurface Stratigraphy and Micropalaeontological Study.
Dept. Mines S.Aust. Geol. Surv. Pal. Rep. 2/63. G.S. 2561.

/2-6/ Ludbrook, N.H. 1962. Mt. Salt Structure Drilling Project of Oil Development N.L. Palaeontological Report.
Dept. Mines S.Aust. Geol. Surv. Pal. Rep. 12/62. G.S. 2433.

Geltwood Beach project

/10/ Ludbrook, N.H. 1964. Beach Petroleum N.L. Geltwood Beach No. 1 Well, Subsurface Stratigraphy and Micropalaeontological Study.
Dept. Mines S.Aust. Geol. Surv. Pal. Rep. 10/63. G.S. 2755.

[11] Starr, T.J. 1963. Review of Structure Drilling Programme, Geltwood Beach, S.A. IN Beach Petroleum N.L. Appraisal of the Geltwood Beach Structure (unpublished report by Geosurveys of Australia Ltd.)

Cellulose Pty. Ltd. Bores

[12, 13] Ludbrook, N.H. 1961. Cellulose Australia Ltd. Water Bore, hundred Mayurra, section 78, Micropalaeontological Examination.
Dept. Mines S.Aust. Geol. Surv. Pal. Rep. 6/61 G.S. 2045.

Beachport No. 1

[17] Ludbrook, N.H. 1962. South East Oil Syndicate Ltd. Beachport No. 1 Well, Subsurface Stratigraphy and Micropalaeontological Study. Dept. Mines S.Aust. Geol. Surv. Pal. Rep. 2/62. G.S. 2297.

Penola No. 1

[19] Ludbrook, N.H. 1961. Oil Development N.L. Penola No. 1 Well, Subsurface Stratigraphy and Micropalaeontological Study. Dept. Mines S.Aust. Geol. Surv. Pal. Rep. 5/61. G.S. 2044.

Comaum coal bore

[22] Harris, Wayne K. 1964. A Reinterpretation of the Stratigraphy of the Comaum No. 2 Bore, South Australia.
Dept. Mines S.Aust. Geol. Surv. Palyn. Rep. 7/64. G.S. 2956.

L.E. Maczkowiack Bore 2

[32] Ludbrook, N.H. 1961. Examination of Water Bores, hundred of Murra Binna, County Macdonnell.
Dept. Mines S.Aust. Geol. Surv. Pal. Rep. 9/61. G.S. 2095.

Keith Bore

/48/ Ludbrook, N.H. 1959. Murray Basin Oil Syndicate Keith Bore, 1958, Preliminary Report. Dept. Mines S. Aust. Geol. Surv. Pal. Rep. 1/59. G.S. 1235.

Pinnaroo Bore

/79/ Ludbrook, N.H. 1956. Murray Basin Oil Syndicate Pinnaroo Bore, Progress Report No. 1, Surface - 600 feet. Dept. Mines S.Aust. Geol. Surv. Pal. Rep. 15/56. G.S. 594.

Ludbrook, N.H. 1956. do. Progress Report No. 2, 600 feet - 835 feet. do. Pal. Rep. 16/56.

Ludbrook, N.H. 1957. do. Progress Report No. 3, 850 feet - 1020 feet. do. Pal. Rep. 4/57.

Ludbrook, N.H. 1958. do. Final Report and Summary. do. Pal. Rep. 14/58. G.S. 1154.

Swan Reach Bridge

/80/ Ludbrook, N.H. 1958. Stratigraphy and Palaeontology of the Swan Reach Bridge Site. Dept. Mines S.Aust. Geol. Surv. Pal. Rep. 1/58. G.S. 895.

Chowilla Dam Site

/97, 99/ Ludbrook, N.H. 1960. Chowilla Dam Site, River Murray, Stratigraphy and Micropalaeontology. Dept. Mines S.Aust. Geol. Surv. Pal. Rep. 9/60. G.S. 1864.

North Renmark No. 1

/98/ Ludbrook, N.H. 1963. A.O.C. North Renmark No. 1 Subsurface Stratigraphy and Micropalaeontological Study.
Dept. Mines S.Aust. Geol. Surv. Pal. Rep. 6/63. G.S. 2589.

SUMMARY OF RESULTS BY COUNTIES

Most of the results of the phosphate-testing programme are included in this report in both graphical and tabulated form. The following county-by-county summary high-lights the significant data in a standardized form for easy comparison.

County Grey

(i) 19 bores (numbered 1 to 19 on the appended locality plan) were examined in whole or in part. The 19 bores represent 11 hundreds out of 21 in the county, but the areal distribution and stratigraphic penetration of these bores are uneven.

(ii) 256 analyses for P_2O_5 were made from this county (including 24*). This high number of analyses is due to the runs of consecutive analyses made on the Mount Salt and Beachport wells in the initial phase of the investigation.

(iii) The highest P_2O_5 analysis for the county was 1.50%* from bore numbered 1 on the locality plan:- Mount Salt No. 1, 575-580 feet, at the top of the Knight Group. Another analysis of the same interval gave 0.37% P_2O_5, emphasizing both the sporadic distribution of phosphorite grains and the difficulty in getting representative samples.

(iv) Other P_2O_5 analyses over 0.5% were:

a) 0.93%* from bore 1 as above, 580-590 feet. Another analysis of the same interval gave 0.50%.

b) 0.87%* from bore 17:- Beachport No. 1, 880-890 feet, at the top of the Knight Group. Another analysis of the same interval gave 0.44%.

c) 0.85%* from bore 17 as above, 870-880 feet, from the base of Buccleuch Group equivalents, overlying Knight Group. An analysis of a composite sample 860-870 feet, 870-880 feet, gave 0.65%.

d) 0.65% from bore numbered 1, 600-610 feet, near the top of the Knight Group. Another analysis of the same interval gave 0.46%.

e) 0.65%* from bore 2:- Mount Salt Structure Hole No. 1, 690-700 feet, near the base of the Gambier Limestone. Another analysis of the same interval gave 0.40%.

f) 0.64% from bore numbered 5:- Mount Salt Structure Hole No. 4, 610 feet, at the top of the Knight Group.

g) 0.56%* from bore 2, 680-690 feet.

h) 0.55% from bore 5, 620 feet.

(v) Comments

Phosphatic grains were recognized from the following levels arranged in ascending stratigraphic order: in Cretaceous beds of the Runnymede Formation (hundred of Penola); near the top of the Knight Group, Middle to ?Upper Eocene, (hundreds of Macdonnell, Mayurra, Lake George); and near the base of the Gambier Limestone (Oligocene basal glauconitic member), (hundreds of Macdonnell, Lake George).

Yellow to brown grits, sands and clays with sporadic phosphorite grains and fish remains near the top of the Knight Group from Beachport to Mount Salt have provided the highest phosphate analyses in this county.

Brown glauconitic and sandy clays near the base of Buccleuch Group equivalents in Beachport No. 1, also yielded phosphate analyses somewhat higher than average.

14 analyses from the Cretaceous Runnymede Formation in Penola No. 1 well ranged from 0.04% to 0.37% P_2O_5, and averaged 0.26%.

County Robe

(i) 11 bores (numbered 20 to 30 on the appended locality plan) were examined representing 8 hundreds out of 18. Most of the bores intersected the Knight Group.

(ii) 83 analyses for P_2O_5 were made from this county, 42 of these being of a section of Naracoorte E. and W.S. Bore

No. 5.

(iii) The highest P_2O_5 analysis for the dounty was 0.80% from bore No. 26 in section 128, Hundred of Spence, 280-290 feet, near top of Knight Group.

(iv) One other P_2O_5 analysis over 0.5% was: 0.58%, Naracoorte E. and W.S. Bore 5 (numbered 30), 414-426 feet, from within the Knight Group (top at 230 feet).

(v) Comments

Phosphorite grains were recognized from near the top of the Knight Group (hundreds of Smith, Joyce, Naracoorte); from the basal glauconitic member of the Gambier Limestone (hundred of Naracoorte); and from the base of the Upper Oligocene Compton Conglomerate (hundred of Naracoorte). As in dounty Grey, the highest analysis comes from near the top of the Knight Group, in this case from a black carbonaceous clay, gritty sandy and silty, with glauconite pellets and grey silty laminae.

County Macdonnell

(i) 8 bores (numbered 31 to 38 on the locality plan) were examined and represent 8 hundreds out of 15. 3 of the bores entered the Knight Group.

(ii) 13 analyses for P_2O_5 were made from this county.

(iii) The highest analysis was 0.81% from Kingston E. and W.S. Bore No. 3 (numbered 31 on locality plan), 190-204 feet, Buccleuch Group equivalents.

(iv) One other P_2O_5 analysis over 0.5% was: 0.58%, from a bore in section 189, hundred of Minecrow (numbered 33) 155-160 feet, very similar to (iii).

(v) Comments

The two phosphate analyses above average came from brown bryozoal marls with abundant limonite pellets, and represent Buccleuch Group equivalents. Phosphatic grains were also seen at this level (hundred of Minecrow).

County Cardwell

(i) 5 bores (numbered 39 to 43 on locality plan) were examined, representing 5 hundreds out of 12.

(ii) 6 analyses for P_2O_5 were made from this county.

(iii) The highest analysis was 0.31% from a bore in section 101, hundred of Richards (numbered 42 on locality plan) 193-217 feet, Buccleuch C, a black carbonaceous calcareous and shelly clay.

(iv) Comments

Pleistocene brown shelly sands in hundred of Coombe contain dark brown fragments that give an apparently strong molybdate reaction, but analyses are low and anomalous effects may be involved.

County Buckingham

(i) 6 bores (numbered 44 to 49 on the locality plan) were examined, representing 5 hundreds out of 11.

(ii) 16 analyses for P_2O_5 were made from this county.

(iii) The highest analysis was 1.25% from Keith Bore, Murray Basin Oil Syndicate, Hundred of McCallum (numbered 48 on locality plan), 553 feet, high in the Knight Group.

(iv) Other analyses over 0.5% were:

a) 1.00% from Keith Bore as above, 675 feet, Knight Group.

b) 0.61% from a bore in section 141, hundred of Stirling (numbered 47 on locality plan) 127-168 feet, Ettrick Formation.

(v) Comments

Rare phosphatic grains were recognized from the Buccleuch Group and the Ettrick Formation in Hundred of Stirling, but highest analyses came from the Knight Group.

County Sturt

(i) 6 bores (numbered 50 to 55 on the appended locality plan) were examined, representing 5 out of the 6 Hundreds which are in part within the Murray Basin.

(ii) 6 analyses for P_2O_5 were made from this County.

(iii) The highest analysis was 1.66% from H. and L.G. Wellington West, Bore 2, Hundred of Brinkley (numbered 51 on locality plan), a tube sample 59-60 feet, in the Ettrick Formation.

(iv) One other analysis over 0.5% was:
0.56% from bore numbered 51, 54-55 feet, in the Ettrick Formation.

(v) Comments

Dark grey-brown phosphatic grains were noted at 42-43 feet in the Wellington West bore (Hundred of Brinkley) and probably occur rarely there in the glauconitic marls, limestones, and clays of the Ettrick Formation between 40 and 60 feet, in which significant molybdate reactions were recorded. The sample 59-60 feet gave the highest phosphate analysis to date in the bores examined - 1.66% P_2O_5.

County Russell

(i) 9 bores (numbered 56 to 64 on the locality plan) were examined, representing 6 Hundreds out of 9.

(ii) 4 analyses for P_2O_5 were made from this county.

(iii) The highest analysis was only 0.24% from A.R. Launer, Bore 2, section 21, Hundred of Ettrick (numbered 62 on locality plan) 270-280 feet, in the Ettrick Formation.

(iv) Comments

The Ettrick Formation was not intersected by the bores available in hundreds of Jeffries and Coolinong. No bores were available from hundreds of Baker, Bonney and Malcolm. It has therefore not been possible to test the Ettrick Formation in the southern half of County Russell

to see whether the higher phosphate values in the Wellington West area are continued to the south.

County Buccleuch

(i) 11 bores (numbered 65, 66, and 68 to 76 on the locality plan) were examined by the writer, representing 9 out of 17 Hundreds. R.T. Russell (1964, cited above) independently examined 22 bores in this county, representing 14 Hundreds out of 17. Only 2 samples were considered by him to be worthy of analysis, and these showed 0.47% and 0.11% P_2O_5. The bore containing the higher analysis has been included in the writer's locality plan and section as no. 67 (Coonalpyn Town Bore no. 3, Section 7, Hundred of Coneybeer).

(ii) 21 analyses were made from this county.

(iii) The highest analysis was 0.47% P_2O_5 from Coonalpyn E. and W.S. Town Bore 3 (numbered 67 on locality plan), 312-317 feet, near the top of the Knight Group.

(iv) Comments

Despite the rather thorough investigation of this county, no significant sedimentary phosphate has been encountered. A phosphatized bone fragment was noted from Buccleuch C (hundred of Roby).

County Chandos

(i) 3 bores (numbered 77 to 79 on the locality plan) were examined representing 3 Hundreds out of 10. No bores were available for examination from the area outside Hundreds.

(ii) 24 analyses were made from this county

(iii) The highest analysis was 0.45% P_2O_5 from M.B.O.S. Pinnaroo No. 1 oil well, hundred of Pinnaroo (numbered 79 on locality plan), 195 feet, in Pata Limestone.

(iv) Comments

Quite strong molybdate reactions were obtained from

Pata, Morgan, and Mannum-Gambier Limestones but analyses were generally low, and all under 0.5%. Over-sensitive ammonium nitro-molybdate reagent is believed to have caused the anomalously strong reactions.

County Eyre

(i) 2 bores (numbered 80, 81 on the locality plan) were examined, representing 2 hundreds of the 9 included in the Murray Basin in this county.

(ii) No P_2O_5 analyses were made.

(iii) Comments

Molybdate testing suggested low phosphate values in the samples examined.

County Albert

(i) 9 bores (numbered 82 to 90 on the locality plan) were examined, representing 8 hundreds out of 13.

(ii) 3 analyses were made from this county.

(iii) The highest analysis was 0.20% P_2O_5 from a bore in section H, hundred of Paisley, (numbered 89 on locality plan), 101-110 feet, in Morgan-Mannum limestone.

(iv) Comments

Morgan-Mannum limestones gave some fair to moderate molybdate reactions but yielded low P_2O_5 analyses.

County Alfred

(i) 7 bores (numbered 91 to 97 on the locality plan) were examined by the writer, representing 7 hundreds out of 8. R.T. Russell (1964, cited above) independently examined A.O.G. Loxton No. 1 oil well to 916 feet, and in addition Beach Petroleum's Loxton No. 2 oil well to 800 feet. Loxton No. 2 is not included in the present report as it contributes little of significance to this investigation. Only one sample (a green glauconitic marl near the top of the Ettrick Formation, 570-580 feet,) was submitted for analysis from this bore, and it showed 0.16% P_2O_5*.

(ii) 9 analyses were made from this county.

(iii) The highest analysis was 0.39% P_2O_5 from A.O.G. Loxton No. 1 oil well (numbered 95 on locality plan), 150-155 feet, in Pata Limestone

(iv) Comments

All the analyses except the one quoted above were under 0.25% P_2O_5.

County Hamley

(i) 3 bores (numbered 98 to 100 on the locality plan) were examined by the writer, all from the area outside hundreds. Russell examined A.O.C. North Renmark No. 1 oil well to 994 feet.

(ii) 10 analyses were made from this county.

(iii) The highest analysis was 0.61% P_2O_5 from Canopus Bore 1 (numbered 100 on locality plan), 600-614 feet, in Knight Group.

(iv) Comments

The next best analysis was 0.36% P_2O_5 from A.O.C. North Renmark No. 1 oil well (numbered 98 on locality plan), 676-686 feet, from Ettrick Formation. This glauconitic shelly marl with rare fish bone fragments gave a strong molybdate reaction.

Four analyses from the Cretaceous interval in North Renmark No. 1 ranged from 0.20% to 0.27% P_2O_5, and averaged 0.25%.

One analysis from underlying Permian glacigenes recorded 0.30% P_2O_5.

CONCLUSIONS

Sedimentary phosphate is ubiquitous in the basins but nowhere has it been found to occur in economically significant concentrations. The average of 449 partial chemical analyses listed in Appendix II is 0.17% P_2O_5. Only three analyses exceeded 1% P_2O_5 viz.:

1.66% County Sturt, hundred of Brinkley, 59-60 feet, Ettrick Formation, in bore numbered 51 on locality plan - H. and L.G. Wellington West Bore 2.

1.50% County Grey, Hundred of Macdonnell, section 783, 575 - 580 feet, top of Knight Group, in bore numbered 1 on locality plan - O.D.N.L. Mount Salt No. 1.

1.25% County Buckingham, hundred of McCallum, section 4, 553 feet, Knight Group, in bore numbered 48 on locality plan - M.B.O.S. Keith Bore.

According to Clark and Washington (quoted by Emmons, Thiel, Stauffer, and Allison, 1939, p. 16) the average phosphorus content of the upper 10 miles of the earth's crust (including both igneous and sedimentary rocks) is 0.13%, which is equivalent to 0.30% P_2O_5. Thus the sediments tested are not generally above crustal average, but rather the opposite, since the molybdate test was used in an attempt to screen out the more phosphatic samples for chemical analysis.

Phosphorite grains were nowhere common and almost always very rare or absent. They were noted in the following positions:

(i) in Cretaceous beds of the Runnymede Formation, County Grey, Hundred of Penola;

(ii) near the top of Knight Group in Counties Grey (hundreds of Macdonnell, Mayurra, Lake George, Penola) and Robe (hundreds of Smith, Joyce, Naracoorte);

(iii) in Buccleuch Group in Counties Grey (hundreds of Macdonnell, Mayurra, Lake George), Macdonnell (hundred of Minecrow), Buckingham (hundred of Stirling) and Buccleuch (hundred of Roby);

(iv) in the basal glauconitic member of the Gambier Limestone of counties Grey (hundreds of Macdonnell, Lake George), and Robe (hundred of Haracoorte);

(v) in the Ettrick Formation, counties Buckingham (hundred of Stirling) and Sturt (Hundred of Brinkley);

(vi) at the base of the Compton Conglomerate, County Robe (Hundred of Naracoorte);

(vii) doubtfully in Pleistocene shelly sands, County Cardwell (hundred of Coombe).

This information, together with the results of molybdate testing and chemical analysis, is plotted graphically in five plans (Nos. 64-1054, 1055, 1056, 1057 and 1058). Only in 12 bores did samples show chemical analyses higher than 0.5% P_2O_5, viz. bores numbered 1, 2, 5, 17, 26, 30, 31, 33, 47, 48, 51, and 100 on locality plan 64-1028. These bores are situated in the vicinity of Port Macdonnell, Beachport, Kingston to Naracoorte, Keith, Wellington, and Canopus Station. Knight Group, Buccleuch Group, and Ettrick Formation provide these relatively higher analyses. It would be worthwhile to test future bores intersecting the following beds:

(i) the upper Knight Group and Buccleuch Group in Counties Grey, Robe, Macdonnell, and Buckingham;

(ii) the Ettrick Formation in counties Sturt, Russell, Buckingham, and possibly Hindmarsh.

Nineteen samples from the Cretaceous and one from the Permian, intersected in deeper bores, yielded only average analyses ranging up to 0.37% P_2O_5.

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Correlation of the Tertiary Rocks of South Australia. Trans. Roy. Soc. S.Aust. 87: 5-15.

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Note: The name 'Gambier Embayment' is now preferred to 'Gambier Sunklands', but drafting and printing of the plans were completed before this change was made. The correct terminology has been used in the text of this report.

APPENDIX I

Location of bores tested for phosphate

No. of bore on locality plan	Name and location of bore
1.	Mount Salt No. 1, Oil Development N.L., section 783, hundred of Macdonnell.
2.	Mount Salt Structure Hole No. 1, Oil Dev. N.L., hundred of Macdonnell.
3.	Mount Salt Structure Hole No. 2, O.D.N.L., hundred of Macdonnell.
4.	Mount Salt Structure Hole No. 3, O.D.N.L., hundred of Macdonnell.
5.	Mount Salt Structure Hole No. 4, O.D.N.L., hundred of Macdonnell.
6.	Mount Salt Structure Hole No. 5, O.D.N.L., hundred of Macdonnell.
7.	Woods and Forests Dept. Bore 6, section 622, hundred of Caroline.
8.	R.F. Lawson, section 489, hundred Blanche.
9.	E. and W.S. (for E.T.S.A.) Bore 2, Mt. Gambier, section 177, hundred of Gambier.
10.	Geltwood Beach No. 1, Beach Petroleum N.L., hundred of Mayurra.
11.	Geltwood Beach Structure Hole No. 7, Beach Petroleum N.L., hundred of Mayurra.
12.	Cellulose Pty. Ltd. Bore 1, section 78, hundred of Mayurra.
13.	Cellulose Pty. Ltd. Bore 2, section 78, hundred of Mayurra.
14.	Burrungule lignite Bore CG 6, boundary section 2, hundred of Young, and section 14, hundred of Hindmarsh.
15.	E. and W.S. Millicent Bore 3, section 583, hundred of Mount Muirhead.
16.	Woods and Forests Dept. Bore 1A, section 130, hundred of Nangwarry.
17.	Beachport No. 1, South East Oil Syndicate Ltd., section 20, hundred of Lake George.
18.	A.W. Shannon, Bore 2, block 5, hundred of Monbulla.
19.	Penola No. 1, Oil Development N.L., section 500, hundred of Penola.
20.	G.R. Cameron, Bore 1, section 65, hundred of Smith.

No. of bore on locality plan	Name and location of bore
21.	C.C. Seymour, Bore 1, section 141, hundred of Killanoola.
22.	Comaum coal exploration, Bore 2, sections 244, 328, hundred of Comaum.
23.	D. Ogilvie, section 119, hundred of Ross.
24.	Broadlands Pastoral Co. Bore 9, section 395, hundred of Joyce.
25.	South East water boring programme, Bore 13A, section423, hundred of Joanna.
26.	Dr. F. Jose, section 128, hundred of Spence.
27.	Naracoorte No. 1, E. and W.S., Townsite block, hundred of Naracoorte.
28.	Naracoorte No. 2, E. and W.S., Townsite block, hundred of Naracoorte.
29.	Naracoorte No. 4, E. and W.S., section 1040, hundred of Naracoorte.
30.	Naracoorte No. 5, E. and W.S., section 1086, hundred of Naracoorte.
31.	Kingston No. 3, E. and W.S., section 374, hundred of Lacepede.
32.	L.E. Maczkowiak, Bore 2, section 500, hundred of Murrabinna.
33.	R. Paltridge, Bore 2, section 189, hundred of Minecrow.
34.	R.G. Harrison, Bore 1, section 435, hundred of Hynam.
35.	M. Hunt, Cattle Creek station, section 25, hundred of Duffield.
36.	M.G. Coleman, Bore 5, section 35, hundred of Parsons.
37.	E.C. Pridham, section 42, hundred of Beeamma.
38.	Australian Primary Oils Ltd., Bore 8, section 70, hundred of Geegeela.
39.	A.H. May, Bore 1, section 27, hundred of Laffer.
40.	Department of Lands, Bore 1, section 19, hundred of Field.
41.	Richardson Bros., section 108, hundred of Colebatch.
42.	L.F. Galley, Bore 1, section 101, hundred of Richards.
43.	H.A. Fiegert (Lewis Bros.), section 134, hundred of Coombe.
44.	R.W. Lemessurier, Bore 3, section 91, hundred of Willalooka.

No. of bore on locality plan	Name and location of bore
45.	Mundulla Public School Bore, Town Block, hundred of Wirrega.
46.	S.R. Makin, section 83E, hundred of Stirling.
47.	P.H. Densley, section 141, hundred of Stirling.
48.	Keith Bore, Murray Basin Oil Syndicate, section 4, hundred of McCallum.
49.	W.H. Wylie, Bore 3, Kangaringa Station, section 1, hundred of Shaugh.
50.	M. Arnold, section 145, hundred of Freeling.
51.	Highways and Local Govt. Dept., Wellington West, Bore 2, Harbours Reserve, hundred of Brinkley.
52.	Dept. of Works, P.M.G., Murray Bridge, Bore 1, Townsite block, hundred of Mobilong.
53.	R.A. Guenther, section 189, hundred of Mobilong.
54.	F. and J. Starick, Bore 2, section 390, hundred of Angas.
55.	J.H. Strauss, Bore 2, section 167, hundred of Ridley.
56.	H.H. Cartledge, Bore 1, section 1, hundred of Jeffries.
57.	G.S. and L. Moore, Bore 1, section 97, hundred of Coolinong.
58.	Highways and Local Govt. Dept., Jervois Punt, Tailem Bend, Bore 1, Harbours Reserve, hundred of Seymour.
59.	C.A. Nagel, section 1 EB, hundred of Seymour.
60.	Zadow Bros., Bore 1, section 1 NA, hundred of Burdett.
61.	A.R. Launer, Bore 1, section 21, hundred of Ettrick.
62.	A.R. Launer, Bore 2, section 21, hundred of Ettrick.
63.	L.H. Wellman, Bore 1, section 4, hundred of Ettrick.
64.	H.A. Rosenburg, Bore 1, section 47, hundred of Younghusband.
65.	C.O. Klitscher, section 10, hundred of Strawbridge.
66.	Coonalpyn No. 2, E. and W.S., section 56, hundred of Coneybeer.
67.	Coonalpyn No. 3, E. and W.S., section 7, hundred of Coneybeer.
68.	Trossachs Pastoral Co., Bore 5, section RSA, hundred of Lewis.
69.	W.G. Jacobs, Bore 1, section 32, hundred of Livingston.
70.	W.J. and N.E. Wilkins, section 18, hundred or Roby.

No. of bore on locality plan	Name and location of bore
71.	A.P. Manley, Bore 3, section 31, hundred of Roby.
72.	K.J. and C.R. Barney, section 38, hundred of Peake.
73.	M. Dall and Son, section 4, hundred of Peake.
74.	Sherlock School, Bore 1, Townsite Lot 44, hundred of Sherlock.
75.	Karoonda Township Bore 2, E. and W.S., section 135, hundred of Hooper.
76.	J.P. Williams, section 69, hundred of Molineux.
77.	K.A. Godfrey, section 91, hundred of Cotton.
78.	Lameroo Township Bore, E. and W.S., section 203, hundred of Bews.
79.	Pinnaroo No. 1, Murray Basin Oil Syndicate, sections 59, 67, hundred of Pinnaroo.
80.	H. and L.G. Dept., Swan Reach Bridge, Bore 8, section 124, hundred of Fisher.
81.	H. and L.G. Dept., Blanchetown Bridge, Bore 8, Harbours Reserve, hundred of Skurray.
82.	A.B. Morrell, Bore 1, section 44, hundred of Forster.
83.	W.N. Ellis, Bore 1, section 26, hundred of Bandon.
84.	G.S. Evans, Bore 1, section 38, hundred of Chesson.
85.	Wanbi Research Station, Bore 1, section 32, hundred of Mindarie.
86.	H.W. Day, section 1CA, hundred of Bakara.
87.	R.M. Stasinowsky, Bore 1, section 39, hundred of Mantung.
88.	W.H. Todd, section 4B, hundred of Mantung.
89.	R.R. Edison, Bore 1, section H, hundred of Paisley.
90.	R.H. Spencer, section 1, hundred of Holder.
91.	C.H. Kirvan, section 43, hundred of Allen.
92.	A.C. Pocock, section 172, hundred of Kekwick.
93.	N.W. Flavel, section 28, hundred of McGorrery.
94.	C.T.J. Schuster, Bore 1, section 42, hundred of Pyap.
95.	Loxton No. 1, A.O.G., section 6B, hundred of Bookpurnong.
96.	E. and W.S. Dept. drainage bore, Shaft 18, section 377, hundred of Gordon.

No. of bore on locality plan	Name and location of bore
97.	Chowilla Dam P.D.1, section 19, hundred of Murtho.
98.	North Renmark No. 1, A.O.C., outside hundreds.
99.	Chowilla Dam P.D.2, outside hundreds.
100.	Canopus Pastoral Co., Bore 1, outside hundreds.

APPENDIX II

Phosphate analyses, molybdate test reactions, and summarized stratigraphy

Only those samples that were analysed have been included. It was not considered practicable or necessary to include details of all samples examined, as those showing better molybdate reactions were analysed. Some bores that were examined but which showed poor molybdate reactions throughout are therefore not included in the following table.

All chemical analyses were done by Australian Mineral Development Laboratories, Parkside. Those marked with an asterisk* were done for Mines Exploration Pty. Ltd., the remainder were done forthe Department of Mines.

References to the stratigraphy of the bores include many unpublished reports and a few published works. The latter are listed under 'References' at the end of this report, the former in the section 'Stratigraphic Control', earlier in the report. Where no reference is given, the stratigraphy was outlined by the writer.

The following abbreviations have sometimes been used in the lithological descriptions to conserve space.

Abund.	abundant
Brn.	brown
Bryoz.	bryozoa, or bryozoal
Calc.	calcareous
Carb.	carbonaceous
Contam.	contamination
Dk.	dark (-coloured)
Ech.	echinoid (-rich)
Ferrug.	ferruginous
Glauc.	glauconitic, or glauconite
Irreg.	irregularly
Lim.	limonitic, or limonite
Lst.	limestone
Lt.	light (-coloured)
Pyr.	pyritic, or pyrite
Recryst.	recrystallized
Sst.	sandstone
V.	very

Number of bore on locality map	Name of bore	Locality	Sample analysed (feet)	Formation	Lithology etc.	Molybdate test reaction	P_2O_5 %
1	Mt. Salt No. 1, O.D.N.L.	Hd. Macdonnell, Sect. 783	575-580	Knight Group	Brn. lim. clayey grit. Lim. pellets; fish teeth, bones. Glauc.	Dk. colitic frags. very weak	0.37 1.50*
	(Ludbrook, N.H. 1963, unpub. rep.)		580-590	"	Dk. brn. lim. clayey sand. Lim. pellets, etc. Cement contam. Few phosphatic grains.	Few frags. moderately strong	0.50 0.93*
			590-600	"	Do. much cement contam.	Few frags. moderate	0.30 0.40*
			600-610	"	Dk. brn. gritty sandy silt and clay. Slightly pyr.	Few frags. moderate	0.65 0.46*
			620-630	"	Dk. brn. silty and clayey grit. Glauc. Carb. Lim.	Almost no reaction	0.16 0.21*
			630-640	"	do.	Not tested	0.14
			640-650	"	Dk. brn. carb. silt (stone)	" "	0.17
			650-660	"	do.	" "	0.12
			660-670	"	do.	" "	0.12
			670-680	"	Dk. brn. carb. gritty silt (stone)	" "	0.11
			680-690	"	do.	" "	0.16
			690-700	"	do.	" "	0.06
			700-710	"	do.	" "	0.04
			710-720	"	do.	" "	0.04
			720-730	"	White grit	" "	0.004

Number of bore on locality map	Name of bore	Locality	Sample analysed (feet)	Formation	Lithology etc.	Molybdate test reaction	P_2O_5 %
1	Mt. Salt No. 1, O.D.N.L. (Ludbrook, N.H. 1963, unpub. rep.)	Hd. Macdonnell, Sect. 783	740-750	Knight Group	Brn. gritty silt(stone), carb.	Not tested	0.04
			750-760	" "	do.	" "	0.06
			760-770	" "	Brn. gritty silt(stone), carb.	" "	0.03
			770-780	" "	do.	" "	0.07
			790-800	" "	do.	" "	0.05
			800-810	" "	do.	" "	0.06
			830-840	" "	do.	" "	0.03
			840-850	" "	do.	" "	0.08
			850-860	" "	do.	" "	0.03
			860-870	" "	do.	" "	0.11
			870-880	" "	do.	" "	0.15
			890-900	" "	Dk. brn. carb. silt(stone) and gritty sand	" "	0.13
			900-910	" "	do.	" "	0.08
			995-1011	" "	Grey, dk. grey, carb. sandy siltstone. Glauc.; Lim. pellets; pyr.	" "	0.07
			1011-1040	" "	Brn.-grey coarse illsorted quartz sand.	" "	0.11
			1040-1050	" "	do.	" "	0.12

Number of bore on locality map	Name of bore	Locality	Sample analysed (feet)	Formation	Lithology etc.	Molybdate test reaction	P_2O_5 %
1	Mt. Salt No. 1, O.D.N.L.	Md. Macdonnell, Sect. 783	1060-1080	Knight Group	Dk. brn.-grey gritty pyr. clay	Not tested	0.10
	(Ludbrook, N.H. 1963, unpub. rep.)		1080-1090	" "	do.	" "	0.11
			1090-1100	" "	do.	" "	0.13
			1100-1120	" "	Brn.-grey coarse illsorted quartz sand.	" "	0.02
			1120-1130	" "	do.	" "	0.00
			1130-1140	" "	do.	" "	0.09
			1140-1150	" "	do.	" "	0.00
			1150-1160	" "	do.	" "	0.00
			1160-1170	" "	Brn.-grey coarse illsorted quartz sand.	" "	0.00
			1170-1180	" "	do.	" "	0.00
			1180-1190	" "	do.	" "	0.00
			1190-1200	" "	do.	" "	0.00
			1200-1210	" "	do.	" "	0.00
			1210-1220	" "	Brn.-grey sandy silt	" "	0.04
			1220-1230	" "	do.	" "	0.03
			1230-1240	" "	do.	" "	0.02
			1240-1250	" "	do.	" "	0.10
			1250-1260	" "	do.	" "	0.05

Number of bore on locality map	Name of bore	Locality	Sample analysed (feet)	Formation	Lithology etc.	Molybdate test reaction	P_2O_5 %
1	Mt. Salt No. 1, O.D.N.L. (Ludbrook, N.H. 1963, unpub. rep.)	Hd. Macdonnell, Sect. 783	1280–1290	Knight Group	Brn.-grey silty coarse sand.	Not tested	0.00
			1290–1300	" "	do.	" "	0.00
			1300–1310	" "	do.	" "	0.02
			1310–1320	" "	do.	" "	0.03
			1320–1340	" "	do.	" "	0.00
			1340–1350	" "	do.	" "	0.00
			1350–1360	" "	do.	" "	0.00
			1360–1370	" "	do.	" "	0.01
			1370–1380	" "	do.	" "	0.03
			1380–1390	" "	do.	" "	0.06
			1390–1410	" "	Brn.-grey sandy silt	" "	0.04
			1410–1430	" "	do.	" "	0.04
			1430–1440	" "	do.	" "	0.05
			1440–1450	" "	do.	" "	0.03
			1450–1460	" "	do.	" "	0.03
			1460–1470	" "	Brn.-grey sandy silt	" "	0.05
			1470–1480	" "	do.	" "	0.05
			1480–1490	" "	do.	" "	0.05
			1500–1510	" "	do.	" "	0.04

Number of bore on locality map	Name of bore	Locality	Sample analysed (feet)	Formation	Lithology etc.	Molybdate test reaction	P_2O_5 %
2	Mt. Salt Structure Hole No. 1, O.D.N.L. (Ludbrook, N.H. 1962, unpub. rep.)	Hd. Macdonnell in or adj. to sect. 783	600- 610	Gambier Lime-stone	Lt. grey dense chalky lst. Abund. spicules.	Not tested	0.07
			610- 620	" "	do.	"	0.08
			620- 630	" "	do.	"	0.08
			630- 640	" "	do.	"	0.08
			640- 650	" "	do.	"	0.08
			650- 690 (composite)	" "	Lt. grey dense lst. with saccharoid-al calcite, some glauc.	650–660: No reaction	0.16
			670- 680	" "	do. rare lim. grains and quartz.	Few reactive spots	0.13*
			680- 690	" "	do. common lim. and quartz, some glauc.	Patch of definite reaction	0.56*
			690- 700	" "	do.	Weak	0.40 0.65 *
			700- 710	" "	do.	Mod. strong	0.38 0.52*
			710- 720	Buccleuch Group	Brown ferruginous muddy sand. Fish remains	Quite strong	0.40 0.38*
			720- 730	"	do.	Moderate	0.26 0.42*
			730- 740	"	do.	Fair	0.31
			740- 750	"	do.	Moderate	0.12
			750- 760	"	do.	Fair	0.11

Number of bore on locality map	Name of bore	Locality	Sample analysed (feet)	Formation	Lithology etc.	Molybdate test reaction	P_2O_5 %
2	Mt. Salt Structure Hole No. 1, O.D.N.L. (Ludbrook, N.H. 1962, unpub. rep.)	Hd. Macdonnell in or adj. to sect. 783	760- 770	Knight Group	Grey pyr. grit. Shark teeth	Weak	0.12
			770- 780	"	Grey pyr. grit. Shark teeth. Muddy matrix	Mod. strong	0.15
			780- 790	"	do.	Weak	0.17
			790- 800	"	do.	Weak	0.19
			800- 810	"	do.	Mod. strong	0.15
			810- 830 (composite)	"	Grey pyr. and lim. grit with shark teeth	Weak to mod. strong	0.13
			830- 850 (composite)	"	do.	Weak	0.15
			850- 870 (composite)	"	Grey pyr. grit	Almost no reaction	0.11
			870- 880	"	do. lim. pellets	Strong	0.10
			890- 920 (composite)	"	Grey grit. lim. pellets	Weak to strong	0.11
			920- 930	"	Grit and carb. siltstone	Weak	0.15
			930- 940	"	do.	Weak - fair	0.06
			940- 950	"	do.	Weak - fair	0.07
			950- 960	"	Grit	Strong	0.12
			960- 980 (composite)	"	Grey-white pyr. grit and mudstone	Weak	0.06
			980-1000 (composite)	"	Silty carb. grit, gritty mudstone	Weak	0.04

Number of bore on locality map	Name of bore	Locality	Sample analysed (feet)	Formation	Lithology etc.	Molybdate test reaction	P_2O_5%
3	Mt. Salt Structure Hole No. 2, O.D.N.L. (Ludbrook, N.H. 1962, unpub. rep.)	Hd. Macdonnell, in or adj. to Sect. 783	775- 785	Knight Group	Brn. pyr. sand. Lim. grains	Very weak	0.03
			785- 790	"	do.	Not tested	0.04
			790- 800	"	do.	Not tested	0.03
			800- 810	"	Grey milky quartz grit	No reaction	0.00
			810- 820	"	Grey milky quartz grit	Not tested	0.00
			820- 830	"	do. somewhat pyr.	Not tested	0.00
			830- 840	"	do.	Not tested	0.00
			840- 850	"	do.	Not tested	0.03
			850- 860	"	Brn.-grey poorly-sorted gritty silty sand	Very weak	0.03
			860- 870	"	do.	Very weak	0.03
			870- 890 (composite)	"	Grey sand - silty	Very weak	0.00
			890- 900	"	do.	V.weak, fair patch	0.03
			900- 910	"	do.	Not tested	0.03
			910- 920	"	do.	V.weak, fair patch	0.03
			920- 930	"	do.	Not tested	0.02
			930- 940	"	do.	Not tested	0.01
			940- 950	"	do.	Very weak	0.02

Number of bore on locality map	Name of bore	Locality	Sample analysed (feet)	Formation	Lithology etc.	Molybdate test reaction	P_2O_5 %
3	Mt. Salt Structure Hole No. 2, O.D.N.L. (Ludbrook, N.H. 1962, unpub. rep.)	Hd. Macdonnell, in or adj. to Sect. 783	950- 960	Knight Group	Grey sand - silty	Not tested	0.02
			960- 970	"	do.	Not tested	0.02
			970- 980	"	do.	Very weak	0.00
			980- 990	"	do.	Not tested	0.00
			992- 997	"	Grey very fine grained carb. silty sst. Micaceous.	Very weak	0.00
			999-1002	"	do.	Very weak	0.00
4	Mt. Salt Structure Hole No. 3, O.D.N.L. (Ludbrook, N.H. 1962, unpub. rep.)	Hd. Macdonnell, in or adj. to Sect. 783	730- 740	Buccleuch Group	Grey marly lst. Somewhat glauc., lin. V.Rare shark's tooth.	Not tested	0.08
			740- 750	"	do.	Weak	0.10
			750- 760	"	Grey very marly do.	Strong	0.14
			770- 780	"	Grey glauc. marl, with pyrite, quartz, shark tooth.	Mod. strong	0.18
			880- 890	Knight Group	Brn. ferruginized sst., carb. silt, pyr.	Moderate	0.19
			890- 900	"	do.	Moderate	0.13
			920- 930	"	Brn. carb. pyr. siltstone and sand	Strong	0.35
			940- 950	"	do.	Moderate	0.18
			970- 980	"	do.	Weak	0.15
			990-1000	"	Brn. interlaminated siltstone, v.fine sst., mudstone; carb.	Fair-moderate	0.15
			990-1002	"	do.	Moderate	0.06

Number of bore on locality map	Name of bore	Locality	Sample analysed (feet)	Formation	Lithology etc.	Molybdate test reaction	P_2O_5 %
5	Mt. Salt Structure Hole No. 4, O.D.N.L. (Ludbrook, N.H. 1962, unpub. rep.)	Hd. Macdonnell, in or adj. to sect. 783	70- 80	Gambier Limestone	Cream recryst. somewhat chalky lst.	Strong	0.06
			90- 100	"	do.	Strong	0.07
			100- 110	"	do.	Strong	0.05
			140	"	do.	Strong	0.03
			160	"	Cream recryst. bryozoal lst.	Strong	0.06
			500	Buccleuch Group	Grey glauc. pyr. marly lst. abund. spicules, flinty.	Weak	0.04
			510	"	do.	Very weak	0.04
			520	"	do.	Very weak	0.05
			530	"	do.	Very weak	0.07
			540	"	do.	Weak	0.03
			550	"	do.	Fair	0.09
			560	"	Greenish grey glauc. marl	Very weak	0.18
			570	"	do.	Very weak	0.17
			580-600 (composite)	"	Greenish to brown glauc. lim. sand; shark and other fish teeth, glauc and lim. pellets	Very weak - fair-moderate	0.50
			610	Knight Group	Brown limonitic silty sand; shark teeth	Fair-moderate.	0.64
			620	Knight Group	Brn. silty lim. grit; teeth and other fish remains	Weak-fair	0.55
			630	"	do.	Weak	0.47
			640	"	do.	Weak	0.50

Number of bore on locality map	Name of bore	Locality	Sample analysed (feet)	Formation	Lithology etc.	Molybdate test reaction	P_2O_5 %
5	Mt. Salt Structure Hole No. 4, O.D.N.L. (Ludbrook, N.H. 1962, unpub. rep.)	Hd. Macdonnell, in or adj. to sect. 783	650-680 (composite)	Knight Group	Red-brn. lim. quartz grit; shark teeth; other vertebrate remains.	Weak	0.36
			690-720 (composite	"	do. and grey pyr. gritty sst.	Very Weak-weak-fair	0.25
			850	"	Grey-brn. silty sst.	Very weak	0.24
			950	"	do.	Very weak	0.24
			960	"	Grey-brn. silty gritty sst.	Very weak	0.28
			970	"	Grey-brn. silty gritty fine sst.	Very weak	0.24
			980	"	do.	Not tested	0.17
			990	"	do.	Not tested	0.24
			992-1002	"	Grey-brn. silty gritty sst.	Almost no reaction	0.10
6	Mt. Salt Structure Hole No. 5, O.D.N.L. (Ludbrook, N.H. 1962, unpub. rep.)	Hd. Macdonnell, in or adj. to sect. 783	730-740	Buccleuch Group	Slightly greenish-grey glauc. marl. Glauc. pellets	Weak	0.13
			740-750	"	Greenish-grey glauc. lim. sand	Weak	0.19
			750-760	"	do. fish remains	Weak	0.27
			760-770	"	Brownish glauc. - lim. sand. Glauc. - lim. pellets	Weak-fair	0.28
			770-780	"	do.	Weak	0.40

Number of bore on locality map	Name of bore	Locality	Sample analysed (feet)	Formation	Lithology etc.	Molybdate test reaction	P_2O_5 %
6	Mt. Salt Structure Hole No. 5, O.D.N.L.	Hd. Macdonnell, in or adj. to sect. 783	780-790	Knight Group	Red-brn. lim. and quartz sand	Weak-fair	0.37
			790-800	"	Brn. lim. sand. Fish teeth	Weak-fair	0.34
			800-820 (composite)	"	Red-brn. lim. sand; grey pyr. silty quartz grit.	Weak-v.weak	0.15
			820-830	"	Grey pyr. silty quartz grit	Weak	0.16
			830-840	"	Grey and clear pyr. quartz grit; silty.	Weak	0.13
			840-850	"	do.	Weak	0.15
			860-870	"	do.	Weak	0.19
			870-880	"	Grey quartz grit. Some pyrite	Weak	0.15
			880-890	"	do.	Weak-moderate	0.13
			890-900	"	do.	Very weak	0.14
			910-920	"	do.	Very weak	0.16
			920-930	"	do.	Not tested	0.11
			930-940	"	do.	Very weak	0.12
			940-950	"	do.	Not tested	0.15
			950-960	"	do.	Very weak	0.12

Number of bore on locality map	Name of bore	Locality	Sample analysed (feet)	Formation	Lithology etc.	Molybdate test reaction	P_2O_5 %
6	Mt. Salt Structure Hole No. 5, O.D.N.L. (Ludbrook, N.H. 1962 unpub. rep.)	Hd. McDonnell, in or adj. to sect. 783	960-970	Knight Group	Dk. brn. gritty silty sand	Very weak	0.11
			970-980	"	do.	Very weak	0.10
			980-990	"	do.	Very weak	0.06
			992-1002	"	Dk. brn. carb. sandy silt; lt. brn. fine sand. Some pyrite.	Very weak	0.00
10	Geltwood Beach No. 1, Beach Petroleum N.L. (Ludbrook, N.H. 1964, unpub. rep.)	Hd. Mayurra, out of sections	970-980	Knight Group	Brn. pyr. quartz grit and sand.	Not tested	0.12 *
			980-990	"	do. with fish teeth	Not tested	0.12 *
			990-1000	"	do. do.	Not tested	0.13 *
			1000-1010	"	Brn. carb. siltstone	Not tested	0.08 *
12	Cellulose Pty. Ltd. Bore 1 (Ludbrook, N.H. 1961, unpub. rep.)	Hd. Mayurra, sec. 78	510	Knight Group (top)	Yellow-brn. lim. sand, and lst. cavings. Lim. pellets, some glauc. Some phosphatic grains. Shark's teeth	Strong	0.35
13	Cellulose Pty. Ltd. Bore 2. (Ludbrook, N.H. 1961, unpub. rep.)	Hd. Mayurra, sec. 78	30	Gambier Limestone.	Off-white, cream, part recryst. bryoz. lst.	Mod. strong	0.10
			50	"	do. flinty	Mod. strong	0.08
			496	Knight Group (top)	Yellow-brn. lim. sand and lst. cavings. Gritty. A few phosphatic fragments.	Mod. strong	0.33

Number of bore on locality map	Name of bore	Locality	Sample analysed (feet)	Formation	Lithology etc.	Molybdate test reaction	P_2O_5 %
14	Burrungule Lignite Bore CG 6	Boundary sect. 2, hd. Young, and sec. 14, hd. Hindmarsh	10-11	Gambier Limestone	Lt. grey, brn. patches, hard recryst. lst. and cream chalky lst. Rubbly.	Fair to mod. strong	0.09
			20-21	"	Cream, brownish bryoz. lst.	Moderate	0.10
16	Woods and Forests Dept. Bore 1A. (O'Driscoll, E.P.B. 1960 not palaeo.-controlled)	Hd. Nangwarry, sec. 130	38-43	Gambier Limestone	Grey-cream hard lst. Some glauc.	Strong	0.14
			43-50	Compton Conglomerate	Yellow calc. sst. or v.sandy lst.	Mod. strong	0.16
17	Beachport No. 1 South East Oil Syndicate Ltd. (Ludbrook, N.H. 1962, unpub. rep.)	Hd. Lake George, sec. 20	540-550	Gambier Limestone.	Cream to off-white bryoz. lst. Some glauc.	Strong	0.47
			550-560	"	Cream-white, pale brn., bryoz. lst. Glauc. Pale brn. frags. strong reaction	Strong	0.37
			750-760	"	Light grey hard recryst. bryoz. lst. Some glauc.	Not tested	0.05
			760-770	" (glauc. member)	Green-grey hard recryst. glauc. bryoz. lst. Glauc. pellets. Pyr.	Very weak	0.04
			770-780	"	do.	Not tested	0.04
			780-790	"	do.	Very weak	0.03
			790-810	"	do.	V.weak-weak	0.04
			810-820	"	do.	Not tested	0.07
			820-830	Equivalents of upper Buccleuch Grp.	Grey-green glauc. marl. Fish remains.	Moderate	0.44 *

Number of bore on locality map	Name of bore	Locality	Sample analysed (feet)	Formation	Lithology etc.	Molybdate test reaction	P_2O_5 %
17	Beachport No. 1 South East Oil Syndicate Ltd. (Ludbrook, N.H. 1962 unpub. rep.)	Hd. Lake George, sec. 20.	830-840	Equivalents of upper Buccleuch Group.	Grey-green glauc. marl. Fish remains.	Not tested	0.34 *
			820-840 (composite)	" "	do.	Moderate	0.29
			840-850	" "	do.	Moderate	0.38 *
			850-860	" "	do.	Not tested	0.18 *
			840-860	" "	do.	Moderate	0.21
			860-870	" "	do.	Fair-moderate	0.44 *
			870-880	" "	Dk. brn. ferrug. clay. Red-brn. iron oxide pellets. Shark's teeth.	Fair-moderate	0.85 *
			860-880 (composite)	" "	do. (composite)	Fair-moderate	0.65
			880-890	Knight Group	Brn. quartz grit. Pebbles. Pyr. Lim. pellets. Brn. clay. Shark's tooth.	Moderate	0.44 0.87 *
			890-900	"	Brn. coarse quartz grit. Pyr. Sideritic matrix	Not tested	0.23 0.25 *
			900-910	"	do.	Fair	0.13
			910-920	"	do.	Not tested	0.17
			920-930	"	Grey, carb. hard fine gr. dense lst. Pyr. Shark's tooth	Very weak	0.18

Number of bore on locality map	Name of bore	Locality	Sample analysed (feet)	Formation	Lithology etc.	Molybdate test reaction	P_2O_5 %
17	Beachport No. 1, South East Oil Syndicate Ltd. (Ludbrook, N.H. 1962, unpub. rep.)	Hd. Lake George, sec. 20	930-965 (composite)	Knight Group	Grey, carb. hard fine gr. dense lst. Pyr. Shark's tooth.	Not tested	0.15
			970-990 (composite)	"	Dk. brn. calc. pyr. clay. Carb. Micaceous.	Almost no reaction.	0.16
			990-1010 (composite)	"	do.	Almost no reaction. A fair patch.	0.12
			1010-1020	"	Brn. lim. sandy lst.	Fair	0.31 *
			1010-1030 (composite)	"	do.	Fair-weak	0.26
			1030-1050 (composite)	"	Dk. brn. sandy clay. Part pyr.	Very weak	0.14
			1050-1060	"	Dk. brn. carb. pyr. clay. Gritty	Not tested	0.13
			1060-1070	"	Dk. brn. gritty pyr. clay.	Weak	0.26
			1070-1080	"	Dk. brn. gritty pyr. clay.	Not tested	0.10
			1080-1090	"	do.	Weak	0.15
			1090-1100	"	Cream-pink, coarse gritty sst. Calcareous matrix.	Not tested	0.12
19	Penola No. 1, Oil Development N.L. (Ludbrook, N.H. 1961. unpub. rep.)	Hd. Penola, sect. 500	215-220	Gambier Limestone.	Grey-cream bryoz. lst. Pale brn. lst. frags. give strong reaction.	Strong	0.09
			235-240	"	do. do.	Strong	0.09
			1055-1060	Runnymede Formation (Upper	Green-grey fine felspathic sandy siltstone; pyr., carb., micaceous.	Faint, one frag. strong	0.04

Number of bore on locality map	Name of bore	Locality	Sample analysed (feet)	Formation	Lithology etc.	Molybdate test reaction	P_2O_5 %
19	Penola No. 1, Oil Development N.L. Ludbrook, N.H. 1961, unpub. rep.)	Hd. Penola, sect. 500	1065-1070	Runnymede Formation (Upper Member)	Green-grey fine felspathic sandy siltstone; pyr., carb., micaceous.	Strong	0.21
			1075-1080	"	do.	Moderate	0.26
			1085-1100 (composite)	"	do.	Moderate	0.32
			1120-1125	"	do.	Mod. strong	0.34
			1130-1135	"	Green-grey fine sandy siltstone to silty sandstone; pyr., carb.	Fair-weak A strong patch.	0.32
			1140-1145	"	do.	Weak; stronger patches	0.30
			1150-1155	"	do.	Mod. strong	0.24
			1300-1305	"	do.	Quite strong	0.24
			1400-1405	"	Greenish-grey siltstone, carb., pyr., micaceous	Weak-strong	0.21
			2400-2405	"	Greenish-grey calcareous fine sandy siltstone. Pyr.	Weak-strong	0.37
			2600-2605	"	Green-grey mudstone; carb., pyr., micaceous. Dolomite.	Weak. Few strong spots.	0.27
			2900-2905	"	Green-grey siltstone; some coal.	Moderate	0.25
			3000-3005	"	Brn.-grey carb. mudstone.	Weak. One frag. mod. strong	0.26

Number of bore on locality map	Name of bore	Locality	Sample Analysed (feet)	Formation	Lithology etc.	Molybdate test reaction	P_2O_5 %
20	G.R. Cameron, Bore 1	Hd. Smith, sect. 65.	265-270	Gambier Limestone	Pale grey, slightly greenish bryoz. and ech. marly lst. Glauc. rare	Moderate	0.07
			270-275	"	do. slightly glauc.	Strong	0.12
			275-280	"	Off-white marly lst. Bryoz., ech. frags. V.rare glauc.	Fair-moderate	0.08
22	Comaum coal exploration bore No. 2. (Harris, Wayne K. 1964, unpub. rep.)	Hd. Comaum, sects. 244/328	34-36 (approx.) (composite)	Gambier Limestone	Light grey-brn. hard recryst. glauc. bryoz. lst.	Mod. strong	0.07
			42(approx.)	"	Cream, hard, recryst., glauc., fine shelly lst.	Quite strong	0.06
			200(approx.)	"	Buff, hard, recryst., glauc. lst.	Strong	0.12
24	Broadlands Pastoral Co., Bore 9. (O'Driscoll, E.P.D. 1960 - part palaeo. control)	Hd. Joyce, sect. 395	4- 12	Recent-?Pleistocene	Yellow-brn. sandy lst.	Mod.-strong	0.06
			12- 15	"	do.	Mod.-strong	0.03
			28- 38	"	Yellow-brn. to lt. grey shelly sandy lst.	Mod.-strong	0.06
			315-325	Gambier Limestone	Lt.grey, greenish, fine sandy marl.	Mod. strong	0.05
			467-474	Compton Conglomerate equivalent	Grey glauc. sandy marl. Lim. pellets.	Mod. strong	0.21
			474-484	Knight Group ?Buccleuch Group	Dk. brn.-grey, lim., gritty shelly marl. Carb., some glauc.	Mod. strong	0.24
			533-543	"	Greenish-brn. lim. sandy marl. Lim. pellets. Some glauc.	Moderate. Strong patch	0.27

Number of bore on locality map	Name of bore	Locality	Sample Analysed (feet)	Formation	Lithology etc.	Molybdate test reaction	P_2O_5 %
24	Broadlands Pastoral Co., Bore 9. (O'Driscoll, E.P.D. 1960 - part palaeo. control)	Hd. Joyce, sect. 395	557-565	Knight Group ?Buccleuch Group	Dk. brn. glauc. lim. fine shelly sandy marl.	Mod.-strong	0.37
26	Dr. F. Jose (O'Driscoll, E.P.D. 1960, palaeo. control)	Hd. Spence, sect. 128	280-290	Knight Group (near top)	Black gritty sandy silty carb. clay. Some glauc. pellets. Laminae of grey micaceous coarse silt.	Mod.-strong	0.80
27	Naracoorte E. and W.S. Bore 1	Hd. Naracoorte Townsite	218-235	Knight Group (top)	V. dk. brn. lim. shelly fine silty sand.	Fair-moderate	0.18
			235-246	"	Brn.-grey lim. shelly calc. sst. Rare fish bone frags. Dk. brn. phosphatic frags.	Strong	0.31
			246-281	Knight Group	V. dk. brn. lim. carb. shelly, fine sst. to silt. Clayey.	Fair.	0.30
			296-306	"	do. sandy clayey silt.	Fair	0.27
			447-448	"	Laminated lt.-dk. brn. grey carb. sandy silty shale.	Fair	0.06
28	Naracoorte E. and W.S. Bore 2. (O'Driscoll, E.P.D. 1960, palaeo. control)	Hd. Naracoorte Townsite.	124-174	Gambier Limestone	Off-white soft, friable sandy marly limestone	Moderate	0.15
			206-226	Compton Conglomerate	Lt. Brn. shelly sand. Lim. pellets. Bryozoal.	Fair-mod.	0.06
			289-340	Knight Group	Dk. brn. lim. calc. shelly sand and sst. Lim. pellets	Moderate	0.28
			390-420	"	Black - brn.-grey sandy shelly carb. mudstone	Moderate	0.12

Number of bore on locality map	Name of bore	Locality	Sample Analysed (feet)	Formation	Lithology etc.	Molybdate test reaction	P_2O_5 %
29	Naracoorte E. and W.S. Bore 4	Hd. Naracoorte Sect. 1040	148-158	Pleistocene ?	Lt. brn. calc. sand, calc. sst., sandy lst.	Moderate	0.06
			158-161	"	do.	Strong	0.05
			167-177	"	Cream do. many lst. frags.	Strong	0.07
			177-187	Gambier Lst.	Pale cream lst.	Strong	0.08
			187-190	"	Cream-white lst.	Strong	0.06
			190-200	"	Cream sandy lst.	Strong	0.05
			200-210	"	do.	Mod. strong	0.05
			240-250	"	Pale cream marly lst.	Moderate	0.18
			250-258	"	Buff marly lst. Brown grains phosphatic.	Strong	0.16
			258-260	"	do.	Moderate	0.10
			260-270	Comptom Conglomerate	Lt. brn. lim. calc. sand. Many brn. grains.	Moderate	0.17
			346-356	Knight Group	Dk. brn. lim. carb. silty sand	Weak, few strong patches	0.48
			433-443	"	Black carb. sandy clayey silt. Fine shelly	Fair-mod.	0.19
			443-453	"	do.	Fair	0.14

Number of bore on locality map	Name of bore	Locality	Sample Analysed (feet)	Formation	Lithology etc.	Molybdate test reaction	P_2O_5 %
29	Naracoorte E. and W.S. Bore 4	Hd. Naracoorte, sec. 1040	453-463	Knight Group	Black carb. sandy clayey silt. Fine shelly	Fair	0.09
			463-473	"	V. dk. grey, streaked lt. grey carb. silt. Slightly shelly	Fair-mod.	0.10
			473-483	"	Black carb. shelly silt.	Fair-mod.	0.13
30	Naracoorte E. and W.S. Bore 5.	Hd. Naracoorte, sec. 1086	0-15 (composite)	Recent-? Pleistocene	Grey-brn. sand, sandy silt, clay. Limey frags.	Very weak	0.20
			15-30 (composite)	"	Lt. grey, brn., yellow and red-brn., clayey silty sand.	Very weak	0.17
			30-36	"	Brn. silty clayey sand and white lst. frags.	Mod. strong	0.16
			36-42	"	do. common white-cream lst. frags.	Strong	0.15
			42-46	?Gambier Limestone	Lt. brn. recryst. sandy lst.	Quite strong	0.08
			46-56	"	Mustard-brn. sandy clayey lst. Rubbly.	Quite strong	0.11
			56-64	"	Lt. grey-brn. sandy lst.	Mod. strong	0.10
			64-70	"	Lt. brn. rubbly sandy clayey lst.	Moderate	0.10
			70-80	"	do. ~~coh.~~ bryoz. frags.	Moderate	0.08
			80-90	"	Cream - lt. brn. do.	Mod.-strong	0.09
			90-100	"	do. do.	Moderate	0.11

Number of bore on locality map	Name of bore	Locality	Sample Analysed (feet)	Formation	Lithology etc.	Molybdate test reaction	P_2O_5 %
30	Naracoorte E. and W.S. Bore 5	Hd. Naracoorte, sect. 1086	100-114	Gambier Limestone	Cream-white bryoz. lst. Clayey	Weak	0.08
			114-125	"	Cream impure sandy bryoz. lst.	Fair	0.07
			125-135	"	do. rubbly. Part.recryst.	Fair-mod.	0.09
			135-145	"	Off-white rubbly bryoz. lst.	Mod. strong	0.09
			145-150	"	do.	Moderate	0.07
			150-164	"	do.	Weak	0.06
			164-174	Compton Conglomerate	Mustard-brn. clayey lim. sand. Lim. pellets	Mod.-strong	0.19
			174-184	"	Brn. lim. sand. Calc., shelly	Very weak	0.14
			184-190	"	do.	Weak	0.11
			190-200	"	do.	Weak	0.10
			200-210	"	do.	Weak	0.10
			210-220	"	Brown bryoz. lim. sand.	Weak	0.10
			220-230	"	do.	Mostly weak. Part strong	0.11
			230-240	Knight Group	Dk. brn.-grey muddy sand. Some glauc. Somewhat carb. Moderately shelly.	Very weak	0.15
			240-270 (composite)	"	do. slightly shelly. More clayey, silty.	Very weak	0.18

Number of bore on locality map	Name of bore	Locality	Sample Analysed (feet)	Formation	Lithology etc.	Molybdate test reaction	P_2O_5 %
30	Naracoorte E. and W.S. Bore 5.	Hd. Naracoorte, sect. 1086	270-300 (composite)	Knight Group	Brn.-grey sandy mudstone. Becoming lim.	Weak	0.23
			300-310	"	Black, dk. brn.-grey muddy sand. Slightly shelly.	Very weak	0.17
			310-330 (composite)	"	Dk. brn. clayey silty sand, somewhat shelly.	Very weak	0.19
			330-335	"	Dk. brn. shelly lim. clayey ferrug. sst.	Weak	0.33
			335-342	"	Dk. grey-brn. lim. shelly sand. Few fish bone frags.	Strong	0.17
			342-350	"	Dk. brn.-grey sandy silt, slightly shelly. White lst. frags.	Very weak	0.25
			350-360	"	Laminated dk.-lt. grey hard carb. micaceous siltstone. Fine shelly.	Weak	0.18
			360-373	"	Dk. grey-brn. carb. sandy mudstone. Slightly shelly.	Weak	0.19
			373-393 (composite)	"	do.	Very weak	0.12
			393-414 (composite)	"	Dk. grey slightly sandy and shelly micaceous silt(stone)	Very weak	0.08
			414-426	"	Dk. grey-brn. pyr. lim. somewhat shelly gritty sand. Silty and clayey.	Fair	0.58
			426-428	"	Brown pebbly gritty sand. Pyr., silty, clayey; somewhat shelly	a few frags. give moderate reaction	0.13

Number of bore on locality map	Name of bore	Locality	Sample Analysed (feet)	Formation	Lithology etc.	Molybdate test reaction	P_2O_5 %
30	Naracoorte E. and W.S. Bore 5.	Hd. Naracoorte, sect. 1086	428-430	Knight Group	Brown pebbly gritty sand. Pyr., silty, clayey; somewhat shelly.	Weak - fair.	0.12
			430-432	"	do.	Almost no reaction	0.04
			432-434	"	do. not shelly	Fair	0.02
			434-442 (composite)	"	Brn. gritty sand with pebbles, some pyr., some clay and sand. A shark's tooth.	Almost no reaction	0.03
31	Kingston E. and W.S. Bore 3. (Ludbrook, N.H. 1963, in part.)	Hd. Lacepede, sect. 374	182-190	Gambier Limestone (lower glauconitic member)	Lt. greenish-grey glauc. hard bryoz. lst.	Mod. strong	0.18
			190-204	Buccleuch Group equivalent (U. Eocene)	Mustard brn. lim. bryoz. marl. Lim. pellets abund.	Mod.-strong	0.81
32	L.E. Maczkowiak, Bore 2. Bore 2. (Ludbrook, N.H. 1961, unpub. rep.)	Hd. Murrabinna, sect. 500	28-33	Recent	Grey-white shell sand and lst.	Mod.-strong	0.05
			33-42	"	do.	Mod.-strong	0.05
			42-65	"	do.	Mod.-strong	0.06
			115-122	Gambier Limestone	Green-brn. bryoz. lst. glauc. lim. Lim. pellets	Quite strong	0.25
			122-130	Compton Conglomerate	Green-brn. bryoz. lim. clayey sand. Lim. pellets. Gritty.	Mod. - strong	0.49

Number of bore on locality map	Name of bore	Locality	Sample Analysed (feet)	Formation	Lithology etc.	Molybdate test reaction	P_2O_5 %
33	R. Paltridge, Bore 2	Hd. Minecrow, sect. 189	37-44	Recent-?Pleistocene	Cream friable sandy lst.	Moderate	0.08
			44-49	"	do.	Moderate	0.10
			155-160	?Buccleuch Group equivalent	Mustard brn. lim. bryoz. marl. Lim. pellets abund.	Moderate	0.58
35	M. Hunt, Cattle Creek Station	Hd. Duffield, sect. 25	165-169	?Reworked Gambier Limestone	Pale grey-brn. hard recryst. travertine lst. with echinoid frags., some glauc. and lim. pellets. Part ferruginized.	Mod.-strong	0.17
36	M.G. Coleman, Bore 5	Hd. Parsons, sect. 35	201-211	?Pleistocene	Creamy yellow-brn. recryst. sandy lst.	Mod.-strong	0.08
38	Australian Primary Oils Ltd. Bore 8	Hd. Geegeela, sect. 70	106-116	Naracoorte Limestone - Gambier Limestone	Cream bryoz. and ech. calcarenite	Fair-moderate	0.03
40	Dept. of Lands, Bore 1 (O'Driscoll, E.P.D. 1960, Palaeo. control)	Hd. Field, sect. 19	200-208	Recent-?Pleistocene	Buff soft lst. Bryozoa, shell frags.	Mod.-strong	0.11
42	L.F. Galley, Bore 1 (O'Driscoll, E.P.D. 1960, palaeo. control)	Hd. Richards, sect. 101	175-177	Reworked Gambier Limestone	Cream, hard, recrystl., slightly glauc. bryoz. lst.	Mod.-strong	0.08
			177-193	Gambier Lime-	Buff, greenish, glauc. lim. bryoz. lst.	Mod.-strong	0.12
			193-217	Buccleuch G	Black, carb. clay. Calc. shelly	Mod.-strong	0.31

Number of bore on locality map	Name of bore	Locality	Sample Analysed (feet)	Formation	Lithology etc.	Molybdate test reaction	P_2O_5 %
43	H.A. Fiegert (previously Lewis Bros.) (O'Driscoll, E.P.D., 1960, palaeo. control)	Hd. Coombe, sect. 134	112–127	Pleistocene	Brn. shelly sand. Abund. Dk. brn. frags.	Strong	0.09
			135–155	?Pleistocene	Lt. brn. do. do.	Mod.–strong	0.11
45	Mundulla Public School Bore. (O'Driscoll, E.P.D. 1960, palaeo. control).	Hd. Wirrega, Town Block, Mundulla	110–120	Naracoorte Limestone	Creamy white bryoz. lst.	Moderate	0.06
			120–130	"	do. part recryst.	Moderate	0.05
			265–272	Gambier Limestone (lower glauc. member)	Slightly greenish-grey, glauc. sandy marly lst.	Mod.–strong	0.38
46	S.R. Makin	Hd. Stirling, sect. 83E	153–162	Ettrick Formation	Greenish-grey marly sand with white lst. frags.	Quite strong	0.38
47	P.H. Densley	Hd. Stirling, sect. 141	127–168	Ettrick Formation	Slightly greenish-grey glauc. marl. Rare dk. brn. phosphorite pellets	Bulk reaction v. weak. Phosphorite pellets v. strong.	0.61
			168–201	Buccleuch Group	V. dk. brn. carb. calc. silty clay. Some glauc. Somewhat shelly. A phosphatized fragment.	Strong	0.36
48	Keith Bore, Murray Basin Oil Syndicate (Ludbrook, N.H. 1959, unpub. rep.)	Hd. McCallum, sect. 4	80–90	Loxton Sands	Yellow-brn. hard calc. sst. Fossiliferous	Strong	0.24

Number of bore on locality map	Name of bore	Locality	Sample analysed (feet)	Formation	Lithology etc.	Molybdate test reaction	P_2O_5 %
48	Keith Bore, Murray Basin Oil Syndicate (Ludbrook, N.H. 1959, unpub. rep.)	Hd. McCallum, sect. 4	223-230	Morgan Limestone (top)	White, cream, lt. brn. hard part. recryst. lst.	Strong to fair	0.07
			387-399	Mannum Formation -Gambier Limestone.	Grey flinty marly glauc. bryoz. ech. lst.	Strong	0.06
			437-448	Gambier Limestone	Lt. grey, quite flinty, glauc. marly lst.	Strong	0.20
			458-468	Gambier Limestone (lower glauc. member)	Greenish and brownish-grey, glauc. marly lst. A fish tooth.	Mod. strong	0.25
			468-479	"	Greenish and brownish-grey glauc. marly sand.	Mod. strong	0.41
			553	Knight Group	Dk. grey-brn. irreg. laminated hard carb. mudstone	Moderate	1.25
			675	"	Brn. greenish glauc. oolitic sst. with lim. and glauc. pellets; bands of shell frags.	Strong	1.00
49	W.H. Wylie, Bore 3, Kangaringa Station (O'Driscoll, E.P.D. 1960, palaeo. control)	Hd. Shaugh, Sect. 1	202-220	Morgan Limestone - Mannum Formation	Cream lst. somewhat bryoz. and sandy.	Strong	0.06
			444-473	Gambier Limestone	Off-white, flinty bryoz. lst. Some glauc.	Strong	0.13
51	Highways and Local Government Dept., Wellington West, Bore 2.	Hd. Brinkley, Harbours Reserve	42-43	Ettrick Formation	Brownish-green sandy lst. Scattered small dk. phosphatic pellets. Glauc.	Strong reaction by pellets	0.45
			53-54	"	Green-brn.-grey glauc. sandy marl, lst., silty clay.	Fair-mod.	0.45

mber f re on cality ap	Name of bore	Locality	Sample analysed (feet)	Formation	Lithology etc.	Molybdate test reaction	P_2O_5 %
51	Highways and Local Govt. Department, Wellington West, Bore 2	Hd. Brinkley, Harbours Reserve	54-55	Ettrick Formation	Grey-green glauc. clay, marl, and lst.	Fair-mod.	0.56
			55-57.5	"	Greenish and brownish lt. grey glauc. lst. Ech., bryoz.	Moderate	0.20
			57.5-59	"	do. sandy	Strong	0.27
			59-60	"	Hard off-white lst. Some glauc.	Mod.-strong	1.66
56	H.H. Cartledge, Bore 1 (O'Driscoll, E.P.D. 1960 palaeo. control)	Hd. Jeffries, sect. 1	64-67	Recent-?Pleist-ocene	Hard pale grey-brn. recryst. sandy lst. Slightly glauc. (?reworked).	Fair	0.06
58	Highways and Local Government Dept., Jervois Punt, Tailem Bend, Bore 1	Hd. Seymour, Harbours Reserve	26-27	Ettrick Formation	Cream fine gr. soft marl, hard marly lst., and flints. Slightly glauc.	Mod.-strong	0.21
			32-33	"	Lt. brn. rather hard lst. Some glauc.	Fair-mod.	0.14
62	A.R. Launer, Bore 2, (Ludbrook, N.H. 1961)	Hd. Ettrick, sect. 21	270-280	Ettrick Formation	Grey sandy marl; green ferrous clay; limonite grains; bryoz., ech. frags.	Fair-mod.	0.24
65	C.O. Klitscher (Ludbrook, N.H. 1961)	Hd. Strawbridge sect. 10	148-158	Buccleuch A	Pinkish - cream bryoz. lst.	Fair-mod.	0.09
66	Coonalpyn E. and W.S. Bore 2. (Ludbrook, N.H. 1961)	Hd. Coneybeer, sect. 56	235-237	Buccleuch A	Dirty - brn. part recryst. hard lst.	Strong	0.39
			237-242	"	Pinkish - white bryoz. lst.	Strong	0.09
			242-247	"	do.	Mod.-strong	0.06

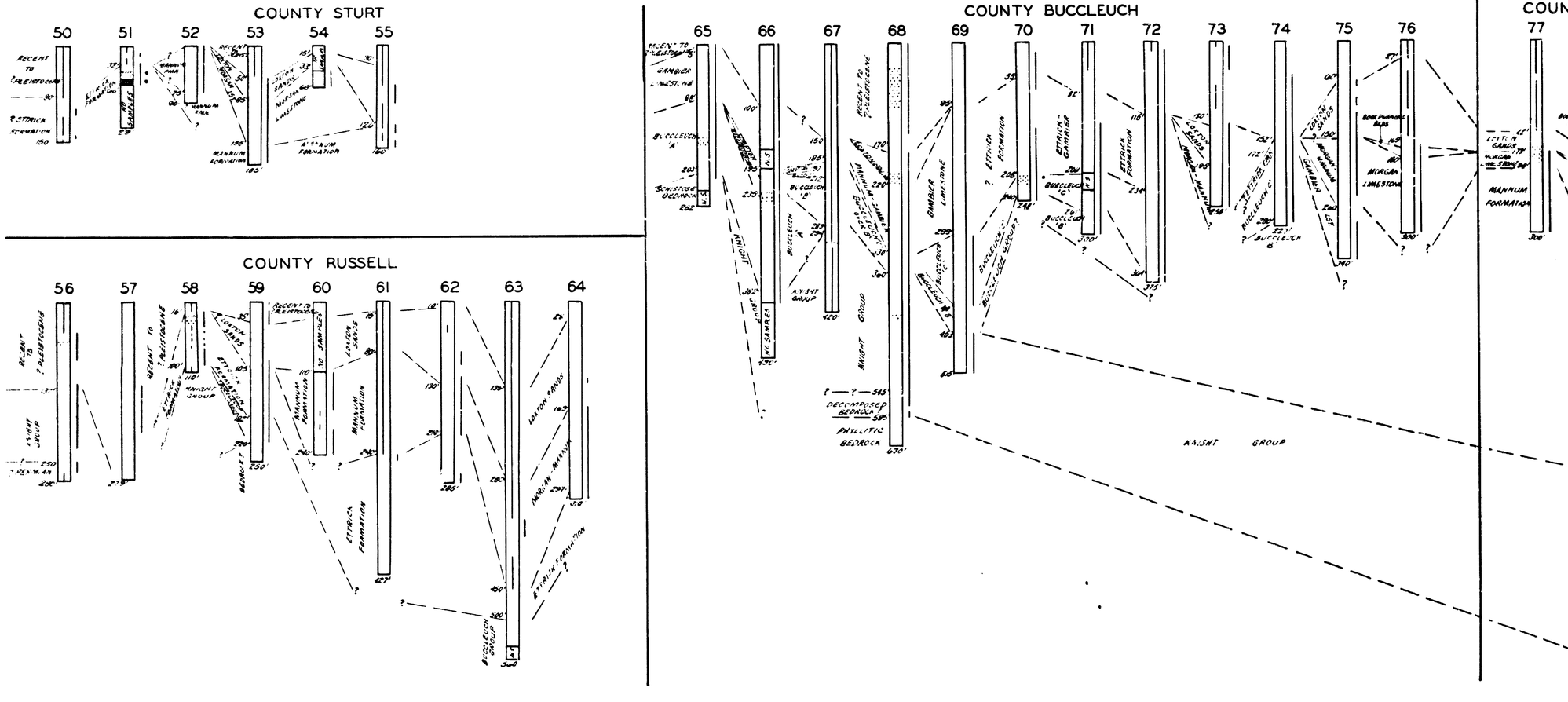
Number of bore on locality map	Name of bore	Locality	Sample analysed (feet)	Formation	Lithology etc.	Molybdate test reaction	P_2O_5 %
67	Coonalpyn E. and W.S. Bore 3.	Hd. Coneybeer, sect. 7	312-317	Knight Group	Brn. ferrug. grit.	Not tested	0.47 *
68	Trossachs Pastoral Co. Bore 5. (O'Driscoll, E.P.D. 1960 no palaeo. control)	Hd. Lewis, sect. R.S.A.	40-50	Recent-?Pleistocene	Lt. brn.-cream aeolianite with abund. calc. grains	Moderate	0.08
			50-60	"	do.	Moderate	0.07
			60-70	"	do.	Strong	0.09 0.06
			70-80	"	do.	Strong	0.09 0.06
			80-90	"	do.	Strong	0.06 0.04
			90-100	"	do.	Mod. strong	0.06 0.04
			205-215	?Pliocene	Creamy lt. brn. sandy lst.	Moderate	0.06
			215-220	"	do.	Fair-mod.	0.06
			426-430	Knight Group	Grey-brn. glauc. pyr. shelly sand	Strong	0.11 0.09
70	W.J. and N.E. Wilkins	Hd. Roby, sect. 18	208-220	Buccleuch C	Grey-black carb. sandy silty clay. Gritty; slightly shelly, pyr., glauc. A phosphatic ?bone frag.	Quite strong	0.15
77	K.A. Godfrey	Hd. Cotton, sect. 91.	173-198	Morgan Limestone	Buff impure lst.	Mod. strong	0.15

Number of bore on locality map	Name of bore	Locality	Sample analysed (feet)	Formation	Lithology etc.	Molybdate test reaction	P_2O_5 %
78	Lameroo E. and W.S. town bore. (O'Driscoll, E.P.D. 1960 palaeo. control)	Hd. Bews, sect. 203, Water Cons. Reserve	212-232	Morgan Limestone	Off-white part recryst. bryoz. lst. Slightly glauc.	Mod. strong	0.11
			232-252	"	do.	Mod. strong	0.14
			252-272	"	Lt. grey do.	Mod. strong	0.13
			272-292	"	do.	Mod. strong	0.30
79	Pinnaroo No. 1, Murray Basin Oil Syndicate (Ludbrook, N.H. 1956, 1957, 1958, unpub. repts.)	Hd. Pinnaroo, adj. sects. 59, 67	195	Pata Limestone	Yellow-brn. gritty lst. Abund. lim., mica, shell frags.	Very strong	0.45
			200	"	Yellow-brn. lst.	Strong	0.21
			205	"	Lt. cream-yellow lst. with shell frags.	Strong	0.10
			210	"	do.	Strong	0.06
			215	"	do.	Strong	0.09
			220	"	do.	Strong	0.07
			225	"	Lt. cream-yellow lst.	Strong	0.06
			230	"	Cream lst.	Strong	0.11
			235	"	Cream-yellow lst. Some glauc. Brn. lst. frags. react strongly	Very strong	0.25
			255	Morgan Limestone	Grey marly bryoz. lst.	Mod.-strong	0.09
			305	"	Very lt. grey do.	Mod. strong	0.09
			315	"	do.	Mod. strong	0.11
			325	"	Lt. creamy-grey do.	Strong	0.07

Number of bore on locality map	Name of bore	Locality	Sample analysed (feet)	Formation	Lithology etc.	Molybdate test reaction	P_2O_5 %
79	Pinnaroo No. 1, Murray Basin Oil Syndicate (Ludbrook, N.H. 1956, 1957, 1958, unpub. repts.)	Hd. Pinnaroo, adj. sects. 59,67.	335	Morgan Lime-stone	Lt. creamy grey marly bryoz. lst.	Strong	0.10
			345	"	do.	Mod. strong	0.06
			355	"	do.	Mod. strong	0.07
			545	Mannum-Gambier	Grey hard bryoz. lst.	Strong	0.07
			570	"	do.	Strong	0.19
			630	Gambier Lime-stone	Grey marly glauc. lst.	Mod. strong	0.09
82	A.B. Morrell, Bore 1	Hd. Forster, sect. 44	234-304	Mannum Forma-tion	Yellow-brn. rubbly lst.	Moderate to weak.	0.14
86	H.W. Day (O'Driscoll, E.P.D. 1960. Palaeo. control)	Hd. Bakara, sect. 1CA	150-180	Morgan Lime-stone	Creamy-yellow bryoz. lst.	Mod.-strong	0.06
89	R.R. Edison, Bore 1	Hd. Paisley, sect. H	101-110	Morgan Lime-stone - ? Mannum Forma-tion.	Pale yellow-brn. lst.	Fair-mod.	0.20
92	A.C. Pocock, 'Paruna Bore 1'.	Hd. Kekwick, sect. 172	100-105	Bookpurnong Beds	Greenish-grey glauc. calc. shelly clayey sand.	Moderate	0.13
			110-115	"	do. fish-bone frags.	Moderate (bulk test) V.weak (pellets)	0.16

Number of bore on locality map	Name of bore	Locality	Sample analysed (feet)	Formation	Lithology etc.	Molybdate test reaction	P_2O_5 %
92	A.C. Pocock, 'Paruna Bore 1'	Hd. Kekwick, sect. 172	135-140	Pata Limestone (and Bookpurnong Beds)	Green-grey glauc. shelly sand; off-white recryst. lst.	Moderate	0.20
95	Loxton No. 1, Australian Oil and Gas Co. Ltd. (Ludbrook, N.H. 1961)	Hd. Bookpurnong, sect. 6B	95-105	Bookpurnong Beds	Grey shelly sand	Fair-mod.	0.08*
			105-110	"	do. a fish tooth	Fair	0.11 *
			150-155	Pata Limestone	Grey shelly marly lst.	Moderate	0.39
			795-805	Knight Group	Grey-brn. clayey lim. sand.	Moderate	0.24
			1440-1445	Albian sediments	Greenish-grey glauc. carb. siltstone.	Moderate	0.07
98	North Renmark No. 1, A.O.C. (Ludbrook, N.H. 1963, unpub. rep.)	Co. Hamley, outside hundreds. Chaffey, I.A. Ral Ral Division, adj. Block 355.	676-686	Ettrick Forma-	Grey glauc. shelly marl. Rare fish-bone frags.	Strong	0.36
			2290-2295	Albian sediments	Green-grey siltstone	Fair-mod.	0.20
			2330-2335	"	do.	Mod.-strong	0.30
			2555-2560	Aptian sediments	Grey calcareous siltstone.	Fair-mod.	0.23
			2605-2610	"	Grey carb. glauc. calc. siltstone	Moderate	0.27
			3660-3665	Permian glacigene sediment.	White calc. sst.	Moderate	0.30

Number of bore on locality map	Name of bore	Locality	Sample analysed (feet)	Formation Formation	Lithology etc.	Molybdate test reaction	P_2O_5 %
100	Canopus Pastoral Co., Bore 1. (Ludbrook, N.H. 1961)	Co. Hamley, outside Hundreds. Pastoral lease 1664	478-480	Mannum Formation equivalents	Grey slightly glauc. marl	Fair-mod.	0.24
			600-614	Knight Group	Brn. silt; greenish-grey silty sandy clay.	Brown phase mod. strong; Grey phase very weak.	0.61
			616-620	"	Brn. silt; grey to brn. grey sandy clay. Shark's tooth.	Moderate	0.29
			623-630	"	Dk. grey and brn. sandy clay.	Moderate	0.29


COUNTY STURT
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COUNTY RUSSELL
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COUNTY BUCCLEUCH
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COUNTY CHANDOS
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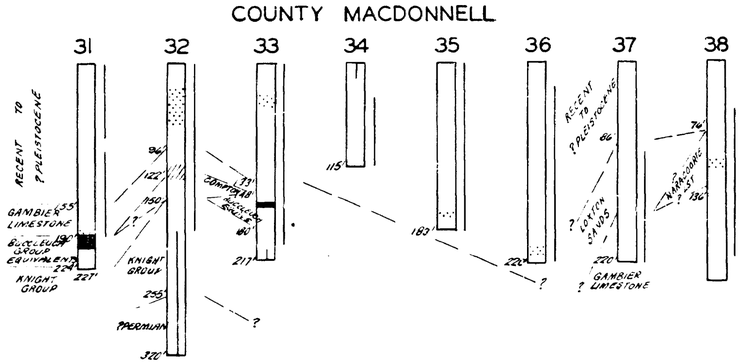
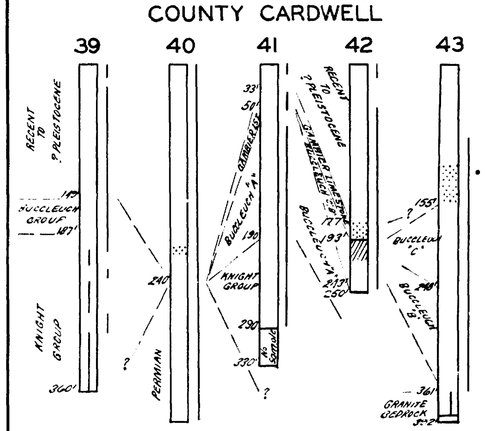
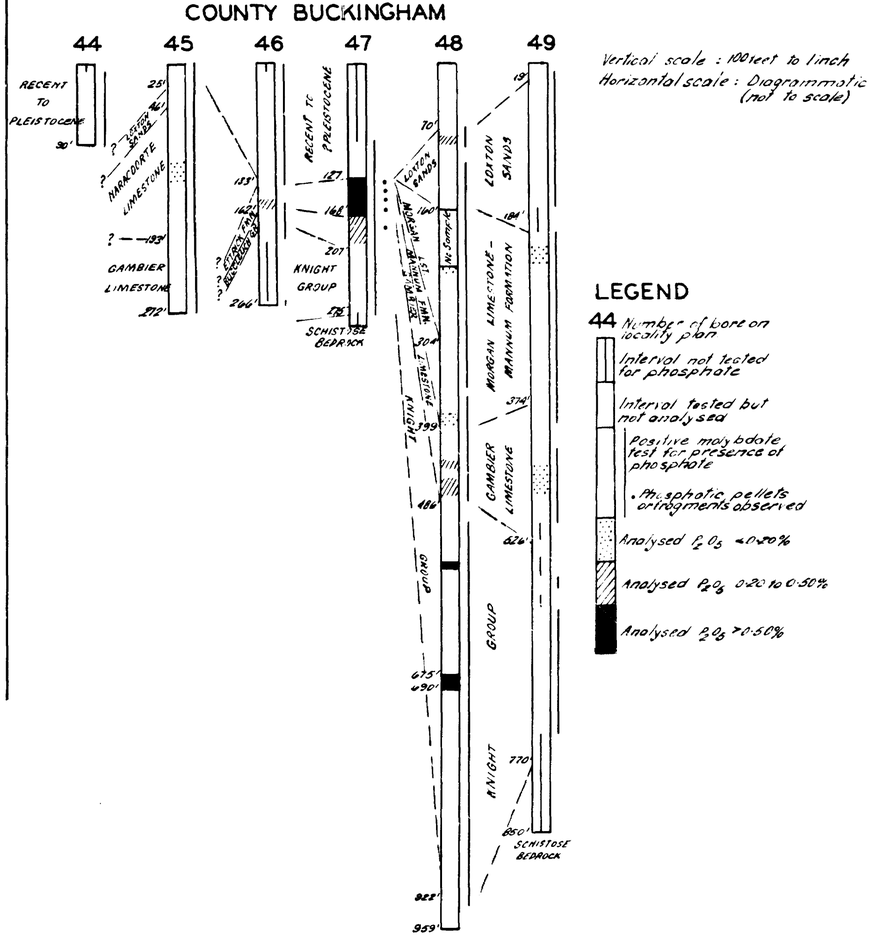
LEGEND
74 Number of bore on locality plan
Interval not tested for phosphate
Interval tested but not analysed
Positive molybdate test for presence of phosphate
• Phosphatic pellets or fragments observed
Analysed P_2O_5 < 0·20%
Analysed P_2O_5 0·20 to 0·60%
Analysed P_2O_5 > 0·60%
vertical scale : 100 feet to 1 inch
Horizontal scale : Diagrammatic (not to scale)
MURRAY BASIN – GAMBIER SUNKLANDS
PHOSPHATE TESTING OF BORES
COUNTIES STURT RUSSELL BUCCLEUCH & CHANDOS
DIAGRAMMATIC CROSS – SECTION
64–1057
Date 22-11-64
To accompany report by J. M. Lindsay







Vertical scale : 100 feet to 1 inch
Horizontal scale : Diagrammatic (not to scale)

LEGEND

44 Number of bore on locality plan

Interval not tested for phosphate

Interval tested but not analysed

Positive molybdate test for presence of phosphate

• Phosphatic pellets or fragments observed

Analysed P_2O_5 < 0·20%

Analysed P_2O_5 0·20 to 0·50%

Analysed P_2O_5 > 0·50%

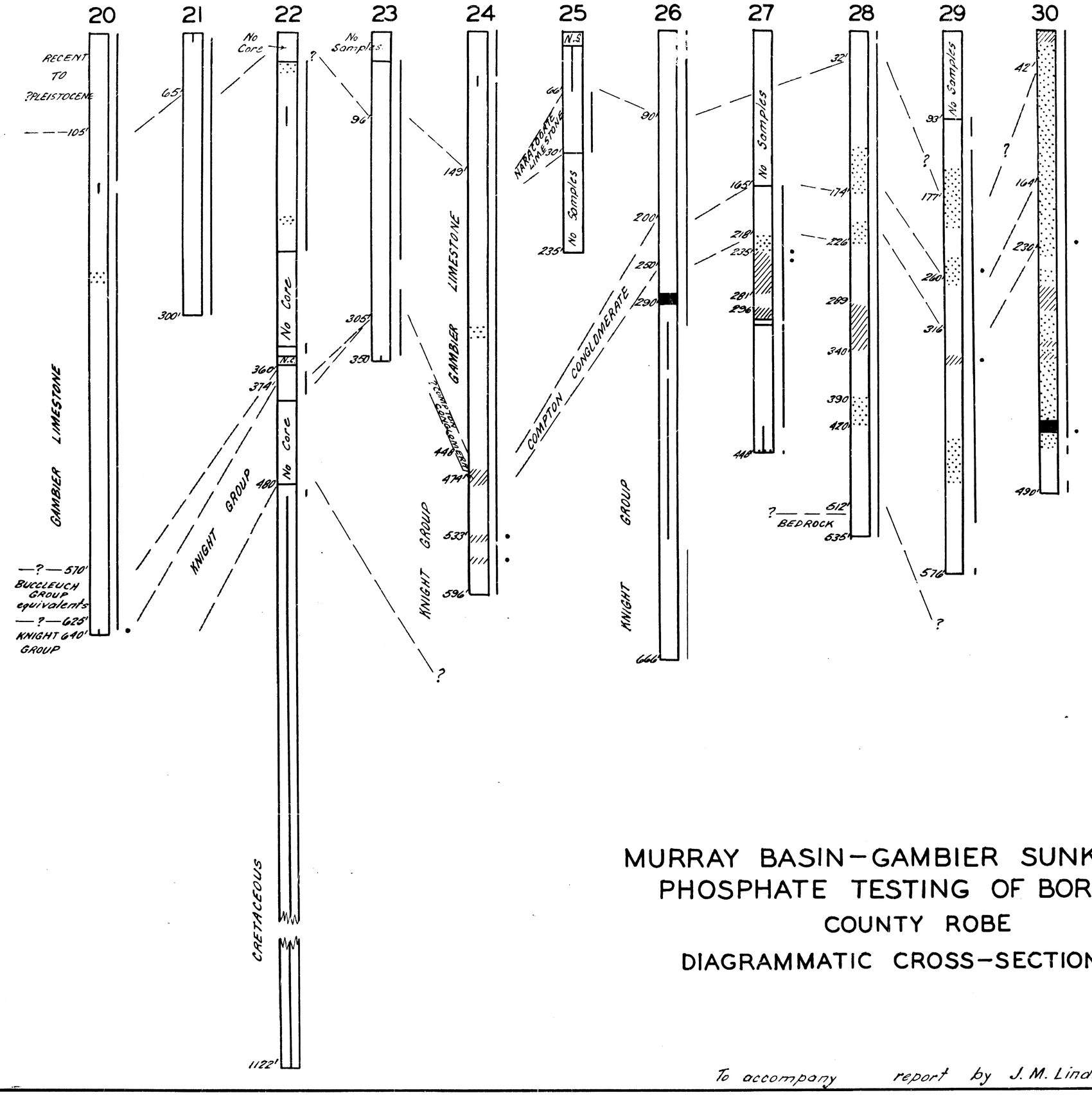
MURRAY BASIN – GAMBIER SUNKLANDS
PHOSPHATE TESTING OF BORES
COUNTIES MACDONNELL CARDWELL BUCKINGHAM
DIAGRAMMATIC CROSS – SECTION

64-1056 JK
DATE 20-11-64

To accompany report by J.M. Lindsay

64-1056
JK

COUNTY ROBE



Vertical scale : 100 ft. to 1 inch

Horizontal scale: Diagrammatic (not to scale.)

LEGEND

24 Number of bore on locality map

Interval not tested for phosphate

Interval tested but not analysed.

Positive molybdate test for presence of phosphate.

• Phosphate pellets or fragments observed

Analysed P_2O_5 < 0·20%

Analysed P_2O_5 0·20 - 0·50%

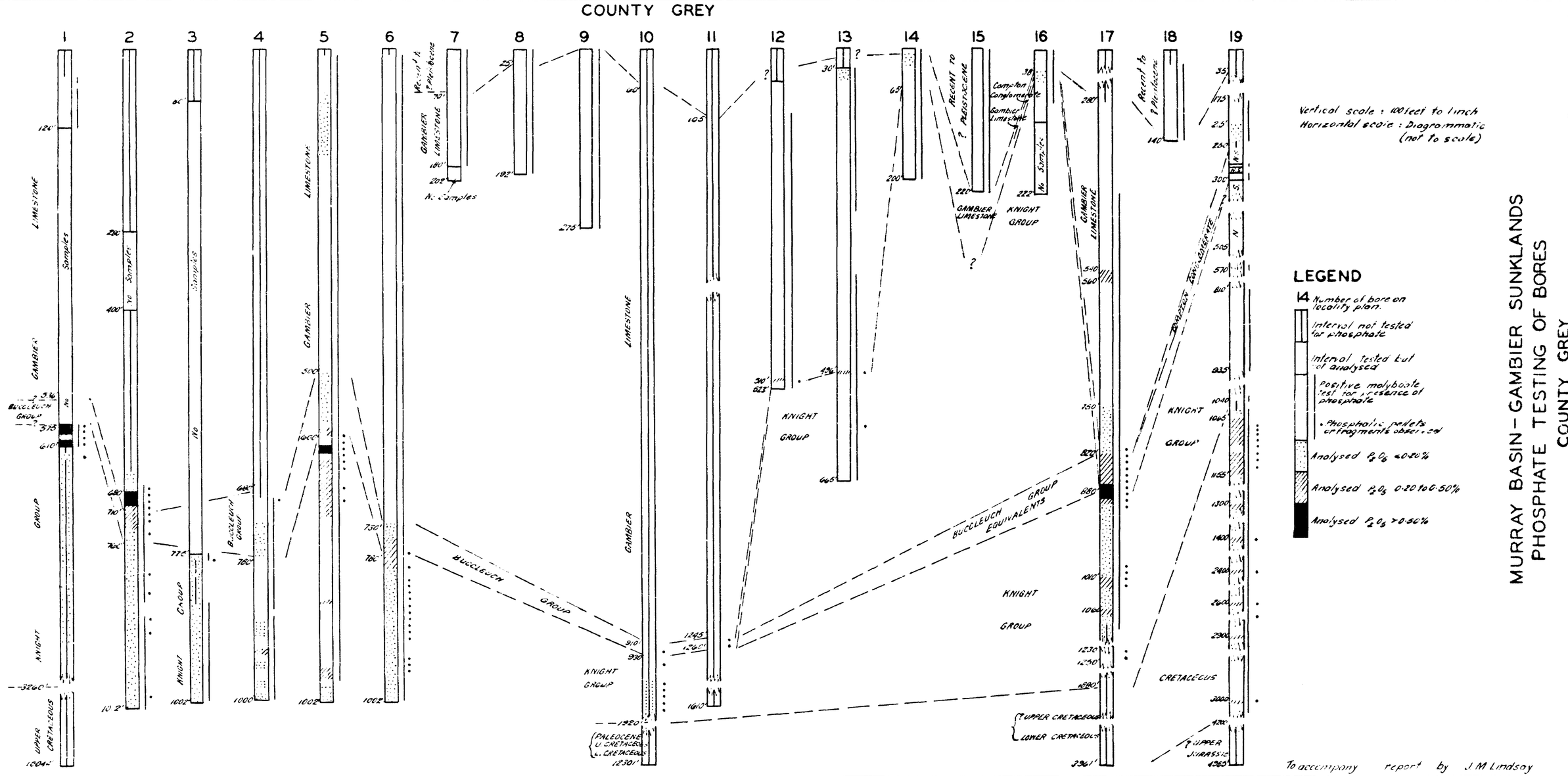
Analysed P_2O_5 > 0·50%

MURRAY BASIN — GAMBIER SUNKLANDS
PHOSPHATE TESTING OF BORES
COUNTY ROBE
DIAGRAMMATIC CROSS-SECTION

To accompany report by J. M. Lindsay.

64-1055 JK

Date : 20-11-64


COUNTY GREY
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19
LIMESTONE
GAMBIER
GROUP
KNIGHT
UPPER CRETACEOUS
Samples
No Samples
BUCCLEUCH GROUP
GAMBIER LIMESTONE
KNIGHT GROUP
BUCCLEUCH GROUP EQUIVALENTS
Compton Conglomerate
Gambier Limestone
Recent to ? Pliocene
? PALEOCENE
U. CRETACEOUS
L. CRETACEOUS
UPPER CRETACEOUS
LOWER CRETACEOUS
CRETACEOUS
UPPER JURASSIC
Vertical scale : 100 feet to 1 inch
Horizontal scale : Diagrammatic (not to scale)
LEGEND
Number of bore on locality plan.
Interval not tested for phosphate
Interval tested but not analysed
Positive molybdate test for presence of phosphate
Phosphatic pellets or fragments observed
Analysed P_2O_5 < 0·20%
Analysed P_2O_5 0·20 to 0·50%
Analysed P_2O_5 > 0·50%
MURRAY BASIN – GAMBIER SUNKLANDS
PHOSPHATE TESTING OF BORES
COUNTY GREY
DIAGRAMMATIC CROSS-SECTION
64-1054
To accompany report by J.M. Lindsay

MURRAY BASIN GAMBIER SUNKLANDS

LOCATION OF BORES TESTED FOR PHOSPHATE

SCALE

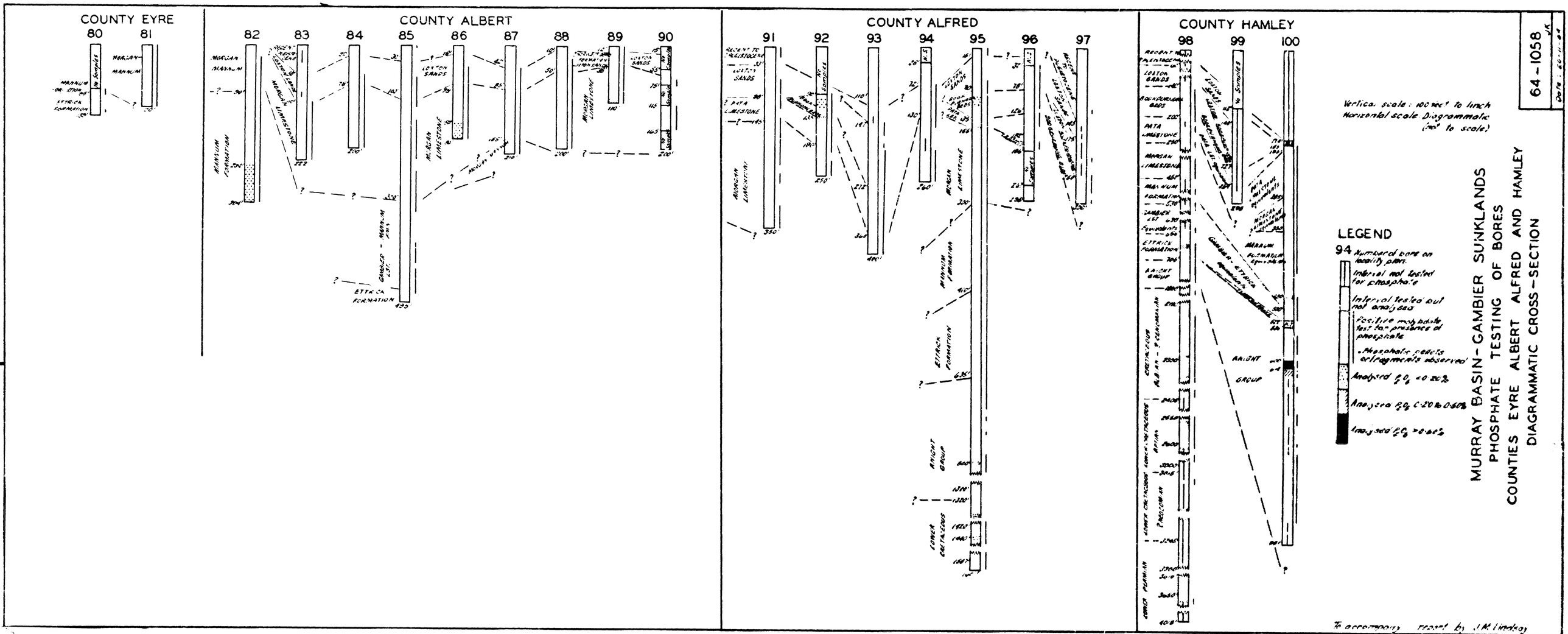
MILES 8 0 8 16 24 32 40 48 56 64 72 MILES

To accompany report by J. M. Lindsay

S. A. Dept. of Mines

64 - 1028

JK


COUNTY EYRE
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COUNTY ALBERT
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COUNTY ALFRED
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COUNTY HAMLEY
98
99
100
Vertical scale: 100 feet to inch
Horizontal scale Diagrammatic (not to scale)
LEGEND
94 Numbered bore on locality plan.
Interval not tested for phosphate
Interval tested but not analysed
Positive molybdate test for presence of phosphate
Phosphatic pellets or fragments observed
Analysed P_2O_5 < 0.30%
Analysed P_2O_5 0.30 to 0.60%
Analysed P_2O_5 > 0.60%
MURRAY BASIN - GAMBIER SUNKLANDS
PHOSPHATE TESTING OF BORES
COUNTIES EYRE ALBERT ALFRED AND HAMLEY
DIAGRAMMATIC CROSS-SECTION
64-1058
To accompany report by J.M. Lindsay