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PRELIMINARY REPORT ON

THE EXAMINATION OF CORES FROM THE PILOT BORE, LAKES ENTRANCE, VICTORIA.

- By -

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CANBERRA. 5TH APRIL, 1945.

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DEPARTMENT OF SUPPLY AND SHIPPING

MINERAL RESOURCES SURVEY BRANCH

PRELIMINARY REPORT ON THE EXAMINATION OF CORES FROM THE PILOT BORE, LAKES ENTRANCE, VICTORIA.

Report No. 1945/24, Plan No. 1195 & 1198.

This report summarises the information so far obtained from the Pilot Bore, Lakes Entrance, and should be regarded as an interim statement pending the completion of work on the cores. The task of correlating this information with that obtained from other sources and the discussion of its bearing on regional problems are reserved for a more detailed report when the work has been concluded.

A. INTRODUCTION

The Pilot Bore is situated 130 feet north of the Lakes Entrance Shaft and 80 feet above mean tide level. The principal purpose of the bore was to provide information on the position and flow of acquifers and on the nature of the rock ahead of shaft sinking operations. Percussion drilling was used to ensure that information on water horizons should be as accurate as possible.

Drilling on the present site commenced in March, 1943, and was completed at a depth of 1219 feet in January, 1945. The bore is cased with 5 inch casing for 1196 feet to the top of the glauconitic sandstone, where the casing was cemented and the top water shut off. Below this point an open hole was drilled with a Baker core barrel for 22' 10" into the glauconitic sandstone. The coring of the sandstone was carried out in 13 separate sections, each approximately 21 inches in depth, with a period of about two weeks bailing between each coring operation. This enabled the distribution of oil and water within the sandstone to be determined and the production from each yielding zone to be measured with reasonable accuracy.

The fluid obtained by daily bailings consisted of free water and an oil-water emulsion in which the percentage of water varied considerably. Free water was drained off and measured, after the fluid had been allowed to stand for about half an hour. The oil-water emulsion was then measured and from samples taken, the water content was determined by tests carried out at the bore. The amounts of water and dry oil in the emulsion were thus calculated and the day's production recorded as total water and dry oil. In each bailing period, a few duplicate samples of the emulsion were sent to Melbourne for determination by the Chief Chemist at the Victorian Mines Department to check the accuracy of the local determinations.

The cores obtained from the Baker core barrel were transferred to air tight cylindrical tins and remained sealed until required for examinations. It was not possible to determine the percentage of core recovered from the drilling operations, but recovery was certainly high, and with the possible exception of very thin layers, all changes in lithology should be recorded. The thickness of the various bands within the sandstone could not be measured accurately from the fragmented material in the core barrel, but a close approximation of the thickness was calculated by relating the total length of fragmented core recovered to the true depth cored and adjusting the measurement of each section of the core accordingly.

B. THE GLAUCONITIC SANDSTONE.

The cores provide an almost complete record of the 23 feet of glauconitic sandstone penetrated, but, owing to the limitations of the core barrel, the record consists of rock chips in varying degrees of fragmentation from which the nature of the original rock has to be deduced. This is comparatively simple where the core provides large fragments, but becomes difficult where fine grained sandy material is produced.

The cores show alternations of three types of material.x

(i) Disc-like fragments ("biscuits") of hard glauconitic sandstone about an inch in diameter, with flat upper surfaces and convex lower surfaces, varying from ¼ to 1 inch in maximum thickness. As many as a dozen of these may form one section of a core with no admixture of finer fragmentary material.

(ii) Small angular chips and fragments of glauconitic sandstone.

(iii) Fine sandy material usually withdrawn from the core barrel as a continuous soft core resembling an unconsolidated sand or sandy shale. It usually contains very small fragments of hard glauconitic sandstone and, in some cases, grades into coarser fragmentary material.

The three types of cuttings usually occur in distinct sections as if representative of alternating bands within the glauconitic sandstone although in actual fact they probably represent variations in texture which grade one into another with few clear lines of demarcation.

The sections of core composed of disc-like fragements are considered to represent bands of particularly tough, fine-grained sandstone which breaks in this manner under the successive blows of the Baker core barrel. Discs of this kind have been reported as a product of the Baker core barrel from areas other than Lakes Entrance, and the quality of "toughness" may be the dominant factor in their production. Most of the discs are clean and provide no evidence to suggest that partings of finer grained or less consolidated material exists between them. However, some of the discs carry a thin veneer of shaly material which may indicate that partings of some kind exist in these sections. In other parts of the section, a single disc is found in unconsolidated sandy material where it probably represents a band or lens of tough massive sandstone interbedded with a more friable rock.

The sections composed of small angular chips are also considered to represent massive glauconitic sandstone although the type of fracture indicates some essential difference from the type of sandstone which produces discs. At the present stage of the petrographic examinations, the sandstone in the angular chips appears to be slightly coarser than that of which the discs are composed.

The origin of the fine sandy material has not been definitely established. In some cores, the material resembles unconsolidated sands in appearance, but the presence of such beds in the section of sandstone exposed in the Pilot Bore is considered very unlikely. Another interpretation is that the fine sandy sections are drillings introduced into the core by the core barrel inadvertently lifting off the bottom of the hole during the upstroke of the drilling tool. This is a possible explanation, but is also considered to be unlikely. The results of petrographic examination suggest that the material represents glauconitic sandstone which is distinctly coarser and less competent than those represented by discs and by angular fragments. The sandstone has presumably been completely broken during coring and emerges from the barrel as a core of wet sand, containing small angular or sub-angular fragments of glauconitic sandstone.

If this interpretation is correct, these beds or lenses are the most important lithological units in the section. On the basis of grainsize and the percentage of very fine material present, they should have a higher permeability than the other types of glauconitic sandstone, and appear the most likely beds to act as reservoirs for oil. Furthermore, this sandy material constitutes the principal sections of the cores which have yielded oil in the laboratory extractions.

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x ~~Columnar section not available until examination of cores complete.~~

The average thickness of these bands or lenses in situ is approximately 3 inches and the total aggregate thickness in the Pilot Bore approximately 4 feet. Cores from the productive oil zones record six lenses (?) with an aggregate thickness of 24 inches.

Although it appears at this stage that these sandy sections represent thin bands or lenses of less competent sandstone, it is as well to point out that cores such as these are inadequate for a lithological study of the glauconitic sandstone, and that the sequence of textural changes within the formation can only be established with certainty on a complete sequence of solid cores.

C. PRODUCTION OF WATER.

The production and distribution of oil and water are shown in Table 1, which summarises the results of all the bailing tests carried out between coring.

The only acquifer encountered in the 23 feet of sandstone lies near the top of the formation, and yields approximately 27 pints of water per 24 hours.

The initial yield was approximately 85 pints per day, but production declined throughout coring operations and over the last 40 days a degree of stability appeared to have been reached and the yield averaged 27 pints per day.

The exact position of the acquifer is not known, but the water may come from the same beds which yielded oil near the upper limit of the formation.

Production figures show conclusively that the formation below this acquifer does not yield any measurable quantity of water. This is subject to two interpretations.

(i) The part of the formation exposed is dry.

(ii) The formation contains water, but the low permeability, in conjunction with other physical factors, prevents any measurable flow.

Tests which Mr. R.F. Thyer, Geophysicist of this Branch, intends to carry out in the near future may determine which of these interpretations is correct. It is considered on the evidence available at present that, with the exception of any truly impermeable bands which may exist, the formation does contain water at a pressure approximating that of the artesian water known to occur beneath it. If this is correct, the inference is that certain beds or lenses within the formation contain both water and oil, but yield oil only, due to the combination of various physical factors of which permeability and saturation are probably the most important.

D. PRODUCTION OF OIL.

The bailing results show that there are only two productive oil zones in the 23 feet cored. These consist of a minor productive zone (initial production approximately 8 pints per day) at the top of the formation, with a maximum thickness of 4 feet, and a major productive zone (initial production 32 pints per day) 8' 3" to 12 feet below the upper limit of the sandstone. The production of oil is, therefore, limited to 7' 9" of the total of 22' 10" of formation exposed.

At the close of coring, the oil yield was 32 pints per day. This is a yield of 1.4 pints per day per vertical foot over the whole formation exposed, or 1.5 and 7 pints per day per vertical foot in the minor and major productive zones respectively.

There is no apparent difference in the lithology of the cores from productive and unproductive sections which suggests that suitable reservoirs are not confined to the productive zones, and may be distributed over the whole formation.

If the reservoir beds are represented in the unproductive sections, it is purely speculative whether they contain oil, but are inhibited from yielding, or whether they are barren, due to factors involving source and migration.

There appear to be three ways in which oil may be stored in the formation:-

(i) Sandy sections, presumed to represent bands or lenses of less competent sandstone, appear in each of the productive zones, with a total aggregate thickness of 24 inches and oil has been extracted from most of these. (See Preliminary Report by R.F. Thyer, 1945/25).

(ii) Discs of glauconitic sandstone, with shaly coatings, carry a film of oil, which may have been yielded by thin horizontal partings in the sandstone and oil extracted from some of the more finely fragmented material may be of similar origin. The total thickness of sandstone carrying such partings in the two productive zones, would not exceed 18 inches, of which a small fraction would be constituted by the partings themselves.

(iii) There is no evidence of regular jointing within the formation, but small cracks have been recorded in specimens of sandstone from Fostar's Bore. Some oil may be yielded from oil-filled fractures in massive and otherwise barren glauconitic sandstone, but the consistency of the yield in the Pilot and in other bores can hardly be explained on the basis of cracks.

In brief, the maximum aggregate thickness of oil-bearing strata in the two productive zones appears to be little in excess of 24 inches and may be between 24 and 30 inches.

E. RESERVES OF OIL.

The factors involved in calculating the reserves of oil in a reservoir are the cubic capacity of the reservoir, the porosity of the reservoir rock, the degree of oil saturation and the anticipated recovery. It cannot be said that any of these factors has been definitel established by the Pilot bore and consequently any estimates made would be based largely on assumptions. For this reason, the discussion of oil reserves should be deferred until estimates can be placed on a factual basis.

F. SUMMARY.

1. The cores from the Pilot Bore show that the glauconitic sandstone is not a homogeneous formation, but contains variations probabl due to changes in the grainsize and texture of the sandstone.

2. At least three variations occur, probably in bands or layers, many of which may grade one into another without sharp demarcation. In addition, thin partings may exist in some sections of the sandstone.

3. Except for a small acquifer near the top of the formation, the glauconitic sandstone does not yield water, although the beds are not considered to be dry.

4. Only 93 inches of the formation so far cored can be said to yield oil, and of this thickness the oil-bearing strata probably constitute little more than 24 inches.

5. Further data on reservoir beds and oil saturations should be obtained before estimates are made of the oil reserves available.

6. The bailing results have provided more precise information on the distribution of oil and water than was available before, and it is anticipated that a second pilot bore, withsuitable drilling equipment, can provide more conclusive evidence on oil reserves and reservoir conditions.

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Geologist.

CANBERRA, A.C.T.
5th April, 1945.

TABLE 1.

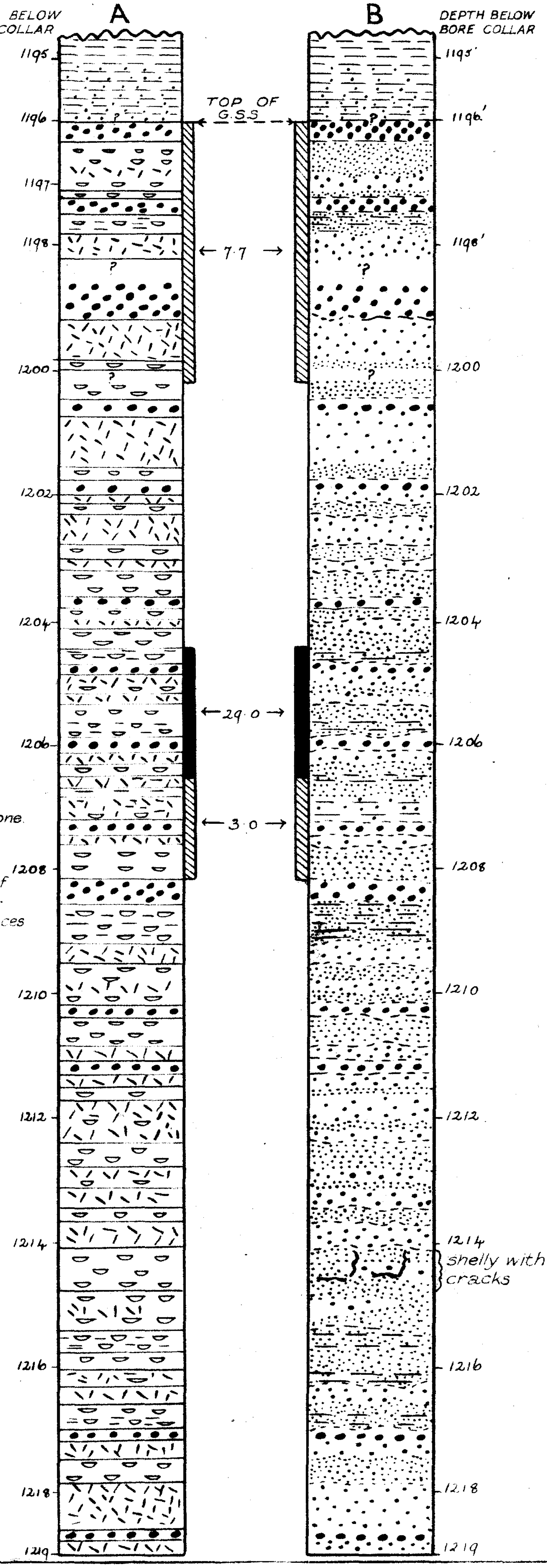
SUMMARY OF OIL AND WATER PRODUCTION, PILOT BORE, LAKES ENTRANCE.

(September, 1944 - February, 1945).

1 Depth of Bore	2 Depth below Top of Glauconitic Sandstone	3 Core Section No.	4 Cores No.		5 Total Water per 24 hrs. Av. for Section. Pints ∅	6 Dry oil per 24 hrs. Stab. prod. for Section. Pints	7 Initial increase in dry oil yield per Section.x Pints 24 hrs.	8 % of total dry oil prod.	9 Water content of emulsion. Average per Section. %	10 Dry oil as percentage of total fluid. Average per Section.
1196'3"	Top	1	5		85.5	4.3	4.3	11.0	30 z	4
1198'2"	1" - 2'0"	2	6		66.0	6.3	2.0	5.0	30 z	9
1200'2"	2' - 4'	3	7		49.9	7.7	1.4	3.5	30 z	13
1201'9"	4' - 5'7"	4	8		44.8	6.3 @	-	-	30 z	12
1204'5"	5'7" - 8'3"	5	9	10	38.3	6.8 @	-	-	30 z	15
1206'5"	8'3" - 10'3"	6	11	12	40.75	36.8	30.0	73.0	51 z	46
1208'2"	10'3" - 12'0"	7	13	14	34.7	39.75	3.0	7.5	40	54
1210'6"	12'0" - 14'4"	8	15	16	31.8	36.3 @	-	-	32.5	53
1211'8"	14'4" - 15'6"	9	17		30.6	36.0 @	-	-	25	55
1212'9"	15'6" - 16'7"	10	18	19	30.5	35.7 @	-	-	25	53
1214'9"	16'7" - 18'7"	11	20	21	25.8	36.3 @	-	-	13.5	59
1216'9"	18'7" - 20'7"	12	22	23	26.5	33.7 @	-	-	15.0	56
1219'0"	20'7" - 22'10"	13	24	25	27.8	32.3 @	-	-	13.25	54

∅ Includes free water (measured) and water contained in emulsion (calculated).
@ Average yield is given in unproductive sections.
x The initial yield from the bore totals 40.7 pints, but production had declined to 32.3 pints at the close of coring.
z Based on incomplete data, but error considered small.

COLUMNAR SECTION
OF THE
GLAUCONITIC SANDSTONE
EXPOSED IN THE
PILOT BORE
LAKES ENTRANCE



COLUMN A

Showing types of fragmentary material constituting the cores.

LEGEND

- Micaceous marl and mudstone
- Sandy marl and mudstone
- Discs ("biscuits") of glauconitic sandstone.
- Chips and angular fragments of glauconitic sandstone.
- Sandy material with small fragments of glauconitic s.s forming continuous core.
- Discs of glauconitic sandstone with traces of partings(?) between.

COLUMN B

Showing nature of the rock in situ as interpreted from the cores.

LEGEND

- Micaceous marl and mudstone.
- Sandy marl and mudstone.
- Fine grained massive glauconitic sandstone.
- Glauconitic sandstone of intermediate texture.
- Less competent, coarser glauconitic sandstone.
- Sandy marl and mudstone.
- 29.0 Major productive zone - initial production of dry oil in pints per 24 hours.
- 3.0 Minor productive zone - initial production of dry oil in pints per 24 hours.

[signature]
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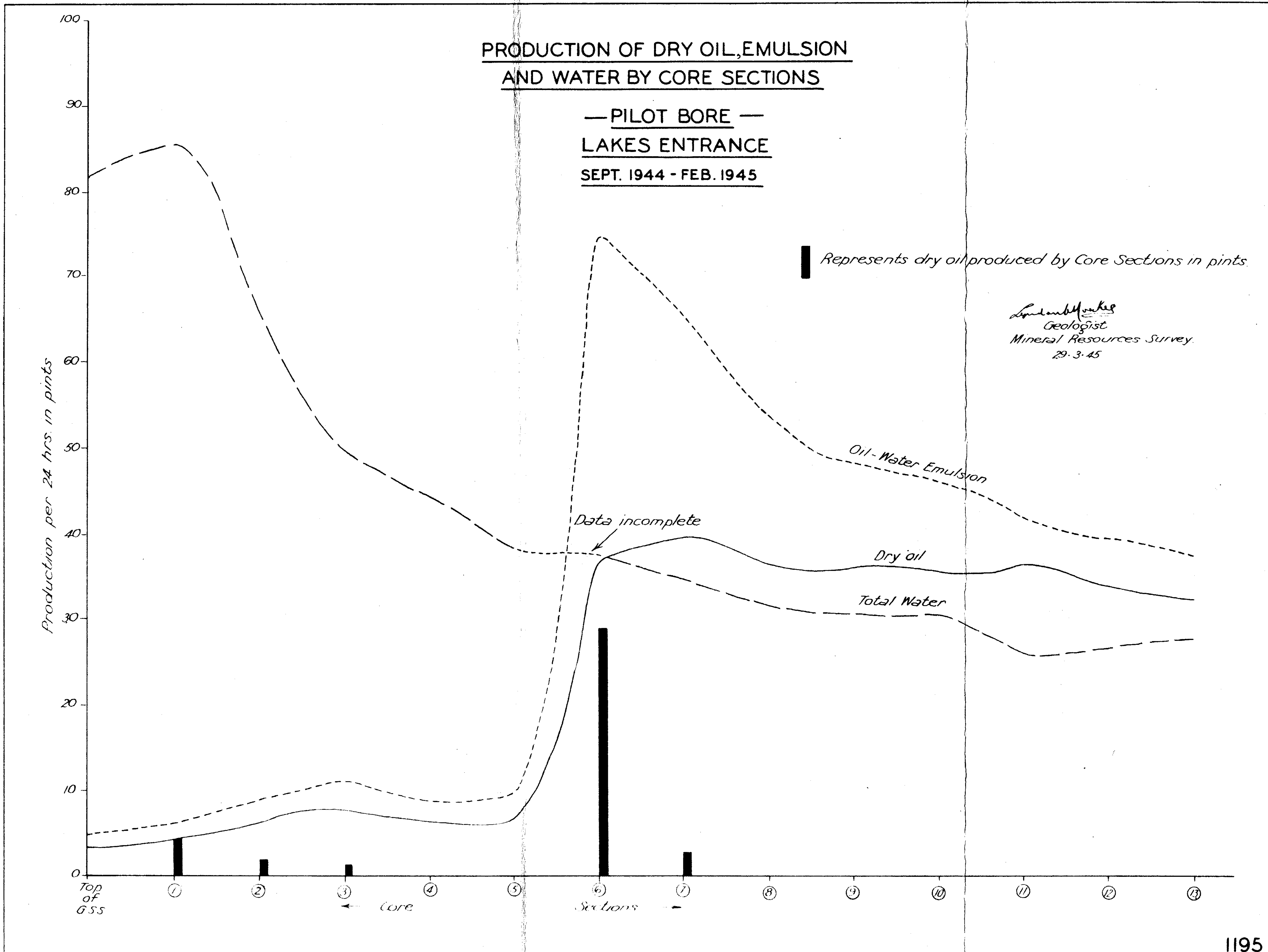
PRODUCTION OF DRY OIL, EMULSION
AND WATER BY CORE SECTIONS
— PILOT BORE —
LAKES ENTRANCE
SEPT. 1944 - FEB. 1945
Represents dry oil produced by Core Sections in pints.
Geologist
Mineral Resources Survey.
29·3·45
Production per 24 hrs. in pints
100
90
80
70
60
50
40
30
20
10
0
Oil-Water Emulsion
Data incomplete
Dry oil
Total Water
Top of G.S.S.
1
2
3
4
5
6
7
8
9
10
11
12
13
← Core Sections →