47

KIRKLINGTON HALL TECHNICAL NOTE

Petroleum Engineering Section

Borehole Survey of Cousland Well No. 1,

7.11.56.

TN.334/57.
17th January, 1957.

1. Introduction.

(a) General.

Cousland Well No. 1 was drilled as part of the British Isles exploration programme by the then D'Arcy Exploration Company over the period 5.9.37 - 12.9.38, to a total depth of 2917'. The bit stuck on bottom at 2917' and drillpipe was backed off at 2086', a cement plug being placed on top of the fish. $8\frac{3}{4}$" casing was cemented to surface, the shoe being at 2057'.

A number of packer tests was made during the drilling period, and several horizons were tested after casing had been run. Details of these tests are given in Section 2 below. Following the last of these tests the producing horizon was plugged off and the well was closed in, as there was no immediate demand for the gas which was proved on test. In November 1956, the well was re-opened and the plug was cleaned out to 1660'.

The casing was then perforated over the interval 1575'-1605'.

(b) Operational.

Logging conditions were as shown on the heading to the attached chart.

2. Packer and Production Tests.

(a) Packer Tests.

The following packer tests had been made:-

1188'-1209'	produced	at	the	rate	of	15,000-20,000	cu.ft.	gas	per	day.
1248'-1275'	"	"	"	"	"	30,000	cu.ft.	gas	per	day.
1582'-1632'	"	"	"	"		4,000,000	"	"	"	"
1724'-1806'	"	"	"	"		5,900,000	"	"	"	"
2094'-2122'	"	"	"	"		150,000	"	"	"	"

(b) Production Tests.

After $8\frac{3}{4}$" casing had been run, the following production tests were made, each interval being perforated with 4 x $\frac{3}{8}$" shots/ft.

(i) 1760'-1806', 17.4.39-24.4.39.

Initial C.I.P. = 659 p.s.i.

Initial production 13 x 10^6 cu.ft. gas per day, declining after three days to 7 x 10^6 cu.ft. per day. Water production increased from 17,000 to 22,000 galls. per day. Total production 35 x 10^6 cu. ft. gas and 75,000 galls. water.

9.5.39-15.5.29.

C.I.P. = 552 p.s.i.
Water free production rate = 70,000 cu.ft. per day.
13.8.39. C.I.P.= 594 p.s.i.
Plugged back to 1740'.

(ii) 1720'-1735', 10.9.39.

C.I.P. = 593 p.s.i.
Well flowed at rate of 800,000 cu.ft. gas per day, then shut in.

(iii) 1582'-1613', 1622'-1630' and 1720'-1735'.

These intervals were tested simultaneously.

3.11.39.

C.I.P. = 587 p.s.i. Gas/water level approx. 1708'.

30.11.39.

Well closed in after flowing total of 30 x 10^6 cu.ft. gas. Following this, well flowed at restricted rate of 1 x 10^6 cu.ft. gas per day. Flowing pressure fell from 580 p.s.i. to 550 p.s.i.

31.12.39.

C.I.P. = 590 p.s.i. Gas/water level approx. 1708'.

The perforated intervals were then plugged off. The hole filled with heavy mud and closed in. The well was re-opened in November, 1956, and the cement plug was cleaned out to 1660'. The interval 1575'-1605' was perforated.

(iv) 1575'-1605'.

Tests indicated that the well will flow at a rate of approximately 3 x 10^6 cu.ft. gas per day.

3. Discussion of Results.

(a) Qualitative.

The gamma ray log delineates the formation boundaries very clearly. The interpretation shown on the chart has been prepared on the basis of the geological log, with which the gamma ray log is generally in good agreement.

The chart also shows the correlation with Cousland Well No. 5. Well No. 1 is structurally some 90'-130' higher than Well No. 5.

It will be seen that the sandstone which has recently been perforated in Well No. 1 is comparatively poorly developed in Well No. 5, being broken by clearly marked shale beds.

(b) Quantitative.

Shale factors have been calculated for a number of corresponding horizons in the two wells. A summary of the method of estimating shale factors is given in the Appendix to this Technical Note.

Whilst we cannot estimate how accurately the shale factors represent the percentage of shale actually present in any given sandstone, we believe that they do give a fairly reliable indication of the relative "shaliness" of the various intervals considered, and hence a comparison of the permeabilities of corresponding zones.

Well No. 1.				Well No. 5.			
$D_{min.}$ = 2.8 divisions. $D_{max.}$ =10.0 " $D_{max.} - D_{min.}$ = 7.2 "				$D_{min.}$ = 1.5 divisions. $D_{max.}$ = 7.0 " $D_{max.} - D_{min.}$ = 5.5 "			
Interval	Deflexion (D)	$D-D_{min.}$	Shale Factor	Corresponding Interval	Deflexion (D)	$D-D_{min.}$	Shale Factor
920'- 950'	4.1	1.3	18	1040'-1065'	3.6	2.1	38
958'- 988'	4.6	1.8	25	1070'-1095'	3.8	2.3	42
1180'-1195'	4.6	1.8	25	1287'-1295'	4.5	3.0	55
1238'-1270'	2.8	0	0	1343'-1368'	1.8	0.3	5
1422'-1444'	3.6	0.8	11	1510'-1530'	1.8	0.3	5
1575'-1604'	3.4	0.6	8	(1690'-1700'	2.3	0.8	15
				(1710'-1720'	1.8	0.3	5
1608'-1633'	3.4	0.6	8	1725'-1752'	1.9	0.4	7

The data given above show that the majority of sandstones are considerably more shaly in Well No. 5 than in Well No. 1. In all cases the shale factors have been calculated for the cleanest parts of the intervals quoted.

4. Conclusions.

There is good gamma ray correlation between the two wells.

Estimates of shale factors indicate that sandstones in Well No. 5 are in most cases appreciably more shaly than in Well No. 1.

P. J. Tracy.

TN.334/57,
17th January, 1957,
/MW.

APPENDIX

Calculation of Shale Factors from Gamma Ray Logs.

1. Determine the point at which radio-activity is a minimum. Let the deflexion at this point be $D_{min.}$.

2. Determine the average deflexion given by shales, ignoring thin marine bands showing exceptionally high radio-activity. Let this average shale deflexion be $D_{max.}$.

3. In the cleanest portion of any sand, the deflexion will have some value, say, D.

4. The shale factor is calculated thus:-

$$S.F. = \frac{D - D_{min.}}{D_{max.} - D_{min.}} \times 100.$$

Note.: The deflexion may be measured in either counts per second or scale divisions. In the estimates given above, scale divisions have been used. On the log of Cousland Well No. 1, $D_{min.}$ (2.8 scale divisions) occurs at 1256', and the average shale deflexion is 10 scale divisions.

This method, together with some of its difficulties and limitations, is discussed more fully in Section IIIb of Report No. KH/PE/13, "Gamma Ray Survey of the Wingfield Flags at Eakring and Duke's Wood," by F. H. Mann and D. Hoyte, June, 1951.

TN.334/57.
17th January, 1957.

LOCATION :- COUSLAND

WELL No. 1

DATE 7th Nov. 56

SHOWING CORRELATION WITH COUSLAND WELL No. 5

INTERPRETATION	WELL No. 1 R.T.E. = 565' GAMMA RAY
	TIME CONSTANT = 2 SENSITIVITY = 400 c.p.s LOGGING SPEED = 1600 F.P.H. ACTIVITY INCREASES → Original vertical scale = 1/500

WELL No. 5 R.T.E. = 551' GAMMA RAY
TIME CONSTANT = 2 SENSITIVITY = 100 cps LOGGING SPEED = 1000 F.P.H. ACTIVITY INCREASES → Original vertical scale = 1/200

Vertical scale reduced on tracing by use of Semi-Scaler to 1/500

Sandstone

Limestone

Limestone

Sandstone

Sandstone

Sandstone

Sandstone & Sandy Fireclay

Sandstone & Sandy Fireclay

Limestone

Sandstone

Sandstone

Limestone

Sandstone

Sandstone

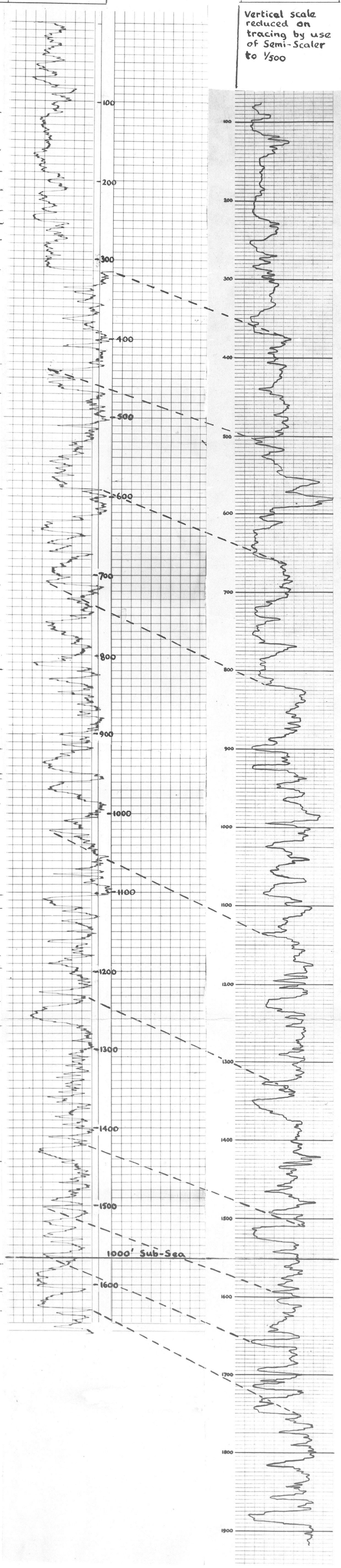
Shales with thin Limestone & Fireclay bands

Sandstone

Shales with thin Limestone bands

Sandstone

Sandstone



250 RGW3

ONE 45203/4

Geological Survey of Great Britain,

SOUTHPARK,

19 GRANGE TERRACE,

EDINBURGH, 9.

Correspondence should be addressed to:—
THE ASSISTANT DIRECTOR and the following reference number quoted.

3rd March, 1960

2469

R.G.W. Brunstrom, Esq.,
BP Exploration Co. Ltd.,
P.O. Box 1,
Southwell,
Notts.

Dear Mr. Brunstrom,

Thank you for your letter of 1st March addressed to the Assistant Director and for the Schlumberger logs of Cousland Boreholes 1, 5 and 6. These logs will be most useful to us in our work on the correlation of these and adjoining boreholes.

Yours sincerely,

R.A. Adam.

District Geologist

250

Geol/250/2679

Your Ref: 2469

1st March, 1960.

The Assistant Director,
Geological Survey of Great Britain,
19 Grange Terrace,
Edinburgh 9.

Dear Sir,

Thank you for your letter of 23rd February, concerning the Cousland No. 6 Borehole. We are grateful for the list of Mr. Wilson's fossil identifications.

Copies are being made of all the Schlumberger logs taken at Cousland, and we will send them under separate cover addressed to Mr. Eden. Of the Cousland wells only No. 5 and No. 6 have had complete surveys of this kind with modern equipment, but in addition a gamma ray log of No. 1 is available. We hope these logs will be of help to you.

Yours faithfully,
for BP EXPLORATION COMPANY LIMITED,

Senior Geologist

RGWB/EER

c.c. Mr. R. A. Eden

Enclosed herewith one copy of each of the following logs:-

Cousland No. 1

Gamma Ray Log	Scale 1/500

Cousland No. 5

Gamma Ray Log	Scale 1/200
Electrical Log	" 1/200
Lateral & SP Log	" 1/200

Cousland No. 6

Electrical Log	Scale 1/200
" "	" 1/500
Micro-caliper Log	" 1/200
" " "	" 1/500
Gamma Ray Log	" 1/200
" " "	" 1/500

449

5th November, 1956.

M. Bordat,
Societe de Prospection Electrique,
Norton Canes Dock,
Pelsall,
Walsall,
Staffs.

Dear M. Bordat,

This is to confirm my telephone conversation with you this morning, and the arrangements made for a gamma ray log and shaped charge perforation at Cousland No.1 well on Thursday, 8th November. The National Grid map reference of the well site is 378681. The well is approximately 2 miles east of Dalkeith. The well has been cleaned out to 1660, and it is required to fire five guns over the interval 1582-1612', the exact shooting depths to be determined from the gamma ray log.

Yours sincerely,

P. L. Adcock

H.120 42559/9301 WWN

4-1

M. Adcock
Formby

Copy

From FIELDS BRANCH, BURGAGE MANOR, SOUTHWELL To FIELDS BRANCH, SUNBURY

Our Ref. Your Ref. Date 6th December, 1939

Subject COUSLAND No.1: PROGRAMME

References : Our memo. 29th November.
Your telegram 1st December.
Telephone conversation 6th December.

We acknowledge receipt of your telegram agreeing to the proposed shut-down of Cousland No.1 for closed-in pressure test, but instructing us that the water is not to be produced. We also confirm telephone conversation with you to-day, in which it was decided that the well is to be left sandbagged, but in condition for production as and when required. These decisions will permit the immediate release of drilling staff urgently required at Eakring.

It should however be borne in mind that before putting the well to sustained production, it would be advisable to plug back the middle sand, 1720/1735 ft. This would be quite a simple job and the necessary drilling staff and equipment could be transferred temporarily should the area be opened up on a production basis.

1650 ays

We are not in a position to say that this work would be definitely necessary, and in view of the decision not to reproduce the shooting water, it will probably remain uncertain whether the water coming into the hole is or is not edge water. It is, however, certain that even if it is edge water it is not coming from the upper sand. The plugging back of the ~~XXXX~~ middle sand to avoid any chance of flooding of the upper sand via the middle sand is therefore advisable as a precautionary measure in the circumstances - especially in view of the fact that the reserves of the middle sand are small. It should be appreciated that there is no danger of the upper sand being flooded whilst the well remains shut-in. The present position is that the Closed-in Pressure had recovered to 585.0 ~~#~~ (D.W.T.Gauge) by 9 a.m. this morning and is still rising slowly.

1660 ays-ed

The gas water level in the hole had fallen to 1700 feet and is still falling.

Total production has been about 30 million cubic feet, and the reserves of the upper sand only, corresponding to the present pressure, are of the order of 350 million cubic feet, assuming no water encroachment. These are preliminary figures only and closer computation of production and reserves figures will be made when equilibrium has been reached.

(Signed) D.Comins

Copies to:-

Mr.Dickie
Mr.Adcock

DC/VEB

H.120 42539/9301 WWN

Mr. Adcock, Cousland.

Copy

From FIELDS BRANCH, SOUTHWELL. **To** FIELDS BRANCH, SUNBURY.

Our Ref. **Your Ref.** **Date** 29th November, 1939.

Subject COUSLAND NO. 1 PROGRAMME

Cousland No. 1 is now due for shut down to obtain the reduction in reservoir gas pressure caused by production. Approximately 27,000,000 cubic feet have been produced since November 3rd and it is clear that the upper sand (1582/1632) may be quite useful, the flowing pressure at 1.0 m. c.ft/day having only fallen 25 ## during the period - from 580 ## to 555 ##.

Based upon the closed-in pressure after a 26 hour shut down 17th/18th November the reserves of the two sands now exposed in the well work out at 325,000,000 cu.ft. on the assumption that there has been no water encroachment. There is no evidence, however, that the pressure had really reached equilibrium and the figure for reserves to be calculated from the next shut down may prove to be much bigger. Of the 325,000,000 cu.ft. referred to above, 25,000,000 may be allocated to the middle sand (1720/1735 ft.), this estimate being based on data obtained when that sand only was exposed. The present position regarding the reserves estimates in this well is, therefore as follows:-

	Million cu.ft.
Bottom Sand 1760 - 1806	175
Middle Sand 1720 - 1735	25

This was in connection with the bottom sand during the tests of the latter, the connection being behind the casing. This channel has now been cemented off and the middle sand is no longer in connection with the bottom sand, but is in direct connection with the upper (1582/1632) sand as the casing opposite both sands is now perforated.

Top Sand 1582 - 1632	300 (preliminary figure)
This is a minimum figure assuming no water encroachment and may be far too low. The final estimate awaits the result of the shut down now due.	Total: 500 (minimum)

No water has been produced in the course of the present production test, but some water has entered the hole, and when the well is flowing is now at 1628 ft. from surface, i.e. just above the bottom of the upper sand. This is probably merely water returning from the formation as some 20,000 gallons were lost, mainly to the middle sand, during gun perforation, and even should it prove to be edge water the behaviou of the well indicates that it is not coming from the upper sand. (The comparatively unimportant middle sand could, if necessary, be plugged back).

It is, however, essential to clear up the source of this water - little can be done from analysis alone at the present stage as in any case the return of some perforating water is inevitable. It is, therefore, recommended that, on conclusion of the closed-in pressure, test water should be produced from the well until either:

(a) 20,000 gallons have been recovered with water still coming in, or

(b) until conclusive evidence is obtained from analyses, whichever of these may be the shorter.

We wish to carry out the closed-in pressure test referred to above before this water production owing to the difficulty of estimating gas production accurately when accompanied by water, but a confirmatory closed-in pressure test should again be made on conclusion of the water production.

The method of producing the water may be either:

(a) by flowing the well through casing at a much higher rate than at present. It is probable that 3 or 4 days' production at the rate of 5 to 10 million cu.ft. of gas a day would suffice, but a firm estimate is not possible. This is the only method at present practicable owing to the absence of equipment;

(b) by running tubing to near bottom and using the gas from the upper sand to gas-lift the water to surface. This has the advantage that the gas production required to produce the water would be much less than under (a), but would involve considerable delay both in obtaining the information and in the evacuation of the area - the necessary equipment not being on site.

A decision at your early convenience is requested as to which of these two methods of producing the water should

be adopted - the point being as to whether there is any commercial or political objection to the extra gas production involved by (a). We shall also be glad of your confirmation by telegram that we may shut down the well forthwith for closed-in pressure test as per programme.

This memorandum has been prepared in discussion and agreement with Messrs. Seamark and Dickie.

(Sgd.) D. COMINS.

Copies to:-

Mr. Adcock, Cousland
D.E.C., Eakring.

DC/RW

A1062—500. C.A.36.

Copy

From D'Arcy Exploration Co. Ltd., Cousland. **To** D'Arcy Exploration Co. Ltd., Llandarcy.

Our Ref. **Your Ref.** **Date** 21st October, 1939.

Subject Cousland No.1 - Gun Perforating from 1630' to 1582'.

17/10/39 - Perforating Well from 1623' to 1630', and from 1610' 9" to 1613'.

Number of bullets fired was 35.

18/10/39 - Perforating Well from 1598' 9" to 1610' 6".

Number of bullets fired was 40.

19/10/39 - Perforating Well from 1582' 0" to 1598' 6", and filling in some of the previous gaps.

Number of bullets fired was 47.

20/10/39 - Filling in the remainder of the gaps.

Number of bullets fired was 42.

The total number of bullets fired during this programme was 164.

cc - Mr.Dickie.
cc - Mr.Adcock.
cc - Mr.Bremner.

Cousland No.1 - Gun Perforating from 1630' to 1582'.

Depth.	Shots fired.	Depth.	Shots fired.	Depth.	Shots fired.
1630' 0".	1.	1613' 0".	1.	1605' 9"	1.
1629' 9".	1.	1612' 9".	1.	6"	1.
6".	1.	6".	0.	3"	1.
3".	1.	3".	1.	0"	1.
0".	1.	0".	1.	1604' 9"	1.
1628' 9".	1.	1611' 9".	1.	6"	1.
6".	1.	6".	1.	3"	1.
3".	0.	3".	1.	0"	1.
0".	1.	0".	1.	1603' 9"	1.
1627' 9".	1.	1610' 9".	1.	6"	1.
6".	1.	6".	1.	3"	1.
3".	1.	3".	1.	0"	1.
0".	1.1.	0".	0.	1602' 9"	1.
1626' 9".	1.1.	1609' 9".	1.	6"	1.
6".	1.1.	6".	1.1.	3"	1.
3".	1.	3".	1.1.	0"	1.
0".	1.	0".	0.1.	1601' 9"	1.
1625' 9".	1.	1608' 9".	1.1.	6"	1.
6".	1.	6".	1.	3"	1.
3".	1.1.	3".	1.	0"	1.
0".	1.	0".	1.	1600' 9"	1.
1624' 9".	1.	1607' 9".	1.	6"	1.
6".	1.	6".	1.	3"	1.
3".	1.	3".	1.	0"	1.
0".	1.	0".	1.	1599' 9"	1.
1623' 9".	1.	1606' 9".	1.	6"	1.1.
6".	1.	6".	1.	3"	1.
3".	1.1.	3".	1.	0"	1.
1623' 0".	1.	1606' 0".	0.	1598' 9"	1.

Depth.	Shots fired.	Depth.	Shots fired.	Depth.	Shots fired.
1598' 6"	1.	1593' 0"	1.1.	1587' 6"	1.
3"	1.	1592' 9"	1.1.	3"	1.
0"	1.1.	6"	1.	0"	1.
1597' 9"	1.1.	3"	1.	1586' 9"	0.
6"	1.1.	0"	1.	6"	1.
3"	1.	1591' 9"	1.1.	3"	1.
0"	1.1.	6"	1.1.	0"	1.
1596' 9"	111.	3"	1.	1585' 9"	0.
6"	0.	0"	1.	6"	1.
3"	1.	1590' 9"	1.	3"	1.
0"	1.	6"	0.	0"	1.
1595' 9"	1.	3"	1.	1584' 9"	1.
6"	1.	0"	1.	6"	1.
3"	1.	1589' 9"	1.	3"	1.
0"	1.	6"	0.	0"	1.
1594' 9"	1.	3"	1.1.	1583' 9"	0.
6"	1.	0"	1.	6"	1.
3"	1.	1588' 9"	1.1.	3"	1.
0"	0.	6"	1.	0"	1.
1593' 9"	1.	3"	0.	1582' 9"	1.
6"	1.1.	0"	1.	6"	1.
3"	0.1.	1587' 9"	1.	3"	1.
				1582' 0"	1.

TOTAL SHOTS FIRED.

17/10/39	.....	35.
18/10/39	.....	40.
19/10/39	.....	47.
20/10/39	.....	42.
		164.

H.120.—C.1.39

Copy

From D'ARCY EXPLORATION CO. LTD., ESKDALE. **To** D'ARCY EXPLORATION CO. LTD., LONDON.

Or Ref. UK/COUS/1 **Your Ref.** UK/A.31 **Date** 10th August, 1939.

Sbject COUSLAND No.1 PROGRAMME

Attached is the revised programme for Cousland No.1 Test Well, compiled with Mr. R.K.Dickie, and in line with your memorandum of the 11th May, 1939.

We estimate that approximately ten days will be required to carry out this programme up to item 7.

We should be glad to have your confirmation of this programme.

(Sgd). S. Roger

cc - Petroleum Engineer, ✓
Cousland.

SR/VEB

COUSLAND NO.1 TEST WELL: PROGRAMME

1. Blow down to zero.

2. Pump in water to fill well. If well takes water uncomfortably fast, switch to mud around 1.2 S.G. until intake reduced to reasonable quantity.

3. Run drill pipe to bottom, circulate mud, and fill with cement to 1740 ft. After cement in hole circulate at 1740 ft. to wash out any surplus.

4. Allow cement to set and bail hole to 1740 ft. as check on cement job.

5. Fill hole with water.

6. Gun perforate 1720/1735 ft. with 60 shot-holes, $\frac{3}{8}$" diameter bullets.

7. Bail out water under pressure using container, producing as little gas as possible.

8. Obtain bottom hole static pressure.

9. Carry out gas production test, starting at low rate of flow, increasing by stages to ascertain if water is coming up.

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cc - Petroleum Engineer, Cousland.

SR/VEB

MARCH 1939.

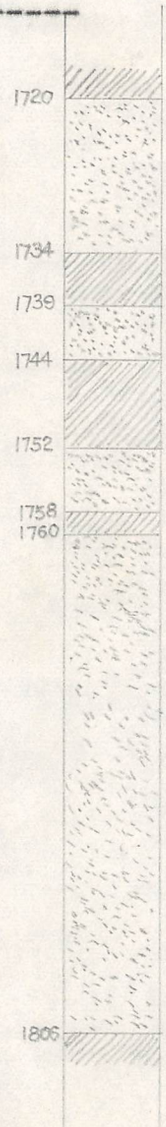
COUSLAND NO.1.

1720 - 1806 -GAS SAND.

A decision was made at the Conference held on the 13th February to gun perforate the 8" casing opposite the 1720-1806 gas sand and to put the well onto gas production.

LITHOLOGY OF 1720' -1806' GAS SAND.

		Permeability in Millidarcys	Gas Prodn. Millions of cu.ft/day.
1652-1720	Mainly Shale.		
1720-1734	Sandstone oozing oil.	4 - 5	1·5
1734-1739	Shale with some sandy fireclay.		
1739-1744	Sandstone oozing little oil.		
1744-1752	Sandy fireclay.		
1752-1758	Sandstone.		
1758-1760	Shale.		
1760-1806	Sandstone with petroliferous smell, and oozing oil between 1804 & 1806'	189 189	4·4



TESTS CARRIED OUT DURING DRILLING.

The sandstones were tested with the Halliburton Full Hole Tester.

(1) Bottom of hole .. 1758'

Packer set at ... 1700'

Diameter of hole 7¾" to 1725'

5⅜" to 1758'

The valve was opened for 8 hours and gas flowed through 2" line for 6 hours

Gas Production ..... 1.5 million cubic feet/day.

C.I.P. corrected (taken before flow when there must have been some mud in the D.P.) 620 lbs/sq.ins.

ANALYSIS OF GAS.

Methane	98.0
Ethane	1.0
Propane & higher	0.7
Nitrogen	0.3

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(2) Bottom of hole ... 1806'

Packer set at ... 1758'

Diameter of hole .. 7¾" to 1790'

5⅝" to 1806'

The valve was opened for 7½ hours and the gas burnt off through 2" and subsequently through 3" line.

Gas Production ..... 4.4 million cubic feet/day.

C.I.P. corrected (taken after well had been flowed i.e. when no mud in hole or D.P. ..... 643 lbs/sq.ins.

ANALYSIS OF GAS.

Methane	94.9
Ethane	2.9
Propane & higher	0.6
Nitrogen.	2.59

PRESENT POSITION OF WELL.

7¾" hole plugged with well set cement from top of wooden plug at 2083' to 2060'.

8" casing cemented (returns of cement obtained at surface) at 2057 ft.

Cement cleaned and outside casing to 2050' and casing left full of water.

Well Head fittings see diagram.

At a depth of 1720 ft. the pressure due to the water column inside the 8" casing is 745 lbs/sq. ins. and at a depth of 1760 ft..... 762 lbs/sq.ins.
The C.I.P. of the gas show at 1760 ft. was 643 lbs/sq.ins.

(Is this water pressure sufficient?

Yes with a margin of about 90 lbs/sq.ins. at 1760 if the C.I.P. had really reached its maximum during the packer test Intld. D.C.)

NUMBER OF SHOTS TO BE FIRED.

Although the two groups of sands between 1720 and 1758 ft. and between 1760 and 1806 ft. may be considered to be one reservoir it would I think be wiser to confine the shooting to the lower and more permeable sand between 1760 & 1806 ft. This sand also produces much higher Resistivity and "Porosity" peaks on the Schlumberger log than the sands of the overlying group.

Recommended 3/8" bullets for greater penetration.

BURNING LINE REQUIRED.

3" line from the well to the quarry ca. 280 ft. The end of the line to overhang into the quarry and so be pointed downwards.

To bring the well onto production.

It will be necessary to swab or bail out approximately 300 linear feet of water.

Observations to be carried out during the course of the Production test.

(1) Arrangements made to measure all water swabbed or flowed.

(2) After amt produced = amt in hole close in and run dippers and float to ensure hole dry.

(3) Long M.C.I.P. test.

(4) Production test measuring prodn. rate daily ? length of test.

(5) Second long M.C.I.P Test.

(Intld D.C.)

STEPS TO BE TAKEN TO KILL THE WELL.

It may become necessary to kill the well.

? How can it be done with plant available.

? What tankage is available.

(Sgd.) A.H. TAITT.

MR. TAITT.

The data from the Prodn. Test will be of little value unless No. 2 is suspended in the same sand before test begun and pressure (gas or water) in No.2 observed during the test on No.1.

In any case the interpretation of data obtained would be inconclusive unless the same sand is water bearing in No.2.

(Itld). D.C.

MR. A. F. BREMNER, ESKDALE.

Memorandum

From RESIDENT GEOLOGIST, COUSLAND, DALKEITH.

To MR. A. H. TAITT, D'ARCY EXPLORATION CO. LTD., LONDON.

Our Ref. Your Ref. Date 31st August, 1938.

Subject HALLIBURTON PACKER TEST CARRIED OUT ON 30/8/38.

A.F.B

Condition of Hole :- 10.5/8" to 2239'.
7.3/4" to 2772'.

Depth of Packer :- 2243'.

The packer valve remained open for 8 hours, during which time observations were made on the fluid level by means of a float hanging in the drill pipe.

Time in hours and minutes.	Depth of fluid level below rotary table.
4.00 p.m.	2239' (level of valve).
4.44 "	1784'
4.58 "	1685'
5.9 "	1612'
5.17 "	1564'
5.26½ "	1508'
5.35 "	1463'
5.46 "	1410'
5.53½ "	1375'
6.2½ "	1336'
6.14 "	1289'
6.27 "	1241'
6.38 "	1202'
6.50½ "	1163'

(Cont'd).

Time in hours and minutes.	Depth of Fluid level below rotary table.
7.3 p.m.	1127'
7.18 "	1084'
7.35 "	1040'
9.7 "	859'
9.31 "	822'
10.00 "	782'
10.30 "	745'
11.2 "	710'
11.34 "	680'
12.7 a.m.	651'.

Plotting these figures as a curve gives a maximum fluid level somewhere between 600 and 550 feet below the table.

On pulling the pipe, the S.G. of the samples of muddy brine obtained were as follows :-

Top of column	1.15
Middle of column	1.1
Bottom of column (average of 2 samples).	1.08
Average S.G. for column	1.1

The gravity of the filtered brine from the bottom of the column immediately above the packer was 1.009 at 58°F.

The more muddy samples contained a little gas which may have tended to reduce the the average S.G. of the column slightly in the drill pipe.

(Cont'd).

ORIGIN OF THE WATER.

From previous tests, we have proved brine from between 2178' and 2227', and from between 2371' and 2404', with recorded S.Gs. 1.002 and 1.023 respectively. Analyses already received show that both these waters are of similar type, differing only in the concentration of salts. The lower S.G. of the upper water may therefore be due to contamination by water previously expressed from the drilling mud returning from the formation, particularly as in the upper test only 14½ cubic feet of fluid was allowed to enter the drill pipe as compared with 32 cubic feet in the lower test.

In the case of the present test, the relatively low S.G. of 1.009 for the water is readily accounted for by contamination from the 529 feet of open hole containing 1.22 mud below the packer, and the increased possibility of drilling water returning from the formation.

It seems possible, therefore, that all the formation below 2178 feet is saturated with brine of S.G. 1.023 or more, and that the estimated fluid level prepared from the results of this test will give an approximate figure for "bottom water pressure".

N.L.F.

A251—C.3.38.

Copy

From D'ARCY EXPLORATION CO.LTD. LONDON. **To** D'ARCY EXPLORATION CO.LTD. COUSLAND.

Our Ref. **Your Ref.** **Date** 19th August, 1938.

Subject SCHLUMBERGER Tests on Cousland No.1. a.H.B.

In connection with the above tests which are to be carried out, we have now received information to the effect that the outfit will arrive at the site between Monday and Wednesday next, August 22nd and 24th.

Tests to be carried out are to cover:-

(1) Resistivity

(2) Porosity

(3) Temperature

In view of the expense involved in any delay due to us, we shall be glad if you will arrange to have the well in suitable condition for these tests as soon as possible after the arrival of the outfit.

Should drilling be completed before the arrival of the outfit, any waiting time should be employed by reaming the hole to 10⅝" down to approximately 2170 ft. (depth to be confirmed by Mr. Falcon), in order that the water shows below 2181 ft. can be effectively tested by the Halliburton packer.

(Sgd.) M.C. SEAMARK.

Copy to:-
Supt. Eskdale.

A259/6941—C.1.38.

Mr. Taitt

RECEIVED
16 JUL 38

Copy

From Resident Geologist, Cousland. **To** Chief Chemist, Scottish Oils Ltd.

Our Ref. **Your Ref.** **Date** 15th. July 1938.

Subject SANDSTONE CORES FROM COUSLAND No.1.

We are sending with this a tin containing three numbered pieces of sandstone core from Cousland No.1 well at 2187- 2189'.

Will you please arrange for a permeability determination of each of these three samples.

Sample No.1 - - - - Oozed no oil but smelt petroliferous

" No.2 - - - - Oozed a little oil

" No.3 - - - - Oozed quite a lot of oil.

N.L.F.

Copy to D.EC.London.

A259/6941—C.1.38.

M. Tait Wk/Cousland/9?2

RECEIVED
15 JUL 38

Copy

From RESIDENT GEOLOGIST, COUSLAND, DALKEITH. **To** ANGLO IRANIAN OIL CO. LTD., SUNBURY ON THAMES.

Our Ref. **Your Ref.** **Date** 14th July, 1938.

Subject SANDSTONE CORE FROM COUSLAND NO.1 WELL.

We are sending you one box containing a sealed tin with a representative sample of a sandstone encountered in Cousland No.1 Well between 2013 and 2017 feet.

This sandstone oozed oil and gassed from the core.

Will you please make an examination of fluid content.

The formal request will be forwarded from London as usual.

N. L. T.

Copy to D.E.C. London.

A249/6931—C.1.38.

Memorandum

From MR. A.H. TAITT. **To** MR. FALCON COUSLAND.

Our Ref. **Your Ref.** **Date** 12th July, 1938.

Subject NATURAL GAS FROM COUSLAND NO.1 AND MIDLOTHIAN NO.1 DISCUSSION OF RECENT ANALYSES.

Attached is a Note on the above by Mr.Lepper of the Petroleum Department.

I should be glad to have any comments or criticisms on this note. I ~~find~~ feel that oiliness of cores is due to lack of permeability and is not necessarily any guide as to the type of gas, whether 'wet' or 'dry', that may be produced from a particular zone.

R.H. Taitt

M: Falcon
Cousland.

Natural Gas from Cousland No.1 and Midlothian No.1.

Discussion of Recent Analyses.

Ref. file P.D. 794/54 and my note of 4th March.1938.

We have now accumulated a dozen analyses of samples of natural gas from the above wells, five reported by Sunbury, two by Fawley (Anglo-American Oil Company) and five from Sheffield (Mines Department Testing Station).

Table I. attached gives the results of the analyses of the samples as received at the laboratory. In nearly every case oxygen and nitrogen were present in the samples. Carbon dioxide does not appear to have been sought for specifically at Sunbury but was probably included in the determination of the air which some of the samples contained.

The analyses of Nos. 1 and 2 were sent to us calculated on an "all paraffin" basis. The percentages of air present and the reduced percentages for the other constituents were kindly communicated to me later by Mr. Stark of Sunbury and I have split up the air into percentages of nitrogen and oxygen present. Later Sunbury analyses have at my request been recorded "as received" and also on an air-free basis.

A preliminary examination of Table I suggests that the Fawley Analysis of No. 10 is incorrect. With regard to No. 6 (Sunbury) we are informed that the container used was probably not fully purged of a previous gas sample (not natural gas?) which contained unsaturated hydrocarbons. It seems best to reject these two analyses.

Oxygen is not a normal constituent of natural gas and we are safe in assuming that its presence is due to contamination of the sample by air. We must therefore eliminate this air and recalculate the results on an air-free basis to enable a better comparison of the analyses to be made.

This has been done* by multiplying the oxygen content by 3.8 to arrive at the corresponding amount of nitrogen present in the air. The residual nitrogen, if any, is regarded as a normal constituent of the gas sample. The necessary adjustments to the figures to arrive at percentages on the air-free basis are then made. The results on this basis are given in Table II. omitting Nos. 6 and 10 for the reasons givenabove.

Sample No.4 was taken during a brief period of gas production from a sand which soon became exhausted. No sample of this gas was available for Sunbury. The Sheffield analysis of this gas compares so very closely with that from No.7 that it is probable that the gas of sample No.4 was a local accumulation which had leaked upwards from the 1,584' gas sand below.

The geological correlation of the Cousland and Midlothian wells shows that the prolific gas source occurring between 1,584' and 1,613' in the former is approximately equivalent to the gas sand occurring between 1,997' and 2,012' in the Midlothian well. The agreement between Sheffield analyses Nos. 7 and 9 is in harmony with this geological relationship.

The variation in nitrogen content after the elimination of air is rather puzzling. We should expect the nitrogen percentages of Nos. 2 and 3 to be in fair agreement yet No. 2 shows no nitrogen. I suspect that this may be due to the probability that (as in the case of No. 1) Sunbury had not been asked to determine the nitrogen content. The fact that every sample from 3 to 12 inclusive contained nitrogen as well as air suggests that Nos.1 and 2 were unlikely to differ in this respect.

The absence of carbon dioxide from all Sunbury analyses indicates that it was not specifically determined rather than

---

* By me where the laboratory concerned has not already given air-free data. In other cases the laboratory figures have been taken as correct.

that it was absent. It may have been included in the "air" determination.

Turning now to the much more important question of the proportions of the gaseous paraffins we may note that in general the proportion of methane is higher in the physical than in the chemical analyses.

As I have pointed out before, where methane ethane and higher paraffins are present chemical analysis alone cannot give the correct proportions of the various paraffins.

As an example of the type of difference between chemical and physical analyses of the same gas, where all analyses were made by the same investigators in the same laboratory the following Table III. is given, compiled from pp.96-97 of U.S.B.M. Bull. 197, for Pittsburgh Natural Gas.

	Chem.	Phys.	Phys.	Phys.	Phys.
Methane	79.2	87.1	87.0	86.3	86.6
Ethane	19.6	5.0	5.8	6.5	5.7
Propane	-	6.5	6.0	6.0	6.1
Nitrogen	1.2	1.4	1.2	1.2	1.6
	100.0	100.0	100.0	100.0	100.0
Total Paraffins	98.8	98.6	98.8	98.8	98.4

Both methods give approximately the same paraffin content.

The differences between the methane contents in analyses 2 and 3 of Table II. are presumably due mainly to the presence of paraffins higher than ethane as proved by the Podbielniak analysis. However the figure of 7.2% for "Ethane" in the chemical analysis is smaller than I should expect in comparison with the total of 9.25% for paraffins higher than methane given by Sunbury. If we recalculate No.3 on 100% paraffin basis the percentages for Methane and "Ethane" become 92.1 and 7.9 respectively which give a closer approach to the Sunbury figures.

Where the paraffins in the mixture under analysis consist only of methane and ethane the chemical and physical results should agree fairly closely. Yet comparison of Nos. 5 and 7 (and 8 which is the same gas as 5 and 7) shows differences for which at present I can find no explanation. As I understand it, the results given by the Podbielniak apparatus are obtained graphically in such a way that there is a very sharp separation between the methane and ethane, and between ethane and the higher paraffins. Any "shading-off" on the graph between the fractions would be noted at once as an indication that the separation was faulty. On the other hand since the physical analyses of the samples under discussion show clearly that paraffins higher than ethane are absent it is hard to understand why the chemical combustion method should give results so different from the physical.

Moreover the chemical results for Nos. 4, 7 and 9 are consistent among themselves, as are the physical data for Nos. 5 and 8 though the degree of agreement between Nos. 5 and 8 is rather less.

When we turn to Nos. 11 and 12 we find a much closer agreement between chemical and physical results - the total paraffins and nitrogen are in very close agreement. In this case Propane is proved to be present and this probably accounts for the difference shown between the methane proportions. The differences and agreements between Nos. 11 and 12 appear to me of the same type as those revealed by the Pittsburgh analyses quoted above.

With regard to evidence, from the analyses, of possible association of the gases with liquid petroleum, Nos. 1 and 2 may be considered as slightly wet gases, No.2 being the wetter. No.3 is of course the same as No.2 but with the small sample available to Sheffield no determination of gasoline content could be made.

It is of interest to note that the 1,188'-1,209' and 1,248'-75' zones consisted mainly of oil saturated sands which are believed to have been the sources of the gas in samples 2 and 3 respectively. In the case of the 1,248'-75' sand a small quantity of oil was obtained for analysis. So far as I am aware however it is not possible to conclude from the analysis of this particular oil that the gas is likely to have been in solution in it or even that the gas would have been appreciably enriched by passing through the oil. However the presence of butane and propane is suggestive of the gas having at some time or other been associated with crude oil.

No. 11 is suggestive of a wet gas since 13% of "Ethane" might well be due to the presence of heavier paraffins. The Fawley analysis of the same gas (No.12) shows only 3% of propane however and nothing heavier. In this case the gas may have come from one or more of four slightly oily sands which occur in the range tested (2,318'-2,400').

The <u>complete</u> dryness of the gas in samples 4-9 as proved by Sunbury seems rather surprising in view of the fact that well saturated oily sands occur between 1,605' and 1,632'. However, the main gas source from 1,584'-1,605' is a clean sand with no obvious oil.

To sum up, we may record:-

(a) Most of the gases so far analysed show high proportions of methane and little or none of paraffins higher than ethane.

(b) Samples from the deeper and more prolific gas sands (Nos. 5 to 12) are dry. The gas from two shallower sands is slightly wet but shows no obvious derivation from the type of oil found closely associated with it.

(c) Certain differences between the results of chemical and physical analyses of gases from the same source have not yet been satisfactorily explained.

I think it advisable that some further chemical analyses of future gas samples should be made at Sheffield for comparison with physical analyses of the same gas. We need more evidence than we now have before a satisfactory explanation of the differences referred to in (c) above can be found.

I should like Sunbury, Fawley and Sheffield to be given copies of this note for criticism in case I may have, inadvertently, misinterpreted any of their data.

S. W. Lepper.
(Signed) S. MEPPER.

June 1st, 1938.

A251—C.3.38

uk/T.3

Copy

From MR. A.H. TAITT.

To Chief Chemist,
Central Laboratory,
Middleton Hall, Uphall.

Our Ref. Your Ref. Date 5th July, 1938.

Subject CORE SAMPLES FROM COUSLAND.

I should be glad if in future oil and water contents of core samples could be given in % by weight and gas content in litres per kilogram. This practice has been adopted by Sunbury in previous examinations. Comparisons would be greatly facilitated if you could adopt a similar procedure.

(Sgd.) A.H. TAITT.

Copy to Mr.Falcon,
Cousland.

UK/Cousland/T 2

S.O., LTD.

Memorandum.

From Resident Geologist, Cousland.

To Chief Chemist, Scottish Oils Ltd,.

Our Ref. **Your Ref.** **Date** 1st. July 1938.

SANDSTONE CORE FOR EXAMINATION

We send with this a sandstone core from a depth of 2105-2106' in Cousland No.1, and would be glad if you would arrange for a determination of permeability and effective porosity.

This sandstone produced gas when tested in the hole.

N. L.F.

Copy to D.E.C.London(Dr. C.T.Barber)

Dr. Barber uk/Cousland/T.2

S.O., LTD. REGISTRY 21 JUN 38

Memorandum.

From Resident Geologist, Cousland.
To Chief Chemist. Messrs Scottish Oils Ltd.

Our Ref. Your Ref. Date 20th. June 1938.

Sandstone Cores for examination from Cousland No.1.

Will you please arrange for an examination of the two accompanying cores from the depths 2013/17' and 2026/27'.

We should like to have permeability determinations of both cores (after benzene extraction), and also an examination of the oil content of the 2013/17' specimen.

If you can also arrange for a determination of the effective porosity of each specimen, after benzene extraction, we should be grateful.

N.L.F.

Copy to D.E.C. London.

A249/6931—C.7.37

49.1

UK/Cousland 1 / T.2

To await arrival **Memorandum**

FILE

From MR. B.R. JACKSON **To** MR. M.C. SEAMARK.

Our Ref. **Your Ref.** **Date** 15th June, 1938.

Subject COUSLAND

-.6/6/38

Please see the attached note from Mr. Comins. The principal points for decision which arise out of the note relate to:-

1. The question of purchasing an Amerada bottom-hole pressure recorder.

2. The provision of a petroleum engineering laboratory and store.

3. Provision of a petroleum engineer.

4. Final programme for the completion of Cousland No. 1.

With regard to 1, I wonder whether we should not be premature in ordering an Amerada at the present juncture.

In regard to 2, should not this question await the time when we can establish a centre for our Scottish operations? It seems pointless to put up a store at Cousland when we shall be drilling elsewhere and Cousland may not be the most desirable point to establish any semi-permanent buildings.

3. I think we should discuss this question with Mr. Jameson.

4. You will have Mr. Taitt's note and will then be able to decide on the programme which you think most appropriate. We should then get Mr. Jameson's approval on this point also.

With regard to the question raised by Mr. Comins on page 9 of a Schlumberger survey, I have written to the Schlumberger Company asking what their terms would be. I have also written to our Anglo-American friends asking them what Schlumberger charged them when this survey was carried out at their Midlothian No. 1.

BRJ

Enclosure

8th June, 1938.

MR. B.R. JACKSON.

COUSLAND.

I attach a note incorporating action taken and points arising out of my visit with Dickie. There is a good deal of detail in this which is mainly intended to serve as a reminder either to Falcon or to myself. You will find the main points for your consideration in the second part.

Dr Lees.

8th June, 1938.

COUSLAND

Notes on a Visit by Messrs. Comins and Dickie
2nd June, 1938.

The following action was taken or arranged:-

I. PETROLEUM ENGINEERING EQUIPMENT.

Equipment was taken up and handed over as per list attached, the bulk of this having been personally selected by Mr. Dickie, from stock available, at short notice. It was arranged with Mr. Falcon that, in order to avoid overlap, he will advise me of any further Petroleum Engineering equipment which he may purchase locally.

II. MEASUREMENT OF CLOSED-IN WELLHEAD PRESSURES.

Dead-weight tester installed and use in direct measurement of wellhead pressures demonstrated. This eliminates the use of pressure gauges for this purpose, except as a preliminary guide. Absolute accuracy obtainable: 2½ lbs. in 1000 lbs., and sensitivity: 0.1 lb. per sq.inch. In the absence of a pressure on the well this demonstration was carried out on a large sample of gas at approximately 150 lbs. pressure.

All gauges used in previous closed-in pressure measurements were tested against the dead-weight tester and the necessary corrections at the significant pressures determined at a temperature of approximately 50°F. It was found that the corrections supplied by the Colliery Company were unreliable.

Results:-

Corrected closed-in pressure when well at 1586' with open hole to 1244', where the 8" casing was set, is 680 lbs. Little reliance can, however, be placed on this figure, as it is

based on the memory of Messrs. Falcon and Winter as to what the gauge was reading at the time (640 lbs.) no actual observation having been made. Furthermore, the open hole included the 1248/1279' sand as well as the first 4' of the 1582/1642' sand. There was also an unknown quantity of cavings at the time.

Corrected closed-in pressure when well at 1652' with packer set at 1596' was 615 lbs., the Anglo-American Oil Company's gauge borrowed for this reading proving to be reading 65 lbs. higher. This pressure should be reliable, as it was measured after the well had been flowed and all mud fluid below the packer ejected.

Corrected closed-in pressure of the 1720/1734' sand with the well at a depth of 1758' and the packer set at 1700' is 620 lbs. This was, however, measured before the well was flowed, with certainly mud below the packer and, possibly, up to 40' or so of mud above it. The true pressure would, therefore, probably be something of the order of 30 lbs. more than the observed pressure.

Corrected closed-in pressure of the 1760/1806' sand with the well at a depth of 1806' and the packer set at 1759' is 643 lbs. This should be reliable, as it was measured after flowing the well. The probability is that the pressure of this sand and that of the 1720/1734' sand are the same.

Further Action.

(1) Valves temporarily installed on dead-weight tester to be replaced by Sunbury Needle valves on arrival. These in turn to be replaced by ¼" Crane Needle valves on arrival (these have been ordered) and Sunbury valves returned to Sunbury (N.F.).

(2) Gauge corrections to be repeated at approximately 70°F for comparison with the corrections at 50°F. (N.F.).

(3) Permanent base to be installed for dead-weight tester with, if possible, levelling arrangements (N.F.).

(4) All future closed-in pressure measurements to be made on well direct by dead-weight tester at any convenient but fixed elevation, which should be reported, the gas being brought to this elevation by means of the high pressure hose supplied. In taking these readings in cases where time is limited owing to the necessity of pulling out the packer, a graph should always be submitted covering the range of readings before the packer is pulled, in order to ensure that if any slight rise in pressure is still occurring this is known and some estimate of the rate of rise is possible (N.F.).

(5) All closed-in pressure readings to be taken after flow. Specific note to be made as to whether there is still any mud spray in the line. This is best observed not at the flare but by blowing off from a connection in the line, through hose supplied, into a glass container (N.F.).

III. WELLHEAD AND PRODUCTION LINE FLOWING PRESSURES AND GAS PRODUCTION TESTS.

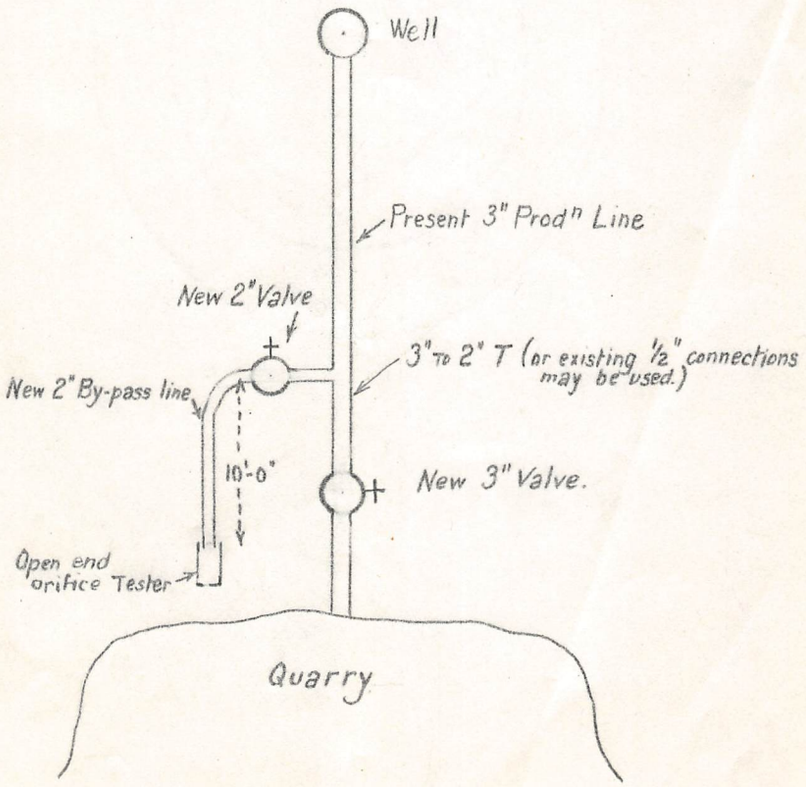
(1) Western gas Chart - based on Oliphant's Formula - handed to Mr. Falcon for purposes of preliminary estimates of gas production based on flowing pressure drop through production line.

(2) Flowing pressure measurements to be by either gauge or manometer as convenient. Corrections of gauges used to be determined by dead-weight tester and correct pressures of previous tests made and revised estimates of production (based on Chart) to be submitted. Accurate observation of wellhead flowing pressure at each production test also essential (N.F.). This has since been done and reported by Mr. Falcon for the 1700/1758' test (with the exception of the wellhead flowing pressure) and for the 1759/1806' test. Similar data still awaited for earlier production tests, including correct wellhead flowing pressures.

(3) Method of determining corrections of gauges at pressures lower than practicable by dead-weight tester explained. This involves the use of tyre pump and manometer in balance with the pressure gauge. Further action:- 48" mercury manometer to be supplied (D.C.). Further supply of mercury to be obtained locally (N.F.).

(4) For purposes of accurate calculation of gas productions which will be done in Head Office, flowing temperatures in the line to be observed and reported. For this purpose special pipe thermometers supplied. Barometric pressure also to be observed and reported. Precise i/d of production line also to be measured and reported (N.F.).

(5) Orifice well tester with full working instructions supplied for measurement of small gas productions where pressure drop through 3" line is inappreciable, and method of use explained This makes the present 2" and 1" production lines superfluous and they may, if desired, be taken up and in their place a short 2" by-pass installed near the open end of the 3" production line, as shown in the sketch below:-



(6) To permit attempts at calculation of the bottom-hole flowing pressure during production tests, the size of drill pipe used always to be reported, and the interval between tool joints. The dimensions (diameter and length) of the bean in the Halliburton flow tester also to be measured and reported (N.F.). There does not appear to be a dimensioned drawing of the flow tester in this Office.

IV. MEASUREMENT OF GAS SPECIFIC GRAVITY ON SITE.

Method explained and necessary data supplied. Such measurements are desirable as a routine in order that early information is obtainable regarding any change in the character of the gas in advance of Sunbury's determinations, the results of which would usually be supplied too late for any further tests of a sand to be made should any important changes in the gas occur. Specific gravity of both the flowing gas on production tests and also of the closed-in gas to be determined as a routine and, if any appreciable difference is observed, samples of both to be collected for analysis. Further action:- Supply drying towers and drying agents (D.C.).

V. GAS SAMPLING.

(1) Winchester bottles for gas samples for Petroleum Department to be sealed with collodion as well as wax (specified by Petroleum Department) as additional precaution against leakage. N.F. to order collodion locally, cancelling Item 11 of H.O.Indent 475.

(2) When collecting gas samples, gas to be passed through vertical gas-water separator - merely a piece of vertical pipe with gas offtake at top and water offtake at bottom, of which construction to be arranged locally by N.F. This is desirable as it was noticed that a sample at Cousland contained water.

(3) One of the large sample containers ordered by Mr. Seamark from O.W.E. was examined and considered satisfactory. The pressure of this sample, after drawing off a certain amount of gas for dead-weight tester demonstration purposes, was 146 lbs. (corrected) at 50°F. and there appeared to be no leak. These containers are, however, too large for routine samples for Sunbury, though very suitable for storage purposes on site, or for sending bulk samples for special investigation.

Further action:-

(a) Pressure of the sample tested to be re-determined in a week or so to ensure that there is in fact no leakage in these containers, allowance being made for the temperatures of the two tests (N.F.).

(b) Recommended that 5 more of these containers should be ordered for storage purposes, making 8 in all, and that one container-full at, say, 500 lbs. pressure, of gas from each sand struck should be stored in these at Cousland against possible future demand.

(4) The sample containers at present in routine use were examined and considered unsuitable, partly on account of the type of valve in use and partly because no mechanical protection is provided for this valve in transit. It is also clear that these are unsatisfactory, the last sample having arrived at Sunbury at no pressure. A design is attached for a type of small sample container which it is proposed to order for routine purposes. These will be ordered in two sizes - 2 and 5 litres capacity at atmospheric pressure - both being otherwise the same and capable of withstanding 1500 lbs. test pressure. Normally the 2 litre size will be used for high pressure samples and the 5 litre for low pressure - i.e. flowing - samples. Samples to be sent in duplicate. For Podbielniak analysis minimum gas requirements are 10 litres, so that a minimum collection pressure of 15 lbs. gauge is desirable for flowing samples in order that each of the

two containers sent to Sunbury should contain sufficient gas for a Podbielniak analysis. The 5 litre size of container would, of course, be used if larger samples should for any reason be required. Initially it is proposed to order 12 of each.
Further action:- Order to be placed (D.C.).

(5) Sample containers to be prepared for filling by preliminary heating with primus blow lamp and by evacuation with Geryk vacuum pump supplied, in order to ensure no possibility of contamination; these to be connected to gas supply still under vacuum and to be blown through for some time before sample actually taken.

(6) In despatching samples, a note to be made on the accompanying letter of the correct pressure of the sample when despatched and of the temperature at which the pressure was observed. Sunbury to compare this with the pressure on receipt, making due allowance for temperature, and to report leakage, if any. A note also to be made on the letter of despatch of the condition of the well at the time the sample was collected.

The following points were discussed, and resultant recommendations are given under each heading:-

I. PRODUCTIVE CAPACITY OF INDIVIDUAL SANDS ; NECESSITY FOR BOTTOM-HOLE PRESSURE RECORDER.

(1) There is no doubt that very considerable back pressure is being imposed on the sands at any appreciable rate of flow by the $\frac{3}{4}$" bean in the Halliburton flow tester and by the drill pipe with its enlargement and contraction of section at each joint and still more so at the tool joints. A calculation of the amount of such back pressure is a matter of some difficulty, but it is probably of the order of at least 100 to 200 lbs. at 5 m.cu.ft. per day. A further note on this point will be submitted if any

satisfactory results can be calculated. In any case, it is certain that the flush production of wells would be very much more through casing, though not necessarily the sustained production rate, which can only be ascertained by a long production test. The only satisfactory method of measuring the bottom-hole pressure drop is by inserting a bottom-hole pressure recorder in the anchor pipe of the flow tester, and it is recommended that an Amerada instrument should be purchased for this purpose. Enquiries will be made as to specification and cost; an approximate figure of £300-£400 may be taken for purposes of making a decision. The A.I.O.C. bottom-hole pressure recorder, though more accurate than the Amerada, would be useless for this purpose, as it is only a single reading instrument. A recording instrument would also have the following advantages:-

(a) that it will give a true picture of the success or otherwise of the shut off of the packer.

(b) that it may be left in site during successive tests at definite rates of flow, whether through casing or through a packer, whereas the A.I.O.C. instrument could not be used with a packer and in casing would have to be withdrawn for reading between each rate of flow.

The construction of a bottom-hole differential pressure/production curve for each sand will enable accurate estimates of flush production capacity to be made and provide reliable data on the comparative permeability of the different sands struck.

(2) In the meantime, more information on the productive capacity of the sands than can be obtained from a production test at one flowing pressure would be obtainable by testing the production of each sand at varying wellhead flowing pressures, and it is recommended that this should be done as far as is practicable

within the time limits imposed by the necessity of avoiding any danger of freezing the packer, this being a matter for decision by the Drilling Superintendent.

(3) It is also recommended that the next sand struck should be tested with two sizes of pilot hole, the initial pilot hole being reamed to a larger size between the first and second tests. (It is not practicable to ream the pilot hole to full hole between first and second tests, as a packer test in full hole would involve some risk of a fishing job). The results of such successive tests would provide some data as to the extent to which production is dependent on the area of sand exposed and on the permeability of the sand.

II. POROSITY AND PERMEABILITY TEST OF SANDS.

It would appear desirable that porosity and permeability tests of each sand penetrated should be carried out on site, as a great deal depends on the discretion of the resident staff in such tests and their familiarity with the samples. Such work would not, however, be practicable unless or until the present staff is augmented.

III. CORRELATION OF SANDS.

In view of pressure results to-date, it would appear that pressures may not be of much help in the reliable correlation of the sands, though opinion on this point is reserved until further accurate dead-weight tester observations of closed-in pressures have been taken. It is also understood that there is considerable difficulty in confident geological correlation of the sands from the Anglo-American well to our well. Under these conditions, a Schlumberger survey may be of great assistance, and it is recommended that this should be made on the present well before the next string of casing is run and on

the next well to be drilled. If any reasonable correlation is obtained between Schlumberger results and coring results on our two wells to the Anglo-American well, it might indeed prove possible to dispense with coring altogether on further wells and rely entirely on Schlumberger correlation. Although no scope can be seen for the application of the Schlumberger methods in our Iranian Limestone fields, it does seem that the conditions of multiple sands which obtain at Cousland are precisely those under which their methods have proved most successful.

IV. FINAL PROGRAMME ON COMPLETION OF WELL.

This was discussed, but it must be to a large extent dependent on the number, if any, of further sands struck, and their contents. Mr. Taitt's suggestion of running a string of casing to bottom and gun-perforating and re-testing the successive sands proved would appear to be the most reasonable. If no further sands are proved, a packer could be run in the casing, and the main upper sand from 1582/1642 conserved in the annular space, and the two lower sands, 1720/34 and 1760/1806, treated as one sand - their pressures being approximately the same - and produced through the packer. Should a number of new sands be proved with varying reservoir pressures, it might be possible to test sands individually by means of a double wall packer. The design of such a packer has already been considered by Mr. Seamark for use in Iran.

V. PETROLEUM ENGINEERING ACCOMMODATION AND STAFF.

It is quite clear that, even with the equipment already supplied, Mr. Falcon's accommodation is very much over-crowded, and it will be essential to erect a small Petroleum Engineering Laboratory and Store. Two rooms are required, the

Laboratory for office and precise instrumental work, and the Store for dirty work, bins, samples, etc. The present General Store is already overcrowded and leaks very badly, which is undesirable with precise instruments, and, in any case, in our experience it is better to keep Petroleum Engineering apparatus out of a general store, otherwise it gets mishandled or used for purposes for which it was not intended.

As regards staff, Mr. Falcon will be able to carry out any Petroleum Engineering work at present necessary, but, should it be decided to carry out porosity and permeability measurements on site, or should oil be struck, he will certainly require assistance. In the latter event, a Petroleum Engineer would be essential. In any case, it is now clear that a man with either Petroleum Engineering or Production experience - preferably both - will eventually be required on this field, as, even if oil is not found, there is no question but that commercial gas has already been proved. It is, therefore, recommended that steps should be taken to allocate such a man to this work, although there is no immediate urgency. In the early stages of the field this need not necessarily be a full-time job; he could be based on this Office, where there is plenty of work to keep him employed, and pay extended visits to Cousland as and when necessary until such time as it is obvious that he should be resident there. This proposal has the advantage that the man responsible for the development of production arrangements - which will be comparatively simple - and reservoir control in this field would be familiar with it from its beginning.

8th June, 1938.

COUSLAND : LIST OF PETROLEUM ENGINEERING EQUIPMENT HANDED OVER 3.6.38.

Pressure Gauges.	2	-	0-50# Dewrance 6" dial.
	2	-	0-250# " 7" dial.
	2	-	0-1000# Budenberg 6" dial.

(The 0-1000# gauges will be repeated with 10" dials, none being available ex stock).

Dead-weight Tester.	1	-	10-1000# Dewrance complete with weights reading to 0.1# and special oil.
Boiling Flasks.	4	-	250 ccs.
Geryk Vacuum Pump.	1	-	2" bore 4" stroke.
Rubber Pressure Tubing.			20 feet.
Clips for ditto (screw).			6
Pipe Thermometers.	2	-	0-160°F. 6" scale screwed ½" gas.
Chamois Leathers.	2		
Steel Flexible Tubing 2500#.	4	-	6' lengths.
Glass Cock grease.	1 tube.		

H.P. Fittings Crane.	12	-	¼" T's.
	6	-	¼" to ½" reducers.
	6	-	¼" to 3/8" reducers.
	6	-	¼" T'S.
	6 each ½", 3/8" and ¼" barrel nipples.		

In addition 6 - 1/8" bore neddle valves posted from Sunbury on loan - to be returned when replaced by Crane ¼" needle valves ordered.

A259/6941—C.1.38.

Copy

From RESIDENT GEOLOGIST
COUSLAND.

To CHIEF CHEMIST,
SCOTTISH OILS, LTD., UPHALL.

Our Ref. **Your Ref.** **Date** May 27 th.1938.

Subject SANDSTONE CORES FROM COUSLAND No.1.

I am sending you with Mr. Crombie two sandstone core specimens from 1791'92' and 1804'/5' respectively.

Would you please arrange for permeability determinations and an examination of the fluid content.

N. L. Falcon.

Copy to Mr. A.H.Taitt. London.

A251—C.10.37.

JOB NO.1170.

Copy

From MR. A.H. TAITT. **To** SUNBURY via R.& T.

Our Ref. **Your Ref.** **Date** 24th May,1938.

Subject (1) GAS SAMPLE FROM COUSLAND NO.1. 1720'-1734'
(2) SANDSTONE CORE " " " 1722'-1723'

The above have been dispatched to you from Cousland. Will you arrange for an analysis of the gas, and an examination of the core along the same lines as previous examinations of cores from Cousland.

(Sgd.) A.H. TAITT.

A259/6941—C.1.38.

UK/Cousland/T.2

Copy

From RESIDENT GEOLOGIST, COUSLAND, DALKEITH. To CHIEF CHEMIST, SCOTTISH OILS, LTD., UPHALL.

Our Ref. Your Ref. Date 20th May, 1938.

Subject CORE FROM COUSLAND WELL AT 1724/25 FEET.

The accompanying sandstone core, which was sealed up this morning immediately on extraction from the core barrel, contains gas and oil.

Will you please arrange, as soon as possible, for an analysis of the fluid content, and for a permeability determination.

A rough preliminary report on the fluid content, particularly the type of oil, would be most useful if you could 'phone it through before undertaking the detailed analysis.

N.L.F.

Copy to Mr.A.H.Taitt, London.

UK/Cousland/T.2

A251/6933—C.7.38

Copy

From RESIDENT GEOLOGIST, COUSLAND, DALKEITH. **To** CHIEF CHEMIST, SCOTTISHOILS, LTD., UPHALL.

Our Ref. **Your Ref.** **Date** 17th May, 1938.

Subject COUSLAND NO. 1 SANDSTONE CORES FOR PERMEABILITY DETERMINATIONS.

In order to have complete records of the important sandstone horizons drilled through in this well, we should be glad if you would arrange for permeability determinations of the accompanying six (6) samples after extraction with petroleum ether.

Particulars are as follows:-

1. Specimens marked 928', 950' and 971', from the 922'/991' Sandstone.
2. Speciment marked 1200', from the 1188'/1209' sandstone zone.
3. Specimens marked 1248' and 1265', from the 1248'/1279' Sandstone.

It will be noticed that specimens 928' and 950' contain much mica, which shows up the bedding planes of the rock. It would be interesting in the case of these two samples to cut discs parallel to, and at right angles to the bedding, so that the permeabilities in these two directions may be compared.

N.L.F.

Copy to Mr.A.H.Taitt, London.

A251—C.A. 1.37.

D: Lee Lowry
M: Jacks

Copy

From RESIDENT GEOLOGIST
COUSLAND, DALKEITH.

To CHIEF CHEMIST,
SCOTTISH OILS, LTD., UPHALL.

Our Ref. **Your Ref.** **Date** 29 th. April 1938.

Subject PERMEABILITY MEASUREMENTS ON SANDSTONE CORES.

We understand from London that you are in a position to make permeability measurements on core samples an that it has been agreed that you will undertake such work when necessary. We are sending you with this 3 core samples for investigation:-

a - Representative sample of 1582/1613' gas sand from ca. 1590'

b - Core of oil soaked sandstone from 1613' (base of 1582-1613' gas sand)

c - Core of sandstone from 1631' part of which is oil soaked and part oil free.

The 1582/1613' gas sand produced no oil on testing, although the core from the base at 1613' oozed oil when taken from the barrel, and the whole sand gave a good gas production (closed in pressure 680 lbs.).
The core from 1631' also came from a sandstone bed which oozed oil in the core barrel and gave a gas production with no oil on test. The oil in this sandstone has been reported by Sunbury to be wax free of S.G. .863.
Apart from your regular permeability observationswe should like you to attempt to force wax free oil of S.G. ca. .863 through these various sandstones and observe what is driven out of them. The object of this investigationis to attempt to explain why oil was not produced from these sandstones on test, and whether the gas sand if oil impregnated can be expected to give a good oil production.

N.L.F.

Copy to Mr. A.H.TAITT.
London.

A251—C.10.37.

Copy

From MR. A.H. TAITT. To SUNBURY
via R.& T.

Our Ref. Your Ref. Date 11th April, 1938.

Subject SANDSTONE CORE FROM COUSLAND.

A sandstone core from 1625/26 ft. in the Cousland well has been dispatched direct from Cousland.

Will you arrange for an examination of this core,

(1) Oil, gas and water content

(2) Analyses of above

(3) Porosity of core

This sandstone is from the sand zone that at 1584 - 86 ft. produced approximately 1 million cubic feet of gas a day.

(Sgd.) A.H. TAITT.

A259/6941—C.1.38.

Copy

From RESIDENT GEOLOGIST, D'ARCY EXPLORATION CO. LTD., COUSLAND, DALKEITH. **To** ANGLO-IRANIAN OIL CO. LTD., SUNBURY-ON-THAMES.

Our Ref. **Your Ref.** **Date** 9th April, 1938.

Subject

SANDSTONE CORE FROM COUSLAND NO.1 AT 1625/26'.

We are sending you today by parcel post, one tin containing an oil soaked sandstone core from 1625/26 feet in Cousland Well No.1.

A request for examination will be forwarded from London in the usual manner.

N.L.F.

Copy to Mr. A.H.Taitt, London.

A251—C.10.37.

Copy

From MR. A.H. TAITT To SUNBURY via R.& T.

Our Ref. Your Ref. Date 8th April, 1938.

Subject SANDSTONE CORE FROM COUSLAND.

A tin containing a sandstone core from between 1586 ft. and 1588 ft. has been sent direct from Cousland.

This core has been described as oil stained in reports so that if sufficient oil is present we should be glad to have an analysis of the oil as well as a porosity determination of the rock itself.

A determination of the type and quantity of the oil present in the core is of particular interest in view of the fact that the gas produced from this zone contained no hydrocarbons higher than Ethane.

(Sgd.) A.H. TAITT.

A259/6941—C.1.38.

Copy

From RESIDENT GEOLOGIST, COUSLAND, DALKEITH. **To** MESSRS. ANGLO-IRANIAN OIL CO. LTD SUNBURY-ON-THAMES.

Our Ref. **Your Ref.** **Date** 7th April, 1938.

Subject SANDSTONE CORE FOR POROSITY DETERMINATION.

We have sent you by parcel post today, one tin containing a sandstone core taken from Cousland No.1 Well between 1586 and 1588 feet. This is a representative sample of the sandstone from which the Gas Show previously logged at 1589/91' comes. (The depth to the top of the sandstone has been corrected after re-measuring the hole with rotary tools).

A formal request for examination will as usual be sent you from London.

N.L.F.

Copy to Mr. A.H.Taitt, London.

A251—C.3.38.

uk/Cousland 1/T.2.

Copy

From D'ARCY EXPLORATION CO.LTD. LONDON. To MR.SEAMARK.

Our Ref. Your Ref. Date 29th March,1939.

Subject COUSLAND. THE 1248'-1279' SAND OF NO.1.

In Cousland No.1 the 1248' (U.G.C. 93.17) sand produced gas at the rate of 30,000 cu.ft. per day and several gallons of oil.

In Cousland No.2 the representative of this sand was encountered at 1490' (8941) and was found to contain salt water which had a C.I.P. of approximately 15 lbs/sq. ins.

At the D'Arcy end of the D'Arcy-Cousland structure the 1248 ft sand is correlated with the 1735' (90 36) oil sand of Midlothian No.1 and the c.a. 2100' (8521) or possibly 2001' (8620) sand of Midlothian No.2. This sand produces oil, c.a. 6 bbls/day and water in No.1 and water in No.2. The fact that water only is produced in No.1 if the well is pumped hard for some days but if left standing oil accumulates seems to indicate that the well has entered the sand near oil/water level and that edge water is being coned up.

The evidence taken as a whole therefore indicates that oil water level is at approximately the 9000 contour. As ground elevation on the Cousland structure only rises slightly above 600 ft. A.S.L. the depth to oil water level at any part of the structure is at most only just over 1600 ft.

In view of the comparatively shallow depths to the oil sand over most of the structure would it not be possible to develop this sand with the heavier Failing Outfit? I would suggest drilling a 7.3/4" hole to the top of the sand, running and cementing 6" casing to this point, and drilling in using oil circulation.

(Sgd.) A.H. TAITT.

Memorandum

From Sunbury **To** D'Arcy Exploration Co. (Mr. A. H. Taitt)

Our Ref. ARS/DF **Your Ref.** **Date** 28.1.38

Subject Examination of Core Samples from Cousland

In reply to your request for details of the methods used at Sunbury for determination of porosity & permeability of cores and the analyses of oils obtained from core samples, the following is the information which you require:-

(1) POROSITY AND PERMEABILITY

The method used for determining porosity is that detailed in Sunbury Report No. AP.S/15 of 10.12.34 and is identical with the "pyknometer method" described in a paper by Thomas, Chisholm and Cameron in J.I.P.T. 1935 Vol 21. pp.723-733. The determination of permeability if required can be performed according to the method given in Sunbury Report No. AP.S/32 of 5.11.36 which is an adaption of a method set out in the review of Porosity and Permeability by Fancher, Lewes & Barnes in the Pennsylvania State College Bulletin No.12 May 1933.

(2) PROPORTION OF OIL CONTAINED IN CORE SAMPLES

Two methods are in use at Sunbury for the extraction of the proportion of oil contained in a core sample. The first of these, one of extraction by a solvent is identical with the Soxhlet process outlined in the paper by Thomas, Chisholm & Cameron under the heading "Preparation of Sample." The solvent used may be benzene or carbon tetrachloride which on removal after extraction leaves as a residue the oil originally contained in the core. It is the practice to grind the core to pass 40 mesh sieves before extraction.

The second method is one of distillation and is carried out in an iron tube 18" long x 2" I.D. fitted with a blank cap and vapour take-off. The vapours evolved on heating are passed through a condenser and adequate arrangements are made to collect all the gases and vapours evolved and if necessary to maintain the condensing system at approximately -20°C. with the use of CO_2 and kerosene.

These two methods do not necessarily give the same values for oil content. In the first case, light hydrocarbons boiling below or at the same temperature as the solvent are removed in the distillation with the solvent and therefore not recovered with the oil.

In the second case, all light hydrocarbons are recovered but not all the asphaltic material. If the heating is continued for a sufficiently long time some of this asphaltic material is cracked with resulting coke formation.

Thus, while no absolutely accurate value for oil content is measured, the two methods do give a true indication of the type of oil present in the core.

(3) EXAMINATION OF OILS

The characteristics of the oils to be determined will naturally depend on the quantity of oil available, but the following gives a list of the more usual tests required:-

a. Specific Gravity @ 60°F.
b. Distillation
c. Sulphur Content
d. Melting Point °F.
e. Wax Content
f. Hard Asphalt Content
g. Soft Asphalt Content
h. Podbielniak analysis of gaseous products, if any

for D. G. SMITH

c.c. Ref. & Tech. Br.

A251—C.10.37.

Copy

From MR. A.H. TAITT. **To** MR. A.C.HARTLEY.

Our Ref. **Your Ref.** **Date** 25th January, 1938.

Subject DATA OF COUSLAND NO.1. OIL SHOW.

The following is the relevant data of the zone now being tested at Cousland.

Depth of well ...	1303'
8" casing set at ...	1244'
Diameter of Pilot Hole from	1244'-1303' .. 7⅞
Oily sand cored from ...	1248'-1279'
Predominantly shale with some thin tight sandstones from	1279'-1303'
Porosity of oily sandstones	18 -23%
Percentage oil by weight extracted from oily sandstone cores	1.5-3.5%

Extracted Oil

S.G. at 60°F.	0.866-0.877
Melting point	102-below 70.
I.B.P.	90
Vol. to 250°C. %	20
Vol. to 375°C. %	55

It is probable that some of the lighter fractions and gas contained in the extracted oil had gone by the time the core fragments were received by Sunbury.

During bailing tests approximately 2½ gals. of oil were produced with a greater quantity of muddy fluid, and gas. The gravity of the oil was 0.86 and the setting-temperature 12°C.

The temperature of the muddy water and oil when brought to the surface in the bailer was 14°C. but we have been unable to obtain any reliable reading of the temperature of the formation at the bottom of the hole. Since this oil was produced the casing seat gave way and the casing has had to be pulled and re-set.

The present programme is -

(1) Bail the hole dry of mud fluid.

(2) Dump water in the pilot hole and wash by rotating a fish tail bit.

(3) Bail to 1280 ft. approx.

(4) Dump kerosene to 1248 ft.

(5) Bail dry after 24 hrs.

(6) Leave hole for 24 hrs, bail and continue drilling with cable tools.

(Sgd.) A.H. TAITT.

A251—C.10.37.

Copy

From MR. A.H. TAITT. To SUNBURY via R. & T.

Our Ref. Your Ref. Date 21st January, 1938.

Subject EXAMINATION OF CORE SAMPLES FROM COUSLAND.

In view of the urgency of many of the examinations of Cousland cores in that our immediate testing policy is liable to be influenced by porosity conditions etc. of the oil sand zones I have discussed the question of examination with Mr. Crichton and Mr. Conacher. Scottish Oils have the equipment and staff for determinations of porosity and permeability of cores and for analyses of oils and are prepared to undertake the work in cases of urgency, and of course in such cases the samples can be sent to their laboratory by road from Cousland.

It is essential, however, if results are to be of comparative value, that Scottish Oils should use the same methods as those used by you, and we should therefore be glad to have details of these methods for transmission to Mr. Conacher.

(Sgd.) A.H. TAITT.

—C.A. 1.37.

Mr. Jackson HM
Mr Taitt A.H.T.

RECEIVED
-6 JAN 38

Copy

From RESIDENT GEOLOGIST, COUSLAND. **To** A.I.O.C. RESEARCH STATTON, SUNBURY-ON-THAMES.

Our Ref. **Your Ref.** **Date** JAN. 4th. 1938

Subject MARKING OF CORE SAMPLES FROM COUSLAND.(of London memo. dated 3rd. inst.)

London office informs us that the two tins sent off respectively on 22nd. and 23rd. December arrived without means of identification. When these tins were dispatched from here they both had typewritten labels pasted on the lid. If these labels had come unstuck they should have been found inside the wrapping paper.

If no trace of the labels can be found we suggest looking at the postmark.

If the wrapping paper has been all thrown away the two samples will now have to be considered as coming from the thick sandstone occurring between 1248 and 1275 feet. In any case owing to poor core recovery the exact positions of the specimens is unknown.

In future tins will be marked with the depth in paint.

Sgd.N.L.Falcon.

Copy to Mr. A.H.Taitt.

A251—C.10.37.

Copy

From MR. A.H. TAITT To MR. N.L. FALCON, COUSLAND.

Our Ref. Your Ref. Date 3rd January, 1938.

Subject MARKING OF CORES FOR SUNBURY.

Sunbury write that the two core samples sent off on the 22nd and 23rd December respectively arrived together and have no identification marks on them. If possible will you let Sunbury know details of the cores so that they may be identified, although in this instance such identification is not of such great importance as both cores are from the same zone.

In future will you ensure that the cores or their containers are marked in such a way, and reference made to this mark in the accompanying memo. to Sunbury, that there can be no possibility of mistake.

(Sgd.) A.H. TAITT.

A251—C.10.37.

Copy

From MR. A.H. TAITT. **To** SUNBURY via R.& T.

Our Ref. **Your Ref.** ARS/MSK. **Date** 3rd January, 1938.

Subject SANDSTONE CORES FROM COUSLAND.

I have asked our Resident Geologist at Cousland to let you know particulars of the cores sent off on 22nd and 23rd December so that they may be identified. This however, is fortunately, not of great importance as both cores are from the same zone.

I have also asked him to ensure that all future samples are marked in an indelible manner.

(Sgd.) A.H. TAITT.

A249/6931—C.A. 12.30.

Memorandum

From Sunbury. **To** D'Arcy Exploration Co.
Attention Mr. A.H. Taitt.

Our Ref. ARS/MSK **Your Ref.** **Date** 29.12.37

Subject Sandstone Cores from Cousland.

With reference to the sandstone cores from Cousland which we are now examining on your behalf, we would like you to take up the matter of identification of samples with your Fields staff.

We have two notes, dated 22nd and 23rd December, from the Resident Geologist at Cousland, stating that cores are being despatched to us for examination upon receipt of London's "formal request".

The core samples are actually here but unfortunately neither bears a label to indicate its origin.

May we therefore suggest that in future some indelible marking, for instance a reference number, be put on the sample tin and that the descriptive covering letter, make mention of this reference.

A251—C.10.37.

Copy

From MR. A.H. TAITT. To SUNBURY via R. & T.

Our Ref. Your Ref. Date 29th December, 1937.

Subject (1) Sandstone Core from Cousland (1248'-1258') (corrected).
(2) Sandstone Core from Cousland (ca.1262')
(3) Gas sample fr m Cousland (1188'-1209')

We should be glad to have an examination of items (1) and (2) along the same lines as that of previous oil saturated sandstones from Cousland. As this sandstone is now being tested this work should be treated as urgent.

If possible we should like to have a fuel analysis, with S.G. of item (3) and a measurement or close estimate of viscosity.

(Sgd.) A.H. TAITT.

A259/6941—C.5.35.

Miss Marrack
Pl. correct the memo.
VGH. 29/10
[illegible]

Copy

From RESIDENT GEOLOGIST,
COUSLAND.

To A.I.O.C. RESEARCH STATION,
SUNBURY-ON-THAMES

Our Ref. **Your Ref.** **Date** DEC. 27th. 1937.

Subject SANDSTONE CORE WITH OIL FROM COUSLAND (1248/58').

We regret to find that our Memo. dated 22nd. Inst. recorded the sandstone as from 1148/58'.

Will you kindly correct this? The correct depth is

1248' - 1258'

Sgd. N.L.Falcon.

Copy to D.E.C. London (MR. A.H.TAITT).

A251—C.A. 6.37.

Copy

From MR. A.H. TAITT. **To** MR. N.L. FALCON, COUSLAND.

Our Ref. **Your Ref.** **Date** 24th December, 1937.

Subject SANDSTONE CORE WITH OIL FROM COUSLAND (1148/58')

With reference to the above sample which was sent to Sunbury, will you please confirm that the depth was 1148/58 and not 1248/58.

(Sgd.) A.H. TAITT.

Dr Lees / Mr Wyllie / Mr Jackson / Mr Mayhew. [initials]

COUSLAND NO.1 WELL. TEST CARRIED OUT ON 23rd. DECEMBER 1937.

Depth of hole at time of testing.

$10\frac{5}{8}$" - 1138'
$7\frac{3}{4}$" - 1294'

Reason for test.

From 1248' to 1279' the cores showed oil soaked sandstone. The core record is as follows :-

1240 - 1258	Recovery 33% made up of	(2 feet dark shale (4 feet sandstone
1258 - 1274	Recovery 62%	Sandstone
1274 - 1294	Recovery 65%	(4' grey micaceous shaley sandstone. (8' grey shale (1' sandstone

Experience has shown that the type of associated shale in these cores usually gives a very good recovery, and drills harder than sandstone. Between 1240 and 1280 the drilling was frequently soft. The core taken above 1240 finished in soft fireclay which rarely cores well. The probability is, therefore, that from 1248' to 1275' is one thick bed of oil saturated sandstone, some of it poorly cemented. The samples give little assistance, but confirm that the sandstone started at 1248'.

Thick mud rings forming at 1246/1250 and 1267/1276 suggest porous sandstone at these horizons.
N.L.F. 27.12.37.

The Test.

The packer was set at 1220 and the valve left open for 2 hours during which time air was expelled from the pipe. On pulling the pipe 15 feet of drilling mud was found above the packer.

Conclusions.

Although it proved little, this test showed that the sandstone beds in our succession must be regarded as separate possible oil reservoirs. The packer was set only 10 feet below the sandstone beds which produced the recent gas show, but it is evident that the sandstones above and below the packer are not in communication.

N. L. Falcon

25.12.37.

A259/6941—C.5.35.

Copy

From RESIDENT GEOLOGIST, COUSLAND.

To A.I.O.C. RESEARCH STATTON, SUNBURY-ON-THAMES.

Our Ref. **Your Ref.** **Date** dec. 23rd. 1937.

Subject SANDSTONE CORE WITH OIL FROM COUSLAND.

We enclose a sample of the Sandstone with oil occurring in Cousland No.1 from 1248 - 1274 feet. It came from about 1262 feet.

London will send the usual formal request for examination in a few days time.

Sgd. N.L.Falcon.

D'Arcy Exploration Co. London (Mr. A.H. Tait).

A259/6941—C.5.35.

? 1248/58.
Cousland asked to confirm.
A.H.T.

Confirmed 27/12/37 VCH

Copy

From RESIDENT GEOLOGIST, COUSLAND. To A.I.O.Co. Ltd., RESEARCH STATION, SUNBURY-ON-THAMES.

Our Ref. Your Ref. Date 22nd December, 1937.

Subject SANDSTONE CORE WITH OIL FROM COUSLAND (1148'/58').

We have today sent you by parcel post, one sealed tin of Sandstone containing light oil. The Sandstone from which this sample was taken occurred between the depths of 1148 and 1158.

London will write you in a day or so on the nature of the examination required.

Only 4 feet of this Sandstone was recovered in the core, but evidence from the cuttings suggests that it is 10 feet thick.

N. L. Falcon.

c.c.-D.E.C. London - Mr.A.H.Taitt.

A251—C.A. 6.37.

Copy

From MR. A.H. TAITT. **To** SUNBURY via R. & T.

Our Ref. **Your Ref.** **Date** 22nd December, 1937.

Subject COUSLAND NO.1 SANDSTONE FROM 1194-1202 FT.

JOB NO.979.

A sample of the above was sent to Sunbury direct from Cousland by parcel post on 20th December.

Will you please arrange for an examination of this sample to be carried out. This examination should be along the same lines as that of the recent cores.

The zone containing this sandstone was tested and gas production of approximately 20,000 cubic feet per day (calculated) with an approximate maximum closed in pressure of 650 lbs.□" obtained.

(Sgd.) A.H. TAITT.

For result see Sunbury Report No. AP.S/41 G.787 dated 15/1/38 filed under section 1248/1279.

A259/6941—C.5.35.

D: Lees Clark
M: Mayhew.
Mr. Wyatt for ref

Copy

From RESIDENT GEOLOGIST, COUSLAND. **To** A.I.C.C. RESEARCH STATION, SUNBURY.

Our Ref. **Your Ref.** **Date** DEC. 20th. 1937.

Subject SANDSTONE WITH OILLFROM COUSLAND NO.1.

We have sent you by parcel post today one sealed tin containing a sample of the sandstone occurring from 1194-1202 feet Cousland No.1.

London will write you in a day or so on the nature of the examination required.

For your information this sandstone contains light oil which oozed a little when the core was first extracted. It smells strongly of kerosene on fresh fracture. When heated slightly it produces light oil resembling that from the cores between 922 and 955 feet already sent you.

Sgd. N.L.Falcon.

Copy to D.E.C London (Mr. A.H.Taitt)

A259/6941—C.5.35.

D: Lees
M: Jackson
M: Mayhew

Copy

From RESIDENT GEOLOGIST, COUSLAND. **To** A.I.O.C. RESEARCH STATION, SUNBURY-ON-THAMES.

Our Ref. **Your Ref.** **Date** DEC. 17th. 1937.

Subject SANDSTONE CORE CONTAINING LIGHT OIL.

We regret to hear that the samples of sandstone sent you on 10th. Dec. from the depths 931/32, 949/50 and 969/70 feet below surface, were found to contain no light oil on arrival.

A tin containing sandstone from 938/39 feet has been sent you by parcel post today, as a replacement. This is part of the same sandstone and definitely contained light oil when sealed up in the tin.

Sgd. N.L.Falcon.

Copy to D'Arcy Exploration Co. London (Mr. A.H.Taitt)

A251—C.A. 6.37.

Copy

From MR. A.H. TAITT. **To** SUNBURY VIA R. & T. BRANCH.

Our Ref. **Your Ref.** **Date** 17th December, 1937.

Subject SANDSTONE CORE FROM COUSLAND.

For result of examination see Report AP.S/41 Sun.Ref.G.787 dated 15/1/38. filed under section 124/79

Fragments of core from Cousland No.1 occurring from 1162 to 1165 ft. were sent direct to Sunbury by parcel post on 16th December.

Will you please arrange to have an examination of these fragments carried out along the lines detailed by Dr. Lees in a memo. of 10th December to Dr. Dunstan.

This work should be treated as urgent.

(Sgd.) A.H. TAITT.

A259/6941—C.5.35.

Mr Mayhew

~~These samples should be examined by the lines detailed in recent memo from Dr Lees to Dr Dunstan~~ A.x.T.

London

Sunbury requested to carry out examination A.x.T. 17/12.

Copy

From RESIDENT GEOLOGIST, COUSLAND.

To A.I.O.C. RESEARCH STATION, SUNBURY-ON-THAMES.

Our Ref.

Your Ref.

Date DEC. 16th. 1937.

Subject SANDSTONE CORE CONTAINING OIL.

Mr Jack file

We have today sent you by parcel post one tin containing representative samples of a sandstone from Cousland No.1 occurring from 1162 to 1165 feet below surface.

London will write to you in a day or so on the nature of the examination required.

For your information this sandstone smells of kerosene on fresh fracture. When heated in an oven it exudes a considerable amount of dark oil which quickly sets to wax on cooling.

Will you please return the empty tin to us.

N. L. Falcon

Copy to D'Arcy Exploration Co. London (Mr. Taitt).

A251—C.A. 6.37.

Copy

From MR. A.H. TAITT. **To** MR. N.L. FALCON, COUSLAND.

Our Ref. **Your Ref.** **Date** 13th December, 1937.

Subject EXAMINATION OF CORE SPECIMENS.

Attached is a copy of a memo. sent to Sunbury on the lines along which we wish to have the cores of oil soaked sandstone examined. You will note that we have requested them to pay particular attention to the lighter fractions of the oil removed by the solvent. In the previous examination these lighter fractions were evaporated off with the solvent, consequently the analysis obtained was that of the waxy residue only.

(Sgd) A.H. TAITT.

A251—C.A. 6.37.

Copy

From DR.G.M.LEES **To** DR.A.E.DUNSTAN

Our Ref. **Your Ref.** **Date** 10th DEC., 1937.

Subject SAMPLES OF OIL SAND FROM COUSLAND.

A sample of oil sand from the Cousland boring was despatched yesterday direct to Sunbury. Will you please instruct Sunbury that we wish from this sample the following information :-

1. Total porosity of sand.
2. Percentage of oil and percentage of water contained in the sand.
3. As complete an analysis of the oil content as possible, including the percentage of unsaturated hydrocarbons.
4. Analysis of the contained water insofar as this is possible.

It should be noted that the oil contains a light oil fraction and this should be differentiated from the Benzine used as a solvent for extracting the core.

(Sgd.) G.M.LEES.

A249/6931—C.10.36

Dr Leeds
Mr Mayhew.
Mr Jacks
file

Memorandum

From MR. N. L. FALCON, COUSLAND, DALKEITH. **To** MR. A. H. TAITT, LONDON.

Our Ref. **Your Ref.** **Date** 10th December, 1937.

Subject SANDSTONE CORE SPECIMENS CONTAINING OIL SENT TO SUNBURY.

I have today sent to Sunbury a box containing core samples from the following depths - 931/32, 949/50 and 969/70. These are fair representative specimens of the thick sandstone occurring from 922 to 991 which was recently unsuccessfully tested.

I have written Sunbury advising them that instructions on the nature of the examination required will be received from you.

After carefully reading Sunbury Report No. AP.S/39 dated 7/12/37 on the Cousland Oil Sand from 831/835 feet, I should like to say that the results seem to me of very little value. All they have done is to determine the nature of the waxy residue obtained when the lighter fractions have been removed. Useful information would be obtained if samples of the core were retorted at low temperatures, and the various fractions distilling over investigated before extracting the residue with carbon tetrachloride. The investigation of the waxy residue by extraction could accompany porosity determinations.

I agree BHM
N. L. Falcon.

This is covered in memo to Dr Duncan
A.H.T.

A250/6932—C.7.36

Mr Mayhew.
Will you please issue the necessary work requisition
Ans. file. 6in/Cou

Memorandum

From N L.FALCON, COUSLAND. **To** MR. A.H.TAITT, LONDON. Ans.

Our Ref. **Your Ref.** **Date** NOV. 23rd. 1937.

Subject OIL SAND CORE FROM COUSLAND NO.1, 831 to 835 feet.

I have today sent this core to Sunbury for chemical examination, in a box marked C /831/35. Will you please take the necessary steps.

Although the core is waxed up on the surface owing to evaporation of the lighter fractions, the oil inside should be in its original condition. The core has never been above 55°F. which cannot be many degrees above its temperature in situ.

I have retained one fragment of core which was heated in the oven and therefore is much more waxed up than the others.

analysis & certificate. N. L. Falcon

A251— A. 6.37.

Copy

From MR. A.H. TAITT **To** MR. FALCON, COUSLAND.

Our Ref. **Your Ref.** **Date** 23rd November, 1937.

Subject MEASUREMENT OF GAS PRODUCTION.

Attached is a copy of a note by Mr. Comins describing a method of measuring gas production.

(Sgd.) A.H. TAITT.

Mr Foulk Adv.

Copy for Mr Falcon Cousland.

22nd November, 1937.

MEASUREMENT OF POSSIBLE GAS PRODUCTION IN THE COUSLAND WELL.

In the absence of an open-end orifice meter or pitot tube, the most convenient method of measuring any gas production which may be obtained is by observing the static pressure drop along the gas-burning line between two points, say, 300 feet apart.

The static pressures should be measured with the same pressure gauge in order to eliminate gauge error. If the pressures are fluctuating, a number of readings should be taken at, say, 20 second intervals over a period of 5 minutes and the results averaged. If the fluctuations are too great, a smaller line may be laid. If the flowing pressures are too low to read by pressure gauge, a manometer may be connected to the pressure gauge connection instead and the pressures recorded in head of mercury or water.

The flowing temperatures of the gas in the line within a few feet of the points of pressure observation should also be observed, the thermometer being inserted either in a pocket in the line filled with water, or through a gland. The flowing temperature should also be observed near the open end of the line.

As the specific gravity of the gas enters into the calculation, two samples should be collected under pressure after blowing off the collecting container several times, and sent to Sunbury for examination.

A two-inch burning line should provide ample capacity for any gas productions that are likely to be encountered, and reduction to one-inch may be necessary in order to get steady flow.

A connection and valve for a one-inch line might therefore be left in the two-inch burning line at a point near the well.

A251—C.A. 6.37.

Copy

From MR. A.H. TAITT. **To** MR. N.L. FALCON, COUSLAND.

Our Ref. **Your Ref.** **Date** 4th November, 1937.

Subject OIL SHALE CORE.

Referring to your memo. of November 3rd on the above subject, all that is required is that you should keep a representative sample of the Oil Shale core.

(Sgd.) A.H. TAITT.

A250/6932—C.7.36

Memorandum

From MR. N.L.FALCON **To** MR. A.H.TAITT

Our Ref. **Your Ref.** **Date** NOV. 3rd. 1937

Subject OIL SHALE CORE.

Referring to our letter to Mr. H.R.J. Conacher dated 27th. October with copy to Mr. P.T. Cox, will you please confirm that there is no need to keep these cores here until Mr. Lepper has seen them. I am keeping in any case a representative specimen which he can see, but he might wish to see the complete core before it is retorted. I intended to write him directly but have lost his initials and address.

N. L. Falcon

COPY.

P. T. COX, ESQ., LONDON.

Mr Tait a/c.
" Engineer
" Jaffrey
file (6th Floor)

27th October, 1937.

H. R. J. Conacher, Esq.,
Messrs. Scottish Oils, Ltd.,
53, Bothwell Street,
GLASGOW.

Dear Mr. Conacher,

We have recently bored through 9 feet of Oil Shale at Cousland, from 617 to 626 feet below surface. At least four feet of this Shale seems from laboratory tests to be fairly high grade material, and it seems to me that the cores should be forwarded to Scottish Oils for examination. The Survey have not seen it yet but will have in a day or so. If you will please let me know where to send it I will arrange despatch by the first available transport.

It appears that this Shale is probably the equivalent of the Raeburn Shale, as it occurs immediately below a shell bed which the Survey considered to be the Raeburn Shell Bed.

Yours sincerely,

(Sgd.) N. L. Falcon.