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U.K. ONSHORE LICENCE PL177

EVALUATION OF THE REMAINING HYDROCARBON PROSPECTS

Exploration Dept.
LASMO
July 1985
Ref: JDCS/0033m

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1. 1.1 INTRODUCTION

The PL177 licence (Figure 1) was awarded in December 1980 to a three company consortium operated by London and Scottish Marine Oil PLC (LASMO), consisting of Christian Salvesen Limited and Candecca Resources PLC (now a subsidiary of Trafalgar House Petroleum PLC).

In an attempt to appraise the hydrocarbon potential of the licence area the Group has shot 55.3 km of seismic data, drilled eight shallow stratigraphic boreholes and drilled three exploration wells.

The above activities adequately fulfilled the work obligation for the PL177 licence and in accordance with the expiry of the first term of the licence in November 1984 the Group relinquished fifty percent of the original acreage.

This report outlines the hydrocarbon geology of the licence and includes evaluations of the remaining prospects and leads and also of the remaining potential of the Cousland and Midlothian fields.

1.2 SUMMARY

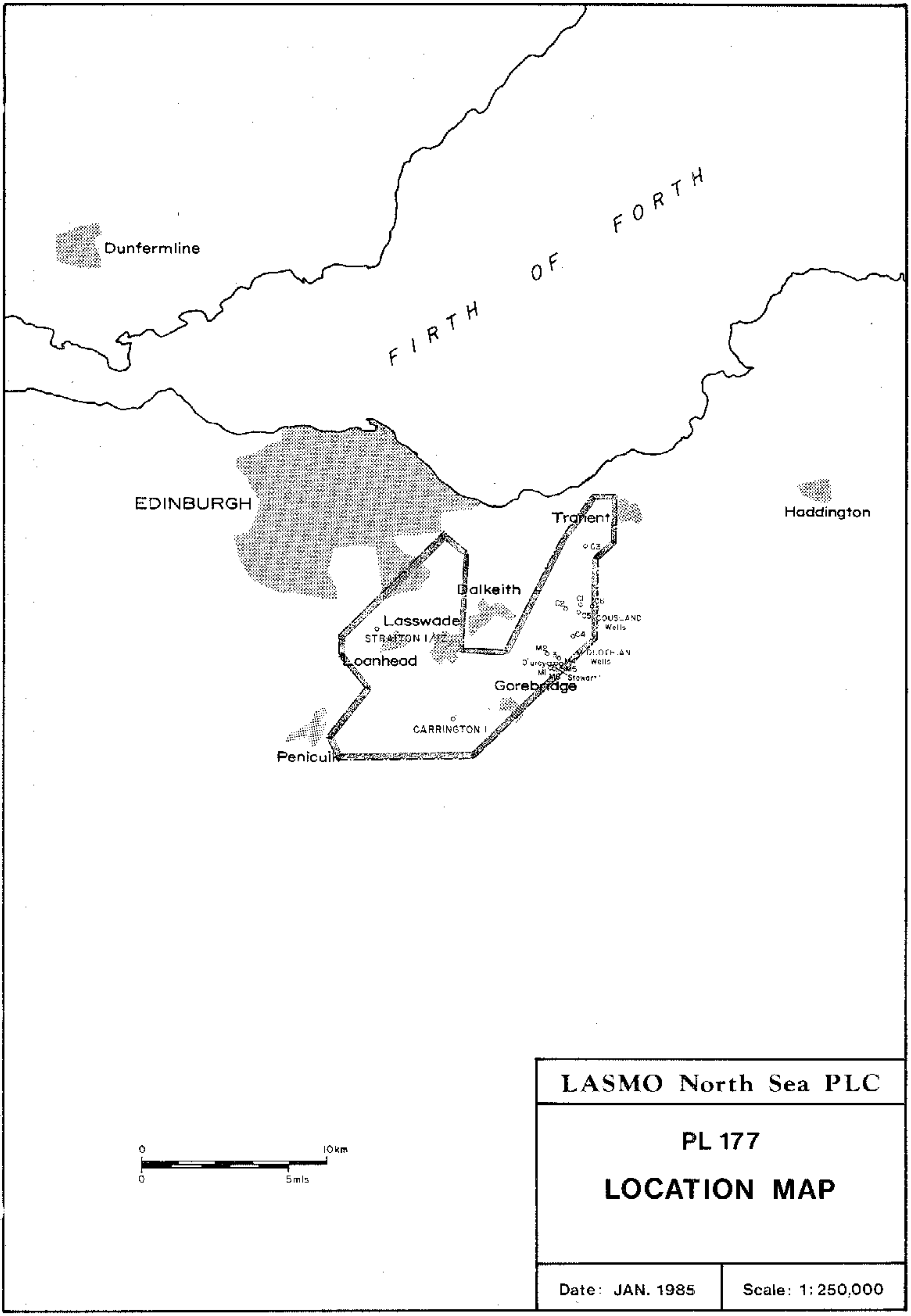
The PL177 licence encloses a region which has proven hydrocarbon potential and indeed both oil and gas have been successfully produced, from the Midlothian and Cousland fields respectively, although on a relatively small scale.

The reservoir rocks of the region are the sandstones of the Upper and Lower Oil Shale Groups of Lower Carboniferous, Dinantian age. These sands are generally thin (less than 30') exhibiting poor to fair reservoir qualities. The source rocks are the interbedded coals and organic shales of the Oil Shale Groups which are interbedded with the sandstone units and thus in situ hydrocarbon generation is envisaged.

The type of crude recovered from the area is generally light but extremely paraffinitic and waxy. Problems thus arise regarding oil mobility since a relatively high pour point temperature inhibits hydrocarbon mobility in shallow reservoirs.

The Cousland gas and Midlothian oil fields produced 221 MMCFG and 30,654 BBL oil respectively prior to the cessation of production in both fields in 1965. Neither accumulation is thought to contain enough remaining reserves to be of commercial interest at the present time.

The PL177 licence still has a number of prospects and leads which remain untested.



LASMO North Sea PLC

PL 177

LOCATION MAP

Date: JAN. 1985

Scale: 1: 250,000

Fig.1

The most attractive feature is the Polton Prospect lying in the western part of the licence. This NNE-SSW trending anticline represents the largest and most well defined structure. The reservoir sands at this location are thought to be buried deeply enough to overcome the oil mobility problem and the recoverable reserves of the prospect range between 2 and 3.4 MMSTB on the basis of mapped closures within the Westphalian Coal Measures.

The remaining leads in the licence are located near the axis of the Cousland Anticline. These are observed either as small fault bounded dip closures along the NE-SW trending Crossgatehall Fault, or small plunging dip closures truncated against faults associated with the Cousland Anticline. None of these leads are thought to represent a commercial drilling prospect.

2. EXPLORATION HISTORY OF THE MIDLOTHIAN BASIN

Hydrocarbon exploration in the Midlothian region commenced with the drilling of the D'Arcy Borehole in 1919 on the Midlothian culumination of the Cousland Anticline (Figure 2 and Enclosure 1). A further twelve wells were drilled on the anticline, six by The Anglo-Iranian Oil Company (now B.P.) and six by the Anglo- American Oil Company (now Esso) prior to 1960. All hydrocarbon production from the region ended in 1965 when the Cousland No. 1 gas producer was shut in (the well was finally plugged and abandoned in 1974), and the Midlothian (Dalkeith) Oil Field ceased production having produced a total of 30,654 barrels of oil since 1939.

In December 1975 the Exploration Licence XL048 (Figure 3) was awarded to Oil Exploration Holdings Limited (Oil Ex.) and during the first quarter of 1977 S.S.L. shot 35 km of seismic data over the Cousland Anticline.

In July 1979 Oil Ex. announced the application for a Production Licence covering 250 km^2 of the western portion of XL048, and the formation of a consortium consisting of Oil Ex. (50%), Christian Salvesen Limited (25%) and Candecca Resources Limited (25%). In November 1979, Oil Ex. merged with LASMO and in November 1980 the LASMO operated Group was awarded the PL177 licence with a work obligation of 3 wells. The remainder of XL048 was retained for further exploration work until 1st December 1981.

The Group spudded the Stewart No. 1 well on 11th July 1981 on the Midlothian culmination of the Cousland Anticline. The well was plugged and abandoned with oil shows, having tested only water, on 12th August 1981. Well summaries of the exploration wells are contained in Appendix 1

During April and May 1982, C.G.G. shot 55.3 km of 48 fold coverage vibroseis seismic data in the licence and an experimental high resolution line. The latter was shot over the Cousland anticline through the Stewart No. 1 well location. The conventional seismic is of poor quality and of little assistance for prospect definition and evaluation. Conversely the high resolution line does resolve sub-surface features to an acceptable standard (see section 4.2.2. Figure 7).

In January and February 1984 a series of eight stratigraphic boreholes were drilled to establish the existence and indicate the areal extent of closure on the southwestern end of the Straiton Anticline. Six months later, on the 9th August, Straiton No. 1 was spudded on a local culmination of the anticline.

The well was plugged and abandoned with oil shows on 24th September. Technical difficulties necessitated a sidetrack and subsequent premature abandonment of the hole.

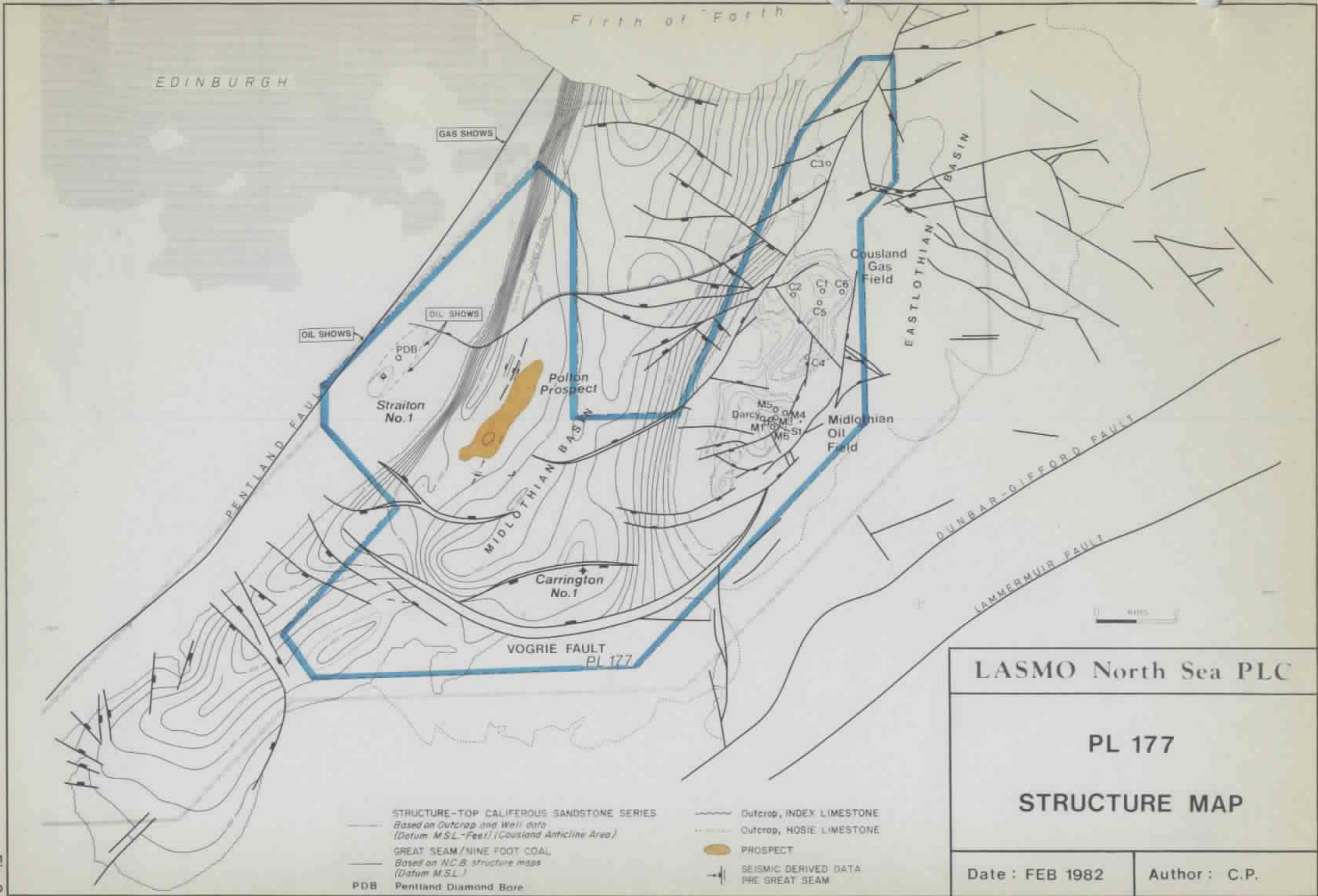
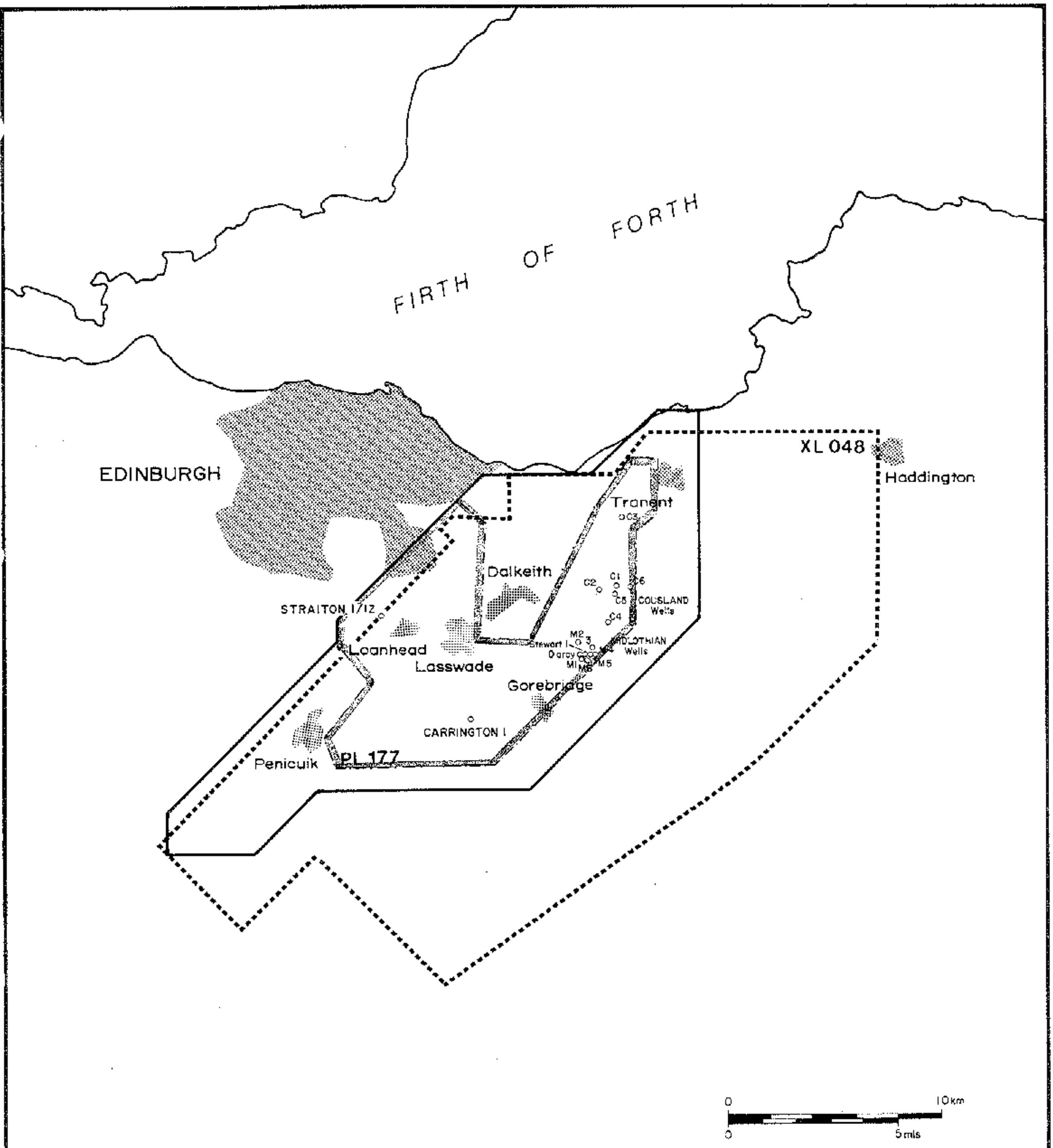

Firth of Forth
EDINBURGH
GAS SHOWS
OIL SHOWS
OIL SHOWS
PDB
Straiton No. 1
Pollon Prospect
MIDLOTHIAN BASIN
PENTLAND FAULT
Carrington No. 1
VOGRIE FAULT
PL 177
C3
C2
C1
C6
C5
C4
Cousland Gas Field
EASTLOTHIAN BASIN
M5
M4
Darcy
M1
M6
S1
Midlothian Oil Field
DUNBAR-GIFFORD FAULT
LAMMERMUIR FAULT
STRUCTURE-TOP CALIFEROUS SANDSTONE SERIES
Based on Outcrop and Well data
(Datum M.S.L.-Feet) (Cousland Anticline Area)
GREAT SEAM/NINE FOOT COAL
Based on N.C.B. structure maps
(Datum M.S.L.)
PDB Pentland Diamond Bore
Outcrop, INDEX LIMESTONE
Outcrop, HOSIE LIMESTONE
PROSPECT
SEISMIC DERIVED DATA PRE GREAT SEAM
LASMO North Sea PLC
PL 177
STRUCTURE MAP
Date : FEB 1982
Author : C.P.

Fig. 2



Exploration Licence XL 048:
Awarded 2nd December 1975
Expired 1st December 1981

Production Licence PL 177:
Awarded 18th November 1981

PL 177 Relinquishment Pattern:
17th November 1984

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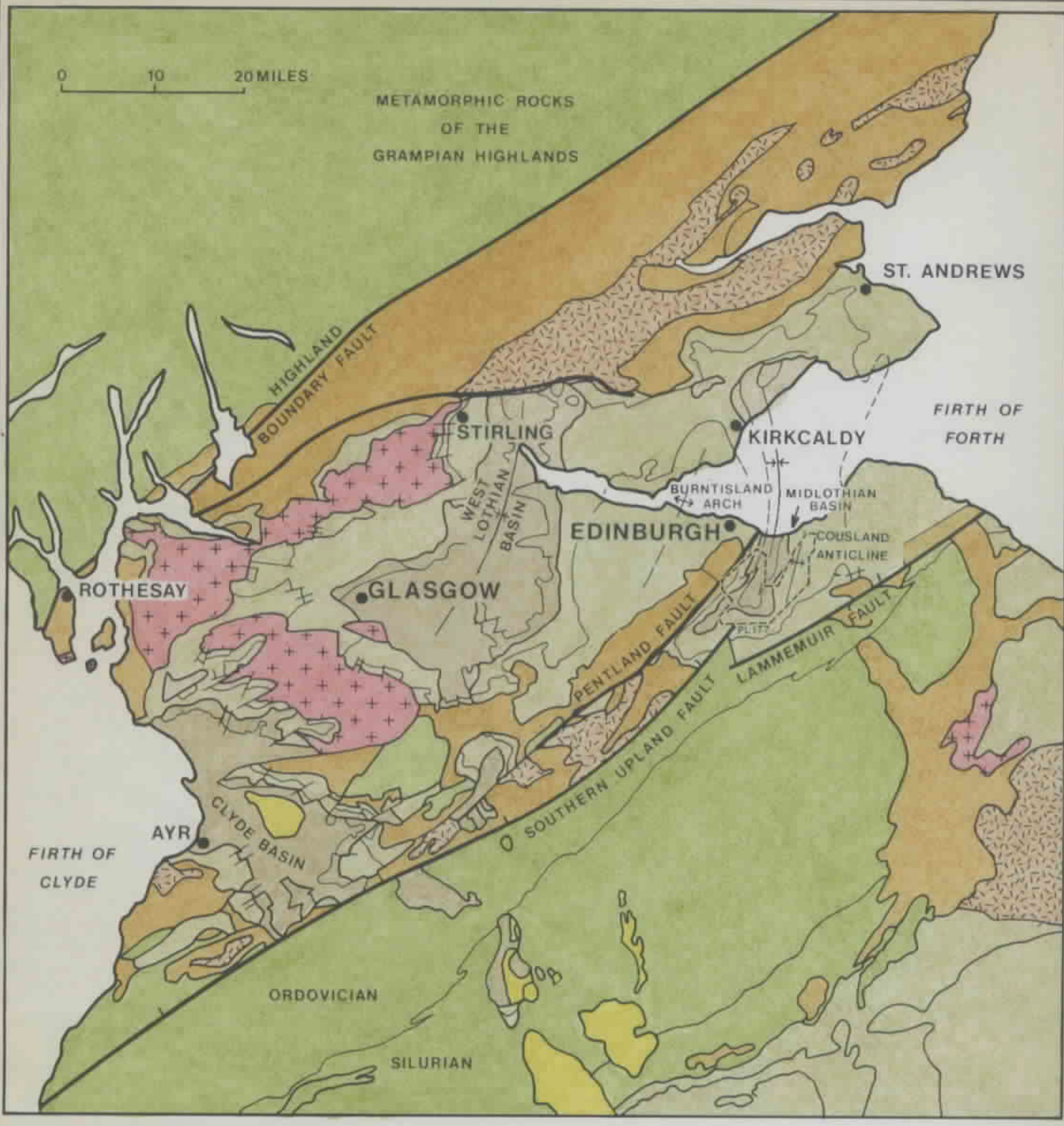
LICENCE HISTORY OF THE MIDLOTHIAN BASIN

Date: JUNE 1985 | Scale: 1:250,000

Fig. 3

Immediately following the Straiton well, Carrington No. 1 was spudded on 30 September 1984. The well was located on a fault bounded, dip closed structure, defined by subsurface NCB mapping, at the southern end of the Midlothian syncline. The well was extensively drill stem tested with one interval producing very limited quantities of light but waxy crude. The well was plugged and abandoned on 24 November 1984 and designated an oil well.

The Group, upon expiry of the first term of the PL177 licence, relinquished 50% of the original PL177 licence area on 17 November 1984. A listing of the coordinates bounding the retained portion of the licence is given in Appendix 4.



CARBONIFEROUS LAVAS

OLD RED SANDSTONE LAVAS

NEW RED SANDSTONE

COAL MEASURES & PASSAGE GROUP

CARBONIFEROUS LIMESTONE SERIES & CALCIFEROUS SANDSTONE MEASURES

OLD RED SANDSTONE

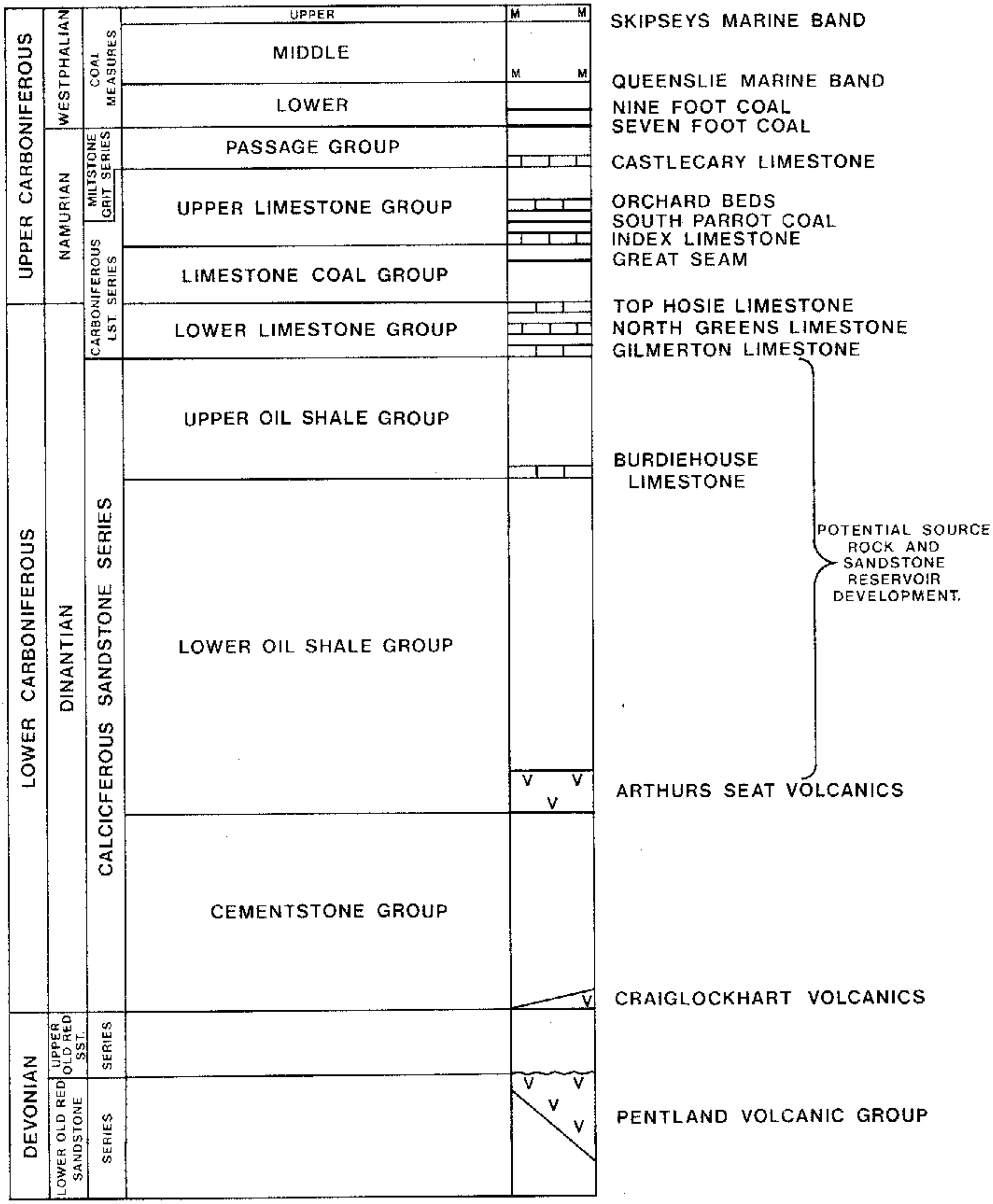
LOWER PALAEOZOIC ROCKS (MAINLY)

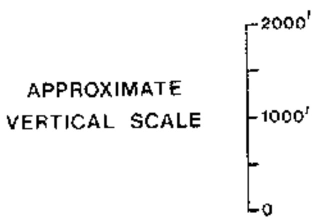
LASMO North Sea PLC

SIMPLIFIED SOLID GEOLOGICAL MAP OF THE MIDLAND VALLEY GRABEN

Date: JUNE 1985 | Author: JDCS/BGS

Fig.4





LASMO North Sea PLC

PL 177

GENERALISED SECTION

MIDLOTHIAN BASIN

After G.Y. Craig 1965.

Date : JAN 1985	Author : J.D.C.S.

Fig.5

Sedimentation in the Midlothian Basin throughout the Carboniferous was cyclical in character and reflected the interplay of eustatic sea level changes and regressive episodes of deltaic sand input. Whilst lacustrine and lagoonal environments characterised the early Carboniferous, marine incursions were more widespread and frequent during Lower and Upper Limestone Group times. Deltaic, alluvial and terrestrial environments were more important and characteristic of the Limestone Coal Group, Millstone Grit and Coal Measures respectively.

The influence of rejuvenated Caledonian Basement structures on sedimentation did not extend into Upper Carboniferous times. Thickness variations within the Productive Coal Measures of the Graben appear to have been caused by broad east-west anticlinal flexuring across the Midland Valley in response to early Hercynian compression. Caledonian lines of weakness were of considerable importance in controlling the orientation of the main end-Carboniferous Hercynian earth movements however. North northeast trending fold axes are developed throughout the eastern and central parts of the Midland Valley, as exemplified by the Cousland Anticlinorium and Midlothian Synclinorium in the Midlothian Basin and the Pentland Anticlinal uplift to the west of PL177.

Much of the Hercynian faulting in the Midlothian Basin post-dates folding. However, the predominantly east-west trends which characterise the central Midland Valley are less strongly represented in the Midlothian area. The major arcuate fractures of the Basin, the Vogrie, Crossgatehall and Sherrifhall Faults, are complex dislocations which show evidence of intra-Carboniferous growth faulting and Early Permian strike-slip displacement in addition to significant late-Carboniferous normal movement. The Pentland Fault in the west of the PL177 licence may have experienced significant strike-slip displacement in response to north-south compression during the Middle and Late Hercynian.

One of the final events of the Hercynian Orogeny was extensive Early Permian intrusive and extrusive igneous activity. In the Midlothian Basin this takes the form of a number of east-west trending dykes, which provide evidence of a regional north-south tensional regime existing at this time. This may have been coincident with the initiation of a Permo-Triassic Basin within the Midland Valley. The thickness of this basin and the extent of later burial cannot be estimated since Tertiary (probably Miocene) uplift and erosion has removed all post-Carboniferous rocks from the region.

3.2. Source Rocks

The presence of reservoired gas and oil in the Cousland and Midlothian prospects of the Cousland Anticline, and the occurrence of a number of oil and gas seeps further to the west of the PL177 licence, associated with the Pentland Fault, are evidence of the generative potential and maturity of source rocks within the Carboniferous of the Midlothian Basin.

The Lower and Upper Oil Shale Groups of the Lower Carboniferous are the most likely intervals to have sourced these hydrocarbons. Three distinct organic facies are developed:

(i) Algal sapropel associated with freshwater-to-brackish lagoonal shales. Geochemically a Type-1 Kerogen, oil-prone and yielding a high wax crude. Volumetrically more significant in the Upper Oil Shale Group, and best developed in the west of PL177, and in the West Lothian oil shale fields as the classic 'Oil Shales' or Torbanites, where the Total Organic Carbon content can reach 25%.

(ii) Mixed oil and gas prone kerogen associated with marine shales. Volumetrically more important towards the eastern margins of the Licence area.

(iii) Gas-Prone coals and habaceous material developed in delta-top and swamp environments. Volumetrically less significant than (i) or (ii) and of questionable maturity as a gas source, even in the deepest parts of the Midlothian Basin.

Vitrinite reflectance and spore colouration analysis on cores from Straiton No.1 indicate that the shales were at some stage, probably during the Carboniferous, buried deeply enough to achieve a maturity level commensurate with peak oil generation. Subsequent uplift has, however, cooled the shales to a point where present day generation is negligible. Indeed it is thought unlikely that hydrocarbons are being generated anywhere within the Midlothian Basin at the present time.

Hydrocarbon generation may have recommenced after Hercynian uplift although the extent of post-Carboniferous burial of the Midland Valley is uncertain.

All of the wells drilled by the LASMO Group, as well as some of the earlier wells, recovered quantities of crude oil upon which geochemical analysis was performed.

The general results of these studies are that the crude, while quite light (30-40° API), has a very high paraffin and wax content ranging from 25% in Cousland No. 1 to a maximum of 57% in one sample from Straiton No. 1. Water flushing of the reservoir sands in all three wells drilled by the Group has occurred and this may result in a partitioning of the crude by removing the lighter ends. Certainly the high wax content of 57% from Straiton No. 1 well was in part due to this. A second sample analysed from this well was from a very tight sand which had retained the light ends, and the crude in this case had a lower wax content of 38%.

The high wax content of the crude means that it will have a high pour point temperature. The exact value of this temperature will vary with the wax content and hence the amount of water washing of the reservoir, but values recorded range from 60° to 95°F.

From the above it is clear that an oil mobility problem will exist within reservoirs at shallow depths where the crude will be very viscous or might even be frozen. This is probably the reason for the very low production rates achieved in the PL177 licence to date.

It is likely that reservoirs which occur at depths greater than those already drilled would not suffer from an oil mobility problem to such an extent, since reservoir temperatures increase with depth. Also, partitioning of the crude by water washing is less likely to occur in deeper parts of the basin.

3.3 Reservoir Rocks

The main reservoir objectives throughout the Midlothian Basin are sands of the Lower Carboniferous Calciferous Sandstone Series, which is sub-divided into the Upper and Lower Oil Shale Groups (Figure 5). The depositional environment of the sands appears to have been deltaic, with the main sediment input originating in the Fife area, northwest of the PL177 licence, where the interval is considerably thicker and more sand-prone.

Sedimentological studies carried out on core material from Stewart No.1 over this interval indicate that the sands were deposited in a wave dominated, delta-like environment and have undergone a high degree of shallow marine and nearshore reworking. It also suggests that the sands at this location were deposited in bodies parallel to the shoreline. It was not determined however, whether these sand bodies would be laterally extensive or be restricted and isolated bars. The lack of facies variations within the cores analysed indicates that the shoreline environment was relatively static but constantly varying between sand and mud-dominated depositional phases. The probability of vertical sand-body connectivity is thus likely to be poor.

The correlation between Carrington No. 1 and Stewart No. 1, especially in the Upper Oil Shale Group, does however indicate that individual shale units may be quite laterally extensive. However, this does not imply that the sands would also be laterally extensive. It is thought that the sand units seen in Stewart No. 1 and Carrington No. 1 represent separate sand bodies with an abandonment shale facies developed between them. It is these shales that make the correlation between the two wells possible. The well correlation of the Lower Oil Shale Group is shown in Enclosure 5.

From petrographic analysis of core material the sands appear to consist of quartz arenites although lithic, calcareous and sideritic arenites also occur. The diagenetic history of the sands generally followed the sequence of quartz cementation, kaolinite authigenesis, formation of late diagenetic carbonates and late authigenesis of pyrite. The observed variations in poroperm charateristics within different sand intervals is mainly due to the extent of the development of carbonate cementation and the development of flow restrictive kaolinite and other clays.

Analysis of well data indicates that generally the individual sand units are between 10' and 30' thick with net-to-gross ratios averaging 0.40 in the Upper Oil Shale Group and 0.22 in the Lower Oil Shale Group.

Reservoir quality of the sands in Stewart No.1 was generally fair to good. Core analysis of the Lower Oil Shales sands gave average porosities of 11 to 18% and horizontal permeabilities in the range 50 to 350 md. The sands cored in the Straiton No.1 well had similar porosities but there was a reduction of permeability which was caused by increased cementation of the sands at this location. The result of the cored interval in the Carrington No.1 can be ignored since the cored interval does not represent a true reservoir unit. Notwithstanding the fact that apparently better, uncored sand units exist in both the Straiton and Carrington wells, log analysis still suggests that there is a slight reduction in reservoir quality when compared to the wells located on the Cousland Anticline. This does not however, preclude the fact that good quality reservoir sands may exist in the Upper and Lower Oil Shale Groups in the west of the licence, especially in the deeper and untested parts of the basin.

It is worth noting at this point that the Cousland No. 1 well is the type well in respect to the sand body nomenclature for the Midlothian Basin used in this report i.e. the 1000', 1248', 1582' and 1720' sands occur at these depths in this well.

3.4 Structure and Trapping Mechanisms

The complex structural evolution of the Midlothian Basin has resulted in the development of a number of potential and proven trapping styles within the PL177 licence area and these are:

i) Regionally developed northeasterly trending 'palaeoswells'. Examples are the Burntisland Arch in Fifeshire, the Cousland Anticline in Midlothian and the Bathgate Axis in West Lothian. These may have originated as Mid-Devonian highs, which were reactivated as stable hinge lines in Dinantian times and over which sediments were attenuated with respect to basinal areas. Progressive anticlinal drape, together with contemporaneous faulting within the Calciferous Sandstone Series in the axial regions of the highs may have provided traps for early generated hydrocarbons prior to Hercynian uplift and folding.

ii) Small scale northeasterly trending rollovers developed on the flanks of the Midlothian structural syncline, as exemplified by the Polton and Carrington prospects. It is unlikely that they represent subsidiary Hercynian corrugations on the flanks of the main folds, since:-

(a) the amplitude of these features increase with depth, suggesting drape over a palaeohigh;

(b) they are isolated features on either side of the Midlothian Basin rather than members of an harmonic fold set, as is seen in the folding of the West Lothian Shale Field in the Upper Oil Shale Group.

Intra-Carboniferous tensional faulting - during Lower Oil Shale Group and/or Lower Limestone Group times - is probably responsible for the development of these features. They thus constitute simple anticlinal rollovers at shallow depths, but become potentially larger, fault bounded reservoirs at objective depth.

iii) Hercynian features. These fall into three categories:-

(a) Major anticlinal fold axes which coincide with Dinantian depositional axes. Examples are the Burntisland Arch in Fifeshire, and the Cousland Anticline in PL177. In the latter case, the productive Cousland and Midlothian structures are associated with local culminations developed along the crest of the major fold axes. There is some evidence to suggest that the en echelon offset between these culminations may be related to transcurrent faulting, since a number of strike-slip faults are present on the anticline.

(b) Flexures with no obvious Pre-Hercynian progenitors, which are developed along the Western margin of PL177. These folds, of which the Straiton Anticline is the best example, are unaffected by significant cross faulting, although geometric accommodation faults are likely within the core of the anticline. These folds, too, show an en echelon offset, and may reflect a transpressive, rather than purely compressive origin.

(c) Tilted fault blocks. These are best developed to the east of the Cousland Anticline, on the margins of the East Lothian Basin, eg along the Sherrifhall Fault. Here, the Carboniferous succession is much thinner compared with the Midlothian area, and the correspondingly greater influence of basement rigidity has precluded the development of high frequency, high amplitude folds. A series of eastnortheast trending normal Hercynian faults cut gently dipping Lower Limestone Group strata.

4. THE REMAINING POTENTIAL OF THE COUSLAND AND MIDLOTHIAN FIELDS

4.1. Introduction

The Cousland Gas field and the Midlothian Oil field are located on separate culminations of the Cousland Anticline which lies in the eastern part of the PL177 licence (Figure 2). The Cousland field lies to the north of the Midlothian field. The two structures have had a total of 12 wells drilled on them, 10 of which were drilled as appraisal wells to the initial discoveries. Both of the fields were developed with one producing well, these being wells Cousland No.1 and Midlothian No.1. Production from both accumulations was from the sandstones within the Lower Oil Shale Group, although different horizons flowed in each field.

The Midlothian field ceased production in 1965 after a total of 30,654 bbl oil had been recovered during a 28 year period. The Cousland No.1 well also ceased production in 1965, although it was not plugged and abandoned until 1972. The total cumulative production during a continuous 7 year flow period from this well was 221 MMCFG.

Discussions of the geological situation and exploration and production history of each of the fields follows. Any potential for future production that either of the two fields may have is also given below, on the basis of the remaining recoverable reserves. These have been calculated volumetrically, based on mapping of the 1977 seismic data, and in the case of Cousland by calculations based on the relationship that exists between cumulative production and pressure decline. It must be stressed that the reserves figures based on the 1977 seismic data are extremely tentative since the quality of the data is so poor.

The surface structure, well locations and seismic base over the Cousland Anticline is shown in Enclosure 1. Enclosures 3 and 4 show the structure at the 1248' and 1592' sand horizons respectively as derived from the 1977 data.

Appendix 2 contains well summary sheets for all the Cousland and Midlothian wells outlining the stratigraphy and listing all available test and petrophysical data.

4.2. The Midlothian (Dalkeith) Oil Field

4.2.1. Geology

The Midlothian Oil Field is located on a southern culmination of the Cousland Anticline. On surface geology (Figure 6) the structure is expressed as a fault controlled dome which exhibits a small degree of rollover before closing against a fault in the southeast. Closure at reservoir depth is achieved against this fault in the southeast and by dip elsewhere.

4.2.2 Exploration History

The structure has been appraised by eight exploration wells, three of which (D'Arcy, Midlothian 1 and 3) flowed limited quantities of oil on test.

The structure was first tested by the D'Arcy borehole which was spudded in 1919 approximately 1/4 mile to the northeast of the southeasterly bounding fault of the structure. The well was completed with an 8" casing run to 1746' MD and a 6" perforated liner which was landed at 1820' MD. Oil rose in the casing to a height of 320 feet. The quantity of oil was not enough to prevent bailing from lasting only a few hours a day however. During the 56 day testing period 53 bbl of oil were recovered. The well was abandoned as an oil well in 1922.

The Anglo American Oil Company spudded the Midlothian No. 1 well in 1937, just updip and southeast of the D'Arcy borehole. The well encountered an oil bearing sand between 1730'-1760' RKB (the 1248' sand equivalent) and from it 5 BOPD were recovered on test. The Midlothian No. 1 well produced gas on test at a rate of 1.4 MMCFGPD from an interval straddling the 1582' sand, which was waterbearing in Stewart No. 1. The 1720' sand also flowed at a rate of 300 MCFGPD on test. The structural position of this sand is thought to be analogous to that of the 1720' sand in the Cousland No. 1 well which had very high dips and suffered severe drawdown on test. In 1939 the well was re-completed over the 1248' sand interval and placed on production.

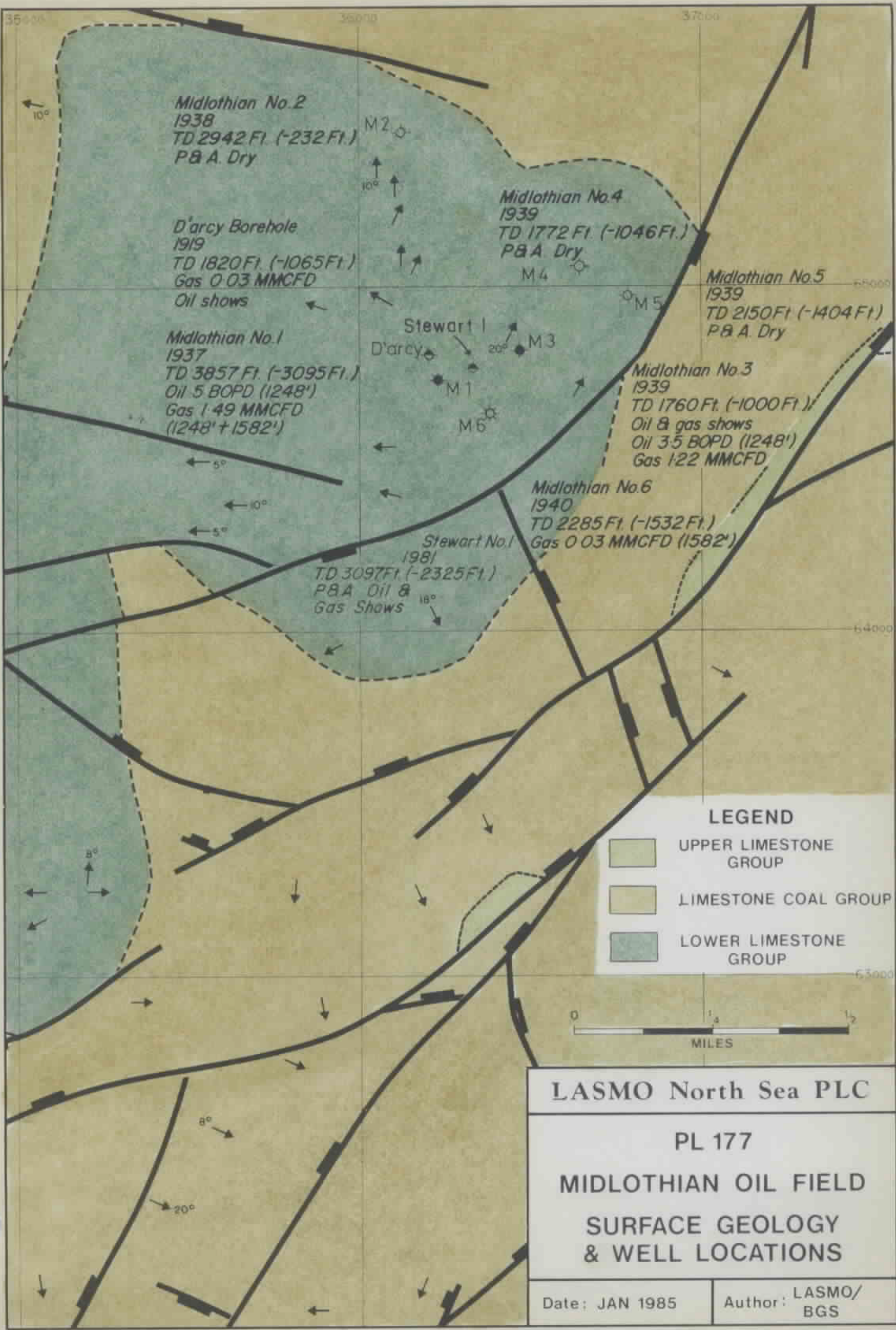

Midlothian No.2
1938
TD 2942 Ft. (-232 Ft.)
P& A. Dry
M2
D'arcy Borehole
1919
TD 1820 Ft. (-1065 Ft.)
Gas 0·03 MMCFD
Oil shows
Midlothian No.4
1939
TD 1772 Ft. (-1046 Ft.)
P& A. Dry
M4
Midlothian No.5
1939
TD 2150 Ft. (-1404 Ft.)
P& A. Dry
M5
Stewart I
D'arcy
M3
M1
M6
Midlothian No.1
1937
TD 3857 Ft. (-3095 Ft.)
Oil 5 BOPD (1248')
Gas 1·49 MMCFD
(1248' + 1582')
Midlothian No.3
1939
TD 1760 Ft. (-1000 Ft.)
Oil & gas shows
Oil 3·5 BOPD (1248')
Gas 1·22 MMCFD
Midlothian No.6
1940
TD 2285 Ft. (-1532 Ft.)
Gas 0·03 MMCFD (1582')
Stewart No.1
1981
T.D. 3097 Ft. (-2325 Ft.)
P&A Oil & Gas Shows
LEGEND
UPPER LIMESTONE GROUP
LIMESTONE COAL GROUP
LOWER LIMESTONE GROUP
0
1/4
1/2
MILES
LASMO North Sea PLC
PL 177
MIDLOTHIAN OIL FIELD
SURFACE GEOLOGY & WELL LOCATIONS
Date: JAN 1985
Author: LASMO/ BGS

Fig.6

Within the next three years a further four wells were drilled to appraise the structure. The Midlothian No. 2 well was drilled 1/2 mile to the northnorthwest, down dip from the No. 1 well, and found the 1248' sand water bearing although oil shows were encountered in sands lower down in the section. However, they did not flow on test. The Midlothian No. 3 well was a rather less adventurous stepout located about 300 yards along strike to the northeast of the No. 1 well. The well proved the 1248' sand to be oil bearing at this location and during a test period thought to have lasted for several days, the well flowed at a rate of 3.5 BOPD. The Midlothian 4 and 5 wells were located about 600 yards downdip from the No. 3 well, to the northeast and eastnortheast respectively. Both wells found the 1248' sand oil saturated but on test the sands did not flow, although a little gas was recovered from a lower horizon in the No. 4 well.

In 1945 the sixth and final well to be drilled on the structure during this period of exploration, was spudded. The Midlothian No. 6 well was located 300 yards to the southeast and updip from Midlothian No. 1. The well encountered an oil bearing 1248' sand which was tight. This is thought to be because the well was located too close to the thrust zone where the sands had lost their reservoir quality. The sands in Midlothian No. 5 are thought to have been similarly affected.

Although appraisal drilling on the structure ceased, Midlothian No. 1 continued production until 1965 when it was plugged and abandoned. During this period, 30,645 bbl of light but waxy crude were recovered. It is notable that during the last 5 years of production the flow rate decreased from 47 to 15 barrels a month. This may indicate a depletion of both the reservoir fluids and reservoir pressure. The extent of increased water production, if any, is not known.

There is evidence to indicate that water washing of shallow reservoirs has occurred within the Midlothian Basin, resulting in the removal of the kerosene and gasoil lightends. This may have resulted in an increase in the bulk wax content of the remaining crude. The low production rates achieved may thus also be due to the resultant highly viscous nature of the "residual" crude.

In August 1981, the LASMO Group spudded Stewart No. 1 some 90 yards to the northeast of the Midlothian No. 1 well location. The well was designed to test the full Carboniferous succession and to assess the possibility of increasing production from the reservoir sands by stimulation or other means. Unfortunately, it appears that the well encountered the 1248' and 1582' sands down thrown in a small graben feature as seen from the high resolution seismic line LV-82-07 (Figure.7) which passes through the well. Although shows were encountered the sands did not flow on test. Pressure data analysis indicated that with the exception of the 1248' and 1000', sands, all sands had near hydrostatic pressures. The 1248' and 1000' sands showed pressure depletion of approximately 100 psi. Production from the Midlothian No. 1 well is thought to be responsible for this.

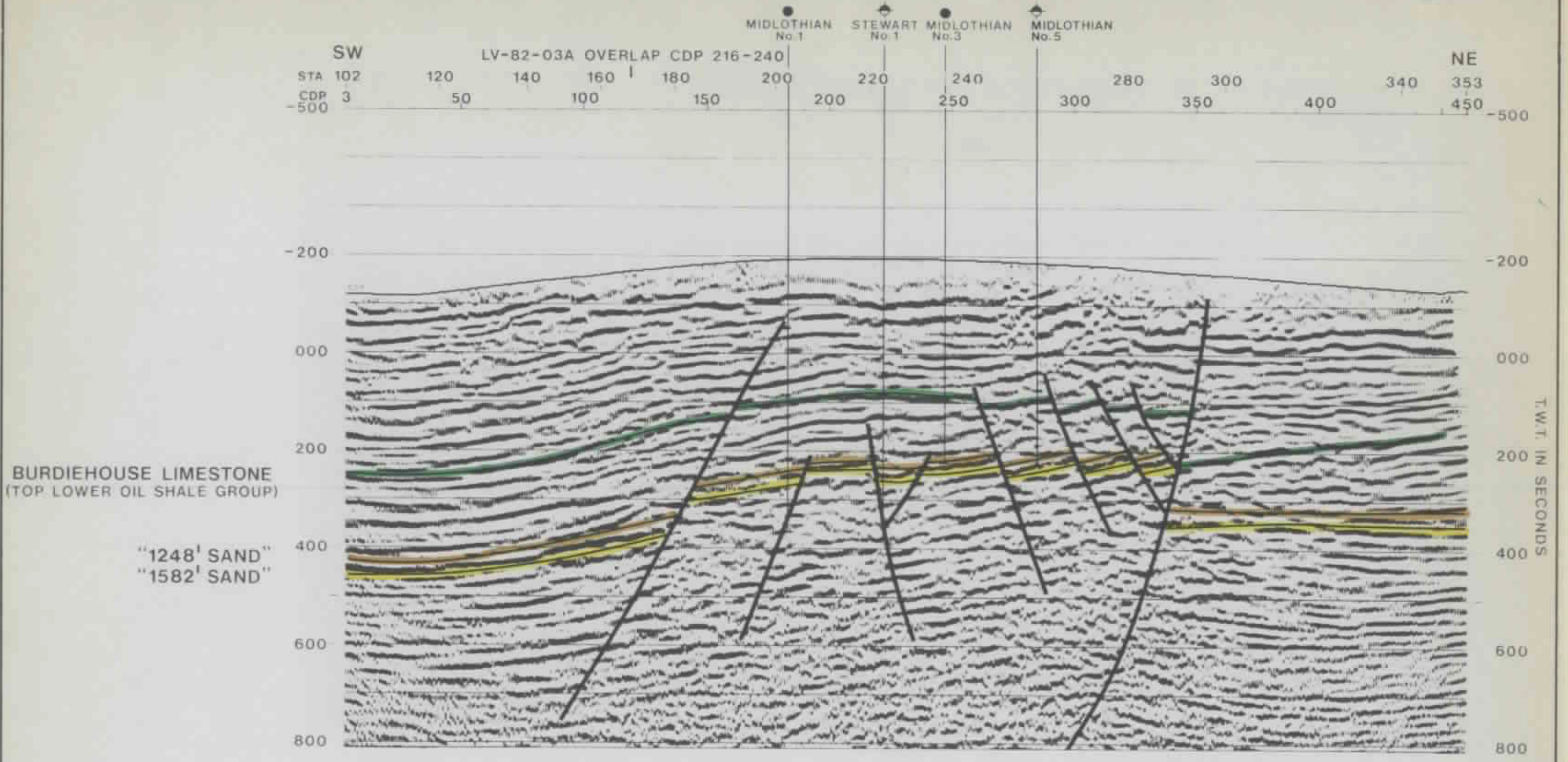
4.2.3 Reserves

It is not possible to assign reserves to the Midlothian Field by using seismic data from the LV-82 survey since only one line, LV-82-07, cuts the structure. The only other seismic data available is from the Oil Exploration Holdings Limited 1977 survey and this has been used. It must also be stressed that the reserves figures below are very optimistic since the results of Stewart No. 1 have had to be effectively ignored. The 1977 survey does not have the penetration to resolve the minor faults seen on line LV-82-07.

The 1248' sand depth map (Enclosure 3), interpreted from the 1977 data, shows the area of closure of the Midlothian field. This is defined by the O.W.C. at -1070'ss just below the producing horizon in the D'Arcy No. 1 well, and the limits of an assumed permeability barrier created within sands located near the thrust zone. Both sands in the Midlothian No. 5 and 6 wells are thought to have been affected. It will be noted that the Midlothian No. 4 well lies within the area of closure, although the sands it encountered did not flow. The well is updip from D'Arcy No. 1 and it is possible that the well did not flow because of poor completion techniques and inadequate test durations. (NB. It was seen from the Carrington No. 1 well that the formation may require several hours to reach equilibrium and flow, especially if there has been skin damage).

The area of closure and the reservoir parameters with which the oil in place figure was calculated are listed below:-

Area of Closure	:	58.4 acres
Net Pay	:	30', (an average for the 1248' sand from the Midlothian 1, 3, 4 and 5 wells).
Bulk rock volume	:	1750 acre feet.
Porosity	:	15% (Midlothian No. 3)
S_W	:	50% (assumed)



LASMO North Sea PLC

PL 177
MIDLOTHIAN OIL FIELD
HIGH RESOLUTION
LINE LV-82-07
MIGRATED SECTION

Date: DEC. 1982	Author: LASMO

Fig.7

F.V.F. : 1.1

O.I.P. 1248' sand : 925,670 BBLS

If a 10% recovery factor is assumed then:

Reserves 1248' sand : 92,567 BBLS.

Deducting the cumulative production to date then:

Remaining reserves in 1248' sands : 61,913 BBLS (ignoring Stewart No. 1 results)

4.2.4 Conclusion

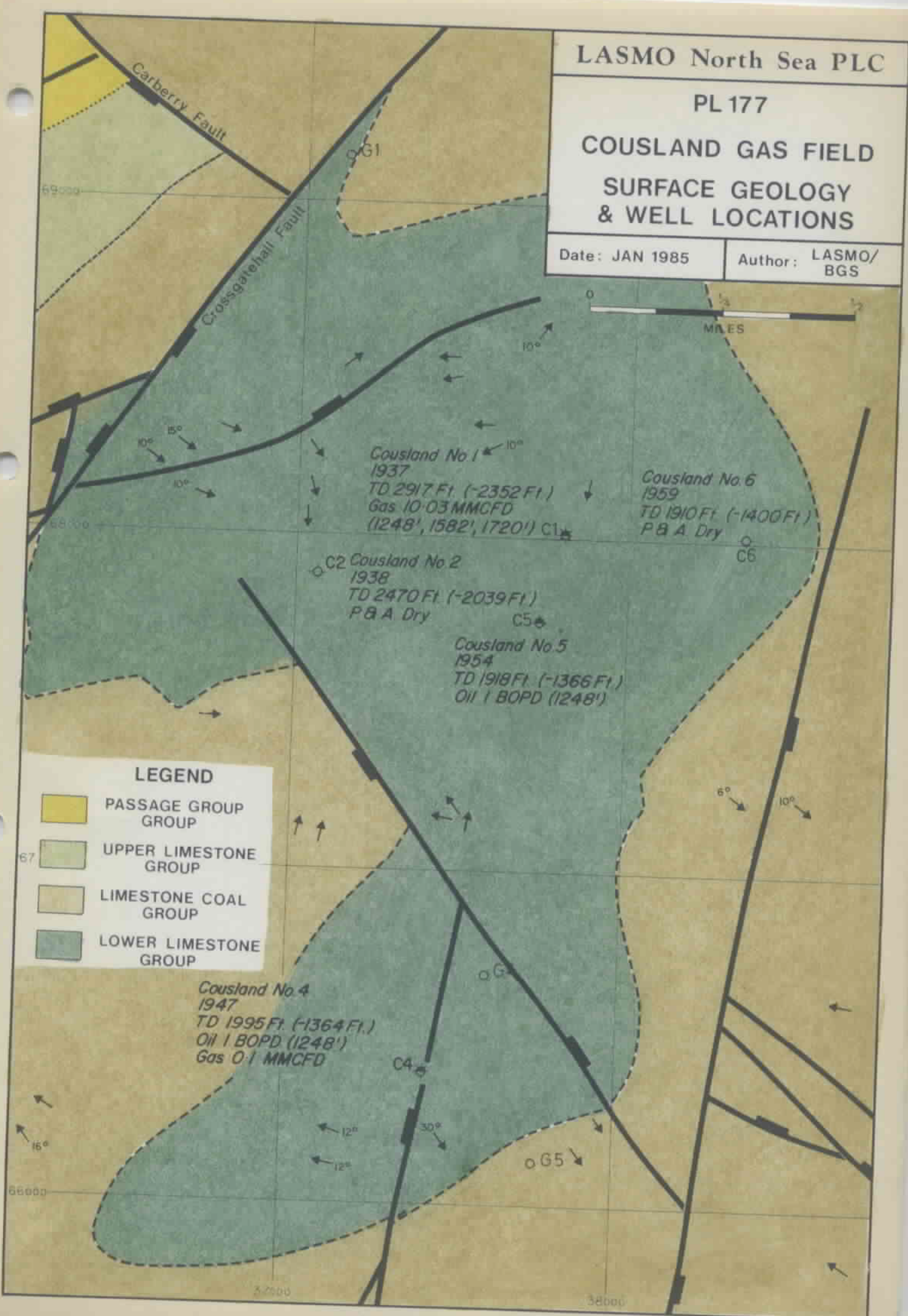
From the above tentative figure there do not appear to be commercial reserves remaining in this structure. Moreover, the reserves could be less if the recovery rate quoted above is optimistic which may be the case since a severe oil mobility problem will occur within reservoirs at such shallow depths. In addition, Stewart No.1 proved the structure to be far more complicated than at first thought and possibly much smaller. Pressure data recorded from this well indicate that there is pressure depletion within the sand bodies which would imply that reservoir quality is insufficient to maintain satisfactory flow rates.

The failure of the 1582' and 1720' sands to flow gas at Stewart No. 1 indicates that the gas accumulation tested by Midlothian No. 1 is of very limited extent, and is not considered to have commercial potential.

4.3 The Cousland Gas Field

4.3.1 Geology

The Cousland gas accumulation is located to the northeast of the Midlothian field on a separate culmination of the Cousland Anticline. Surface geology (Figure 8) indicates that this is a dome type structure which exhibits four way dip closure, with the crest of the structure lying to the north of the Cousland No.1 well location. The structure also has a southwestwards plunging extension which is down faulted to the southwest by a northwest-southeast trending fault. The displacement of the fold axis indicates that this apparently normal fault also has an element of sinistral strike-slip movement.


LASMO North Sea PLC
PL 177
COUSLAND GAS FIELD
SURFACE GEOLOGY
& WELL LOCATIONS
Date: JAN 1985
Author: LASMO/BGS
0
1/4
1/2
MILES
Carberry Fault
Crossgatehall Fault
G1
Cousland No 1
1937
TD 2917 Ft. (-2352 Ft.)
Gas 10·03 MMCFD
(1248', 1582', 1720') C1
Cousland No 6
1959
TD 1910 Ft. (-1400 Ft.)
P & A Dry
C6
C2 Cousland No 2
1938
TD 2470 Ft. (-2039 Ft.)
P & A Dry
C5
Cousland No 5
1954
TD 1918 Ft. (-1366 Ft.)
Oil 1 BOPD (1248')
LEGEND
PASSAGE GROUP
UPPER LIMESTONE GROUP
LIMESTONE COAL GROUP
LOWER LIMESTONE GROUP
Cousland No 4
1947
TD 1995 Ft. (-1364 Ft.)
Oil 1 BOPD (1248')
Gas 0·1 MMCFD
C4
G5
69000
68000
67
66000
38000

4.3.2. Exploration History

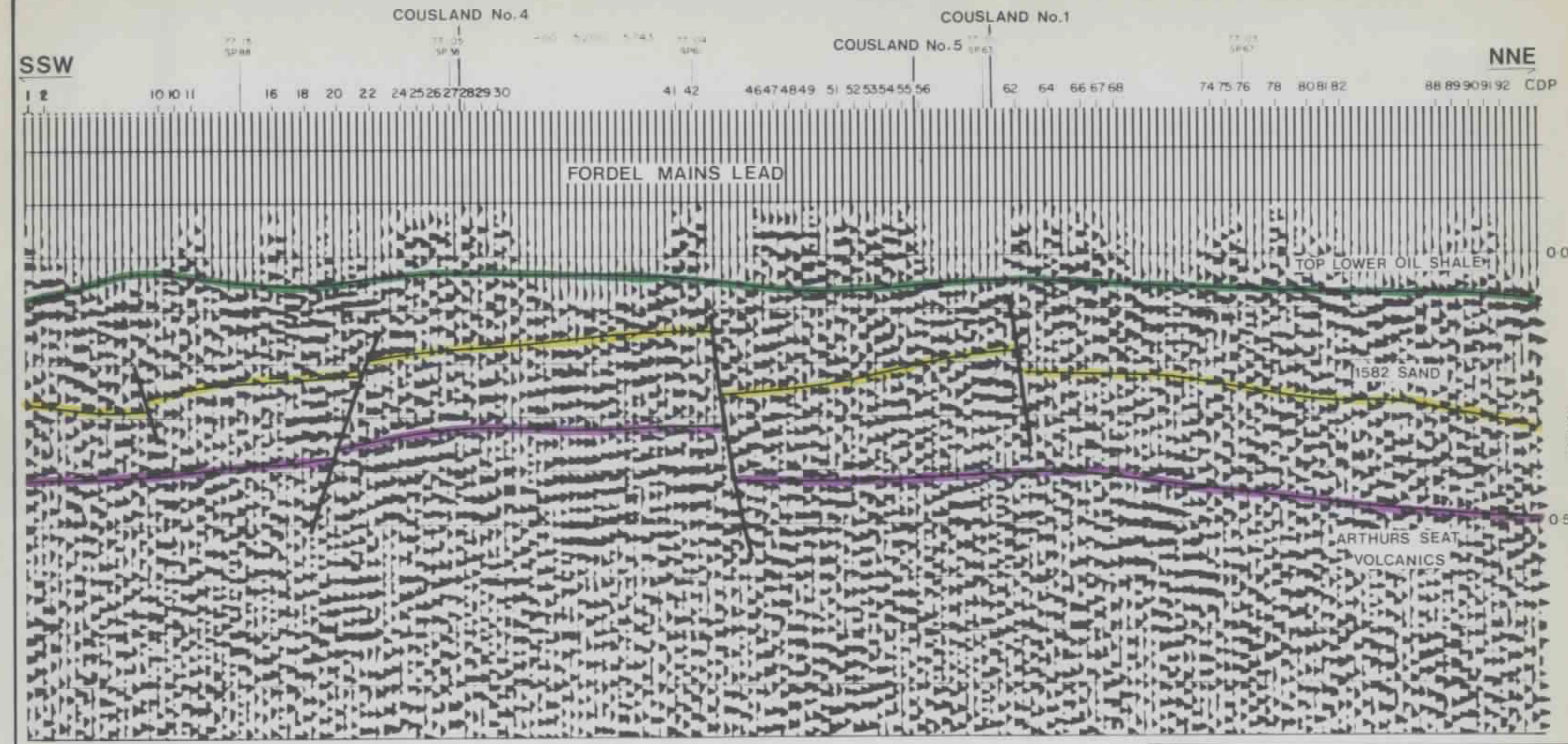
The first well to be drilled on the structure was the Cousland No. 1 well, spudded in 1937 by the Anglo-Iranian Oil Company, and was located at a near crestal position as defined by surface geology. The well was drilled to a total depth of 2,917' MD after encountering several sands exhibiting hydrocarbon shows. On test the well flowed gas from the 1582' and 1720' sands at rates of 4 MMCFGPD and 6 MMCFGPD respectively.

The 1248' sand, which was an oil reservoir in the Midlothian field, flowed only 30 MCFGPD with no associated oil production. Following the suspension of the above well, the Cousland No. 2 well was spudded 1/2 mile to the west in November 1938. As can be seen from the 1582' sand depth map (Enclosure 4) this was quite a bold step out. The well encountered the 1582' and 1720' sands 230' and 300' deeper respectively than in the No.1 well. On test they both flowed only water. The Cousland No. 3 well tested what is now termed the Falside Hill lead located 1 3/4 miles to the north of the Cousland structure, (the well was supposed to test the northern development of the 1582' sand as interpreted at the time from sand isopach maps). The well also only tested water from these sands.

There followed an eight year period before the next well was drilled on the Cousland structure. The Cousland No. 4 well, spudded in 1947, was located just over a mile south of the first well and tested what is now termed the Fordel Mains lead . The well was designed to test the southern extension of the 1582' and 1720' sand development, as inferred from well correlations between the Cousland and Midlothian wells. The well encountered the 1248' and 1720' sands some 36' and 94' deeper than in the first well, and they flowed 0.85 BOPD and water plus a trace of gas respectively. The 1582' sand in this well occurred at a depth of 1592'MD, some 56' higher than in the No.1 well. On test it flowed at an initial rate of 7,500 CFGPD, which however, decreased to 320 CFGPD by the end of the test.

The interest in this well however is that a test that straddled two sands between 1463'-1502' MD produced gas at a rate which increased from zero to 25,000 CFGPD during an initial 2 hour 39 min. flow period. A subsequent 3 hour 9 min. test saw the flow rate increase from 50,000 to 101,000 CFGPD. Unfortunately there are no electric logs available with which to assess accurately the thickness and quality of these two sands. The wellsite lithlog indicates that total net thickness of both the sands was 19' and that both sands exhibited oil staining.

Seven years elapsed before the Cousland No. 5 well, located 300 yards down dip to the southsoutheast, was drilled to appraise the Cousland No. 1 discovery. The well encountered the 1248', 1582' and 1720' sands all approximately 120' deeper than in the first well. However, the 1248' sand was the only one which exhibited significant hydrocarbon shows. On test the lower two sands flowed small amounts of gas and water whereas the 1248' sand flowed an average of 1.1 BOPD and 60 CFGPD.



LASMO North Sea PLC

PL 177

LINE : 77-02
(FILTERED STACK)

FORDEL MAINS LEAD

Date: 1977

Author: OIL EX

Fig. 17

The last exploration well to be drilled on the Cousland structure was the Cousland No. 6 well which was spudded in 1960, some four years after the Cousland No. 1 well had been re-entered (see below). The well was located 600 yards due east of the No.1 well and was presumably to test the eastern extension of the sand development. It appears that this well crossed a thrust zone lying to the east of the Cousland structure and the well was not drilled deep enough to encounter the down thrown reservoir sand sequences. Although some sand units were observed, these only flowed minor amounts of gas on test. The thrust zone or reverse fault is possibly the northerly extension of the southeasterly bounding fault of the Midlothian field.

As stated above, prior to the drilling of Cousland No. 6, the Cousland No. 1 well was re-entered and re-completed in the 1582' sand using a 3" perforated tubing string. In November 1956 the well was retested (see appendix 2) and after encouraging results the well went into production. During the period October 1957 to April 1965 the well was produced and the gas was piped to Musselburgh where it was mixed with coal gas and supplied to the City of Edinburgh for local consumption.

The well was shut in in April 1965 after having produced 221 MMCFG from the 1582' sand interval during a 7 year continuous flow period.

4.3.3 Reserves

The assignment of reserves to the Cousland structure has been attempted by using volumetrics, based on the 1977 seismic data, and by calculations based on average reservoir pressure and cumulative production. Neither of these two methods will give reliable or accurate figures in this instance simply because the quality of the original data is poor. In the absence of any other data however, it has been used here. The mapped closure of the Fordel Mains lead has not been included.

1) Volumetric Reserves Calculations

Reserves of gas in the Cousland Field are restricted to the 1582' sand since the 1248' sand was oil bearing and the 1720' sand watered out after initially encouraging high flow rates of gas. On the 1582' sand depth map (Enclosure 4) the area of closure of the Cousland field is defined by the -1170'ss contour, representing the gas/water contact in the Cousland No. 1 well.

Using the parameters below:

Area of Closure	:	121 acres
Net Pay	:	20' (assumed average across the structure)
Bulk Rock Volume	:	2660 acre feet
Porosity	:	15%
S_w	:	50%
Reservoir Pressure	:	660 psi (maximum estimated BHSIP plus pressure of gas head, gas gradient is 0.0147 psi/ft)
Reservoir Temperature	:	528°R (from Cousland No.1)
Compressibility Factor	:	1.165 (calculated from gas composition)
Initial G.I.P. of 1582'sand	:	312 MMCFG
Total cumulative production	:	221 MMCFG
Gross remaining gas	:	108 MMCFG

Assuming a 70% recovery rate then:

Reserves of gas in 1582' sand	:	75.6 MMCFG

2) <u>Pressure and Production Reserves Calculations</u>

From a report by M.E. Ford for British Gas written in November 1969, various reserves figures were generated based on pressure decline and cumulative production data. The calculations are repeated in detail in Appendix 5, but a summary of the results are set out below:-

Initial G.I.P. assuming no water influx	:	804 MMCFG
Initial G.I.P. allowing for water influx	:	619 MMCFG
Initial G.I.P. using unsteady state method	:	547 MMCFG

4.3.4 Conclusions

The most optimistic upside figure for the remaining reserves are generated using the 619 MMCFG initial gas in place figure. This was calculated assuming water influx into the reservoir. Evidence for water influx is the gradual rise in shut in pressure in the Cousland No. 1 well which was still occurring three years after the well was suspended. The upside reserves figure for the field is, on the basis of this calculation, of the order of 300 MMCFG.

The calculations above suggest that the field may contain significant reserves of gas which range between 75-300 MMCFG. However, the large variations in reservoir permeabilities that occur in the sands over this field would necessitate a very low production rate to prevent the sands from watering out prematurely. The Cousland No. 1 well has already produced some 221 MMCFG and so the water level must have risen substantially, although it is believed that the well never actually produced water from the 1582' sand.

The necessary low production rates coupled with the very low wellhead flowing pressure would present severe problems in terms of well deliverability and, in conclusion, the Cousland field is not considered to be a viable commercial accumulation at this time.

5. PROSPECT EVALUATION

Within the PL177 licence there remains only one feature which warrants prospect status and this is described below. The two other prospects identified in the licence were drilled by the Straiton and Carrington wells respectively.

5.1 The Polton Prospect

The Polton Prospect is located in the west of the Midlothian Basin (Figure 2) and is recognised at surface as a NNE-SSW trending isolated anticline.

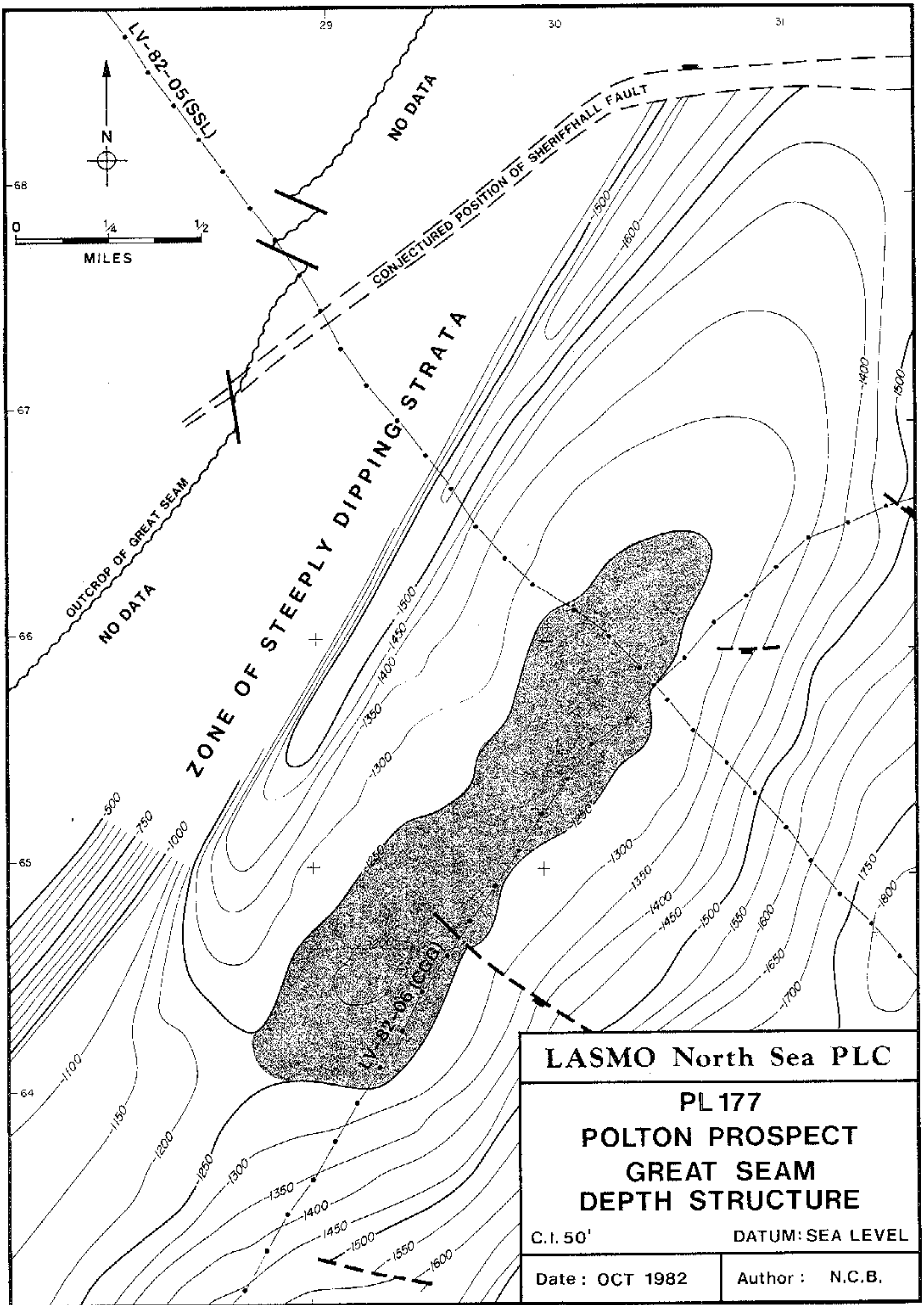
It is believed that Polton has a better chance of containing commercial hydrocarbons than any other prospect so far drilled in the PL177 licence. The proximity of active coal workings and severe access problems have prevented the prospect from being drilled to date.

The Polton Prospect montage is contained in Enclosure 2.

5.1.1 Structure

The Polton Prospect is a large Lower Carboniferous high on the western flank of the Midlothian Basin. The feature is seen at the surface as a northnortheast - southsouthwest trending unfaulted rollover. Subsurface control over the feature is provided by N.C.B. depth contour maps of the Great Seam (Figure 9) and the Parrot Seam (Figure 10). Maps of both horizons confirm the surface feature and suggest that the structure increases in relief with depth. The Parrot Seam map is particularly useful as it demonstrates good closure (i.e. over 100') in all directions and also indicates the possible position of the crest of the structure.

The increase in relief with depth, which is demonstrated by the N.C.B. maps indicates that structural growth was occurring on the Polton feature during the Lower Carboniferous. This growth upgrades the Polton prospect considerably. Early formed structures which are unaffected by post-Carboniferous faulting are thought to be more likely to contain hydrocarbons since they will not have been breached subsequent to hydrocarbon emplacement.

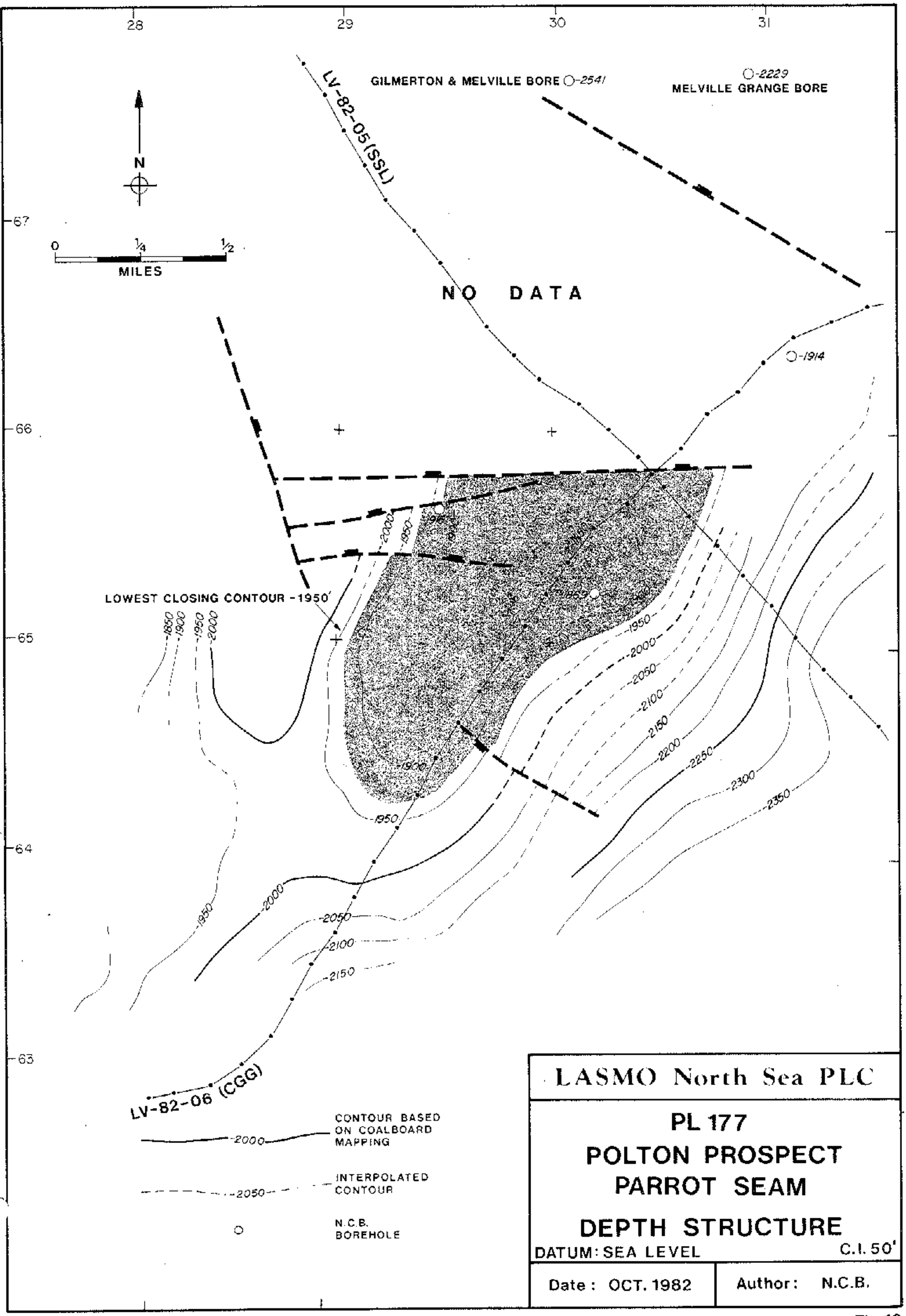


LASMO North Sea PLC

PL 177
POLTON PROSPECT
GREAT SEAM
DEPTH STRUCTURE

Date : OCT 1982 | Author : N.C.B.

Fig. 9



28
29
30
31
67
66
65
64
63
N
0
¼
½
MILES
GILMERTON & MELVILLE BORE -2541
-2229
MELVILLE GRANGE BORE
LV-82-05 (SSL)
NO DATA
-1914
LOWEST CLOSING CONTOUR -1950'
1850
1900
1950
2000
-1950
-2000
-2050
-2100
-2150
-2200
-2250
-2300
-2350
-1900
-1950
2000
-2050
-2100
-2150
1950
LV-82-06 (CGG)
2000
CONTOUR BASED ON COALBOARD MAPPING
2050
INTERPOLATED CONTOUR
N.C.B. BOREHOLE
LASMO North Sea PLC
PL 177
POLTON PROSPECT
PARROT SEAM
DEPTH STRUCTURE
DATUM: SEA LEVEL
C.I. 50'
Date: OCT. 1982
Author: N.C.B.

Fig.10

Unfortunately, seismic control over the feature is weak, it is restricted to two roughly perpendicular lines of poor quality, LV-82-05 and LV-82-06 (Figures 11 and 12). Nevertherless, it is apparent that the two sources of information (i.e. N.C.B. maps and seismic data) are in reasonable agreement. The seismic data does, however, suggest that the feature is more complicated at depth than indicated by the NCB maps, and that the rollover seen at the shallower levels probably reflects drape over a roughly north-south trending horst block.

Evidence from those prospects already drilled suggests that the structural character of the region is far more complicated than first envisaged. The lack of good quality seismic data prevents detailed structural investigation and this limits the structural control of the prospect at depth. Better quality seismic data could probably be achieved by acquiring high resolution data comparable to one test line shot over the Midlothian field, line LV-82-07 (Figure 7). This type of seismic acquisition would, however, be substantially more expensive than the more coventional form.

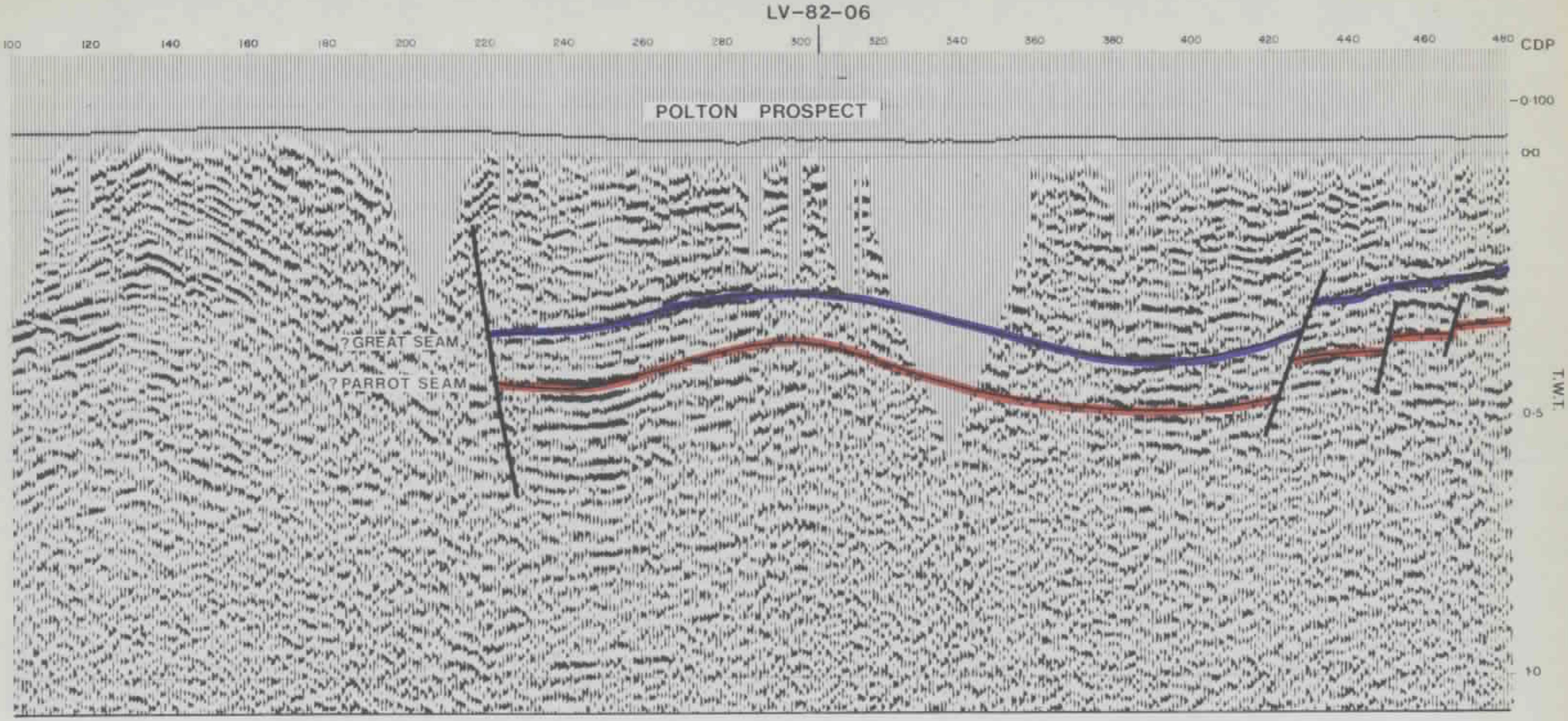
5.1.2 Reservoir

The reservoir objectives of the Polton Prospect are sands of the Upper and Lower Oil Shale Groups (a well prognosis is shown in Figure 13). These sand units are similar to those seen at the Stewart, Straiton and Carrington wells being up to 30' thick with net to gross ratios of the Upper and Lower Oil Shale Groups of 0.40 and 0.22 respectively. Multiple pay zones are envisaged.

Reservoir quality of the sands is thought to be reasonable with porosities of the order of 11-18% and permeabilities from 5 md to 350 md on the basis of well data from Straiton No. 1 and the wells drilled on the Cousland Anticline. However, the exact nature of the poroperm characteristics of the sands in this part of the basin is not known.

Water flushing of the reservoir had occurred on the Straiton and Carrington wells resulting in the removal of the light end hydrocarbons from the better quality sands. The anticipated depths of the Polton objectives are much deeper (about 5,500') where the effects of water flushing of the reservoir might be expected to be significantly less.

Oil mobility in the reservoir at Polton is also not thought to be a problem owing to the increased temperature due to the greater depth. Using a temperature gradient of 1.1^{0}F/100', derived from data from the Stewart and Carrington wells, a reservoir temperature for the Polton prospect of approximately 110^{o}F at 5,500' is computed. (N.B. Pour points for the crude recovered at Midlothian 1 and Carrington 1 were 60^{o}F and 86^{o}F respectively).



LASMO North Sea PLC

PL 177

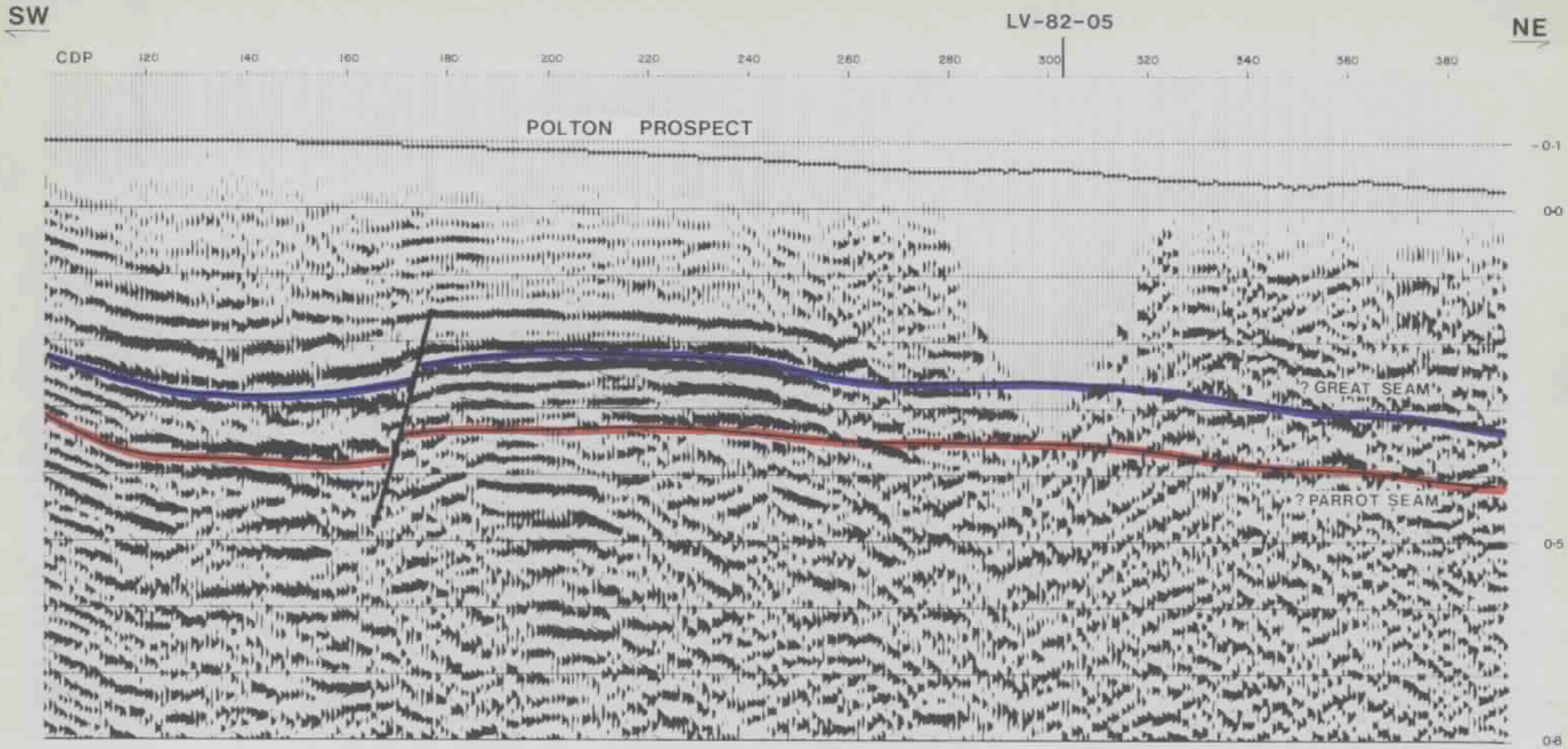
LINE : LV-82-05

(FINAL STACK)

POLTON PROSPECT

Date: 1982	Author: LASMO

Fig. 11



LASMO North Sea PLC

PL 177

LINE: LV-82-06

(FILTERED STACK)

POLTON PROSPECT

Date: 1982	Author: LASMO

Fig.12

POLTON

PROVISIONAL GEOLOGICAL PROGNOSIS

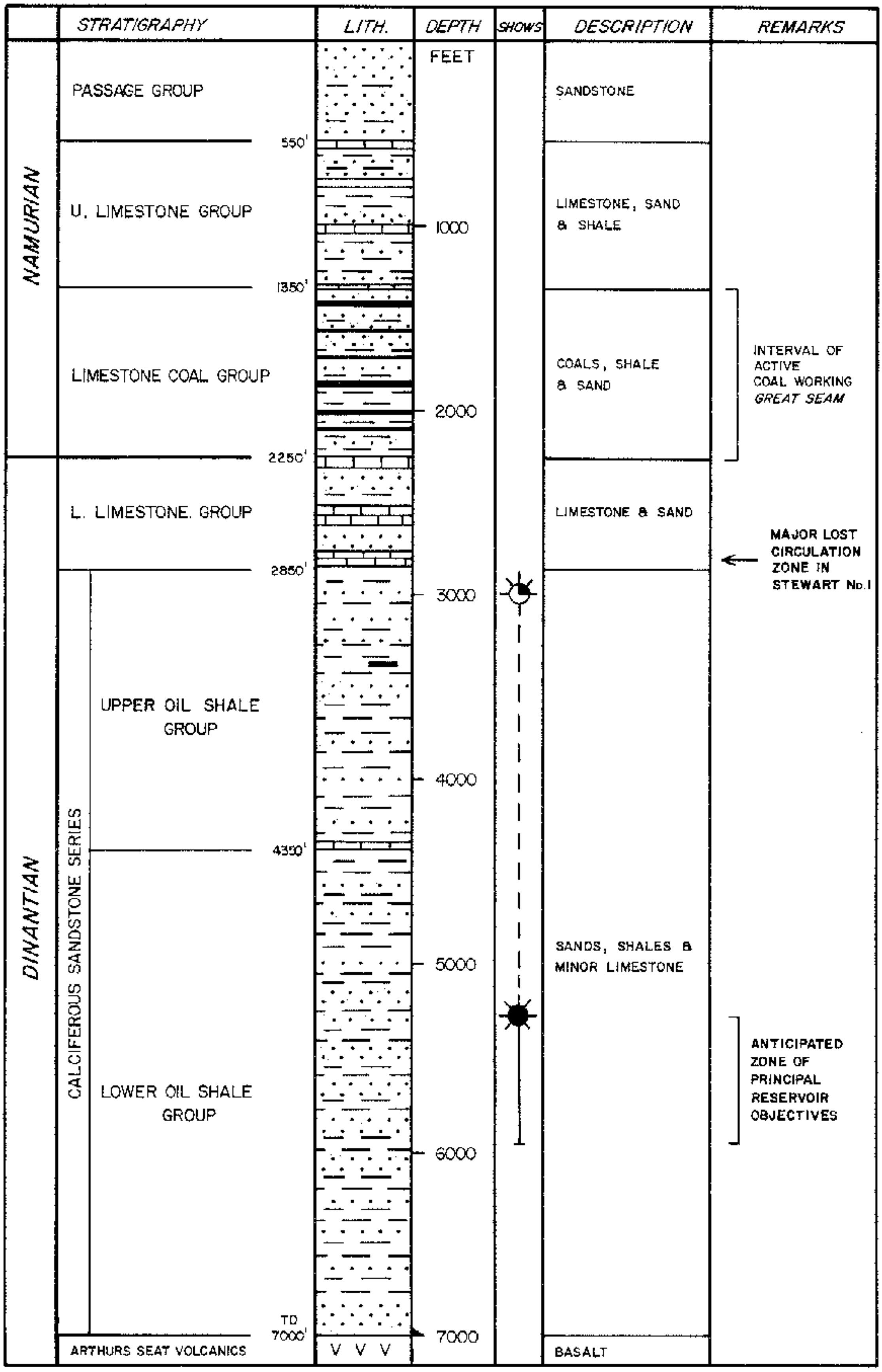


Fig. 13

5.1.3 Source

The region is regarded as proven in terms of source rock potential, indeed all wells drilled to date in the PL177 licence have encountered hydrocarbon shows.

5.1.4 Seal

Shales of the Upper and Lower Oil Shale Group should provide an effective seal unless the structure is severely fault breached and/or vertical sand to sand contact occurs. Over the Polton Prospect, faults do not appear to penetrate the Upper Carboniferous at depth suggesting that trap integrity is maintained.

5.1.5 Reserve Estimates

Reserve estimates must be considered speculative due to the considerable uncertainty of the areal extent of the prospect and also because of the inherent problems associated with producing an oil field in an active coal mining region.

Structural closure, as seen at the Great and Parrot Seams, has been measured as 454 and 770 acres respectively. Although the structure is likely to change shape with depth these areas have been used as best guess estimates of the likely range of possible closure. Reserves have been calculated using the following parameters:

Area	454 acres	770 acres
Net Pay	60'	
Porosity	15%	
S_w	30%	
FVF	1.1	
RF	10%	
OIL IN PLACE	20 MMSTB,	34 MMSTB
RESERVES	2 MMSTB,	3.4 MMSTB

5.1.6 Conclusion

The Polton Prospect is considered to have genuine commercial hydrocarbon potential. To date, however, various attempts to drill the prospect have been thwarted by the occurrence of overlying N.C.B. coal workings and the prohibitive costs of drilling highly deviated holes, in what can be a difficult drilling area. Unless future discussions with the N.C.B. can furnish an acceptable drilling location the prospect could well remain undrilled for some considerable time.

6. LEADS

6.1 Introduction

In addition to the Polton Prospect five leads have been identified, all of which are located in the eastern part of the licence (Figure 14). Apart from the Fordel Mains lead, they all lie along the Crossgatehall Fault and are fault bounded dip closures. The Fordel Mains lead is located on the Cousland Anticline and lies on the southern extension of the Cousland Gas Field structure. All of the leads are identified by expressions of surface geology.

Some of the leads were crossed by the 1977 seismic survey and maps generated by Oil Exploration Limited have been included here as have a number of seismic lines. These are the only data available across this area of the licence and serve to illustrate some of the features of individual leads. However, it must be stressed that they are of poor quality and not considered reliable in terms of accurately defining the structure and fault pattern at depth.

Figure 15 shows a detailed generalised vertical section of the Cousland Anticline which indicates the age relationships between the various coal and limestone units of the Carboniferous Limestone Series. It is these coal and limestone units which identify the surface expressions of the leads.

The five leads that have been identified are listed below and a discussion on each of them follows below:

1) Fordel Mains;
2) Carberry Hill;
3) Chalkieside Hill;
4) Falside Hill;
5) Wallyford.

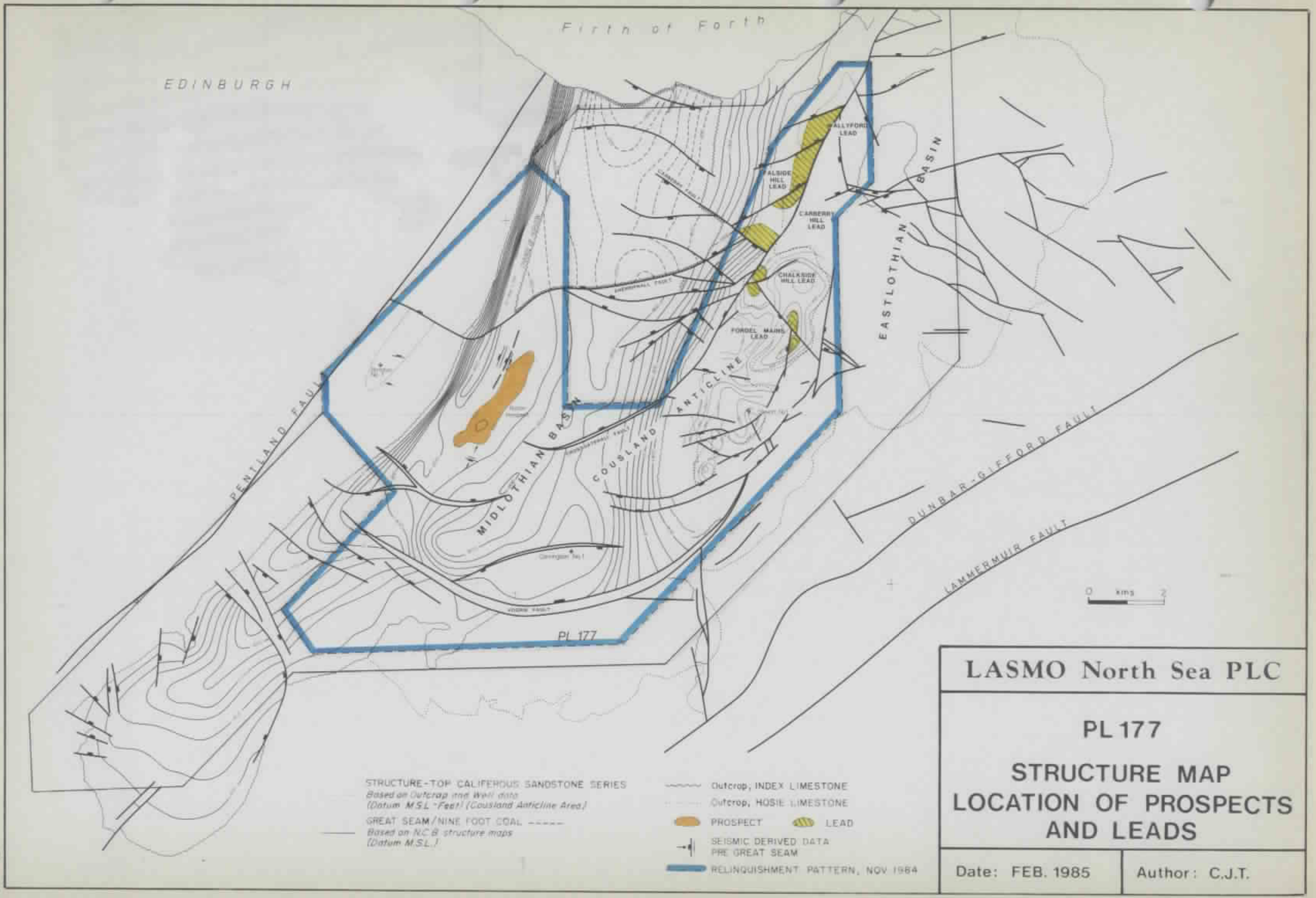

Firth of Forth
EDINBURGH
WALLYFORD LEAD
FALSIDE HILL LEAD
CARBERRY HILL LEAD
CHALKSIDE HILL LEAD
FORDEL MAINS LEAD
EASTLOTHIAN BASIN
MIDLOTHIAN BASIN
COUSLAND ANTICLINE
PENTLAND FAULT
DUNBAR-GIFFORD FAULT
LAMMERMUIR FAULT
PL 177
0 kms 2
STRUCTURE-TOP CALIFEROUS SANDSTONE SERIES
Based on Outcrop and Well data
(Datum M.S.L.-Feet) (Cousland Anticline Area)
GREAT SEAM/NINE FOOT COAL
Based on N.C.B. structure maps
(Datum M.S.L.)
Outcrop, INDEX LIMESTONE
Outcrop, HOSIE LIMESTONE
PROSPECT
LEAD
SEISMIC DERIVED DATA
PRE GREAT SEAM
RELINQUISHMENT PATTERN, NOV 1984
LASMO North Sea PLC
PL 177
STRUCTURE MAP
LOCATION OF PROSPECTS
AND LEADS
Date: FEB. 1985
Author: C.J.T.

Fig.14

COUSLAND ANTICLINE
GENERALISED VERTICAL SECTION
(PRE-UPPER LIMESTONE COAL GROUP)

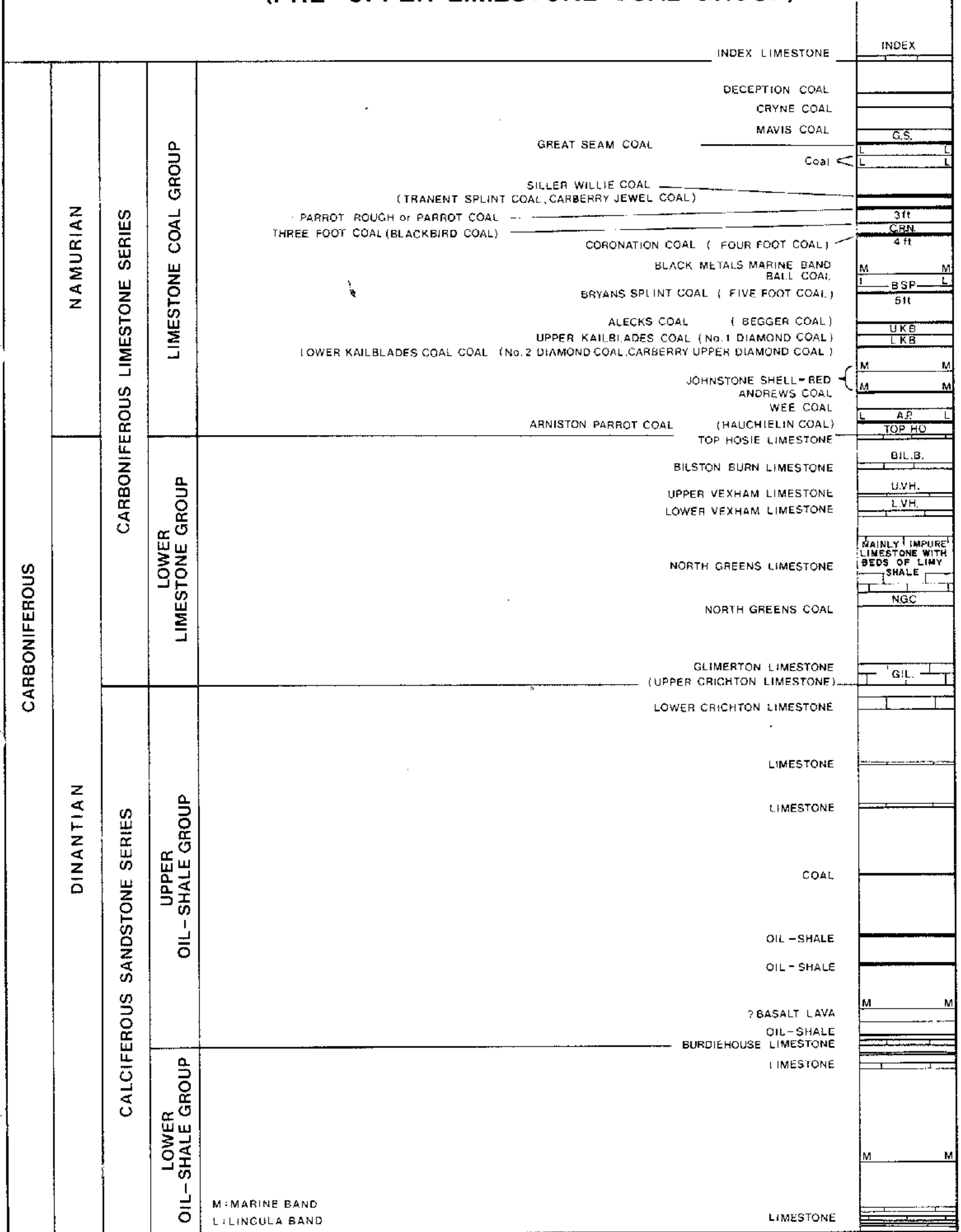


Fig.15

6.2 Fordel Mains

The Fordel Mains lead is located on the Cousland Anticline and lies on the southern extension of the Cousland Gas Field Structure.

6.2.1 Surface Geology

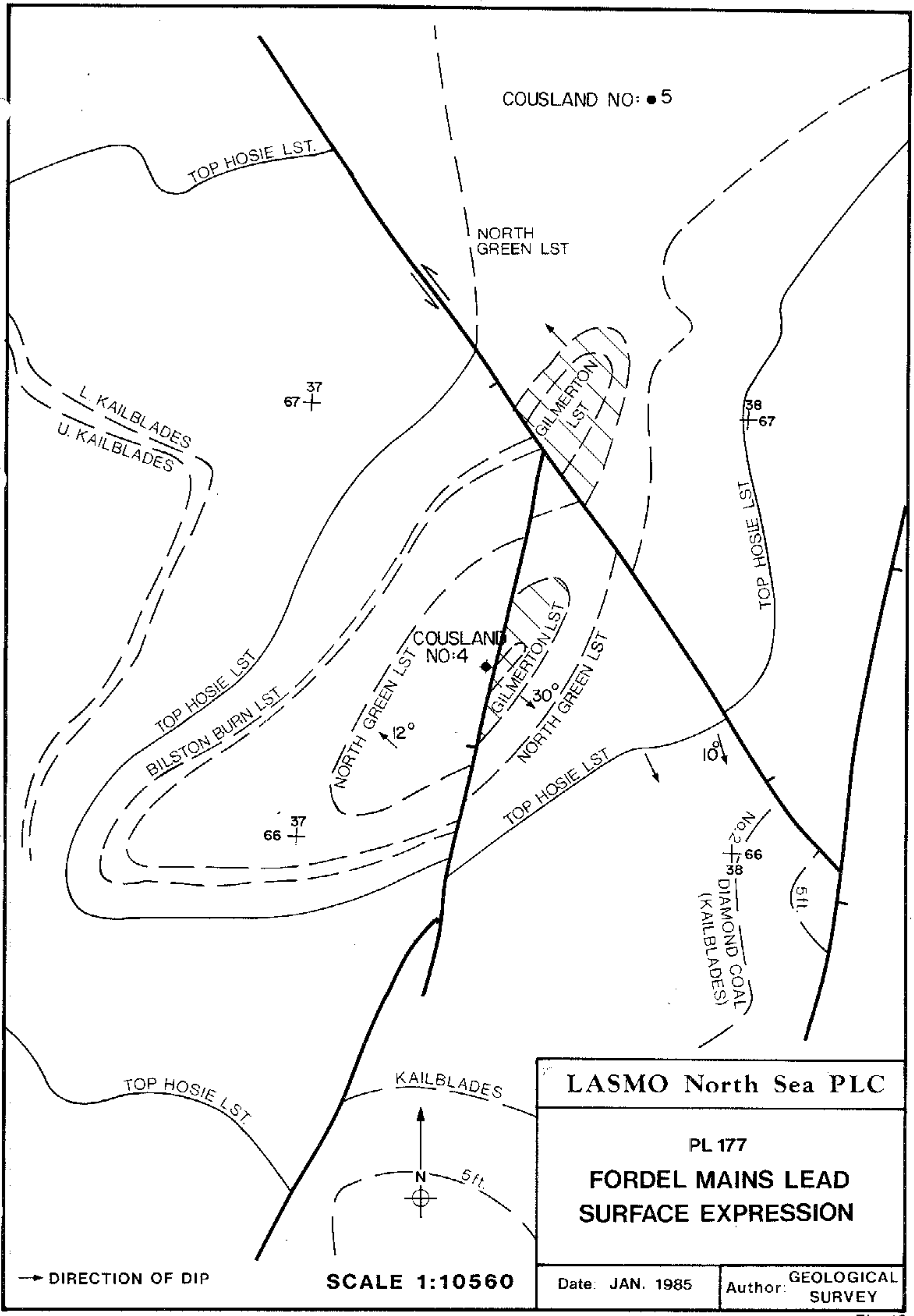
The evidence of the surface geology suggests that two structurally high areas, defined by the outcrop of the Glimerton Limestone, are developed on the southern extension of the Cousland Gas Field structure near the Cousland No. 4 well location (Figure 16). The first is immediately to the northeast of the Cousland No. 4 well and lies on the upthrown side of a north-northeast trending normal fault whose throw at surface is about 50' to the west. The second, 700 yards to the north, is developed on the upthrown side of a northwest trending fault whose apparent vertical displacement at surface is over 200' to the southwest. This fault clearly has a strong element of sinistral strike-slip, since the trace of the fold axial surface is displaced about 330 yards to the southeast across it. The age of movement on this fault is not known.

6.2.2 Seismic Mapping

The lead is crossed by two lines of the 1977 survey which are of poor to moderate quality (Figures 17 and 18).

Line 77-04 (E-W) cuts the northern surface expression of the lead in a near crestal position (Enclosure 4). The line indicates the locations of faults to the west and east of the lead. The existence of the small antithetic fault in the northeast is questionable. The fault in the east has a north-south trend and has a normal throw at surface, down throwing to the east. However, the seismic data indicate that this is a reverse fault at depth. It appears that this is the northern continuation of the southeastern bounding fault of the Midlothian Field. The fault to the west of the lead appears to be the continuation of the northerly bounding fault, as seen on line 77-02, and downthrows to the northwest. This fault is not expressed at surface.

Line 77-02 (NNE-SSW) cuts the lead almost parallel to the fold axis as seen at surface. This line defines the location of the southern and northern bounding faults of the Fordel Mains fault block. Both of these faults appear to have normal throws.



LASMO North Sea PLC

PL 177

FORDEL MAINS LEAD SURFACE EXPRESSION

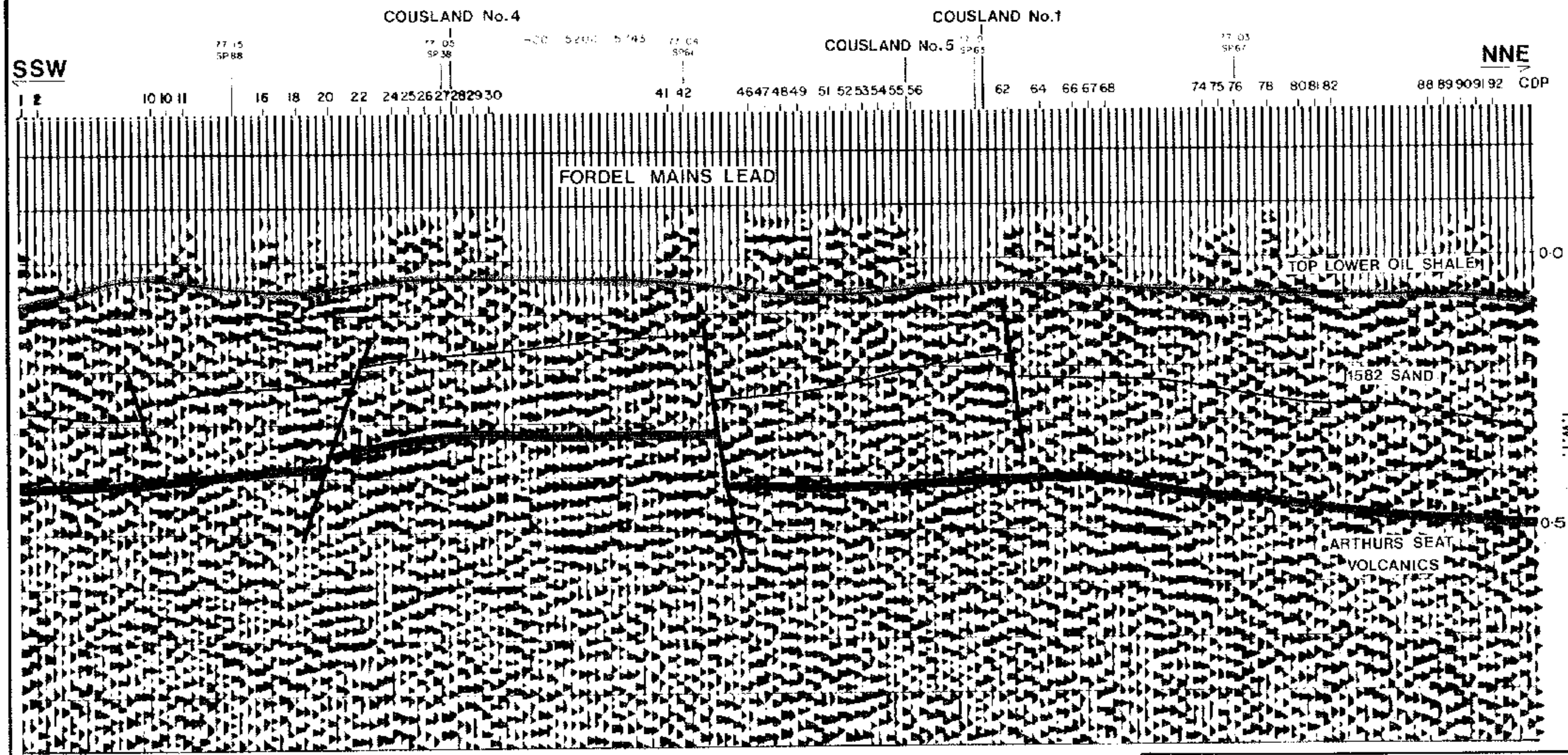
Date: JAN. 1985

Author: GEOLOGICAL SURVEY

→ DIRECTION OF DIP

SCALE 1:10560

Fig. 16



LASMO North Sea PLC

PL 177

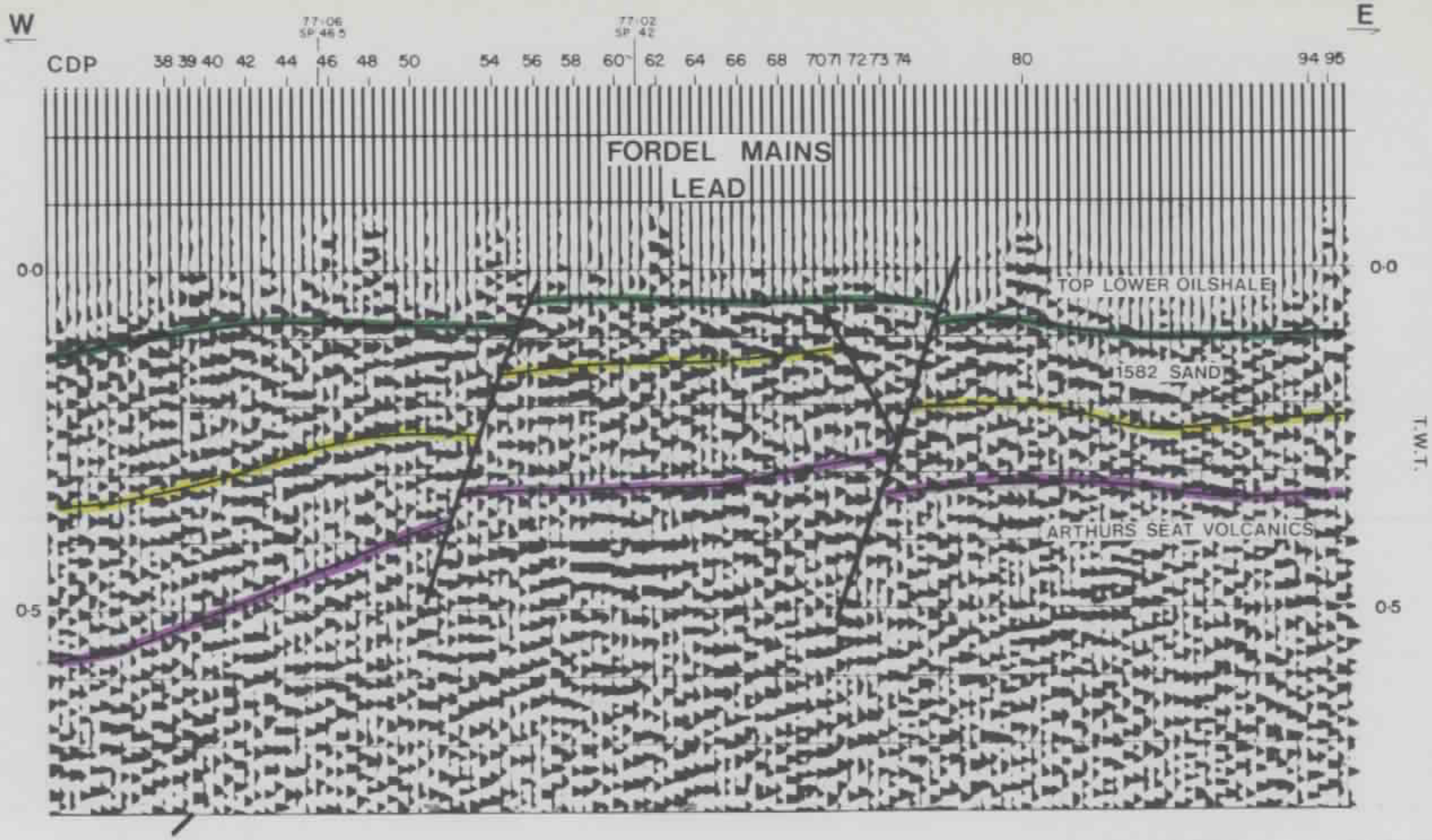
LINE : 77-02

(FILTERED STACK)

FORDEL MAINS LEAD

Date: 1977	Author: OIL EX

Fig.17



LASMO North Sea PLC

PL 177

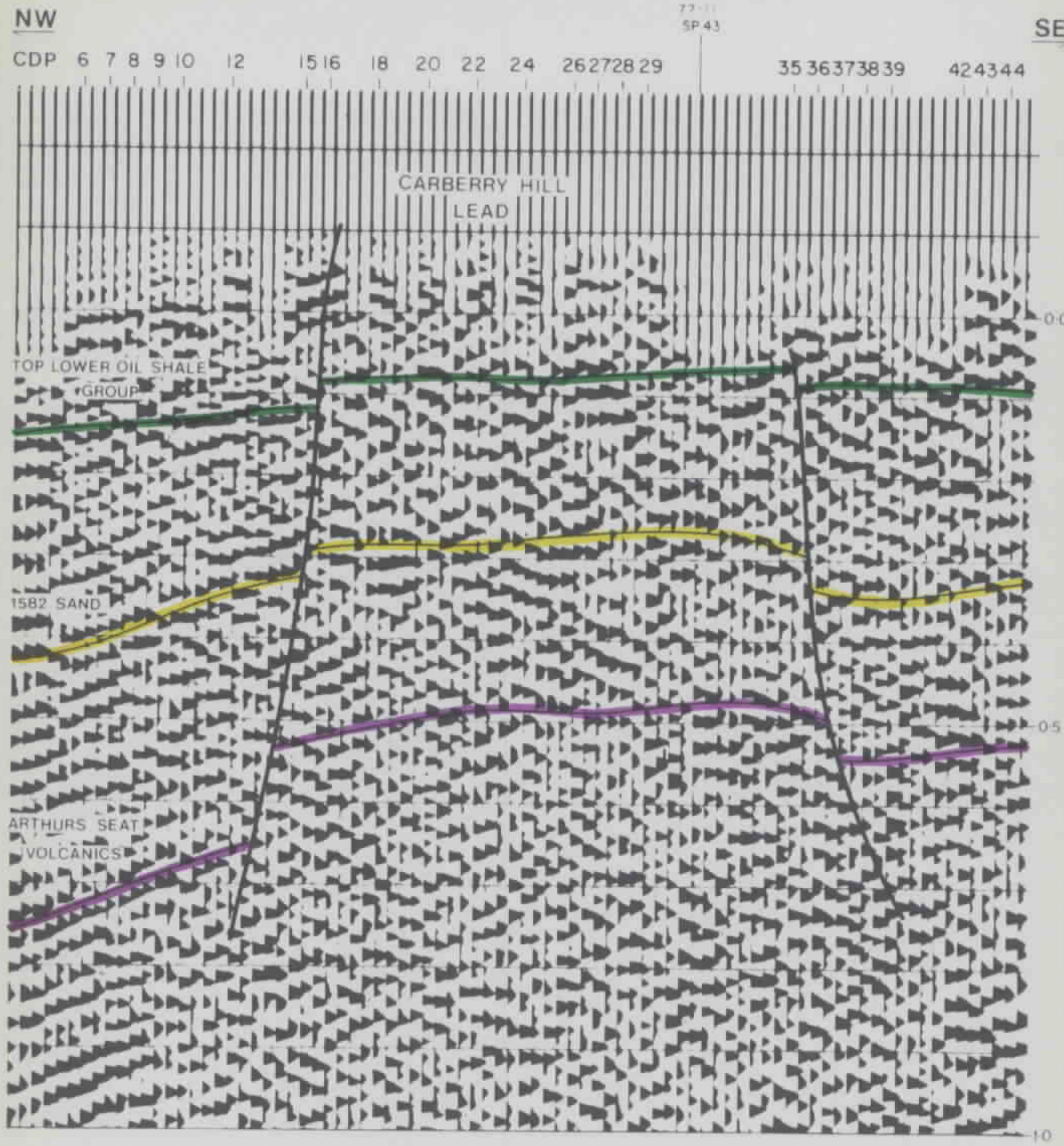
LINE: 77-04

(FILTERED STACK)

FORDEL MAINS LEAD

Date 1977	Author OIL EX

Fig.18



LASMO North Sea PLC

PL 177

LINE : 77-07

(FILTERED STACK)

CARBERRY HILL LEAD

Date: 1977	Author: OIL EX

Fig.20

6.2.3 Well Control

The Cousland No. 4 well was located in a structurally analogous position to the Cousland No. 1 well (approx. 1800 yards to the north) but was some 40' higher than the latter well from the surface geology. The well however encountered the major reservoir sand units at lower levels and the only significant flow was achieved from the 1248' sand from which 0.85 BOPD was recovered.

The well did flow on test, however, up to 101,000 CFGPD from a thin sand interval between 1463'-1502' MD (top at -849' ss).

6.2.4 Discussion

The only prospective reservoir interval in the Fordel Mains lead is the sands that flowed at a rate of 101,100 CFGPD. The 1248' sand is not prospective because of the small potential reserves and an oil mobility problem which probably occurs here since the reservoir would have temperatures in the region of 65°F or less. The 1582'sand appears to have no potential according to the test results. The 1720'sand horizon also has little potential for although the sand flowed 5,800 CFGPD on test both the sand intervals above and below it had significant water production, and it is thought that this sand would also water out in a similar way. It is worth noting that the equivalent sand in the Cousland No.1 well initially flowed 6 MMCFGPD before it watered out.

As has previously been stated, the 1977 seismic data are of very poor quality. Consequently the resultant depth map at the 1582' sand is open to considerable doubt in many areas. However, any attempt to re-interpret the 1977 survey is not worthwhile since the poor definition and resolution of the data would only result in equally ambiguous results.

The above comments have not ruled out the fact that the Fordel Mains lead may well have a gas reservoir. This may be in the form of a simple horst block trap as shown by surface geology, or a more complex feature occurring at depth and as yet not determined. There are unfortunately two facts that downgrade the lead. The first is that subsurface well data indicate that there is a regional thinning of the Upper and Lower Oil Shale Groups in an easterly direction over the lead and thus there is the possibility that the thin reservoir sands may attenuated updip. The second is that closure at depth may be against the thrust fault in the east which might not be an effective seal.

6.3.2 Seismic Mapping

The lead is crossed by two lines of the 1977 survey (Figure 21). Line 77-11 (NE-SW) intersects the Cousland No. 3 well location to the northeast, and cuts the northwesterly and southerly bounding faults of the lead. In both cases the faults are difficult to pick on the section and have to be located on the basis of the surface geology and projected down to reservoir depth. Even though the line cuts the Cousland No.3 well, reflectors can not be traced with any degree of confidence across the lead and thus any dip closure which may occur at reservoir depth can not be observed. Line 77-07 (Figure 20) is a dip line across the Crossgatehall Fault and northwesterly bounding fault. Again quality is poor, but the upthrown horst block can be identified by the dip of the sediments which become more gentle across it than is the case beyond the northwesterly bounding fault. The sense of throw on the Crossgatehall Fault at this position appears to be normal from this section.

The 1582' sand horizon depth map (Figure 21) shows a northerly and southerly area of closure within the fault block which are separated by a westerly plunging faulted saddle. The northern closure is defined by the 1550' contour at the 1582' sand horizon. It is dip closed, except in the northwest where it relies on fault sealing. The southern area is potentially larger and closure is against the Crossgatehall Fault and Carberry Fault to the southeast and south respectively.

6.3.3 Well Control

The nearest well to the lead is Cousland No. 3 located 1000 yards to the north. This well was drilled near the crest of the Falside-Carberry anticline, in a seperate fault compartment, downthrown approximately 170' at surface to the Carberry Hill block. The seismic mapping at the 1582' sand horizon indicates a throw of 475' at this level.

In the No. 3 well all sands were water-bearing. The 1248' sand was cored and had a slight show of gas. The 1582' sand was also cored which had shows of gas in its upper part and oily joints and bedding planes.

6.3.4 Discussion

The seismic interpretation of this lead indicates considerable structural differences between the surface geology and the deeper section in terms of the position of the fold axis and interpreted throw on faults. Inevitably the poor seismic quality places doubt on the structural integrity of the lead.

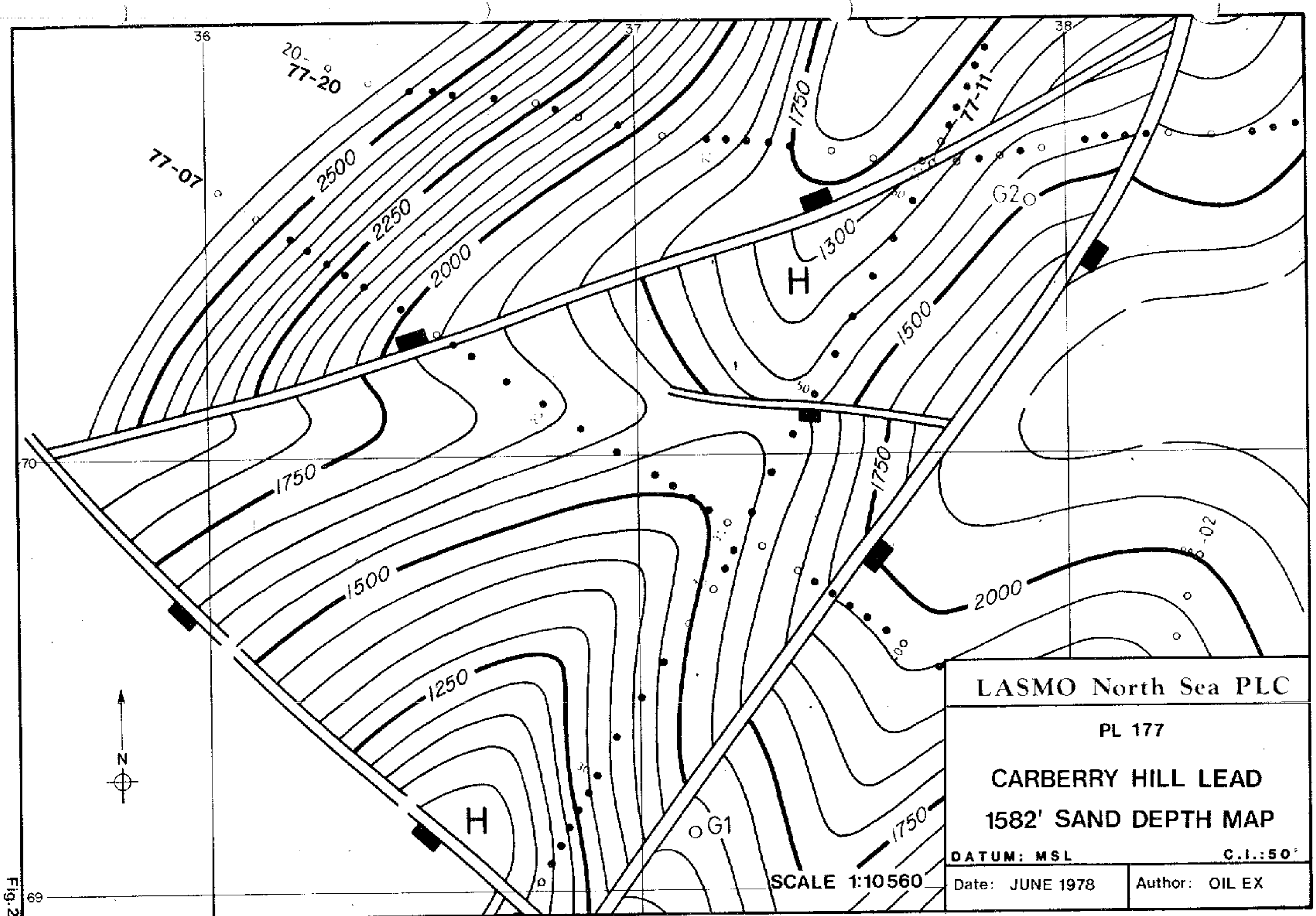

LASMO North Sea PLC
PL 177
CARBERRY HILL LEAD
1582' SAND DEPTH MAP
DATUM: MSL
C.I.:50'
Date: JUNE 1978
Author: OIL EX
SCALE 1:10560
77-20
77-07
77-11
2500
2250
2000
1750
1500
1300
1250
H
G1
G2
N
36
37
38
70
69

Fig. 21

Within the Carberry Hill block there is no closure independent of faulting. The Crossgatehall Fault, and the associated faults which bound the lead, are known to have a complex history of movement which extends, at least, into the Early Permian. This lead is downgraded because movement of the fault which could cause trap rupture may have postdated hydrocarbon generation and emplacement. The results of the Cousland No.3 well would tend to imply that this is the case in this area.

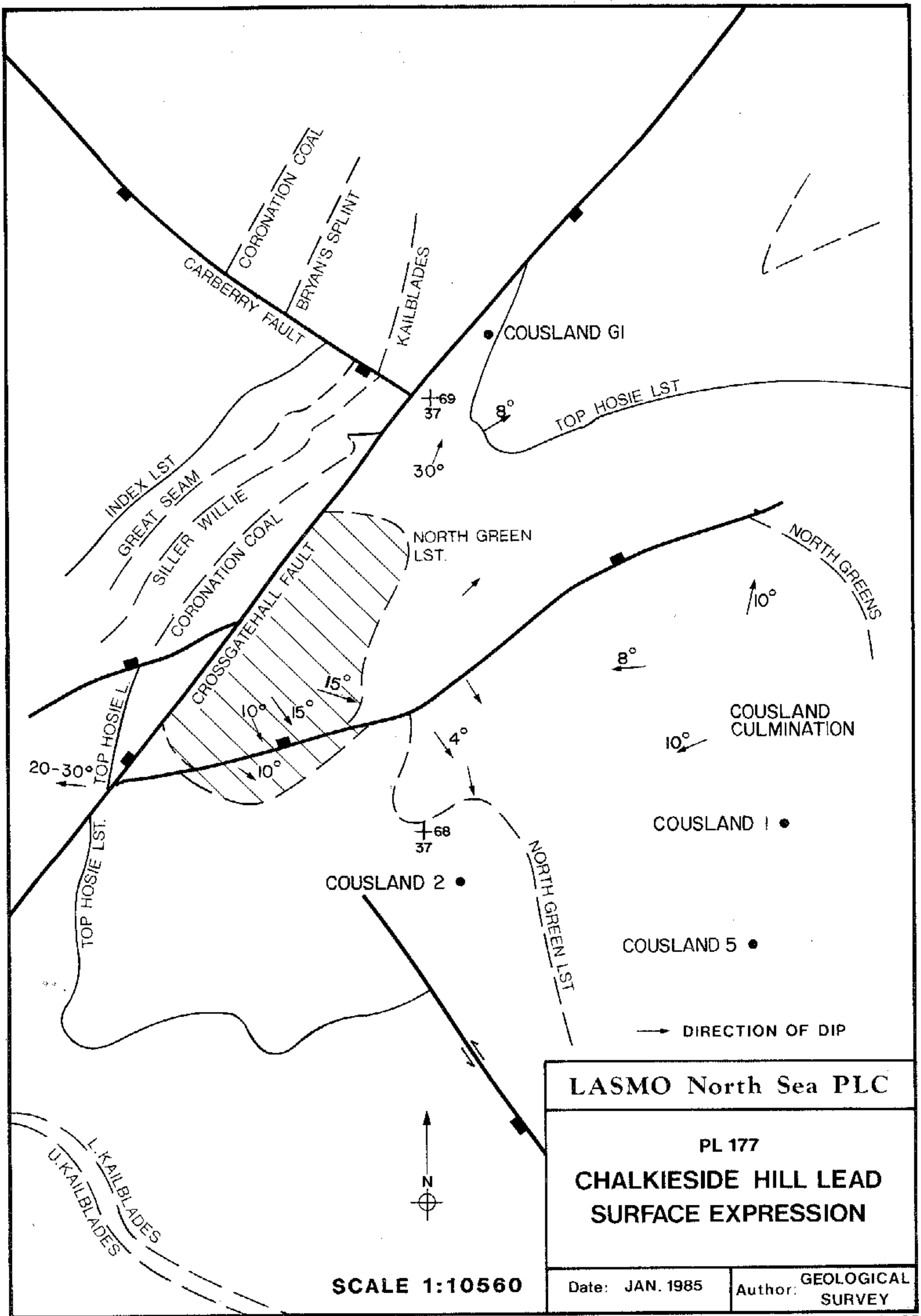
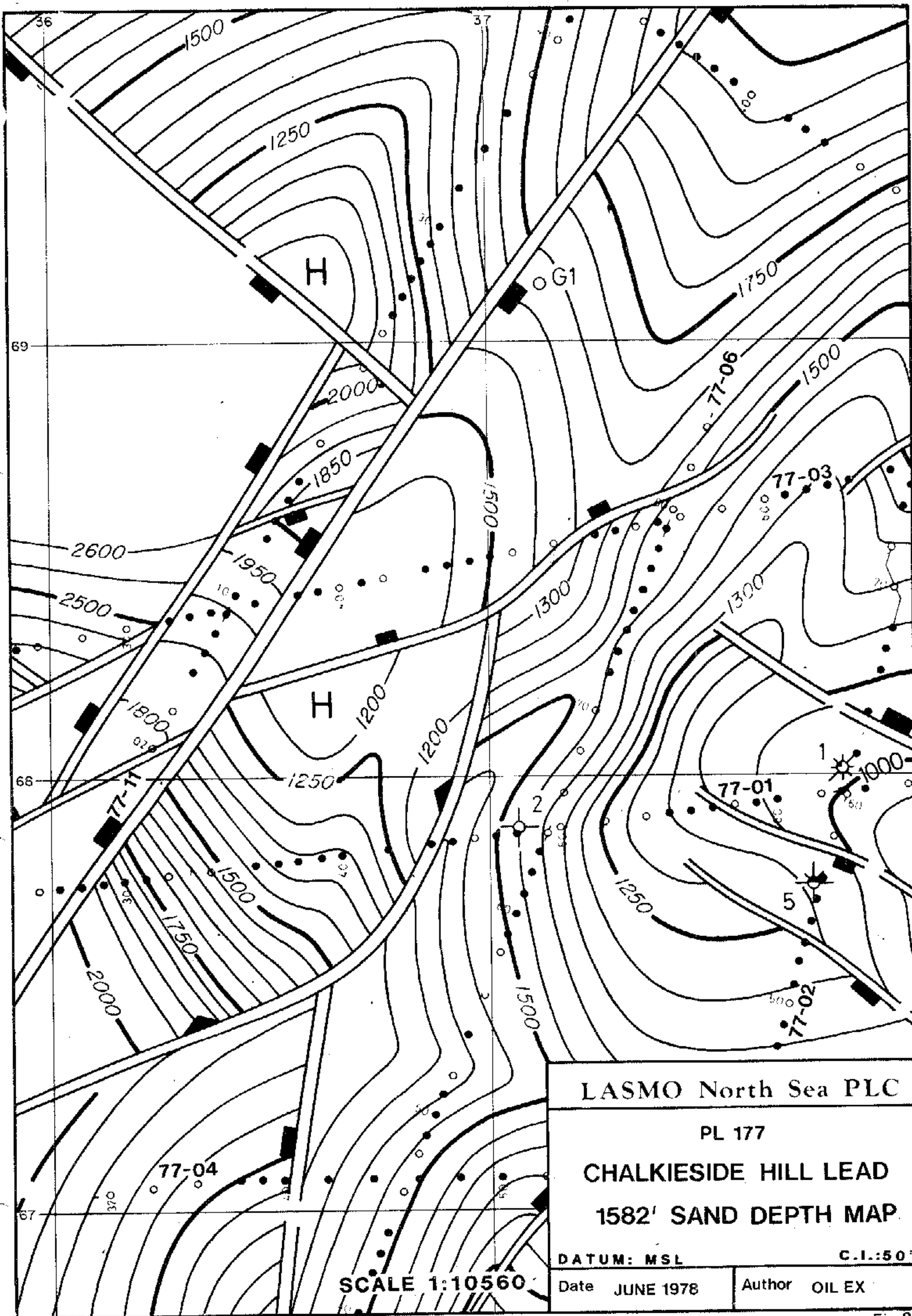
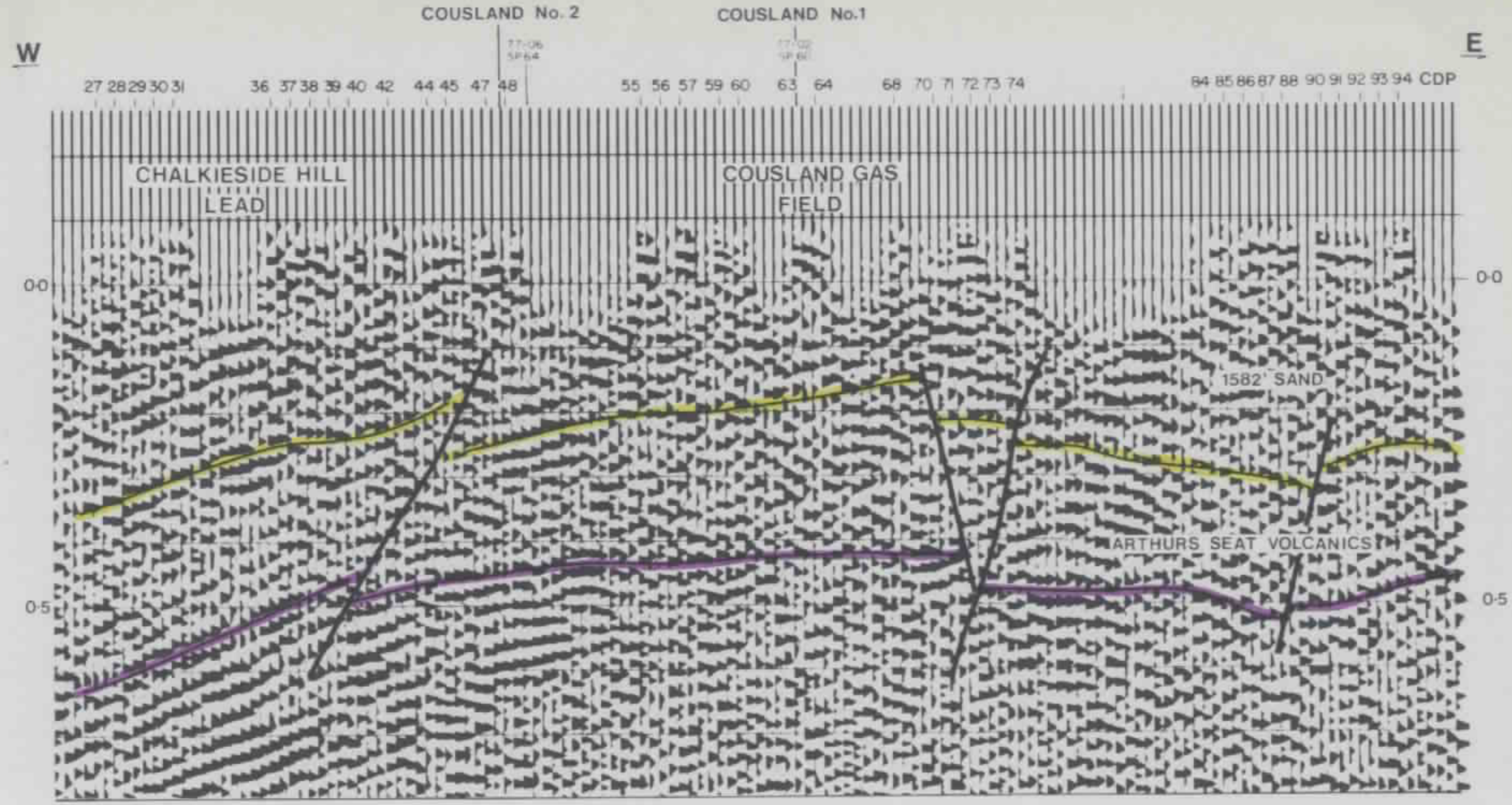

CARBERRY FAULT
CORONATION COAL
BRYAN'S SPLINT
KAILBLADES
COUSLAND GI
TOP HOSIE LST
69
37
8°
30°
INDEX LST
GREAT SEAM
SILLER WILLIE
CORONATION COAL
CROSSGATEHALL FAULT
NORTH GREEN LST.
NORTH GREENS
10°
8°
COUSLAND CULMINATION
10°
15°
10°
15°
4°
TOP HOSIE L.
20-30°
10°
68
37
COUSLAND 1
TOP HOSIE LST.
COUSLAND 2
NORTH GREEN LST
COUSLAND 5
DIRECTION OF DIP
LASMO North Sea PLC
PL 177
CHALKIESIDE HILL LEAD
SURFACE EXPRESSION
N
L.KAILBLADES
U.KAILBLADES
SCALE 1:10560
Date: JAN. 1985
Author: GEOLOGICAL SURVEY

Fig.22


LASMO North Sea PLC
PL 177
CHALKIESIDE HILL LEAD
1582' SAND DEPTH MAP
DATUM: MSL
C.I.:50'
Date JUNE 1978
Author OIL EX
SCALE 1:10560
77-01
77-02
77-03
77-04
77-06
77-11
G1
H
H
1500
1250
1750
2000
1850
1950
2600
2500
1800
1300
1200
1000
36
37
69
68
67
Fig.23



LASMO North Sea PLC

PL 177

LINE 77-01

(FILTERED STACK)

CHALKIESIDE HILL LEAD

Date : 1977	Author : OIL EX

Fig.24

contact than that on the Cousland culmination. In the absence of the faulting it is uncertain that significant dip closure would be developed beneath the Chalkieside Hill anticline within the Lower Oil Shale Group. This is because significant westerly thickening of this interval (as indicated by No. 2 well results) would deepen the objective sands in this direction and offset the effect of axial uplift which is seen at surface. It is difficult to substantiate the subsurface interpretation with the existing seismic coverage and quality. At best, any trap developed would be small.

6.5 Falside Hill

6.5.1 Surface Geology

The Falside Hill lead at surface is defined by faults on three flanks and apparent dip closure on the fourth (Figure 25). The easterly fault is the dextral strike slip Crossgatehall Fault which down throws by approximately 250 ft. to the southeast in this area. The northern bounding fault is down thrown to the northnorthwest, with a throw of approximately 100 ft at the western end of the lead. The southeastern bounding fault shows a 125 ft. upthrow in that direction. The structure is a continuation of the anticlinal trend seen in the Carberry Hill fault block.

Two closures are apparent from surface mapping at Top Hosie Limestone level. Each is dependent on fault closure to the north and south respectively and they are separated by a small saddle. Westerly dip closure over the block as a whole is demonstrated by measured dips of the order of 20°. Cousland No. 3 was drilled in the fault block at an apparently near crestal location.

6.5.2 Seismic Mapping

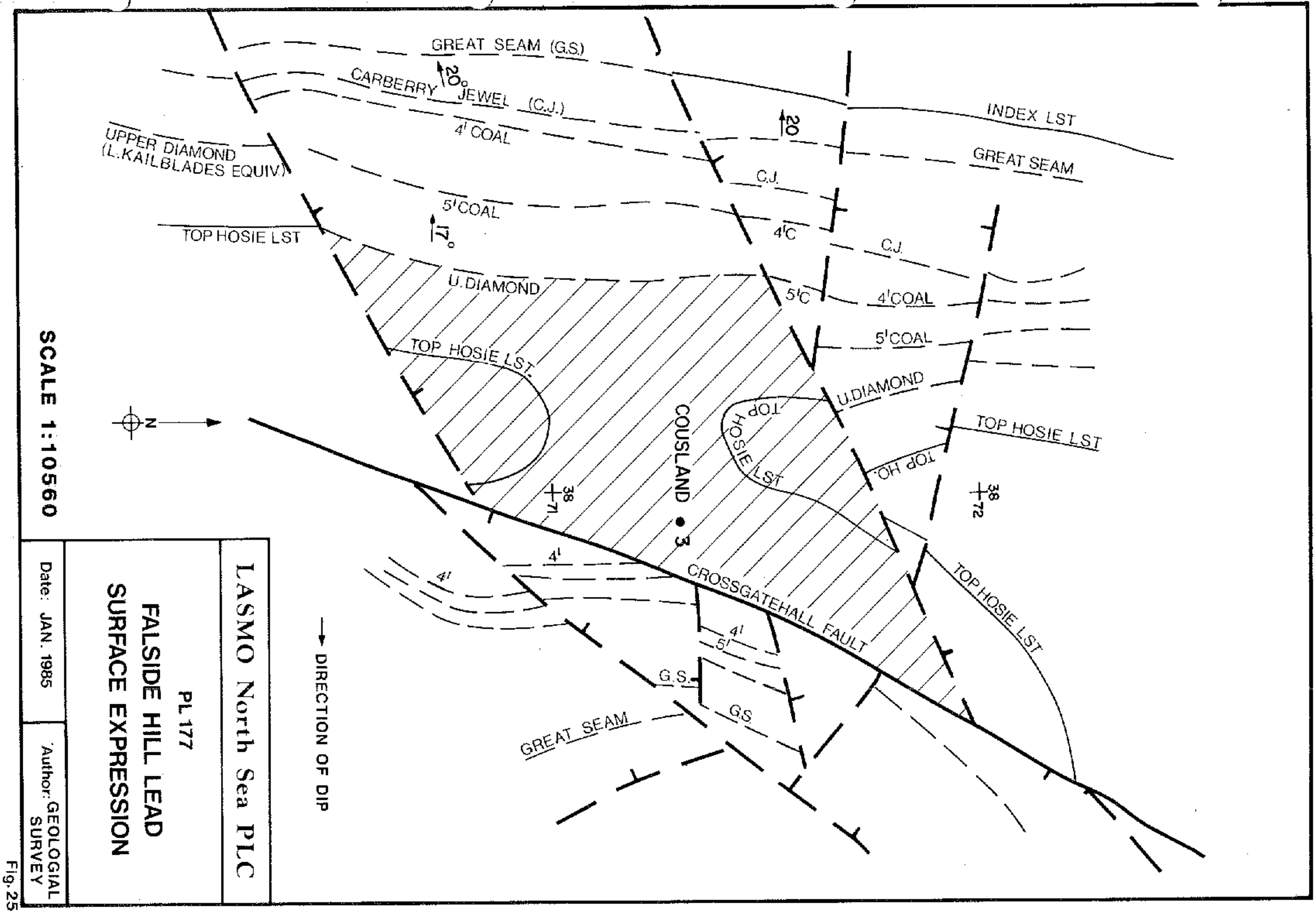
Two seismic lines cross the structure, 77-11 running NNE through the Cousland No. 3 well location and 77-20, running almost E-W across the southern part of the fault block. The faults are located on these sections on the basis of surface mapping. These lines shed little light on the true nature of the subsurface structure in this lead.

6.5.3 Well Control

Cousland No. 3 was located on the Falside Hill lead close to the Crossgatehall Fault. All sandstones encountered in the well were water bearing. The 1248' sand had slight gas shows, and the 1582' sand had gas shows in its upper part and oily joints and bedding planes.

6.5.4 Discussion

The lead, as currently interpreted from surface geological data appears to have been adequately tested by Cousland No. 3. The absence of any movable hydrocarbons in the well is attributed to the lack of seal, probably across the Crossgatehall Fault and possibly across the other bounding faults as well. Migration of any hydrocarbons previously reservoired in the fault block would be updip into the Carberry Hill lead to the south.



LASMO North Sea PLC

PL 177

FALSIDE HILL LEAD SURFACE EXPRESSION

Date: JAN. 1985

Author: GEOLOGIAL SURVEY

Fig. 25

6.6 Wallyford Lead

6.6.1 Surface Geology

The Wallyford Lead from surface geology (Figure 26) is structurally similar to the Falside Hill Lead, being a fault block with anticlinal dip closure to the west, partial dip closure to the east and fault closure on its other flanks. The fault block is upthrown 270ft to the west of the Crossgatehall Fault, 190ft to the south of the northern bounding fault, 40ft to the north of a partially bounding southern fault, and downthrown 150ft to the north of a main southern bounding fault. The axial surface of the anticline runs NNE-SSW through the block, providing some independent dip closure on both flanks.

6.6.2 Seismic Mapping

No seismic data have been acquired over the lead.

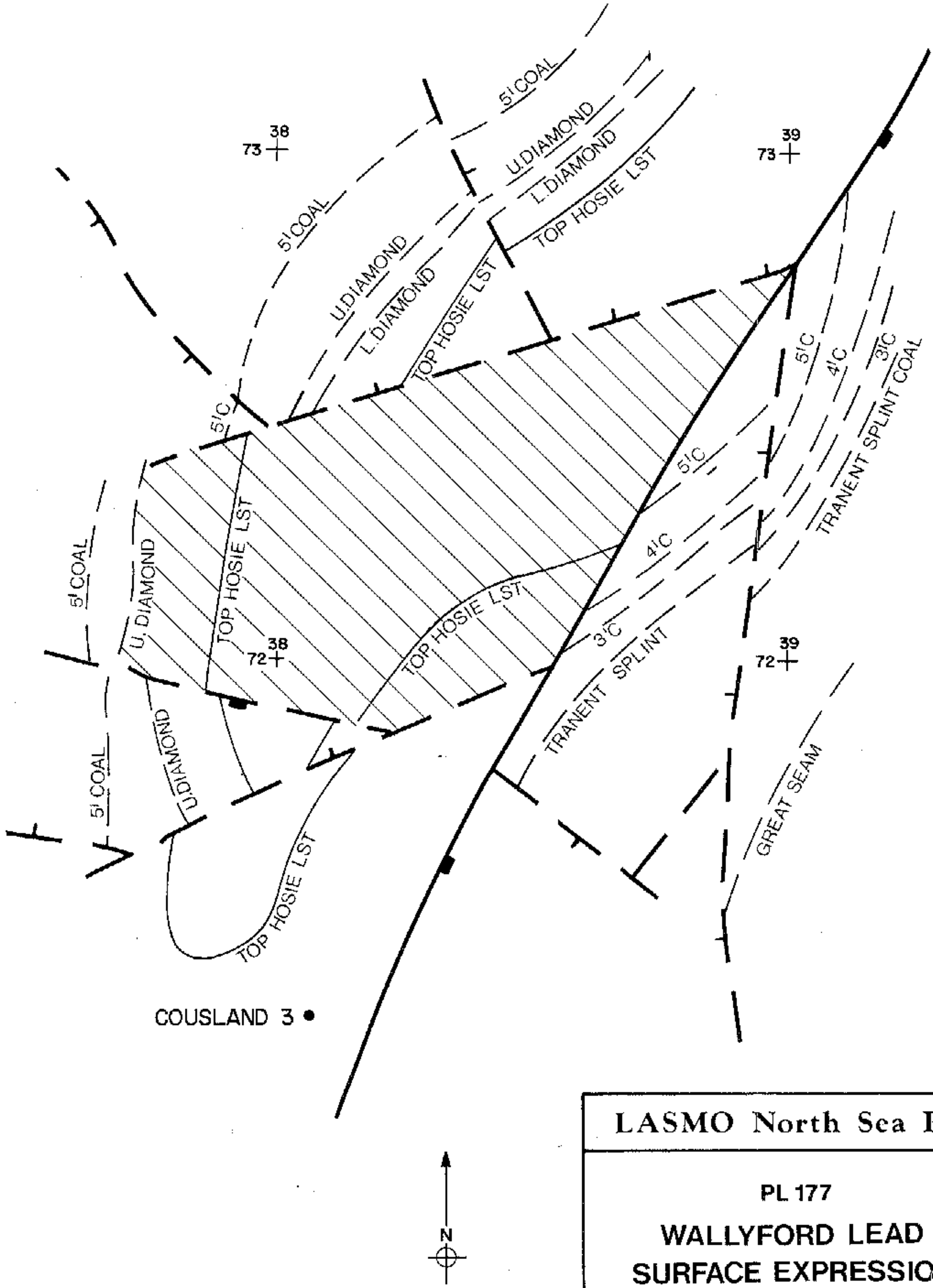
6.6.3 Well Control

The nearest well is Cousland No. 3 (see section 6.4.3), which is located on and tested the Falside Hill lead some 1100 yds to the south.

6.6.4 Discussion

The lead is defined solely on the surface geology. The apparent structural elevation is largely a result of the topography, the fold being more deeply eroded at the location of the lead than it is further south.

In addition to the reliance on fault sealing to the east along the Crossgatehall Fault, the presence of a quartz dolerite dyke running east-west across the lead provides an additional vertical conduit for hydrocarbon leakage. This lead has little or no potential.



SCALE 1:10560

LASMO North Sea PLC

PL 177

WALLYFORD LEAD SURFACE EXPRESSION

Date: JAN. 1985	Author: GEOLOGICAL SURVEY

Fig.26

7. CONCLUSIONS

The PL177 licence contains two abandoned hydrocarbon fields: the Cousland Gas accumulation and the Midlothian Oil Field. Although the two fields contain some remaining reserves, these are thought not to be large enough to be commercially attractive at the present time. Part of the reason for this conclusion is that both fields suffer from very low reservoir pressures, which when combined with the problems of oil mobility in the Midlothian field, and the possibility of premature water coning in the Cousland field, mean that only very low rates of production could be achieved.

The licence contains a number of leads which are located on the western side of the Crossgatehall Fault. These leads are all very small, ill-defined and rely on fault sealing along the Crossgatehall Fault. The latter is known to have been active at least until the Permian. However, if reservoir sequences were developed which had retained hydrocarbons, they would all suffer from an oil mobility problem owing to their shallow depth.

The Fordel Mains Lead, located at the southern end of the Cousland Field structure, has the most potential, although it lacks structural and seismic control. The Cousland No. 4 well produced on test a cumulative flow rate in excess of 190 MCFGPD with some associated water production. The possibility of an economic accumulation occurring at depth can not be determined across this lead without the help of high resolution seismic data. However, such seismic data are expensive to acquire, and the expenditure is thought not to be justifiable at the present time.

There is only one remaining feature within the PL177 licence which has true potential, and this is the Polton Prospect.

The Polton Prospect is located in the western part of the licence and lies directly beneath the workings of the Bilston Glen Mine. It can be observed at depth on two orthogonal seismic lines of 1982 vintage and also by subsurface mapping (NCB Seam maps). The structure appears from these data to be a horst block at reservoir depth over which latter sediments have been draped. Subsequent erosion has created the surface expression of the prospect which is in the form of a NNE-SSW trending anticline.

The reservoirs in this prospect occur deep enough to prevent oil mobility from being a problem and the areal extent of the prospect is large enough to contain economic reserves. The quality, and indeed development of reservoir sands in this part of the basin is unknown. The results of the Carrington and Straiton wells do, however, suggest that good sand units occur in the west of the licence, both in the Upper and Lower Oil Shale Groups.

The overriding problem of the Polton Prospect is the difficulty of finding a suitable drilling location acceptable both to the PL177 Group and the N.C.B. This has effectively made the prospect undrillable in the past, however, efforts will continue to be made to find a solution to this problem.

APPENDICES

APPENDIX 1

EXPLORATION WELL SUMMARIES

1.1 Stewart No. 1 (Figure 27)

Location: Midlothian Prospect, Cousland Anticline, close to Midlothian wells 1 and 3 and the D'Arcy borehole.

Objective: To establish detailed geology and potential reservoir control. To enable a more accurate assessment of the possible increase in production by stimulation or other means from the Cousland Anticline.

Results: Encountered many sandstone intervals within the Oil Shale Group, several with good reservoir characteristics and hydrocarbon shows. Core and log analysis gave low oil saturation and indicated the reservoir had been flushed.

Conclusion: The well tested only water. Numerous faults and highly dipping beds were interpreted from the dip meter indicating that the structure was much more complex than previously supposed. Pressure data from the 1000' sand and 1248' sand indicated depletion was possibly due to production from the adjacent Midlothian No.1 well.

STEWART No.1

RESULTS SUMMARY

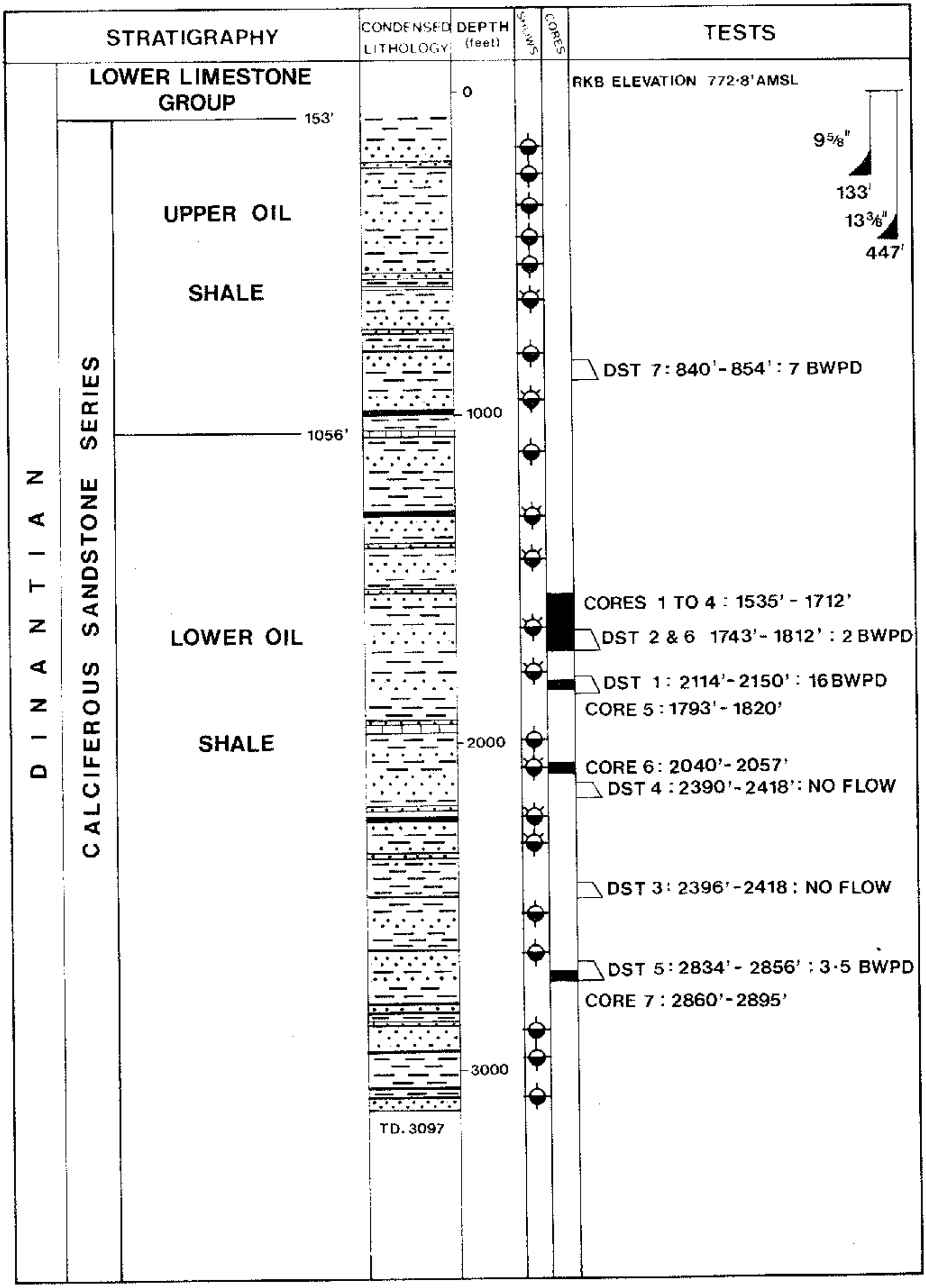


Fig. 27

1.2 Straiton 1/1Z (Figures 28 and 29)

Location: On a NE-SW trending Hercynian anticline located on the western margin of PL177 close to the Pentland Fault.

Objective: To test a full Oil Shale Group section of the Straiton Prospect and thus penetrate the Arthur's Seat Volcanics.

Results: The well had to be sidetracked and then terminated prematurely without reaching the Authur's Seat Volcanics due to technical problems.

Many sandstone intervals had hydrocarbon shows and one core exhibited bleeding oil. Subsequent log analysis gave water saturation of 90% or more. One open hole DST attempt failed due to packer failure.

Analysis of hydrocarbon recovered from core samples indicated water flushing of the reservoir.

Conclusions: The original hole had reasonable sand intervals exhibiting acceptable reservoir parameters. The structure was, however, shown to be far more complex than thought when the sidetrack hole cut a thrust zone and encountered poorer quality sands exhibiting poor to no hydrocarbons.

STRAITON No.1

RESULTS SUMMARY

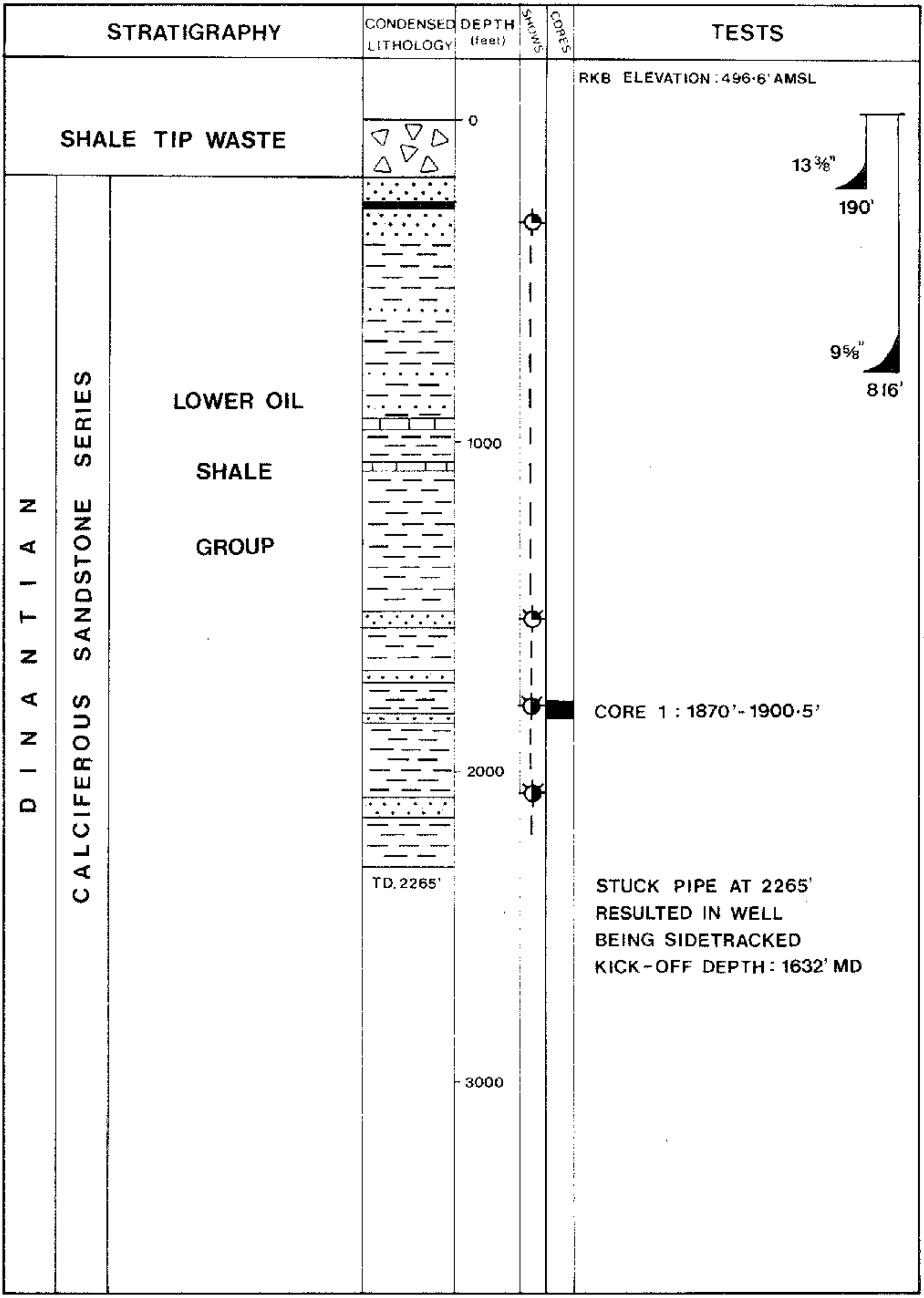


Fig. 28

STRAITON 1Z

RESULTS SUMMARY

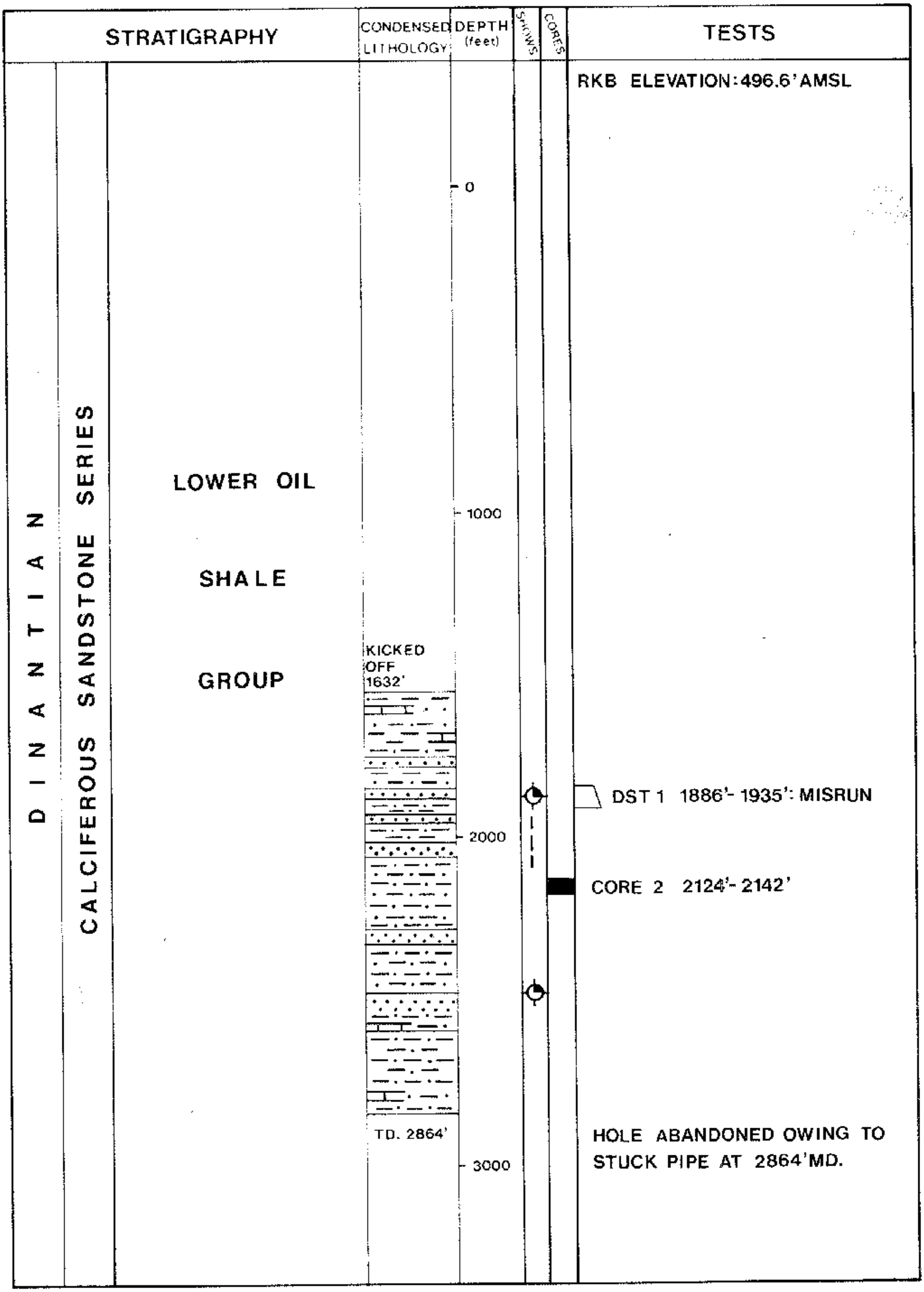


Fig.29

1.3 Carrington 1 (Figure 30)

Location: On the southern end of the Midlothian Syncline.

Objective: Lower Carboniferous Upper and Lower Oil Shale Group Sandstones in a fault bounded dip closed structure.

Results: Several good shows were encountered with small quantities of waxy oil being recovered from a sand at 3690' MD within the Upper Oil Shale.

Conclusion: Encouraging result that surface and subsurface mapping (i.e. N.C.B. coal seam maps) apparently proved closure in a deeper part of the basin although late movement of the Carrington fault would appear to have breached the structure at most of the potential reservoir horizons. However, limited amounts of light but waxy crude were produced on test. The low flow rates achieved reiterated the problem of oil mobility in shallow, low temperature, reservoirs.

CARRINGTON No.1

RESULTS SUMMARY

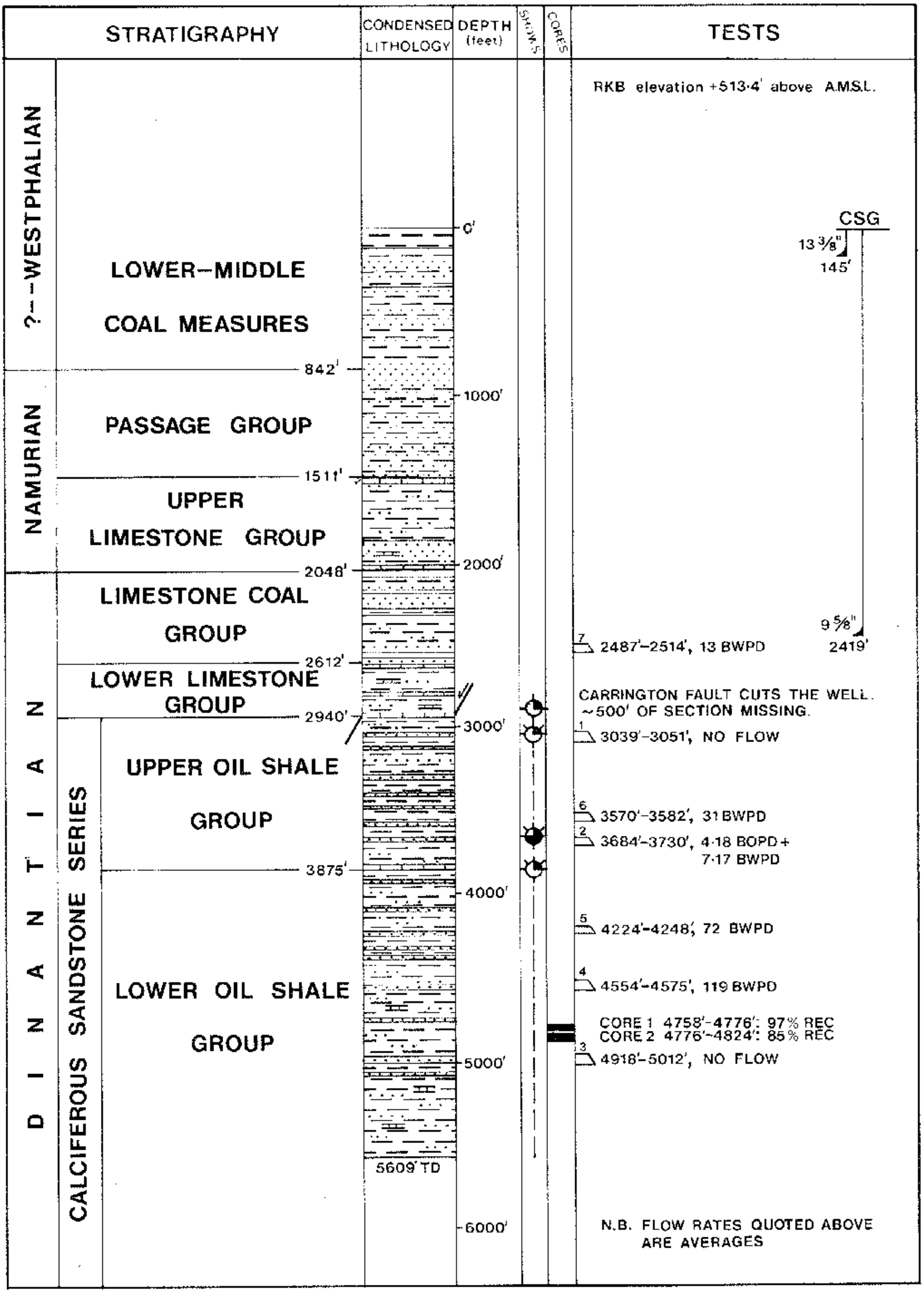


Fig.30

APPENDIX 2

PL177 COUSLAND & MIDLOTHIAN WELL SUMMARY SHEETS

WELL SUMMARY SHEET

WELL:	D'Arcy No. 1	LOCATION:	55°53' 13.30" 03°03' 42.25"
		(Grid Ref:	NT36 003365 006648)
DATE:	1919-1922	TD:	1,820' MD
RTE:	755'	STATUS:	P&A oil well.
GLE:	750'		

STRATIGRAPHY

UPPER OIL SHALE GROUP	:	?
LOWER OIL SHALE GROUP	:	1,190' MD
"1000' SAND"	:	?
"1248' SAND"	:	1,770' MD
"1582'SAND"	:	Not reached

TESTING SUMMARY

A 6" perforated casing was run from between 1746' to 1820', oil rose to 1500' but there was insufficient quantity of oil to prevent bailing the oil for more than a few hours a day. Cumulative production before the well was plugged and abandoned in 1922 was 53 barrels.

WELL SUMMARY SHEETS

WELL:	Midlothian No. 1	LOCATION:	55°52'18"N 03°01'07"
DATE:	1937-8	TD:	3,855' MD
RTE:	771'	STATUS:	OIL WELL
GLE:	762'		

STRATIGRAPHY

LOWER LIMESTONE GROUP :	TOP NOT SEEN
UPPER OIL SHALE GROUP :	163' MD
LOWER OIL SHALE GROUP :	1140' MD
"1000' SAND" :	1611' MD
"1248' SAND" :	1735' MD
"1582'SAND" :	1985' MD
"1720' SAND" :	2335' MD
ARTHUR'S SEA VOLCANICS:	3130' MD
DEVONIAN :	3665' MD

TESTING SUMMARY

INTERVAL (MD)	RESULTS
575'-605'	No recovery
700'-736'	100,000 CFGPD duration 20 mins. Build up pressure 190 psi
1458'-1469'	Recovered only drilling fluid
1750'-1818'	Recovered only drilling fluid
1952'-2012'	1.4 MMCFGPD, SIP: 740psi. Test interval changed to 1967'- 2012'MD and 1997'-2012'MD with similar flow rates achieved.
2032'-2046'	Recovered only drilling fluid

2318'-2400'	300,000 CFGPD, through 3/8" choke SIP: 800 psi
2578'-2675'	Zero recovery
2752'-2852'	Zero recovery
3660'-3763'	Zero recovery
1735'-1760'	5 BOPD, 75-90,000 CFGPD with some water through 3" tubing after fracturing.

REMARKS

a) POROSITY DATA FROM "1582' SAND" UNIT

DEPTH(MD)	POROSITY (%)
1440'	8.9
2010'	11.1
2230'	12.0
2265'	7.4

b) GAS COMPONENT ANALYSIS (% BY VOLUME)

	COMPONENT				
TEST INTERVAL (MD)	C1	C2	C3	C4	N_2 etc.
1735'-1760'	87.3	4.2	-	-	7.94

WELL SUMMARY SHEETS

WELL:	Midlothian No. 2	LOCATION:	55°52' 40"N 03°01' 18"W
DATE:	1938	TD:	2,943' MD
RTE:	621'	STATUS:	P&A Oil Shows
GLE:	614'		

STRATIGRAPHY

LOWER LIMESTONE GROUP :	Top not seen
UPPER OIL SHALE GROUP :	421' MD
LOWER OIL SHALE GROUP :	1440' MD
"1000' SAND" :	1815' MD
"1248' SAND" :	2002' MD
"1582' SAND" :	2340' MD
"1720' SAND" :	?2910' MD

TESTING SUMMARY

INTERVAL (MD)	RESULTS
867'-882'	Zero recovery
1014'-1036'	Zero recovery
1783'-1836'	Zero recovery
1809'-1855'	Zero recovery
1999'-2020	Zero recovery
2406'-2426'	Recovered gas cut mud with salt water.

INTERVAL (MD)	RESULTS contd....
323'-2491'	Zero recovery
2481'-2510'	Recovered saltwater (330')
2500'-2525'	Recovered non-saline mud with oil traces (40')
2491'-2890'	Zero recovery

NB: Various levels were tested through 7" casing, no data available.

REMARKS

a) POROSITY DATA

DEPTH(MD)	POROSITY (%)
2405'	7.75
2420'	9.1
2430'	1.35 - 3.4
2875'	6.4

WELL SUMMARY SHEETS

WELL:	Midlothian No. 3	LOCATION:	55°52' 20.5"N 03°00' 0.57"N
		(Grid Ref:	36456481)
DATE:	1939	TD:	1,760' MD
RTE:	760'	STATUS:	Oil Well
GLE:	750'		

STRATIGRAPHY

LOWER LIMESTONE GROUP :	TOP NOT SEEN
UPPER OIL SHALE GROUP :	166' MD
LOWER OIL SHALE GROUP :	1150' MD
"1000' SAND" :	1540' MD
"1248' SAND" :	1716' MD
"1582'SAND" :	Not reached

TESTING SUMMARY

INTERVAL (MD)	RESULTS
694'-733'	260,000 CFGPD
1577'-1608'	960,000 CFGPD
250'-1755'	? Recovered limited quantities of oil
1713'-1738'	2.5 BOPD (before perforation) 3.5 BOPD (after perforation)

(These sands were then fractured with 200 lbs of explosives; results unknown)

REMARKS

a) POROSITY DATA

INTERVAL (MD)	POROSITY (%)
1720'	15
1735'	12.3

WELL SUMMARY SHEETS

WELL:	Midlothian No. 4	LOCATION:	55°52' 28.75"N 03°00' 46.00"W
		(Grid Ref:	36426639)
DATE:	1939	TD:	1,771' MD
RTE:	726'	STATUS:	P & A Oil Shows
GLE:	719'		

STRATIGRAPHY

LOWER LIMESTONE GROUP	:	Top not seen
UPPER OIL SHALE GROUP	:	310' MD
LOWER OIL SHALE GROUP	:	1140' MD
"1000' SAND"	:	1568' MD
"1248' SAND"	:	1731' MD
"1582'SAND"	:	Not reached

TESTING SUMMARY

INTERVAL (MD)	RESULTS
1600'-1631'	Recovered gas-cut mud with some oil.
1731'-1755'	Recovered drilling fluid only.

REMARKS

WELL SUMMARY SHEETS

WELL:	Midlothian No. 5	LOCATION:	55°52' 25.5"N 03°00' 37.5"W
		(Grid Ref:	36796497)
DATE:	1940	TD:	2,150' MD
RTE:	746'	STATUS:	P & A Oil Shows
GLE:	740'		

STRATIGRAPHY

LOWER LIMESTONE GROUP :	Top not seen
UPPER OIL SHALE GROUP :	330' MD
LOWER OIL SHALE GROUP :	1150' MD
"1000' SAND" :	1590' MD
"1248' SAND" :	1746' MD
"1582'SAND" :	Not reached

TESTING SUMMARY

INTERVAL (MD)	RESULTS
1763'-1838'	Recovered drilling fluid only (formation "rather tight")

REMARKS

WELL SUMMARY SHEETS

WELL:	Midlothian No. 6	LOCATION:	55°52'14.25"N 03°00'59.50"W
		(Grid Ref:	36404062)
DATE:	1945-46	TD:	2299'
RTE:	760'	STATUS:	P & A Oil and Gas Shows
GLE:	753'		

STRATIGRAPHY

LOWER LIMESTONE GROUP	:	Top not seen
UPPER OIL SHALE GROUP	:	180' MD
LOWER OIL SHALE GROUP	:	960' MD
"1000' SAND"	:	1440' MD
"1248' SAND"	:	1568' MD
"1582'SAND"	:	1900' MD

TESTING SUMMARY

INTERVAL (MD)	RESULTS
150'-1510'	Unknown
1510'-1605'	Unknown
1810'-2300'	35 MCFGPD, through a 1/2" choke with some water production.

REMARKS

WELL SUMMARY SHEETS

WELL:	Cousland No. 1	LOCATION:	55°54' 03.5"N 02°59' 41.0"W
DATE:	1937-1974	TD:	2917'
RTE:	565'	STATUS:	Gas Well (P & A November 1974)
GLE:			

STRATIGRAPHY

LOWER LIMESTONE GROUP :		Top not seen
UPPER OIL SHALE GROUP :		242' MD
LOWER OIL SHALE GROUP :		803' MD
"1000' SAND" :	)	1000' MD
"1248' SAND" :	)	1248' MD
"1582' SAND" :	) Type Well	1582' MD
"1720' SAND" :	)	1720' MD

TESTING SUMMARY

INTERVAL (MD)	RESULTS
1153'-1240'	Gas show giving 15,00-20,000 CFPD. C.I.P. ca 500-600 psi. Duration 11 hours.
1220'-1294'	15' mud entered D.P. Duration 2 hours.
1240'-1303'	Few gallons of oil and mud obtained, including slightly saline water. Duration 5 days.
1244'-1303'	ca. 15 gals, muddy saline water recovered. Duration 48 hours.
1244'-1310'	ca. 30,000 CFPD gas.
1557'-1591'	Gas ca. 800,000 CFPD. Duration 5 days.

TEST SUMMARY contd...

1596'-1642'	"Much gas". Duration 1 hour.
1618'-1645'	4 CF mud in D.P. Duration 1/2 hour.
1596'-1652'	ca. 3,000,000 CFGPD at 615 psi. Duration 5 hours.
1618'-1652'	ca. 250,000 CFGPD. Duration 1 hour.
1627'-1652'	133' mud entered D.P. Duration 1 hour.
1700'-1758'	ca. 1.5 MMCFGPD. C.I.P. 650 psi. Duration 8 hours.
1759'-1806'	ca. 4.4 MMCFGPD at 643 psi. Duration 7.5 hours.
1857'-1985'	Negative. 1/4 hour.
2004'-2053'	Negative. 1/4 hour.
2096'-2127'	Gas production of 150,000 CFPD obtained. Duration 2.5 hours.
2178'-2227'	150' slightly gassy saline muddy water entered D.P. S.G. water (contaminated ?) 1.003. Duration 35 mins.
2371'-2404'	400' slightly gassy saline water entered D.P. S.G. 1.024 (contaminated ?). Duration 70 min.
2243'-2772'	Muddy sale water entered D.P. and rose to 650'. S.G. water (contaminated ?) 1.011. Duration 8 hours.

TEST RESULTS AFTER COMPLETION WITH 8 1/2" PERFORATED CASING

ZONE PERFORATED	RESULT
1760'-1806'	C.I.P. 650 psi. Gas/Water level calculated from evidence in No. 2 well at ca: 1905'MD. During 7 days production 35.4 MMCFGPD 73,500 gals. water. Gas declined 13 to 7 MMCFPD in first 3 days during which time water production rate increased from 17,000 to 22,000 GWPD.

TEST RESULTS contd....

	Well closed in. Max. C.I.P. 552 psi. Water level during period down to bottom of perforations (1800'). Flowed 600,000 CFGPD (total water free production is 70,000 CFPD at flowed pressure of 5 psi. Under these conditions water level in well was 120 ft. from surface. C.I.P. 555 psi. Rise in C.I.P. indicates that feed of gas from remote parts of sand to vicinity of well is in excess of 100,000 CFPD. Up to 13.8.39 rise of water level in formation was at least 26 ft, while on that data flowhead pressure was 593 psi and still rising. Rise of water considered to be compressing gas in reservoir. Hole filled with cement to 1740'.
1720'-1735'	After hole had remained dry since bailing on 25.8.39 C.I.P. was 593 psi. Gas production 800,000 CFPD. No water. Well flowed 8 hours and then shut in. C.I.P. 596.5 psi.
1582'-1613' and 1623'-1630'	C.I.P. 630.5 psi. (Constant from 25.10.39 - 3.11.39). Fluid level 1738'MD. 30 1/2 MMCFG produced and then well closed in. Production rate restricted and drilling and shooting water not reproduced. Flow pressure declines from 589 psi. to 550 psi. Production rate of 1 MMCFPD partly due to rise of water in hole to 1600'MD. C.I.P. 590 psi. Gas/Water level about 1708' but still falling.

REMARKS

a) Gas Component Analysis: (% by Volume)

	COMPONANT				
INTERVAL (MD)	C_1	C_2	C_3	C_4	N_2 etc
1188'-1279'	95.85	2.30	1.24	0.60	-
1248'-1279'	90.75	3.10	3.50	2.65	-
1582'-1632'	95.85	2.60	-	-	1.55
1720'-1800'	94.00	2.90	0.60	-	2.59
2094'-2122'	87.9	3.85	1.05	0.65	6.53

REMARKS contd...

b) Porosity and Permeability Data

Interval (MD)	Ø (%)	K (md)	Oil Content (% wt)
928'	-	26.01, 26.32	-
931'-932'	-	-	3.17
938'-939'	-	-	6.0
949'-950'	-	108.6	2.6
969'-970'	-	-	4.8
971'	-	61.37	-
1192'-1202'	-	-	1.4
1200'	-	2.06, 1.91	-
1248'	-	9.83	-
1248'-1258'	23.0	1.5	-
1262'	13.1	3.5	-
1265'	-	27.25	-
1586'-1588'	17.0	-	0.5
1590'	-	256, 280,284.6,	-
	327.9		
1613'	-	72.8, 26.55, 43.53,32.44	-
1625'-1626'	15.4	-	2.1
1631'	-	1.94, 2.73, 6.98, 5.64	-
1724'-1725'	-	4.35, 5.23	1.5
1791'-1792'	-	189	0.77
2013'-2017'	1.9-2.0	9.46	2.73 , 1.2
2020'-2027'	2.5, 1.8	15.77, 16.45	-
2105'-2106'	1.5, 1.6	166.8, 190.6	-
2187'-2189'	-	37.68, 45.22, 18.73, 19.94, 7.0	-

c) Crude Composition Analysis

Interval	S.G. (60°F)	API	Sulphur (% wt)	Wax (% wt)	Wax M.P (°F)
1248'-1275'	0.862 (32.5°)	32.70	0.06	26.5	95

Asphaltenes (%wt)	Nickel (ppm)	Vanadium (ppm)	Setting Point (°F)
-	7	1	54

d) Crude Distillation Analysis

	Volumes (%)							
IBP(°C)	125°C	150°C	175°C	200°C	225°C	250°C	275°C	300°C
87	1.0	3.0	4.5	6.0	8.0	12.0	16.0	21.0

WELL SUMMARY SHEETS

WELL:	Cousland No. 2	LOCATION:	55°54' 00.5"N 03°00' 24.45"W
DATE:	1938	TD:	2470'
RTE:	431'	STATUS:	P & A Oil Shows
GLE:	-		

STRATIGRAPHY

LOWER LIMESTONE GROUP :	Top not seen
UPPER OIL SHALE GROUP :	325'MD
LOWER OIL SHALE GROUP :	890'MD
"1000' SAND" :	?
"1248' SAND" :	1485'MD
"1582' SAND" :	2050'MD
"1720' SAND" :	2305'MD

TESTING SUMMARY

INTERVAL (MD)	RESULTS
1461'-1528'	Saline water only, FWHP 15 psi. Pressure at 1500' was 690 psi. Duration 3 hours.
1726'-1878'	5,000 CFGPD and Saline water which rose to 1117' MD. Duration 2 hours 38 mins.
2021'-2120'	Saline Water and mud only. Water rose to 138' MD. SIP at 2039' MD was 851 psi. Duration 2 hours 20 mins.
2090'-2432'	Saline water rose to 142' MD. Pressure at 2305' was 995 psi. Duration 2 hours 15 mins.

REMARKS

a) Many Sandstone intervals in the Lower Oil Shale Group exhibited oily bedding planes.

b) Bulk Chloride in concentration from interval 1878' gave: 30,580 ppm total chlorides (50,000 ppm NaCl).

c) Porosity data

Depth (MD)	Porosity (%)	Permeabilities (md)
1496' (1248' Sand)	8.6	197.0, 138.3
1512'	1.2	1.88, 3.32
1515'	10.4	2.96, 2.73
2028'	10.2	53.72, 55.2
2057' (1582' Sand)	6.6	
2072/73'	3.6	
2095'	6.7	186.3
2286'	5.6	
2295'	11.7	
2310'	9.4	
2330'	5.2	
2340'	7.2	
2360'	3.1	
2366'	4.1	
2375'	11.1	
2385'	10.1	
2392'	4.6	
2404'	7.5	

WELL SUMMARY SHEETS

WELL:	Cousland No. 3	LOCATION:	02°59' 27.7"W 55°55' 50.5"N
DATE:	1939-40	TD:	2168'
RTE:	468'	STATUS:	P & A Oil Shows
GLE:			

STRATIGRAPHY

LIMESTONE COAL GROUP	:	Top not seen
LOWER LIMESTONE GROUP	:	150'
UPPER OIL SHALE GROUP	:	689' MD
LOWER OIL SHALE GROUP	:	1309'MD
"1000' SAND"	:	1670' MD
"1248' SAND"	:	1842'MD
"1582' SAND"	:	2102'MD
"1720' SAND"	:	Not reached

TESTING SUMMARY

INTERVAL (MD)	RESULTS
1467'-?1581'	Recovered only saline water, water rose to 1202' MD. Duration 1 hour 27 mins.
1762'-1792'	Recovered only saline water, water rose to 1628' MD. Duration 1 hour 44 mins.
1749'-1830'	Recovered only saline water, water rose to 1024' MD. Duration 1 hr 43 mins.
2117'-2164'	Recovered only saline water, water rose to 1907' MD. Duration 1 hour 30 mins.

REMARKS

a) The "1582' Sands" exhibited oily joints and bedding planes in cores.

b) Chloride ion concentrations from the sands at 1468'-1581' were 41,700 ppm total chlorides (68,000 ppm NaCl).

WELL SUMMARY SHEETS

WELL:	Cousland No. 4	LOCATION:	55°53' 12.20"N 03°00' 02.5"W
DATE:	1947	TD:	1995'
RTE:	631'	STATUS:	P & A Oil and Gas Shows
GLE:			

STRATIGRAPHY

LOWER LIMESTONE GROUP	:	Top not seen
UPPER OIL SHALE GROUP	:	84'MD
LOWER OIL SHALE GROUP	:	840' MD
"1000' SAND"	:	1098'MD
"1248' SAND"	:	1350'MD
"1582' SAND"	:	1592'MD
"1720' SAND"	:	1880'MD

TESTING SUMMARY

INTERVAL (MD)	RESULTS
319'-345'	237 BWPD
490'-540'	51 BWPD. Duration 63 mins.
750'-760'	428 BWPD. Duration 20 mins.
832'-930'	6,000 CFGPD, no water. Duration 35 mins.
932'-963'	160 CFGPD. Duration 92 mins.
932'-992'	1,500 CFGPD maximum and still rising at end of test. Duration 2 hrs 23 mins.
1022'-1055'	10,000 CFGPD. Duration 2 hrs 3 mins.
1075'-1105'	590CFGPD. Duration 2 hrs 1min.
1153'-1186	110CFGPD. Duration 2hrs 15mins.
1236'-1291'	4,000 CFGPD, 43 BWPD. Duration 1 hr 32 mins.

INTERVAL (MD)	RESULTS contd....
1369'-1402'	40 CFGPD , 0.85 BOPD. Duration 2 hrs 39 mins.
1442'-1482'	70,000 CFGPD maximum and increasing. Duration 4 hrs 4 mins.
1471'-1520'	50-101,000 CFGPD. Duration 2 hrs 39 mins.
1571'-1604'	320 CFBPD. Duration 4 hrs 40 mins.
1605'-1654'	90 CFGPD. Duration 2 hrs 7 mins.
1842'-1797'	11,500 CFGPD with some water production. Duration 1 hr 17 mins.
1843'-1888'	5,800 CFGPD no water. Duration 42 mins.
1940-1955'	245 BWPD (gas cut). Duration 1 hr 31 mins.

REMARKS

WELL SUMMARY SHEETS

WELL:	Cousland No. 5	LOCATION:	55°53' 55.6"N 02°59' 44.7"W
DATE:	1954	TD:	1918'
RTE:	551'	STATUS:	P & A Oil and Gas Shows
GLE:			

STRATIGRAPHY

LOWER LIMESTONE GROUP	:	Top not seen
UPPER OIL SHALE GROUP	:	280'MD
LOWER OIL SHALE GROUP	:	910'MD
"1000' SAND"	:	1091'MD
"1248' SAND"	:	1350'MD
"1582' SAND"	:	1693'MD
"1720' SAND"	:	1833'MD

TESTING SUMMARY

INTERVAL (MD)	RESULTS
887'-916'	137 BWPD (gas cut)
1053'-1084'	24 BWPD
1327'-1320'	1.1 BOPD and 60 CFGPD
1509'-1527'	224 CFGPD
1646'-1695'	3,850 CFGPD and 57 BWPD
1686'-1702'	80 CFGPD and 5.4 BWPD
1706'-1722'	47.8 BWPD

INTERVAL (MD)	RESULTS contd....
1724'-1755'	350 CFGPD and 68.8 BWPD
1830'-1861'	No flow
1868'-1903'	280 CFGPD and 88 BWPD

REMARKS

a) Crude Composition Analysis

Interval(MD)	S.G. (29°F)	API	Sulphur (% wt)	Wax (% wt)	Wax M.P (°F)
1327'-1350'	0.88	29.30	0.16	24.6	92

Asphaltenes (%wt)	Nickel (ppm)	Vanadium (ppm)	Setting Point (°F)
0.05	16	1	-

b) Crude Distillation Analysis

Volumes (%)

IBP(°C)	100°C	125°C	150°C	175°C	200°C	225°C	250°C	275°C	300°C
87	-	1.04	3.0	4.5	6.0	8.0	12.0	16.0	21.0

Total distillate : 18.4 % by Vol

Residue : 81.5 % by Vol

WELL SUMMARY SHEETS

WELL:	Cousland No. 6	LOCATION:	55°54' 04.9"N 02°59' 09.8"W
DATE:	1959-60	TD:	1910'
RTE:	556'	STATUS:	P & A Gas Shows
GLE:			

STRATIGRAPHY

LOWER LIMESTONE GROUP :	Top not seen
UPPER OIL SHALE GROUP :	230' MD
LOWER OIL SHALE GROUP :	?755' MD
"1000' SAND" :	?
"1248' SAND" :	?
"1582' SAND" :	?
"1720' SAND" :	?

TESTING SUMMARY

INTERVAL (MD)	RESULTS
1179'-1215'	No production
1357'-1382'	No production
1390'-1455'	No production
1483'-1568'	150 CFGPD
1444'-1543'	365 CFGPD (after fracturing)
1405'-1543'	72 CFGPD (after fracturing)

REMARKS

APPENDIX 3

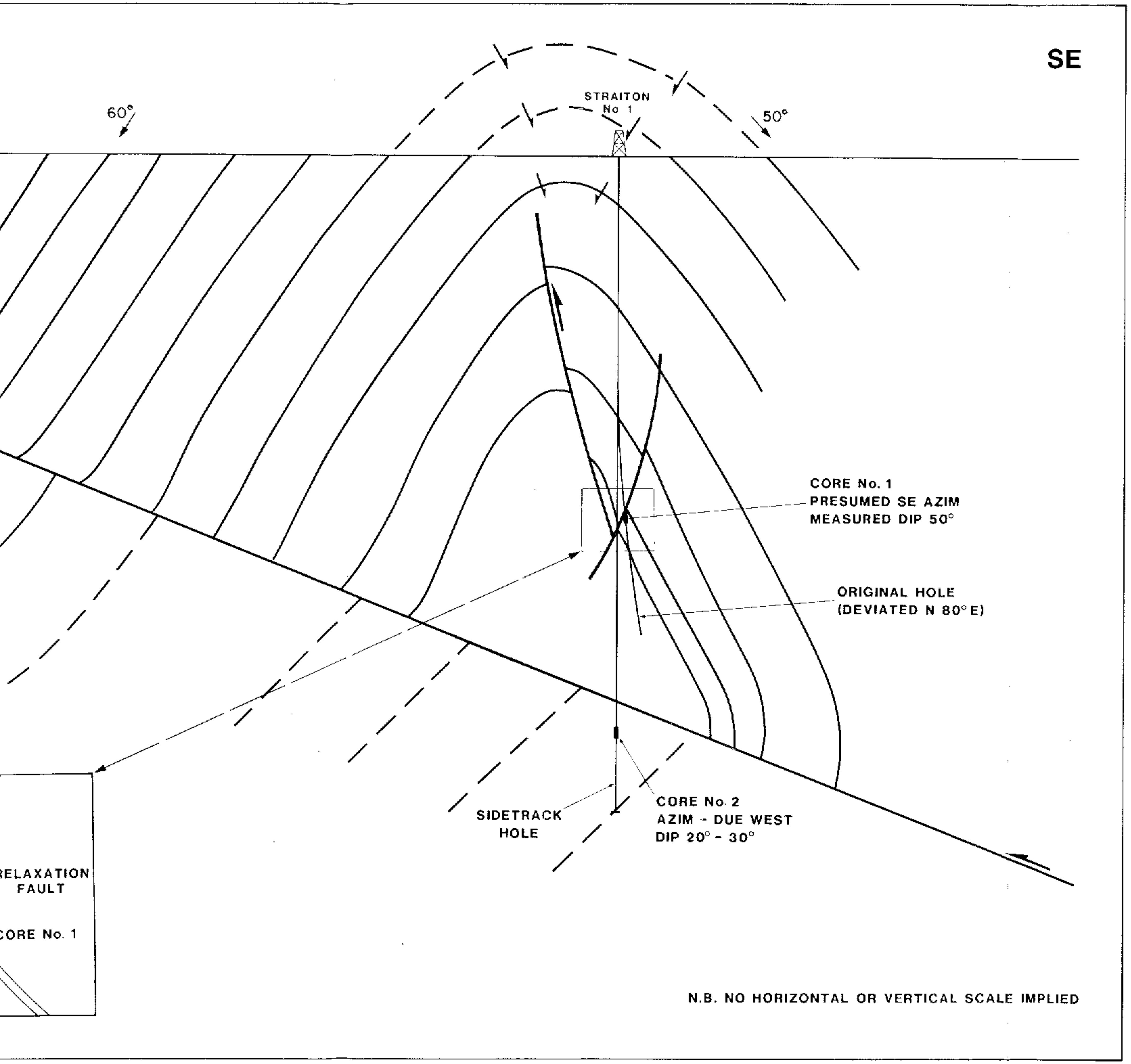
STRAITON 1/1Z STRUCTURAL MODEL

To explain the depth discrepancy between the same sand units in the original and the sidetrack hole, a structural model as illustrated in Figure 31 has been proposed.

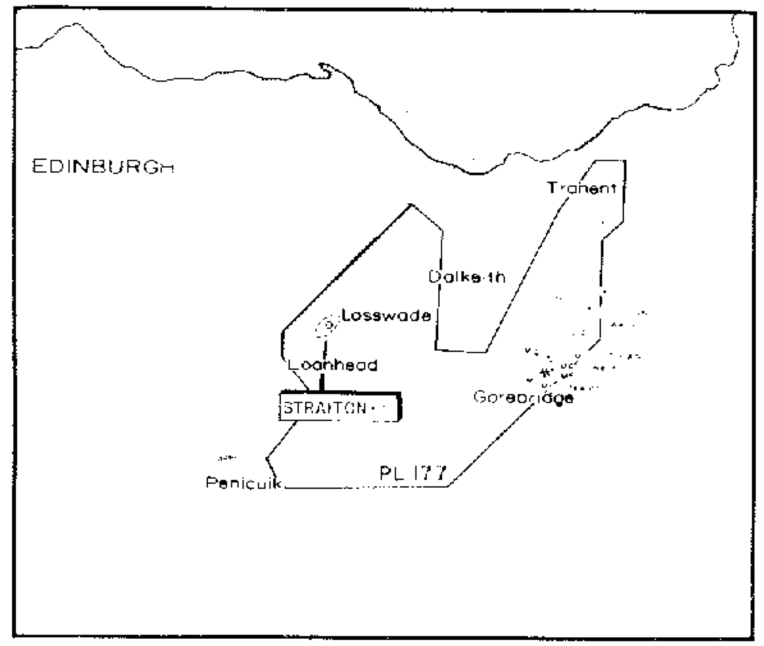
The surface dips and the high dips seen in the core cut in the original well indicate that this hole was located on the southeastern flank of the tight Straiton Anticline.

The sidetrack hole, by cutting a relaxation fault to a small thrust plane at a lower depth, did not encounter the sequence including the sand cored in the original hole until a deeper, much shallower angled thrust repeated the section.

The shallow dips and the azimuth of the bedding planes seen in the core from the sidetrack hole support the above hypothesis.



LOCATION MAP



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MODEL MUST HONOUR

1 SURFACE DIPS
2 DEVIATION OF ORIGINAL HOLE
3 DEPTH DISCREPANCY OF 30' BETWEEN CORED SAND IN ORIGINAL HOLE AND SAME SAND IN SIDETRACK
4 HIGH DIPS IN CORE #1, ASSUMED TO DIP TO SE
5 LOW DIPS IN CORE #2, OBSERVED TO DIP TO W.

LASMO North Sea PLC

STRAITON ANTICLINE
STRUCTURAL MODEL
(POST STRAITON No. 1)

Date : JAN. 1985	Author : LASMO

Fig. 31

APPENDIX 4

PL177 FIRST TERM RELINQUISHMENT DETAILS

At the expiry of the first term of the PL177 Licence on the 17th November 1984, in accordance with the Department of Energy Onshore Production Licence regulations, LASMO, as operator for the Group, relinquished fifty percent of the original PL177 licence acreage (Figure 3).

The retained portion of the licence is bounded by the lines connecting the points described by the following grid co-ordinates measured from the Edinburgh O.S. Sheet 66.

$^{3}246$	$^{6}585$	Bottom left and then in a clockwise direction.
238	597	
268	628	
250	650	
350	660	
307	716	
317	706	
315	650	
339	650	
373	721	
389	740	
398	740	
398	708	
388	698	
388	647	
$^{3}328$	$^{6}585$	Bottom right

APPENDIX 5

ABSTRACT FROM A REPORT BY M E FORD, BGC, NOVEMBER, 1969

ON THE PERFORMANCE CHARACTERISTICS

AND REMAINING GAS RESERVES OF THE COUSLAND NO. 1 WELL

1. <u>ESTIMATE OF INITIAL GAS IN PLACE</u> (assuming no water influx)

Wellhead Shut in Pressure	INITIAL	620 psia
	FINAL	459 psia
Gas produced		221×10^6 scf
Estimated gas gravity	0.6	
Formation Depth	1580'	
Estimated Formation Temperature	530^oR	
Estimated BH SIP	INITIAL	641 psia (Z=.91)
	FINAL	475 psia (Z=.93)

Gas Initially in Place = (Depletion Drive)

$$221 \times 10^6 \times \frac{641}{.91} \times \frac{1}{\left(\frac{641}{.91} - \frac{475}{.93}\right)}$$

$$= 804 \times 10^6 \text{ Scf}$$

2. ESTIMATE OF WATER INFLUX FROM SHUT-IN PRESSURE DATA

Average rate of pressure build-up during the 1st 100 days after shut-in	.0446 psi/day
Estimated bottom-hole pressure at shut-in	475 psia
Initial estimate of gas-in-place	804×10^6 scf
Cumulative Production at shut-in	221×10^6 scf
Reservoir Temperature (estimated)	530°R

$$W_e = G_f (B_{g1} - B_{g2})$$

W_e — Water Influx

G_f — Estimated Gas in Place at Shut-in

$(B_{g1} - B_{g2})$ — Change in Formation Volume Factors

$$W_e = (804 - 221) \times 10^6 \times \frac{14.7 \times 530}{520} \left(\frac{1}{475} - \frac{1}{475\ .0446} \right)$$

$$= 583 \times 10^6 \times \left(\frac{14.7 \times 530}{520}\right) \times 1.977 \times 10^{-7}$$

$$= 583 \times 10^6 \times 2.961 \times 10^{-6} = 1726 \text{ cu.ft./day}$$

Assuming an average rate of water influx during the production period at half the final rate

$$W_e = 863 \text{ cu.ft./day}$$

Total water influx during the production period of 2555 days

$= 2.205 \times 10^6$ cu.ft.

(equivalent to 75.2×10^6 scf)

3. **ESTIMATE OF INITIAL GAS IN PLACE WITH PRELIMINARY CORRECTION FOR WATER INFLUX**

Pressure/Volume relationship at constant temperature:

$$\frac{P_1}{Z_1}\frac{V_1}{G_1} = \frac{P_2}{Z_2}\frac{V_2}{G_2}$$

where:

P = Bottom Hole Shut in Pressure (psia)

V = Reservoir Volume of Gas (cu.ft.)

Z = Compressibility Factor

G = Volume of Gas at Standard Conditions (Scf)

Subscript 1 Initial Condition

2 Final Condition

Then $$\frac{P_1}{Z_1}\frac{G_1 \; B_g}{G_1} = \frac{P_2}{Z_2}\frac{(G \; B_{g1} - W_e)}{(G_1 - G_p)}$$

where:

Bg = Initial Formulation Volume Factor of Gas

G_p = Gas Production during interval

$$G_1 = \frac{\frac{P_1}{Z_1} \; B_{g1} \; G_p - \frac{P_2}{Z_2} \; W_e}{B_{g1} \; \left(\frac{P_1}{Z_1} - \frac{P_2}{Z_2}\right)}$$

3. contd....

First Estimate of Gas in Place	804×10^6 scf
Initial Bottom Hole Pressure (estimated)	641 psia
Final Bottom Hole Pressure (estimated)	475 psia
Initial Compressibility Factor	0.91
Final Compressibility Factor	0.93
First Estimate of Water Influx	2.205×10^6 cu.ft.
Average Reservoir Temperature	530°R
Gas Produced	221×10^6 scf

$$\frac{P_1}{Z_1} = \frac{641}{.91} = 704 \quad , \quad \frac{P_2}{V_2} = \frac{475}{.93} = 511$$

$$B_{g1} = \frac{14.7}{641} \times .91 \times \frac{530}{520} = .0213$$

$$G_1 = \frac{(704 \times .0213 \times 221 \times 10^6) - (511 \times 2.205 \times 10^6)}{.0213 \times (704 - 511)}$$

Initial Gas in Place = 532×10^6 scf

4. SECOND ESTIMATE OF GAS INITIALLY IN PLACE, ALLOWING FOR WATER INFLUX

Combing the equations of Sections 2 & 3

$$G_1 \; B_g \left(\frac{P_1}{Z_1} - \frac{P_2}{Z_2}\right) = \frac{P_1}{Z_1} \; Bg_1 \; Gp - \frac{P_2}{Z_2} \; C \; (G_1 - Gp)$$

Where C is the produce of the production period (in days) and the average water influx rate/day/unit volume of gas in place at shut-in

$$\text{Then} \quad G_1 = \frac{Gp \left(\frac{P_1}{Z_1} \; Bg_1 + \frac{P_2}{Z_2} \; C\right)}{Bg_1 \; \frac{P_1}{Z_1} - \frac{P_2}{Z_1} + \frac{P_2}{Z_2} \; C}$$

$$C = 2555 \times 1.481 \times 10^{-6} = 3.783 \times 10^{-3}$$

$$G_1 = \frac{(221 \times 10^6 (704 \times .0213) + (511) \times 3.783 \times 10^{-3})}{(.0213 \;\; (704 - 511)) + (511 \times 3.783 \times 10^{-3})}$$

Initial Reserves = 619×10^6 scf

Remaining Reserves = $(619 - 221) \times 10^6$ scf

= 398×10^6 scf

5. ESTIMATE OF GAS IN PLACE BY UNSTEADY STATE METHODS

The rate of pressure build-up after shut-in may be used to estimate the approximate volume of the gas reservoir provided the rate of water influx is known. But the rate of water influx is a function of the pressure differential (P_w) across the aquifer and of the effective reservoir radius (r) may be eliminated from the calculations by using the unsteady state dimensionless water influx relationships developed by Van Everdingen and Hurst but the unknown pressure differential remains. By combining material balance and unsteady state dynamic methods an estimate of effective reservoir radius and hence reservoir volume can be made.

A cross-plot of dimension less water influx coefficent (Q_t) (assuming an infinite aquifer) against a range of values of effective reservoir radius (r) and also against a range of pressure differentials across the aquifer (P), using the known reservoir parameters and the observed pressure build-up, gives a point of intersection of the curves at which both relationships are satisfied.

If the indicated pressure differential across the aquifer implies that the pressure at its outer boundary has declined the aquifer radius is not infinite; but this does not greatly change the theoretical rate of water influx at this stage. An iterative procedure could be introduced to improve this approach but there would be little reward in terms of an increased significance of the result.

(a) Dimensionless water influx coefficient (Q_t) as a function of pressure differential (P_w) (assuming a nearly constant rate of influx).

$$W_e = \frac{\pi r^2 h}{5.61} \; \emptyset_h \; \frac{\Delta P_{gas}}{P_{igas}} \quad \text{(Material Balance)}$$

water influx

$$W_e = 1.119\, \emptyset_h\, C_w\, r^2 h\, Q_t \Delta P_w \quad \text{(Unsteady State)}$$

where:

r = reservoir radius (ft)

$\emptyset_h$ = porosity (occupied by gas)

h = reservoir thickness (ft)

ΔP_{gas} = pressure build-up in reservoir psi

P_i = reservoir pressure at shut-in psia

C_w = compressibility of water psi^{-1}

then: $Q_t \, \Delta P_w = .5005 \dfrac{(\Delta P)\ gas}{(P_i)gas\ C_w}$

for

$$\begin{cases} \Delta P gas = 10 \text{ psi} \\ P_i gas = 460 \\ C_w = 3 \times 10^{-6} psi^{-1} \end{cases}$$

$$Q_t = \frac{.5 \times 10}{460 \quad 3 \times 10^{-6}} \times \frac{1}{\Delta P_w}$$

$$= 3623 \times \frac{1}{\Delta P_w}$$

ΔP	Qt
200	18.1
150	24.2
100	36.2
50	72.5
20	181
10	362

(Plotted as curve 1, figure 32)

(b) Dimensionless water influx coefficient (Q_t) as a function of effective reservoir radius (derived through the Van Everdingen relationship of (Q_t) with dimentionsless time (t_D)

$$t_D = \frac{2.64 \times 10^{-4}\ Kt}{\emptyset \mu_w c_w r^2}$$

where:

K = permeability (md) = 17 md

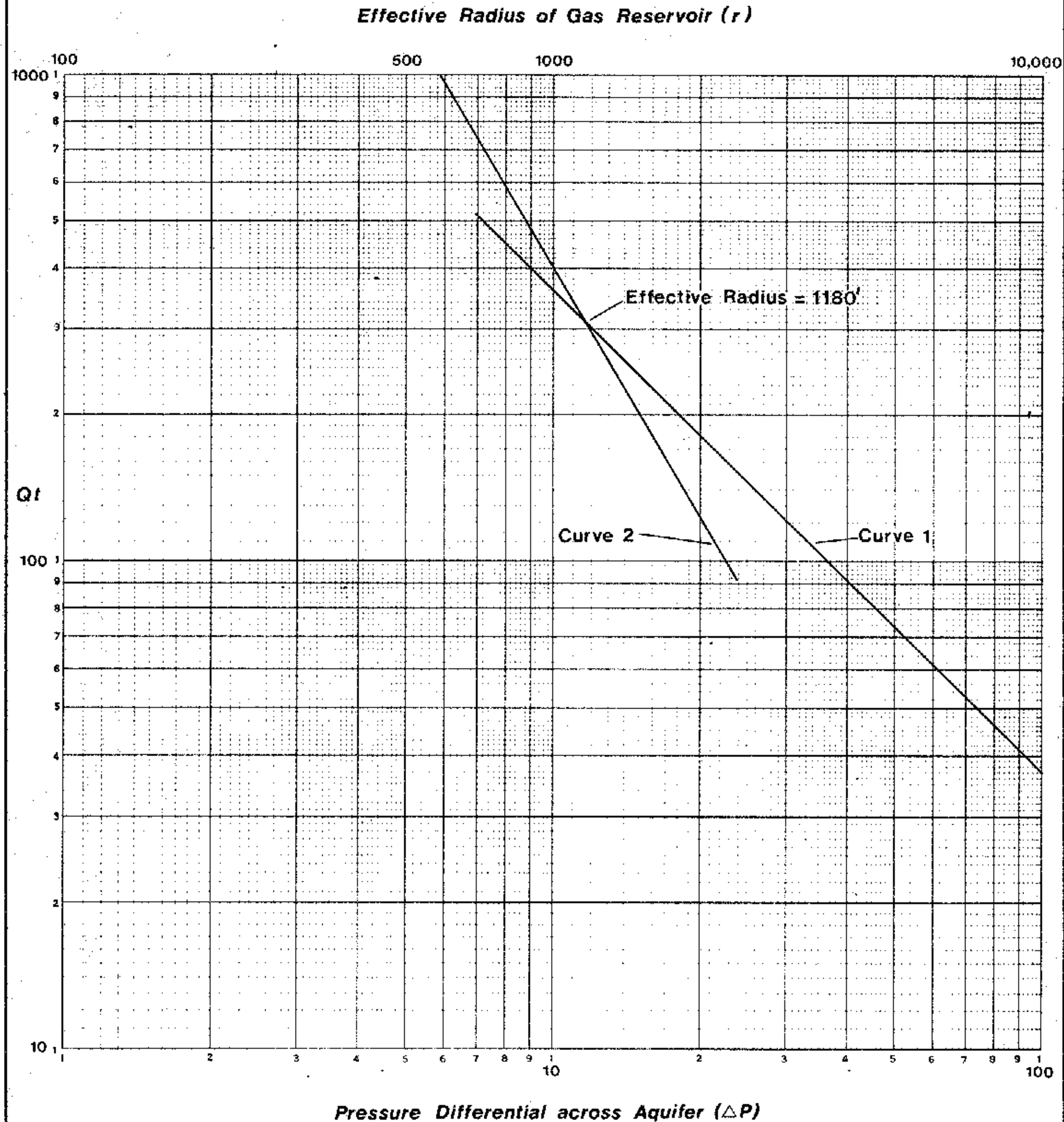
t = elapsed time (hours) = 19440

μ_w = viscosity of water (cp) = .17

c_w = compressibility of water = 3×10^{-6}

$\emptyset$ = effective posority

$$t_D = \frac{1.426 \times 10^9 Kt}{r^2}$$



Graph based on :

a) 10 psi pressure rise in 27 months after well shut in.

b) Reservoir permeability of 17md, estimated from well test data.

LASMO North Sea PLC

PL 177

CROSS PLOT Qt vs r and △P

(After BGC)

Date: JAN 1985 | Author:

Fig.32

r	r^2	t_D	Q_t
500	$2.5x10^5$	5702	1318
800	$6.4x10^5$	2228	574
1000	10^6	1425	392
1200	$1.44x10^6$	990	293
1500	2.25×10^6	634	196

(Plotted as curve 2)

From the intersection of the cross plot at r = 1180' (Figure 32)

$$G = \pi \times (1180)^2 \times 40 \times .12 \times (1-.25) \times \frac{475}{(.93 \times 14.7)}$$

gas in place therefore = 547×10^6 scf

PRESSURE AND PRODUCTION DATA

COUSLAND NO. 1

COUSLAND - PRODUCTION -v- PRESSURE FROM JANUARY 1958

	1958			1959			1960			1961		
	Volume thou.cu.ft.		Press. psig	Volume		Press.	Volume		Press.	Volume		Press.
	Month	Cum	end mo	Month	Cum	end mo	Month	Cum	end mo	Month	Cum	end mo
J	2180	2180	620	2464	27340	593	1473	50374	577.5	4426	82107	545.5
F	2099	4207	611.5	2326	29666	591.5	1325	51699	577.5	4034	86141	544
M	2358	6565	608.5	2616	32282	590	2465	54164	574.5	3875	90016	540
A	2261	8826	606.5	286	32568	592	2456	56620	573	4377	94393	537
May	1950	10776	605.5	843	33411	591.5	2362	58982	571	4270	98663	534
Jne	1732	12508	604.5	2160	35571	588.5	1886	60868	569	3955	102618	532
Jly	1682	14190	604	2089	37660	587	1844	62712	568	3787	106405	529
Aug	1726	15916	603	2232	39892	585	1985	64697	566.5	4078	110483	526
S	1971	19887	601	1066	41958	583.5	2606	67303	565	4023	114506	522
O	2281	20168	599.5	2243	44201	581.5	2882	70185	563.5	4332	118838	520
N	2272	22440	597	2336	46537	580	3009	73194	557.5	4437	123275	514.5
D	2436	24876	595	2364	48901	578.5	4487	77681	550.0	3488	126763	512
	24876			24025			28780			49082		

	1962 Volume thous.cu.ft.		Press psig	1963 Volume		Press	1964 Volume		Press
	Month	Cum	end mo	Month	Cum	end mo	Month	Cum	end mo
J	3144	129907	Overhaul	3231	165489	490.5	3339	203346	457.5
F	2760	132667	Overhaul	3006	168495	488	1796	205142	458
M	2906	135573	551.5	3238	171733	486	1195	206337	460.5
A	2939	138512	508	3280	175013	483.5	1244	207581	460.5
May	3050	141562	505	3409	17842	479.5	1259	208840	460.5
Jne	2928	144490	504	3312	181734	476	1261	210101	460.5
Jly	2974	147464	503	3107	184841	473.5	1294	211395	460.5
Aug	2929	150393	501.5	2622	187463	473	1337	212732	460.0
S	2812	153205	Not taken	2996	190459	469	1335	214067	459.5
O	2948	156153	497.5	3195	193654	466	988	215056	459.0
N	2960	159113	495	3016	196670	461.5	1341	216397	459.0
D	3145	162258	493	3337	200007	459.5	1332	217729	459.0
	34595			37749			17722		

COUSLAND WELL-HEAD PRESSURE

(Well Closed-In on 22 April, 1965)

Date	Time	Interval (days)	Elapsed Time (days)	Pressure (psig)
22.4.65	10 am - 2 pm	0	0	455.5
23.4.65	0800	0	0	455.5
	0900	0	0	455.5
	1200	1	1	455.5
	1800	1	1	455.5
	2200	1	1	455.5
24.4.65	1000	1	2	455.5
25.4.65	1100	1	3	456
	1600	1	3	456.5
	2100	1	3	456.5
26.4.65	1000	1	4	456.5
	1600	1	4	456/5
	2100	1	4	456.5
27.4.65	0830	1	5	456.5
28.4.65	0830	1	6	456.5
29.4.65	0830	1	7	456.5
30.4.65	0830	1	8	456.5
3.5.65	0830	3	11	456.5
5.5.65		2	13	456.5
10.5.65		5	18	456.5
12.5.65		2	20	457

Cont./...

Date	Time	Interval (days)	Elapsed Time	Pressure (psig)
19.5.65		7	27	457.5
25.5.65		6	33	458
9.6.65		15	48	458.5
23.6.65	1100	14	62	459.5
15.7.65	1145	22	84	459.5
13.8.65	1430	29	113	461
24.9.65	1130	42	155	462
9.11.65	1115	46	201	465
7.12.65	1130	29	230	463
30.12.65	1515	23	253	463
4.2.66	1430	36	289	464
24.2.66	1145	20	309	464
1.4.66	1415	34	343	465
22.4.66	0845	21	364	465
25.5.66	1215	33	397	465.5
30.6.66	1200	36	433	465.5
20.7.66	1625	20	453	466
22.8.66	1225	33	486	466
10.10.66	1130	49	535	467
6.3.67	1130	147	682	468.5
5.4.67	1545	30	712	468.5
8.5.67	1145	33	745	469
6.6.67	1130	29	774	469
25.7.67	1200	49	823	469.5