# AN OIL SEEPAGE NEAR TOTON LANE, STAPLEFORD, NOTTS.

by

Frank M. Taylor

## Summary

An oil seepage escaping from a dolomitic sandstone is recorded from a locality near Toton Lane, Stapleford, Nottinghamshire. An account of local Trias stratigraphy is given, supplemented by observations from recent exposures in adjoining areas. The sandstone is considered to occur at the junction of the Keuper Waterstones and Keuper Marl, in a group of grey-green siltstones and sandstones. From a consideration of adjacent Carboniferous outcrops, the oil is thought to have its origin in marine strata of Namurian age and to have accumulated in a reservoir immediately above the source rocks or possibly in a sandstone of Lower Westphalian age. The subsequent geological history of the area has allowed the oil to migrate upwards into Trias strata, possibly along the fault plane of the Chilwell fault.

## Introduction

During routine examination of the excavations for the Stapleford - Sandiacre By-pass road (A.52) during May, 1963, a seepage of crude oil and bitumen was observed, escaping from a dolomitic sandstone which was found close to the footbridge which spans the road and links the grounds of the George Spencer County Secondary School. Information from adjacent areas is here used to determine the age of the dolomitic sandstone and the possible source beds for the oil.

## Stratigraphy

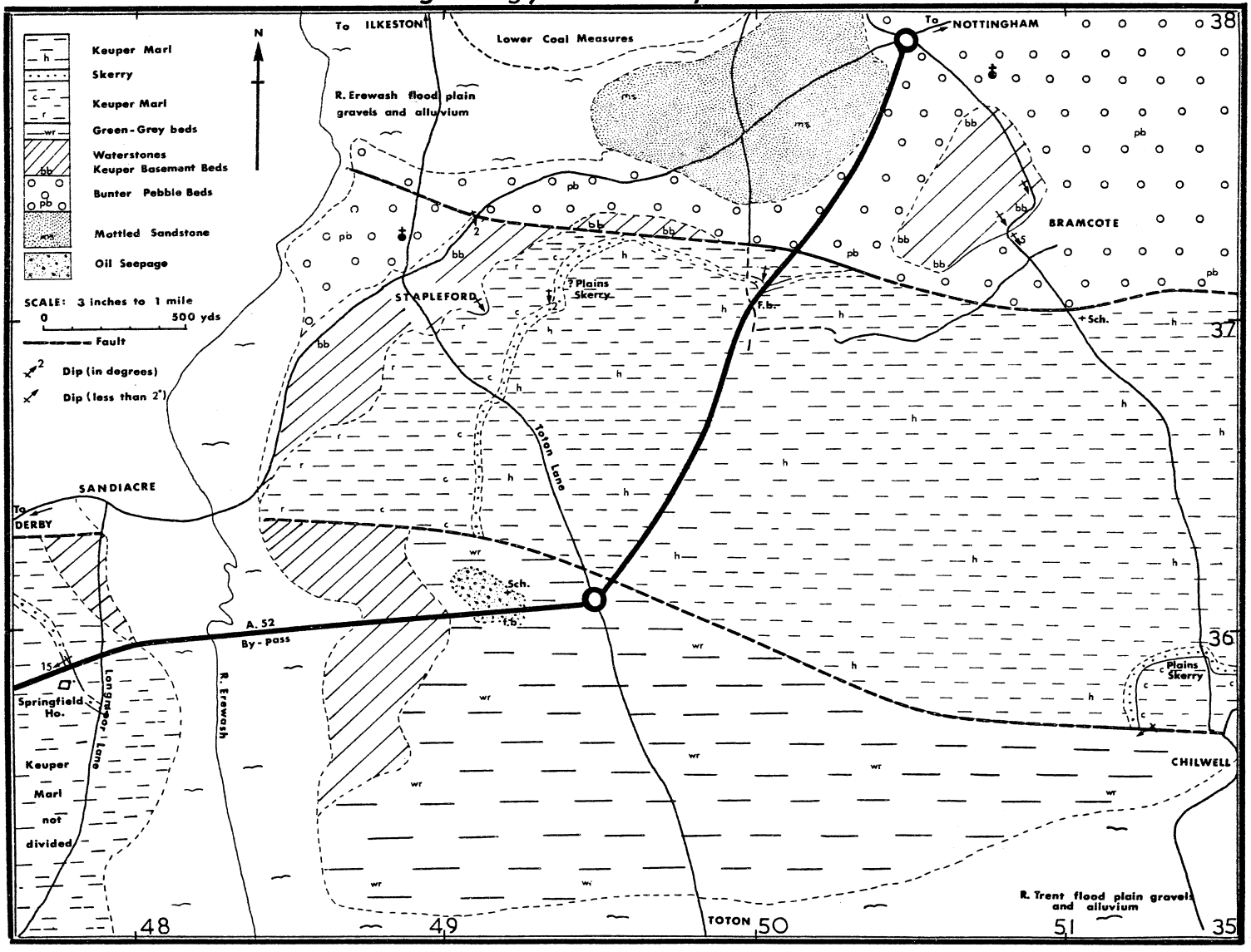
The geological sequence in the Stapleford - Sandiacre area has been determined as follows. The distribution of the rocks and important localities are shown on text-fig. 1.

| | Lithological divisions | Thickness | Keuper Formations (after Elliott, 1961) |
|---|---|---|---|
| | Keuper Marl | 30 feet plus | Harlequin |
| | Skerry Beds | 10 to 25 feet | Plains Skerry |
| | Keuper Marl | 45 to 55 feet | Carlton & Radcliffe |
| | Waterstones | 40 to 50 feet | Waterstones |
| TRIAS | Keuper Basement Beds | 0 to 15 feet | Woodthorpe |
| | | Non-sequence | |
| | Bunter Pebble Beds | 50 to 100 feet | |
| | Mottled Sandstone | 0 to 50 feet | |
| | | Unconformity | |
| | | Kilburn Coal | |
| | Lower Coal Measures | Alton Marine Bed (Gastrioceras listeri) | |
| | (Westphalian) | Crawshaw Sandstone | |
| | | Gastrioceras subcrenatum Marine Bed. | |
| | | G. cumbriese Marine Bed | |
| | | G. cancellatum Marine Bed | |
| CARBON- | | Chatsworth Grit | |
| IFEROUS | Millstone Grit | Reticuloceras superbilingue Marine Bed | |
| | | Ashover Grit | |
| | (Namurian) | R. gracile Marine Bed | |
| | | Kinderscout Grit | |
| | | Edale Shales | |
| | Carboniferous Limestone (Avonian) succession. | | |
| | | Unconformity | |
| PRE- CAMBRIAN | Charnian Beds | | |

Because of the absence of boreholes drilled below the base of the Trias in this area, the Carboniferous sequence is speculative. (See also Shipman 1891 and Lamplugh and Smith 1914).

The Keuper Marl. This division of the Trias outcrops extensively north of the Trent Valley in the Stapleford - Sandiacre area. It is composed of dark red siltstones and mudstones with a small amount of finely disseminated gypsum. Irregular patches or thin regular seams of green-grey coloured sediments are common. The green-grey beds are often dolomitic. In the lower part of the Keuper Marl succession (Radcliffe Formation), finely laminated beds are encountered. In the upper part (Carlton & Harlequin Formations), laminated beds are rare, the beds being uniform in character or "massive".

# Triassic geology of Stapleford.




Explanation to text-fig. 1. Geological symbols:- h = Harlequin Formation, c = Carlton Formation, r = Radcliffe Formation, Wr = Green-grey beds at the junction of the Waterstones and Radcliffe Formations, bb = Keuper Basement Beds, pb = Bunter Pebble Beds, ms = Mottled Sandstones. Geographical symbols:- sch. = school, fb = footbridge.

The Skerry Beds. A series of hard green-grey siltstones occurs about 55 feet above the base of the Keuper Marl. The rocks are well cemented, very hard, and contain dolomite, calcite and gypsum. These evaporite minerals are frequently leached out of the rock, giving an exceedingly porous bed. In places grain size increases to sandstone grade. The fine grained beds often exhibit sedimentary structures, particularly ripples of which there are two sizes, large and small (miniature). Salt pseudomorphs and irregular nodules are common. The best exposure of these beds is at the Chilwell Brickworks (SK 513358). The presence of the above structures, the occurrence of "ramifying green patches with purple centres" (Elliott 1961 p. 207) in the red marl below, and the extent of this horizon suggests correlation with the Plains Skerry of the Nottingham area. An exposure of thin skerry beds was seen at the eastern end of the By-pass road (Text-fig. 1); these can be traced westwards by a feature, until it eventually meets the Chilwell fault. It would follow that the thin series of marls above the skerry would belong to the Harlequin Formation with the Carlton and Radcliffe Formations occurring below. Whilst it is possible to use the skerry as a mapping division between two Formations, the division between the Carlton and Radcliffe Formations was not considered sufficiently pronounced to draw on the map.

The Waterstones. The junction of the Keuper Marls with the underlying Waterstones is usually taken at the first fine-grained, micaceous, brown sandstone, usually only a few inches in thickness. (But see also Elliott, 1961, p. 216). The sandstones become more numerous at depth and two or three feet thick; they were excellently exposed recently in a mains drainage trench at the extension of Windsor Street, Stapleford (SK 492371), the upper part of the cutting revealing the Waterstones/Keuper Marl Junction.

On the By-pass (SK 492361), the junction appears to be rather different. The lowest beds seen are fine to medium-grained red sandstones. These beds grade upwards into 17 to 18 feet of green-grey siltstones and sandstones with interbedded thin dolomitic seams, one of which occurs about $5\frac{1}{2}$ feet above the base. A similar succession is seen in the mains drainage trenches on the nearby housing estate on the north side of the road (SK 491362). The rocks, other than the dolomite, contain abundant mica. The finer grained beds exhibit sedimentary structures. These include large and small (miniature) ripples and salt pseudomorphs, together also with irregular nodules apparently produced by differential sedimentation. The thick series of siltstones and sandstones and the presence of mica suggests that the beds belong to the Waterstones. The dolomitic beds, colour and sedimentary structures are more typical of the Keuper Marl skerry beds. On the map (text-fig. 1) these green-grey beds are shown separated from both the Waterstones and the Keuper Marl and indicated with the symbol "wr".

Keuper Basement Beds. The lowest beds of Keuper age are a series of thin beds of alternating dark red marl and light red or buff, fine to medium grained sandstone. The sandstones in part contain very small pebbles. These rocks are seen at the top of the Stapleford sand quarry (SK 493373); at the roadside near the Carr Fastener Works, Stapleford (SK 492373), these two exposures being separated by the Beeston fault; and at the top of the hill in Bramcote village (SK 508373). The rocks can be compared with the Keuper Basement Beds of Swinnerton (1918) and Smith (1912); or the Woodthorpe Formation of Elliott (1961). (See also Shipman 1891).

Bunter Pebble Beds. A layer of large pebbles usually underlies the Keuper Basement Beds. The presence of these pebbles has generally been taken to indicate an erosion, dreikanter pebbles being found. The Pebble Beds are made up of coarse sands, commonly red in colour but sometimes yellow or buff, as in the Sandiacre area. They are normally friable rocks with little cement but the Stapleford and Bramcote Hills are famous for their red sandstone with irregular barytes cement, i.e. the Hemlock Stone (SK 499387). Pebbles are scattered throughout the deposit, usually aligned either with the current bedding or with the true bedding planes. The Pebble Beds were encountered at the extreme eastern end of the By-pass, about 200 yds. east of the footbridge (SK 500371) taking Baulk Lane over the road and on to the end of the By-pass at the Sherwin Arms Hotel (SK 504379). The excavation for the main drainage sewer, cut in a northerly direction 800 yds. east of the footbridge, exposed the lowest division of the Trias, the Mottled Sandstone. The junction of the Pebble Beds with the Mottled Sandstone occurs at road level at this point.

The Mottled Sandstone. (Sometimes referred to as the Lower Mottled Sandstone). These oldest beds of Trias age are finer grained than the Pebble Beds and pebbles are absent. The rocks, poorly cemented show irregular buff and green patches and seams. The beds are either thinly bedded or more commonly current bedded. Towards the base of the sequence, the inclusion of a small amount of clay (approx. 10%) mixed with the fine grained sand renders the deposit suitable for use as a moulding sand. In the area under discussion, the junction of the Pebble Beds with the Mottled Sandstone is gradational. The pebbles first disappear with depth, giving a medium-grained, well bedded sandstone. The beds become finer in grain size, the change being accompanied by a change of colour to a darker shade of red. As mentioned above, beds of the Mottled Sandstone were exposed temporarily in a deep excavation at the eastern end of the By-pass road.

Pre-Triassic Stratigraphy. The Triassic rocks described above are either faulted against or are seen to overlie unconformably the Carboniferous rocks which outcrop to the north in the Erewash Valley. Both faults and unconformity tend to strike in a more or less east - west direction. The one inch to one mile map published by the Geological Survey, Sheet No. 125, Derby, indicates the occurrence of the "Rough Rock" of Namurian (Millstone Grit) age also striking east - west in the Dale - Sandiacre area. A fault separating Pebble Beds, dipping south, from the "Rough Rock", dipping north, is well seen north of the escarpment at Stoney Clouds, Sandiacre (SK 475377). In the Matlock area to the north, the Geological Survey has shown that the sandstone previously referred to as "Rough Rock" is of Coal Measures age and the equivalent of the Crawshaw Sandstone. It is probable that the Millstone Grit type sandstone in the Sandiacre area, previously stated to be the "Rough Rock", is also of Coal Measures age.

It follows therefore, that the Carboniferous rocks to be expected beneath the Trias begin at the base of the Coal Measures and continue through a sequence of Namurian and Lower Carboniferous strata. (See table p. 24).

## The Oil Seepage

The oil occurred in the top beds of the green-grey siltstones and sandstones described above (p. 26) at the junction of the Waterstones and Keuper Marl. The known areal extent of the seepage is indicated on text-fig. 1. When the excavations were first made on the site of the By-pass, the more porous sandstones were completely saturated with bitumen and crude oil. In places cavities, up to 1" by ½" in size and lined with calcite crystals, were full of oil. The seepage occurred across the complete width of the road cutting and along the length of the outcrop made by the excavations, an area of approximately 2,500 square yards.

Recently the oil saturated rocks were seen in the excavations on the adjoining housing estate on the north side of the road, thus considerably increasing the known lateral extent of the oil contaminated rocks.

Oil continued to seep in the road cutting twelve months after the original discovery. Fine grained green or bluish-green marls and siltstones form the topmost beds of the section and no doubt formed the "cap rock" containing the oil below.

## Structure

Faults. The present survey of the Sandiacre-Stapleford area has confirmed the presence, and fixed more accurately the positions, of two east-west faults. The first is the Beeston fault, which emerges from the Trent Flood Plain west of Beeston Post Office (SK 528368) and runs westwards, cutting Chilwell Lane, Bramcote, just north of the Alderman White County Secondary School (SK 510371). The fault was recently exposed here during water main pipe-laying operations. The fault then continues, cutting the By-pass approximately 200 yards east of the Baulk Lane footbridge. Throughout this part of its course, the fault separates Keuper Marl on the south side from Bunter Pebble Beds on the north.

The second fault,not so well exposed, is first seen at the Chilwell brick works. Near the chimney stack at the southern end of the quarry, green-grey siltstones and sandstones are separated from Keuper Marl on the north side. The green-grey beds appear to be the same as the oil bearing rocks seen on the By-pass road. The fault continues westwards cutting the By-pass close to the Toton Lane roundabout (SK 495361) (Text-fig. 1). Unfortunately excavations here failed to reveal whether or not exposed red marl was adjacent to or on top of the oil bearing rocks and so the exact position of the fault was not located.

Folds. The dip of the Triassic rocks in the Nottingham area seldom exceeds one or two degrees. Steeper dips usually indicate the proximity of faults. Thus the dip of 15° noted near Springfield House, Longmoor Lane (SK 477359) in Keuper Marl, suggested at first the possibility of a fault along the Erewash Valley. Whilst this is not ruled out at this stage, the presence of Waterstones and the base of the Keuper Marl on the hill to the east of the Erewash Valley may be the result of fold movements (anticlinal) bringing up the older rocks to the east against the Chilwell fault.

## Source beds for the oil

Having noted the geological structure and sequence of the area, one can now speculate on the source of the oil. The classical theory for the origin of oil demands that it originates in marine strata from organic remains. The rocks which best satisfy these requirements are the marine organic shales of the Carboniferous.

Such beds can be found close to the Namurian Coal Measures boundary. The marine beds are those from the Gastrioceras cancellatum horizon to that of G. subcrenatum. There are more numerous marine shales in the lower parts of the Namurian Series, Stages E to R. Finally there are the marine beds of the Carboniferous Limestone, particularly the upper beds. The marine beds are thought to be the source beds for the oil found in the East Midlands oil field areas, i.e. at Eakring and Gainsborough (Brunstrom 1963; Falcon and Kent 1960 - these references list East Midland oilfield literature.) In these areas, geologists of the British Petroleum Company have shown that the oil reservoirs (oil sands) are the porous sandstones in the lower part of the Coal Measures (i.e. Crawshaw Sandstone) and in the Namurian strata (i.e. Ashover and Chatsworth Grits.) No records are available of commercial quantities of oil being extracted from sandstones of Keuper age in this country.

It is assumed that oil collected in the usual oil sands prior to the deposition of Trias sediments. The upper oil sands (i.e. Crawshaw Sandstone) may well have been eroded away in the area studied before the deposition of Trias sediments. After the long period of erosion and after the deposition of the Trias sediments, the oil migrated to its present position. In the absence of a thick series of Coal Measures sediments, the migrating oil had a relatively short upward passage to the green-grey sandstones of Keuper age.

The geological conditions outlined above for the Trias indicate why the oil accumulated in the green-grey beds. From surface investigations there is no indication of the characters of the hidden oil trap, whether this be anticlinal or controlled by faulting, or indeed if it exists at all. Movement along a fault (the Chilwell fault is conveniently placed) has allowed the oil to escape from the postulated hidden oil reservoir.

## Further Investigations

The need for further geological search is indicated. Geophysical surveys would indicate possible hidden structures. A series of shallow bore-holes would help to complete the surface geology. A geo-chemical survey (cf. Evans et al.1962) would indicate the extent of the seepage and possibly the centre of the reservoir. Comparative analyses of Eakring and Stapleford oils would provide further useful data.

## Conclusions

The oil seepage at Toton Lane, Stapleford, Notts., is seen to occur in porous sandstones at the junction of the Keuper Waterstones and Keuper Marl. It is thought to have originated in underlying Carboniferous sediments and to have migrated upwards possibly along the line of the Chilwell fault. Only further investigations and a bore-hole can prove the presence of commercial quantities of oil which may still remain in a hidden Carboniferous oil sand.


## Acknowledgements

The author acknowledges useful discussion of this topic with Dr. P. E. Kent and Dr. F. Howitt of BP (Petroleum Development) Ltd., on the origin of the oil; and with Mr. R. E. Elliott of the National Coal Board, East Midlands Division on the Keuper Formations in the area. Grateful thanks are extended to the Resident Engineer, Mr. Dixon, of Derbyshire County Council, for permission to visit excavations and for information on the state of excavations; to Nottinghamshire County Council's Surveyor and Engineer for access to site investigation reports, and to Dr. W. A. Cummins of the Department of Geology, University of Nottingham, who read the text and made useful suggestions.



F. M. Taylor, Ph. D., B. Sc., F. G. S.,
Dept. of Geology, The University,
Nottingham

## References


BRUNSTROM, R. G. W. 1963. Recently discovered oilfields in Britain. Proc. 6th World Petroleum Congress, Frankfurt, Section I, paper 49, pp. 10, text-figs. 8.

ELLIOTT, R. E. 1961. The Keuper Series in Southern Nottinghamshire. Proc. Yorkshire Geol. Soc., Vol. 33, pp. 197-234, pl. 15, text-figs. 6.

EVANS, W. D., COOPER, B., CORBETT, D. W., and GOUGH, K., 1962. A geochemical survey of the Nottinghamshire oilfields and related sediments. Quart. J. Geol. Soc. London., Vol. 118, pp. 25-38, pls. 2, text-figs. 4.

FALCON, N. L., and KENT, P. E., 1960. Geological results of petroleum exploration in Britain 1945 - 1957. Mem. No. 2, Geol. Soc. London. pp. 56, text-figs. 26, tables 5.

LAMPLUGH, G. W., and SMITH, B., 1914. The water supply of Nottinghamshire. Mem. Geol. Surv., U. K. pp. 174, pl. 1.

SHIPMAN, J. 1891. The geology of Stapleford and Sandiacre. Trans. Nottingham Naturalists Soc., 1891, pp. 10 - 17, pl. 1, text-figs. 2.

SMITH, B. 1912. The green Keuper Basement Beds in Nottinghamshire and Lincolnshire. Geol. Mag., Vol. 49, pp. 252 - 257.

SWINNERTON, H. H. 1918. The Keuper Basement Beds near Nottingham. Proc. Geol. Assoc., Lond., Vol. 29, pp. 16 - 28, text-figs. 2 - 5.


(Manuscript received 8th October, 1964)