

The Norfolk Oil-Shale Rush, 1916-1921

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ABSTRACT

Oil shales are one of those naturally occurring resources that require so much costly treatment to convert them into useful products that they are only worked on a large scale at times when the availability of cheaper alternatives is restricted. The need to find secure UK supplies during the First World War led to attempts to exploit the potential oil reserves contained in the more organic-rich parts of the Jurassic Kimmeridge Clay Formation. The most costly of these was that carried out in west Norfolk by the privately-funded English Oilfields Ltd (EOL) in 1916-1921 under the direction of Dr William Forbes-Leslie M.D., FGS. Extensive treatment works were constructed on the Kimmeridge Clay outcrop at Setchey, five miles south of King's Lynn, but very little oil shale was worked or retorted. An extensive drilling programme claimed to have proved sulphur-free oil shales, hundreds of millions of tons of free oil, a 21-m thick seam of natural paraffin wax (ozokerite), and an abundance of metalliferous minerals. At its peak in 1920, the stock-market value of the company was several hundred million pounds at present-day prices. The turning point came in 1921 when samples of shale oil from Setchey and the products derived from them by distillation were shown to have no commercial value because of their high sulphur contents. There was, at that time, no commercially viable method of reducing the sulphur contents to an acceptable level. The free oil, ozokerite and metalliferous minerals only existed in the reports to the shareholders.

Key words: oil shale Kimmeridge Clay Jurassic Norfolk English Oilfields Ltd

1. Introduction

Prior to the availability of large quantities of underground oil in the late 19th century, most of the oil for lubrication, heating and lighting in the UK came from the distillation of organic-rich rocks, mostly Carboniferous coals and oil shales¹ worked in Scotland. The first substantial shale-oil industry was begun in the Lothians of

¹ The term oil shale refers to organic-rich mudstones (> 10% total organic carbon) that yield appreciable quantities of oil when retorted at 400°C to 500°C: they contain little free oil.

Scotland by John (Paraffin) Young and others in 1851. It was initially based on Carboniferous cannel coals (that burned like a candle) and later on oil shales in the same Carboniferous succession. By 1865 about 120 shale-oil works were operating in Scotland, and in 1913 a maximum of over 3.2 million tons of shale was worked as the UK prepared for war (Carruthers *et al.*, 1927). The industry declined slowly but steadily from this peak, with a minor expansion during World War 2, due to the increasing availability of cheap crude oil from the Middle East.

Notwithstanding the contribution made by the Scottish oil-shale industry and imports from the Middle East, there were fuel crises from time to time during the First World War. Most of the dreadnoughts ran on coal, but many smaller ships, submarines, tanks, planes and lorries required oil, and there was not always enough of it. In December 1918, a month after the war had ended, a government commission reported that there had been times when large parts of the British Fleet had been inoperative not due to enemy action, but due to a shortage of fuel oil. Ships had remained in harbour due to the lack of oil reserves (*Petroleum World*, December 1918).

The Scottish oil-shale industry continued to flourish after World War 1 when nationalism became an important sales element. If foreigners could find oil then so could we, only ours would be of better quality. The commercial success of the industry depended in part on a tax concession that had been granted in World War 1 to encourage domestic oil production and reduce the dependence on imported oil. The industry closed in 1962 when the subsidy was withdrawn as a result of pressure from Middle East suppliers on the grounds of unfair competition (Cameron and McAdam, 1978). The large mounds of red-shale waste (binges) produced by the retorts still form a picturesque addition to the landscape of the Lothians, principally in the West Calder to Broxburn area.

Elsewhere in Britain, the Blackstone in the Jurassic Kimmeridge Clay Formation had been used in the Bronze Age and by the Romans to make ornamental vases and bowls, and probably also as a fuel (Arkell, 1947). From medieval times onwards until the 1930s it was dug on a small scale in Dorset for domestic use under the name Kimmeridge Coal. It burns with a sooty, foul-smelling flame on account of its high sulphur content, and leaves behind large quantities of ash. Accounts of rural Dorset by Victorian gentlemen travellers describe evil-smelling peasants crouching around smoky fires in their sooty hovels. The possibility of retorting the Blackstone to

produce oil was explored by the government in 1917-18 in the Kimmeridge and Corton areas of south Dorset (Figure 1). It was concluded that although hundreds of millions of gallons of oil could be produced, the cost of removing the high sulphur contents (6 to 8%) of the shale oils was too high for the refined oil to be competitive with Scottish shale oils (Strahan, 1920).

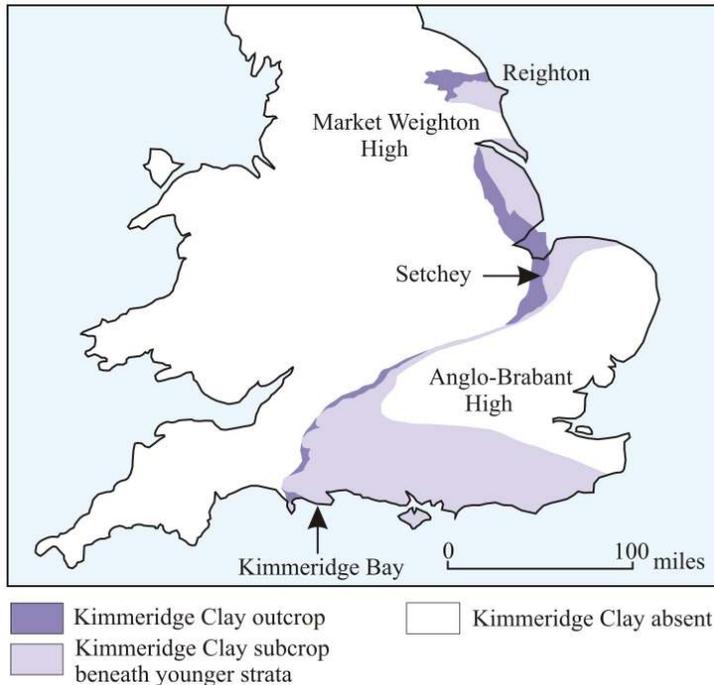


Figure 1. Geological sketch map of the English onshore outcrop and subcrop of the Kimmeridge Clay Formation (after Gallois, 1979).

2. The birth of a new industry

The urgent need to find new local sources of oil during World War 1 led to government and privately-financed searches for suitable source rocks in various parts of the U.K. Prominent among these was Dr William Forbes-Leslie, a Scottish medical doctor who, according to his own accounts, was an expert on oil shales in general, on those in the Kimmeridge Clay in particular, and was the first person to discover oil shale in Norfolk (Forbes-Leslie, 1917a). This last statement was not true. The first published record was that of William Smith on his geological map of Norfolk (1819) where he noted that the "Oaktree Clay" [Kimmeridge Clay] was "part slaty and bituminous as at Kimmeridge in Dorset". Rose (1835, p.175) subsequently recorded inflammable shales "that burned like cannel coal" in the Kimmeridge Clay in a brickpit at Southery [probably TL 617 958]. Forbes-Leslie later claimed that he had predicted that large quantities of oil shale would be found in the Kimmeridge Clay in

the King's Lynn area of Norfolk in 1912, the year in which he was elected to fellowship of the Geological Society of London. Later that year he visited the area where he met a farmer, a Mr H. Harrod of Wormegay, and showed him samples of oil shale and explained to him what to look for.

Shortly after, Mr Harrod sent a sample of shale that he had found in a drainage ditch (the Puny Drain: TL 626 1460) at Setchey 5 miles south of King's Lynn. Forbes-Leslie had it analysed, pronounced it to be a rich oil shale, and when he visited the site saw oil seepages in the Puny Drain that he presumed were derived from the Kimmeridge Clay (Forbes-Leslie, 1917a). It was largely on the evidence of these seepages and the prospect of finding oil shales comparable to those in Dorset, that exploration was begun at Setchey in 1916 by English and Foreign Oil Finance Ltd under the direction of Forbes-Leslie as their geological expert.

The results of this early trenching and drilling were reported by Forbes-Leslie in two accounts (1917a; 1917b), one of which included a description of the occurrence of petroleum in Britain, that received much publicity. At Setchey at least three 6-ft (1.8-m) thick oil-shale seams had been proved, two of which could be retorted to yield more than 50 gallons of oil per ton of dry shale² (Figure 2). Up to 75% of the oil was described as free oil that filled cavities in the shale (1917b), and yellow sandstones impregnated with bitumen were also said to be present (1917a).

In addition to supervising the exploratory work in Norfolk, Forbes-Leslie gave lectures in London and elsewhere on British oil prospects that were reported worldwide. He noted in one of these that oil had been struck in sandstones in a borehole near Newark, Lincolnshire at a depth of 2440 ft (682.8m). He deduced from this that “It should be possible to intersect the first oil-sands in North West Norfolk at 2000 to 3000ft below ground level”, presumably on the assumption that the oil-bearing sandstone was an unbroken horizontal sheet. He went on to explain that the amount of oil in the sands must be great because only part of it had leaked out to form the “hundreds of millions of tons” of free oil that were in the Kimmeridge Clay oil shales in Norfolk, and that it would therefore provide a “practically inexhaustible” source of oil (*The Straits Times*, 19 March 1917).

² gal/ton in this account refers to imperial gallons (1 gal = 4.546 l) and imperial tons (1 ton = 1016.1 kg)

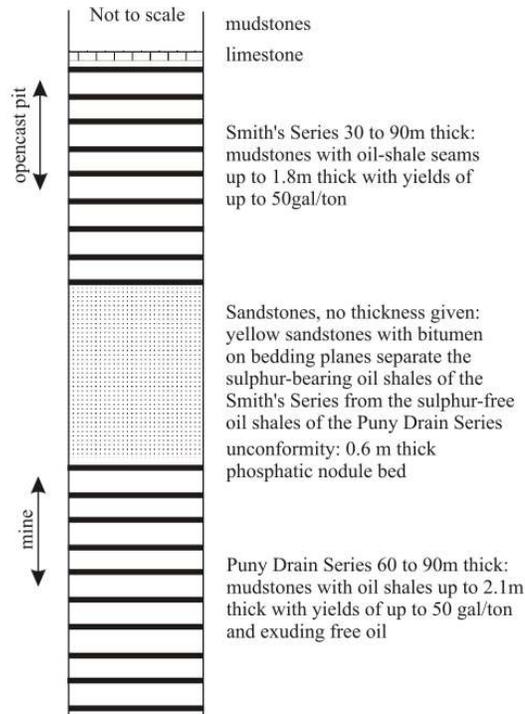


Figure 2. The oil-rich part of the Kimmeridge Clay succession proved in boreholes at Setchey according to Forbes-Leslie (1917a).

A new company was launched in 1917 on the basis of the Setchey results. The share prospectus for the proposed English Oilfields Ltd (EOL), dated 18th August 1917, offered 300,000 shares at £1 each (a total of c. £50 million at present-day costs). It stated that borings had proved that the property was underlain by a rich oil shale that had previously gone unrecorded; that the oil present was of an unprecedentedly high quality that would command the highest price on the market; and that the mining of the productive seams, the extraction of the shale oil and the production of ammonium sulphate as a by-product could be carried out commercially and cheaply. In summary, the proven oil seams were claimed to be sufficient to support several companies working 1000 ton of shale per day for 60 years. The share offer was successful and the company began work at Setchey in 1918 under the direction of Forbes-Leslie.

Between 1918 and 1919 the thickness and quality of the proved oil-shale seams increased steadily in Forbes-Leslie's statements to the English Oilfields shareholders. Yields of 20 to 40 gal/ton with sulphur contents of 4.5 to 8% were quoted in the analytical reports that accompanied the 1917 share prospectus. By July 1919 yields of 50 to 80 gal/ton of "practically sulphur free" oil had been achieved (*The Times* 8th

July, 1919). At an Extraordinary General Meeting held in September 1919 it was reported that the No. 1 Mine, which was in the process of being deepened to 200ft (61m), had proved a ‘middle series’ of sulphur-free oil-shale seams that was separated from the ‘upper series’ of sulphur-bearing seams by an unconformity (the Puny Drain and Smith’s Series in Figure 2). It was agreed to increase the capital of the company to £1,500,000 by the addition of 1,200,00 shares of £1 each (*The Times*, 2nd September, 1919). By December 1919, an 85 to 95 gal/ton-seam had been discovered and it was envisaged that an exceedingly profitable industrial complex would be built which, in addition to the oil, would produce cheap Portland cement (from the shale waste and the nearby Chalk), high quality bricks (from the Kimmeridge Clay overburden), electricity (from the waste gas from the retorts) and metalliferous minerals (from unspecified metamorphic rocks that had been discovered beneath the Kimmeridge Clay). In addition, it was claimed that large quantities of free oil had been discovered together with a widespread 70 ft (21.3 m) thick seam of natural paraffin wax (ozokerite). These results were widely quoted in the national and technical press, where the discovery of oil reserves in England that were as good or better than any elsewhere in the world was met with enthusiasm.

Extensive works were carried out at the Setchey site between 1919 and the end of 1920. A licence was granted in 1918 for a mine at Setchey, the only mining licence ever granted in Norfolk. It was stated in the application that it would open in 1919 with an underground staff of three and an above-ground staff of two. Two opencast pits were opened, one on the east side of the site to work Pleistocene gravels for aggregate, and one in the north west to work oil shales (Figure 3). Work was started on four retorts that were designed to process 1000 tons of oil shale per day, a network of standard-gauge and 2 ft-gauge railway tracks was laid to connect the mine and oil-shale opencast pit to the retorts (Figures 3 and 5), and a spur line (Clarke’s Drove Siding) was constructed to link the site to the main Great Eastern Railway (GER) London to King’s Lynn railway line. At its peak in 1920 the workforce comprised several hundred construction workers, and medical, fire and security teams with their own dedicated vehicles. The company was granted a licence by the Ministry of Munitions on the 26th January 1920 to “search for and get” oil from an area that covered the whole of north west Norfolk, c. 1000 sq km that stretched from Walpole St Andrew and Welney in the west to Burnham Market and Methwold in the east (Figure 4).

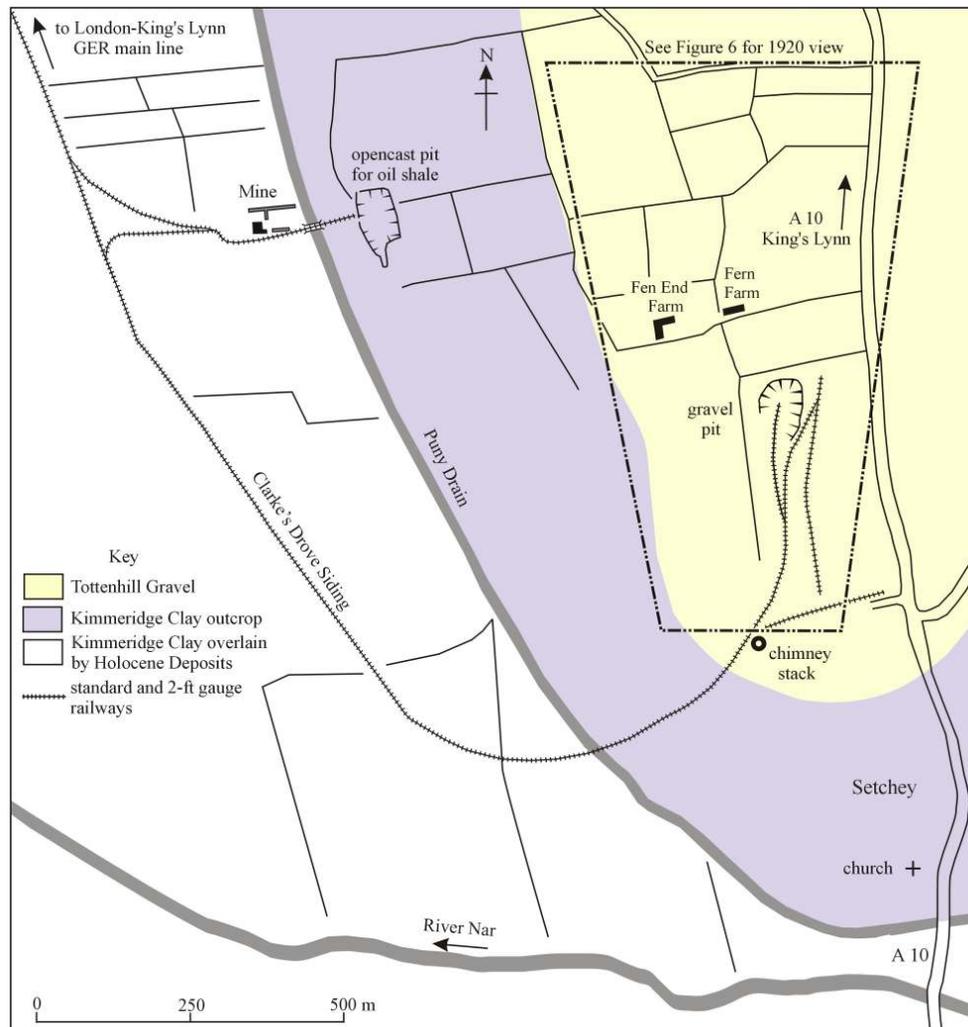


Figure 3. Sketch map of the EOL site at Setchey based on parts of Ordnance Survey 1 to 2,500 scale Sheets Norfolk 45/6 and 45/7 (1928).

The ongoing exploratory drilling was accompanied by extensive testing of the ‘natural’ oil and shale oil and their potential products. As a result, an 'expert working group' that included Forbes-Leslie was able to report in October 1920 that after distillation the oil shale yielded an average of 30.75 gal/ton dry shale. This was made up of motor spirit (23%), kerosene (32%), lubricating oil (29%) and bitumen solids (16%), all with 0.2% sulphur. When tested against a leading commercial brand the motor spirit was found to give 37 mpg against the 33mpg for the commercial brand (*Oil News* 23/10/20). The report also concluded that all the oil shales could be obtained more cheaply than had previously been estimated by working them in opencast pits. This was seen as having the additional advantage that it avoided the use

of large numbers of miners who were regarded as troublesome employees. The mine was closed in 1920 and its licence revoked in October that year.

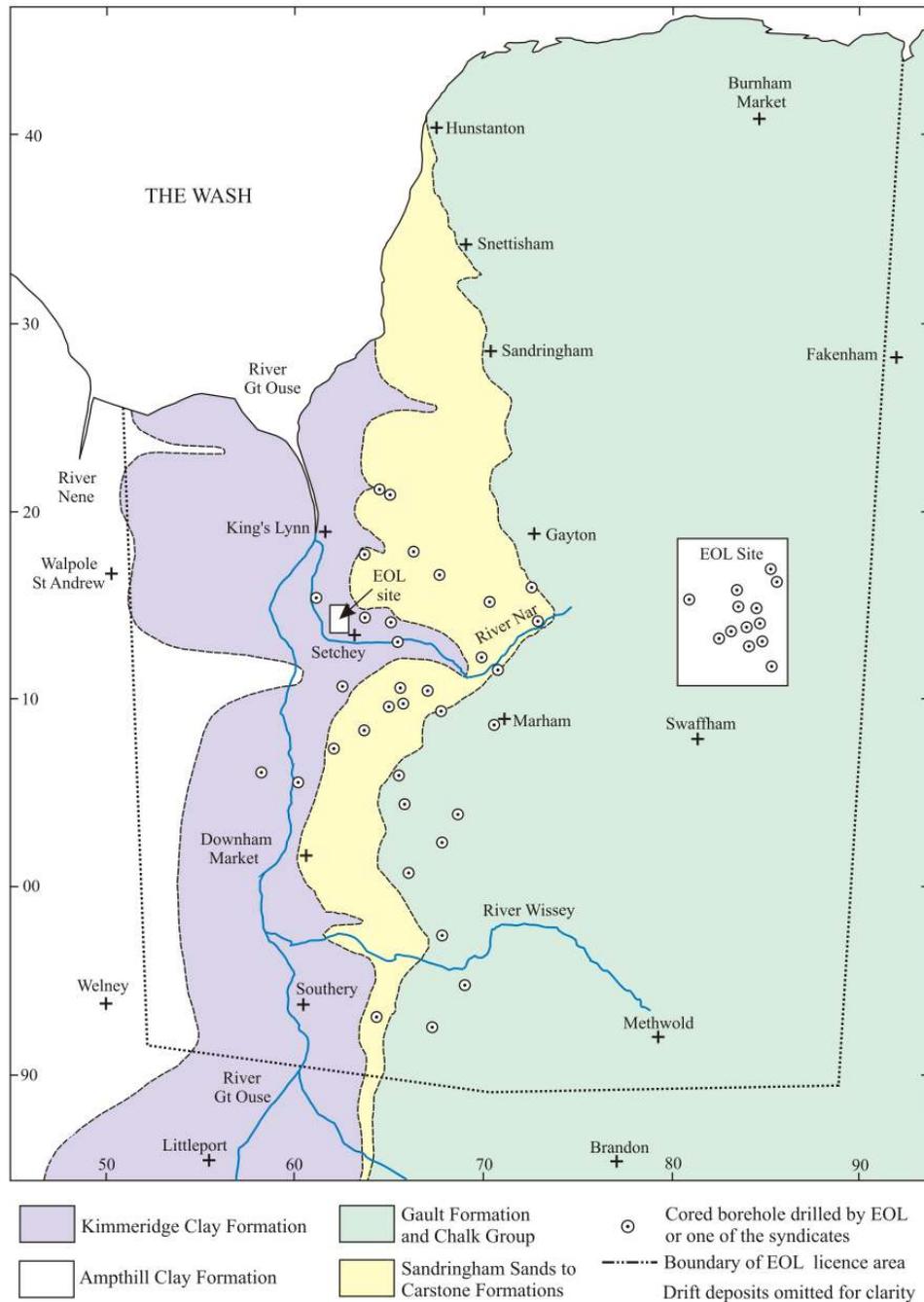


Figure 4. Geological sketch map of west Norfolk showing the English Oilfields Ltd (EOL) site, the company's licence area and selected oil-shale exploration boreholes drilled by EOL and local syndicates.

At the Annual General Meeting of EOL on January 1st 1921 the Chairman reported that the company was in a better position than ever before (*Oil News*, 8th January, 1921).

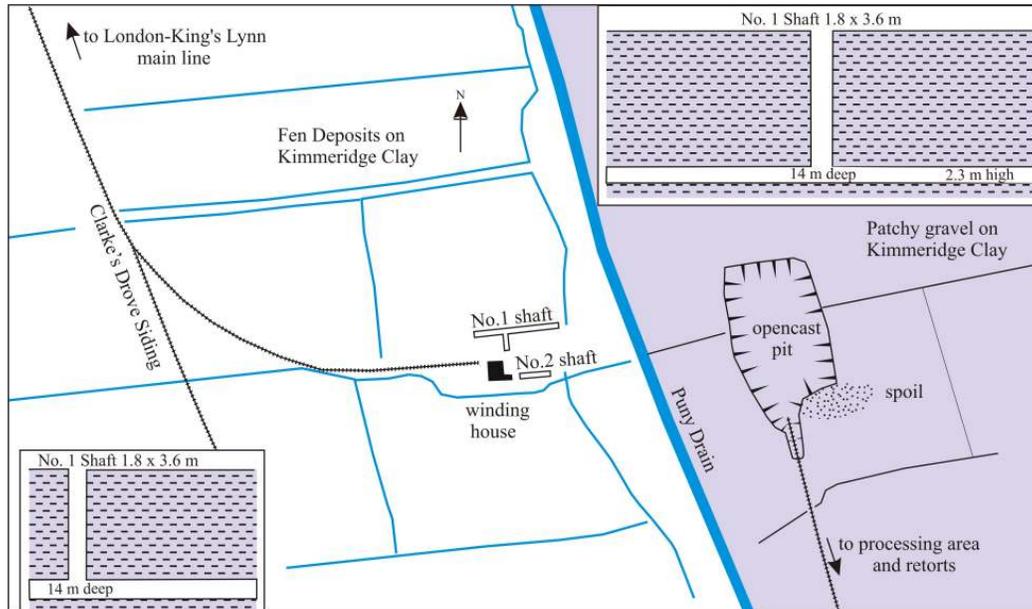


Figure 5. Sketch map of the area around the EOL mine and opencast pit based on Ordnance Survey 1 to 2,500 scale Sheet Norfolk 45/6 (1928) and Department of Mines Plan 7476.

3. Decline and fall

The turning point came in 1921 when Beeby Thompson and Partners were appointed as geological consultants, presumably in response to shareholder pressure as a result of a rapid fall in the EOL share price in the latter part of 1920. This was partly due to adverse publicity regarding the reportedly high sulphur content of the shale oil, and partly due to the failure of the company to produce any tangible results. In April 1921, Beeby Thompson sent a sample of the Setchey shale oil to Messrs Young's Paraffin and Light Mineral Oil Company Ltd at their oil-shale works at Uphall, West Lothian for distillation and analysis. Young's reported that the motor spirit (petrol) had an excessively high sulphur content and was not marketable; that the kerosene emitted large volumes of sooty, strongly acidic vapour when burned and was not marketable; that the fuel oil contained an excessively high sulphur content that made it unsuitable for use in internal combustion engines, but it might be used in liquid-fuel furnaces; that the lubricating oil had a high setting point and high sulphur content that lessened its suitability for use as a lubricating oil; and that the paraffin wax was present in too small a quantity to be of commercial interest. In addition, it was difficult to remove,

and its presence had an adverse affect on the setting point of the lubricating oil. In short, the Setchey shale oil had no commercial value.

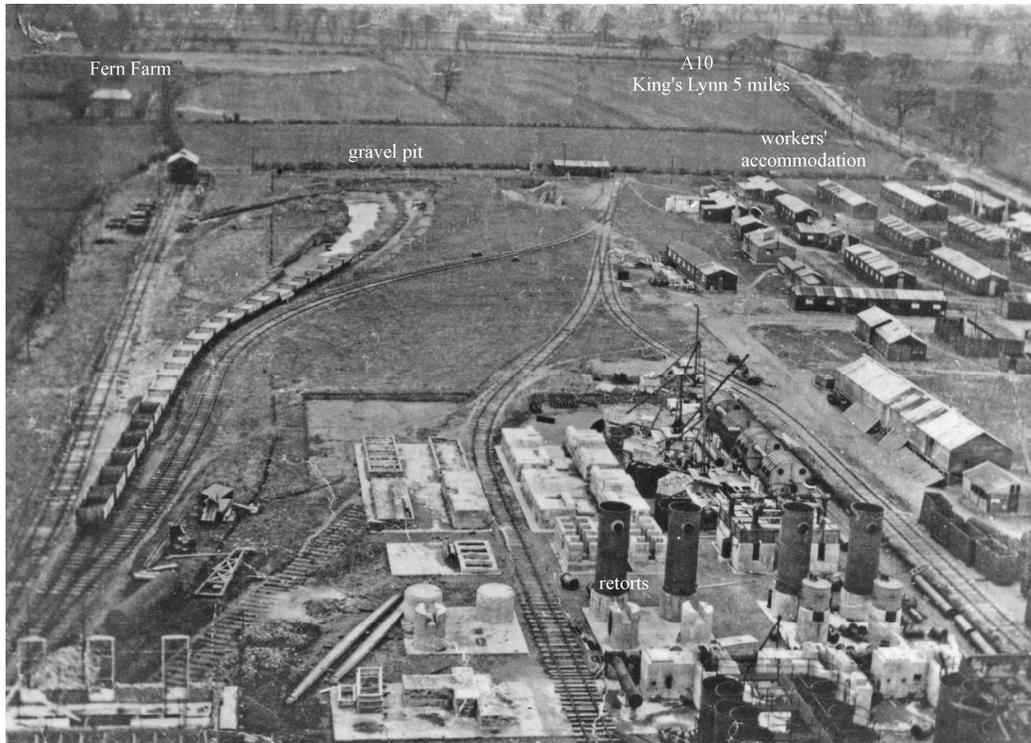


Figure 6. View north across the EOL site in c. 1920 from the top of the 49 m-high chimney stack. See Figure 3 for site map.

In contrast to 1919 and the early part of 1920 when the latest EOL discoveries were reported in the international and technical press on an almost weekly basis, the company received little publicity in 1921 and thereafter. At the Annual General Meeting on January 1st 1922 the shareholders expressed concern that the company had not still produced any practical results, and appointed a new Board of Directors. *Mining Magazine* (January, 1922, Vol. 26) reported that the Board still lacked a director with a knowledge of oil technology. At their peak in 1919, the £1 shares had changed hands at over £4 per each on the London Stock Exchange. Their sell price at the time of the January 1922 meeting was 34.5 pence. Subsequent meetings were largely concerned with disposing of any assets that could be sold (railway wagons, scrap metal etc) and with extracting the company from the expensive leases of large tracts of land in the exploration-licence area. The directors appear from this time onward to have accepted that the mineral riches promised in earlier reports were

either absent or were present in such low concentrations as not to be commercially workable. The full-scale retorts were never completed, the mine and opencast pit were abandoned, and there was little activity after about 1922. At the Annual General Meeting on January 6th 1928 it was reported that no accounts had been produced for two years and nine months, and that whereas in 1923 there had been £129,000 in the bank there was only £81 (*King's Lynn News and Advertiser*, 6th January 1928).



Figure 7. The opencast workings in 1920, view west towards the headgear of the winding engine at the mine. The narrow-gauge railway led to the full-gauge track at the mine that enabled the oil shales to be transported to the retort. See Figs 4 and 5 for site map.

The company operated on a small scale as an importer and wholesale distributor of oils during the 1920s and 30s, and produced oil for use in medicinal soaps under the trade name *Ichthylol*. The name was derived from the Swiss *Ichthammol*, a sulphurous, mildly antiseptic (active ingredient erythromycin) fatty wax used for skin complaints such as sores and eczema. It was not, as sometimes suggested, a contraction of 'ichthyosaur oil'. None of this oil came from Norfolk, and except for equine use the trade died out with the advent of penicillin. The company was wound up in 1966.

In 1919 and 1920, at the time when the publicity attached to EOL was at its most favourable, several small syndicates of local landowners and investors were formed to explore the oil shales in their particular parts of west Norfolk. These were the

Fincham Oilfield Development Co., the Norfolk Oil Shale Syndicate, the Pentney Syndicate and the Wissington Syndicate. All four drilled boreholes in the range 50 to 200 m deep that were wholly cored in the Kimmeridge Clay part of the succession. In contrast to EOL, all four allowed full access to the cores by the Geological Survey palaeontologist Dr J. Pringle. He was able to show on the basis of the faunas that the oil-shale seams occurred at similar stratigraphical levels to those in the Kimmeridge Clay in the Dorset type section. One particular seam contained an abundance of the free-swimming microcrinoid *Saccocoma* that enabled him to correlate this 0.1 m-thick bed with the Blackstone of Dorset 270 km away, a remarkable achievement at that time (Pringle, 1920).

None of the boreholes drilled by the syndicates found seam thicknesses or yields comparable to those reported by Forbes-Leslie, and none of them recorded any free oil. Had they done so, it would have resulted in a legal dispute because the area of the exploration/production licence that had been granted to EOL in 1920 included their lands. The Pentney Syndicate were so concerned about the possibility that any oil they found would be claimed by EOL that they wrote to the Director of the Geological Survey in April 1921 to enlist his help in a request to the Minister of Munitions to rescind that part of the licence which included their land. All the syndicates had ceased activity by the end of 1922.

Following the failure of the EOL operations in Norfolk, Forbes-Leslie persuaded investors to set up the Shaline Company in 1924 to exploit oil shales in the Lias Group that are exposed in extensive cliff and foreshore outcrops on the north Somerset coast between Watchet and Hinkley Point. These were described in what had become characteristic of his style as being “of a class hitherto unknown in England” (Forbes-Leslie, 1924). As in the Kimmeridge Clay in Norfolk, the oil shales occur as thin (mostly < 0.2 m thick) beds separated by thick beds of mudstone with low organic contents. The mudstones are rich in pyrite and the kerogens in the oil shales contain sulphur compounds: both contribute to high sulphur contents in the shale oils obtained from retorting. The company was short lived. It built a kiln at Kilve that is now an English Heritage listed building (Figure 8), but there is no evidence that any oil was produced commercially.



Figure 8. The Shaline Company retort at Kilve, Somerset.

4. The geological reality

Between 1918 and 1922, EOL and the local syndicates drilled more than 50 cored boreholes in the area between the Gaywood River at King's Lynn and the River Wissey at Stoke Ferry (Figure 4). Few geological details have survived from the EOL boreholes because of the secrecy maintained by the company. The Petroleum (Production) Act of 1918 did not necessitate oil-exploration boreholes to be reported,

and the Mining Industries Act, which compelled companies to provide geological details of their activities to the Geological Survey, was not enacted until 1925. The results of some of the boreholes and the sections proved in the oil-shale mine and opencast works at Setchey are referred to in publications by Forbes-Leslie (1917a; 1917b). Unfortunately, these accounts provide no stratigraphically useful information because the thicknesses of the oil-yielding strata are grossly exaggerated, in places by more than 100-fold. His reports to the shareholders also recorded the presence of free oil, oil-bearing sandstones, ozokerite and metalliferous minerals, none of which have ever been substantiated.

In 1975-76, the British Geological Survey (BGS) carried out a national resource assessment of oil shales in the Kimmeridge Clay that included several continuously cored boreholes through the full thickness of the formation. This showed that throughout England the greatest concentrations of seams occur in five oil-shale-rich bands, in the lower and upper parts of the *Aulacostephanus eudoxus* Zone, in the *Pectinatites elegans* Zone, in the upper part of the *P. wheatleyensis* Zone and the basal part of the *P. huddlestoni* Zone (Bed KC 42), and in the upper part of *P. huddlestoni* Zone and the lower part of the *P. pectinatus* Zone (Gallois, 1979).

One of these boreholes was drilled on the outcrop of the Sandringham Sands Formation at North Runcton [TF 6404 1624], close to the Kimmeridge Clay outcrop and about 1.5 km down-dip from the EOL opencast pit at Setchey. A total of 7.17 m of oil shale was proved in over 80 seams in the *A. eudoxus* to *P. pectinatus* zones within a 53m-thick mudstone succession (Gallois, 1994). The seams ranged from 1 to 47 cm in thickness with an average thickness of 9.0 cm. Eighty two percent of the seams were < 0.2 m thick, and 60% of the total volume of oil shale occurred in seams that were < 0.2 m thick. The full succession was sampled and the potential oil yield was determined for each 2 m-run of core by retorting at 450°C. Only one 2 m-run, that which is the correlative of the Blackstone and adjacent beds in the Dorset succession, had a potential yield of more than 10 gal/ton (Figure 9).

Analyses of spot samples showed that the richest potential yield recorded (40gal/ton) was that from an 0.2 m-thick bed with abundant *Saccocoma* in the Wheatleyensis Band, the correlative of the Blackstone of Dorset. An excavation made in the north face [SY 6267 1466] of the former EOL opencast pit in September 1975 also proved the Wheatleyensis Band with *Saccocoma* and enabled the succession there to be correlated with that in the North Runcton Borehole. In the lowest part of

the excavation, the oil shales were highly fractured and the excavation rapidly filled with water up to a level in the oil-shale-rich beds. This is the natural water level and similar to that maintained in the nearby Puny Drain for agricultural reasons. It is unlikely, therefore, the EOL ever deepened the opencast pit beyond that shown in Figure 10. The total thickness of the oil-shale seams worked in the opencast pit was <1m within a 2-m thick succession of thinly interbedded oil shales and mudstones (Figs 7 and 10). Assuming that the potential oil yields recorded in the North Wootton Borehole are similar to those that would have been obtained from the correlative beds in the opencast pit, the yield of shale oil from the pit would have been more than a few hundred gallons.

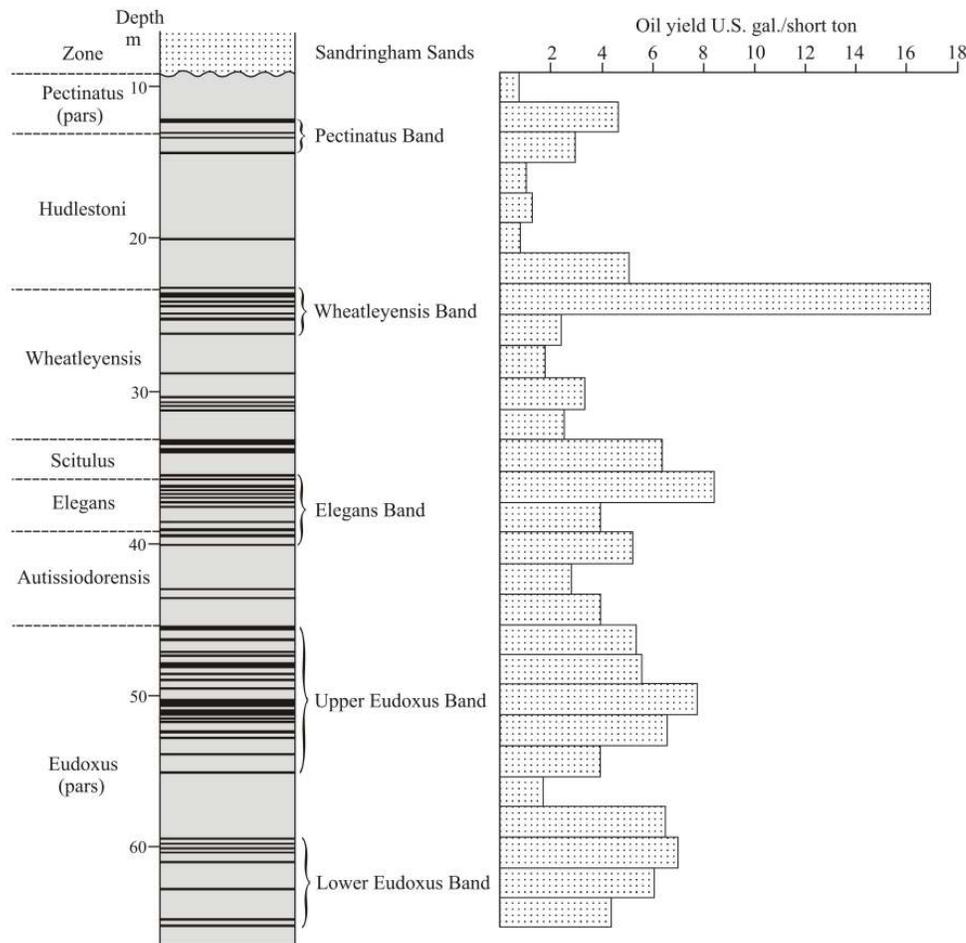


Figure 9. Kimmeridge Clay succession and bulk yields proved in the BGS North Runcton Borehole, 1.5 km NE of the EOL Setchey site (after Gallois, 1979).

When allowance is made for the low (c. 1°) easterly dip, the oil shales recorded in the mine were probably in the Elegans Band. The total volume of mudstone and oil shale worked is unlikely to have yielded more than 20 gallons of shale oil. Taken together, the total amount of shale won from the opencast pit and the mine would have probably filled only 3 or 4 of the 22 wagons shown in Figure 6. If the retorts had ever been brought to their full capacity of processing 1000 tons of oil shale per day, the opencast pit would have needed to expand at the rate of c. 400 m² per day. If it had been 100 m wide and had been worked 365 days per year in order to maintain the heat in the retorts, it would have reached King's Lynn within 10 years, devouring several hundred houses on the way.



① spoil ② cryoturbated gravelly Head Deposit ③ pale and medium grey calcareous mudstones ④ thinly interbedded mudstones and oil shales

Figure 10. The EOL opencast pit in 1920 showing a c. 3m-thick succession of overburden resting on c. 2m of thinly interbedded mudstones and oil shales in which the oil shales weather out as ribs. The gentleman in the bowler hat is thought to be Mr F. Porritt, the site manager.

5. Summary and conclusions

Retorting oil shales to produce shale oil produces large volumes of spent shale that, together with aqueous distillate from the retorting, may contain low concentrations of biologically active compounds including carcinogens. As a result, most of the waste materials produced by past commercial oil-shale working throughout the world have

been left as abandoned tips. Even if the oil shales in the Kimmeridge Clay in Norfolk had been capable of generating large quantities of shale oil, the high sulphur contents would have made it impossible to exploit them commercially. During World War One, when the Navy would, *in extremis*, make use of oils with up to 3% sulphur, there was no commercially viable method of reducing the sulphur in the shale oils even to this level.



Figure 11. Oblique aerial view north west across the south east part of the site in c. 1950. The 160-ft (49 m) high ‘Setchey Chimney’, a local landmark that could be seen from much of west Norfolk, was demolished on the 31st May 1961.

Much of the sulphur in the Kimmeridge Clay oil shales is present in complex sulphur compounds within kerogen complexes. Experiments during and in the years shortly after the war to remove the sulphur by means of distillation, chemical treatments and solvents had shown that the sulphur was so tightly bound within these complexes that the hydrocarbons became degraded before the sulphur compounds broke down. This could even result in a higher sulphur content in the products than was present in the shale oil (Challenger *et al.*, 1925). In theory, the high sulphur contents in shale oils could be converted into valuable products such as ammonium sulphate, but the technical difficulties of doing this economically were insurmountable at the time of the Setchey workings, and remain so. Even at the present time when sulphur is removed from naturally occurring oils by catalytic fractionation, the most commercially desirably

oils are those with low (c. 0.5% or less) sulphur contents known as sweet crudes (Figure 12). These are the cheapest to convert into the high-purity fuels needed for petrol, diesel and aviation engines in which the sulphur contents are mostly 5 to 10 ppm.

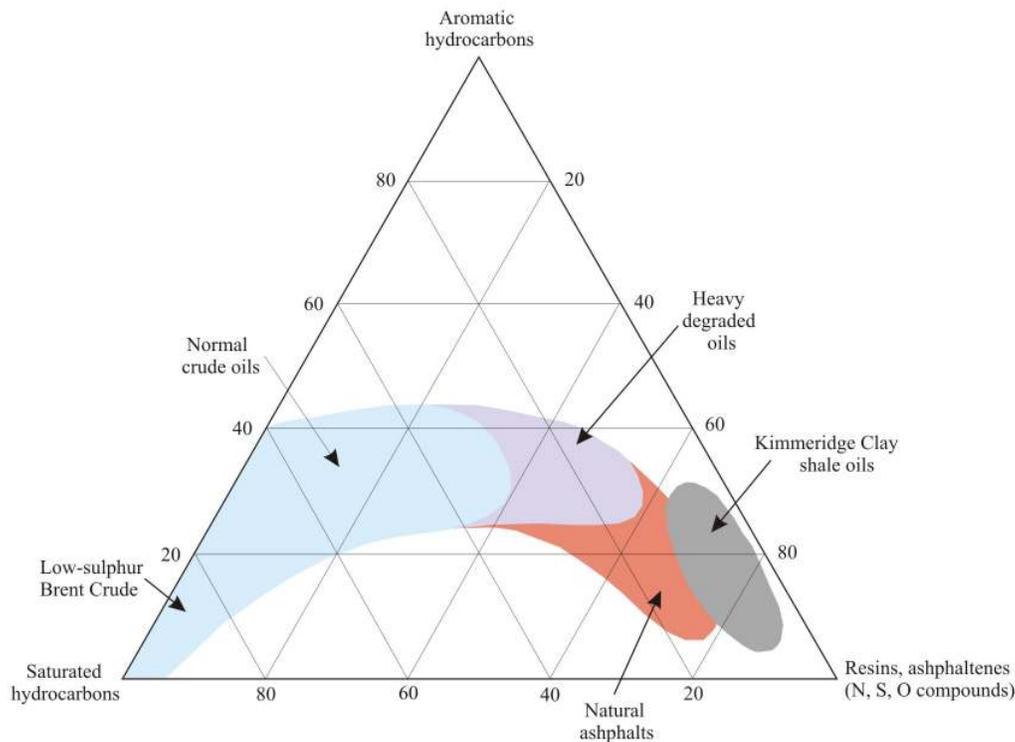


Figure 12. Chemical relationship of Kimmeridge Clay shale oils to naturally occurring ‘hydrocarbon’ deposits (after Gallois, 1979).

One might think from the disparity between the resources that had been ‘proved’ by EOL, as shown in the statements to the shareholders, and what was actually present in the ground that the company was based entirely on a confidence trick with Forbes-Leslie as the principal architect. He was, however, clearly a complex character. Born William Paterson in Banchory, Scotland in 1865, he graduated in medicine at Aberdeen University in 1891. He changed his name to William Paterson Forbes-Leslie in 1892 and to William Forbes-Leslie in 1894. He published two papers on malaria (Forbes-Leslie, 1897; 1899), was employed as a Civil Surgeon with the South African Field Force in 1900 to 1902, and published an epic romantic poem (1915) set in the times of the Crusades in which the hero, Leslie, was a aristocratic Scottish knight from Aberdeenshire. There is no evidence to show that Forbes-Leslie received any formal geological training, but he was elected to Fellowship of the Geological Society of

London in 1912, the same year in which he ‘discovered’ the oil shales in the Kimmeridge Clay in Norfolk. From that time onwards he was referred to as “the geologist” in EOL statements and in the technical and popular press. His papers on the oil shales in Norfolk (1917a) and petroleum in Britain (1917b) were both well received by the Institute of Petroleum Technology, the Ministry of Munitions, and by the press.

Although greatly exaggerated with respect to thicknesses, some of Forbes-Leslie's early claims for the Norfolk oil shales were well founded. It is possible to obtain potential yields of 50 gal/ton from small (a few grams) samples of the most organic-rich parts of some of the seams, and the shale oils do contain high (4.5 to 8%) sulphur contents as stated in the 1917 EOL share prospectus. He subsequently claimed (1919 MS) that these oils were derived from the Smith's Series (Figure 2) which contained two thick beds of pyrite. When these beds were removed prior to retorting the sulphur content of the shale oils was only 0.5%. The claims to have proved the presence of sulphur-free oil shales (the Puny Drain series), hundreds of millions of tons of free oil, and metalliferous minerals were all fictitious.

In the early stages of his investigations, Forbes-Leslie's lack of geological experience coupled with his charismatic personality may have led him to genuinely believe that there were rich deposits of oil to be discovered in west Norfolk. When he found that there was a large public, commercial and government audience willing not just to believe him but wanting him to succeed, he must have felt that he had found his true career. The successful flotation of English Oilfields Ltd in 1918 gave him access to the present-day equivalent of hundreds of millions of pounds of shareholders' money and, at the same time, obliged him to show that he was spending their money in such a way that it would be returned with interest. The company was well received in west Norfolk. It provided many jobs, had its own football team, and allowed its ambulance and medical team to attend local accidents. There are also contemporary accounts of special trains that brought investors from London to be wined and dined in an impressive office in King's Lynn, and then into the heart of the site via Clark's Drove Siding. Forbes-Leslie was removed from the Fellowship of the Geological Society in 1931, and was jailed for fraud in 1935. There is, however, no evidence to suggest that either of these events were related to the failure of EOL and the Shaline Company.

In conclusion, the outcome of the exploration conducted under the guidance of Forbes-Leslie for English Oilfields Ltd in Norfolk and the Shaline Company in Somerset could have been predicted before it started. It was already known prior to 1916 that the oil shales in the Kimmeridge Clay gave rise to shale oils with high sulphur contents, that there was no known method of reducing the sulphur contents to a commercially acceptable level, that the individual seams were thin, and that they comprised a relatively small part of a thick succession of predominantly organic-poor mudstones.

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