CHAPTER TWO

"History belongs not only to those who made it, but to those who inherit it”


2 West Lothian, Oil Shale and the Shale-oil Industry

The county of West Lothian and its shale bings are unique within the United Kingdom making it necessary to include some background information on various features of their origins.

2.1 The Geography of the County

West Lothian, the second smallest of Scotland’s mainland counties (after Clackmannanshire), is located on the southern shore of the River Forth, in the middle of central Scotland between Glasgow and Edinburgh (Hendrie, 1986). The area of land which it now encompasses was, for many centuries, most of Linlithgowshire and part of Edinburghshire (Ordnance Survey, 1987a; 1987b): later to be renamed West Lothian and Mid Lothian. After some major boundary changes in 1975 the modern day West Lothian was created as a district of Lothian Region (Tranter, 1979) but since April 1996 has been a 'new unitary authority’ (West Lothian Council, undated). The present political boundary encloses 414 square kilometres (160 square miles) of land.

The main towns are Linlithgow, Torphichen, Bathgate, Armadale, Broxburn, Uphall, East-, Mid-, and West Calder, Bo’ness (Borrowstounness), Blackburn, Whitburn and Livingston, the fourth of Scotland’s New Towns (1962) and the largest population centre in the Lothians, after Edinburgh (Tranter, 1979).

2.2 The Geology

The whole of central Scotland lies in a large rift valley formed between the Highland Boundary and Southern Upland faults. During the Old Red Sandstone Period (410 –
360 million years ago) the rift began to fill with debris from the newly risen Caledonian Mountains and accumulated over 50 million years. This was a time of extensive volcanic activity resulting in the formation of the Pentland Hills. The era was followed by the Carboniferous Period, when Scotland lay on the Equator and experienced a tropical climate (360 – 285 million years ago). At both the beginning and end of the Carboniferous there were again considerable plutonic activities, resulting in the rock formations at Arthur’s Seat, and Salisbury Crags in Edinburgh, the Bass Rock, in the Forth Estuary and Berwick Law. Binnie Crag, Dechmont Law and other volcanoes and sills in West Lothian were the result of the same activities (Cadell, 1925).

Between the two periods of volcanic activity, warm seawater flooded across the central Scotland valley in a vast tropical lagoon; limestones developed from coral reefs and a host of organisms (including sharks and amphibians) were preserved as fossils in the silt of the lagoon basin. The land at the edge of this expanse of water was a swamp of primitive plants, which over time turned into coal under great thicknesses of sandstone. In the centre of the lagoon, layer upon layer of fine silt and plant debris were deposited by the tides to form oil-shale (Cadell, 1925).

*Westlothiana lizziae* (also known as ‘Lizzie’), the oldest known fossil lizard in the world, was discovered in the Calderwood shales near Bathgate by professional collector Stanley Wood in 1989 (Smithson, *et al.*, 1994; Smithson and Rolfe, 1990). At the end of the Carboniferous Period the strata of the central Scotland valley were folded from the pressure of new, developing mountains to the north, causing the coal and shale deposits to be twisted into the formations we find today (Figure 2.1).

Scotland continued to slowly drift northward during the Permian, Triassic and Tertiary periods (from 245 – 5 million years ago). New Red Sandstone developing from dry dune formations during the Tertiary period was deposited in the new folds of the central Scotland valley. The deposition of glacial tills and scouring by glaciers and ice melt caused by three major glacial advances over Scotland between 50 million and 10,000 years ago, plus an easterly tilting of the whole landmass, have left a heterogeneous mixture of rocks and minerals in central Scotland (Cadell, 1925). West Lothian has inherited (from west to east) bands of coal, fireclay, cement
limestone, sandstone, limestone and oil-shale covered by a rich glacial till. The present landscape of the county, apart from a small part of the coastal belt, is a record of exploitation of the land and its riches, both agricultural and industrial.

Figure 2.1 Geological Map of West Lothian

Simplified geological map of West Lothian (adapted from Institute of Geological Sciences, 1979 and Sheldon, 1997).

A: Westphalian coal measures; these extend west through Lanarkshire.
B: Millstone grit series; the source of fireclay
C: Carboniferous limestone series; formed of narrow bands of limestone and sandstone

2.3 The History

The history of West Lothian has been somewhat overshadowed by that of its larger neighbour, Edinburgh, however there have been settlements in the area since prehistoric times. Although largely an agricultural county, at various times in its history West Lothian has been mined for the diverse mineral deposits under its rich glacial till (Tranter, 1979; Hendrie, 1986; Colledge, undated). Coal was first mined...
by monks at Carriden in 1165 (Cadell, 1925). Other major industrial operations included mining for ironstone, limestone, fireclay and shale. Slate was quarried at Mid Calder, and sandstone from Binnie quarries provided the yellow stone for most of Edinburgh’s New Town (including the National Galleries, Register House and the Scott Monument). Even silver was mined in the Bathgate Hills from 1607 until 1614, when King James VI decreed that all proceeds were to go to Crown; at this point all the seams immediately "ran out". The silver mines were never mined for silver again but when the old workings were surveyed in 1873, nickel ore was discovered in the waste heaps and mining recommenced (Cadell, 1925; Hendrie, 1986; Tranter, 1979; Keay & Keay, 1994).

2.4 The Shale Oil Industry

An industrial process to extract crude oil from shale was first patented in 1694 in Britain. The first commercial plants were built in France in 1838 and Scotland (West Lothian) in 1851 (McHenry, 1992). Also in 1851, James “Paraffin” Young (1811-1883) (Figure 2.2) patented a new method of retorting paraffin oil from Cannell coal and oil bearing shale and built the first paraffin works at Boghall (Bathgate). This changed the face of West Lothian (Tranter, 1979; Hendrie, 1986; Colledge, undated).

Figure 2.2 James "Paraffin" Young (1811-1883)

*Founder of the Scottish oil industry in 1851 (photograph courtesy of "The Scotsman” newspaper archives).*
2.4.1 The global picture

On a global scale, oil extraction plants were built in Australia, Brazil and the United States of America by the late 19th century, and by the early 20th century, China (Manchuria), Estonia, New Zealand, South Africa, Spain, Sweden and Switzerland were also producing oil from shale. Most production stopped by mid-century due to the discovery of large supplies of crude oil in the Middle East, although Estonia and Manchuria still operate commercial paraffin extraction plants (McHenry, 1992; Cadell, 1925).

2.4.2 The importance of the industry in West Lothian

In West Lothian, James Young opened the original paraffin works using oil extracted from Cannel (parrot) coal but the seam soon ran out and no other Cannel coal was available locally. However oil-bearing shale was discovered near Broxburn and West Calder in 1858 and Young discovered that paraffin oil was also extractable from this source. He patented the process and crude oil was retorted at Westwood and Winchburgh then refined at Pumpherston into the paraffin oil that earned him his nickname, “Paraffin” Young. The patent ran out in 1864 leading to a massive increase in industrial workings (Tranter, 1979; Cadell, 1925) (Table 2.1).

Table 2.1 Industrial workings

The industries and works shown on Ordnance Survey maps of the West Lothian area (Ordnance Survey, 1987a; 1987b; 1957).

<table>
<thead>
<tr>
<th>Type of industry</th>
<th>No. of works</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron mine</td>
<td>1</td>
</tr>
<tr>
<td>Coal mine</td>
<td>16</td>
</tr>
<tr>
<td>Iron works</td>
<td>1</td>
</tr>
<tr>
<td>Coke oven</td>
<td>1</td>
</tr>
<tr>
<td>Stone quarry</td>
<td>9</td>
</tr>
<tr>
<td>Shale mine</td>
<td>14</td>
</tr>
<tr>
<td>Brick works</td>
<td>1</td>
</tr>
<tr>
<td>Oil works</td>
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</tr>
<tr>
<td>Chemical works</td>
<td>1</td>
</tr>
<tr>
<td>Chemical factory</td>
<td>1</td>
</tr>
<tr>
<td>Unspecified mines/works</td>
<td>77</td>
</tr>
</tbody>
</table>
This is a huge under representation of the extent of these industries, as only those commercial plants based outwith the towns are recorded. By 1865 there were 120 oil works in operation in the county, alongside their associated shale pits and mines, producing 25,000,000 gallons (@ 600,000 barrels) of crude oil every year and employing 30-40,000 people (Hendrie, 1986).

Miners streamed into West Lothian from Cornwall, Wales, Ireland, the North of England and all quarters of Scotland. Towns and villages expanded rapidly causing the county to resemble the American Wild West. Gunpowder was produced at Camilty Powder Mill near Harburn and sold to shale miners (who had to supply their own explosives) in blue paper twists for 2d. Complete new villages grew up around the shale mines at Winchburgh, Niddrie, Seafield, Oakbank and Addiewell (Tranter, 1979; Hendrie, 1986).

Soon imported American oil was cheaper than the home manufactured product but by this time shale oil was used to produce motor spirit, naphtha, diesel oil, paraffin wax, petroleum jelly, wax for beekeepers, fluid for powering lighthouse lamps and detergent. By products were produced at the chemical works in Broxburn and Bathgate, including ammonia, sulphuric acid, mothballs, paints, rubber goods and candles (Tranter, 1979; Cadell, 1925; Hendrie, 1986; Keay and Keay, 1994). West Lothian was booming.

The maximum output from the industry was in 1913, when 3.5 million tons (27,125,000 barrels) of crude oil was produced. There was a gradual reduction in operations until, by 1951, output was reduced to only 1.5 million tons (11,625,000 barrels) and by 1958 only 7 mines and 2 opencast workings remained in operation (the latter were in the process of closing), although the industry still employed 2,850 men. Production had totally ceased by 1963; the last working mine was at Westwood (Tranter, 1979; Hendrie, 1986).

### 2.5 The Parent Rock

The parent rock, from which paraffin is extracted, is a sedimentary rock containing varying amounts of solid organic material (kerogen) that, when heated to 500° C,
yields hydrocarbons. It is not an oil bearing rock and the shale fields never contain any liquid oil (Cadell, 1925). As described the oil shales occur in Lower Carboniferous strata in the Upper and Lower oil-shale Groups (Cameron & McAdam, 1978). Commercially viable deposits are found in Estonia, the Soviet Union, Manchuria, Brazil, and the United States of America.

In West Lothian oil-shale is found from the Firth of Forth, between Blackness and South Queensferry in the north, through the major producing areas to West Calder and Addiewell in the south (Figure 2.1). The strata of the West Lothian oil-shale fields are covered by superficial deposits of boulder clay, sand and gravel beds, and by extensive beds of peat in the south. The thickness of these deposits varies from a few metres to more than 20 metres thick (Cadell, 1925; Cameron & McAdam, 1978). As a result of post-Carboniferous volcanic action, igneous intrusions have produced sufficient heat to distil kerogen out of the oil-shale seams. This produces small pockets of solid wax and liquid paraffin in cavities and fissures of the oil-shale beds at the boundaries with the intrusions (Cadell, 1925).

2.6 The Main “By Product”

The process of retorting crude oil from oil-bearing shale is destructive and results in a vast amount of waste. On average, every 10 barrels of oil manufactured required the extraction of 8 tons of shale and left 6 tons of burnt shale waste (Hendry, 1925; Bradshaw & Chadwick, 1980). This was left lying around the West Lothian landscape in vast piles, the county’s unique red shale bings. Bing is a Scots word meaning pile or heap and has been used from the 16th century; its derivation is from the Old Norse ‘bingr’: a heap (Robinson, 1985).

2.6.1 The physical scale

It is impossible to live, work or travel through West Lothian without being aware of these massive monuments to industry in the area and their overpowering effect on the landscape. It is even more difficult to convey the sheer size of these bings and the amount of shale they contain to someone who has never seen them. Each ton (1.016 tonnes) of fresh shale mined produced a cubic yard (0.765 m$^3$) of spent shale after
processing. The throughput for Scottish Oils in 1923 was 8,000 tons (8,128 tonnes) of crude oil a week. Thus new spent shale was being added to the bings at a rate of 2,920,000 cubic yards (2,233,800 cu. metres) every year. This is the equivalent of a single bing with a volume almost as great as the Cheops pyramid in Egypt (which is 451 ft [137.465 m] high) (Cadell, 1925).

H.M. Caddell produced a wonderful mental image to convey the size of this vast accumulation of spoil in his 1925 publication “The Rocks of West Lothian”.

From 1883 to 1923 “…the total quantity of spent shale comes to 116,800,000 cubic yards. This large figure will, no doubt, convey little or no meaning to ordinary readers, but if we imagine the material to be all collected into one vast heap, its size can be more easily appreciated. Let us suppose some titanic magician could sweep up all the shale bings and place them on an equally titanic carpet, then lift it by the four corners and fly with the bundle to the neighbourhood of Arthur’s Seat. To demonstrate to the intellectuals of Edinburgh the bulk of the aerial cargo, he might hover over the New Town, pierce the bag and let the shale stream out, as sand streams through the neck of an hourglass. It would form a cone with sides sloping at 40° and the base would reach from the middle of Charlotte Square to the Melville Monument in St Andrews Square, while the top would rise to a height of 1285 ft above George Street, and would be almost level with the crest of Allermuir on the Pentlands. If this were considered too frightful a piece of vandalism to inflict on Scotia’s darling seat, our magician might fly seawards and drop the ashes on the foreshore at Portobello, where they would produce a cone 1½ times as high as the ancient volcano of Arthur’s Seat.” (Cadell, 1925, p310).

Since that description was written many of the bings have been added to and others have been destroyed. When production ceased in 1962 there were 27 bings containing over 200 million tons of shale (Scottish Development Department, 1966). The red shale has been used as hard core for roads, footpaths, infill for building sites and briefly as foundation material for houses, until builders discovered that the shale reacted with mortar and cement causing new houses to collapse (Hendrie, 1986). The M8 and M9 motorways are founded on burnt shale.

2.6.2 The visual impact

The 19 remaining bings cover 139 Ha (0.4% of the total land area of the county) and, as already described, are significant landmarks in the low lying and undulating landscape (Figure 2.3). The local hills rarely rise more than 200 m above sea level.
and the highest natural feature in the county is the Knock in the Bathgate Hills, at 315m (Sheldon, 1997).

**Figure 2.3 Topography of West Lothian**

*Simplified map of West Lothian displaying all physical features rising more than 185 m above sea level: naturally occurring land as shaded areas and the 10 bings as dark triangles. The Knock, the highest point in West Lothian at 315 m, is displayed as a circle.*

The plateaued summit of Greendykes Bing (Figure 2.4) rises to 195 m and towers over the towns of Broxburn and Uphall (Russell, 1971). The multiple peaks of Five Sisters Bing at Westwood (Figure 2.5) resemble the knuckles of a defiantly clenched fist raised above the surrounding agricultural area. This is a landmark so unique that it is reproduced on Newpark roundabout, Livingston (Figure 2.6) and is incorporated into the new West Lothian County logo, alongside the Union Canal and the 39 arch railway viaduct (Figure 2.7).
Figure 2.4 Greendykes Bing

Greendykes bing is an Industrial Heritage Site. The most visible of the remaining bings in the county, it is surrounded by agricultural land.

Figure 2.5 Five Sisters

Five Sisters bing (sometimes known as Westfield) is also an Industrial Heritage Site. This bing is unique in having multiple peaks.
Figure 2.6 Newpark Roundabout

Newpark roundabout, Livingston with its central sculpture replicating Five Sisters in stone and copper.

Figure 2.7 West Lothian County Logo

Five Sisters again, this time appearing in stylised form with the viaduct and the Union Canal as part of the West Lothian County logo.