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Geology and the Environment at Prestoungrange

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PRESTOUNGRANGE UNIVERSITY PRESS
www.prestoungrange.org

FOREWORD

This series of books was specifically developed to provide an authoritative briefing to all who seek to enjoy the Industrial Heritage Museum at the old Prestongrange Colliery and, more broadly, what were the medieval baronial lands of Prestoungrange and Dolphinstoun. They are complemented by learning guides for educational leaders. All are available on the Internet at www.prestoungrange.org the Baron Courts' website.

They have been sponsored by the Baron Courts of Prestoungrange and Dolphinstoun which my family and I re-established when we were granted access to the feudal baronies in 1998 and 1999. But the credit for the scholarship involved and their timeous appearance are entirely attributable to the skill with which Jane Bonnar, assisted originally by Annette MacTavish of the Industrial Heritage Museum service, found the excellent authors involved and managed the series through from conception to benefit in use with educational groups.

We thank the authors one and all for a job well done. It is one more practical contribution to the Museum's wider role in helping its visitors to lead their lives today and tomorrow with a better understanding of the lives of those who went before us all. For better and for worse, we stand on their shoulders as we view and enjoy our lives today, and as we in turn craft the world of tomorrow for our children. As we are enabled through this series to learn about the first millennium of the two baronies we can clearly see what sacrifices were made by those who worked, and how the fortunes of those who ruled rose and fell. Today's cast of characters may differ, and the specifics of working and ruling have surely changed, but the issues remain the same.

I mentioned above the benefit-in-use of this series. The Baron Courts are adamant that it shall not be 'one more resource' that lies little used on the shelves. A comprehensive programme of onsite activities and feedback reports by users has been designed by Jane Bonnar and is available at our website www.prestoungrange.org – and be sure to note the archaic use of the 'u' in the baronial name.

But we do also confidently expect that this series will continue to arouse the interest of many who are not directly

involved in educational or indeed museum services. Those who live locally and previously worked at Prestongrange, or had relatives and ancestors there (as I did in my maternal grandfather James Park who worked in the colliery), will surely find the information both fascinating and rewarding to read. It is very much for them also to benefit – and we hope they will. The reception thus far certainly seems to show the authors' work is greatly appreciated.

Finally, of course, the titles have provided an excellent basis and complement for the Arts Festival the Baron Courts have lately initiated, most especially the murals programme.

Dr Gordon Prestoungrange
Baron of Prestoungrange
February 26th 2002

Matthew Carter and Julian Wills

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Acknowledgement
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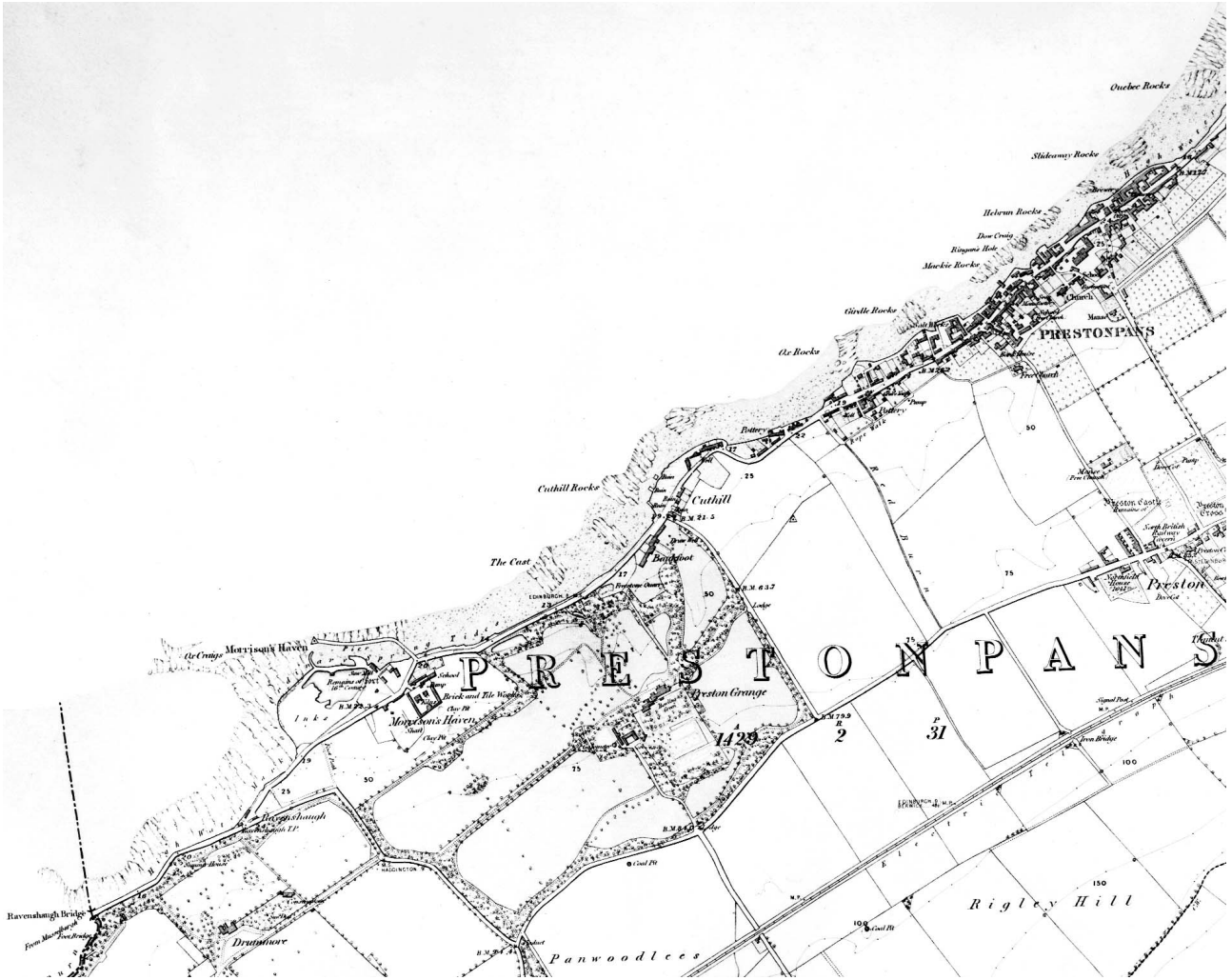

Prestonpans and Morison's Haven in 1853 (OS 1:10 560 Haddington Sheet 8)

1. INTRODUCTION

The Barony of Prestoungrange has been worked for its geologically derived resources, including brickearth, clay, peat and of course coal, for nearly 1000 years. The extraction of these resources combined with the production of salt, glass and pottery on the site around the beam engine and Morrison's Haven inevitably had a significant impact on the environment.

This study comprises a brief history of the site to give an indication of the diverse industrial activities that have taken place there. The key industry, which attracted other industries to the area, was coal, which made possible the production of salt, pottery and bricks.

The geology of the barony was critical to the facilitation of these industries. The East Lothian basin runs north to south, from the Firth of Forth at Musselburgh southwards along the Esk valley. The area is underlain by limestone and coal measures of the Carboniferous Period and Old Red Sandstone of the Devonian Period.

Coal production at Prestongrange Colliery, however, has been plagued with the problem of flooding discussed at length by Ewan Wilson in No. 8 in this series, *Water at Prestongrange and Pumping it Out*. The other industries that located at Prestoungrange may have had a greater short term success, but none of them endured as long as coal mining.

The environmental impacts of the industries concerned and the substantial efforts to clean up the site are also discussed in conclusion of this study.

2. INDUSTRIAL HISTORY OF PRESTOUNGRANGE

In order to understand the environmental impacts of the industries that have been located at Prestoungrange through the last millennium it is important to provide a brief history of the barony and surrounding area.

The Monks of Newbattle and Holyrood Abbeys were granted permission to use the lands at Prestoungrange late in the twelfth century. By the end of the first decade of the thirteenth century they had also been granted the right to

quarry for coal which passed along the 'Salters Road' between Prestoungrange and Newbattle. The monks found that coal was a more efficient source of energy for heating and salt production and it was the early production of salt as a preservative by panning that gave Prestonpans its name. The monks became skilled miners and worked the Great Seam going as low as 4m below the level of the Firth of Forth.

Coal became a very tradable item during the following centuries and the location of Prestoungrange made it an ideal shipping location. Salt was also being shipped from the Prestonpans coastline and in 1526 specific permission was sought to build a harbour. By this time, however, it was no longer the monks that were the major miners and shippers. The application for the harbour was made by Alexander Acheson, a name familiar to all those who know the history or live in Prestonpans.

Trading suffered during the religious Reformation and the lands themselves were transferred to the Kerrs and then the Morisons. Acheson's Harbour in due course became known as Morrison's Haven after extensive rebuilding and then ultimately the Grants and Grant-Sutties held the barony after the two Kingdoms were united until the end of the 20th century.

In 1697 formal permission to build a glass factory at Morrison's Haven was given. Glass had actually been produced on a large scale in Prestonpans for many decades previously. Coal production at the mine was sporadic at this time with the endemic problem of flooding returning again and again to halt production.

The major significant industrial era at Prestoungrange started during the early ownership of the Grant-Sutties under Sir James. Coal mining began in earnest. In 1825 Matthias Dunn took out a personal lease to mine on a larger scale than had been seen previously and four years later sunk two shafts, lined with iron rings to help prevent flooding. However, even with pumps in place Dunn could not stop the mines from flooding and production again ceased in 1838. Sir James' son, Sir George, re-opened the mine himself in 1848 but was soon to encounter the same fate as Dunn.

In 1872 the Cornish Beam Engine was shipped in and installed which heralded the onset of much new industrial activity. Kitto, Loam and Brental took out a 99-year lease and formed the Prestongrange Coal and Iron Company. The No.2 Shaft was used for extracting coal from the 'Jewel Seam' and

the beam engine was situated on No.1 Shaft to pump out the water. However, due to the drop in price of coal, miners' strikes and the heavy debts incurred from company formation the Prestongrange Coal and Iron Company survived only until 1879.

In 1881 three more industrialists, Gneiss, Stephenson and Ellison established a successor company, the Prestongrange Coal and Firebrick Company. This enterprise operated for thirteen years until the same forces as previously forced closure. It was at this time that brickworks were created on the scale we can still see today, and bricks were produced on a substantial scale at Prestoungrange.

In 1894, Sir George Grant-Suttie sold the industrial estate including the colliery to the Summerlee and Mossend Iron and Steel Company. This new company sank a third shaft for ventilation purposes and bore down to the 'Beggar Seam'. They extracted coal and fireclay for use at the brickworks and for export. Around 1900, Morrison's Haven was exporting in excess of 5000 tons of clay products. But the next twenty years were to prove very difficult for the whole of the country as it passed through World War I, miners started demanding much improved conditions and more money, and then the price of coal collapsed. It all culminated in the General Strike of 1926.

The Summerlee and Mossend Iron and Steel Company remained afloat longer than all other enterprises until in 1947 when it was acquired by the new statutory corporation, the National Coal Board. At the end Morrison's Haven had long fallen into disuse through silting up and the coal and other outputs were despatched by rail and road.

During the next fifteen years six seams were worked and the colliery and brickworks employed nearly 800 staff. Morrison's Haven was infilled in 1957 and in 1962 the NCB closed the mine.

These industries and many more have left their mark on the environment around Prestonpans. Some are clearly still visible; some are not so obvious such as the chemical bi-products arising through the production of coal.

References

1 Burnett, Allan: *Industrial Ownership and Relations at Prestongrange,* No.4 Prestoungrange University Press, 2000

2 Black, Kirsty: *Health Hazards over the Centuries at Prestongrange*, No. 6 Prestoungrange University Press, 2000

3 Aitken, Julie: *Morrison's Haven, What Came and Went and How?,* No.2 Prestoungrange University Press, 2000
4 Wilson, Ewan: *Water at Prestongrange and Pumping it Out*, No. 8 Prestoungrange University Press, 2000

3. GEOLOGY OF THE PRESTONPANS AREA

Broadly speaking, the geology of Scotland can be divided into regions, each area exhibiting similar geological characteristics. Prestongrange, indeed East Lothian, falls into the fault valley region of Scotland known as the Midland Valley. The Midland Valley is defined to the north by the Highland Boundary Fault and to the south by the Southern Upland Fault.

Rocks from the Devonian period are overlain by Carboniferous rocks, which dominate the region. It is the Carboniferous rocks that are of most interest and will be looked at most closely in this section, as these were the rocks from which coal, limestone, fireclay, ironstone and shales were extracted and used for industry. Rock from the Devonian period had a lesser effect on Prestongrange. Upper Old Red Sandstone was used primarily as building material, and can still be seen at Morrison's Haven today.

The presence of these Carboniferous rocks was the fundamental determinant of central Scotland's industrial development from East Lothian across to Glasgow and Ayr.

Figure 1 (given as the centre spread of this booklet) shows the whole of the Midland Valley of Scotland, courtesy of the British Geological Society.

Formation of Sedimentary Deposits

Although there are many igneous rock formations in Scotland, these tend to be towards the northern and upland areas such as the Grampians. The Midland Valley is, relatively speaking, lower and flatter than most of Scotland, indeed Prestonpans is virtually at sea level. Sedimentary deposits dominate the rock structure although there are areas, such as the Pentland Hills and the Ochil Hills, where igneous deposits can be found at the surface due to the weathering and erosion of weaker overlying rocks.

Prestongrange is dominated entirely by rocks from the Carboniferous Period and beach deposits of the Pleistocene Period and exhibits no igneous rocks.

As mentioned previously, the materials that enabled industry to locate along the southern shore of the Firth of Forth were extracted from sedimentary deposits. Weathering (breaking of rocks by in-situ processes) and erosion (breaking of rocks by moving processes) disintegrates rocks into small enough fragments so that they can be transported. Once broken down, water, ice and wind transport rock fragments to where they will eventually be lithified, often via intermediate environments such as river flood plains.

Sedimentary rocks are usually formed in wet conditions and are deposited in one of four water environments – a riverbed (fluvial), a lakebed (lacustrine), the sea (marine) or a river delta. As sediments settle on the bed of the water body they compact sediment previously deposited and in turn are compacted by subsequent sediment deposition. Sediments consisting of relatively large fragments, such as sand, also need to be cemented together by naturally occurring elements such as iron oxide (FeO_2) and calcium carbonate ($CaCO_3$) to lithify them. Some cementation elements colour the rock giving it a reddish or yellowish look. Combining compaction, cementation and internal heat from the earth causes lithification of the sediment.

When considering the time periods involved, it is possible to visualise how the East Lothian sediments were lithified. The Carboniferous period alone lasted approximately 72 million years, which not only makes it possible to see how the rocks were formed, but also how the cyclic deposition of the rocks occurred.

Cyclic deposition is the process by which strata are laid down in a series of facies or a sequence of strata. In the Midland Valley there are many different localised facies, but a typical one would consist of coal measures and seat earth overlying non-marine limestones and sandstones. At the base of the sequence, marine limestones and sandstones would be present. This cyclic deposition partly explains the reason behind the varying depths of different coal seams, as one facies overlies another creating 'beds' of coal deposits.

The cycles of facies were formed as a result of ground subsidence and eustatic (sea level) change. The weight of the strata formed caused, and is still causing, the ground to subside, which allows more beds to be formed above previously

formed strata. If the ground did not subside, then facies would be created laterally, building up usually towards the source of the sediment.

The Midlothian basin is a good example of localised subsidence, and evidence from boreholes drilled in the area shows cyclic deposition occurred across the whole region. The major eastern coalfields of the Midland Valley are located around the Midlothian basin, making it one of the best areas for the location of coal reliant industries, such as those located at Prestoungrange.

Coal Formation

The creation of coal is predominantly dependent on climate and as it is formed from the remains of plants the climate needs to be humid and wet to stimulate plant growth. Such a climate is not found today in Britain.

However, during the Carboniferous period it may seem surprising to learn Britain was located between 5° North and 5° South of the equator. That gave a very wet, humid climate just as the equatorial regions experience today. It was during this time that there was very high level of plant growth which led to the formation of the very extensive British Isles coal measures.

Coal is formed under the same conditions as other sedimentary rocks. Laid down in swampy, boggy conditions, the plant matter is compressed and altered in almost fully anaerobic conditions, such that coal ranges in carbon purity of 70–98%. The coal extracted at Prestoungrange will, in the most part, be lignite (approx. 70% carbon purity) and bituminous coal (approx. 80% carbon purity), both good sources of heat. Where the purity is less, there will be more contaminants in the coal, such as sulphur and iron, both of which create environmental problems when it is burned.

The cyclic deposition described above enabled many beds of coal and peat to be laid down over one another some, if thick enough, creating the seams that were worked at Prestongrange Colliery.

There were many other Carboniferous deposits that have been important industrial materials such as peat (used by the monks of Newbattle Abbey at the dawn of the last millennium), and fireclay (used in the potteries and brickworks of the area). These were laid down under the same conditions as the coal and exhibit similar characteristics, the only difference being the level of carbon content and plant remains.

Sandstones

Any sand deposited during the Carboniferous period would have been compressed to form the Millstone Grit that dominates the area around the periphery of the Midlothian basin. Millstone Grit is an excellent building material evident in the housing of the Cornish beam engine and some of the local housing as well.

The Red Sandstone that is present, most notably in part of Morrison's Haven's wall, is not present at Prestoungrange but has been transported approximately 10km from near Niddrie, south of Edinburgh's centre. The reason for the stone's colour is that the sediments which formed the stone were laid down during the Devonian period, which preceded the Carboniferous period. During this time the climatic conditions were very different from those in the Carboniferous. They were dry, arid conditions due to Britain being located between 5 and 10 degrees south of the equator where, as today, conditions were very dry and scattered with deserts.

The sediments that made up the Upper Old Red Sandstone were laid down in a fluvial or lacustrine environment. Examining the fossils of species that were trapped in the sediments reveals the depositional environment, as marine and non-marine species are almost exclusive to one environment. This technique is used widely to identify horizons in stratigraphical sequences throughout the world.

The Rocks that Influenced Industry

The Lower Carboniferous (Dinantian)

The Carboniferous Limestone Series was the first series of the Carboniferous period to be deposited in the Midland Valley and is split into two groups, the Calciferous Sandstone Measures and the Lower Limestone Group (see Fig. 3.1).

The series contains many strata including limestones, oil shales and throughout the Lower Limestone Group sandstones and coals are also present. However, in East Lothian, coals are relatively thinly bedded and therefore not workable and the oil shales seams are absent.

The Upper Carboniferous (part of the Silesian subsystem)

The Upper Carboniferous is the sub-period during which the majority of the workable coal seams and the fireclays were

deposited and is split into the Namurian (Millstone Grit Series) and the Westphalian (Coal Measures) described below.

The Namurian

This series is split into three groups, making up the Millstone Grit Series; the Limestone Coal Group at the base, the Upper Limestone Group and the Passage Group (formerly Scottish Millstone Grit).

The Limestone Coal Group consists of some very productive coal seams, present only in the Central Coalfield (to the west of Edinburgh) and not so much in East Lothian. Much of the central and western Scottish coal industry was based on the Limestone Coal Group.

The Upper Limestone Group provides no workable coal seams throughout the entire Midland Valley region, but instead having thick beds of limestone and sandstone. No workable coal is a result of either the physical or climatic conditions (or both) changing, and plant growth reducing.

The Passage Group has many of the sought after raw materials, but the coal and ironstone beds, although numerous, are thinly bedded and therefore unworkable. The Upper and Lower Fireclays included in this group are of economic value mined for use in the production of bricks and ceramics. This is the last group of the Millstone Grit Series and underlies the Westphalian Coal Measures.

The Westphalian

These comprise the Lower (Westphalian A), Middle (Westphalian B) and Upper (Westphalian C and D). The coal measures of the Westphalian provided the raw materials that enabled the rise of industry throughout Britain.

The Lower and Middle measures exhibit similar characteristics, both laid down under similar conditions to those found in the Namurian. The Upper Measures were mostly laid down under drier and sandier conditions, due to the British Isles moving northwards away from the equatorial/tropical climate and into a more arid one.

The facies comprise strata, including coal, sandstone, siltstone and mudstone, laid down in a fluvio-deltaic environment.

Collectively the Lower and Middle Coal Measures were known as the ‘productive coal measures’ and as mentioned above, had up to 20 workable seams. At the Prestongrange Colliery accessing the coal was the most difficult factor, which

is well documented, but once the physical problems were overcome, extraction took place from eight seams. These seams were not particularly deep by modern standards and were from the Lower and Middle Coal Measures, drilled to a depth of 766 feet below ground level i.e. the Beggar Seam. (This is disputed from other sources, which state the Beggar Seam to be just 462 feet.)

Many seams in the Upper Coal Measures were either poorly developed or later oxidised by exposure to air and/or water and were given the name 'Barren Red' due to the colouration caused by this oxidation. The partial destruction of these coal seams meant that it was only economical to mine from the Lower and Middle Measures.

The Geology of Prestongrange Colliery

Over the course of 250 years, Prestongrange Colliery has had many owners and been closed due to flooding on numerous occasions. Coal has been extracted from eight different seams, ranging from 35 metres (120 feet) below ground level to in excess of 150 metres below ground level (500 feet). The seams are part of the Lower and Upper Coal Measures and not very thickly bedded, between 1 and 2.5 metres thick, making working conditions very difficult.

There were two shafts drilled at Prestongrange sunk by Matthias Dunn in 1829. One shaft (No.2) was used for lifting coal to the surface and the other shaft (No.1) was used to pump water latterly using the giant Cornish beam engine until its retirement in 1954. Plans to sink a third shaft by the

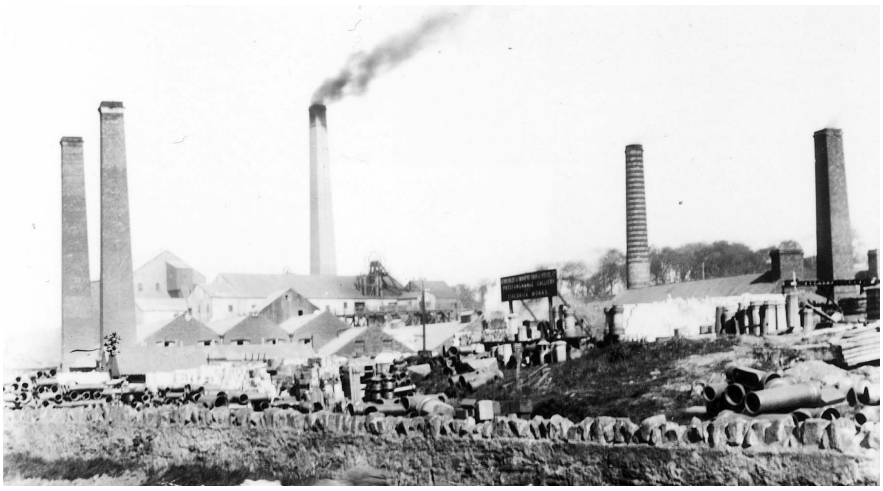

Figure 2

Prestongrange Coal and Fire-Brick Company were stopped by a drop in coal prices and miners strikes, which forced the company out of business in 1894.

When the coal industry was nationalised in 1947, all eight Prestongrange seams were being worked. These seams were (top down): Great Seam, Diver Seam, Clay Seam, Five-foot Seam, Jewel Seam, Beggar Seam and No.1 and No.2 Diamond Seams. These seams vary in name from previous records, which pre-date nationalisation.

Fireclay extraction

The Passage Group, and to a lesser extent the Lower Coal Measures, contain valuable deposits of fireclay, which were especially useful for the refractory industries including glass, pottery and brick. Coaly shales that were a by-product of mining were used in the production of bricks and were abundant at Prestongrange due to a high clay content in the soils (clay weathers into shale).

There are also beds of fireclay scattered across the Midlothian basin. It has been shown in historical records that Morrison's Haven received a large amount of clay imports from London and Cornwall.

LITHOSTRATIGRAPHY			SERIES	SUBSYSTEM
Upper	Upper Coal Measures	Coal	Westphalian C–D	
	Middle Coal Measures		Westphalian B	
Carboniferous	Lower Coal Measures	Measures	Westphalian A	Silesian
	Passage Group	Millstone		
(Pennsylvanian)	Upper Limestone Group	Grit	Namurian	
	Limestone Coal Group	Series		
Lower	Lower Limestone Group	Carboniferous		
Carboniferous	Calciferous Sandstone Measures	Limestone	Viséan	Dinantian
(Mississippian)		Series	Tournasian	
Devonian	Upper Old Red Sandstone			

Figure 3 Stratigraphy of the Carboniferous

References

5 British Geological Survey: *Geological Memoirs: No.5* (1985), HMSO

6 British Geological Survey *Research Report RR/99/07*
7 Black, Kirsty: *Health Hazards over the Centuries at Prestongrange*, No. 6, Prestoungrange University Press, 2000
8 Burnett, Allan: *Industrial Ownership and Relations at Prestongrange,* No. 4, Prestoungrange University Press, 2000.

4. ENVIRONMENTAL IMPACTS OF INDUSTRY AT PRESTOUNGRANGE

The numerous industries that located at Prestoungrange over the centuries have each caused their own particular environmental problems although clearly the colliery and the brickworks create the most visible effects. Less noticeable are the effects of salt, oil of vitriol (sulphuric acid) and glass production processes. These industries often left contaminants in the ground itself.

All the major environmental issues likely to arise will accordingly be addressed here in sequence.

Coal

There are many environmental impacts associated with coal mining. The most visible impact at Prestongrange is the large area of land, to the south of the beam engine, covered with colliery spoil that is now vegetated with trees. Other environmental issues that arise from coal mining include subsidence, water pollution, slope stability and visual disamenity.

Colliery Spoil

Colliery spoil is often described as 'overburden', comprises waste rock such as sandstones and siltstones, poor grade coal, iron pyrite and other minerals including quartz, silica, aluminium, sulphur (included in the coal), heavy metals (e.g. copper, nickel, zinc), magnesium, potassium, sodium and iron (see Goodman & Chadwick).

Spoil 'heaps', as they are commonly known, are often formed in conical piles, or as mini plateaux on hillsides. Aesthetics is not a problem at Prestoungrange but there is a real impact on the ecology and water quality of the area due to the low level construction and grading of the spoil.