

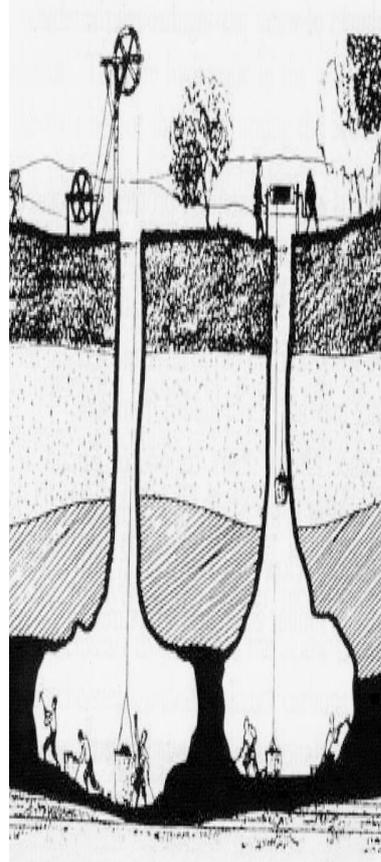
Geology and the Environment at Prestongrange

A resource pack for teachers and students

***This Resource Pack is
one of a series offering an
introduction to local history
while fulfilling National
Curriculum targets across a
number of subject areas. It has
been designed for the 5-14 age
range and mixed abilities.***

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1. A brief account of geology and the environment at Prestongrange

Coal mining, salt production and associated industrial activities have had a major impact on the environment in and around Prestonpans for over 700 years. A number of environmental issues are associated with the wide variety of industries which developed in Prestonpans over the centuries. Some of these are high visibility, others are less noticeable, but all had an environmental impact, especially through contaminants in the ground.

Geology of the area

East Lothian is part of the Midland Valley, a geological fault valley stretching across central Scotland from coast to coast. For industry, the significant geological period is the Carboniferous, the source of peat, coal, limestone, fireclay (for pottery and bricks), ironstone and shale. 'Millstone Grit', a building material used for the housing of the Cornish Beam engine and for some local house building is also obtained from Carboniferous deposits. These were extracted from a series of strata laid down one on top of the other on the southern shore of the Firth of Forth. The relative depth of these strata and their width determine the location of industries based on coal production, such as those at Prestongrange.

Coal

Within the Carboniferous period, the most important in terms of Prestongrange are the Upper Carboniferous sub-divisions of the Namurian and the Westphalian periods. A sub-division of the Namurian Series, the 'Passage Group', provides the fireclay for bricks and ceramics. Above the Namurian Series lies the

Westphalian Series. The Lower and Middle coal measures of this series comprised up to twenty workable seams. Eight of these seams were mined at Prestongrange, to depths ranging from 100 to 766 feet below ground level (the Beggar Seam). At the time of nationalisation in 1947, the eight workable seams at Prestongrange were known (from the top down) as: the Great Seam, the Diver Seam, the Clay Seam, the Five-foot Seam, the Jewel Seam, the Beggar Seam and Nos. One and Two Diamond Seams. Fireclay was valued for its importance in the manufacture of glass, pottery and brick, and mining by-products such as shale (used in brick production) also played their part in industry.

Waste rock in colliery spoil heaps contain minerals. These have a different environmental effect depending on whether the spoil is fresh or weathered. Fresh spoil has a high pH value and is therefore alkaline, whereas weathered spoil can be very acidic. Moreover, spoil heaps can become unstable as the size of particles inside them are reduced. Iron pyrite occurs naturally within Carboniferous rock. When it oxidises on contact with oxygen and water, it creates further compounds, resulting in lower pH values, toxic soil, water contamination and an increase in temperature. To prevent this, pollutants must be buried more than one metre deep, and the area covered with clean topsoil, then planted with agricultural crops or tree species capable of tolerating ecological extremes. At Prestongrange, these areas have been regraded and planted, mainly with alder,

hawthorn and birch, although some surface environmental pollution is still evident, in the form of pieces of equipment, brick, coal and metal. The soil in these areas is also darker in colour than neighbouring areas.

Another result of pyrite oxidation is pollution of surface and groundwater, known as 'acid mine drainage'. This can seriously threaten plant and algae growth and reduces the amount of oxygen present in fish and animals, thereby reducing their chances of survival.

However, there is little surface evidence of acid mine drainage at Prestongrange, although one significant victim in the past was the offshore oyster industry. The long history of underground flooding and the lack of nearby freshwater lakes or streams suggests that water passing through the shafts has transported water-borne pollutants out towards the sea, thereby limiting damage from such pollutants to the area around the shoreline.

It is impossible to judge the problem of subsidence accurately because of the long history of mining at Prestongrange and later land levelling and reclamation. However subsidence is likely to be a problem. Early 'Bell Pits' were tunnels dug down into the ground with the area below hollowed out until the danger of collapse forced the miners to withdraw. The 'Stoop and Room' method left large pillars of coal underground while removing coal from the area around them, while the 'Longwall' method shored up cavern roofs with artificial props which were later removed or left to rot.

Salt

The salt industry, with its long association with the area is second only to coal mining in its potential environmental impact. One by-product

of salt manufacture is sulphuric acid, or 'Oil of Vitriol', which was valued for bleaching linen. In 1749, a production plant for this chemical opened at Prestonpans. There are no records of the impact of its manufacture at Prestonpans, but this industry was dangerous; even small concentrations of sulphuric acid can seriously damage the lungs, and it is extremely hazardous to the environment, particularly if it enters the water supply.

A range of chemicals are released by salt production. Increases in sodium levels can alter the pH balance of the soil, affecting the survival of vegetation. Sodium and other chemicals in the ground can kill whole communities of plants and micro-organisms. Salt can also prevent plants from reaching water by forming a crust near the surface, damaging their root systems and reducing the moisture within the soil. However, thanks to its location close to the shore, the local vegetation will have a fairly high tolerance for salt and thereby reducing the environmental impact.

Bricks and Tiles

Coal mining and brick production release heavy metals, most commonly iron, copper, lead and zinc. These have a limited effect on humans not living in or near an active industrial area, but their environmental impact can be severe in the long term. However, there is no current evidence of dangerously high levels of such metals in the coastal vegetation around Prestonpans.

Clay for bricks and tiles was not mined at Prestongrange, but was imported from elsewhere, therefore the areas most likely to be affected by ground contamination from manufacture would be the sites of the Hoffman kiln and the 'Beehive' kilns. The heat generated by

such industrial activity and any associated chemical reactions would certainly have affected any shallow-rooted plants, mosses and lichens close to the kilns. This would also have been an issue near the salt pans along the coast. However, current observation shows vegetation breaking through cracks in the concrete at the kiln sites, indicating that the soil beneath is reasonably healthy. Glass was produced only during a brief period in the late 1690s, and has had no currently observable effect on the local environment.

Cockenzie Power Station

Large quantities of ash from Cockenzie Power Station have been spread around Morison's Haven, especially between the beehive kilns and the beam engine. This ash can have similar environmental effects to that of coal spoil. However, in a stable state it causes limited environmental problems. In this case, the area is covered with grass,

suggesting that vegetation is not too seriously affected.

Railways

Land near industrial railways can also be highly contaminated. However, the large scale of industry at Prestongrange meant that much of the area was built over, thereby protecting the land below, while the lack of freshwater streams or lakes in the area has limited any significantly adverse effect on wildlife.

Conclusion

Because industry in and around Prestonpans disappeared gradually, over many years, from the late 19th century onwards, the site is now relatively clean. Revegetation has helped the recovery process site and it is now undergoing natural processes of reclamation. However, even though industrial activity had ceased by the end of the 1960s, the more recent removal and infilling of historic sites has added to the environmental damage to the site.



2. Summary

Geology

The geological fault valley stretching across central Scotland contains **deposits** of **fossil fuels**.

Mining

At Prestongrange, eight seams from the **Carboniferous** period were mined for coal, fireclay and shale. Colliery spoil heaps contain **minerals** which affect the **pH** balance in the soil. **Iron pyrite** in spoil heaps can **oxidise**. This causes **toxic** soil, **contaminated** water and increased temperatures. '**Acid mine drainage**' threatens plants and **algae** and reduces oxygen, which fish and animals need. However flooding in the **seams** at Prestongrange probably washed such **pollutants** out to sea. **Subsidence** is also a problem where mining has taken place.

Sulphuric Acid

A factory was producing **sulphuric acid**, or 'Oil of Vitriol' in Prestonpans in the 1750s. Even small **concentrations** of **corrosive** sulphuric acid in the air or water are harmful to humans and the environment.

Salt

Salt from the salt pans can prevent plants from reaching water.

Sodium can kill communities of plants and **micro-organisms**.

Heavy Metals

Coal and brick production releases **heavy metals** such as iron, copper, lead and zinc.

Heat

Heat from brick and pottery production and from the salt pans can affect shallow-rooted plants, mosses and **lichens**.

Ash

Ash from Cockenzie Power Station has been spread around the Prestongrange site. This can have similar effects to coal spoil.

Railways

Oil leaked from trains can affect the ground beneath.

The Whole Story

Much of the Prestongrange site is now covered in vegetation, which suggests that the ground beneath is fairly healthy. Much of the site was protected because buildings covered the ground. A natural process of recovery is now taking place and because industrial activity was spread over so many years, the area is now fairly clear of contaminants.

3. Glossary

Geology

The study of the earth.

Deposit

A layer of coal beneath the ground

Fossil fuel

A fuel formed from the remains of living organisms in the distant geological past

Carboniferous

A geological time period millions of years ago, when coal deposits were formed

Mineral

A non-living substance eg gold

pH

a measure of acid or alkali in the soil, based on how much hydrogen it contains. Too much or too little can seriously affect plant growth

Iron pyrite

An iron compound found in carboniferous rock

Oxidise

A chemical change when iron comes into contact with oxygen (seen as rust)

Toxic

Extremely poisonous

Contaminated

Containing poisonous elements

Acid mine drainage

Water on the surface or below ground contaminated by iron pyrite

Algae

Non-flowering water plants

Seam

An underground stretch of coal

Pollutant

A substance which causes environmental damage

Subsidence

Collapse of the surface due to holes under the ground

Sulphuric acid

A chemical compound containing sulphur.

Concentration

A measure of how much of a substance is in a measured amount of air, water etc.

Sodium

A metallic element occurring naturally in salt

Micro-organism

A living thing too small to be seen

Heavy metal

A metal with high density

Lichen

Fungi and algae occurring together

4. Timeline

- 1150s** - Charter grants the Cistercian monks of Newbattle Abbey by Seyer de Quincy, Earl of Winchester to establish a coalworks and quarry between Whytrig Burn and the boundaries of Pinkie and Inveresk.
- 1308** - Act of Parliament forbids the use of coal in London due to smoke and fumes. Coal is used to heat large monastic and nobles' houses in Scotland whilst being associated with trade and industry.
- 1300s** - James V allows construction of Acheson's (now Morrison's) Haven. The Abbey is granted the right to transport coal from the workings beside the River Esk for shipment in small boats. Packhorses make the return journey with salt and with goods traded for the salt and coal shipped at the harbour.
- 1450s** - Accessible supplied of coal diminish while demand for coal increases.
- 1500s** - Scottish coal output is approximately 40,000 tons, but still from small scale workings. However, 6 tons of coal were needed to produce one ton of salt (salt was very profitable).
- 1609** - Export of coal forbidden.
- 1606** - Law reduces colliers to a form of slavery (serfdom).
- 1700** - Annual output of coal c4 million tons
- 1705** - Thomas Newcomen patents the steam engine.
- 1707** - Union of the Parliaments of Scotland and England sees the decline of the Prestonpans salt industry.
- 1722** - Tranent and Cockenzie Waggonway laid.
- 1741** - Evidence of the use of horse gins at Prestongrange.
- 1743** - Morrison's Haven harbour ceases trading.
- 1746** - Mining temporarily ceases at Prestongrange due to flooding.
- 1780** - James Watt successfully modifies Newcomen's design.
- 1800** - Total coal output for Britain is 10 million tons
- 1812** - William Murdoch perfects a method for extracting gas from coal for lighting.
- 1814** - Sir John Hope's Pinkie Railway between Pinkiehill and Fisherrow is constructed.
- 1815** - Tranent and Cockenzie Waggonway replaces wooden rails with cast iron.
- 1830** - George Grant-Suttie leases land at Prestongrange to Matthias Dunn
- 1830** - No 1 shaft sunk, re-opening the mine after more than 65 years.
- 1831** - Edinburgh and Dalkeith Railway ('Innocent Railway') constructed.
- 1838** - Waggon road at Prestongrange runs from pit bottom to working. Bearers replaced by wheeled rails.
- 1838** - Matthias Dunn gives up the lease of Prestongrange.
- 1840** - No. 1 shaft flooded.
- 1850s** - Turnpike System is introduced in Scotland.
- 1850** - The Prestongrange Company takes over the Prestongrange lease.
- 1850** - Opening of the mineral railway junction links Prestongrange Colliery with the main East Coast line.
- 1870** - Total output of coal in Scotland is 15 million tons.
- 1874** - The Cornish Beam Engine is installed at Prestongrange.
- 1878** - The Mining Institute of Scotland is established.
- 1893** - The Prestongrange Company fails.
- 1895** - The first mechanical washer for cleaning coal in Scotland is installed at Prestongrange.
- 1900** - 439 employed at Prestongrange Pit: 61 above ground and 378 below.
- 1905** - The Cornish Beam Engine has its pumping capacity improved.
- 1910** - 873 employed at Prestongrange: 153 above and 720 below (including many Irish immigrants).
- 1910** - An electric turbine pump is installed to pump water from Prestongrange.
- 1913** - Total coal output for Scotland 42 million tons.
- 1915** - total coal output for Scotland 35.25 million tons.
- 1945** - Total coal output for Scotland less than 20 million tons.
- 1946-7** - Nationalisation. The government takes over the coal mines.
- 1962** - Prestongrange Pit closes.

5. Curriculum Target: Knowledge and understanding of people in the past

STRAND	LEVEL C	LEVEL D	LEVEL E	LEVEL F
<p>People, events and societies of significance in the past: Developing an understanding of distinctive features of life in the past and why certain societies, people and events are regarded as significant</p>	<p>Describe the diversity of lifestyles of people in the past, eg the life of a peasant as opposed to a landowner</p>	<p>Describe some features of societies, people and events of the past and suggest why they might be considered significant</p>	<p>Explain the motives or actions of people in particular historical situations Explain the values or attitudes that characterised various societies in the past Explain why particular societies, people and events from the past are thought to be of significance</p>	<p>Apply knowledge and understanding of the motives or actions of people in particular historical situations and/or the values and attitudes of particular societies in the past to reach conclusions on a given historical issue or question</p>
<p>Change and continuity, cause and effect: Developing an understanding of change and continuity over time and of cause and effect in historical contexts</p>	<p>Make a comparison between present and past lifestyles/circumstances/features. What is different? What is the same? Give some reasons for differences and for aspects of continuity</p>	<p>Identify important features of a development that have changed over an extended period of time eg transport, role of women Explain in simple terms why these features were important and describe what effects they had on people's lives</p>	<p>Demonstrate a detailed knowledge and understanding of the main features of a particular event/development/attitude with regard to change and continuity Give some reasons to explain why a specific historical event/action/development took place and what the specific consequences were</p>	<p>Apply knowledge and understanding of the process of cause and effect to provide detailed explanation as to why a particular development/event took place and give balanced assessment as to the significance of its consequences</p>
<p>Time and historical sequence: Developing an understanding of time and how events in the past relate to one another in chronological sequence</p>	<p>Put a series of events with their dates in chronological order Use the words 'decade' and 'millennium' correctly</p>	<p>Explain the meaning of the terms 'bc' and 'ad' Place a number of events from a specific historical development on a timeline that crosses BC/AD divide</p>	<p>Explain the relationship between specific dates and the relevant century Name and place significant historical periods in chronological order</p>	<p>Compare and contrast timelines from a significant historical period in different parts of the world</p>
<p>The nature of historical evidence: Developing an understanding of the variety of types of historical evidence and their relative significance</p>	<p>Describe ways in which people remember and preserve the past, eg war memorials and suggest reasons why they should do this</p>	<p>Suggest a variety of sources of information about the past and what use they might be to someone studying a particular topic Explain the meaning of the term 'heritage' and give some examples, eg castles, literature</p>	<p>Suggest ways in which society's awareness of its own past can affect its present and future development eg devolution in Scotland, conflict/peace in Northern Ireland</p>	<p>Describe how heritage and evidence can be used in both positive and negative ways eg to promote social, economic or political ends</p>

