
Geology Walk (1) — Vogrie Country Park

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This short walk through the Midlothian landscape tells the geological story of the last 430 million years. You will see extinct volcanoes, and evidence of long-gone oceans, tropical seas, lakes, rivers and swamps and the last ice age; and, much more recently, of the mining for coal and lime.

This information was prepared by Tasmin Fletcher as part of an Outreach Project at the School of Geosciences, University of Edinburgh in 2015, with support and information from Vogrie Country Park Ranger Service and Lothian and Borders GeoConservation.

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Special Points (SP) are marked on the map with notes below.

SP1. Road metal [NT 380 632] in front of Vogrie House. Typical product of aggregate quarries in the Scottish Borders, probably hard 430 million year old ocean sandstone.

SP2. Walled garden [NT 377 631] The red bricks of the walled garden are probably local and made out of waste excavated as part of the underground mining of coal.

SP3. Vogrie burn [NT 367 628] Boulder clay. This clay, quite rich in pebbles and cobbles, is the product of ice melting at the base of an ice sheet.

SP4. Boulders beside Path [NT 366 630] The clay soils and landscapes of the surrounding countryside are relics of the last ice age. The fields originally started off as sediments left behind as the great ice sheet, which covered this area, started to melt and retreat some 18,000 years ago. The boulders beside the path are mainly 300 to 330 million years old Carboniferous sandstone, but there is a dark rounded one of igneous origin, dolerite from the 300 million years old Midland Valley Sill. Similar boulders come to the surface every year during ploughing.

SP5. Steadings nearby of brick [NT 365 630] Brick and tile making is usually a by-product of coal mining and the colour of the waste material determines the colour of the brick. Here it is predominately yellow, at Vogrie Park, it is red. However there was a clay pit in Newlandrig.

SP6. Borehole [NT 364 632] Coal seams lie a few metres beneath the surface of these fields and this metal capped borehole may have been an observation point to check water quality underground.

Stretching out towards the Pentlands is the Midlothian Coalfield, where coal was mined up until 2003. Coal was central to Midlothian's history, and many of the fields to the west were first stripped of the top few metres of soil and then mined for coal in opencast operations.

The coal owes its origin to the tropical swamps that existed here around 320 million years ago, in which scaley, fern-like trees known as lycopsids grew. After they died, millions of years of heat and pressure of burial transformed these dead forests into hard, black coal. Looking South west towards Newtongrange you might be able to make out the chimney of the National Mining Museum, where further information can be found.

SP7. Viewpoint 1 [NT 363 633] From here we have a view, starting in the north- east, of North Berwick Law (187m) and, moving clockwise, the Hopetoun Monument (204m), Traprain Law (221m) and the Lammermuirs (Meikle Says Law 525m) round to the Moorfoot Hills (Windlestraw Law 659m) in the south-west.

- **North Berwick Law** (compass bearing from Viewpoint: 040°N) is a conical hill which stands at 613 ft (187 m) above sea level. Geologically, the law is the “plug” of one of the many extinct volcanoes which erupted here about 345 million years ago. The plug was formed in the pipe, through which the magma (molten rock) erupted, when volcanic activity ceased and the rock still in the pipe cooled to form very hard phonolitic trachyte. The Law has survived the scraping glaciers of the Ice Age from the west and protected the softer rock to the east, creating a “crag and tail” formation, with a prominent tail extending eastwards.
- **Traprain Law** (compass bearing from Viewpoint: 060°N) is a long flattish hill about 724 ft (221m) above sea level. Geologically, it is a sheet intrusion or concordant pluton known as a laccolith . These occur when magma has been injected between two layers of sedimentary rock and the pressure of the magma is high enough to force the overlying strata upwards into a dome or mushroom-like shape. Traprain Law was created during the volcanic activity of 345 million years ago.
- **The Bass Rock** (compass bearing from Viewpoint: 060°N) is a steep-sided volcanic island which stands 351 ft (107 metres) at its highest point, about 2 kilometres (1.2 miles) north-east of town of North Berwick. It is sometimes called "the Ailsa Craig of the East" and is geologically a volcanic plug of phonolitic trachyte like nearby North Berwick Law. It is home to a large colony of gannets.
- **The Lammermuirs, Moorfoots and other hills** surrounding Vogrie are part of the Southern Uplands, originally a belt of mountains stretching right across Scotland, which was thrown up when the tectonic plates carrying “Scotland” and “England” collided 420 million years ago. Much of the Southern Uplands consist of Ordovician and Silurian rocks that were once sand and mud deposited on the floor of the Iapetus Ocean south of the Equator between 490 and 420 million years ago. Erosion since then has reduced the mountains to the hills you see today, which have been further carved and smoothed during the last Ice Age which ended 11,500 years ago.
- **The Lammermuirs** to the south-east are a significant range of hills. The highest point is Meikle Says Law (compass bearing from Viewpoint: 98°) at 1755 feet (535m) with nearby windfarm. In certain parts there are exposures of coarse sandstones and conglomerates, coloured red as evidence of geological conditions here 390 million years ago when this area was arid, without vegetation, and subject to flash floods.
- **The Moorfoot Hills** lie to the south west. The highest of these gently rolling hills is Windlestraw Law (compass bearing from Viewpoint: 180°N) at 2162 feet (659 metres). To the right and slightly lower is Blackhope Scar (compass bearing from Viewpoint: 200°N) at 2136 feet (651m) which is classed as a 'Marilyn', one of the 1217 hills in Scotland with a drop all round of 150 metres or more.

SP8. Drystone wall [NT 360 638] Some stones show clear evidence of how the parent rocks were formed in water, some with different coloured layers, others with clear ripple marks left by the action of wave, current or wind over 300 million years ago. There are also stones containing tree-like fossils.

SP9. Quarry [NT 363 639] Stone walls were popular barriers because of the nearby availability of stone, which was quarried as locally as possible. In this wood is a 10 foot deep hole in an area of about 25 square yards , which was formerly a quarry and is now overgrown.

SP10. Limestone quarry [NT 360 646] Lime has, since biblical times, been important for the making of mortar for building. It also became used as the protective coating for buildings, often called whitewash. More recently , the calcium in limestone was recognised as a valuable fertiliser, and its use was encouraged by the Society of Improvers, who brought about an agricultural revolution across the Scottish Lowlands.

This large shallow hole, much overgrown, is an old limestone quarry dating from the 18th century. Once quarried, the limestone was taken to the nearby kiln at Kiln Cottages where it was burned to produce the fertiliser known as quicklime.

The limestone here formed 330 million years ago when this area was a shallow sea near the Equator. The limestone formed from the shells of dead sea creatures falling to the ocean floor and compacted over millions of years. These sea creatures made their shells from calcium in the sea water, and it is the calcium in limestone which makes it useful as a fertiliser for farmers.

SP11. D'Arcy Oil Well [NT 362 647] All that you see here now is an ordinary field but, during the early 20th century, this was the site of Scotland's second ever oil well. The well was drilled in 1919-1922 by Anglo-Iranian Oil Company (D'Arcy Exploration Co Ltd) and some gas and oil was struck on 6th May 1922 at a depth of 1810 feet (Hansard). It cost at least £42,000 and went on to produce 30,000 barrels of oil between 1946 and 1965. You can see a photo and read more at <http://britgeoheritage.blogspot.co.uk/2013/03/exploratory-oil-drilling-darcy.html>.

Oil's story begins from around 340 million years ago, when lakes covered the land. Microscopic plant remains and algae that lived in the water accumulated on the lake floor. These became compressed under layers of rock for millions of years to form oil and gas. The oil then became trapped in folds in the rock that were created during the collision of two tectonic plates, an event which closed the sea and formed mountain belts right across Europe. The oil began to accumulate and that meant it could be drilled and used as a fuel in the 20th century.

SP12. Viewpoint 2 [NT 360 650] To the north-west we can see the Pentland Hills round to Arthur's Seat (251m) and then looking north and east over to Fife, on a clear day, you may be able to see the twin tops of the extinct volcanoes Largo Law (290m - compass bearing from Viewpoint: 009°N) and, still farther east, Kellie Law (184m - compass bearing from Viewpoint: 025°N).

- **The Pentland Hills** to the north-west provide much evidence of volcanic activity of about 410 million years ago, of later desert conditions, and of the last period of intense geological activity 15,000 to 11,500 years ago, when the ice which covered Scotland thawed and released huge quantities of water to shape hills and create valleys. Scald Law (579m, compass bearing from Viewpoint: 252°N) is the highest hill of the Pentlands and is composed of volcanic rock.
- **Arthur's Seat** (compass bearing from Viewpoint: 315°N) with its distinctive lion's head and body shape is the remains of volcanic eruption around 340 million years ago. This has now eroded leaving us the main lava flows and exposing the internal volcanic structure.
- **Salisbury Crags** (compass bearing from Viewpoint: 310°N) starting with a sheer cliff in the west and tapering to Arthur's Seat in the east, is a "sill", part of the internal structure of a volcano. Sills are formed during eruption when some magma is forced sideways through the rock, instead of erupting through the vent, and eventually cools to form very hard rock. Erosion has exposed this sill, and local tilting has lifted the west end high above the plain.
- **Castle Rock** (compass bearing from Viewpoint: 310°N) Edinburgh Castle stands upon the plug of an extinct volcano which is estimated to have erupted about 340 million years ago. When volcanic activity ceased the magma still in the pipe cooled to form very hard dolerite, a type of basalt. This hard plug resisted glacial erosion from the west creating a "crag and tail" formation, starting with the castle and a gentle descent down the High Street to Holyrood Park. The summit of the Castle Rock is 430 ft (130 metres) above sea level.

SP13. Lawfield Quarry [NT 357 656] Through the garden fence you can see the face of a former sandstone quarry.

SP14. Viewpoint 3 [NT 357 657] Looking west towards Dalkeith, we can see in a field a cylindrical sandstone-built tower [NT 349 663]. This is an airshaft dating back to the era of deep mining in this area and the requirement for ventilation.

SP15. Lawfield Wood [NT 359 658] Site of sandstone quarry. Two coal seams were formerly visible in the east face.

SP16. Windmill Wood [NT 370 651] The ground is unnaturally irregular with shallow holes a few yards across. This is evidence of mining a few feet below the surface. These "crown holes" were created when the site was abandoned and the roof of the shallow mines, perhaps originally propped up with timbers, subsequently collapsed.

SP17. Windmill House [NT 371 651]. Late 18th century sandstone built windmill (for grinding wheat?) converted into a house.

SP18. Edgehead Wall [NT 376 649] Stones in wall showing sedimentary layers.

SP19. Viewpoint 4 [NT 373 642] Looking south you can see the Lammermuirs and the extensive windfarms at Soutra in front of Headshaw Hill (411 m, NT 486 565).

SP20. Yellow/reddish pool [NT 378 638] Look down in the Vogrie Burn and you will see a coloured pool where an "ochreous" stream, possibly emitting from an old coal working, joins the main burn.

Further details of geological walks

We hope you have enjoyed this walk. If you would like further details on geological walks in the Edinburgh area and beyond please visit the following websites:

Lothian and Borders Geoconservation leaflets —

<https://www.edinburghgeolsoc.org/publications/geoconservation-leaflets/>

Geowalks — <https://geowalks.scot/>

Figures

(Figure 1) Map showing stops on the walk

(Figure 2) How the swamps of Midlothian might have looked in the Carboniferous.

(Figure 3) North Berwick Law in the distance.

(Figure 4) The Bass Rock.

(Figure 5) Arthur's Seat.



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(Figure 3) North Berwick Law in the distance.



(Figure 4) The Bass Rock.



(Figure 5) Arthur's Seat.