James Hutton Founder of Modern Geology (1726–1797)

From the portrait by Sir Henry Raeburn

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Acknowledgements

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Text by Cliff Porteous and Mike Browne; additional images by Howard Turner and Angus Miller. Designed by Derek Munn. Produced by the Lothian and Borders GeoConservation Group of the Edinburgh Geological Society, a charity registered in Scotland Charity No: SC008011.

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Figures

(Front cover) From the portrait by Sir Henry Raeburn.

(Figure 1) Map showing localities associated with Hutton.

Introduction

Scotland between the years of 1730 and 1790 enjoyed a spell of intense intellectual activity known as the Scottish Enlightenment — a unique period in history, one of optimism, improvement and discoveries in industry, commerce, agriculture, science and the arts.

James Hutton's life (1726–1797) spanned this period and he made a considerable contribution to our understanding of Earth processes and of the immensity of 'deep time'. Although trained as a physician, he spent much of his life as an agriculturalist, working on the farms which he had inherited. He was an outstanding natural philosopher and was elected to the Royal Society of Edinburgh.

Hutton of course pre-dated photography, so the only clues we have as to his appearance come from painting and sculpture, not all of which can be considered life-like. The image on the right, a portrait medallion of James Hutton by James Tassie in 1792, is considered to be a good likeness.

Meeting of Burns and Scott

This important oil painting, by Charles Martin Hardie, is on display at Abbotsford House near Melrose. It shows the only meeting of the young Walter Scott (aged 15) with Robert Burns, which took place in 1787 at Sciennes House, the home of Professor Adam Ferguson. James Hutton and several others are also shown, although since it was not painted until 1893, it is uncertain whether the painting represents an actual meeting of all these Enlightenment figures. Burns, Scott, Joseph Black, James Hutton, Adam Ferguson, Ferguson jnr, Adam Smith, Dugald Stewart, John Hume.

James Hutton's Theory

The surface of the Earth is constantly being eroded and the products deposited in the sea. Hutton believed the sediments were then compressed, folded and uplifted, sometimes with volcanic activity, for the cycle of erosion to resume. He also said that earth processes of the past were similar to those acting at present (a prevalent idea — Comte de Buffon 1790), and that the slow cycle was capable of repeating itself. He put it succinctly: "the result, therefore, of our present enquiry is that we find no vestige of a beginning — no prospect of an end."

Localities associated with Hutton

Hutton at the Scottish National Portrait Gallery, Queen Street, Edinburgh [NT 25571 74243]

The portrait of James Hutton by Sir Henry Raeburn, reproduced on the front cover of this leaflet, is on display in the Scottish National Portrait Gallery. It shows Hutton in an informal pose, with crossed legs and open waistcoat. The manuscript on the table is probably Hutton's 'Theory of the Earth' and Raeburn has also included geological specimens, including fossils, on the table top.

Hutton is also included in the processional frieze in the Great Hall of the gallery. This frieze on themes from Scottish history was painted in 1898 by William Hole RSA.

The extract below (see PDF) shows (left to right): Sir Henry Raeburn (painter), Lord Jeffrey, (judge), Sir Walter Scott (novelist), John Hunter (surgeon), Robert Burns (poet) in striped waistcoat, James Hutton (geologist), Thomas Telford (civil engineer), James Watt (engineer, inventor of steam engine) with others.

High up on the outside of the building is a statue of Hutton, with hammer and rock in hand (sculptor David Watson Stevenson). On his left is John Hunter the renowned surgeon and anatomist. The building stone is red, wind-blown, Triassic sandstone from Corsehill, near Annan and Moat, Cumbria.

James Hutton Memorial Garden [NT 263 734]

This marks the site of James Hutton's Edinburgh home on St John's Hill in the Pleasance above Holyrood Road.

This memorial garden was constructed in 2001 for the University of Edinburgh and marks the site of the house where Hutton lived from about 1770 until his death in 1797. The garden contains a memorial plaque and five boulders which illustrate two main themes of Hutton's geological work.

Hutton used the presence of granite veins in schist, a metamorphic rock formed by heat and pressure acting on existing sedimentary rock, in Glen Tilt near Blair Atholl to demonstrate that granite is an igneous rock and that it must have been younger than rocks it penetrated. The granite veins can be seen in the larger of the two grey boulders from Glen Tilt, which come from close to the actual spot investigated by Hutton.

The third boulder pictured, and two others nearby, are conglomerate from Barbush near Dunblane and are full of fragments of older rocks, demonstrating the continuity and cyclic nature of geological processes.

North Newton shore, Arran 1787 [NR 933 517]

Hutton discovered his first unconformity in the summer of 1787. This site displays an angular unconformity between steeply inclined metasedimentary rocks of the Precambrian Dalradian Supergroup (600 million years old) and the much younger sedimentary rocks of the early Carboniferous Period (360 million years old). The exposure is complicated by the presence of a calcrete layer in the upper part of the Dalradian rocks. This suggests these rocks were exposed in a hot, semi-arid climate before the younger rocks began to accumulate on top.

Inchbonny, Jedburgh [NT 650 199]

John Clerk of Eldin's beautiful engraving of the Inchbonny section (see PDF)

Here, at the second of his unconformity sites, Hutton found nearly vertical sedimentary strata with horizontal Old Red Sandstone strata on top. He concluded that the vertical beds must have been raised above the surface of the ocean, subjected to the levelling effect of weathering and erosion before sinking below sea level when a new set of sediments mainly sandstones and mudstones were deposited on top. Hutton was wrong in one detail. At none of his sites of unconformity are the directly overlying rocks of marine origin, they are in fact river deposits.

Hutton's Section in Holyrood Park, Edinburgh [NT 27131 72871]

A key site that supported Hutton's new understanding of geology is found at the south end of Salisbury Crags. Hutton associated "extreme heat" as the agent of folding and uplift of strata. In his own words "We know that the land is raised by a power which has for its principle subterraneous heat, but how that land is preserved in its elevated station, is a subject which we have not even the means to form a conjecture." He believed that molten rock (magma) could be 'intruded' between or across sedimentary rocks, sometimes reaching the surface as lava flows. He found evidence to support this at the base of the Salisbury Crags sill, where magma intruded between sedimentary layers has cooled to form tough igneous rock (dolerite or whinstone). The junction between the dolerite and sandstone shows that the magma was intruded forcefully, disrupting the existing sedimentary layers. Such a dynamic contact feature is incompatible with the common view in Hutton's time that igneous rocks 'crystallised like salt from sea water'.

Siccar Point near Cockburnspath 1788 [NT 81266 70975]

Hutton believed that cyclic processes (similar to orbits in astronomy, and blood circulation in the body) operated in the Earth. He saw weathering and erosion denuding the land and producing sediments under the sea which then consolidated into rock. The cycle was continued through uplift with the necessary energy supplied by internal heat. He thought of the Earth as a dynamic heat engine capable of helping to drive the cycle. The most convincing proof of his cyclic theory was obtained on the Berwickshire coast at Siccar Point, the third of his unconformity sites which he visited with Sir James Hall and John Playfair.

Silurian sediments were laid down and consolidated into poorly sorted sandstones (greywackes). These rocks were uplifted, folded and eventually eroded. Deposition of Upper Old Red Sandstone sediments took place during the latter part of the following geological period, the Devonian. The rock cycle continued, resulting in the present day picture. In this spectacular exposure, the gap in time represented by the unconformity is about 65 million years!

Hutton's farm at Nether Monynut [NT 72765 64547]

This farm rests mainly on Silurian sandstones and shales on the eastern flank of the Lammermuir Hills. The soil is thin and stoney, and the land rises to 300m above sea level.

Hutton's farmhouse at Slighhouses near Duns, Berwickshire [NT 82199 59411]

At the start of the 18th century agriculture was still rather primitive in Scotland with heavy wooden ploughs, no hedges or fences, and a 'runrig' system of scattered strips of cultivation. Between 1697 and 1703 there were periods of harvest failures and famine. This farm and that at Nether Monynut, eight miles away were inherited by Hutton. From 1754 to 1767 he chose to live at Slighhouses. He set about enclosing and draining the land. He introduced new methods of crop rotation and ploughing, with modern ideas he had seen in practice in Norfolk and Flanders. During this time he never lost his enthusiasm for solving geological problems. Slighhouses Farm is on Upper Old Red Sandstone sedimentary rocks with a superficial cover of glacial till.

Hutton's Marl Pit [NT 833 594]

Hutton used Slighhouses as a living laboratory to investigate agriculture and other natural history phenomena. The marl pit he created is still in evidence, and he wrote of using marl (limey mud) on his fields to improve crop yield. He was not

always successful as some of the marl was too poor in lime.

Dunglass Collegiate Church (15th century Gothic) [NT 76657 71896]

This is the resting place of Sir James Hall of Dunglass, geologist and chemist, (1761–1832). He admired Hutton, while not accepting the enormous periods of time required for Hutton's Uniformitarian view that geological history is a matter of ordinary forces and unlimited time. In 1798 Sir James Hall investigated the action of heat and pressure on rocks. The Wernerians had pointed out that basalt, when heated and cooled in experiments, turned to glass not crystalline rock, therefore basalt must be a precipitate from a universal ocean. Hall allowed molten basalt to cool very slowly, and it reformed as crystals not as a glass. By experiment, he showed the igneous nature of basalt and granite. In the 18th century, the Church held that the age of the Earth was nearly 6000 years.

On reading Hutton's Theory Playfair realised how difficult it was to understand, and being an excellent communicator himself decided to publish his 'Illustrations of the Huttonian Theory' in 1802. This book set out the sound principles and “bold outline traced by Hutton” for others such as Sir Charles Lyell and Sir Archibald Geikie to build on.

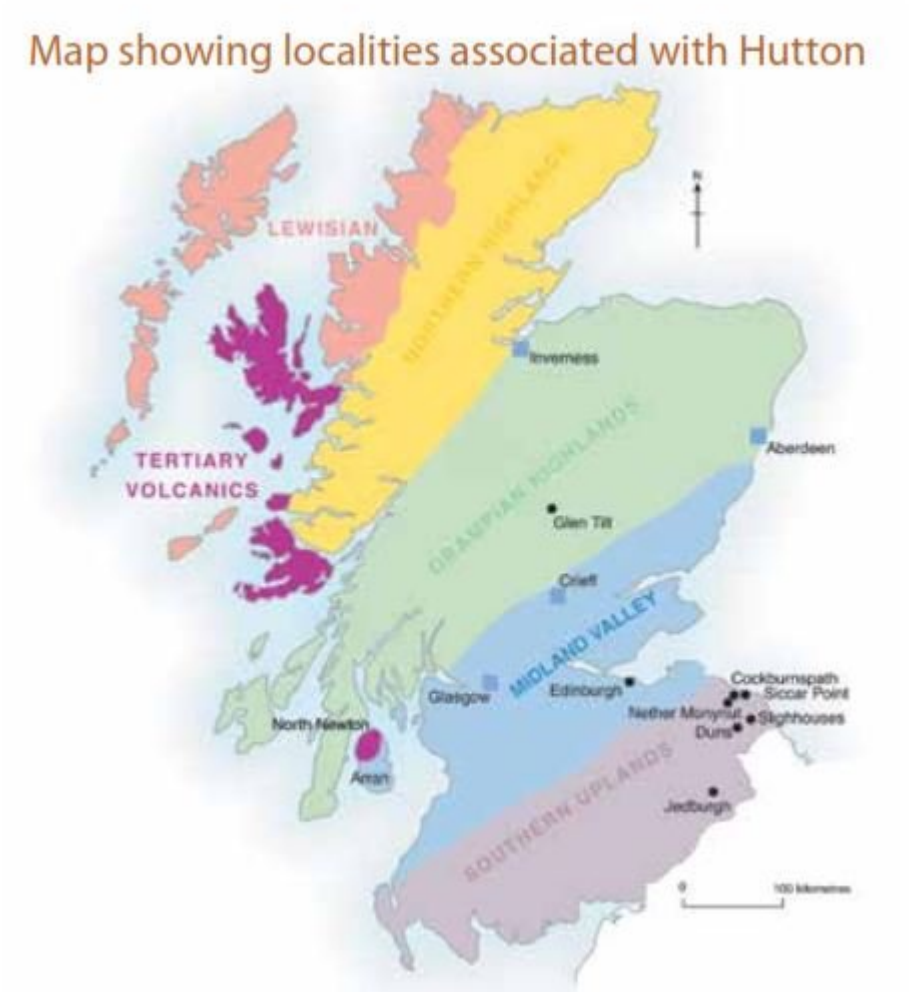
Hutton roof, National Museum of Scotland [NT 25755 73279]

Andy Goldsworthy's four sandstone blocks invite us to look down through the layers of time and think of their formation from desert sands 270 million years ago, and yet again to the origin of the sand grains from erosion in periods even farther back in time.

Hutton's grave in Greyfriars Churchyard, Edinburgh [NT 25639 73267]

His grave in the Balfour family vault in the section known as the Covenanters' Prison was unmarked until November 1947 when a simple plaque was erected marking the 150th anniversary of Hutton's death. In 1997 a Bicentenary International Conference was held in Edinburgh, a wreath laid, and a eulogy spoken by Professor Donald McIntyre which finished with these words:

"Today we have come to know that living creatures evolve, that continents drift, that stars and galaxies are born, mature, grow old and die. We salute the memory of James Hutton, who opened our minds to these wondrous possibilities."



Map showing localities associated with Hutton.

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