James Hutton (1726 – 1797) was a landowner, farmer, agriculturalist, physician, chemist and geologist, not all of which can be considered a profession in his time. He was elected to the Royal Society of Edinburgh in 1754 and in 1783 made his famous geological visit to the Scottish Borders to study the great unconformity at Sighthouses. His hypothesis of the Earth’s geology was built on the principles of uniformitarianism and the concept of cyclic processes. He argued that the Earth has a very long geological history, and that processes observed today are similar to those that occurred in the past. This led to the development of the concept of uniformitarianism, which states that the past can be used to understand the present.

Hutton’s Theory

Hutton’s Theory is that the Earth is continually being eroded and the surface of the Earth is constantly being uplifted. He believed that the slow cycle of erosion was capable of removing all vestiges of the Earth’s past. He also said that earth processes of the past were similar to those acting at present, which was a prevalent idea at the time.

James Hutton’s Theory

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Sir John Clerk of Penicuik, Bt. for permission to reproduce the etching of the Jedburgh unconformity by John Clerk of Eldin, and to the Scottish National Portrait Gallery for permission to reproduce the Raeburn portrait of James Hutton.

The Scottish Borders James Hutton Trail, links locations associated with the life and times of James Hutton including sites of geological significance. This trail was initiated by Borders Foundation for Rural Sustainability in partnership with Marshalls’ at Sighthouses, the Thomson’s at Nether Monynut, Lothian and Borders RIGS Group and the British Geological Survey (Scottish office).

Text by Cliff Porteous and Mike Brown. Designed by Derek Munn.
Salisbury Crags Sill - Hutton's Section

in Holyrood Park, Edinburgh

A key site in his new understanding of geology is at the south end of this escarpment formed by the intrusive dolerite sill that is over 300 million years old. Hutton associated 'extreme heat' as the agent of folding and uplift of strata. The question as to what produced the heat could not be answered at that time.

In Hutton's 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) under pressure could be ‘intruded’ between or across layers of sedimentary rocks, sometimes reaching the surface as lava flows. He found evidence to support this in Holyrood Park. The photograph shows a section of the Salisbury Crags sill where igneous rock (called whinstone locally) has been intruded between sedimentary layers. Here at the base of the sill magna has forced its way into the underlying sedimentary strata. Such a dynamic contact feature is incompatible with the then contemporaneous view that igneous rocks 'crystallised like salt from sea water'.

North Newton shore, Arran 1787

Hutton discovered his first unconformity site in the summer of 1787. This site displays an angular unconformity between steeply inclined metasedimentary rocks of the Precambrian Dalradian Supergrupo (600my. old) and the much younger sedimentary rocks of the latest Devonian / earliest Carboniferous Kinnessow Formation (360my. old). The exposure is unusual in having a calcated 'surface' in both series of rocks suggesting a long period of exposure of the unconformity surface in a hot semi-arid climate when the younger rocks started to be laid down.

Hutton’s farmhouse at Slighouses near Duns, Berwickshire

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 famine in the land, and harvest failures. This farm and that at Nether Monynut, eight miles away were inherited by Hutton. From 1754 to 1767 he chose to live at Slighouses. 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.

Slighouses Farm is on Upper Old Red Sandstone sedimentary rocks (370my old) with a superficial cover of glacial till deposited during the last ice age about 27000 - 13000 years ago.

Hutton’s Marl Pit

Hutton used Slighouses 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 (limy mud) on his fields to improve crop yield. He was not always successful as some of the marl was not limy.

Hutton’s grave in Greyfriars Churchyard Edinburgh.

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 Bicentennary International Conference was held in Edinburgh, a wreath laid, and a eulogy spoken by Professor Donald Miller which finished with these words: “Today we have come to know that living creatures 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.”

Jedburgh etching of Inchbonny section 1787

John Clerk of Eldin’s beautiful engraving is reproduced by kind permission of Sir Robert Clerk of Penicuik.

Inchbonny, Jedburgh (photographed in 2001)

Here, at the second of his unconformity sites, at Inchbonny, Hutton found nearly vertical sedimentary strata with horizontal Upper Old Red Sandstone red beds 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 but they are in fact fluviat.

Dunglass Collegiate Church. (15th century Gothic)

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.

Hail allowed molten basalt to cool very slowly, and it re-formed as crystals not as a glass. By experiment, he showed the igneous nature of basalt and granite.

In 1785, the Church held that the age of the Earth was nearly 6000 years. Bibles published in 1793 were annotated to that effect.

Siccar Point near Cockburnspath 1788

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 fresh red Upper Old Red Sandstone sediments took place during the following geological period of the Upper 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 55million years.

Hutton’s, farm at Nether Monynut.

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.