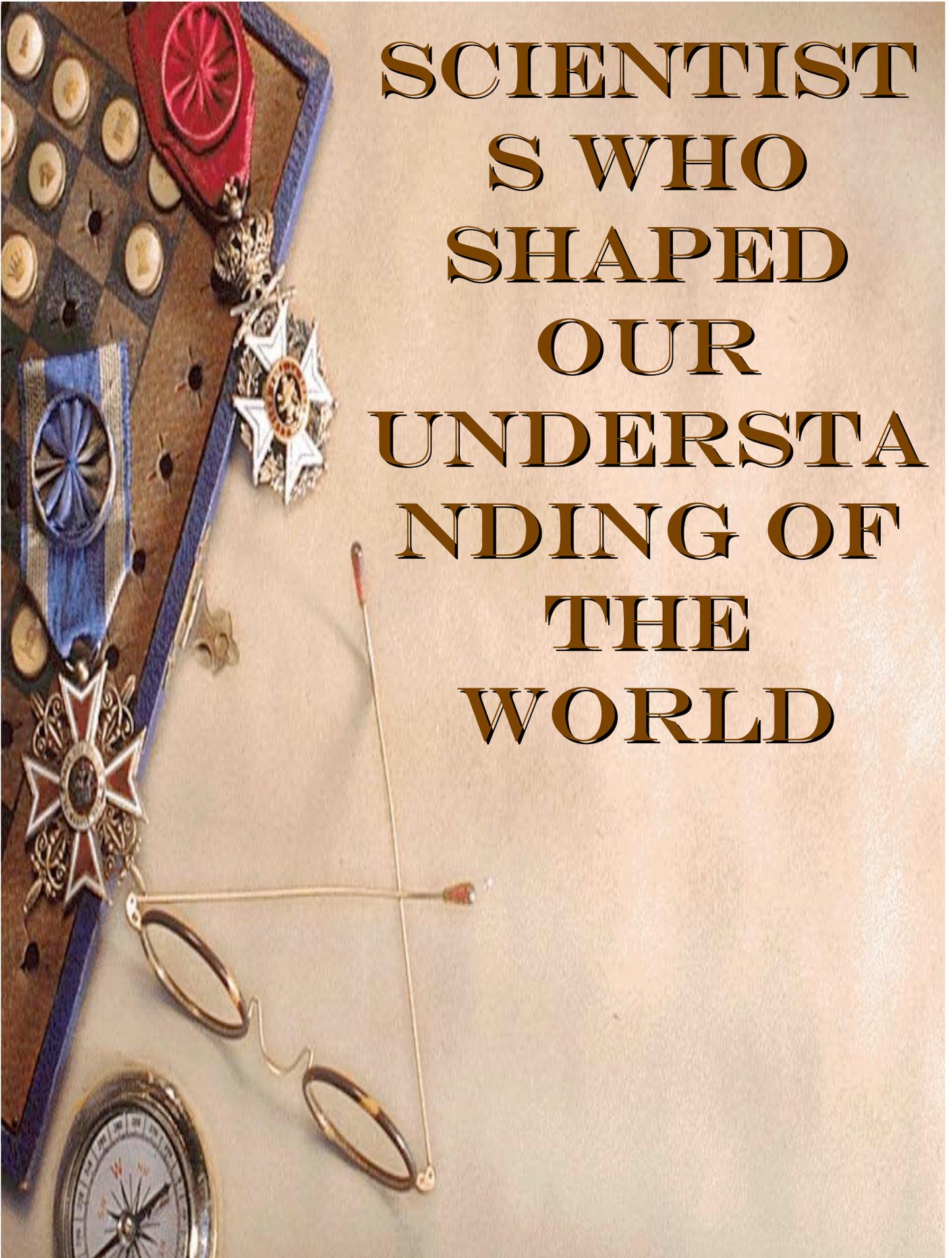


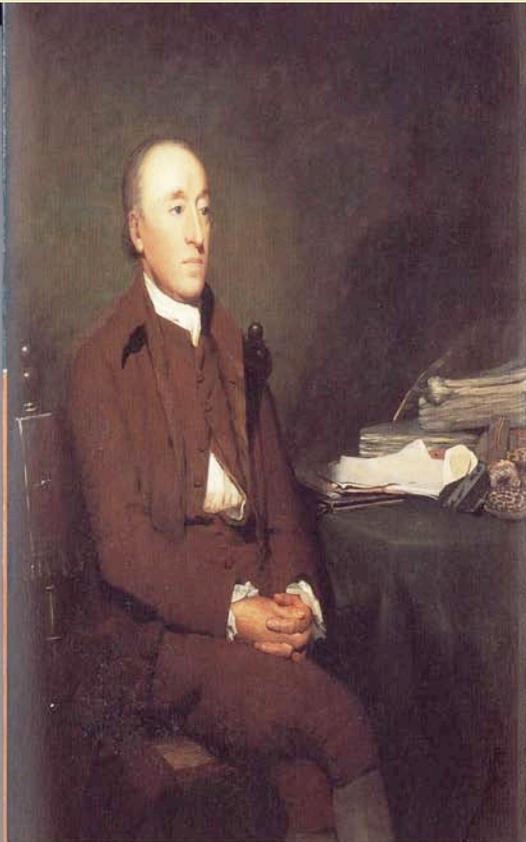
SCIENTIST
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SCIENTISTS WHO SHAPED OUR UNDERSTANDING OF THE EARTH

18TH AND 19TH CENTURY





JAMES HUTTON by Henry Raeburn. Reproduced by kind permission of The Scottish National Portrait Gallery

JAMES HUTTON AND HIS THEORY OF THE EARTH

James Hutton (1726-1797) was an Edinburgh man, scientist, philosopher and a leading member of the Enlightenment. He is now regarded as the father of modern geology.

Before his time geological theory was largely speculative, but Hutton put it on a sound basis with his *Theory of the Earth* (1788) which could be confirmed by field observations.

He drew vital evidence for his theory from rock exposures in Holyrood Park, of which the small quarry known as Hutton's Section, at the south end of Salisbury Craigs, is the most important. This has made it a place of international geological pilgrimage.

Briefly, the main elements of Hutton's Theory are:

- 1 Present-day processes operated in the past and are clues to the interpretation of the rocks (e.g. Arthur's Seat is considered to be volcanic by analogy with present day volcanoes).
- 2 The energy for geological processes is heat: from the sun (weathering, etc.) and from the Earth's interior (volcanoes etc.).
- 3 Some rocks originated as sediments, (e.g. sandstone) formed from erosion of pre-existing rocks; other rocks are igneous, i.e. crystallised from molten rock (e.g. lava).
- 4 Geological processes operate on a very long time scale in continuous cycles (e.g. a mountain chain may be slowly eroded away, the debris making new rocks, these elevated in renewed mountain building, only to be eroded away in their turn, and so on).

Today these principles seem self evident, but this was not so in Hutton's day. His original ideas created the framework for the development of geology as a modern science.

The theory took some time to be widely accepted, partly because it conflicted with some religious beliefs of that time and also with the view then held that the Earth was only a few thousand years old.

Hutton realised that the Earth was millions of years old, with geological operations working in long-period continuous cycles, leading him to conclude his Theory with the famous aphorism:

*"WE FIND NO VESTIGE
OF A BEGINNING
AND NO PROSPECT
OF AN END"*





HOLYROOD PARK

HUTTON'S SECTION

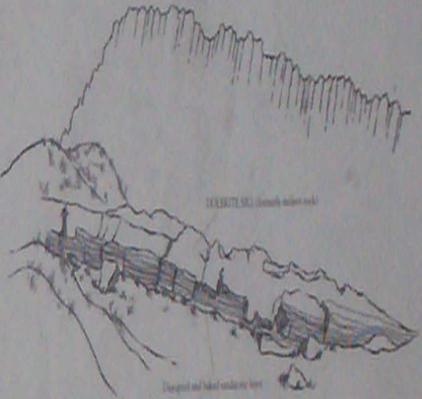
It was at this location that a fundamental discovery was made by James Hutton (1726-1797), regarded as the founder of modern geology. Using exposures created by the quarry then active on Salisbury Crag, he demonstrated that the rocks of the Crag had been formed from hot molten material.

The revolutionary idea differed from the accepted wisdom of the day, that rocks were formed from cold precipitation in the sea. He developed his ideas on geology over many years, using numerous locations in and around the Edinburgh area. His book, *Theory of the Earth*, was published in 1785.

About 150m further up the road, on the right, is Hutton's Rock. This is an early example of conservation, when Hutton is reported to have asked the quarrymen to save this rock so it showed a fine example of an out-crop.



James Hutton was something of a polymath, a farmer, a scientist, philosopher and was just what he was in the Scottish Enlightenment. This was the time given to the period in the later part of the eighteenth century which was characterised by enthusiastic intellectual activity, and which put Edinburgh at the forefront of cultural and scientific advancement.



The Park is generally a Scheduled Ancient Monument and is a Site of Special Scientific Interest. The Park Regulations are printed on the back of the leaflet. However certain areas of the Park are closed to the following activities:
No off-road cycling
No dog walking on grass
No feeding other than in designated areas
Littering is prohibited
No alcohol drinking









SICCAR POINT

James Hutton (1726 – 1797) known as the founding father of geology was a man of genius.

Whilst farming nearby, he indulged in his passion for geology. The rocks here at Siccar Point were the defining proof for his revolutionary Theory of the Earth. Most people at this time thought the world no older than a few thousand years. Hutton realised that earth processes are cyclical and that geological time is virtually unlimited. What we see today is very much how he would have seen it over 200 years ago (but a moment in geological time!).

SAFETY WARNING
The slope down to the unconformity is steep and dangerous. Please proceed with care at your own risk along the field boundary to your right. You do not need to go down to the shore to observe what these photographs illustrate.



A close-up of the unconformity from the shore



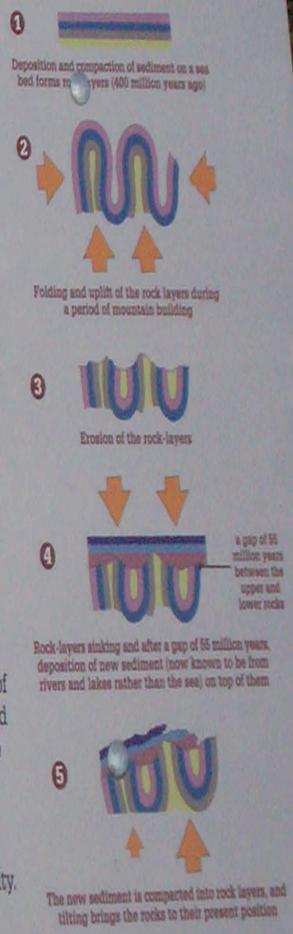
A view onto the unconformity from the top of the slope.

The yellow lines mark the time gap between the underlying vertical rock-layers (greyish in colour and called 'Greywackes') and the overlying gently dipping rock-layers (reddish in colour and called 'Old Red Sandstone and Conglomerates'). The gap represents 55 million years.

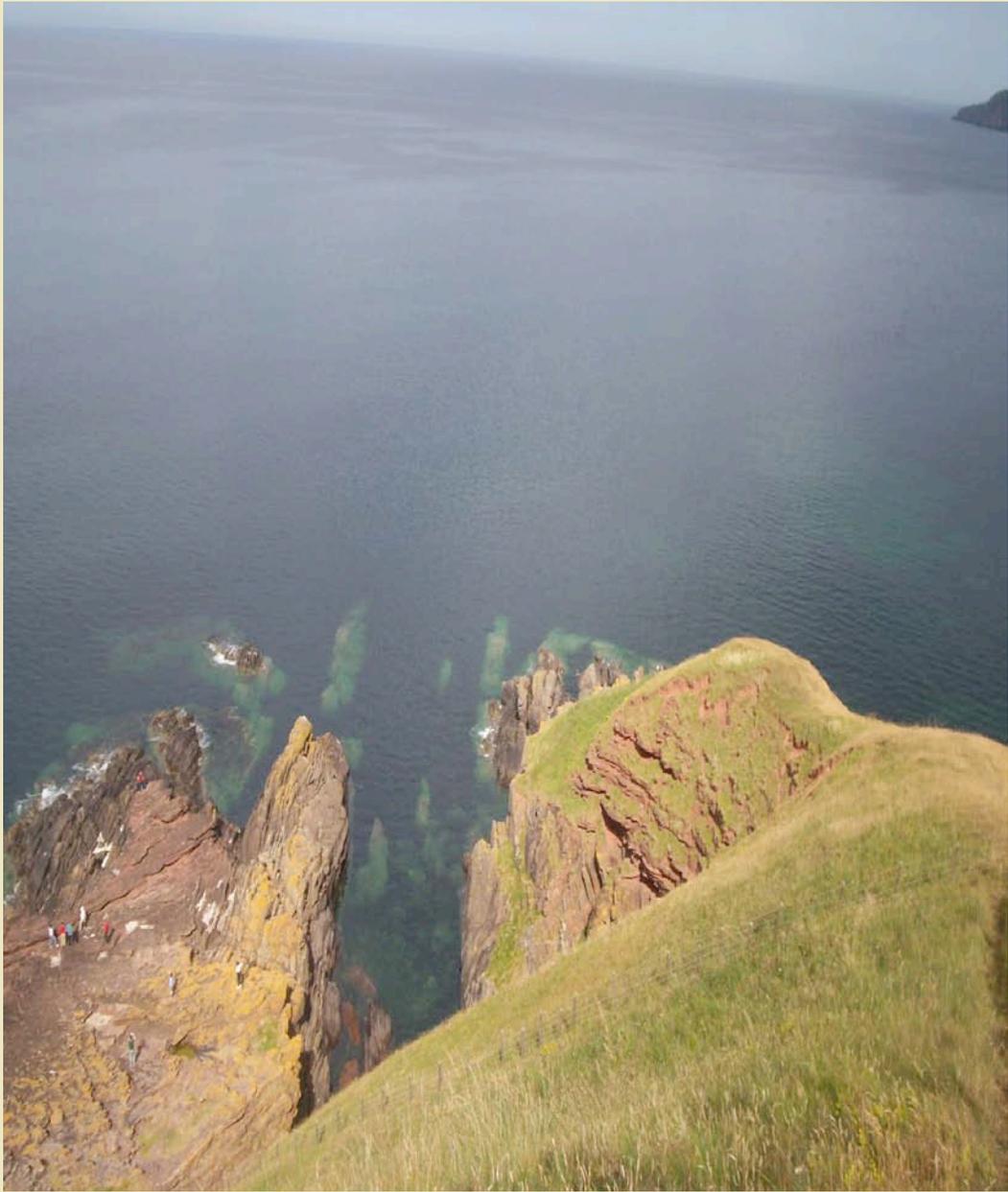
During this time the underlying rocks formed from layers of sediment deposited on the floor of an ancient ocean, had been folded, uplifted and eroded. This produced an uneven land surface onto which the overlying rocks were then deposited as sand and gravel. The irregular surface between the vertical and the gently dipping rock-layers is known as an unconformity.

"Having taken boat at Dunghlas Burn, we set out to explore the coast", writes James Hutton of his trip down the Berwickshire coast with his friends John Playfair and James Hall from nearby Dunghlas, to find the proof for his theory... and this they did "At Siccar Point", he wrote "...we found a beautiful picture of the junction watched later by the sea". John Playfair, deeply moved by the significance of what they observed wrote later "The mind seemed to grow giddy by looking so far into the abyss of time"

HOW THE UNCONFORMITY WAS FORMED



To find out more about Hutton AND THE TRAIL take a trip to the James Hutton Exhibition located at the Reiver Country Farm shop in Auchencrow.







John Playfair



(1748-1819)

Scottish scientist best known for his book, “Illustrations of the Huttonian Theory of the Earth.” It was through this work that Hutton’s principle of uniformitarianism first reached a wide audience. He accompanied Hutton to Siccar Point.

James Hall (1761-1832)

Scottish geologist and geophysicist.

His research on granite showed that it was possible for molten rock to form non-conformities. He also accompanied Hutton to Siccar Point.





Baron Georges Cuvier (1769–1832)

French naturalist and zoologist.

He studied and identified fossils of the hippopotamus, the cave-hyena, the pterodactyl, the extinct species of rhinoceros, the cave bear, the mastodont, the extinct species of elephant, fossil species of manatee and seals, fossil forms of crocodilians, fishes, and birds.

He expounded a scientific theory of Catastrophism to explain the fossil record as the result of a series of catastrophes in the manner of the Biblical Flood.

William Smith (1769-1839)

Father of English Geology.

He drew some of the first geological maps and began the process of ordering rock strata (layers) by examining the fossils in them.

Victoria Cave



Imagined view from an ancient Victoria Cave 12,000 years ago including forest, fields, some small streams, highland moor, rough heath, upland and hill-fall.

Recreation showing the earth landscape around Victoria Cave shortly after the last Ice Age around 12,000 years ago.

Few other British caves show so strikingly the changing cycles of the world's weather. We've probably all heard of the ice Ages but just try to imagine a time in between the glaciers when it was warm enough for Hippopotamus and elephants to wander across the rough pasture you are surrounded by today.

It's perhaps easier on a winter's day up here, to imagine the wind-swept, arctic tundra occupied by brown bear and reindeer which followed the last Ice Age, 12,000 years ago. It was this landscape which the first Dales people hunted across and just like the glaciers, hippos and hyenas before them, they left their mark in Victoria Cave.

By the time the humans arrived, the climate had warmed, and brown bears no longer inhabited in the cave. It became instead a shrine and workshop area for people from nearby fells and settlements. Then the humans moved out and foxes and badgers moved in for the next 1500 years.

All that changed in 1837 when a dog went in after a fox led to the cave being rediscovered. Since then the cave has been almost almost beyond recognition. The original narrow entrance was enlarged and literally hundreds of tons of material dug out by hand.

Today you are standing on the spoil heaps which are all that remains after the Victorian scientists emptied the cave. Their discoveries have allowed us to reconstruct a fascinating picture of the changing face of the Yorkshire Dales over the past 130,000 years.

Today this cave and the land around it are owned and protected by the Yorkshire Dales National Park Authority. Recent work restoring paths has been undertaken by the Authority, carried out in partnership with the Yorkshire Dales Millennium Trust using funds from the Millennium Commission.

12,000 year old deer antelope horns found in Victoria Cave.



The entrance to Victoria Cave as it was in 1837.



- 1837 - 1838: Cave used for working large quantities of lead ore.
- 1837 - 1838: Cave used for working large quantities of lead ore.
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YORKSHIRE DALES NATIONAL PARK AUTHORITY

The Yorkshire Dales National Park Authority are pleased to be allowing the information on this site and the provision of interpretation to be made generally available to the Millenary partners.

The Yorkshire Dales National Park Authority carrying out recent restoration work on paths near Victoria Cave.

The life of a cave

WARNING! UNSAFE CAVE. Danger of falling rock. Safety helmets only beyond this point.















William Buckland (1784-1856)

English geologist and palaeontologist.

Buckland wrote the first account of a fossil dinosaur. He was a proponent of Old Earth Creationism and flood geology, and catastrophism.

He investigated Kirkland Cave and Victoria Cave where he found fossil bones of rhinos, elephants, and hyenas. He believed the landscape and cave “proved” the deluge as described in the Bible. He also believed that science and religion were mutually reinforcing.

He later changed his mind and became convinced of the glaciation theory of Louis Agassiz.



Louis Agassiz (1807-1883)

Zoologist, glaciologist, and geologist

Agassiz was the first to scientifically propose that the Earth had been subject to a past ice age. In 1840, he visited the mountains of Scotland with William Buckland. Together they found clear evidence of ancient glacial action. 20,000 years ago, Scotland was covered by at least 1 kilometer of ice.

Blackford Hill is one site Agassiz visited.



CHARLES DARWIN (1809-1882)



“Darwin was born in the static world of scripture,
and he left us a turbulent world of perpetual change”

Jonathan Weiner, Scientific American, March 2006, p.101



Charles Darwin was an English naturalist who produced considerable evidence that species originated through evolutionary change and proposed the scientific theory that natural selection is the mechanism by which such change occurs. This theory is now considered a cornerstone of biology and has changed the thinking in many scientific fields of study.

Darwin attended the University of Edinburgh. He sailed on the *Beagle* for five years in the 1830s where his observations and writing brought him fame as a popular writer. His biological finds led him to develop his theory. He read “Principles of Geology” on the voyage which explained geologic features as processes over time. He wrote that he was seeing landforms “as though he had the eyes of Lyell.”



The Origin of the Species” was published in 1859, 20 years after the trip on the *Beagle*. He was aware that his work would be extremely controversial. It turned out to be a pivotal point in the history of science from religious and theological to secular science.

ON
THE ORIGIN OF SPECIES

BY MEANS OF NATURAL SELECTION,

OR THE
PRESERVATION OF FAVOURED RACES IN THE STRUGGLE
FOR LIFE.

By CHARLES DARWIN, M.A.,

FELLOW OF THE ROYAL, GEOLOGICAL, LINNEAN, ETC., SOCIETIES;
AUTHOR OF "JOURNAL OF RESEARCHES DURING H. M. S. BEAGLE'S VOYAGE
ROUND THE WORLD."

LONDON:
JOHN MURRAY, ALBEMARLE STREET.
1859.

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