Siccar Point — Hutton's Unconformity — travel through the "abyss of time"

Lothian and Borders GeoConservation

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[Edinburgh Geological Society webpage]

How to get to Siccar Point

Location 40 miles east of Edinburgh, close to the A1. From the A1 head towards Coldingham on the A1107. After crossing the narrow Pease Dean Bridge, take first left, signposted Pease Bay. Then proceed straight on, ignoring the next left turn to Pease Bay. Park in the large lay-by on the left-hand side of the road, before the gates into the Drysdales' site. From here two information boards guide you along the cliff top path to Siccar Point. Nearest toilets and shop are at Cockburnspath village (see map).

SAFETY WARNING Visit Siccar Point at your own risk.The grassy slope down to the rocks is steep, may be slippery and there is no path. Sturdy footwear is recommended.The safest option is to view the rocks from the top of the grassy slope; binoculars may be useful.

Hammering and rock specimen collection is prohibited.

Acknowledgements

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Siccar Point, the world's most important geological site

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(Figure 4) Portrait of James Hutton. Portrait by Sir Henry Raeburn

James Hutton, father of modern geology, visited Siccar Point by boat in 1788, an event which led to a profound change in the way the history of the Earth was understood. A man ahead of his time, James Hutton used the evidence from Siccar Point to decode Earth processes and to argue for a much greater length of geological time than was popularly accepted.

As John Playfair later recorded of their visit “The mind seemed to grow giddy by looking so far into the abyss of time”. A concept of 'deep time' emerged with the recognition that the geological processes occurring around us today have operated over a long period and will continue to do so into the future.

You can visit Siccar Point today, and see the spectacular junction between two distinctive types of rock, just as Hutton himself found it.

The two sets of rocks at Siccar Point are dark grey steeply tilted rocks formed in an ancient ocean, and the much younger, almost horizontal red rocks formed on land.

The deposition of the two different types of rock was not continuous, but separated by a gap of 65 million years during which time the older rocks were changed and eroded.

Walk in James Hutton's footsteps and explore the story of this remarkable man and our modern understanding of his geology, representing millions of years of erosion, deposition, folding, faulting and uplift.

James Hutton 1726–1797

James Hutton was born in Edinburgh on 3rd June 1726. At the age of 14 he went to Edinburgh University to study humanities and medicine. Later he studied chemistry and anatomy in Paris, before obtaining his MD in 1749 from Leyden in the Netherlands.

In 1750, he inherited and worked two farms in the Scottish Borders. He travelled to Norfolk and Flanders to learn new farming methods and employed them on his own lands. After witnessing first-hand the processes of erosion and sediment deposition on his farms, he became interested in geology.

Hutton returned to Edinburgh in 1767, where he developed and finally published his geological theories. He was an important contributor to the Scottish Enlightenment, a period when Edinburgh, described by Tobias Smollett as “a hotbed of genius”, saw the rise of revolutionary ideas in sciences and humanities. Hutton enjoyed the company of prominent Enlightenment figures including Sir James Hall of Dunglass (also a natural philosopher), James Watt, Adam Smith and Joseph Black.

Hutton's Theory of the Earth was presented in 1785 in front of the Royal Society of Edinburgh, then published in 1788 and enlarged to two volumes in 1795. Field visits to his three famous unconformity sites in North Arran, Jedburgh and Siccar Point took place in 1787-88. All provided evidence in support of his theory. He died on 26th March 1797, and is buried in Greyfriars Kirkyard, Edinburgh.

Hutton at Siccar Point

Hutton realised that the processes of erosion, deposition and uplift were connected and operated continuously, driven by the earth's internal heat, in a way not understood at the time. At Siccar Point in 1788, he finally found the clear evidence he needed to demonstrate his understanding of the processes and cycles that shaped the Earth.

Hutton arrived at Siccar Point by boat, accompanied by Sir James Hall of Dunglass and John Playfair. Playfair wrote: “Dr Hutton was highly pleased with appearances that set in so clear a light the different formations, and where all the circumstances were combined that could render the observation satisfactory and precise ■ We felt necessarily carried back to a time when the schistus on which we stood was yet at the bottom of the sea, and when the sandstone before us was only beginning to be deposited, in the shape of sand or mud, from the waters of the supercontinent ocean■ The mind seemed to grow giddy by looking so far into the abyss of time; and whilst we listened with earnestness and admiration to the philosopher who was now unfolding to us the order and series of these wonderful events, we became sensible how much further reason may sometimes go than imagination may venture to follow.”

Hutton inferred from the sharp junction between the two sets of rocks that an enormous interval of time was required for the underlying strata to be folded and eroded before the overlying sandstones were deposited. The fundamental geological principle of deep time was thus established and Hutton famously concluded his work Theory of the Earth with: "We find no vestige of a beginning — no prospect of an end". Since then different geological eras have been recognised and dated, and we now know that the Earth is around 4.5 billion years old.

Hutton's discoveries fulfilled a tremendous mission: placing geology in a much wider time frame than the popular belief that the Earth was created in 4004 BC (as calculated by Bishop Ussher in 1650). This enabled geology to become a science in its own right with Hutton as its founding father.

The Siccar Point Unconformity [NT 81266 70975]

The two sets of rocks at Siccar Point are separated by an unconformity: an ancient land surface representing a time gap in the normal geological sequence. The Siccar Point unconformity is clearly visible as an etched junction with the dark grey vertical rocks underneath and the much younger, almost horizontal red rocks on top.

Below the unconformity

Silurian greywacke sandstone and mudstone

These rocks formed as flat-lying layers in deep water during the Silurian period, about 435 million years ago. Greywacke is a type of hard sandstone containing a mixture of rock fragments in a fine matrix of clay.

The greywacke layers are separated by thin layers of mudstone, and together the rocks tell an interesting story of the conditions on the ocean floor. Most of the time, gentle ocean currents brought fine-grained mud into the deep sea, allowing the slow build up of layers that would eventually form mudstone. But every so often, dramatic, fast-moving torrents of sediment would be swept down the continental slope, forming layers of unsorted sandstone — the greywacke. These turbidity currents have been observed in modern oceans, and the greywacke layers at Siccar Point demonstrate that the same process happened here.

The Silurian strata at Siccar Point formed in the Iapetus Ocean, a long-lost ocean that separated two continents. As the Iapetus Ocean closed, the sea floor was subducted beneath the northern continent and some of the sea floor sedimentary rocks were buckled and compressed. The layers you can see at Siccar Point are now nearly vertical because of this tectonic movement.

After the ocean had closed, the ocean-floor rocks spent 65 million years at the surface, gradually being eroded. The softer mudstone layers wore away more easily, leaving the edges of the greywacke layers protruding dramatically and giving a corrugated land surface with many metres of visible relief.

Recent erosion by the sea follows the same pattern, so that the Silurian rocks exposed at Siccar Point and along the coast to the east have a distinctive character with strong ribs of greywacke separated by narrow clefts where mudstone has worn away.

James Hutton thought these rocks were laid down under the sea, and this was confirmed in 1792 when Sir James Hall found recognisable marine shells in associated rocks not far from Siccar Point.

Above the unconformity

Upper Devonian red sandstones

These rocks occur widely across Scotland. They formed on land in a low-lying area experiencing a tropical climate with wet and dry seasons. Rivers deposited sand and silt as the wet season declined. In the dry season this material was blown about by the wind, sometimes into dunes. Soils were poorly developed and vegetation sparse, consequently the erosive power of the rivers was even greater than it is today. The red colour of the rocks results from the presence of iron oxide. The sands and silts were deeply buried and gradually converted into rocks.

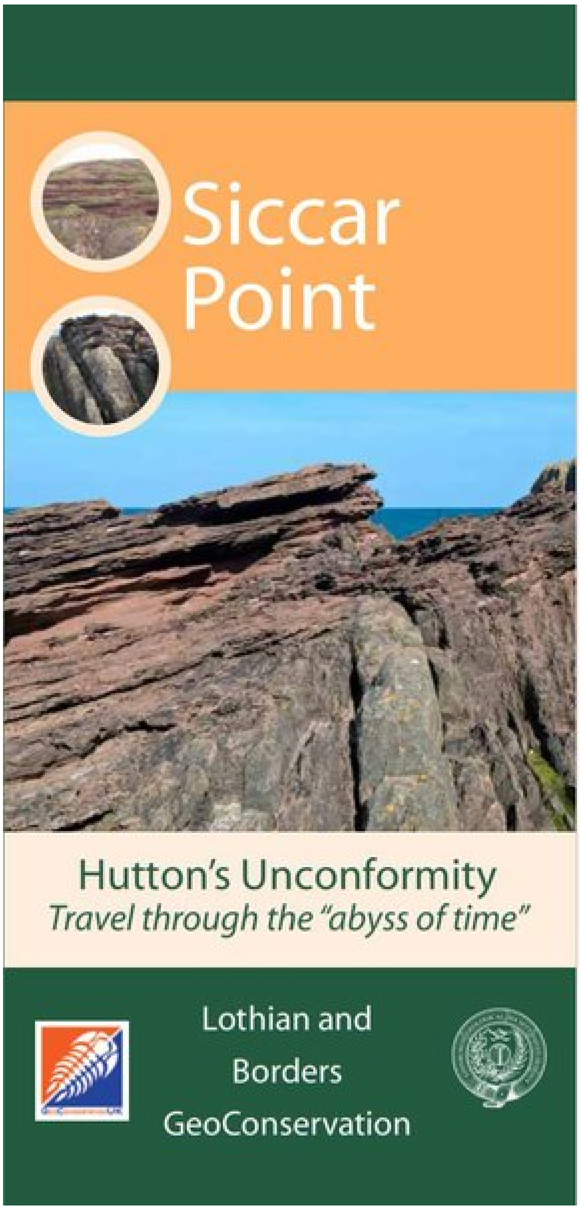
Upper Devonian basal conglomerate

Angular slab-like fragments of the underlying greywacke sandstone are common in the lowest layers of the red sandstones. These fragments were created from erosion of the older rocks, dumped on the land surface as talus (scree) and moved on by highly energetic, seasonal rivers flowing in desert wadis (valleys). The alignment of these fragments shows that the current flow in the wadis was from the northeast.

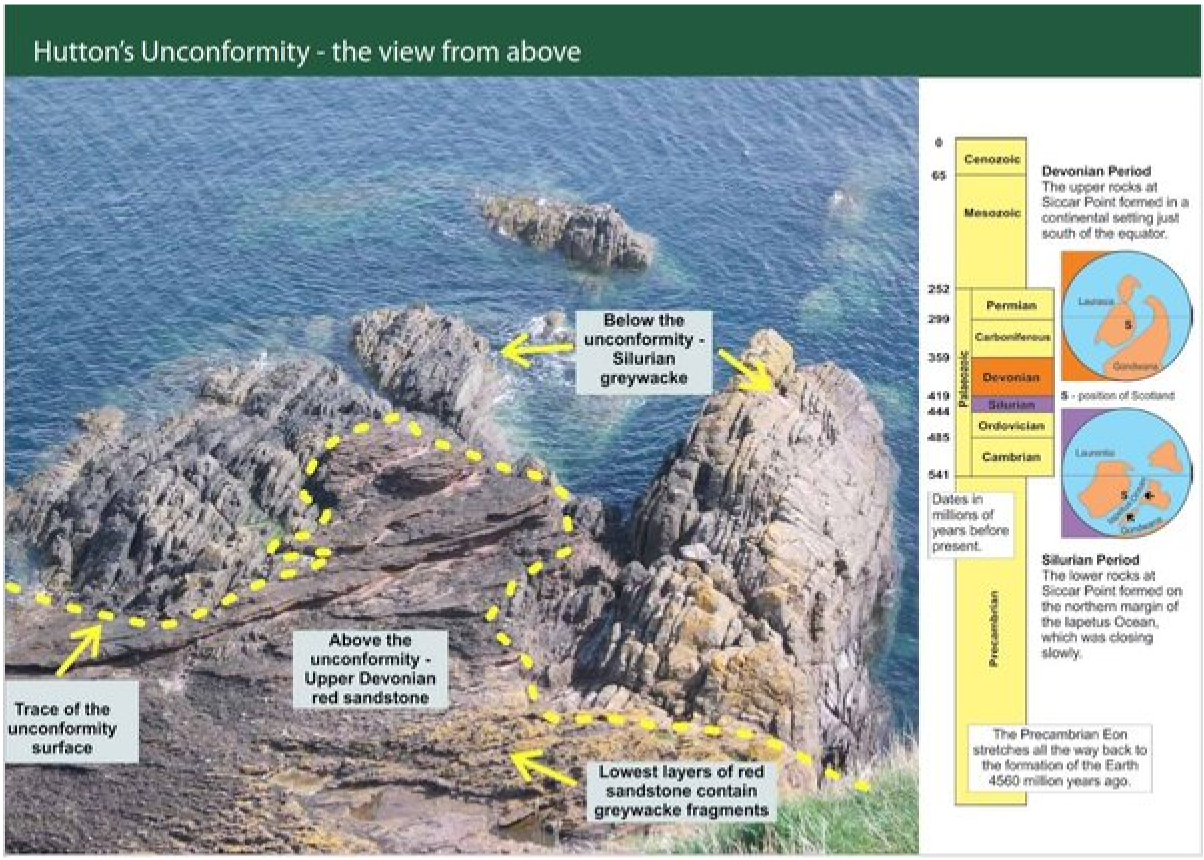
What was Hutton looking for?

Hutton and his companions were well aware of the surrounding geology, and the landscape contrast between the older grey rocks - forming the hills of the Southern Uplands - and the younger rocks to the north and west that underlie more fertile farming areas.

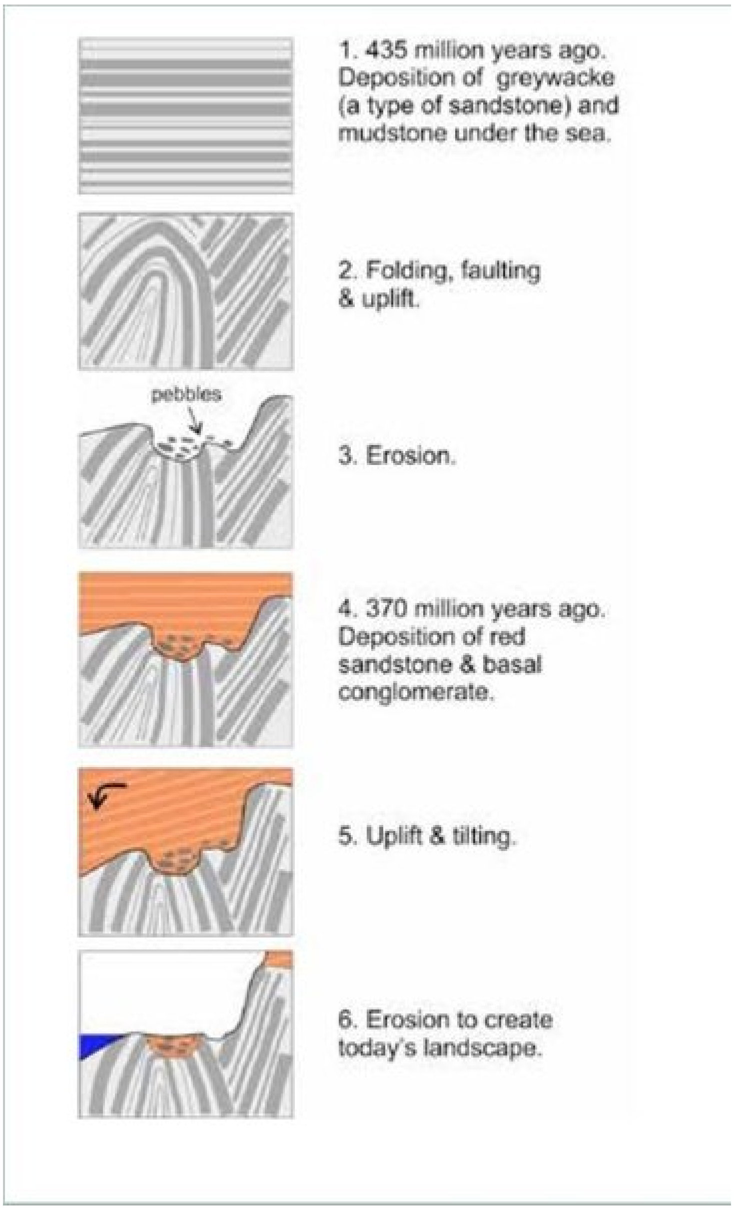
In making their boat journey along the coast, they were hoping to find a clear example of the unconformity exposed in a sea cliff. The cliff on the south side of Siccar Point does show the unconformity very well, but Hutton was delighted to find that at the Point itself he could actually walk on the unconformity, "a beautiful picture of this junction washed bare by the sea" (Playfair).



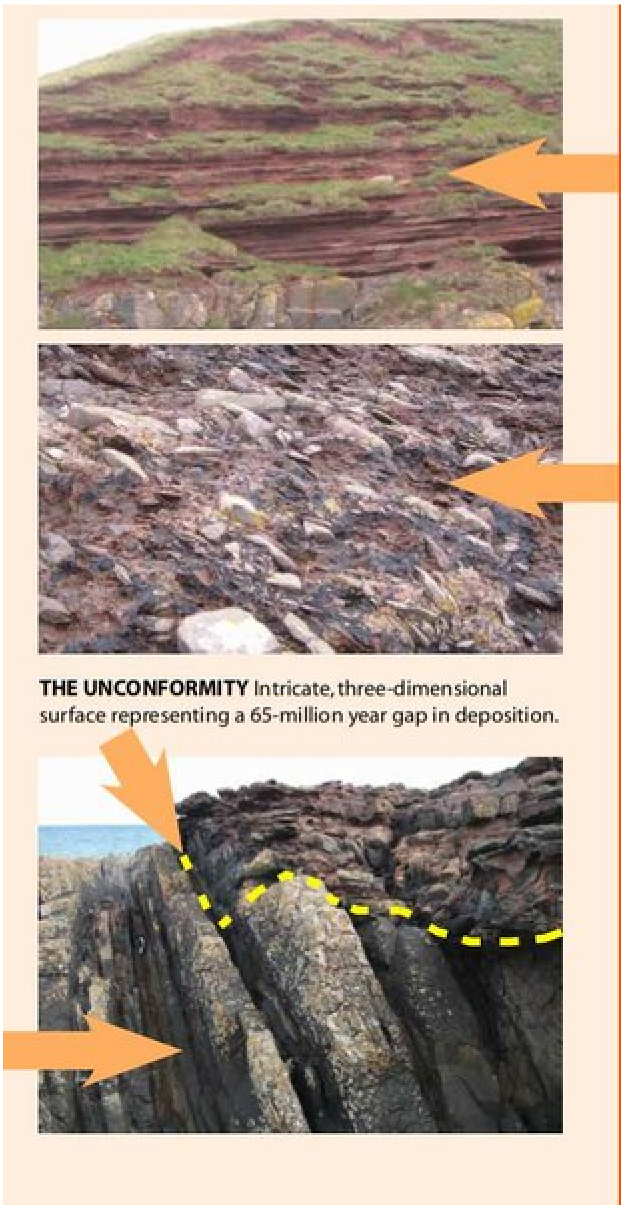
Front cover.



Hutton's Unconformity — the view from above. An annotated photograph.



Stages in the formation of the Siccar Point Unconformity.



Below the unconformity (bottom); The unconformity Intricate, three-dimensional surface representing a 65-million year gap in deposition. Above the unconformity: Upper Devonian basal conglomerate (middle), Upper Devonian red sandstones (top).

Portrait of James Hutton. Portrait by Sir Henry Raeburn.