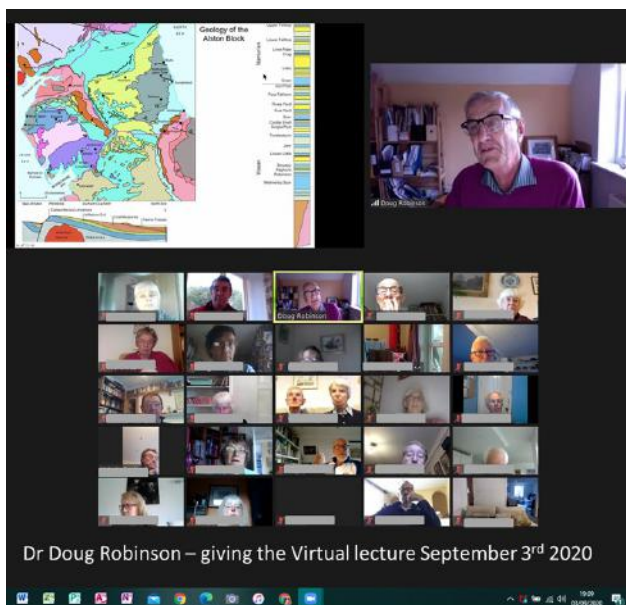


Polly Sternbauer and the tea and biscuits faithfully provided by Jan Williams.



The 50th Anniversary Celebration

At the onset of 2020 the Committee was preparing to organise a weekend event to celebrate the 50th anniversary of the Society. A date in October had been chosen and enquiries were being made for a venue and a line-up of mini talks. A grant of £350 was obtained from the Geologists' Association and local groups in the South-West were to be invited to celebrate our anniversary achievement. Unfortunately this has had to be postponed and we will endeavour to hold this event in 2021.

Field Trips

The only field trip we were able to run was to Brown's Folly on February 29th. All other trips in 2020 were unfortunately cancelled. A number of organisations have begun running field trips again and we are looking to run some trips in 2021 with social distancing measures in place.

The 2020 Committee

Chairman: Graham Hickman
Treasurer: Phil Burge
Membership Secretary: Polly Sternbauer
Meetings Secretary: Anne Hunt
Journal Editor & Zoom: Mellissa Freeman
Field Trip Secretary: Sue Harvey
Field Trip Safety: Bob Mustow
Webmaster: James McVeigh
Linda Drummond-Harris
Professor Maurice Tucker

I have been very grateful to the hard work and commitment of the Committee during this difficult time. Their efforts have resulted in the continued the

programme of Zoom lectures, updating the website and producing the newsletter/journal. The Committee has worked hard communicating news and re-building the membership. The financial implications have been analysed and Zoom technologies grappled with. Under normal conditions the committee meets 3 or 4 times per year but under these situations we have met virtually about 6-7 times. The strength of a Society like ours is measured by those who volunteer their time and I am indebted by those on the committee.

The saying 'hindsight is 20/20' can certainly be applied to the year 2020. It's incredibly hard to predict the future, we are all in this together, if you have any comments or suggestions we would love to hear from you. On behalf of your committee thank you again for your support.

Graham P Hickman
chairman@bathgeolsoc.org.uk

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Arbroath to Auchmithie – Old Red Sandstone Extravaganza

By Charles Hiscock

Arbroath, a town about the same size as Chippenham, is situated on the north shore of the Firth of Tay 16 miles east of the city of Dundee. It is the largest town in the county of Angus and is famous for 'Arbroath Smokies', salted haddock which are then dried and smoked over a hardwood fire. They have been produced in the Arbroath area since the 18th century, having been started in the village of Auchmithie, 3 miles east of Arbroath and now, under EU rules, have to be made within 4 kilometres of Arbroath. Indeed, as one walks around the harbour area the smell of smoke mixed with fish is quite noticeable.

In the middle of the old part of Arbroath, on the highest point and dominating the sky line is the ruined abbey. Built from the local stone, it was founded in 1178 and dedicated to St Thomas Becket. It was not completed until 1233 and, in 1214 the founder, King William the Lion, was buried in the chancel. His tomb is marked by a tombstone in front of the high altar in the quire. As with all monastic establishments, the abbey was dissolved by Henry VIII, fell into ruin and was 'quarried' by the local inhabitants for buildings in the town. The abbey came to national attention in 1951 when, early one morning, the caretaker was surprised by four young men who told him that they had deposited the 'Stone of Scone' in front of the altar. The 'Stone' had been stolen from the Coronation Chair in Westminster Abbey earlier that year. The four men departed as quickly as they had appeared, leaving the surprised caretaker to report to the authorities. The 'Stone' was returned to Westminster but later repatriated to Edinburgh while a copy of the stone was made and can be seen in Arbroath Abbey.

The abbey has substantial remains of which the most obvious feature is the bright red sandstone and conglomerate, imparting an impressive presence to the

ruins in bright sunlight (fig. 01, 02). The stone was quarried by the monks from the cliffs to the east of Arbroath which lie along the back of the beach and extend for many miles. This article describes the rocks and geological features which outcrop in the three miles or so from the eastern end of Victoria Park, the grassy area east of the harbour. The geological trail is part of the Whiting Ness (the headland at the east end of Victoria Park) to Ethie Haven SSSI, selected for its geological interest, coastal grassland, birds, flower and insect species. The tarmacked footpath passes along the top of the cliffs and allows the observer to see all the geological features described with the exception of a couple which are only visible from the beach.



Fig. 1: Arbroath Abbey



Fig 2: Arbroath Abbey

The headland at the east end of Victoria Park, Whiting Ness, displays the angular unconformity between the conglomerates and sandstones of the Upper Devonian Burnside Sandstone Formation 359-385mya and the fine sandstones of the Lower Devonian Arbroath Sandstone Member 398-410mya (fig. 03). The unconformity is irregular and reflects a period of non-deposition of about 40 million years. The Lower Devonian sandstone is tilted about 18 degrees south-east while the Upper Devonian dips 10 degrees south-south-east. On the wave cut platform below the Ness can be seen marks cut into the sandstone surface by the wheels of the carts the monks used to remove the stone to the Abbey (fig. 04).



Fig. 3: Whiting Ness unconformity



Fig. 4: Cart tracks in wave cut platform

A short distance east of the Ness, the unconformity is well displayed in the headland, marked by the irregular surface of the fine Lower Devonian sandstone and the base of the Upper Devonian conglomerate (fig. 05). As one walks along the footpath a significant geo (inlet) is reached where two levels of erosion mark two periods of sea level in the past (fig. 06).



Fig. 5: East of Whiting Ness



Fig. 6: Geo

The next feature is 'Needle E'e', (local dialect for Needle's Eye) which is a collapsed sea cave opened out by the sea during stormy periods. It lies about 23 feet above the present beach, having been formed when sea levels were that much higher (fig. 07).



Fig. 7: Needle's E'e



Fig. 8: Cross bedding, Maiden's Kirk

Another cove, formed when the sea level was higher than now, is 'The Mermaid's Kirk' where, high on the east side, cross-bedding in the Lower Devonian sandstone can be seen (fig. 08). Here a north-east trending fault has been opened up by the sea forming a geo approximately parallel to the line of the cliff. Access to the Kirk is hazardous so only the foolhardy attempt to get a photo!



*Fig. 9:
The Crusie*

The Crusie is the next feature that the walker comes on, where joints in the Lower Devonian sandstone have been excavated by the sea to form caves. These have fallen in, forming the blowhole called The Crusie (fig. 09) on the right and a geo to the left of the observer. Another blowhole is seen some distance along followed by a geo called ‘Dickmont’s Den’. This is the largest of the geos, being 200 metres long and 100 metres wide, cut mainly in the Lower Devonian sandstone but with some Upper Devonian sandstones and conglomerates perched on the north-east wall (fig. 10). Beyond the Den and lying some distance from the cliff is The Deil’s Head, a sea stack in the Lower Devonian sandstone which clearly shows the dip of the bedding (fig. 11), followed closely by a cleft parallel to the cliff line produced by erosion along a small seaward dipping fault line. Continued erosion along the fault line could eventually produce a sea stack similar to the Deil’s Head.



Fig. 10: Dickmont’s Den—fault controlled geo



Fig. 11: The Deil’s Head

About 2 miles from the start, the walk drops down into Carlingheugh Bay providing excellent views of further structures. Two sea stacks project away from the cliff line, one of which gives a passable impression of The

Sphinx (when seen at the right angle and an eye of faith!) while alongside is an elongate stack with two mounds – The Camel’s Hump (fig. 12).



Fig. 12: The Sphinx and Camel’s Hump



Fig. 13: Dark Cave Fault (Lower ORS & Upper ORS)

Across Carlingheugh Bay in the headland there is a fault, dipping at about 80 degrees, which separates the Lower Devonian (to the left) from the Upper Devonian (on the right). The movement along the nearly vertical fault downthrows the Upper Devonian in relation to the Lower (fig. 13).



Fig. 14: Baryte veins in LORS conglomerate, Auchmithie Harbour

There are many other features between Carlingheugh Bay and Auchmithie but the walk becomes more arduous so a return walk to Arbroath was undertaken and then a drive around to Auchmithie. The village sits at the top of the cliff but the harbour, now a ruin, is accessed by a rough steep road. The cliffs around the harbour are composed of conglomerates of the Lower Devonian Auchmithie Conglomerate Member 398-416mya, the only time conglomerates of this age are seen on the trail (fig. 14). The face of the cliff is cut by a nearly vertical fissure with two or three branches which have been infilled with barite veins (fig. 15).



Fig. 15: Barite (Auchmithie Harbour)

Depositional History

During the Devonian Period, Scotland lay somewhat south of the equator and the climate was hot and arid with seasonal heavy rain causing flash flooding on a huge scale. These temporal rivers carved their way across the arid landscape, leaving large masses of sand, gravel and cobbles which are now the Devonian Old Red Sandstone. During the drier periods the sands were blown by strong winds into dunes, forming the cross-bedding seen in exposures such as the top of the cliff at The Mermaid's Kirk. In the late Ordovician (480 – 440mya) and the Silurian Period ((440 – 410mya) a huge mountain range was being formed during the Caledonian Orogeny, of which the Scottish Highlands are just a small part. To the north east of the Arbroath area, these large rivers drained into the fault controlled lowlands of the Midland valley (bounded by the Highland Boundary Fault complex and Southern Uplands Fault) during the Lower Devonian Period, bringing the products of the erosion, the sands, gravels and cobbles, which can be seen along the coast. The conglomerates of the Lower Old Red Sandstone as seen in the cliffs at Auchmithie consist of rounded pebbles and cobbles of mainly quartzite with some limestone. At Whiting Ness near Arbroath, below the unconformity with the Upper Old Red Sandstone, the rocks are composed of red sandstone with interleaving beds and lenses of conglomerates containing small pebbles.

As has been said, the unconformity which is so well displayed in the cliff at Whiting Ness and about 200 yards east, marks about 40 million years of the Middle Old Red Sandstone period when either there was no deposition or rocks that were deposited have been

eroded away. During this period, however, tectonic activity tilted the Old Red Sandstone beds to the south east and, at the same time, were subjected to wind and water erosion leaving a land surface which is now seen in the irregular contours of the unconformity.

Deposition of the Upper Old Red Sandstone began about 370 mya, consisting of sands, gravels and boulders transported by rivers flowing to the south east from much reduced mountains to the north west. Much of the conglomerates and breccias forming the Upper Old Red Sandstone are derived from the erosion of the Lower Old Red Sandstone. Later tectonic activity tilted the Upper sandstones to the south-southeast by about 10 degrees.

The sequence which can be seen along the trail is:

Upper Devonian	Burnside Sandstone Formation	consisting of red, orange or yellow sandstones, conglomerates and breccias mainly of Lower Devonian clasts
Lower Devonian	Scone Sandstone Formation - including Arbroath Sandstone Member and the Auchmithie Conglomerate Member	Cross bedded pebbly red sandstones with large white mica flakes and conglomerates with limestone and mudstone pellets. Conglomerates of well-rounded fine to coarse mainly quartzitic stones with beds of sandstone also containing limestone pellets.

The trail leaflet is well written with clearly annotated photographs, an excellent map and diagrammatic cross sections of features of the geology. The excellent footpath as far as Carlingheugh Bay is paved. However, because the trail continues across the beach at the Bay, stout shoes and care are needed from there to Auchmithie. The coastal trail provides excellent views of the geological features and also information for those with interests in natural history, local history and conservation. Some sections of the trail are fenced where the edge of the cliff is very close but much of it is open, leaving health and safety considerations very much to the walkers' common sense!

The leaflet "Arbroath to Auchmithie Geodiversity Trail" is published jointly by the British Geological Survey, UKRIGS Scotland, Tayside Geodiversity and Angus Council. I am pleased to acknowledge the source of the information in this article is drawn from the Trail leaflet.

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