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THE BRORA COALFIELD

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The Background

Britain is noted worldwide as the cradle of the Industrial Revolution. This fame is down to one geological factor – the presence of widespread reserves of coal which literally fuelled the Revolution, was exploited by the early industrialists and entrepreneurs and put the 'great' in Great Britain. Even before the start of the Industrial Revolution in the late 18th century, these coal reserves were being extracted in small quantities. There are records of the Romans using coal as a fuel and it was as early as 1603 that a landowner called Huntingdon Beaumont started drift mining in Nottinghamshire, using a horse drawn tramway to carry the coal. In 1621 the Whickham Grand Leaseway mine was opened on Tyneside while, in 1721, the first true colliery was opened at Middleton, Leeds. The revolution gathered pace so that by the late 19th century, coal mines had been sunk in all the localities of Coal Measures across Britain from Kent to Tyneside, from Somerset to Scotland and from the Wales to the west Midlands. In 1947, 1503 mines were operating.

One can be forgiven for assuming that the coal reserves in Britain were all laid down during the Carboniferous period, particularly the Westphalian Stage, known as the Coal Measures. However, coal was formed during other geological epochs. In Britain, small reserves of lignite have been mined from the Neogene of Devon and the Cretaceous of Kent while the Jurassic has been the source of coal in Cleveland and the east coast of Scotland. It is the history and unique geology of the latter, the Brora Coalfield, that is the subject of this article.

A Brief History

The town of Brora is situated on the east coast of Sutherland in Scotland 59 miles north of Inverness, on the A9. It is a small attractive seaside town with a harbour through which the River Brora enters the sea. Just inland of the harbour the river runs through a gorge for about half a mile, having cut a course through the yellow sandstone. Fig 1



Fig 1, *Jurassic Beds in River Brora*

On the coast of the North Sea, The Links – extensive grassy low sand dunes – run north from the river for some miles and provide the town with its local golf course, also shared with sheep, cattle and walkers! Just to the south of the harbour another small area of dunes was the site of another golf course, named ‘the other Gleneagles’ which was used by the townsfolk who were barred from the main course. These Links and the town lie on a broad raised beach of



Fig 2, *Coast from Brora north*

variable width backed up to the mountains

which run along much of the coast from Dornoch to Helmsdale. Fig 2.

The first evidence of coal at Brora, like many other localities on the North Sea, was the ever present supply of ‘sea coal’ – pieces of coal which had been eroded from the sea floor and washed onto the beach and into the river. This supply had been used by the folk of Brora for centuries, the first record being in 1529, and was also extracted from shallow mines on the coast since the late 16th century to supply the heat for the salt pans which were established behind the beach just south of the harbour. Unfortunately, coastal erosion has removed most of the ruins of the salt pan buildings while those remaining have been demolished but a remnant of the past industry can be seen nearby in the line of small two storey houses in Salt Street. However, a low ‘cliff’ in the sand at the back of the beach showed a thin



Fig 3, *Coal layer under old coal mine site*

layer of coal fragments, a remnant of the coal used to fuel the pans. Fig 3. In 1811 the Duke of Sutherland sank a 250 ft pit, called the Ross Pit, in the area of the salt pans, into the ‘42 inch’ coal seam and also tapped a number of deeper, thinner seams below. The coal thus mined was used locally to fuel a woollen mill, a brick works and the Clynelish distillery, the latter being the only one of these industries still in

production, and very successfully too! By the 1960's the pit was exhausted so two new drift mines were opened in 1969 about 500 metres west of the Ross Pit in the district of Fiscally. Poor mining conditions, which made extraction difficult, and high absenteeism forced closure of the pits in 1974. An additional hazard was that the coal contained high levels of iron pyrites which frequently caused spontaneous combustion. The site was cleared in 1977. So ended the most northerly and only Jurassic coal mining enterprise in Britain.

The Geology of the Brora Coalfield

See figure 4 - The Jurassic Sequence in the Brora Coalfield

The source of the coal is the shallow seams in the Bathonian Stage of the Middle Jurassic (170 mya), which dip inland from the coast until they are cut off by the NE-SW trending Helmsdale Fault. The Jurassic outcrop runs along the coast from Golspie, 4 miles south of Brora, where Lower Jurassic overlies Triassic rocks, to Helmsdale, 11 miles to the north, where the Kimmeridgian Stage of the Upper Jurassic is exposed. The

JURASSIC SEQUENCE IN THE BRORA AREA

After A&A Cruickshank 2003

	STAGE	FORMATION	MEMBER
Late Jurassic	Oxfordian 154-159 mya	Balinstore Formation Brora Arenaceous Formation	Ardassie Limestone Brora Sandstone Clynelish Quarry Sandstone Fiscally Sandstone
Middle Jurassic	Callovian 159-165 mya	Brora Argillaceous Formation	Fiscally Siltstone Brora Brick Clay Glaucous Sandstone Brora Shale Brora Roof Bed
	Bathonian 165-170 mya	Brora Coal Formation	Brora Coal Bituminous Shale

After British Geological Survey Opengeoscience 2014

	STAGE	FORMATION	MEMBER
Late Jurassic	Oxfordian 154-159 mya	Balintore Formation	Ardassie Limestone Brora Sandstone Clynelish Quarry Sandstone Fiscally Sandstone Fiscally Siltstone Brora Brick Clay
Middle Jurassic	Callovian 159-165 mya	Clynekirton Sandstone Formation Strathsteven Mudstone Formation	Glaucous Sandstone Brora Shale Brora Roof Bed
	Bathonian 165-170 mya	Brora Coal Formation	Brora Coal Inverbrora Member Bituminous Shale

Fig 4. The Jurassic sequence in the Brora Coalfield

outcrop also extends under the sea to the east of the Moray Firth and provides the source of the oil and gas of the North Sea reserves. On shore, yellow sandstones which are exposed on the beach are the Clynekirton Sandstone Formation within the Callovian Stage of the Middle Jurassic, the type section being the foreshore south of Brora and the cliff sections on the south bank of the river. The quarry at Clynelish near Brora is still in production. Here, the lithology consists of sandstone and argillaceous rocks with some carbonaceous material with a rich fauna of ammonites and bivalves. On the north side of the river, the Clynekirton Sandstone Formation is formed of limestone and calcareous sandstone overlying a bituminous siltstone of the Brora Brick Clay Member. It is this Clay Member which provided the raw material for the brickworks. The Ardassie Sandstone and Brora Sandstone are not exposed.

The rocks on the foreshore at Brora



Fig 5, Siltstones overlying the bituminous sandstone

are well exposed at low tide but have been heavily eroded by the sea and are considerably obscured by the blocks of conglomerate of the Helmsdale Boulder Beds, sand and seaweed. North of the river mouth, the yellow sandstone of the Fassally Siltstone, highly bioturbated and rich in ammonites and bivalves, succeeds the Brora Brick Clay member (Fig 6) but south of the river, there was only the yellow sandstone exposed which was generally unfossiliferous. However, some fossils can be found on the surfaces of the rocks although they are well worn and, to the south of the river, crumbling pebbles of grey mudstone displaying the white fossilised remains of bivalves can be found on the beach. Due to the friable nature of the rock, they are useless as specimens but their appearance is identical to the friable whitish fossils that can be found at Kimmeridge Bay in Dorset. Fig 6.



Fig 6, Fossils in Jurassic Beds 6,

During a couple of hours searching for fossils on the beach, water worn specimens of a *Gryphaea*, a *Trigonia*, (Fig 7) a large pecten and fragmentary bivalves were discovered. Also on the beach were found pebbles of bituminous siltstone which gave off a strong tarry smell when split open and many small 'pebbles' of coal, still being dragged up from the offshore coal deposits. Within the bituminous mudstone there was clear

evidence of much bioturbation from



Fig 7, Trigonia in siltstone

preserved trace fossils (Fig 8). In an interesting recognition of Brora's geological heritage, there is a large ammonite on the face of one of the dressed stone blocks in the town's war memorial. (Fig 9)



Fig 8, Trace Fossils in Bituminous Beds

The formation of the Jurassic sequence along the coast of Sutherland has been elucidated and is particularly distinctive. Rising abruptly a mile or two inland from the coast are the mountains formed of Devonian Old Red Sandstone, schists of the Moine Supergroup and to the north west of Helmsdale, the Helmsdale Granite which was emplaced during the Silurian (about 420 mya). Along the eastern side of the mountains is the Helmsdale

Fault. This rising fault escarpment, a branch of the Great Glen Fault, caused the formation of the North Sea basin which subsided during late Jurassic times. On the shoulders of the granite, Middle Old Red Sandstone sediments were deposited, derived from the north west. Subsequently, thin Bathonian and thick Kimmeridgian sediments with much organic material were deposited in the basin, the latter stage providing the oil



Fig 9, Ammonite on Brora War Memorial

found in the sandstone reservoir rocks of the offshore oil field. The 100 metres or so of Bathonian sandstones and shales at Brora are followed by 700 metres of the Kimmeridge Clay to Helmsdale. Well exposed on the beach from Brora to Helmsdale are large blocks and boulders of the unusual and remarkable Helmsdale Boulder Beds containing huge blocks of the Helmsdale Granite, Old Red Sandstone, gneisses and Jurassic sandstones. (Fig 10) In the photograph can be seen clasts of a variety of sizes while northwards the clasts become bigger with boulders of a metre or larger. (photo 10) The boulders litter the beach from Brora to Helmsdale with a couple of fallen stacks of the Devonian Middle Old Red Sandstone Caithness Flags, the 'Fallen Stack of Portgower' being particularly well known, just south of Helmsdale. The explanation for the Boulder Beds have been varied over the



Fig 10, Conglomerate of the Helmsdale Boulder Beds

decades but is now taken to be the result of debris flows, turbidity currents and storm surges, caused by repeated movements on the Helmsdale Fault which triggered huge sediment movements over the edge of the fault scarp and from submarine fan deltas into the chasm on the edge of the developing North Sea Basin. During quieter times, soft sediments were deposited over and around the boulder beds and these soft sediments also caused sliding to redeposit the boulder components.

The history of the coal industry of Brora is well documented and is related in the leaflets which accompany walks of varying length around the town. It is an attractive area where walking, golf and traditional holiday attractions are available while, away from the coast, excursions into the mountains and lochs of Sutherland let the visitor experience the history and wildness of the Scottish interior. For those

who enjoy 'a wee dram', then pay a visit to the Clynelish distillery on the edge of the town. Particularly recommended is to visit during late May and June when the gorse and primroses are in spectacular bloom in a profusion not seen south of the border.