The Vasculum

The North Country Journal of Natural History

Editor

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Editorial

This represents the seventh issue of the electronic Vasculum. This is intended to replace the paper-based journal that was published up to December 2005 by the Northern Naturalists’ Union which ceased to exist in that month. The purpose of the Vasculum remains the same i.e. recording and celebrating aspects of the natural history of Northumberland and Durham.

The Permian Landscape of the North-east Coast in 2012

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Introduction

The coastline exposure of Permian rocks in north-east England is unique in the United Kingdom. It offers the best opportunity to study and explore rocks of this age, and type, in the country. The outcrop consists of a succession of limestones, dolomites, and dissolved evaporate residues, forming a spectacular sea cliff landscape extending from Cullercoats to Hartlepool. The rocks also form a basis for the characteristic flora of the magnesian limestone grasslands.

Objectives

The objectives of this article are

1. To provide a layman interpretation of the geology of the coast from Cullercoats to Hartlepool
2. To provide a visual record of the landscape at this point in its evolution.

The interpretation is intended for those with a layman interest in the rocks forming the coastline. Much of the existing literature is difficult for the non-specialist to understand.

After decades of industrial despoliation caused by large scale deep coal mining, and general marine pollution, we have seen major land reclamation, habitat restitution, and water quality improvement projects take place. Some projects have been completed and others are continuing. The coastal landscape has changed radically in recent years and this is likely to continue with increased rates of erosion and removal of colliery waste by natural processes. Persistent heavy rainfall, particularly in 2012, is also having significant effects. This article is intended to provide a record of the landscape at this point in time.

Some historical images of the Durham coast are available on the British Geological Survey Geoscenic website (http://geoscenic.bgs.ac.uk/asset-bank/action/viewHome).
Context in time and Geological Periods

<table>
<thead>
<tr>
<th>Geological Period</th>
<th>Time Range (million years)</th>
<th>Visible Landscapes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jurassic</td>
<td>205-142</td>
<td>Yorkshire coast and moors</td>
</tr>
<tr>
<td>Triassic</td>
<td>248-205</td>
<td>Tees Valley</td>
</tr>
<tr>
<td>Permian</td>
<td>300-248</td>
<td>East Durham</td>
</tr>
<tr>
<td>Carboniferous</td>
<td>358-300</td>
<td>Coalfield and Dales</td>
</tr>
</tbody>
</table>

Key Workers and Literature

There have been many workers and there is an extensive literature. Detailed bibliographies can be found in the site reviews held in the Geological Conservation Review Database (http://jncc.defra.gov.uk/page-2949). The key workers on the Durham Permian strata were:

**Charles Trechmann**-published various papers. A full bibliography can be found in The Vasculum, 84, No. 3, 1999


**Tim Pettigrew**-published Geology, in *The Magnesian Limestone of Durham County* (ed. T.C.Dunn), Durham County Conservation Trust. 1980


The Geological Conservation Review programme has produced the Geological Conservation Review Series which is a series of publications describing classic and important

Information from this literature has been used in this paper.

### Some Principles

![Diagram showing Lateral Change in environment](image)

With one small exception (Hebburn or Monkton tholeiite dyke, White Steel, Whitburn) all the rocks on the coast are sedimentary. Sedimentary rocks are formed from the deposition and cementation of materials such as silt, mud, sand, and salts.

In any exposed strata the rocks at the bottom are older than the rocks at the top (unless the strata are upside down).

The characteristics of sedimentary rocks are evidence of the environment at the time they were deposited. Fossils provide part of this evidence. Environmental change over time is recorded in vertical changes in the rocks.

Environments are different at a particular point in time in different places. This is recorded in lateral changes in the rock at a particular level in the strata.

The Principle of Uniformitarianism states that any environment recorded in the past can be found in existence somewhere on the planet (or another planet?) today.
Rock Forming Processes

The rock forming processes can be classified into-

*Pre-diagenetic processes* …before rock formation e.g. ripple marks, dune bedding, cross bedding, slumping

*Diagenetic processes* (Diagenesis) ….rock formation e.g. cementation, crystallisation

*Post-diagenetic processes* ….after rock formation e.g. re-crystallisation, dissolution, faulting, folding

The Permian strata of Durham exhibit a high degree of chemical and structural post-diagenetic processes, particularly dissolution, replacement, recrystallisation and brecciation. Many features seen in exposures are the result of events that happened after the rocks had formed i.e. after diagenesis.

Rock types and De-dolomitisation

Evaporite

Evaporites are rocks formed from the residue of evaporated water containing high concentrations of dissolved salts. Rock salt, gypsum, anhydrite and potash are the most common-but there are many evaporites. Chemically, they tend to be sulphates and chlorides. Evaporation also produces residues that are not classed as evaporites such as carbonates and ‘impurities’ e.g. iron oxides. Carbonates are not classed as evaporites as they are more commonly formed by other processes.

Limestone

The most common carbonate rock, consisting primarily of Calcite (Calcium Carbonate - CaCO₃) or Dolomite (Calcium Magnesium Carbonate- CaMg(CO₃)₂). The origin of limestone is normally organic remains such as molluscs, algae, coral, or precipitation from water. Dolomite is a mineral from which dolostones are formed. The Magnesian Limestone is a dolostone. The origin of dolomite has been difficult to determine. There are significant quantities of dolostones in the geological record but there seems to be very little forming on the planet today. It is difficult to find an environment today within which dolomite rich sediment is accumulating. There has been some debate whether dolomite forms as a deposit direct from the environment or is the result of diagenetic or post-diagenetic chemical processes.
**Breccias and Conglomerates**

Breccias and conglomerates are rocks formed by the cementation of large rock fragments. In breccias the fragments are angular, in contrast to conglomerates where the fragments are rounded. Typically, the fragments in conglomerates have been rolled in water.

**Evaporite Residue**

Groundwater percolating through evaporate deposits can dissolve and remove the salts leaving insoluble residues. This process can reduce very thick beds of rocks to very thin beds. This can cause the collapse of overlying beds fracturing the rocks to form breccias.

**De-dolomitisation**

Groundwater percolating through dolostones and evaporites can induce a chemical reaction called de-dolomitisation. Dolomite reacts with calcium and sulphate ions in the water, possibly from the dissolution of evaporites, to form calcite and dissolved magnesium and sulphate ions. Dolomite converts to calcite.
Durham Permian Stratigraphy

The strata are classified into various formations and groups with the oldest being the Yellow Sands and the youngest the Roxby Formation.
<table>
<thead>
<tr>
<th>Group and Evaporite Cycles</th>
<th>Formations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Permian</td>
<td></td>
</tr>
<tr>
<td>Eskdale Group EZ5</td>
<td>Roxby Formation</td>
</tr>
<tr>
<td>Staintondale Group EZ4</td>
<td>Sherburn Anhydrite Formation</td>
</tr>
<tr>
<td></td>
<td>Rotten Marl Formation</td>
</tr>
<tr>
<td>Teesside Group EZ3</td>
<td>Boulby Halite and Potash Formations</td>
</tr>
<tr>
<td></td>
<td>Billingham Anhydrite</td>
</tr>
<tr>
<td></td>
<td>Seaham Formation</td>
</tr>
<tr>
<td>Aislaby Group EZ2</td>
<td>Seaham Residue</td>
</tr>
<tr>
<td></td>
<td>Roker Dolomite</td>
</tr>
<tr>
<td></td>
<td>Concretionary Limestone Formation</td>
</tr>
<tr>
<td></td>
<td>Hesleden Dene Biostrome</td>
</tr>
<tr>
<td>Don Group EZ1</td>
<td>Hartlepool Anydrite</td>
</tr>
<tr>
<td></td>
<td>Ford Formation with Reef</td>
</tr>
<tr>
<td></td>
<td>Raisby Formation</td>
</tr>
<tr>
<td></td>
<td>Marl Slate</td>
</tr>
<tr>
<td>Lower Permian</td>
<td>Yellow Sands</td>
</tr>
</tbody>
</table>
A Basic Interpretation of Coastal Sites

The formation exhibits grading and dune bedding structures. It was laid down in a desert environment and is formed into dune structures. The Yellowsands are exposed at only two places on the coast; here and the head of Frenchmans Bay. The rock is poorly cemented and erodes easily to form interesting structures. It has been quarried for sand from inland quarries.
The Raisby Formation at the base of the point consists of undisturbed limestones. The Raisby formation above this is heavily disturbed, consisting of blocks of dolomite resting on a submarine slide surface. This has been interpreted as a massive submarine avalanche towards the North-east, perhaps caused by an earthquake. Between the blocks is a matrix of smaller dolomite fragments cemented with dolomite. The Formation contains foraminifera, bivalves, crinoid columnals and plant remains.

Above the Raisby are two very thin bands. The first represents the Ford formation consisting of the Trow Point Bed. This bed drapes the underlying surface and contains stromatolites, foraminifera and ostracods. The second represents the clay remains (residue) of
the Hartlepool Anhydrite after it was dissolved away by groundwater. In coal boreholes elsewhere, and at Hartlepool, the Hartlepool Anhydrite has been found to be 150m thick.

The Concretionary Limestone Formation consists of a very disturbed breccia that shows evidence of de-dolomitisation. Some fragments have weathered differentially to form very regular shaped cavities in the rock. There is also evidence of repeated fracturing and movements. This brecciation has been interpreted as the result of collapse and movement due to the dissolution of the underlying Hartlepool Anhydrite.

*Trow-Breccia fragment in Concretionary Limestone*
Frenchmans Bay

The bay is formed from cliffs of brecciated Concretionary Limestone with Raisby Formation at the base of the cliff. The Yellowsands and Marl Slate are sometimes exposed in the base of the cliffs at the head of the bay (obscured by rockfall and beach in 2012). The Ford Formation and Hartlepool Anhydrite are represented by the very thin Trow Point Bed, and a residue respectively. Both are less than 0.6m thick.
The cliffs and stacks of Marsden Bay are all formed from Concretionary Limestone Formation. This exhibits a wide variety of responses to collapse as a consequence of the Hartlepool Anhydrite dissolution. Some beds are heavily deformed and brecciated. Some are relatively undisturbed.

The strata gradually dips South-eastwards bringing down the top of the brecciated limestone towards the beach. It is succeeded by dolomites and limestones which exhibit some disturbance and contain various grades of grains and proportions of mud. Some of the limestones are finely laminated with carbonaceous laminates. These beds have yielded fossil fish. Some of the un laminated beds contain gastropods, bivalves and ostracods. There are large wide cracks (gashes) in some places containing breccia from overlying strata-Gash Breccias.
Marsden, North of Grotto

Velvet Beds

(NZ397653/N/31:12:2012)

(NZ398651/NW/31:12:2012)

(NZ399649/N/31:12:201)
Marsden, South of Grotto
The cliffs south of the Grotto are a continuation of those to the north and are composed of dolomitic limestones overlain by a limestone. The contact between these is marked by a persistent thin breccia containing many spherical structures.
Lizard Point Concretionary Limestone

The formation here consists of laminated and unlaminated limestones. It is very variable laterally and is interpreted as a submarine slope deposit.

The rocks north of Lizard were deposited in anoxic (low oxygen) conditions and South of the Lizard in oxic (oxygen rich) conditions. The laminated deposits were deposited in quiet water and the unlaminated deposits in turbid moving water. Deposition on the upper part of the slope was unstable leading to large scale slumping. The limestone also exhibits some slumping and folding due to dissolution of the underlying Hartlepool Anhydrite.
Between Lizard Point and Potters Hole- Middle to Upper Concretionary Limestone

Byers Hole and Byers Quarry (filled) were known for Bivalves, Gastropods, Foraminifera, and Ostraod fauna. Trechmann reported plant remains.
Ryhope-Roker Formation

The coast from Ryhope to Seaham is composed of Roker Formation limestones capped with extensive deposits of boulder clay which obscures the geology in many places. The distinction between Concretionary Limestone and the Roker Formation can be very obscure as one grades into the other. The Roker Formation has been interpreted as a shallow water equivalent of the Concretionary Limestone -at least in part.
Seaham-Roker Dolomite, Seaham Residue and Seaham Formation

The Seaham Formation is composed of limestone and dolomite with algae and bivalves.
Red Acre Point-Seaham Formation

This is the classic exposure for the Seaham Formation and for the Magnesian Limestone in general. The extreme lateral variation in the Magnesian Limestone, algal remains (*Calcine*ma) and evaporate dissolution structures are well exhibited.

*Red Acre Point (NZ433495/S/24:11:2012)*

*Lateral variability*

*Calcine*ma

*Dissolution structures*
Dawdon-Chemical and Blast Beach-Roker Formation

Cliffs and Liddle Stack composed of Roker Dolomite at Chemical Beach.

Approximate position of the Seaham Fault in the harbour. This produces Seaham Formation in the cliffs North of the Harbour and Roker Formation South of the harbour.
Blast Beach-Roker Dolomite Formation

The cliffs here consist of Roker Dolomite. Blast Beach is a good place to examine the effects of colliery waste dumping, and the erosion of that waste. The waste forms an artificial raised beach that is gradually being removed. The waste has protected the cliffs from wave erosion. As the waste is removed the cliffs and other structures will become exposed to this erosion. The beach may also be subject to mine subsidence from the closed coastal mines. This would have the effect of ‘raising’ the sea level.

2008

2009

Colliery waste erosion-seems to be slow above high tide mark.

Blast Beach to Noses Point (NZ437474/N)

2012
The removal of colliery waste is leaving previously protected features vulnerable to increased erosion from the waves.

Blast Beach-stack collapse-Roker Dolomite (NZ439469/NE/24:11:2012)
Hawthorn Hive-Roker Formation

Hawthorn Hive (NZ442459/N/2:1:13)

Shippersea Bay-Roker Formation

Shippersea Bay (NZ443452/W/2:1:13)
The cliffs at Easington are a continuance of the Roker Formation, but the cliffs in a southerly direction become more obscured by boulder clay slumps.
Foxhole Dene to Blackhall

The geology is much obscured by glacial debris along this length of the coast.

*Horden beach from Fox Holes (NZ444436/S/31:12:2012)*
The biostome exists between the Ford and Roker Formations. It consists of a conglomerate containing boulders of Ford Formation. The cliffs north of Gin Cave are composed of this conglomerate. Within the conglomerate are laminate sheets produced by algae. The laminates can be seen as fine coatings of limestone in contorted layers, in cracks and coating boulders.
The cliffs south of Gin Cave are formed of laminitic (finely bedded) limestones.

Stromatolite domes can be seen on the foreshore and in the cliffs south of Gin Cave. Stromatolites are fossil structures produced by blue-green algae that form mats and trap sediment.
The heavy and persistent rain of 2012 caused extensive slumping of boulder clay and rock falls from the cliffs all along the coast. In November/December this process removed the lower part of the stairs at Blackhall.

Blackhall stairs
November 29th, 2012

The same place December 29th 2012- a slump has removed the lower part of the stairs.
A fault between Limekiln Gill and Cross Gill brings the Seaham Formation and Seaham Residue (left) into contact with the Roker Dolomite Formation (right). The base of the Roker dolomite rises to the cliff top beneath the boulder clay. The cliff to Gin Cave is composed of biostrome laminites.
Crimdon-Seaham Formation

The low cliffs of Seaham Formation between Limekiln Gill and Crimdon show further examples of very recent boulder clay slumps. The Formation consists of well-bedded limestones.
Canker and Blight

It is not often that an ascomycete fungus makes national headlines, but we live in interesting times. Ash Dieback hit the headlines in 2012 with apocalyptic predictions of the effect on UK Ash trees. It is predicted that Ash may go the way of English Elm. The agent responsible has been identified as Chalara fraxinea (Ash Dieback) which is the asexual form of Hymenoscyphus pseudoalbidus. This may be the same species as Lambertella albida associated with Japanese Ash. It would appear to be an alien species that arrived in the country on imported Ash saplings. However, it is not the only ‘alien’ tree pathogen causing significant concern and cost.

The genus Phytophthora, which is an Oomycete (Water Mould), includes species responsible for various plant diseases. Perhaps the most well-known is Phytophthora infestans (Potato Blight) which caused the Irish Famine in the nineteenth century. The Forestry Commission published a research briefing in 1999 outlining the biology, ecology, and distribution of Phytophthora plant pathogens. The briefing points out that there has been a significant spread of species throughout the world caused by movement of people and materials on a global scale. The result has been the introduction of Phytophthora species to new hosts that have little or no immunity, as the hosts did not evolve with the pathogen. Some of the outbreaks of disease have been very serious causing major ecological change. For instance, P. cinnamomi has caused serious damage to Eucalyptus marginata forest in Western Australia. There is a significant risk to trees and heathland (woody plants).

The Department for Environment, Food and Rural Affairs (DEFRA) established a Phytophthora programme in 2009 to reduce the risk to trees and heathland. This programme is being carried out by the Food and Environment Research Agency and the Forestry Commission with a consortium of other conservation, horticultural and agricultural organisations. The primary objective at present seems to be to “reduce pathogen inoculum to epidemiologically insignificant levels by removing sporulating host plants from high risk areas”.

In the UK the following species have become a cause of concern to the Forestry and Environmental organisations

Phytophthora austrocedrae (Austrocedrus and Juniper Blight)

This was first recognised in the UK on Juniper bushes in Upper Teesdale in 2011. It was first described as a species when isolated from Austrocedrus in Argentina. It has since been found in Cumbria and Scotland. Infected Juniper has been cut and burned in Teesdale, and biosecurity measures implemented.

Phytophthora kernoviae (Bleeding Canker)

Phytophthora kernoviae was first found in 2003 infecting Beech and Rhododendron in Cornwall. It has since been found on Vaccinium myrtillus (Bilberry).
Phytophthora lateralis (Cedar Root Rot)

Phytophthora lateralis is known only on Lawson Cypress. It was first found in 2010 in Scotland, and has since spread to sites across the UK.

Phytophthora ramorum (Sudden Oak Death, Ramorum disease)

This was found mostly on Rhododendrons, Camellias and Viburnums. In 2008 it was found on Vaccinium myrtillus (Bilberry). In 2009 it was found to be killing Japanese Larch. There has been little infection of Oaks in the UK to date, and there seems to be some evidence of resistance. There are significant biological and commercial control measures in place.

Phytophthora alni (Alder Blight)

Phytophthora alni is specific to Alder in riverside and flood prone situations (riparian). The species is a new hybrid species first detected in 1993.

Detailed research information, identification guides, fact sheets and posters are available from the Forestry Commission web site (http://www.forestry.gov.uk/forestry/infd-6abl5v).
Notes

Rain—Perhaps the most obvious note to make is that 2012 has been the wettest year on record, with many examples of flooding and extreme weather over the year.

Some flowering plants in October and November.

An escaped garden clematis at Dawdon cliff top (NZ436482) flowering on 24th November 2012

*Cakile maritima* (Sea Rocket) in flower at Blackhall beach (NZ474385) on November 29th 2012.

*Verbascum nigrum* (Dark mullein) growing on a road cutting in Sunderland near the museum (NZ398564) on 18th October 2012.
Recorders

**Butterfly Recorder Northumberland**
Roger Norman, Tel: 0191 285 831
Email: roger@norman784.plus.com

**Butterfly Recorder Durham**
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**Moths: Durham**
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**Dragonflies**
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**Birds: Durham Bird Club**
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**Birds: Northumberland and Tyneside Bird Club**
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**Bats:** Durham Bat Group:

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**Badgers** (Badger groups may be contacted via the relevant Wildlife Trusts).

**Plants:** B.S.B.I. recorders

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The EYE Project - web based recording

http://www.eyeproject.org.uk/

Environmental Records Information Centre for the North East of England

http://www.ericnortheast.org.uk/home.html