Tees Valley RIGS Group

QUARTERLY NEWSLETTER

Issue Nº. 2

March 2014

View of a recently exposed footprint surface showing underlying horizontally bedded laminated silts of Quaternary age at Happisburgh on the Norfolk coast.

Photo: Wikipedia (Simon Parfitt).

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Editorial

Welcome to the 2nd issue of TVRIGS' Quarterly Newsletter dated March 2014. Much has transpired since I last penned the brief Editor's Note on the closing page of the first issue in December 2013. Here's just a taste of it.

Whether the Weather...

Exceptional meteorological conditions, leading to a succession of deep Atlantic low pressure systems sweeping across Britain, have taken their toll on the south and west this winter. I'm sure that no-one needs reminding of flooding in Somerset, London, Essex and elsewhere, destruction of coastal defences and essential infrastructure at Dawlish, the opening of sink holes in susceptible areas and devastation along parts of the west coast.

In Wales, the Ceredigion coastal path, between Cardigan and Ynyslas, suffered more than £100,000 of damage during the winter storms. In 2012 some 51,936 people used the route which has been diverted until repairs can be made.

Damage on the Ceredigion Coastal Path caused by winter storms.

Photo: WalesOnline

Not all results of the storm surges could be described as negative however, and a variety of Quaternary and Holocene features were brought to the attention of geologists as a result of increased coastal erosion.

- At Tywyn, north of Aberystwyth on the Welsh coast, storm surges have removed beach deposits revealing beds of peat containing fallen trees and stumps. Initial reports suggest that these appear roughly contemporaneous with the Peat and Forest Bed remnants at Coatham and Hartlepool, dating from the return of modern sea-levels some 6,000 years ago. Similar reports are emerging from the Isle of Man.

- At Happisburgh on the Norfolk coast, erosion has revealed a surface bearing the oldest human footprints outside of Africa. Magnetic signatures from beds in which the footprints occur suggest they were deposited between the two most recent geomagnetic reversals – the Bruhnes-Matuyama reversal around 780,000 years ago and the Jaramillo reversal around 950,000 to 1 million years ago [see cover image].

The TVRIGS area did not escape unscathed with damage caused to sea defences at Saltburn and flooding in Whitby during the storm surge of December. This also affected Quaternary and Recent deposits between Saltburn and Marske where erosion at the foot has created high faces of sand in several places.

Farther south, between Sandsend and Whitby, the surge had the opposite effect creating slumps which have obscured some of the former Quaternary detail on show there. Beach deposits were carried away near Raithwaite Gill (NZ 8716 1217) revealing the Raithwaite Ironstone (Dogger Formation) once mined nearby. Images appear later in the Newsletter.

Little Scar, Lewis Hunton & New Friends

Amongst other activities undertaken in the early post-Christmas period TVRIGS members have made a brace of visits to view beds of Early Triassic age at Little Scar, Seaton Carew.

On the first occasion we were joined by Michael Mawson of Durham University. Michael carried out extensive survey work here in the summer of 2010 when sections at this low-lying outcrop were excellently exposed.

Little Scar at Seaton Carew as exposed in summer 2010

Photo: TVRIGS

In early February 2014 however conditions were far less amenable and only 150m^2 of beds were accessible opposite the Staincliffe Hotel around NZ 5254 3043.

Toward the end of February a second visit was made following contact with Karl Egelund-eriksen of Northumbria RIGS and OU group. After examining the Permian Roker Formation at Heugh Battery and Throston Scar on the Headland, the combined group of ten moved on to Seaton Carew. On this occasion the Triassic was very poorly exposed with a mere 50m^2 of outcrop on view. To compound matters further strong southerly winds ensured that windward faces were caked in sand obscuring many small-scale features.

Needless to say, the Hartlepool section of the Peat and Forest Beds remain stubbornly ensconced beneath littoral deposits. The group expect to invite Northumbria RIGS and OU for an outing at Errington Wood and Marske Quarry later this year.

We also look forward to collaborating with Mike Windle and members of North East Yorkshire Geological Trust (NEYGT) in a project popularising the life and achievements of Lewis Hunton of Loftus. More information will be available at our next meeting scheduled for March 2014.

Freebrough Hill

We are proud to announce that, following an extended gestation period of several years, our Freebrough Hill interpretation panel has finally been installed beside a public footpath at the east end of Birk Brow car park around NZ 6592 1481.

Sirius in Retrograde?

Following a period of re-evaluation York Potash, the subsidiary of Sirius Mining behind plans to extract polyhalite at Dove's Nest Farm, Sneaton (NZ 8951 0510) have redesigned their Mineral Transport System (MTS) intended to carry the mined evaporite some 45Km across the North York Moors to Wilton on Teesside. The original plans involved a slurry pipeline between the two sites with ore being processed at the minehead, but the firm appear to have ditched this idea in favour of a conveyor system.

The plans will add around £167m to costs and are intended to significantly reduce environmental impact. Ore will travel to Wilton via conveyor before being crushed, processed and despatched from the nearby port facilities. Maintenance for the conveyor system will also be based on Teesside, decisions which could see an estimated 1000 new jobs created. More information is available in the Evening Gazette of Thursday 27th February 2014.

And Finally...

Before I sign off I'd like to thank all those who have taken the time to contribute to this quarter's newsletter, your efforts are greatly appreciated.

To our readers may I add that we hope you enjoy our second issue, and look forward to receiving any comments, suggestions or even articles you may wish to communicate.

Our next meeting is scheduled for 6pm on 27th March 2014 at Margrove Heritage Centre.

A.C.

Sites News

The latest revision of the TVRIGS database of geological sites is dated 4th January 2014. It holds updated information on 190 localities.

Shortly after Christmas several members of the RIGS Group and Cleveland Naturalists visited Quaternary deposits on the shore between Marske and Saltburn. Historically these till cliffs have been considered difficult to survey due to repeated slumps. Examining them after the storm surge in December 2013 there was noticeable erosion of beach sand, in places leaving vertical faces to two metres. Although slumping was still common a bed of sand, apparently continuous and sandwiched between two boulder clays, could be traced for much of the section.

Quarternary deposits between Marske and Saltburn. Arrows indicate thick bed of sand.

Photo: TVRIGS

Signs of the underlying boulder clay seemed lacking, and future visits are expected in a bid to locate this bed and estimate the thickness of the intervening sand.

Geotrail at Runswick and Wrackhills Ironworks

This geotrail records a walk that took place during the summer, 2013 as a tribute to the late John Owen whose 1988 report on Wrackhills Ironworks was reprinted by the Cleveland Industrial Archaeology Society (CIAS) in 2010. The walk has been described fully in a recent CIAS newsletter and this note adds some geological detail. It is important to set out on a falling tide about 2 hours before low water.

The Geological Succession

Quaternary

Till (boulder clay)

Jurassic

Saltwick Formation	50m (>150ft)
Dogger Formation (Top Seam)	1-2m (3-6ft)
Whitby Mudstone Formation	74m (245ft)
Cleveland Ironstone Formation	29m (95ft)

Landslips

Much of the immediate area is covered by thick deposits of boulder clay (glacial till) and has been subject to repetitive slipping. During the Ice Age the hinterland of Runswick Bay formed an embayment along the side of the main ice stream that mostly moved southwards off the present coast. This gave rise to unstable slopes and thick glacial deposits that are now subject to intense marine and sub-aerial erosion. It is thought that Wrackhills and Rosedale Wyke, amongst other smaller inlets, represent smaller versions of the same phenomenon.

As a result the area is subject to landslips of varying size. In 1682 Runswick village was destroyed (it was on what is now the beach). Fortunately no lives were lost; the villagers are said to have been at a party waking a corpse. Another landslip took place at Wrackhills in 1730 as noted by John Owen. Kettleness village and alum house were hit in 1829, again without loss as

people managed to board the alum sloop *Little Henry*. In the 1990s, cracks and slips appeared on the 'new' road down to the beach and access was restricted. The area was stabilised against this boulder clay creep and sea defences of Norwegian armourstone emplaced, work that was completed in 2001. There have also been repeated rock falls above Kettleness Sands.

Hob Holes

When waiting for the tide a short diversion can be made here where the *Jet Rock* with old mine workings is exposed. There were formerly natural sea caves said to be the home of the hob who was able to relieve whooping cough.

Runswick Shore

Solid Jurassic rocks crop out on the foreshore below the Lifeboat Station and in the cliff to the north of the village. A significant fault, trending NNW-SSE and with a displacement of 15m to the west passes across the gully above the village. It appears again on the coast at the northern end of Wrackhills where the coast turns towards Port Mulgrave. This, also, might be contributing to the land-slipping.

Make your way north-eastwards trying to keep away from the wettest parts of the scar. The scar here is formed of dark shale (the *Bituminous Shale*) with a shallow dip to the south that gradually brings one on to older beds. The largely pelagic fossil assemblage of bivalves and ammonites is typical of the restricted, oxygen-poor sea bottom conditions.

Cobble Dump, Lingrow End and Caldron Cliff

View the cemented beach conglomerate and the sandstone boulders on shale pedestals. Agar (1960) recorded these features, as well as old wave-cut erosion notches, at various locations along the coast that were regarded by him as representing an ancient stage in coastal erosion.

The cliffs exhibit a fine section of the upper parts of the Lower Jurassic, *Lias Group*, *Whitby Mudstone Formation* (the *Alum Shale Member*) and the *Dogger* and *Saltwick Formations* of the Middle Jurassic, *Ravenscar Group*.

The Dogger Formation is visible (Rastall & Hemingway, 1940) as a 6ft (2m) thick, berthierine bearing sandstone (with thin beds of siderite mudstone and with a pebble bed at its base that is evidence of a non-sequence. The massive, deltaic sandstone of the Saltwick Formation above has been quarried as building stone.

Topman Steel

The sinuous rock platform of the *Top Jet Dogger* bed of muddy limestone with the associated large concretions immediately above (the Millstones) make a welcome change to easy walking. These beds and the 30ft (9m) of strata below that consist of dark grey, oily mudstone with more named layers of concretions (the Curling Stones, Cannon Balls, etc.) constitute the Jet Rock. Hard jet is mainly found as thin planks in the 10ft (3m) or so of beds immediately underlying the Top Jet Dogger. It's easy to find smears and, also, pyritised impressions of the ammonite *Harpoceras.* It's believed that the seawards edge of the Top Jet Dogger outcrop and the ground to the northeast that is full of pedestals of the concretions are manmade, the result of quarrying for jet.

Wrack Hills

On reaching several conspicuous blast furnace slag balls on the edge of the boulder field one crosses a further 100m or so of difficult boulder terrain in order to reach the remains of Wrackhills harbour. View the large blocks of dressed sandstone and adherent spillages of once molten metal and slag. One can also scramble up to the calcining kilns, the main visible remains of the ironworks. Return to Runswick the way you came; continuing northwards on the scar there is a boulder field that is difficult to cross.

It's possible that there was a boat landing, possibly even a harbour that predates the iron works. The ground, terraced probably as a result of rotational landslips, was used for drying, calcining and, perhaps, steeping seaweed for use as alkali in the alum works (hence the name 'wrack'). The iron and cement works (the Victoria (later Albert) Iron and Cement Company) dates from the 1850-60s and was planned to use local ironstone and *cementstone* nodules in order to produce pig iron and hydraulic cement. Two shafts were sunk to reach the Main Seam at 70ft (21m) below sea level with one taken further down through the other seams and 33ft (10m) below the *Avicula* Seam probably to form a sump.

The sequence of the Main Seam is:

3ft (0.9m)	Ironstone (Top Block)
7ins (0.2m)	Shale
2ft 10ins (o.9m)	Ironstone (Bottom Block)

It probably had 25-27% Fe, poor by North Cleveland standards, but would have been fairly consistent in quality and thickness over the small area of the lease.

The Top Seam is shown as 4ft 4ins (1.3m) in thickness on an 1862 plan. It was probably variable in quality and thickness within the lease area. It was mined successfully for a time at Rosedale Wyke, Port Mulgrave immediately to the north.

The first works (1857) was wrecked by a landslip in 1858; there are pictures of the devastation in the Illustrated London News. A second works, built to a new design, opened in 1862 but only lasted a year or two.

Ironstone Sedimentation

In Jurassic times the Cleveland Basin continued to subside probably as a result of crustal extension and gradually infilled with sediment. Within the basin, reactivation of earlier structures gave rise to basin and swell structures and some faulting. The area was one of subdued relief, subject to marine flooding and to variable depth of water. There were periods of sediment starvation giving rise to condensed successions. The low latitude probably resulted in lateritic weathering on the land to the north and this is the most likely source of the iron carried down as sub-microscopic iron-rich particles by the rivers.

There are no modern analogues of ironstone sedimentation, the nearest is the ‘verdine facies’ (Young, 1993) giving rise to the formation of ferric iron clay minerals such as glauconite. Young (1989) considers ‘proto-berthierine’ (or gel or odinite) as the likely precursor of berthierine, the iron silicate that

forms the ooids (that give the characteristic caterpillar egg-like texture) and was generated within the clay sediment immediately beneath the sea bottom. With the low sediment accumulation rate, the ooids were subject to storm events that resulted in much reworking in an offshore shoal environment. The other major iron-bearing mineral, siderite (iron carbonate), is believed to be secondary.

D.G.

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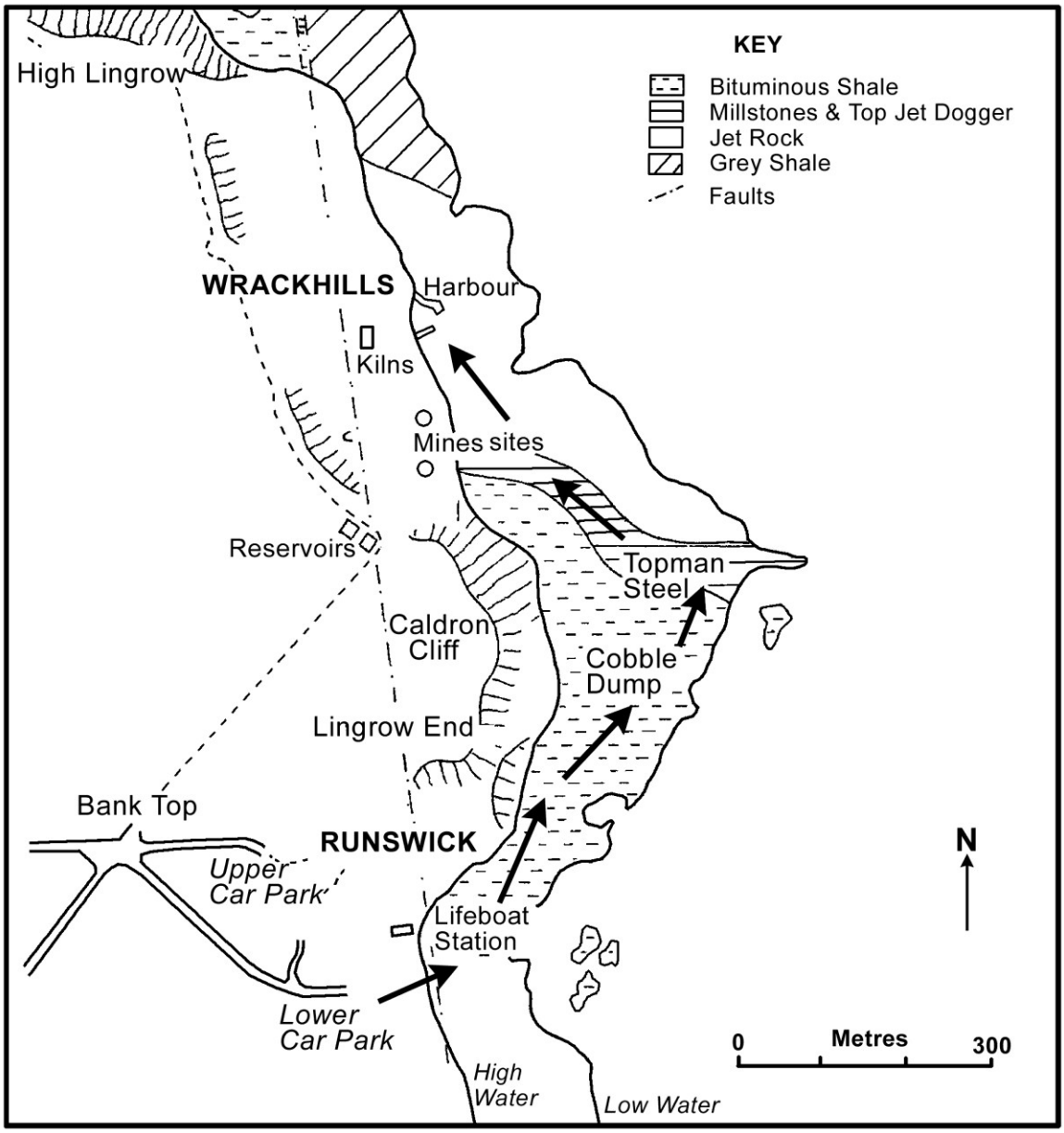


Figure 1. Sketch map showing the route (arrowed).

Figure 2. Runswick, the start of the geotrail.

Figure 3. On the Top Jet Dogger at Topman Steel. The cliff is formed of Whitby Mudstone Formation capped by Saltwick Formation sandstone with the thin Dogger Formation, in deep shadow, between.

Figure 4. Blast furnace slag balls provide a marker to locate the harbour remains.

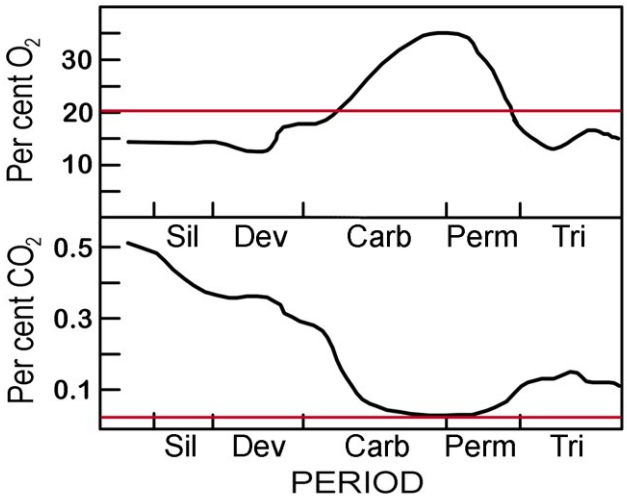
Figure 5. Remnants of the harbour at Wrackhills. Kettleness is in the background.

Thoughts on Coal, Lignin and Fungi

A response to last issue's article penned by Alan Simkins

The possibility of a link between coal formation, lignin and fungi was first suggested by Jennifer Robinson, who proposed that lignin degrading organisms were rare or absent during the Palaeozoic. The idea originated when she was on a flight over the Amazon Basin after a discussion of Palaeozoic biogeochemistry in relation to Berner's model of atmospheric oxygen and carbon dioxide levels. She wondered why the Basin is not a coal swamp.

In Berner's model atmospheric oxygen levels reached a peak of 35% in the late Carboniferous while carbon dioxide fell from 0.5% in the Silurian to 0.03% by the end of the Carboniferous. Photosynthesis by cyanobacteria, algae and plants uses light energy to split water into its component hydrogen and oxygen. The oxygen is released to the atmosphere as a waste product while the hydrogen combines with carbon dioxide to produce sugars, which in plants are then used to produce polymers including cellulose and lignin. Oxygen can accumulate in the atmosphere only when there is an imbalance between the amount produced by photosynthesis and that consumed in respiration of living organisms, weathering of rocks and volcanic gases. Permanent burial of organic matter as coal is the most important way of disrupting this process.



Changes in atmospheric composition during the period from the Silurian to the Triassic. The red lines indicate present day levels. Graph replotted using data from Berner's model.

It is estimated that 90% of the world's coal reserves date from the Upper Carboniferous and Permian, a period that accounts for less than 2% of Earth's history. On currently available evidence it is probable that two main factors were responsible for this accumulation of coal: the exponential increase in the use of lignin by plants, which led to dramatic increases in both plant size and abundance, and the absence of fungi or other organisms with the ability to degrade lignin. Then, according to the hypothesis proposed by Gregoriev and colleagues on the basis of their fungal genome analysis, the era of coal formation was brought to an end by the emergence late in the Carboniferous of an ancestral white rot fungus with the ability to digest lignin. Extant white rot fungi are a diverse assemblage of species that digest the lignin of wood and leave behind a white cellulosic residue. In contrast, the brown rots digest cellulose and hemicellulose and leave a brown crumbly residue of lignin.

The palaeobotanical evidence indicates that lignin evolved early in the Devonian when maximum plant height was about half a metre and plants were confined to moist habitats. By the end of the Devonian the first trees had evolved and colonisation of drier habitats was made possible by the evolution of the first seeds. By the Upper Carboniferous the swamp forests that gave rise to coal deposits were populated by a diversity of tree forms – lycopsids, sphenopsids, ferns, pteridosperms and cordaites – all made possible by the prolific use of lignin.

All plant cells are enclosed by a primary cell wall composed of a mesh of cellulose microfibrils in a matrix of hemicelluloses and pectin, a structure similar to fibreglass. There are microspaces between the molecules in the wall, which is consequently permeable to water. The wall provides rigidity only as a result of the turgor pressure of the protoplasmic contents within. Herbaceous plants, which still depend on turgor pressure for support, wilt and collapse without a continuous supply of water.

Xylem cells, the components of wood, are specialised for the conduction of water and providing mechanical support to stems and leaves. They have a thick secondary wall layer, which is laid down on top of the primary wall. It also is constructed of cellulose microfibrils in a matrix but additionally it is impregnated with lignin, which fills the microspaces and is cross-linked to

the hemicellulose to confer an impermeable and rigid structure to the cells, and by extension to the whole plant.

Cellulose is a simple chain polymer of beta-glucose, relatively easy to degrade, whereas lignin is a complex polymer of aromatic alcohols with no defined primary repeating structure, and this is probably the reason for its resistance to degradation.

The first evidence for a decay resistant secondary wall layer came from water conducting cells of *Gosslingia breconensis* from the early Devonian of Wales. On this and similar evidence it is most probable that the first lignified cell walls were those of the xylem, essentially the wood, which also supplied the rigid mechanical support that enabled plants to attain increasingly greater size during the Devonian. Further support was supplied by the evolution of strands of lignified fibres in outer tissues of stems, including bark, and in the veins of leaves, where they provided the necessary support to the thin lamina. As a consequence, by the Upper Carboniferous much of the world land surface was populated by a prolific diversity of plants with architecture ranging from rhizomatous ferns to forest trees but all supported by decay resistant lignified tissues.

The accumulation of massive coal deposits during the late Carboniferous and early Permian was a unique event and such events are best explained by singular circumstances, in this case an accidental alliance of biology, climate and geology. On the hypothesis discussed here coal deposition depended on the exponential increase in use of lignin by woody plants and the absence of lignin degrading organisms; its cessation resulted from the emergence of lignin degrading fungi. This is unlikely to be the whole story, however, and another key factor was probably the convergence of continents to form Pangea with its wet climate and flood plains that provided the setting for the coal swamps.

David L Smith

Storm Damage and Shifting Sand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The storms and tidal surges of Dec. 2013 & Jan. 2014 gave rise to lots of features that are referred to on our assessment forms as 'active surface processes'.

1. The remains of the Raithwaite ironstone (Dogger Seam) mine jetty near Sandsend (16/12/2013) that is seldom seen.

2. The basal boulder clay resting on Whitby Mudstone (16/12/2013).

3. Two weeks later the sand had returned but heavy runoff had created a mini-canyon (2/1/2014).

4. Both the jetty stumps and the geology had disappeared, but the wall of steelmaking slag still needs to be repaired (2/1/2014).

5. The storm exposed well the basal stone courses and pile stumps of the old sea wall of Sandsend alum house (16/12/2013).

6. Much damage was done to Saltburn beach and the old Stockton and Darlington railway sleepers easily flung around (24/12/2013).

D.G.

Events Diary

Listed here are various events publicised on other geological sites...

From the website of the North East Geological Society:

March 21st (AGM prior to Lecture) 2014

The Stones of Durham, (with particular reference to Durham Cathdral).

Brian Young
Durham University

From the website of Cleveland Industrial Archaeological Society:

13th January 2014

Joseph Dodds, the disgrace of a Pioneer of the Cleveland Iron Trade

Joseph Dodds was a solicitor, ironmaster and the first MP for Stockton. He abruptly resigned from Parliament in 1888, just prior to being struck off the rolls for misappropriating funds from his clients. Fleeing, he was declared bankrupt in his absence and did not return to face the consequences, dying in 1891. The talk will explore Dodds' industrial activities and how these contributed to his downfall.

Elizabeth Marsh

St. Mary's Centre, Corporation Road, Middlesbrough

PLEASE CHECK THE APPROPRIATE WEBSITE FOR FULL DETAILS

News from the Web

Given below are links to geologically-themed stories on other websites.

Grand Canyon 'formed recently'

The world famous Grand Canyon, which snakes through the American state of Arizona, only took its present form relatively recently.

http://www.bbc.co.uk/news/science-environment-25881953

Europe's Goce gravity satellite probes Earth's mantle

Europe's Goce gravity satellite has provided striking new visualisations of the Earth's deep interior.

http://www.bbc.co.uk/news/science-environment-25911846

Giant gas platform sinks below waves

A structure the size of a soccer pitch has been sent plunging to the bottom of the ocean 125 miles off Norway. It will house a giant compressor claimed to be the world's biggest offshore machine.

http://www.bbc.co.uk/news/science-environment-23043525

EXPLOSIVE ERUPTION OF MT. KELUD 13TH FEB 2014

An hour after the authority raise the alert from level III to its maximum (level IV), Kelud Mt in East Java Indonesia explosively erupted on Thursday, February 13, 2014, 10:56 PM local time, several more blasts have been recorded since.

http://indonesiandisaster.blogspot.co.uk/2014/02/explosive-eruption-of-kelud-mt-february.html

River Thames breaks records for water flows in January

The amount of water flowing through the Thames this January was the highest recorded for that month since records began in 1883.

http://www.bbc.co.uk/news/science-environment-26175213

Earliest footprints outside Africa discovered in Norfolk

Scientists have discovered the earliest evidence of human footprints outside of Africa, on the Norfolk Coast in the East of England.

http://www.bbc.co.uk/news/science-environment-26025763

Earth Heritage, a free online magazine, is available from GeoconservationUK at http://www.earthheritage.org.uk/

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Email Contact Details

INFO@tvrigs.org.uk

tvrigs@gmail.com