
# 'TROPICAL YORKSHIRE'

# Fieldtrip to the Corallian Group (Upper Jurassic) of the North Yorkshire Moors

**Part of the 58th Annual Meeting of the Palaeontological Association, held at the University of Leeds**

**19th December 2014**

J.D. Witts 20/11/14

# TROPICAL YORKSHIRE – FIELDTRIP TO THE CORALLIAN GROUP (UPPER JURASSIC) OF THE NORTH YORKSHIRE MOORS

## INTRODUCTION

Welcome to this one-day fieldtrip, run as part of the 58th Annual Meeting of the Palaeontological Association at the University of Leeds.

Today we will visit three inactive quarries in the southern part of the North York Moors, to the East of Leeds, to look at various facies of the Oxfordian (Upper Jurassic) Corallian sediments in the area.

We will start at Betton Farm Quarry, an SSSI site that has recently been cleared. Here there are metre-scale reef structures formed by the coral genera *Isastraea* and *Thamnasteria*, together with very fossiliferous inter-reef facies containing molluscs, echinoids and other fauna. Also in the quarry are examples of the surrounding oolitic facies of the Malton Oolite Member (Coralline Oolite Formation).

After lunch at the quarry we will move to Ravenswick Quarry to look at tall quarry faces displaying weathered surfaces of the Malton Oolite, some beds of which are packed with large gastropods, and the overlying Coral Rag Member, which contains in-situ *Rhabdophyllia phillipsi* corals and the characteristic echinoid spines of *Paracidaris florigemma*.

We will then drive a short way to Spaunton Quarry to look again at the Coral Rag, which here contains patch reefs and various inter-reef facies, and is overlain by the sandy sediments of the Newbridge and Spaunton Sandstone Members of the Upper Calcareous Grit Formation, from which ammonites can sometimes be collected. We will then return to Leeds.

A more formal timetable for the day is included overleaf. A copy of the Risk Assessment can be found at the back of this guide. **By signing onto the coach at the start of the day, you will have agreed to read and abide by this legally binding document.**

Please dress warmly as we will be exposed to the elements during the day. Stout footwear will be useful, although there will not be a lot of walking on the day. Hard hats will be provided.

## TIMETABLE

**08:00am** – Depart University of Leeds (Parkinson steps)

**10:00am** – Arrive Betton Farm (**1**)

**12:00pm** – Lunch at Betton Farm, South Quarry

**12:45pm** – Leave Betton Farm, drive to Ravenswick Quarry

**13:05pm** – Arrive Ravenswick Quarry (**2**)

**14:05pm** – Depart Ravenswick Quarry, drive to Spaunton Quarry

**14:15pm** – Arrive Spaunton Quarry (**3**)

**16:00pm** – Depart Spaunton Quarry

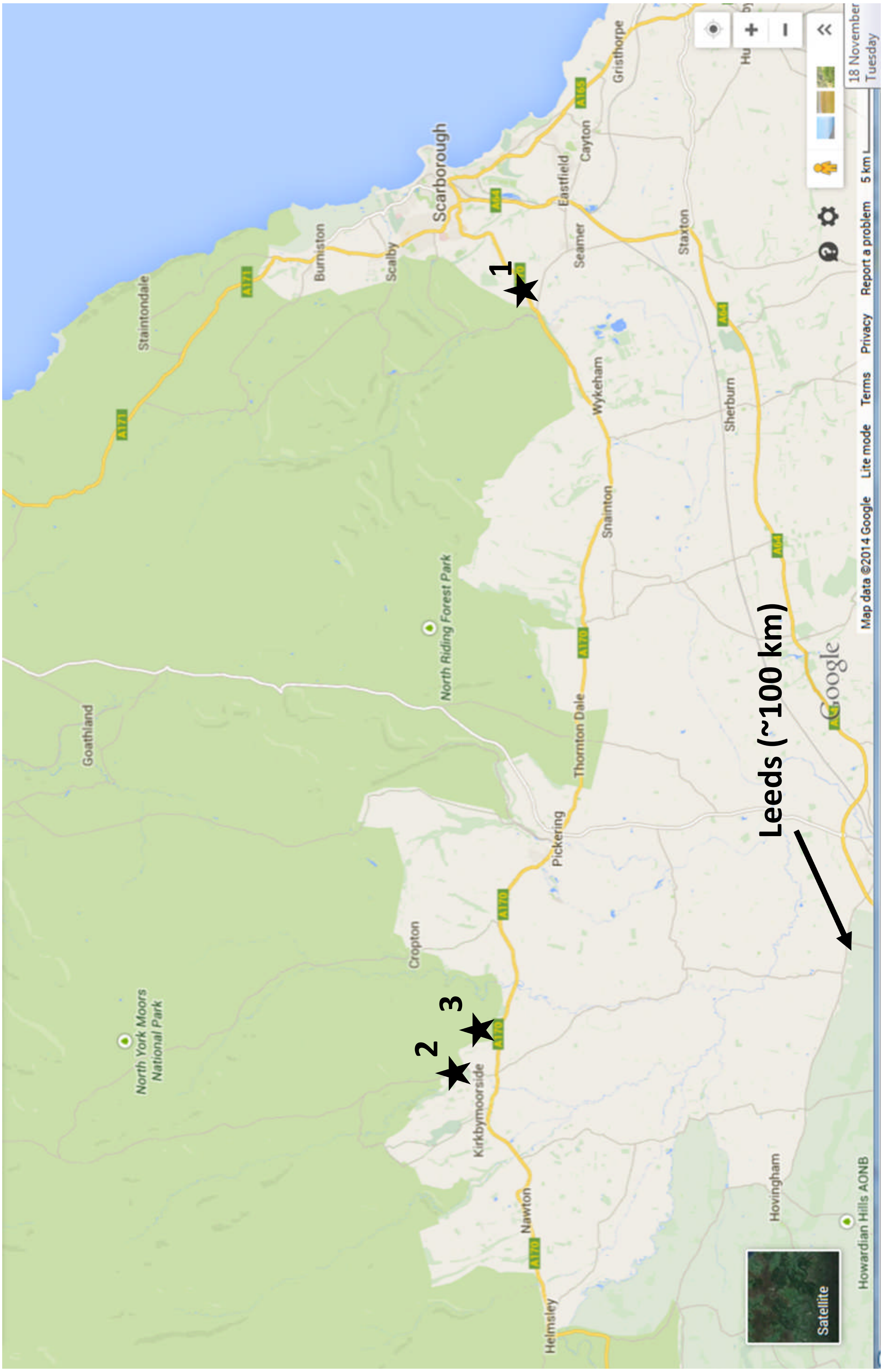
**18:00pm** – Arrive Leeds (Railway station and then University of Leeds)

Numbers in parentheses refer to numbers on location map overleaf.

Due to the short day and the requirement to be back in Leeds by 18:00pm to enable some participants to catch trains, we will be attempting to adhere to this timetable as closely as possible.

**Please assist us in doing this by promptly following the guidance of the field trip leaders and helpers when in the field!**

## LOCATION MAP



## GEOLOGICAL BACKGROUND

### The Cleveland Basin – general context

The rocks we will be examining today were deposited in the Cleveland Basin during the Upper Jurassic (Oxfordian Stage) (**Fig. 1**). During the Jurassic, the Cleveland Basin formed part of a system of shallow epeiric seas and extensional tectonic basins, linked to the south-east via the Sole Pit Basin (a half-graben) to the North Sea Basin. The Cleveland Basin itself was relatively small, and bounded to the north and west by tectonic highs. To the south lay the East Midlands Shelf, the northern part of which comprised the Market Weighton High (MWH), a stable unfolded block characterised by reduced rates of sedimentation throughout the Jurassic.


**Figure 1: Geological map of the Jurassic strata of the Cleveland Basin (modified from Powell, 2010). Field trip locations marked by black stars.**

The MWH is an asymmetrical structure over which subsidence and sedimentation rates were reduced; it separated rapid subsidence and higher sedimentation rates to the north in the Cleveland Basin, from more gradual subsidence to the south in the Lincolnshire area of the East Midlands Shelf. The high is essentially a hinge between the shelf and the basin, the main line of inflection being the Howardian-Flamborough Fault Belt. (See Rawson and Wright (2000) and Powell (2010) for more detailed overviews of Jurassic sedimentation in the Cleveland Basin.)

## The Corallian Group – overall lithostratigraphy and biostratigraphy

The Corallian Group ranges in thickness from 70–150 m and predominantly comprises ooidal and micritic limestone and calcareous, spiculitic, fine-grained sandstone. The group is equivalent to the mud-rich West Walton Formation and the lower part of the Ampthill Clay of the East Midlands Shelf.

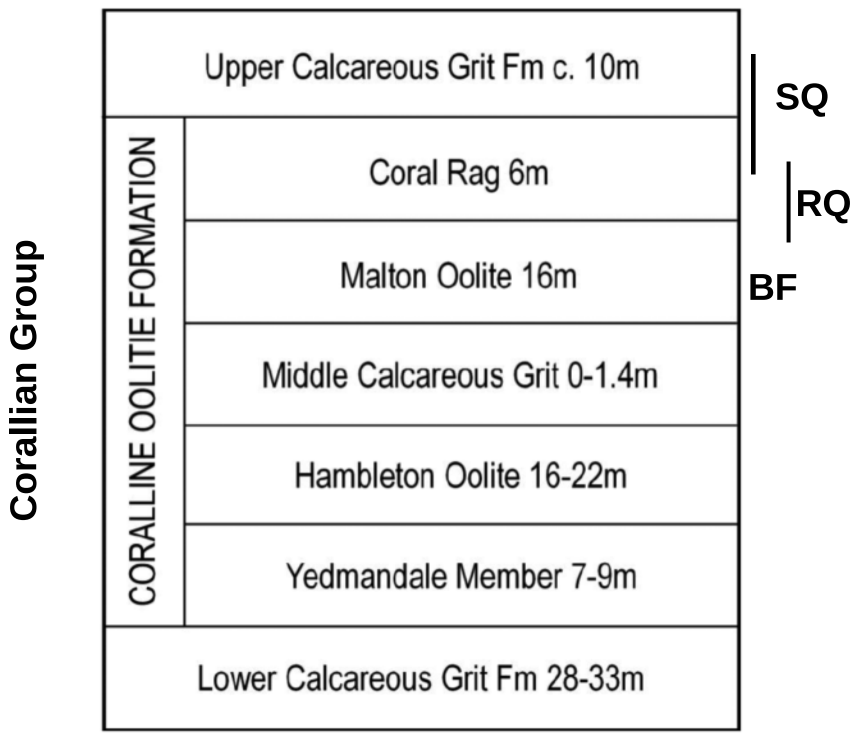



**Figure 2: Lithostratigraphy of the Yorkshire Corallian in the vicinity of Ayton (from Wright and Rawson, in press). Fieldtrip localities marked against their rough stratigraphic location. BF = Betton Farm, RQ = Ravenswick Quarry, SQ = Spaunton Quarry**

The basic sequence of strata in the Yorkshire Corallian was established by studying outcrops running on the north side of the Vale of Pickering and through the Hambleton and Tabular hills. The rather involved evolution of the nomenclature of the Yorkshire Corallian Group has been discussed by Wright (1972) and Wright

(2009). The succession outlined in **Fig. 2** with three distinct formations has become the established nomenclature. Disconformities are also present within the formations over parts of the basin and lateral lithofacies changes have enabled the recognition of numerous impersistent members (**Figs. 2 and 4**).

Ammonites have traditionally provided the biostratigraphical and chronostratigraphical framework for the Jurassic of the Cleveland Basin. Ammonites typical of the Boreal (northern) and Tethyan (southern) realms are present as a result of periodic connection between these two palaeobiogeographical provinces. Tethyan forms appear to have been dominant during the Early Jurassic (Sinemurian-Aalenian), but during the later Jurassic Boreal faunas were dominant – especially during the Callovian transgression and the Oxfordian.

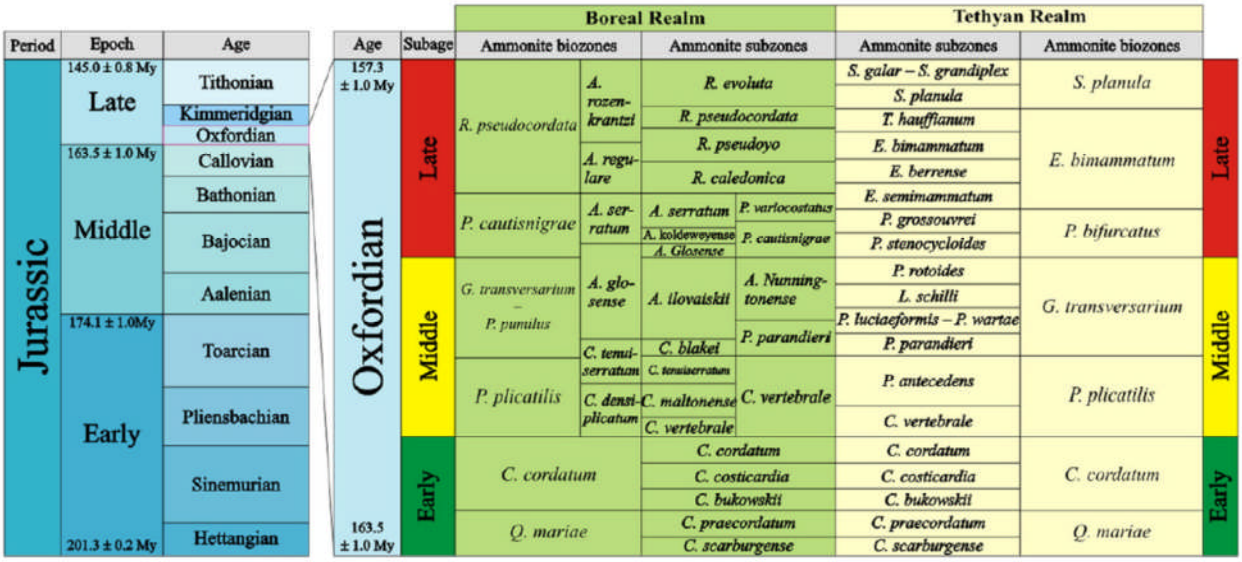



**Figure 3: Position of the Oxfordian age in the Jurassic period (from the International Stratigraphic Chart 2012) and the chronostratigraphy and ammonite biostratigraphy of the Oxfordian (taken from Martin-Garin et al., 2012)**

In the lower Oxfordian, one uniform zonal and subzonal scheme is used right across northern and central Europe. However, in the Middle and Upper Oxfordian, ammonite families become more provincial, and separate schemes for the Boreal, Sub-Boreal and Sub-Mediterranean faunal provinces have been introduced (**Fig. 3**). Strata in Britain are allocated to either the Boreal or the Sub-Boreal schemes, depending on the predominance of cardioceratid (Boreal) or perisphinctid (Sub-Boreal) ammonites. Zones identified in the Corallian successions of the Cleveland Basin are outlined alongside the stratigraphy in **Fig. 4**. This scheme indicates the group spans the upper Lower, Middle, and lower Upper Oxfordian stages.

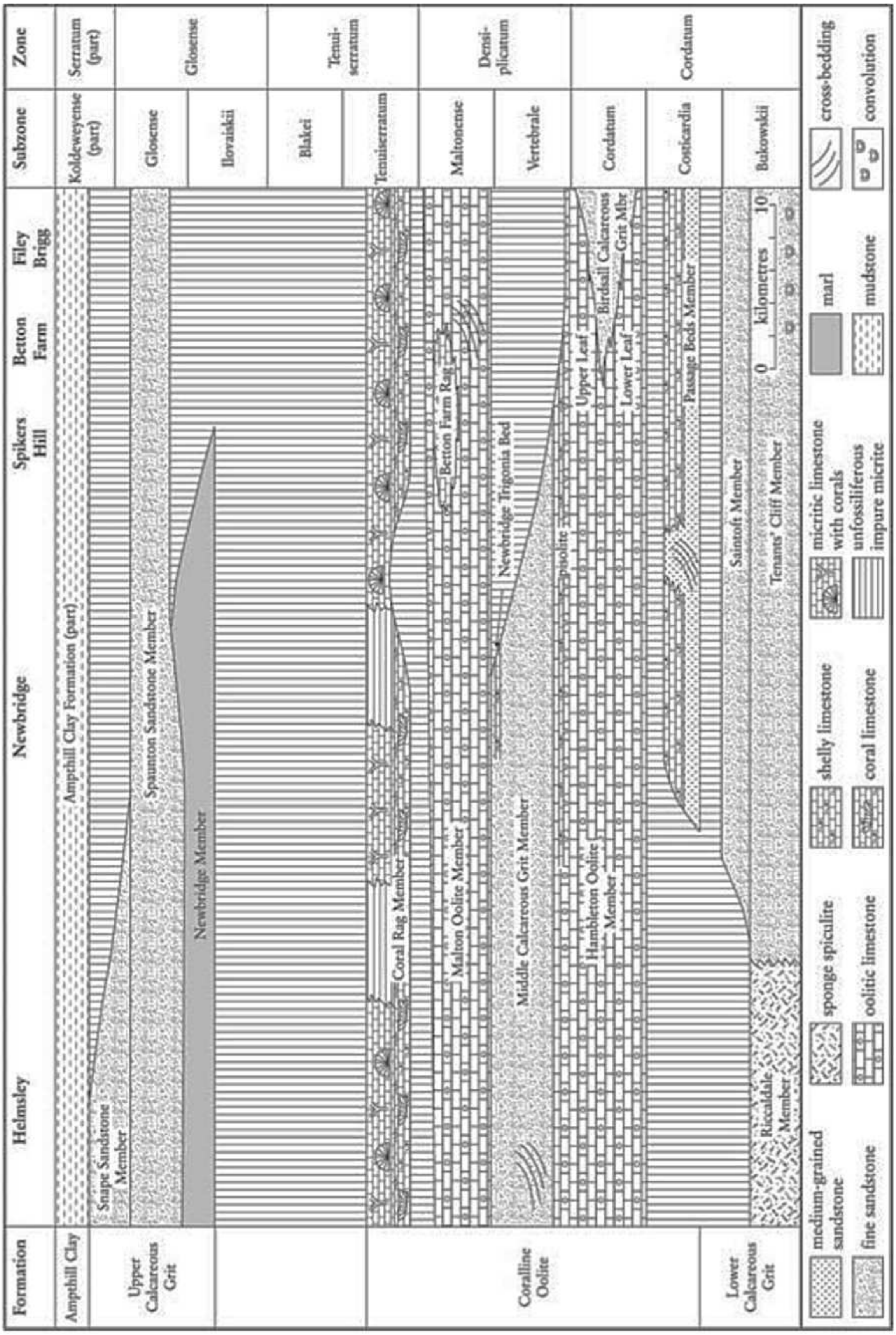



**Figure 4: Stratigraphical cross-section of the Yorkshire Corallian (from Wright and Cox, 2001)**

## Detailed lithostratigraphy and biostratigraphy

A broad, shallow carbonate platform was established across the Cleveland Basin area during mid Oxfordian times, contrasting with more rapid subsidence and deeper water sedimentation across the East Midlands Shelf. The spicule-rich calcareous sandstones and micritic, bioclastic, reefal and ooidal limestones that comprise the Corallian Group (70–150 m) were deposited in a warm, shallow sea during a relative sea-level low stand.

At the base of the Corallian Group, the **Lower Calcareous Grit** (LCG) ranges from 22–48 m thick in the Hambleton and Howardian Hills, and reaches 50 m on the Yorkshire coast. It consists predominantly of yellow, buff, fine- to medium-grained, calcareous sandstone, with subsidiary beds and concretions of blue-grey, micritic limestone; both lithologies are variably ooidal and peloidal. Siliceous spicules of the sponge *Rhaxella perforata* form much of the clastic component, and diagenesis of these has produced secondary thin beds of chert, particularly in the lower part of the formation. *Thalassinoides* burrows are very common on bedding planes at some horizons; the backfilled burrows have a higher spicule content and are more resistant to weathering, giving an irregular, nodular appearance to weathered faces. Despite the general absence of primary current structures, the lithological and faunal characteristics indicate deposition in shallow to moderate depths (*c*. 10–30 m) in the offshore zone.

The **Coralline Oolite Formation** comprises the following five members, in upward sequence: **Hambleton Oolite, Birdsall Calcareous Grit, Middle Calcareous Grit, Malton Oolite and Coral Rag**. The estimated thickness of the formation ranges from 60–70 m. The Coralline Oolite Formation consists of a varied sequence of grey, predominately ooidal and peloidal limestone (ooidal wackestone to ooidal grainstone texture) intercalated with wedges of buff-yellow, sparsely ooidal, calcareous fine-grained sandstone. Subsidiary lithologies include micritic limestone and reefal boundstone rich in corals and algae. Over most of the Cleveland Basin, from Scarborough in the east to Northallerton in the west, the stratigraphical relationship of the members assumes a 'layer-cake' sequence. As the formation is traced from the NW of the district to the SE and beyond to the Howardian Hills, however, lateral changes in lithofacies are prevalent, particularly in the lower three members. The top of the formation is defined by the base of the Upper Calcareous Grit which rests disconformably on the Coral Rag Member.

The **Hambleton Oolite Member** (up to 34 m thick) caps the escarpment of the Hambleton Hills and forms extensive dip slopes north of Pickering on the North

Yorks Moors. It consists of pale grey to white ooidal limestone (packstone to grainstone texture), with a variable proportion of quartz sand,peloids and fragmented shells; chert nodules are common in places. Thin beds of calcareous sandstone with scattered ooids are present in the southern part of the outcrop. Cross-bedding and shallow scours are locally common in the ooidal limestone and the beds are frequently penetrated by circular, vertical burrows, up to 1 cm in diameter. The oolite member splits into an upper and lower leaf in parts of the Hambleton Hills and in the Howardian Hills. Ammonites indicate an age ranging from the Cordatum Subzone to the Vertebrale Subzone, spanning parts of the Cordatum and Densiplicatum zones.

The **Birdsall Calcareous Grit Member** (Cordatum Subzone) is a yellow-buff, calcareous, fine-grained spiculitic sandstone with scattered ooids and lenses of grey chert, which was deposited coevally with the Hambleton Oolite. It is up to 12 m thick in the Hambleton Hills, but reaches 30 m in the Howardian Hills to the south, suggesting a provenance from that direction. Nodular texture is common and is due to abundant silica-rich *Thalassinoides* burrow-fill; *Chondrites* burrows are locally present in thin-bedded siltstones. The Birdsall Calcareous Grit has yielded the subzonal ammonite *Cardioceras cordatum* as well as bivalves, including *Chlamys fibrosa*.

The **Middle Calcareous Grit Member** crops out in the south-east of the Hambleton Hills, on Byland Moor where it is about 12 m thick. It is similar in lithology to the Birdsall Calcareous Grit, and the rock is often decalcified at outcrop, so that only relict ooids can be seen. The unit probably belongs to the upper part of the Vertebrale Subzone and the lower part of the Maltonese Subzone.

The **Malton Oolite Member** (up to 20 m thick), formerly known as the Osmington Oolite, separates the Middle Calcareous Grit from the stratigraphically higher Coral Rag Member, and comprises variably shelly, ooidal limestone. Quarries in the Malton area show large scale cross-bedding, indicating deposition as laterally migrating ooidal shoals, similar to parts of the present-day Bahama Banks. Sparse ammonites indicate the Antecedens Subzone.

The uppermost unit, the **Coral Rag Member** (up to 9 m thick), belongs to the Parandieri Subzone, and comprises coral–algal patch reefs, coral–shell inter-reef debris and micritic limestone; both fore-reef and off-reef bioclastic (ooidal–coral–shell) debris with the echinoid *Hemicidaris* and the oyster *Lopha* are common. Isolated patch reefs had a relief of up to 3.5 m high above the surrounding substrate.

The distribution of lithologies, fauna and facies suggest that the Coralline Oolite Formation was deposited in a warm shallow sea that covered an extensive carbonate platform, across which ooid shoals prograded offshore (south-eastwards) from the nearshore zone situated to the north of the district. Micritic carbonates developed in sheltered lagoons that were protected, in part, by coral–algal patch reefs during deposition of the Coral Rag Member. Intercalation of ooidal carbonates and calcareous sandstones in the lower part of the formation, and lateral passage to increasingly siliciclastic-dominated lithofacies to the SW, suggest a southeasterly transition from nearshore to offshore zones.

The lithological characteristics of the ooid lithofacies, taken together with the low-dipping, multidirectional cross-bedding and shallow scours, suggest periodic migration of oolitic shoals on a shallow-water carbonate platform, influenced by waves and oscillating tidal currents. Sparse vertical burrows indicate temporary stability of the substrate that allowed colonization by infauna.

The pattern of fluctuating sea-level is repeated with deposition of the Middle Calcareous Grit Member, Malton Oolite Member and Coral Rag Member which together form the second upwards shallowing cycle in the Corallian Group. Shell beds composed of *Myophorella hudlestoni* in the Middle Calcareous Grit, together with *Rhizocorallium* burrows and cross-bedding, suggest a highenergy, shallow-marine environment of deposition. The shoaling cycle is capped by the Malton Oolite and Coral Rag members. Large-scale foresets and a paucity of benthic faunas in the Malton Oolite indicate large mobile laterally migrating ooidal shoals, similar to parts of the present-day Bahama Banks, formed during strong flood and ebb storm surges and preserved as mega-dune foresets. The Coral Rag comprises locally developed coralalgal patch reefs, coral–shell inter-reef debris, and micritic limestone deposited in back-reef lagoons.

As the name suggests, the **Upper Calcareous Grit Formation** marks a return to spiculitic sand sedimentation. It is between 12–15 m thick and consists of very fine- to fine-grained, calcareous, spiculitic sandstone and siltstone, with abundant beds of clayey, micritic limestone in the middle of the unit.

In the Kirkdale to Pickering outcrop, the formation was divided into three members by Wright (1972), spanning the Nunningtonense Subzone to early Serratum Zone. In upward sequence, these are the **Newbridge Member**, **Spaunton Sandstone** and **Snape Sandstone**. The Newbridge Member consists of buff, thin-bedded siltstone, marl and fine-grained sandstone. The Spaunton Sandstone is a buff, thin-bedded, bioturbated, calcareous sandstone with abundant sponge spicules and siliceous nodules. The fauna includes belemnites and sparse bivalves. Ammonites collected from the Spaunton Sandstone indicate the Glosense Zone. The

Snape Sandstone Member is about 8 m thick, and consists of buff, flaggy, cross-laminated siltstone and finegrained sandstone with abundant ammonite fragments and, locally, bioclastic limestone. Ammonites collected from the Snape Sandstone indicate the Serratum Zone of the Upper Oxfordian. The junction between the Upper Calcareous Grit and the overlying Upper Jurassic clays (Ampthill Clay and Kimmeridge Clay formations) is a burrowed, gradational boundary.

As sea-level rose towards the end of Corallian Group deposition, the Upper Calcareous Grit Formation was deposited in slightly deeper water across the Market Weighton High and northwards into the Cleveland Basin. Very fine- to fine-grained, highly calcareous, spiculitic sand and silt, with abundant beds of clayey lime-mud in the middle of the unit, was deposited in moderate depths on the shelf in nearshore to offshore environments. Increased rates of subsidence and global sea-level rise around Serratum Zone time resulted in 'drowning' of the shallow siliciclastic and carbonate platform, with the deposition of mud (Ampthill Clay and Kimmeridge Clay) in deeper water environments.

## LOCALITY 1: Betton Farm

*OS Grid Reference: TA00208565 and TA00158555*

The Betton Farm site comprises two adjacent disused quarries situated either side of the A170, approximately 1 km north-east of East Ayton. The exposures occur at the southeastern extremity of the Tabular Hills, and were first described by Blake and Hudleston (1877) and Hudleston (1878).

Today we will be concentrating on the exposures in the South Quarry (**Fig. 5**). Here, the Betton Farm Coral Bed contains a large framework reef of the compound coral *Thamnasteria* growing upon a hard-ground surface that formed early on during sedimentation of the Malton Oolite Member. This framework protected a shallow platform area in which coral-shell sand accumulated, with the development of patch reefs and at least one small ribbon-reef. The ribbon-reef itself protected a small lagoon in which fine carbonate sediment accumulated with a prolific gastropod fauna. Also in this more protected area grew branching corals (*Thecosmilia* and *Rhabdophyllia*), fragments of which when broken off during storms are found in the coral-shell sand enveloping the reef corals.

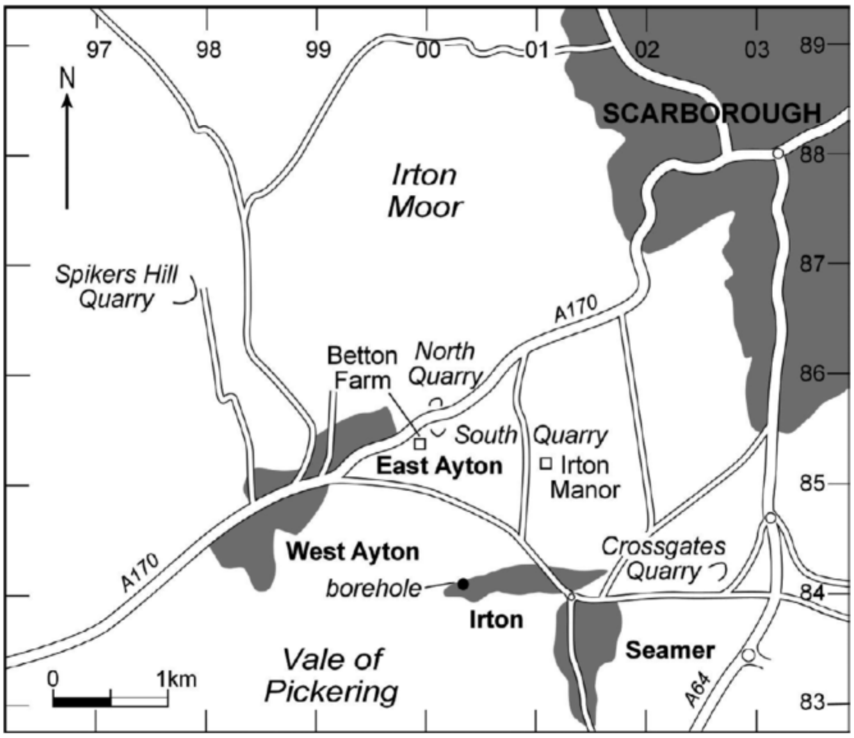



**Figure 5: Location map of Betton Farm sections (from Wright and Rawson, in press).**

In the South Quarry massive *Thamnasteria* corals form a small ribbon-reef framework that runs through the quarry on a north–south line. To the west, the reef coral abuts against an apron of shelly carbonate sand containing abundant shell debris, coral debris and occasional ooidal bands (**Fig. 6**). Competition between the growth of the *Thamnasteria* framework and the accumulation of the apron of fringing sediment saw periods when the *Thamnasteria* expanded over the fringing sediment and periods when encroaching sediment cut back the area of coral growth considerably (**Fig. 7**). The coral shell sand facies consists of a bioclastic micrite with fragments of *Nanogyra nana* and other bivalves, small gastropods, cidarid echinoid spines and *Rhabdophyllia phillipsi*, and very abraded fragments of corals *Thecosmilia* and *Thamnasteria concinna*. One bed approaches a sparry, shelly rock containing a small percentage of ooids. This deposit thus consists of bioclastic debris dispersed through the area by storms, with subsequent bioturbation introducing lime mud derived from the reef.

**Figure 6: View of the western face of the South Quarry, showing level bedded coral-shell sand facies abutting against reef limestone to the right. 30 cm hammer for scale (from Wright and Rawson, in press).**

Other patches of ribbon-reef may have formed immediately to the west of the present one and now have been quarried away, leaving just the softer associated sediments which were of no use to the quarrymen. The *Thamnasteria* ribbon reef that is still preserved protected a small lagoonal area (**Fig. 8**). In this protected area, close to the ribbon-reef, coral-shell sand washed in, and organisms that lived in close proximity to coral thrived. This variant of the protected facies consists of coarsely shelly micrite with unbroken *Chlamys nattheimensis*, *Lopha gregaria* and *Nanogyra nana*, spines of *Nenoticidaris smith, Rhabdophyllia phillipsi*, and numerous small, abraded fragments of *Thamnasteria* and *Thecosmilia*.

**Figure 7: Growth of the ribbon-reef in the South Quarry (right), showing periods of encroachment of coral-shell sand (left) over massive *Thamnasteria* (middle of hammer shaft), and subsequent growth of the coral over coral-shell sand (above hammer). Hammer, 30 cm.**

These shelly carbonates then pass laterally into argillaceous micritic marly limestone. Thus, in this more protected lagoonal area, lime-mud accumulated, and a substantial population of the gastropod *Bourgetia saemanni* became established. The sediment consists of a fine micrite with very few corals or coral fragments, scattered thin-shelled bivalves (*Modiolus* sp.), the gastropods, and echinoids such as *Pseudodiadema* sp. and *Hemicidaris* cf. *intermedia*.

In other protected areas of the platform, where there was slightly more nutrient input, there was growth of the more delicate *Rhabdophyllia* and *Thecosmilia*. Fragments of these branching corals are commonly found in the coral-shell sand. They were more suited to the lower light and food input of these slightly deeper areas, but they were also easily prone to damage during storms, and rolled fragments such as those seen at Betton Farm were incorporated into nearby shallow ooidal sandbanks (See **Fig. 9** for suggested distribution of facies types during deposition of the Betton Coral Bed).

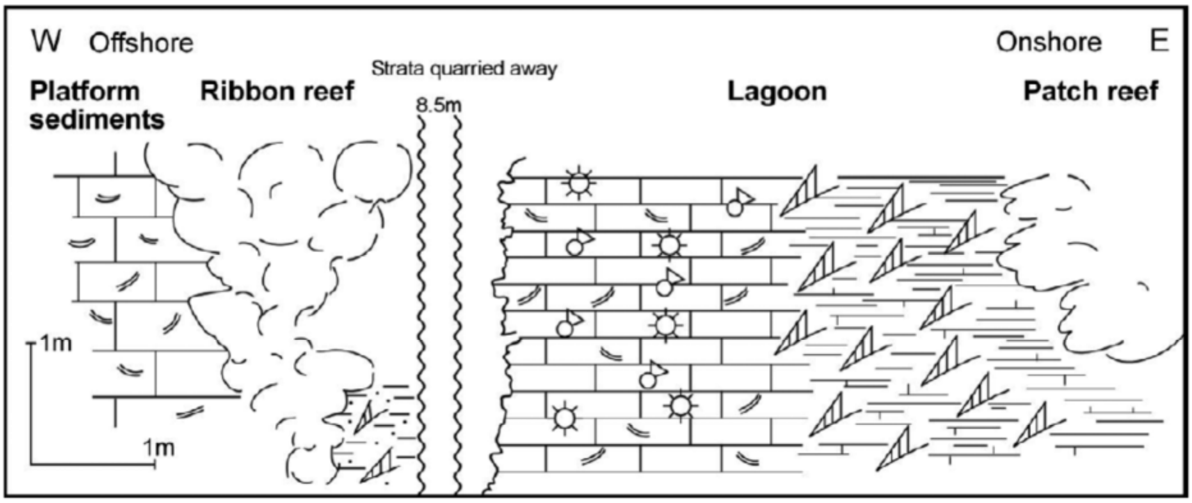



**Figure 8: Reconstructed cross-section of the South Quarry, showing the relationships of the various facies. From left to right: coralshell sand; ribbon reef; coralshell sand rich in bivalves and echinoids; fine carbonate mud with gastropods; patch reef.**

There has been some debate in the literature as to the precise stratigraphic position of the Betton Farm Coral Bed within the Coralline Oolite Formation. Early workers suggested these sections represented part of the Coral Rag Member, but recent work suggests these *Thamnesteria* patch reefs represent an earlier phase of reef growth in the lower portion of the underlying Malton Oolite Member (**Fig. 4**) (Wright and Cox, 2001; Wright and Rawson, in press).

**Figure 9: Close-up view of colony of *Thamnesteria concinna* in the field (from Wright and Rawson, in press).**

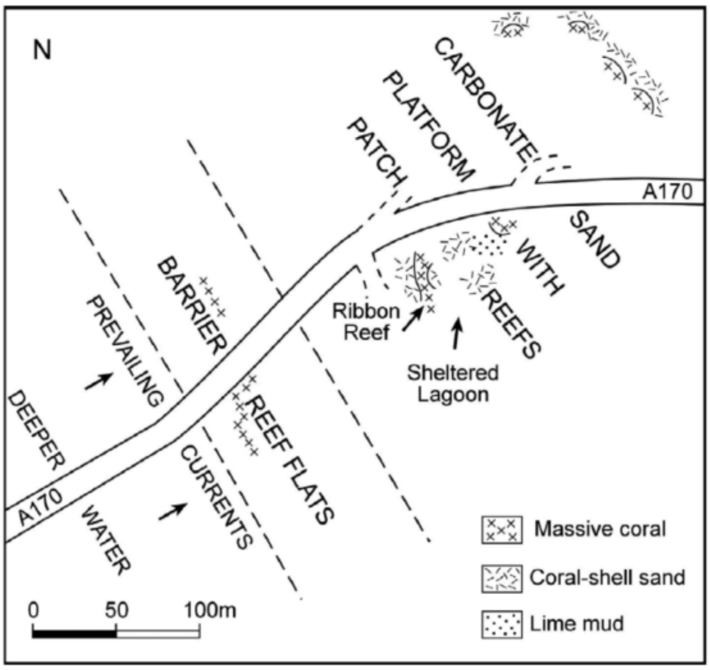



**Figure 10: Suggested distribution of facies during accumulation of Betton Farm Coral Bed (from Wright and Rawson, in press).**

## LOCALITY 2: Ravenswick Quarry

*OS Landranger Sheet: 94*

*Map Ref: SE712873*

Ravenswick Quarry displays tall weathered surfaces of the Malton Oolite, some beds of which are packed with large gastropod species *Pseudomelania heddingtonensis* (Sowerby), and the overlying Coral Rag Member, which contains in-situ *Rhabdophyllia phillipsi* corals and the characteristic echinoid spines of *Paracidaris florigemma*.

**Figure 11: Typical outcrops of upper Malton Oolite Member and overlying Coral Rag Member at Ravenswick Quarry (photo by J. Witts)**

**Figure 12: Specimens of in-situ *Rhabdophyllia phillipsi* corals in the Coral Rag member, Ravenswick Quarry (photo by J. Witts).**

**Figure 13: Spine of *Paracidaris florigemma* – indicative of the Coral Rag Member, Ravenswick Quarry (photo by J. Witts).**

## LOCALITY 3: Spaunton Quarry

*OS Grid Reference: SE800860*

At Spaunton Quarry we will look again at the Coral Rag, which here contains patch reefs and various fossil-poor inter-reef facies, and is overlain by the sandy sediments of the Newbridge and Spaunton Sandstone Members of the Upper Calcareous Grit Formation, from which ammonites can sometimes be collected.

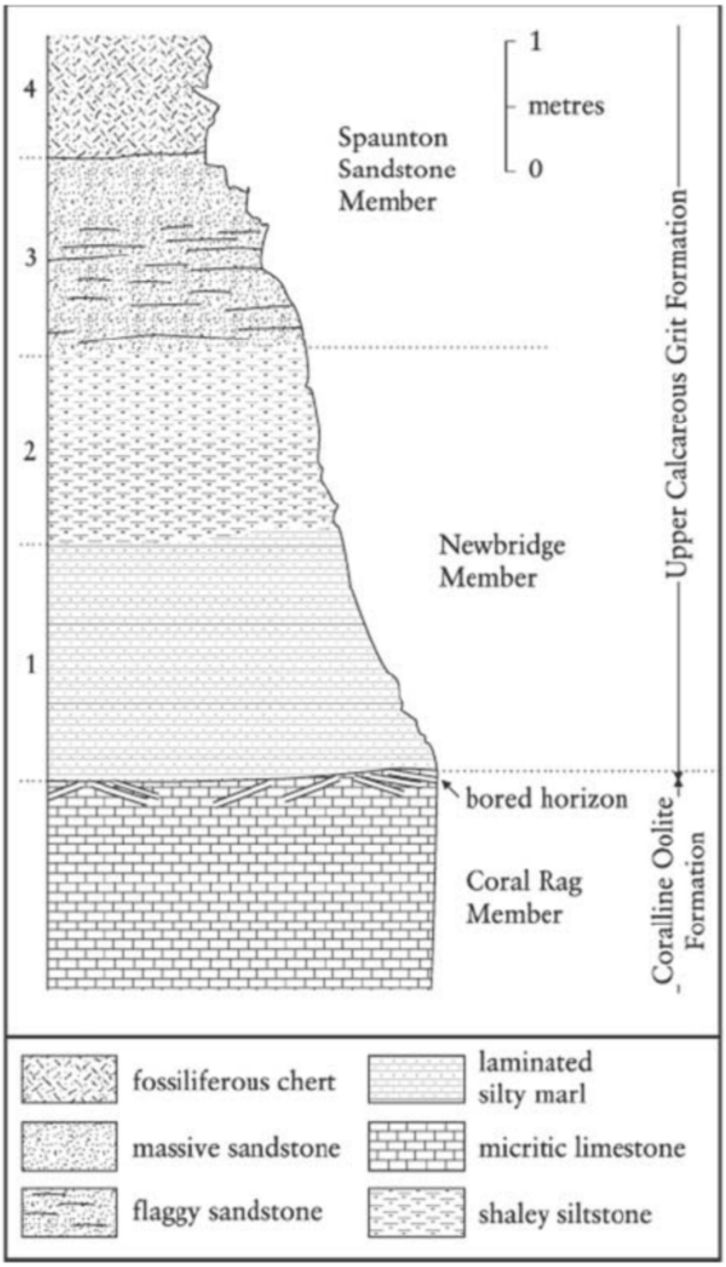



**Figure 12: Stratigraphy of the upper portion of the Coralline Oolite Formation, and Upper Calcareous Grit Formation at Newbridge Quarry, Pickering. A very similar stratigraphy is seen at Spaunton Quarry. (From Wright and Cox, 2001.)**

The Coral Rag here is 7.5 metres thick and contains well developed patch coral reefs, similar to those seen at Betton Farm, as well as inter-reef facies. The lowest 6.5 metres consist of well to massively-bedded, sparsely-oolitic limestone with many spines of *Paracidaris florigemma*, also *Ctenostreon proboscideum*, *Nerinea, Pseudomelania,* etc. At the top, a one-metre bed of similar limestone contains abundant *Rhabdophyllia phillipsii.*

The Newbridge Member shows a succession consisting of silty shale overlain by  of poorly-sorted, clayey, flaggy sandstone. The two facies vary in importance. At Spaunton, one metre of blue-grey marl is overlain by one metre of flaggy sandstone.

The Spaunton Sandstone Member comprises 5 metres of massive, spongy-weathering, fine-grained sandstone, full of *Thalassinoides* burrows; blue-hearted and calcareous when unweathered, with sporadic ammonites (*Perisphinctes* spp. and *Amoeboceras* sp.). Overlying this is 0.25 metres of oolitic sandy limestone containing occasional ammonites.

The uppermost layers in the quarry are assigned to the Snape Sandstone Member, and consist of 1.5 metres of silty, flaggy, decalcified sandstone with a profusion of fossil casts of *Belemnites* sp., *Chlamys* sp., and *Microbiplices.*

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## RISK ASSESSMENT

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| **Location** | Palaeontological Association Annual Meeting – post-conference fieldtrip to North Yorkshire Moors |
| **Description of activity and purpose** | One day fieldtrip for the purpose of geological and palaeontological observation, from a range of geological outcrops in x 3 inactive quarries in the North Yorkshire Moors. |
| **Itinerary** | December 19th 2014. Travel by 51 seat coach (Geldard's Coaches) from Leeds to East Ayton. A portion of the day will be spent at Betton Farm, Racecourse Road, East Ayton (nr Scarborough), North Yorkshire, Y013 9HT. Tel: 01723 863143. The remainder will be spent at two quarries in the vicinity of Kirkbymoorside and Keldholme, North Yorkshire. |
| **Organiser details** | Trip will be overseen by three organisers (x2 members of academic staff, x1 PhD student from the University of Leeds). |
| Principal organiser | Dr. Crispin Little, School of Earth & Environment, University of Leeds. Email: c.t.s.little@leeds.ac.uk Mobile: 07847651883 |
| **Participant details** | 51 persons. Contact details for all participants will be provided to field trip organisers on separate list and copies will be carried in the field. |
| **Hazard(s) identified** | **Control measures** |
| **Nature of site(s)** | Visiting geological outcrops in x3 inactive quarries. All three sites visited are easily accessible via well used paths and/or roads. The field party will drive between the three sites. Moderate risk from slippery rocks and moderate terrain (walking boots or similar to be worn by all members), and falling rocks (hard hats to be worn by all participants and no one to venture directly beneath cliff faces with overhanging rocks). One site involves a road crossing over a busy minor road to gain access to a footpath. Trip organisers in high-visibility clothing will be on hand to direct participants and warn of oncoming traffic. Spaunton Quarry is owned by a private company (CEMEX), and entry has been agreed with the quarry manager (David Leckenby – 01751 472257). This is conditional on the field party following the |

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| | instructions outlined below:<br><br>a) Ensure that each member of your party will comply with any directions (including a direction that the visit be curtailed or that your parties activities should be confined to a specified area of the site, or that they should wear any protective clothing which we ask them to bring or which we make available) issued by any of our servants or agents or by the servants or agents of any other CEMEX company on the site.<br><br>b) Your undertaking to ensure that neither yourself nor any member of your party will approach any plant or any equipment on the site unless with the express permission, and in the company, of a member of the company management.<br><br>c) Your accepting full responsibility for any loss, any death or injury caused by you or any member of your party during the Visit. And your indemnifying us and any other CEMEX company present on the site and our respective servants, agents, tenants, invitees, licensees and other visitors present on the site against all costs, proceedings, claims, demands and expenses resulting from any such injury arising out of the visit (however caused): and your waiving any claim against any such person arising out of the visit: except that you will not be required to indemnify such a person or to waive any such claim in respect of any negligent act or default attributable to such a person.<br><br>d) Your confirming that no member of your party will be a minor at the time of visit or that a parent or guardian of any minor who will be present has, or will have, consented to that minor making the visit. |
| **Process** | Direct observation of rock faces to enable participants to examine geological and palaeontological structures therein. One site is a SSSI so no hammering of outcrops will be undertaken. |
| **Transport** | Transport to and from Leeds via 51 seat coach. |
| **Equipment** | No equipment required. Manual handling of small rock/fossil |

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| | specimens by participants. Hard hats to be worn in vicinity of cliff faces. Hi-visibility jackets to be worn by trip organisers. All organisers to carry first aid kits. |
| **Supervision** | Participants are mostly field geologists and palaeontologists with extensive field experience. Field trip organisers have experience of leading large groups on geological field courses for educational purposes. |
| **Other control measures** | All field activities will take place in daylight hours (10:00am start, return to Leeds 16:00). All localities have been visited previously by field trip organisers. Two of the sites are regularly visited by members of the general public, and the third is overseen by a quarry company (CEMEX). |
| **Additional information** | All participants are at low risk. Special care will be taken if individuals identify themselves as subject to increased risk (e.g. injury, medical condition).<br><br>The Palaeontological Association has public liability insurance which covers this trip. |
| **Agreement** | By signing a register on the coach at the start of the trip, participants will have agreed to read and abide by this document. |
| **Assessment carried out by** | Dr Crispin Little<br><br>Mr James Witts<br><br>Miss Joanna Hall |